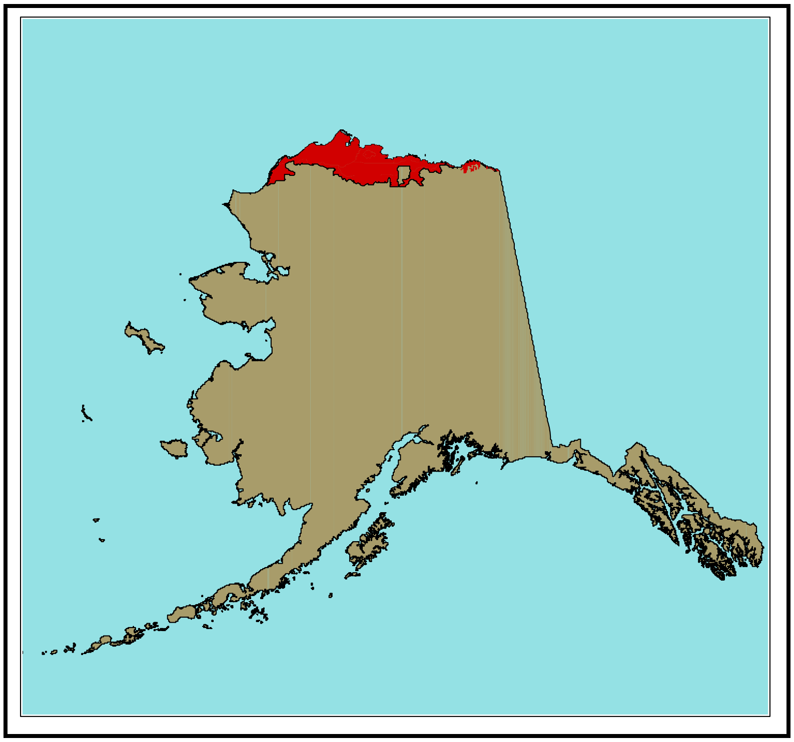
WATERFOWL BREEDING POPULATION SURVEY
ARCTIC COASTAL PLAIN, ALASKA
2008



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March 10, 2009

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ABSTRACT. Prior to 2007 two distinct waterfowl breeding population aerial surveys were conducted annually to monitor distribution and abundance of waterbirds in wet and moist tundra habitats on the Alaskan Arctic Coastal Plain. The two surveys differed in their timing and spatial coverage that caused some differences in results among species which vary somewhat in distribution and timing of arrival and departure. Analysis of historic data led us in 2007 to combine the two surveys into a single survey that sampled important habitats for all species during the period from 10-20 June. The survey objectives were to monitor the abundance and distribution of waterbird populations with specific relevance to spectacled eider recovery criteria, population trends of waterfowl harvested under the Migratory Bird Treaty Act, and permit requirements for oil and gas exploration and development. Survey methods were unchanged from previous surveys except that beginning in 2007; the survey used 4 different levels of sampling intensity instead of uniform intensity. Survey data were analyzed in two different spatial units, one using 20 geographical strata for totals of the entire area, and the other using only 10 strata, corresponding with the study area of the1992-2006 Eider Survey for historical context. The 1992-2008 population growth rates were calculated using the 10 eider strata to minimize bias associated with survey timing effects. For 10 primary species we tested for population growth rates significantly greater or less than 1.0 (with significance probability <0.10) for all survey years (1992-2008) and for the most recent 10 years. Of these, for all survey years the growth rate for Red-throated loon was <1.0, while greater scaup, king eider, greater white-fronted goose and tundra swan were >1.0. For the most recent 10 years, only northern pintail was <1.0, while yellow-billed loon, greater scaup, king eider, white-fronted goose and tundra swan were >1.0. The 2008 spectacled eider index (6,207) was near the 16-year mean (6,635), after a low estimate (4,676) in 2007. Scaup and tundra swan indices were the highest on record for the eider strata.

Key Words: aerial survey, Alaska, arctic, breeding, distribution, eider, nesting, population, waterfowl

INTRODUCTION

From 1992 to 2006, two aerial waterfowl breeding pair surveys were conducted on the Arctic Coastal Plain (ACP) during the month of June. The first was a comprehensive aerial waterfowl breeding population survey initiated on the ACP in 1986, and continued annually to 2006. That survey (herein referred to as the "historic Standard ACP Survey"), was conducted from late June through early July, which was phenologically too late for an accurate assessment of spectacled and king eiders, the males of which typically begin to depart the breeding grounds for the post-nuptial molt soon after nest initiation, about 20 June ± one week.

Anticipating the listing of spectacled and Steller's eiders under the Endangered Species Act, we initiated an additional survey in 1992 timed earlier to assess the annual population index and distributional data for these two species. The latter survey (herein referred to as the "Eider Survey" has consistently provided useful data for spectacled eiders and king eiders, but has proven inadequate in sampling intensity for Steller's eiders due to their very low breeding densities. All other waterbirds recorded on the historic Standard ACP Survey were also included in the Eider Survey. Comparison of data sets from the two surveys in 2006 suggested that the Eider Survey may more precisely describe the size and distribution of the breeding component of the spring population of most waterfowl species because it is timed prior to the main period of nest failure and subsequent local and regional redistribution birds from breeding to molting areas.

To help describe the difference between population indices generated from the two surveys, we plotted total indicated birds for 8 key species against median survey dates for both historic Standard ACP and Eider Surveys, 1992-2008 (Fig. 1). With one exception (1992, when the Eider Survey was late due to scheduling conflict), density indices calculated from the two surveys are clearly separated as distinct clusters in these graphs (Fig. 1). A precipitous drop in indices of spectacled and king eiders during mid to late June is clearly seen in these graphs, strongly favoring the early time period for these species. The other 6 species (Yellow-billed loons, red-throated loons, pintails, long-tailed ducks, white-fronted geese and tundra swans all showed essentially level trends through the two survey periods, suggesting that consistent survey timing within the overall survey period is not critical for tracking trend for these species. The one possible exception is the yellow-billed loon, which indicates a slight increase through the overall survey period (Fig. 1), which could be due to late arrival, or an artifact of small sample size in the historic Standard ACP Survey (two percent aerial coverage, vs. four percent for the Eider Survey). On the other hand, increases in the flocked proportion of the recorded samples for pintails, long-tailed ducks, white-fronted geese and tundra swans suggests the potential for large portions of these species to move to molting sites, apparently mostly still within the survey area, which would give an increasingly erroneous picture of breeding distribution through time (Fig. 2). These examples support the earlier (eider survey) timing for obtaining the most accurate picture of the size and distribution of the breeding population of these species on the arctic coast of Alaska.

The new survey is titled the "Waterfowl Breeding Population Survey, Arctic Coastal Plain, Alaska", and referred to in this report as the "ACP Survey". This report describes the methods and results of the 2008 ACP survey. For the sake of continuity, long-term trends were calculated and presented using historical data from the Eider Survey and 2008 data from the 10 survey strata matching the geographic extent of the Eider Survey (eider strata). This is appropriate since the timing of the current ACP Survey matches that of the Eider Survey. Long-term means from the historic Standard ACP Survey, and 2007 and 2008 indices from all strata in the current ACP survey are also provided for total ACP context.

OBJECTIVES

Objectives for the 2008 ACP Survey relate to the Spectacled Eider Recovery Plan (U. S. Fish and Wildlife Service 1996), ongoing evaluation of the potential impacts of extractive resource development, and USDI obligations for annual assessment of harvested waterfowl populations under the Migratory Bird Treaty Act of 1918, as follows:

Spectacled Eider Recovery Plan

B1.4. Monitor trends and generate breeding pair abundance estimates for the [North Slope] spectacled eider breeding population.

This task relates to the decision criteria for future de-listing or reclassifying from Threatened to Endangered. These criteria are based on population growth rate and the minimum abundance estimate, which is defined as the greater of the lower end of the 95% confidence interval from the best available estimates, or the actual number of birds counted.

Specific objectives:

1. Determine the population trend for spectacled eiders in light of recovery and reclassification criteria, including power analysis.

2. Estimate the abundance of spectacled eiders observable from the air.

Evaluation of potential impacts of Oil and Gas development on waterbird resources

Describe the distribution of observed spectacled eiders and other waterbirds within 500 meters of actual location, covering all known important waterfowl habitat on a rotational basis each 4 years using a systematic grid sampling frame. Use data to produce point location and density polygon maps describing location of observed waterbirds and areas with specified ranges of (multi-year mean) peak breeding density.

Migratory Bird Treaty Act obligations

Estimate the annual breeding population of harvested waterfowl species using the protocol specified in the "Standard Operating Procedures for Aerial Waterfowl Breeding Ground Population and Habitat Surveys in North America" (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987).

STUDY AREA AND METHODS

Aerial crew for 2007:

William Larned, *Migratory Bird Management, Soldotna, Alaska*

Robert MacDonald, *Migratory Bird Management, Juneau, Alaska*

Study area, survey design, navigation, and observation

The 2008 ACP Survey area (Fig. 3) was identical to that of 2007, consisting of a 57,336 km^2 portion of the 61,645 km^2 historic Standard ACP Survey area. Small areas (total 4309km^2) of relatively unproductive upland habitat were deleted from the historic ACP survey in 2007 to increase operational efficiency. Procedures followed the standard protocol described in the "Standard Operating Procedures for Aerial Waterfowl Breeding Ground Population and Habitat Surveys in North America" (U. S. Fish and Wildlife Service and Canadian Wildlife Service 1987). A series of transects, oriented in an east-west direction (Fig. 3), were flown in a Cessna model 206 amphibious aircraft, at 38 m altitude and 176±19km/hr ground speed. Both the pilot and the starboard observer recorded all water birds, avian predators and shorebirds observed within 200m either side of the flight path. Observers used tape markers placed on the aircraft lift struts to aid in determining the outer transect boundaries. Viewing angle was determined trigonometrically, and a clinometer was used to position the tape for each observer.

Transects consisted of computer-generated great-circle segments, for compatibility with Global Positioning System (GPS) navigation. Transects were spaced systematically in each of 20 geographic strata (Fig. 3, Table 1) from a randomly-selected starting point. Spacing varied by stratum, in 4 categories of sampling intensity: Low (9.5 km), Medium (4.75 km), High (2.375 km) and Super High (1.1875 km). Stratification and spacing assignments were based on a combination of physiographic (mostly hydrographic) characteristics, historic waterfowl breeding density data, and in some cases boundaries of planning areas for current and proposed oil and gas leases. In each stratum every fourth transect is flown in a given year; the sampling frame shifted incrementally the following year. Four years are required for coverage of all transects, after which the cycle will be repeated; thus transects flown in 2008 will be flown again in 2012. Stratification slightly decreased variance of estimates of some species, and facilitates comparisons among geographic areas. Transects flown in 2008 are depicted in Fig. 4.

Flight time required to complete the 2008 ACP Survey was 48.5hrs., not including ferry time to and from the survey area.

Data recording and transcription

Each observer had a notebook computer, into which bird observations were entered vocally via a remote microphone. Each computer received position data concurrently from a GPS receiver mounted in the aircraft instrument panel, was supplied with power via a DC to AC power inverter connected to the aircraft's electrical system. The vocal and GPS inputs resulted in a sound file (.wav format) with voice recording, and a linked position file containing location, date and time. After the flight, the observer played back the sound file on the computer and entered the species name and group size for each observation using a custom transcribing program. The transcription program produced an ASCII text file, each line of which contained a species code, group size, geographic coordinates, date, time, observer code, observer position in aircraft, stratum and transect identifier. The system also created a "track file" containing a list of geographic coordinates for the aircraft recorded every five seconds during flight. These data files were used to produce maps, tables and other products describing population trends and distribution of the various taxa surveyed. The software used for this system was developed by John I. Hodges, U.S. Fish and Wildlife Service, Migratory Bird Management, 3000 Vintage Blvd., Suite 240, Juneau, AK 99801-7100.

Data Analysis

We provide an index to the number of individuals of each waterfowl species and other selected bird species present within the survey area. The term index as used here is defined as a number that represents an unknown proportion of the population of birds occupying the survey area during the nesting season and detected by the observers. While unknown, the proportion is assumed to be constant among years, and the index is used to help track population changes through time.

Waterfowl data in general were treated according to the protocol described for the Aerial Waterfowl Breeding Ground Population and Habitat Surveys in North America (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987). That is, for all ducks except scaup, the indicated total population index is calculated as twice the number of males observed as singles, in pairs, and in groups of males up to four, plus birds in flocks of 5 or more regardless of sex composition. Male scaup not visibly paired are not doubled according to protocol, as scaup are known to have sex ratios strongly skewed toward males (ibid.). The protocol prescribes indices of all other waterbird species to consist of total birds recorded, with single birds not doubled. However, we deviated from this protocol by doubling the less visible single dark geese (white-fronted geese, Canada geese, black brant, and sandhill cranes) to account for assumed undetected mates on nests. All indices were geographically extrapolated.

To be consistent with the standard protocol, we have provided a table of duck indices expanded using visibility correction factors (VCF) derived during a three-year helicopter/fixed wing study conducted in tundra habitat on the Yukon-Kuskokwim Delta (Conant et al. 1991). This is designed to provide a more realistic estimate of true population by accounting for birds present but not detected by observers in fixed wing aircraft. Untested assumptions are: 1. the helicopter crew recorded all birds present, 2. observers are equal in performance, and 3. detection rates of ducks in the Yukon-Kuskokwim Delta are similar to those in the ACP. Eiders were not included in the YK delta study, so no VCF is applied for these species.

Bias

Indices are subject to biases typically associated with aerial survey data collection. Bias in this survey comes primarily from three sources: 1. *sampling error* due to variability among the transects within each sampling stratum, 2. *mistiming* of the survey relative to bird breeding phenology or asynchronous bird phenology, and 3. variation in *detection rate* of birds. In this survey s*ampling error* was estimated by ratio estimate procedures described by Cochran (1977), and the calculated variance is used to produce 95% confidence intervals for the population estimates. Survey *timing* is designed to coincide with the peak presence of males in the case of ducks, and the presence of peak numbers of all surveyed species on breeding territories in intact pairs. Proper timing is especially important for eiders and other sea ducks, which are normally present on the breeding grounds only from arrival until shortly after nest initiation, when they move offshore for the postnuptial molt (Kistchinski and Flint 1974, Lamothe in Johnson and Herter 1989, for spectacled and king eider, respectively). Variations in timing of arrival and departure between individual spectacled eider males on a study area in the Prudhoe Bay vicinity suggest that there may be few, if any, days when all breeding males are present in the survey area at the same time, especially in years of early spring melt (Troy 1997). Median nest initiation dates for Spectacled eiders at Prudhoe Bay from 1993 to 1996 varied from 7 to 16 June (average 1982-96 = 15 June), and telemetry data suggest that male departure begins within about 3 days of that date, and is more synchronized in the years when it commences later (ibid.). Most spectacled eider males depart the tundra for offshore molting areas by 20 to 25 June. Comparable data are not available from other parts of the ACP, but aerial observations from the Eider Survey since 1992 suggest consistency within approximately ±1 week among areas and years. King eider phenology is similar, but the period of male presence is normally more protracted and less synchronous than that of spectacled eiders, perhaps because: 1. king eiders utilize a greater diversity of wetland types which thaw at different times, and 2. king eiders that breed on the ACP are widely distributed during the winter (A. Powell and S. Oppel, pers. comm.., Phillips 2005), so timing of spring migration would likely vary among wintering populations. Daily counts of male king eiders on a Study area immediately southeast of Teshekpuk Lake in 2002 indicated a stable presence from June 8 to 16, with rapid departure of most males on 18 June (L. Phillips, pers. comm.). On 18 June a brief spike in the number of males present suggested a transient group of departing males moving through the study area. An earlier study in Canada found males departing from Bathurst Island, N.W.T. rather abruptly and synchronously from one week to 10 days after clutch initiation (Lamothe 1973). For the Eider and current ACP Survey we assumed that proper timing for spectacled eiders is adequate for king eiders.

Our procedure for determining proper survey timing consisted of the following: 1. We monitored weather, and ice and snow cover data, planning to arrive in the survey area when ponds and tundra vegetation were just becoming available to nesting eiders over most of the arctic slope. 2. We contacted biologists in Prudhoe Bay and Barrow for their observations on eider phenology. 3. We flew a reconnaissance survey to determine whether or not waterfowl, spectacled eiders in particular appeared to be occupying breeding territories as pairs, rather than in mixed-sex/species flocks. Our observations from past years in this area suggest this behavior normally occurs as soon as there is extensive open water in most shallow vegetated wetlands and tundra vegetation is mostly snow-free around pond margins.

To determine retrospectively the appropriateness of the timing of our survey for comparison of data quality among years for spectacled and king eiders, and long-tailed ducks and northern pintails, we used a ratio of lone drakes (males unaccompanied by females) to total males (with and without females), averaged over the entire survey. This ratio, called the lone-drake index (LDI), has been used for many years in the northern prairies of Canada and the U. S. (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987). The assumption inherent in this index is that the proportion of lone or grouped males in the surveyed population will increase as the season progresses because males remain visible on breeding ponds, while females spend more time with nesting activities. This index is easy to interpret for dabbling ducks, which normally remain on the breeding grounds after nest initiation to molt in local wetlands, whereas male eiders and other sea ducks depart the breeding grounds for distant, mostly marine molting habitats immediately after nest initiation, making them unavailable for observation. Hence, it is expected that the ratio will reach a peak at or slightly beyond the peak of nest initiation, followed by an abrupt drop as post-breeding males depart the survey area while birds still visible may be mostly unsuccessful inexperienced pairs which stay on the breeding grounds beyond peak departure of successful males. This pattern has been observed in the Prudhoe Bay area (Warnock and Troy 1992). Above-noted shortcomings notwithstanding, we consider the average lone drake ratio for the survey period and a plot of daily totals of this ratio helpful when considered in combination with other indicators of phenology, especially in determining the beginning of the survey window.

We have made little progress in addressing *detection bias*. The survey is assumed to track the populations of birds that visit the ACP during the breeding season. Of this total, some birds will not be represented in the sample because: 1. They have not yet arrived in the survey area; 2. They have left the survey area; 3. They have flushed from the sample transect before detection due to disturbance by the survey aircraft; 4. They are not visible from the aircraft (hidden by vegetation, terrain, aircraft fuselage etc.); 5. They are misidentified; 6. Observers fail to see them due to any of several variables of detection bias, such as fatigue, experience level, visual acuity differences, distractions, sunlight conditions, presence or absence of snow and ice, cryptic bird behavior, and work load (density of other birds or objects competing for the observer's attention). As previously mentioned, we have attempted to minimize the effects of numbers 1 and 2 by proper survey timing. Aerial survey crews working in other areas have attempted to compensate for the net effect of all the other variables by ground-truthing a sub-sample using ground or helicopter crews (US Fish and Wildlife Service and Canadian Wildlife Service 1987), and using those data to calculate visibility ratios to adjust operational survey data. During the 2001 Eider Survey we conducted a fixed-wing/helicopter detection study covering a 270 km^2 subset of our operational transects. The results of this study were unsatisfactory in that our fixed-wing count often exceeded the helicopter count, suggesting a flaw in design or implementation. Therefore we default to an unadjusted annual index to abundance, for which we strive to minimize effects of observer bias by using the same observers and methods to the extent possible. This year we analyzed data from individual observers as well as that from combined observers to examine the relative contribution of observer effect to variation of results among species.

RESULTS

Habitat conditions, survey schedule

Spring breakup was slightly ahead of normal upon our arrival on 7 June, with water levels below normal for this date. Imagery from the

NASA Modis Rapid Response website (http://rapidfire.sci.gsfc.nasa.gov/) showed most snow cover gone from the tundra on 7 June, and daily high temperatures remained well above freezing throughout our survey. Weather during the survey was typical of mid-June, with coastal fog issues limiting our operations early and/or late most days, and winds >20kts encountered on two days causing us to change or truncate our flight plan. We lost on complete day in Barrow to fog and low ceiling (15 June), and completed the survey 16 June.

The overall ratio of lone males to total males during the survey, a rough measure of survey timing in relation to nest initiation, was average for spectacled eiders, and slightly above average for king eider, long-tailed duck and pintail, suggesting the 2008 survey was conducted slightly later in relation to nesting than most years of the Eider Survey 1992-2006 (Table 2). The daily trend in this measure showed a gentle upward slope for all of these four species. We suggest this is consistent with survey completion prior to post-nest-initiation departure of males (Figure 4). In summary, we feel satellite imagery, observations during the survey, and LDI interpretation all suggest a survey well timed for describing the breeding abundance and distribution of most waterbirds on the ACP in 2008.

Population indices for selected species

Totals for 2008 sample data (singles, pairs and flocked birds in the sample), as well as indices calculated from these data, are presented in Table 3 for the eider strata (strata 3-6, 9, 11, 15, 18-20), and Table 4 for all strata. Table 5 presents long-term population trend slopes, growth rates, and the power of the survey to detect trends (expressed as the minimum number of years required to detect a growth rate equivalent to a population growth or decline of 50 percent in 20 years), using data from the eider strata only. Table 6 provides a comparison of indices from all surveyed strata (2008) with 2007 indices and 1986-2006 means from the historic Standard ACP Survey (Mallek et al. 2007). Figures 5-22 include stacked bar graphs and tables describing the size and composition of the 2008 and historic population indices for selected species for the 10 eider strata. Column divisions separate the sample into singles, assumed mates of singles, and birds in pairs, small flocks (≤5 birds) medium flocks (6-30 birds), and large flocks (>30 birds). We used Eider Survey data for trend because of the similarity of that survey to the current ACP survey (2007 & 2008) in timing and spatial coverage. Population growth rates are given both for the full 17 years of data (16 for eiders, see figs. 15 & 16) and for the most recent 10 years. Please note that only variation resulting from spatial sampling error is accounted for in these calculations, as other sources (e.g. observer effects, phenological timing) are unmeasured in this survey. Note also that in addition to composite indices, bar graphs include depictions of indices derived from data from individual observers: the green lines represent indices from observer Larned, who observed on all Eider Surveys 1992-2008, mostly from the left front (pilot's) seat, while the brown lines trace indices from various other observers who usually occupied the right front seat. The CONCLUSIONS section contains some general observations about apparent observer effects suggested by these graphics.

Spatial breeding distribution for the more abundant species has been well described at a scale commensurate with the 4-year sampling intensity (~8 percent for the historic Standard ACP Survey and 16 percent for the Eider Survey), and is available in past annual reports from both historic surveys. Since the data set from the current design contains only two years or data, we will not generate equivalent figures showing species density isopleths until we have accumulated a 4-year data set (2010). However, we have included maps of eider observations from 2007 and 2008 surveys (Figs. 18-19). Maps showing locations of recent observations of other species may be generated on request (william_larned@fws.gov, or call 907-260-0124).

Following are results and comments by species. Indices and trends relate to the eider strata and Eider Survey only, unless otherwise noted.

Loons

The 2008 yellow-billed loon index (1,235) was down 12% from 2007, but still 10% above the long-term mean, and the population growth rate indicated a significant positive trend over the most recent 10 years (Tables 3-6, Figure 5). Distribution was similar to other years: densest in the area between Teshekpuk Lake and the Topogoruk River. The Pacific loon index (21,315) was down dramatically (-30%) from 2007, but still slightly (2%) above the long-term average (Tables 3-6, Fig. 6). The 16 year and 10 year growth rates do not differ significantly from 1.0 (Table 5). Pacific loons are abundant throughout most of the ACP where there are high pond densities. The 2008 red-throated loon index (1,996) was also lower (-30%) than that of 2007, and 23% below the 17-year mean (Tables 3-6, Fig. 7). Long term data from the eider survey area shows a significant negative trend for this species, but is level over the most recent 10 years (Fig. 7). Our observations on habitat selection are consistent with those of Bergman and Derksen (1977); that is, red-throated loons on the ACP tend to select wetlands smaller and shallower than other loon species. This apparent partitioning of wetlands by size among loon species may result from interspecific competition. While red-throated loons may be driven from larger lakes by territorial Pacific loons, unlike the latter, their very short takeoff distance requirements(15-40m, Norberg and Norberg 1971), and their habit of flying to marine or riverine habitats to forage for themselves and their young enables them to use small wetlands devoid of fish for breeding. In the absence of such competition red-throated loons have been observed to select wetland sizes according to random availability (Douglas and Reimchen 1988).

Jaegers

Jaeger species are combined for this survey to help avoid diversion of observer focus from eiders and other high priority species. The jaeger index fluctuates widely following prey abundance (primarily North American brown lemming, *Lemmus trimucronatus*). Lemming populations and Jaegers spiked across much of the arctic coastal plain in 2006, and were still present in good numbers in many areas in 2007. Shorebird biologists noted very high lemming and pomarine jaeger numbers in the Barrow area, but low around Teshekpuk Lake (Richard Lanctot pers. comm..). Our 2008 jaeger index (4,630) was 16% lower than that of 2007, but still 11% above the mean of 4,184 (Tables 3-6, Fig. 8). The extremely variable annual index does not indicate a significant trend in either short or long term (Fig. 8).

Gulls & terns

Discounting birds in flocks, a category whose annual value can vary widely if the year's transects happen to cross large breeding colonies or transient flocks, the glaucous gull index has remained level and stable in both short and long terms (Tables 3-5, Fig. 9). However, indices of singles and pairs for 2007 and 2008 are the highest yet for the survey. This year's total index of 15,346 was 21% below that of 2007, but 22% above the long-term mean. The Sabine's gull index (10,113) was just 2% below last year's record high, and 40 percent above the 17-year mean (Tables 3, 5). This species showed a significant positive growth rate (1.065, 90%CI=1.020-1.111) over the past 10 years. The arctic tern index increased steadily through 2000, resulting in a significant positive growth rate from 1992-2008, but the trend has been more level and erratic since 2000 (Fig. 10, Table 5).

The 2007 index (13,119, Table 3, Fig. 10) was 24% below the 17-year mean.

Ducks

Most duck indices in 2008 were consistent with trends established over the last several years of the Eider Survey (Figs. 11-36). The 2008 red-breasted merganser index (591) was below that of 2007, but 24% above the long-term mean, and the species has a significant positive growth rate over both 17 year and most recent 10-year time periods (Tables 3-6, Fig. 11). However, the 2007 and 2008 all-strata estimates were below both the long term average figures for the historic Standard ACP Survey (Table 6), suggesting a late migration pattern for this species, and possibly a recent trend toward earlier nesting related to climate change. Most red-breasted mergansers have been recorded along river corridors, well inland.

Mallard, American wigeon and green-winged teal are recorded at such low numbers that we have little confidence in trends (Table 5). Observations of all three species in 2008 were widely scattered, and mostly inland.

The 2008 northern pintail index (59,450) was 34% higher than that of 2007, and 20% above the long-term average for the eider strata. Though an in-depth analysis has not been conducted, casual inspection suggests data sets from the eider survey and the historic ACP Survey both have high inter-annual variation, and the two indices are not strongly correlated among years(Mallek et al. 2007, Fig. 12 this report). Pintails are known to be mobile both within and among breeding seasons. Since the two surveys were conducted at substantially different times in June, the intraspecific variability and interspecific differences could be explained by movements of large numbers of birds within the ACP and/or between the ACP and other portions of the breeding range during June. These questions and the very strong male bias of the ACP spring pintail population provide fertile ground for further study, but so far the long-term trajectory does not warrant concern (Fig. 12).

The all-strata 2008 index (249,749, expanded) was 35% above the 2006 index from the historic ACP Survey, and 13% above the long-term mean of 220,494 (Table 6)

The 2008 scaup index (11,468) was the highest on record, and continues a significant upward trend in the l7-year and especially the 10-year time scale for the eider strata (Table 5, Fig. 13). With a 2008 expanded total ACP index of 50,200, scaup rank as the third most abundant duck behind northern pintail and long-tailed duck (Table 6). ACP scaup are assumed to be mostly greater scaup, but identification is not considered reliable, and generally not attempted on aerial surveys, including this one. Given the concerns about declining continental scaup populations, we believe this apparently expanding population deserves study of species composition and flyway affinities.

The 2008 long-tailed duck eider strata index (33,345) was 36% above that of 2007, and 9% above the 17-year mean (Table 3, Fig. 14), however the all-strata expanded index (94,513) was 12% below the 1986-2006 ACP mean (Table 6). The population index growth rate for the eider strata was <1.0 for both the 17-year (0.985) and 1most recent 10 year (0.978) periods, but neither was significant (Fig. 14).

Aerial observations of this species are difficult to accurately interpret due to the similar coloration of spring males and females relative to other species. Perhaps this explains the large and variable discrepancies among observers (Fig. 14).

The 2008 spectacled eider index (6,207) was 33% higher than that of 2007, but 6% below the 16-year mean (Table 5, Fig. 15). The slight negative trend in was not significant in either the long term or recent 10 year context. Ten of 310 indicated birds in the sample were recorded outside the 10 eider strata, which was similar to 2007. While the distribution of 2008 spectacled eider observations is grossly similar to most other survey years, Figure 19 illustrates some differences between 2007 and 2008. For instance, we observed no spectacled eiders in a large area around Atqasuk, and very few north of Teshekpuk lake in 2007, while these areas had numerous observations in 2008.

The 2008 king eider index (16,230) was slightly lower than that of 2007 (17,685), which was the highest estimate on record for the Eider Survey (Fig. 16). The 2008 index was 21 percent above the long-term mean, and the species maintains a positive trend significant in both long-term and the recent 10 year period. A map of survey observations clearly illustrates the previously noted partitioning of habitat among king and spectacled eiders, especially in the Teshekpuk Lake area (Fig. 18).

Though Common eiders are recorded during this survey, they nest primarily on barrier islands and other coastal habitats, which are not sampled adequately by this survey. A specific coastal survey is conducted annually for this species, by C. Dau and others (Dau and Larned 2008).

There are so few Steller's eiders detected during this survey that it is used primarily to document occurrence and long-term distribution rather than to detect a meaningful trend. Intensive aerial surveys (50% coverage) conducted in the Barrow area annually since 1999 were conducted again in 2008. This year of 25 indicated pairs observed, all but two were within about 20km southeast of Barrow (Obritschkewitsch pers. comm.), while they are normally somewhat better dispersed throughout the survey area. We observed only a single male Steller's eider during our survey, north of Teshekpuk Lake (Fig. 18), which extrapolated to an estimate of 25 indicated birds (Table 3, Fig. 17).

White-winged scoters have made up most of the scoter population observed during the eider survey since 1992. In 2008, only 8 indicated white-winged scoters were recorded in the eider strata, compared to 74 in the ACP (all) strata. Most were seen south of Teshekpuk Lake, primarily along the drainages of Fish Creek and the Ikpikpuk River, which is typical for this species. The 2008 white-winged scoter index (186) was below both the long-term mean and the 2007 index for the eider strata (Fig. 18), but the all-strata index (expanded) of 4,793 was 19% above that of 2007 (Table 5). Note that the data from the historic Standard ACP Survey contains a large component of scoters unidentified to species, hence the discrepancy between "all scoters" and the total of white-winged and black scoters (Table 5).

Geese and swans

This survey does not adequately sample snow geese, which occur mainly in isolated coastal breeding colonies. Our estimates fluctuate wildly in response to transect placement relative to these colonies. Recent specific aerial snow goose surveys have been conducted by ABR inc. (Fairbanks). These surveys indicate strong positive growth rates for most individual colonies and the overall ACP breeding population (Ritchie pers. comm.)

The 2008 white-fronted goose index (152,634) was spectacularly high for the second consecutive year for the eider strata. The 2008 all-strata index (210,047, Tables 4, 6) is 7% lower than that of 2007, but still exceeds the highest index from the historic Standard ACP Survey (192,426 in 1999, Mallek et al. 2007). The trends are significantly positive in both the long and recent 10-year periods. In 2007 we guessed the high numbers were related to an early molt migration of non-breeding and failed breeding birds from the interior where water levels were extremely low, but water levels were normal to high in 2008, so we can't think of anything to blame the high ACP populations on this year.

The 2008 Canada goose indices were 3,304 (eider strata, Table 3) and 5,284 (all strata, Table

4), which were considerably below means in both cases, and the second lowest on record for the eider strata.

Most Black brant nest colonially on the North Slope, so trends are difficult to detect with our systematic transect survey design. But the long-term trend, and particularly the portion since 1999, suggests a convincingly increase in brant (Table 5, Fig. 20). The 2008 index (12,247) was third highest since the inception of the eider survey, and the last 5 years have seen the 5 highest counts (Fig. 20). The number and proportion of flocked birds in the sample have increased dramatically since 2002, suggesting a climate change effect. The 2008 all-strata index (12,247) was 25% above the 1986-2006 mean for the ACP survey (also very similar to the long-term average from the historic Standard ACP Survey (Table 6). Ritchie et al. (2002) in their more focused study of brant colonies did not detect a significant upward trend in breeding black brant on the North Slope, and Mallek et al. (2005) could not detect a trend due to high sampling error.

The 2008 tundra swan index (10,575) edged out the 2007 count for the highest on record for the eider strata (Fig. 21), and the all-strata index (15,079) was well above that of 200 and the long-term mean (13,444, and 9,971 respectively, Table 6). Tundra swan indices indicate a significant positive growth rate for both long-term (1.033) and 10-year (1.053) reference periods (Table 5, Fig. 21).

For a detailed discussion of North Slope snow goose and black brant colonies see Ritchie et al. (2007).

Raptors, Ravens, other birds

Despite concerns about raven populations expanding on the North Slope in response to increased anthropogenic nesting habitat (buildings and other artificial structures) and year-round food sources (garbage), we have detected neither a positive growth rate nor a geographic shift in our sample (Table 5). The likelihood of our detecting ravens among industrial and residential facilities is low, as they normally spend a large part of their time on or near such structures, which we intentionally avoid during our surveys due to regulatory and safety considerations. In addition we expect detection of dark birds associated with structures would be poor.

Owl populations are extremely variable on the North Slope, typically following lemming population cycles. The last notable high lemming population was in 2006 (personal observation and numerous contacts in Barrow), and 2008 owl indices were predictably low (short-eared owl: 45 for eider strata, 246 for all strata, snowy owl: 188 for eider strata, 188 for all strata, Tables 3, 4). Most of the Short-eared owl observations were near the Colville Delta and Deadhorse, while most snowy owl observations were along the Beaufort Coast, near Barrow and in the Teshekpuk Lake area.

We have recorded very few sandhill cranes during the Eider Survey (2008 ACP Survey index from 10 eider strata = 214, Eider Strata 1992-2008 mean = 128, Table 5). We began recording shorebirds during the Eider Survey in 1997, largely as a measure of timing of their arrival on the breeding grounds, and large-scale distribution. Some shorebird species are difficult to distinguish on aerial surveys, and of low priority for this survey, so we split them into 2 categories: “Small“ (*Charadrius spp., Pluvialis spp., Calidris spp., Arenaria spp*.) and "large“ (*Numenius spp., Limosa spp*.). Beginning in 2006, we pooled all shorebird observations. The shorebird index growth rate (0.984) is not significantly different from 1.0 (Table 5). There are several sources of bias associated with aerial detection of shorebirds, which confound evaluation of the shorebird index. For instance, flushing rates due to disturbance from our aircraft are unknown, probably vary a lot by species and phenology, and most shorebirds we record are in flight, due to cryptic coloration while on the ground among tundra vegetation. Of those we see on the surface, the most common by far are phalaropes, which spend a large part of their time on water bodies, and thus relatively visible, and large plovers (black-bellied and golden), which are large, conspicuously marked, and often display in sparsely vegetated areas.

CONCLUSIONS

The species of greatest interest in terms of objectives for this survey are yellow-billed loon (species of international concern, proposed for ESA listing), red-throated loon (species of statewide concern, high proportion of Alaska population in ACP), Pacific loon (high proportion of Alaska population in ACP), northern pintail, greater scaup, king eider, long-tailed duck, white-fronted goose (harvested species of international concern, and ACP populations numerically significant in Alaska, North America), Tundra swan (ACP population comprises about 10% of the harvested eastern population, has management issues related to expanding population, causing habitat degradation and crop damage), and spectacled eider (listed as threatened under the ESA, ACP is one of three largest global breeding populations). All these populations are at some risk from detrimental effects of extractive resource development and other anthropogenic changes. The other species recorded on this survey, while important contributors to the biodiversity of the arctic coastal ecosystem, are not addressed adequately by this survey design (e.g. Steller's eider, common eider, snow goose, common raven), and/or are present at such a small proportion of their range-wide population that even a large change in index would likely not elicit management action (e.g. mallard, American wigeon, northern shoveler).

This (2008) was the second year of the current design combining the Eider and the historic Standard ACP Survey, and, unlike 2007, apparently a year well-timed for most species. Two more years are required to complete a full 4-year cycle; which will be a logical time to map species distribution and fully evaluate the design compared to its predecessors. However, we are confident that the primary survey objectives are being adequately addressed.

The trends for individual observers in the population trend graphs for the focal species for which we have adequate samples (Figs. 5-7, 12-16, 21, 23) suggest that for most years and species, the constant observer/pilot had higher counts than the other observer. This is not surprising since the one constant observer has much more experience than the others both in general and specifically on this project. Regarding individual species, some show very close agreement among observers while others are very different. Estimates are consistent among observers for both spectacled and king eiders (Figs. 15 and 16), even despite small sample sizes. Reasons for this strong agreement may include positive focal bias: observers are aware that these are high priority target species, so they work with greater diligence to develop an appropriate search image. Loons (Figs. 5-7) often dive as the aircraft approaches, putting them out of sight as the aircraft passes. The pilot ordinarily spends more time than the observer looking ahead (for obvious safety reasons), and thus may see and record more loons before they dive. Pintails (Fig. 12) and long-tailed ducks (Fig. 14) are more difficult to detect compared to the other priority ACP species, due both to more cryptic coloration, and because they are often scattered about in very small wet depressions in vast upland areas where detection is difficult and observer vigilance and focus may vary considerably, adding variability to detection rates. Observer performance for white-fronted geese appears less variable (Fig. 21), probably because white-fronts are large and usually flush at the approach of the plane, making them easy for most observers to detect and identify. Tundra swans are well-distributed, large, white and rarely flush when surveyed, resulting in detection rates close to 1.0 (Conant et al. 1991) and populations monitored well by this survey.

Hopefully this discussion provides helpful insights into reasons for variation in detection rates among species. A detection rate study for the Arctic Coastal Plain would be extremely useful, but challenging due to the relatively low densities of birds and expensive logistics.

RECOMMENDATIONS

We recommend continuation of the survey annually as in 2008. We welcome any comments, or suggestions for improving the survey.

ACKNOWLEDGMENTS

The authors would like to thank Rob MacDonald for the excellent job during his second consecutive season as observer on this survey. Special thanks to the Bureau of Land Management for supporting the additional aerial coverage in the Teshekpuk Lake region.

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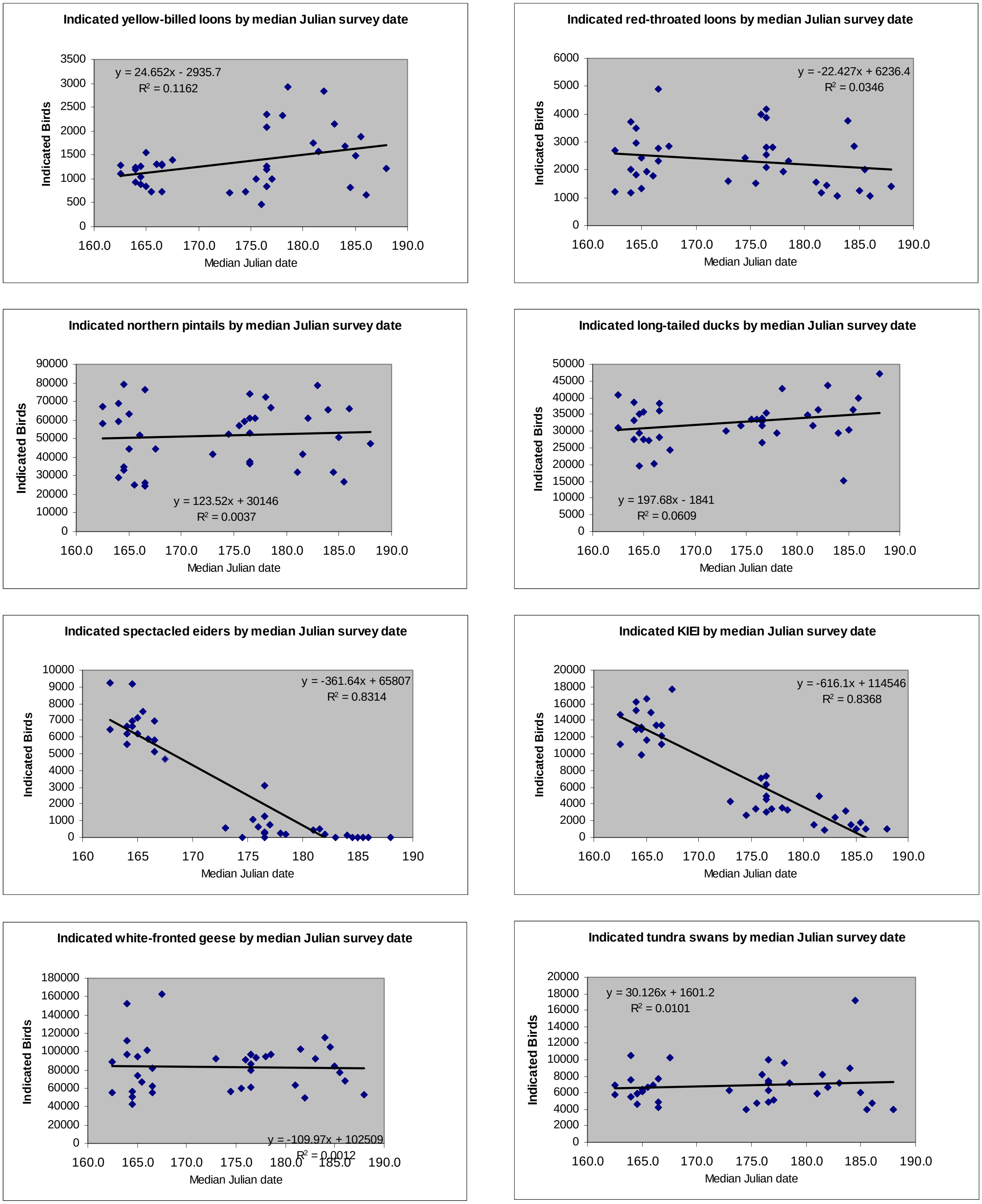


Figure 1. Indicated birds of selected species by median Julian survey date, Eider and Standard ACP Surveys, arctic coastal plain of Alaska, 1986-2008.

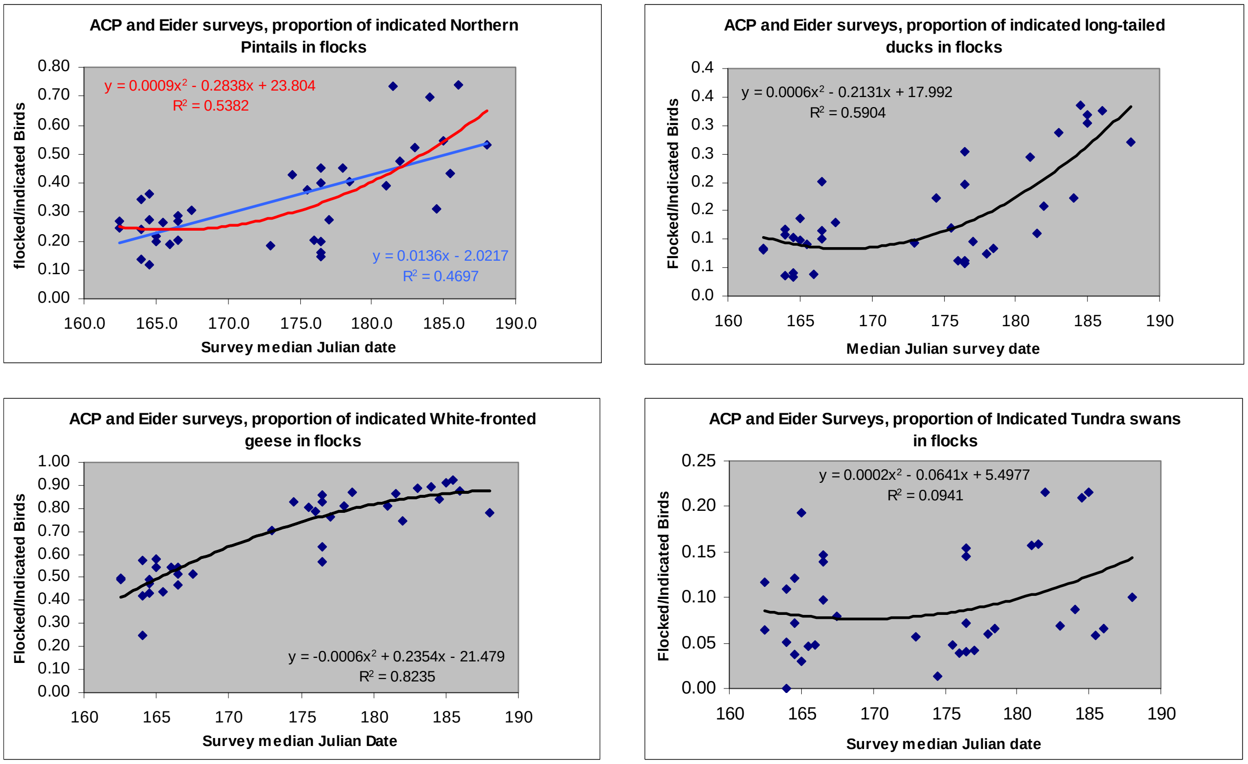


Figure 2. Proportion of birds in groups of 3 or more in the survey sample, Eider and Standard ACP Surveys, arctic coastal plain, Alaska, 1986-2008.

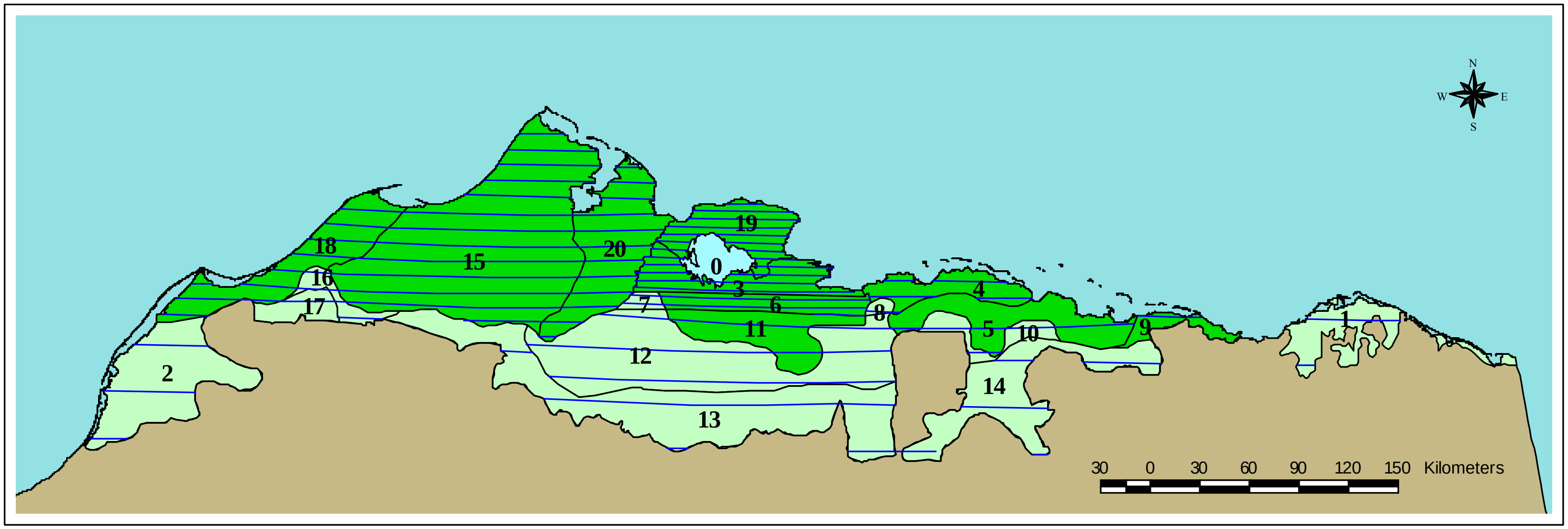


Figure 3. Spatial design of the aerial waterfowl breeding population survey, Arctic Coastal Plain, Alaska, June 2008. Eider strata are shown in dark green, strata outside the eider strata area are shown in light green. Blue lines show locations of the 2008 design transects. Numbered strata are described in Table 1 below.

Table 1. Sampling design by stratum, aerial waterfowl breeding population survey, Arctic Coastal Plain, Alaska, June 2008.

ID	Stratum Name	Stratum Area km^2	Sample Area km2	Sample % of Stratum Area	ID	Stratum Name	Stratum Area km^2	Sample Area km2	Sample % of Stratum Area
0	Non-habitat				14	Sag Low	3,571	61	1.7%
1	Arctic NWR Low	1,812	25	1.4%	15	Barrow Hi	11,358	485	4.3%
2	Pt Lay Low	3,916	50	1.3%	16	S Kuk Hi	582	28	4.8%
3	Teshekpuk SHi	2,019	170	8.4%	17	S. Kuk Low	748	13	1.7%
4	Colville Hi	1,423	56	3.9%	18	Icy Wain Hi	3,093	127	4.1%
5	Prudhoe Med	2,581	45	1.7%	19	N Teshekpuk SHi	2,044	164	8.0%
6	S Teshekpuk SHi	1,362	105	7.7%	20	E Dease Hi	3,768	162	4.3%
7	SW Teshekpuk SHi	226	16	7.1%					
8	S Colville Hi	128	6	4.7%		All Low:1,2,9,13,14,17	18,276	271	1.5%
9	Canning Low	577	14	2.4%		All Med:5,10,11,12	13,058	323	2.5%
10	Sag Med	784	28	3.6%		All Hi: 4,8,15,16,18,20	20,351	864	4.2%
11	Central Med	2,240	69	3.1%		All SHi: 3,6,7,19	5,650	455	8.1%
12	S Eid Med	7,453	181	2.4%		Eider Strata:3-6,9,11,15,18-20	30,465	1,397	4.6%
13	S Central Low	7,652	108	1.4%		All Strata	57,336	1,912	3.3%

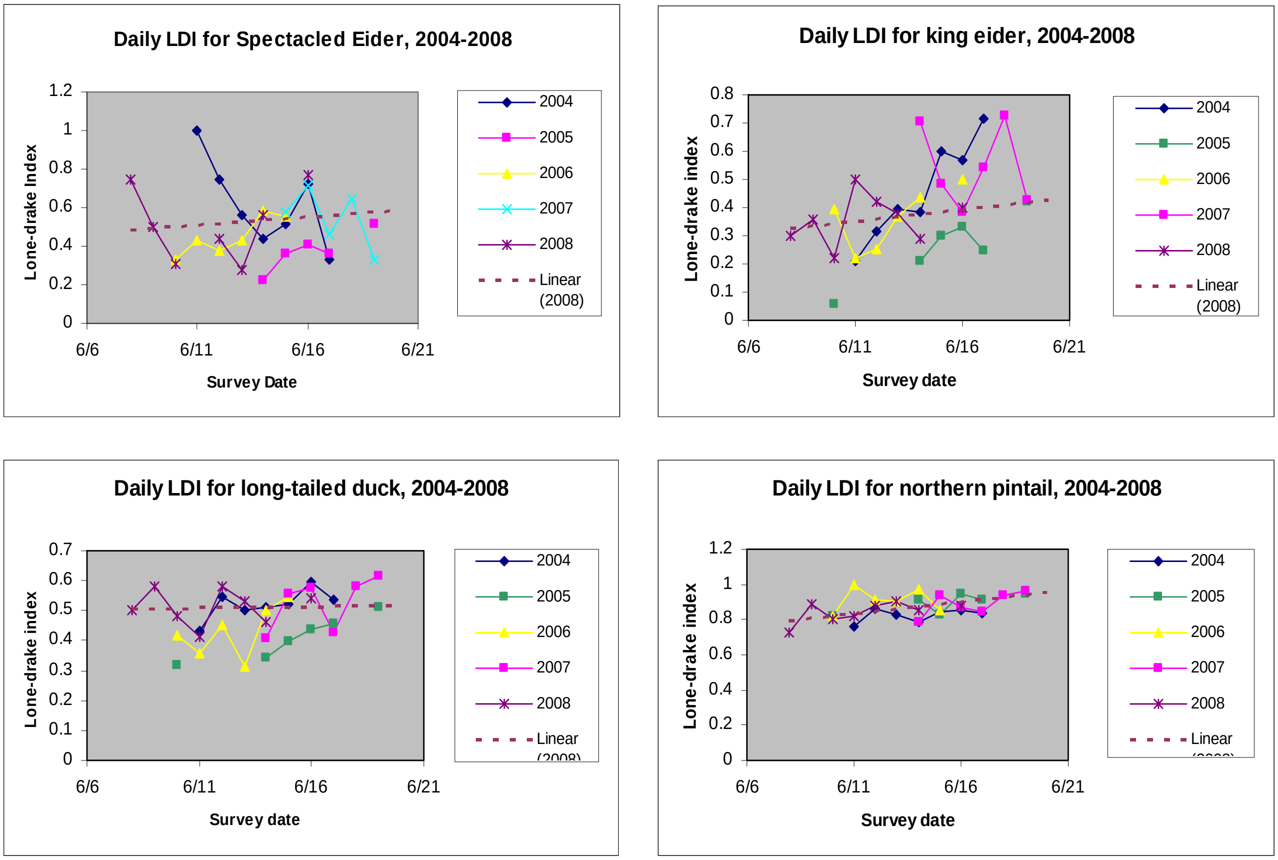


Figure 4. Daily ratio of lone males to total males (lone males plus males in pairs) of selected duck species observed during the Eider Survey (2004-2006) and the 2007-8 Standard waterfowl breeding population (ACP) survey, arctic coastal plain, Alaska.

Table 2. Average and range of ratios of lone males to total males (lone males plus males in pairs) of selected duck species observed during the Eider Survey (1992-2006) and the ACP 2007-8 survey, arctic coastal plain, Alaska.

Species	LDI Avg. 1992-2007	LDI SD	LDI range	LDI 2008
Spectacled eider	0.49	0.08	0.29-0.59	0.49
King eider	0.36	0.12	0.14-0.58	0.40
Long-tailed duck	0.49	0.05	0.39-0.57	0.51
Northern pintail	0.83	0.07	0.67-0.90	0.88

Table 3. Combined observations by starboard and port observers on aerial survey transects, arctic coastal plain, Alaska, June 2008, with observable population indices. Includes observations from previous eider survey strata only (Fig. 2). Expanded indices for selected ducks were calculated using visibility correction factors (VCF) developed on the Yukon Kuskokwim Delta for tundra habitats (Conant et al. 1991).

Species	Single	Pair	Flocked Birds	Indicated Total	Density birds/km2	Population Index	Population 95%CI	VCF	Expanded Pop. Index	%CV
Yellow-billed loon	27	12	3	54[1]	0.041	1,235	813-1,658	NA		17.5
Pacific Loon	230	366	9	971[1]	0.700	21,315	18,086-24,544	NA		7.7
Red-throated loon	25	32	3	92[1]	0.066	1,996	1,277-2,715	NA		18.4
Jaeger spp.[3]	166	13	18	210[1]	0.152	4,630	3,225-6,035	NA		15.5
Glaucous gull	346	116	157	735[1]	0.504	15,346	12,955-17,738	NA		8.0
Sabine's gull	191	85	152	513[1]	0.325	9,901	7,698-12,104	NA		11.4
Arctic tern	273	178	12	641[1]	0.431	13,119	10,227-16,011	NA		11.2
Red-breasted merganser	7	8	0	30[2]	0.019	591	144-1,038	1.27	750	38.6
Mallard	0	1	0	2[2]	0.002	47	0-141	4.01	188	102.8
Am. wigeon	10	8	6	42[2]	0.030	901	232-1,570	3.84	3,459	37.9
Am. Green-winged teal	3	0	0	6[2]	0.004	137	24-249	8.36	1,141	42.1
Northern pintail	1144	175	467	3105[2]	1.951	59,450	49,215-69,685	3.05	181,323	8.8
Northern shoveler	0	5	0	10[2]	0.006	172	30-314	3.79	653	42.0
Greater scaup	96	105	192	498[1]	0.376	11,468	4,768-18,168	1.93	22,134	29.8
Long-tailed duck	349	321	161	1501[2]	1.095	33,345	27,945-38,745	1.87	62,355	8.3
Spectacled eider	71	79	0	300[2]	0.204	6,207	5,047-7,368	NA		9.5
Common eider	2	5	0	14[2]	0.011	340	0-851	NA		76.5
King eider	141	272	14	840[2]	0.533	16,230	13,819-18,641	NA		7.6
Steller's eider	1	0	0	2[2]	0.001	25	0-70	NA		92.0
Black scoter	0	0	0	0[2]	0.000	0	0-0	1.17	0	
White-winged scoter	4	0	0	8[2]	0.006	186	0-443	1.17	218	70.4
Snow goose	12	39	286	376[1]	0.261	7,938	762-15,114	NA		46.1
Gr. White-fronted goose	589	2264	1869	7575[2]	5.010	152,634	132,938-172,331	NA		6.6
Canada goose	25	25	36	136[2]	0.108	3,304	2,155-4,452	NA		17.7
Black brant	82	108	306	686[2]	0.402	12,247	6,091-18,402	NA		25.6
Tundra swan	210	115	54	494[1]	0.347	10,575	8,368-12,783	NA		10.6
Sandhill crane	4	1	0	10[2]	0.007	214	21-407	NA		45.9
Unid. Shorebird[4,5]	264	196	589	1245[1]	1.565	47,663	31,624-63,702	NA		17.7
Common raven	2	0	0	2[1]	0.004	114	0-340	NA		101.5
Short-eared owl	2	0	0	2[1]	0.001	45	11-80	NA		38.7
Snowy owl	9	0	0	9[1]	0.006	188	0-427	NA		64.8
Golden eagle	3	0	0	3[1]	0.002	56	10-102	NA		41.7

1. singles+(2*pairs)+flocked 2. 2*(singles+pairs)+flocked 3. *Stercorarius longicaudus, S. parasiticus, S. pomarinus* 4. *Charadrius sp., Pluvialis spp., Calidris spp., Arenaria sp., Numenius sp., Limnodromus sp.* et al. 5. Data from left-side observer only.

Table 4. Combined observations by starboard and port observers on aerial survey transects, arctic coastal plain, Alaska, June 2008, with observable population indices. Includes observations from all strata (Fig. 1). Expanded indices for selected ducks were calculated using visibility correction factors (VCF) developed on the Yukon Kuskokwim Delta for tundra habitats (Conant et al. 1991).

Species	Single	Pair	Flocked Birds	Indicated Total	Density birds/km2	Population Index	Population 95%CI	VCF	Expanded Pop. Index	%CV
Yellow-billed loon	32	18	3	71[1]	0.034	1,970	1,513-2,426	NA		11.8
Pacific Loon	289	438	18	1183[1]	0.553	31,699	28,215-35,183	NA		5.6
Red-throated loon	27	38	3	106[1]	0.042	2,425	1,649-3,201	NA		16.3
Jaeger spp.[3]	228	21	18	288[1]	0.154	8,850	7,272-10,428	NA		9.1
Glaucous gull	398	135	157	825[1]	0.340	19,467	16,829-22,104	NA		6.9
Sabine's gull	200	94	152	540[1]	0.191	10,937	8,424-13,451	NA		11.7
Arctic tern	356	237	15	845[1]	0.386	22,120	18,577-25,663	NA		8.2
Red-breasted merganser	10	16	0	52[2]	0.029	1,660	997-2,323	1.27	2,108	20.4
Mallard	1	1	0	4[2]	0.002	129	0-293	4.01	518	64.8
Am. wigeon	10	8	6	42[2]	0.016	901	232-1,570	3.84	3,459	37.9
Am. Green-winged teal	7	1	0	16[2]	0.012	700	168-1,231	8.36	5,850	38.7
Northern pintail	1312	208	491	3531[2]	1.428	81,885	70,228-93,542	3.05	249,749	7.3
Northern shoveler	4	8	0	24[2]	0.017	998	216-1,780	3.79	3,783	40.0
Greater scaup	159	204	221	788[1]	0.454	26,011	17,954-34,067	1.93	50,200	15.8
Long-tailed duck	428	416	165	1853[2]	0.882	50,542	44,579-56,505	1.87	94,513	6.0
Spectacled eider	73	82	0	310[2]	0.113	6,497	5,260-7,735	NA		9.7
Common eider	2	5	0	14[2]	0.006	340	0-851	NA		76.5
King eider	152	290	14	898[2]	0.324	18,563	15,705-21,422	NA		7.9
Steller's eider	1	0	0	2[2]	0.000	25	0-70	NA		92.0
Black scoter	0	3	0	6[2]	0.004	247	0-612	1.17	289	75.3
White-winged scoter	7	30	0	74[2]	0.071	4,096	2,184-6,009	1.17	4,792	23.8
Snow goose	13	40	290	383[1]	0.148	8,476	1,247-15,705	NA		43.5
Gr. White-fronted goose	659	2463	2418	8662[2]	3.663	210,047	185,773-234,320	NA		5.9
Canada goose	32	37	36	174[2]	0.092	5,284	3,702-6,866	NA		15.3
Black brant	82	108	306	686[2]	0.214	12,247	6,091-18,402	NA		25.6
Tundra swan	232	133	119	617[1]	0.263	15,079	12,710-17,448	NA		8.0
Sandhill crane	4	2	0	12[2]	0.005	271	69-474	NA		38.1
Unid. Shorebird[4,5]	315	217	622	1371[1]	1.041	59,658	42,786-76,530	NA		14.4
Common raven	4	0	0	4[1]	0.004	214	0-468	NA		60.6
Short-eared owl	6	0	0	6[1]	0.004	246	0-501	NA		52.7
Snowy owl	9	0	0	9[1]	0.003	188	0-427	NA		64.8
Golden eagle	6	0	0	6[1]	0.004	226	136-316	NA		20.4

1. singles+(2*pairs)+flocked 2. 2*(singles+pairs)+flocked 3. *Stercorarius longicaudus, S. parasiticus, S. pomarinus* 4. *Charadrius sp., Pluvialis spp., Calidris spp., Arenaria sp., Numenius sp., Limnodromus sp.* et al. 5. Data from left-side observer only.

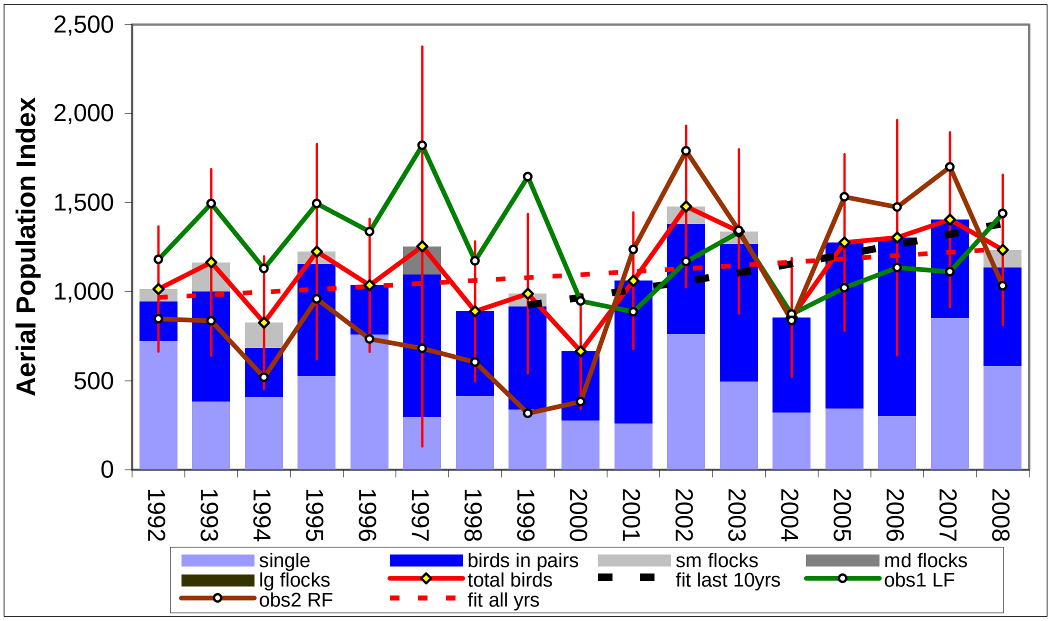
Table 5. Mean population indices, population growth rates, and years to detect a population trend equivalent to a 50 percent growth or decline in 20 years, for observations of selected bird species in early to mid-June 1992-2008 sampling Arctic Coastal Plain wetlands in Alaska. Variance estimates used were based on within-year sampling error among transects as stratified by 10 physiographic regions (Eider Strata). Significant growth rates are colored green for positive trend, red for negative.

Species	Measure	Years	n years	Mean pop. Index	Log-linear slope	Mean pop. growth rate	Pop. Growth rate 90% CI	Avg. sampling error coef. of variation	Years to detect a slope of 0.0341	Mean pop. growth rate last 10 years	Pop. GR last 10 years 90% CI
Yellow-billed loon	S + 2*Pr + Fl	1992-2008	17	1,119	0.016	1.016	0.999 - 1.033	0.221	15	**1.046**	1.004-1.089
Pacific Loon	S + 2*Pr + Fl	1992-2008	17	20,909	0.007	1.007	0.991 - 1.023	0.070	7	1.008	0.980-1.038
Red-throated loon	S + 2*Pr + Fl	1992-2008	17	2,578	-0.049	**0.952**	0.924 - 0.981	0.154	12	1.011	0.958-1.068
Jaeger spp.	S + 2*Pr + Fl	1992-2008	17	4,184	0.014	1.014	0.977 - 1.054	0.118	10	1.024	0.940-1.116
Glaucous gull	S + 2*Pr + Fl	1992-2008	17	12,580	0.011	1.011	0.990 - 1.033	0.149	11	1.032	0.982-1.084
Sabine's gull	S + 2*Pr + Fl	1992-2008	17	7,050	0.021	1.021	0.994 - 1.048	0.132	10	**1.065**	1.020-1.111
Arctic tern	S + 2*Pr + Fl	1992-2008	17	10,611	0.037	**1.038**	1.025 - 1.050	0.112	9	1.011	0.981-1.042
Red-breasted merganser	2 * (S + Pr) + Fl	1992-2008	17	477	0.098	**1.103**	1.053 - 1.156	0.405	22	**1.083**	1.031-1.137
Mallard	2 * (S + Pr) + Fl	1992-2008	17	201	-0.043	0.958	0.866 - 1.060	0.667	30	0.976	0.778-1.224
Am. wigeon	2 * (S + Pr) + Fl	1992-2008	17	390	-0.014	0.986	0.897 - 1.083	0.662	30	0.943	0.753-1.181
Am. Green-winged teal	2 * (S + Pr) + Fl	1992-2008	17	293	-0.116	**0.890**	0.811 - 0.977	0.500	25	1.158	0.989-1.357
Northern pintail	2 * (S + Pr) + Fl	1992-2008	17	49,558	-0.020	0.980	0.944-1.019	0.101	9	**0.912**	0.869-0.956
Northern shoveler	2 * (S + Pr) + Fl	1992-2008	17	205	0.034	1.035	0.924-1.159	0.532	26	1.044	0.839-1.299
Greater scaup	S + 2*Pr + Fl	1992-2008	17	4,671	0.073	**1.076**	1.051-1.102	0.185	13	**1.126**	1.064-1.191
Long-tailed duck	2 * (S + Pr) + Fl	1992-2008	17	30,530	-0.015	0.985	0.969-1.001	0.070	7	0.978	0.935-1.023
Spectacled eider	2 * (S + Pr) + Fl	1993-2008	16	6,635	-0.012	0.988	0.972-1.004	0.127	10	0.990	0.966-1.015
Common eider	2 * (S + Pr) + Fl	1992-2008	17	388	-0.006	0.994	0.917-1.077	0.783	34	1.108	0.913-1.345
King eider	2 * (S + Pr) + Fl	1993-2008	16	13,421	0.023	**1.023**	1.011-1.036	0.100	9	**1.029**	1.005-1.053
Steller's eider	2 * (S + Pr) + Fl	1992-2008	17	168	0.023	1.024	0.920-1.139	0.750	33	0.958	0.744-1.232
Black scoter	2 * (S + Pr) + Fl	1992-2008	17	113	-0.073	0.930	0.849-1.018	0.732	32	**1.121**	1.002-1.254
White-winged scoter	2 * (S + Pr) + Fl	1992-2008	17	340	0.062	1.064	0.992-1.141	0.600	28	1.022	0.940-1.110
Snow goose	S + 2*Pr + Fl	1992-2008	17	6,786	0.181	**1.199**	1.079-1.332	0.565	27	1.229	0.941-1.606
Gr. White-fronted goose	2 * (S + Pr) + Fl	1992-2008	17	84,004	0.048	**1.049**	1.023-1.075	0.075	7	**1.078**	1.025-1.133
Canada goose	2 * (S + Pr) + Fl	1993-2008	16	7,827	-0.014	0.987	0.946-1.029	0.271	17	0.981	0.888-1.083
Black brant	2 * (S + Pr) + Fl	1992-2008	17	6,870	0.110	**1.116**	1.087-1.146	0.250	16	**1.144**	1.090-1.202
Tundra swan	S + 2*Pr + Fl	1992-2008	17	6,558	0.033	**1.033**	1.016-1.051	0.112	9	**1.053**	1.024-1.083
Sandhill crane	S + 2*Pr + Fl	1992-2008	17	128	0.048	1.049	0.990-1.111	0.637	30	1.014	0.887-1.159
Unid. Shorebird	S + 2*Pr + Fl	1997-2008	12	43,964	-0.016	0.984	0.951-1.017	0.092	8	0.983	0.939-1.030
Common raven	S + 2*Pr + Fl	1992-2008	17	60	-0.004	0.996	0.934-1.062	0.690	31	0.937	0.818-1.073
Short-eared owl	S + 2*Pr + Fl	1992-2008	17	81	0.034	1.035	0.961-1.114	0.484	25	0.909	0.776-1.065
Snowy owl	S + 2*Pr + Fl	1992-2008	17	851	-0.024	0.976	0.881-1.081	0.374	21	1.115	0.877-1.416
Golden eagle	S + 2*Pr + Fl	1992-2008	17	45	0.030	1.030	0.975-1.089	0.777	34	1.105	0.983-1.243

Table 6. Breeding population indices, standard Alaska ACP Survey, 1986-2006 means (Mallek et al. 2007) compared with indices from 2007 and 2008 surveys (all strata), which were flown earlier in June. Duck Indices were adjusted by multiplying by the standard tundra visibility correction factors from the Alaska-Yukon Breeding Population Survey (Conant et al. 1991).

Species	VCF	ACP Survey mean 1986-2006	All ACP strata 2007 (SE)	All ACP strata 2008 (SE)
Yellow-billed loon	1.00	2,778	1,702 (284)	1,970 (233)
Pacific Loon	1.00	29,756	26,783 (2,663)	31,699 (1,788)
Red-throated loon	1.00	3,240	3,667 (514)	2,425 (396)
Jaeger spp.3	1.00	7,197	11,088 (1,048)	8,850 (805)
Glaucous gull	1.00	17,188	24,826 (2,442)	19,467 (1,346)
Sabine's gull	1.00	11,810	11,590 (1,285)	10,937 (1,282)
Arctic tern	1.00	23,544	24,646 (1,660)	22,120 (1,808)
Red-breasted merganser	1.27	2,340	1,822 (767)	2,108 (429)
Mallard	4.01	1,848	3,212 (1,632)	518 (337)
Am. wigeon	3.84	4,123	88 (65)	3,459 (1,309)
Am. Green-winged teal	8.36	3,210	4,640 (181)	5,850 (2,266)
Northern pintail	3.05	220,494	185,532 (16,507)	249,749 (18,138)
Northern shoveler	3.79	987	910 (368)	3,783 (1,512)
Greater scaup	1.93	32,721	37,749 (4,474)	50,200 (7,934)
Long-tailed duck	1.87	107,041	70,652 (4,720)	94,513 (5,689)
Spectacled eider	1.00	619	5,288 (727)	6,497 (632)
Common eider	1.00	441	440 (239)	340 (260)
King eider	1.00	3,999	20,783 (1,935)	18,563 (1,458)
Steller's eider	1.00	743	337 (251)	25 (23)
Black scoter	1.17	43	113 (64)	289 (218)
White-winged scoter	1.17	247	4,021 (1,161)	4,793 (1,142)
All scoters	1.17	10,381	4,134	5,082 (1,360)
Snow goose	1.00	3,025	64,110 (56,016)	8,476 (3,688)
Gr. White-fronted goose	1.00	123,963	226,952 (14,012)	210,047 (12,384)
Canada goose	1.00	18,309	28,346 (5,638)	5,284 (807)
Black brant	1.00	9,792	10,138 (1,657)	12,247 (3,140)
Tundra swan	1.00	9,971	13,444 (828)	15,079 (1,209)
Sandhill crane	1.00		110 (88)	271 (103)
Common raven	1.00		252 (122)	214 (130)
Short-eared owl	1.00		120 (62)	246 (130)
Snowy owl	1.00	1,219	1,711 (926)	188 (122)
Golden eagle	1.00	426	262 (126)	226 (46)

YBLO **Yellow-billed Loon** North Slope early-June survey



NSE 10 strata =30,465 km2

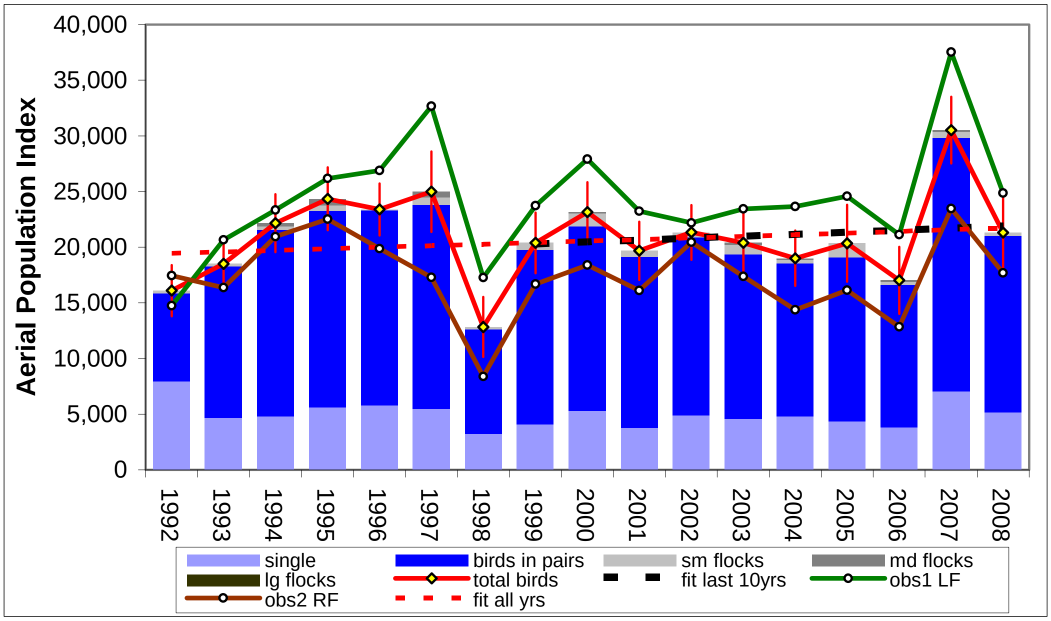
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	725	219	71	0	0	**1015**	179
1993	386	617	162	0	0	**1165**	267
1994	408	277	141	0	0	**826**	190
1995	527	628	70	0	0	**1226**	308
1996	761	275	0	0	0	**1036**	191
1997	297	801	0	157	0	**1254**	573
1998	416	474	0	0	0	**890**	200
1999	340	579	70	0	0	**989**	229
2000	277	388	0	0	0	**665**	165
2001	262	800	0	0	0	**1062**	196
2002	762	620	97	0	0	**1479**	231
2003	495	773	71	0	0	**1339**	236
2004	323	533	0	0	0	**856**	170
2005	344	932	0	0	0	**1277**	253
2006	302	1002	0	0	0	**1304**	337
2007	854	551	0	0	0	**1405**	251
2008	582	556	97	0	0	**1235**	216

YBLO

Aerial index: Total birds	
n yrs =	17
mean pop index =	**1119**
std dev =	226
std error =	55
low 90%ci =	1012
high 90%ci =	1226
ln linear slope =	0.0155
SE slope =	0.0103
Growth Rate =	**1.016**
low 90%ci GR =	0.999
high 90%ci GR =	1.033
regression resid CV =	0.208
avg sampling err CV =	0.221
Power (yrs to detect -50%/20yr rate) :	
w/ regression resid CV =	14.0
w/ sample error CV =	14.6
most recent 10 years :	
Growth Rate =	**1.046**
low 90%ci GR =	1.004
high 90%ci GR =	1.089

Figure 5. Population trend for Yellow-billed Loons (*Gavia adamsii*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Calculation of power used alpha = 0.10, beta = 0.20, and a coefficient of variation based on either regression residuals or averaged annual sampling error. The power to detect trends can be compared across species using the estimated minimum years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

PALO **Pacific Loon** North Slope early-June survey



NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	7931	7944	227	0	0	**16103**	1174
1993	4669	13592	251	0	0	**18512**	958
1994	4773	16753	354	266	0	**22146**	1329
1995	5592	17703	467	584	0	**24347**	1438
1996	5821	17495	71	0	0	**23387**	1193
1997	5497	18298	696	490	0	**24981**	1848
1998	3220	9392	222	0	0	**12833**	1370
1999	4070	15690	625	0	0	**20385**	1386
2000	5299	16556	1161	137	0	**23152**	1364
2001	3767	15326	581	0	0	**19675**	1330
2002	4880	16020	431	0	0	**21330**	1250
2003	4536	14842	842	177	0	**20397**	1701
2004	4802	13751	312	148	0	**19014**	1269
2005	4340	14728	1283	0	0	**20351**	1760
2006	3839	12783	250	147	0	**17018**	1532
2007	7051	22807	505	144	0	**30507**	1525
2008	5172	15853	290	0	0	**21315**	1647

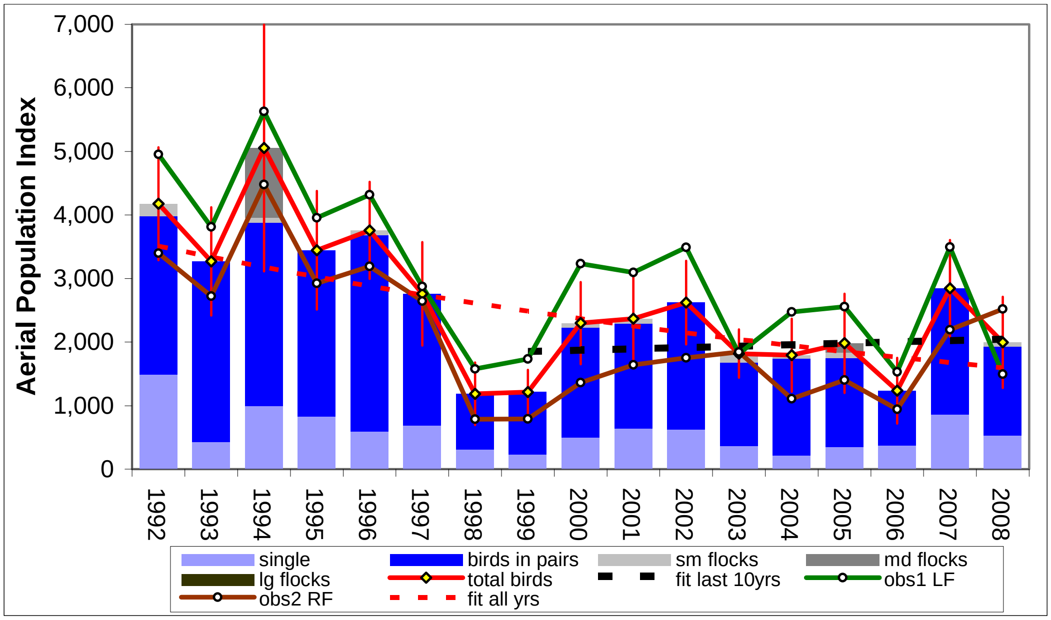
PALO

Aerial index: Total birds

n yrs =	17
mean pop index =	**20909**
std dev =	3943
std error =	956
low 90%ci =	19035
high 90%ci =	22783
ln linear slope =	0.0069
SE slope =	0.0097
Growth Rate =	**1.007**
low 90%ci GR =	0.991
high 90%ci GR =	1.023
regression resid CV =	0.196
avg sampling err CV =	0.070
Power (yrs to detect -50%/20yr rate) :	
w/ regression resid CV =	13.5
w/ sample error CV =	6.8
most recent 10 years :	
Growth Rate =	**1.008**
low 90%ci GR =	0.980
high 90%ci GR =	1.038

Figure 6. Population trend for Pacific Loons (*Gavia pacifica*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Calculation of power used alpha = 0.10, beta = 0.20, and a coefficient of variation based on either regression residuals or averaged annual sampling error. The power to detect trends can be compared across species using the estimated minimum years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

RTLO **Red-throated Loon** North Slope early-June survey



NSE 10 strata =30,465 km2

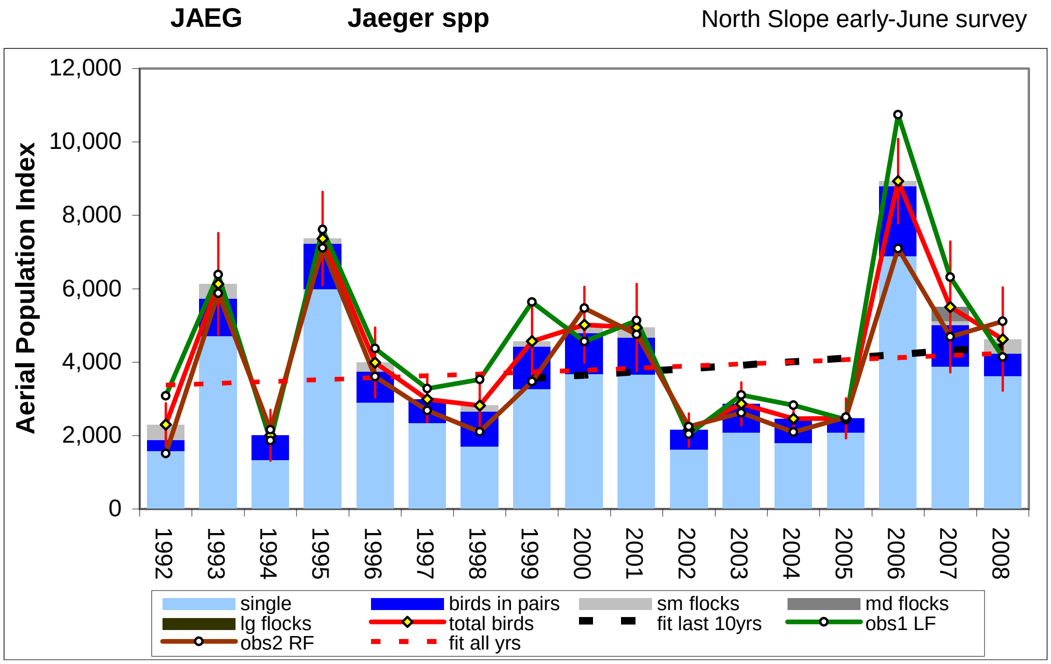
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	1487	2495	196	0	0	**4177**	453
1993	421	2850	0	0	0	**3271**	434
1994	993	2888	75	1099	0	**5054**	990
1995	827	2617	0	0	0	**3445**	476
1996	596	3087	73	0	0	**3756**	390
1997	683	2075	0	0	0	**2758**	415
1998	306	879	0	0	0	**1185**	251
1999	234	983	0	0	0	**1216**	176
2000	502	1727	69	0	0	**2298**	330
2001	634	1663	71	0	0	**2367**	387
2002	627	1994	0	0	0	**2621**	335
2003	363	1315	140	0	0	**1818**	194
2004	217	1528	49	0	0	**1793**	294
2005	348	1398	94	141	0	**1980**	399
2006	374	862	0	0	0	**1236**	264
2007	860	1986	0	0	0	**2846**	388
2008	530	1395	70	0	0	**1996**	367

RTLO

<u>Aerial index: Total birds</u>

n yrs =	17
mean pop index =	**2578**
std dev =	1090
std error =	264
low 90%ci =	2059
high 90%ci =	3096
ln linear slope =	-0.0492
SE slope =	0.0180
Growth Rate =	**0.952**
low 90%ci GR =	0.924
high 90%ci GR =	0.981
regression resid CV =	0.364
avg sampling err CV =	0.154
<u>Power (yrs to detect -50%/20yr rate) :</u>	
w/ regression resid CV =	20.3
w/ sample error CV =	11.5
<u>most recent 10 years :</u>	
Growth Rate =	**1.011**
low 90%ci GR =	0.958
high 90%ci GR =	1.068

Figure 7. Population trend for Red-throated Loons (*Gavia stellata*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Calculations of power used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.



NSE 10 strata =30,465 km2

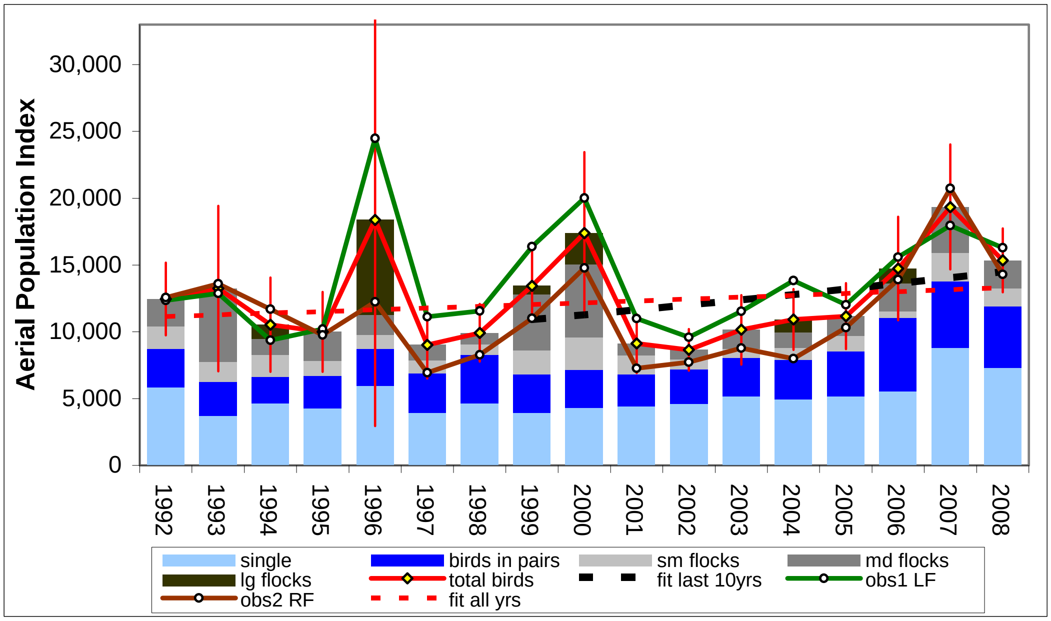
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	1588	301	409	0	0	**2298**	297
1993	4713	1014	405	0	0	**6131**	706
1994	1335	671	0	0	0	**2007**	353
1995	5989	1232	144	0	0	**7365**	650
1996	2897	842	253	0	0	**3992**	485
1997	2346	638	0	0	0	**2984**	316
1998	1702	952	164	0	0	**2817**	384
1999	3276	1143	154	0	0	**4572**	477
2000	3673	1124	221	0	0	**5018**	526
2001	3655	1005	286	0	0	**4946**	604
2002	1622	525	0	0	0	**2147**	232
2003	2078	785	0	0	0	**2863**	300
2004	1793	666	0	0	0	**2459**	242
2005	2081	390	0	0	0	**2471**	278
2006	6893	1891	147	0	0	**8930**	589
2007	3886	1125	99	392	0	**5502**	909
2008	3618	620	392	0	0	**4630**	717

JAEG

Aerial index: Total birds	
n yrs =	17
mean pop index =	**4184**
std dev =	1988
std error =	482
low 90%ci =	3239
high 90%ci =	5129
ln linear slope =	0.0142
SE slope =	0.0231
Growth Rate =	**1.014**
low 90%ci GR =	0.977
high 90%ci GR =	1.054
regression resid CV =	0.467
avg sampling err CV =	0.118
Power (yrs to detect -50%/20yr rate) :	
w/ regression resid CV =	24.0
w/ sample error CV =	9.6
most recent 10 years :	
Growth Rate =	**1.024**
low 90%ci GR =	0.940
high 90%ci GR =	1.116

Figure 8. Population trend for jaeger species (*Stercorarius parasiticus, S. pomarinus, S. longicaudus*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

GLGU **Glaucous Gull** North Slope early-June survey



NSE 10 strata =30,465 km2

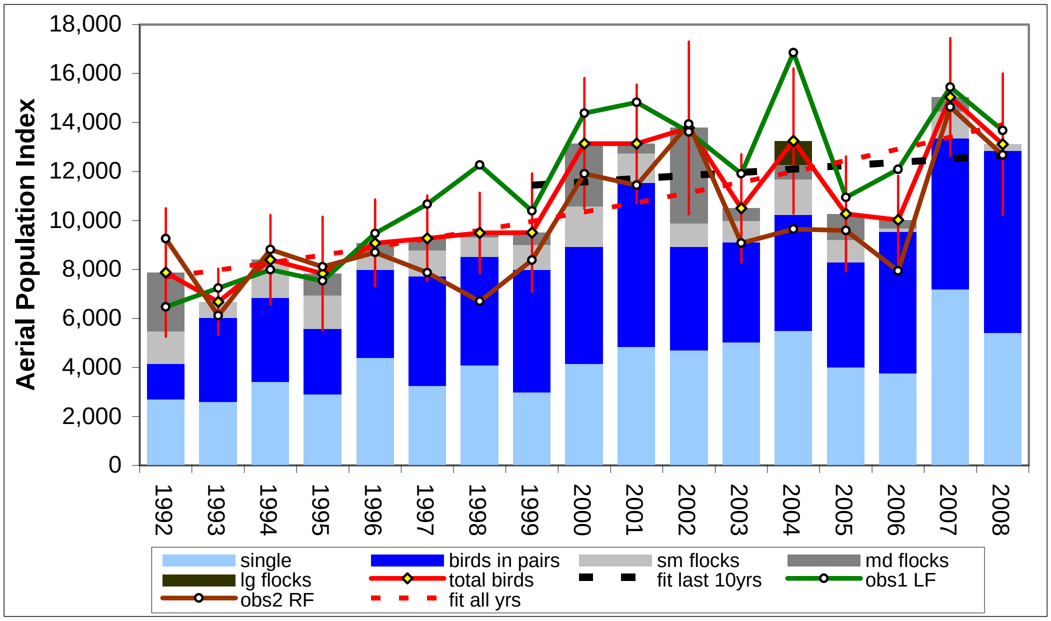
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	5840	2875	1704	2050	0	**12469**	1385
1993	3724	2536	1489	5490	0	**13238**	3151
1994	4648	1964	1640	1223	1057	**10532**	1794
1995	4300	2396	1119	2185	0	**10000**	1522
1996	5959	2772	1034	1501	7107	**18372**	7868
1997	3919	2979	973	1158	0	**9028**	1289
1998	4645	3636	786	859	0	**9926**	1097
1999	3932	2900	1780	4168	656	**13435**	1343
2000	4303	2832	2464	5454	2342	**17394**	3095
2001	4423	2391	1429	886	0	**9130**	1124
2002	4596	2615	706	732	0	**8649**	788
2003	5182	2878	645	1449	0	**10153**	1325
2004	4921	2971	898	1181	951	**10921**	1164
2005	5162	3376	1134	1503	0	**11175**	1255
2006	5573	5465	505	2098	1102	**14743**	1976
2007	8807	4945	2169	3424	0	**19345**	2390
2008	7304	4615	1326	2101	0	**15346**	1220

GLGU

Aerial index: Total birds	
n yrs =	17
mean pop index =	**12580**
std dev =	3396
std error =	824
low 90%ci =	10966
high 90%ci =	14194
ln linear slope =	0.011
SE slope =	0.0129
Growth Rate =	**1.011**
low 90%ci GR =	0.990
high 90%ci GR =	1.033
regression resid CV =	0.260
avg sampling err CV =	0.149
Power (yrs to detect -50%/20yr rate) :	
w/ regression resid CV =	16.2
w/ sample error CV =	11.2
most recent 10 years :	
Growth Rate =	**1.032**
low 90%ci GR =	0.982
high 90%ci GR =	1.084

Figure 9. Population trend for Glaucous Gulls (*Larus hyperboreus*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

ARTE **Arctic Tern** North Slope early-June survey



NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	2691	1449	1327	2411	0	**7877**	1340
1993	2605	3425	652	0	0	**6682**	692
1994	3419	3417	1418	147	0	**8400**	933
1995	2905	2655	1393	879	0	**7832**	1186
1996	4398	3597	560	528	0	**9083**	906
1997	3252	4464	1069	488	0	**9274**	891
1998	4098	4409	806	179	0	**9491**	838
1999	2969	5016	1007	515	0	**9508**	1230
2000	4151	4783	1635	2571	0	**13141**	1361
2001	4844	6685	1217	389	0	**13135**	1236
2002	4698	4221	956	3905	0	**13778**	1800
2003	5033	4077	872	512	0	**10493**	1128
2004	5491	4735	1441	617	964	**13248**	1509
2005	3997	4301	917	1051	0	**10266**	1195
2006	3779	5752	147	348	0	**10026**	917
2007	7173	6186	1107	575	0	**15040**	1227
2008	5409	7435	275	0	0	**13119**	1475

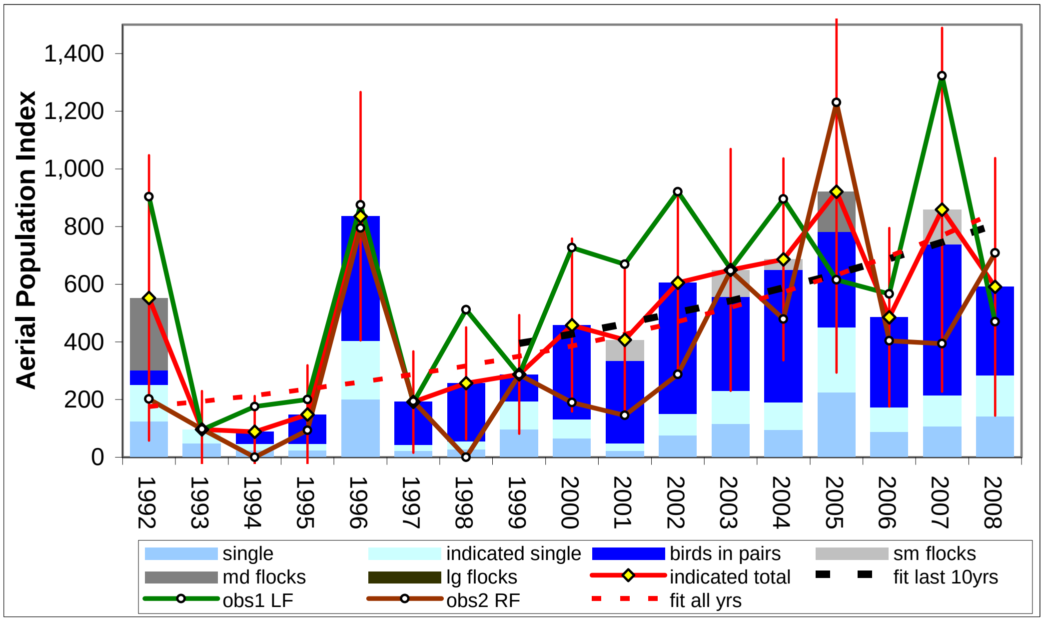
ARTE

Aerial index: Total birds

n yrs =	17
mean pop index =	**10611**
std dev =	2478
std error =	601
low 90%ci =	9433
high 90%ci =	11789
ln linear slope =	0.0371
SE slope =	0.0073
Growth Rate =	**1.038**
low 90%ci GR =	1.025
high 90%ci GR =	1.050
regression resid CV =	0.147
avg sampling err CV =	0.112
Power (yrs to detect -50%/20yr rate) :	
w/ regression resid CV =	11.1
w/ sample error CV =	9.3
most recent 10 years :	
Growth Rate =	**1.011**
low 90%ci GR =	0.981
high 90%ci GR =	1.042

Figure 10. Population trend for Arctic Terns (*Sterna paradisaea*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

RBME **Red-breasted Merganser** North Slope early-June survey



NSE 10 strata =30,465 km2

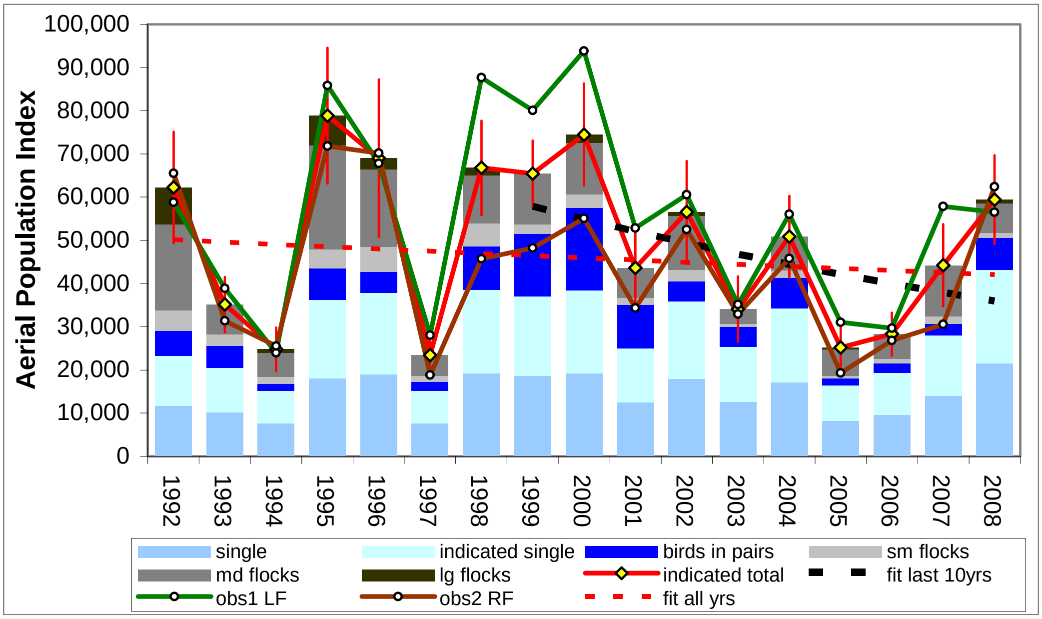
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	250	50	0	252	0	**552**	252
1993	97	0	0	0	0	**97**	68
1994	47	41	0	0	0	**88**	63
1995	47	101	0	0	0	**148**	87
1996	403	433	0	0	0	**836**	220
1997	42	149	0	0	0	**192**	90
1998	55	202	0	0	0	**256**	99
1999	193	95	0	0	0	**287**	105
2000	132	326	0	0	0	**458**	153
2001	47	287	72	0	0	**407**	132
2002	150	454	0	0	0	**604**	155
2003	230	326	93	0	0	**650**	214
2004	191	459	37	0	0	**686**	179
2005	451	329	0	141	0	**921**	320
2006	174	312	0	0	0	**485**	158
2007	216	523	120	0	0	**858**	322
2008	283	308	0	0	0	**591**	228

RBME

Aerial index: Indicated total	
n yrs =	17
mean pop index =	**477**
std dev =	269
std error =	65
low 90%ci =	350
high 90%ci =	605
ln linear slope =	0.0983
SE slope =	0.0286
Growth Rate =	**1.103**
low 90%ci GR =	1.053
high 90%ci GR =	1.156
regression resid CV =	0.577
avg sampling err CV =	0.405
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	27.6
w/ sample error CV =	21.8
trend of most recent 10 years :	
Growth Rate =	**1.083**
low 90%ci GR =	1.031
high 90%ci GR =	1.137

Figure 11. Population trend for Red-breasted Meganser (*Mergus serrator*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

NOPI **Northern Pintail** North Slope early-June survey



NSE 10 strata =30,465 km2

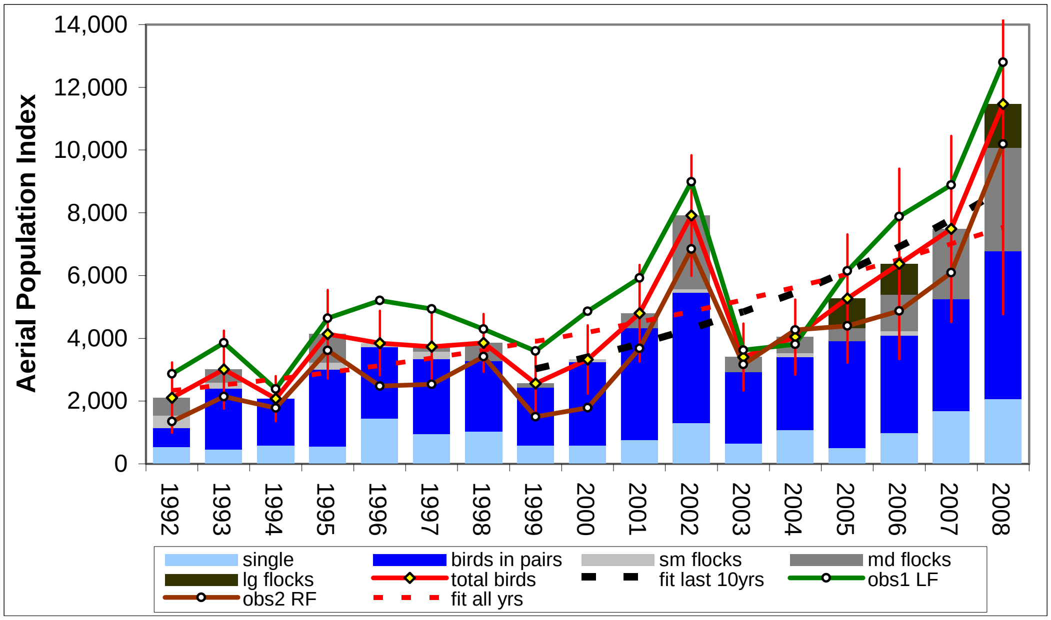
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	23339	5630	4752	20018	8491	**62230**	6591
1993	20441	5126	2668	6905	0	**35141**	3261
1994	15254	1573	1550	5590	802	**24768**	2589
1995	36195	7281	4396	24109	6892	**78872**	8012
1996	37891	4794	5743	18034	2558	**69020**	9306
1997	15217	1984	1439	4812	0	**23452**	2624
1998	38469	10126	5255	11094	1832	**66775**	5576
1999	37076	14400	2264	11702	0	**65443**	3896
2000	38434	19056	3134	11843	1999	**74466**	6031
2001	24965	10029	1749	6882	0	**43625**	4392
2002	35915	4630	2602	12529	881	**56557**	6030
2003	25320	4725	643	3387	0	**34075**	3873
2004	34272	6991	1804	7817	0	**50885**	4796
2005	16381	1703	592	6047	481	**25205**	2544
2006	19280	2265	1118	5627	0	**28290**	2551
2007	28009	2669	1758	11796	0	**44232**	4828
2008	43134	7417	1202	6877	820	**59450**	5222

NOPI

Aerial index: Indicated total	
n yrs =	17
mean pop index =	**49558**
std dev =	18657
std error =	4525
low 90%ci =	40689
high 90%ci =	58427
ln linear slope =	-0.011
SE slope =	0.0211
Growth Rate =	**0.989**
low 90%ci GR =	0.955
high 90%ci GR =	1.024
regression resid CV =	0.425
avg sampling err CV =	0.099
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	22.5
w/ sample error CV =	8.5
trend of most recent 10 years :	
Growth Rate =	**0.949**
low 90%ci GR =	0.892
high 90%ci GR =	1.009

Figure 12. Population trend for Northern Pintail (*Anas acuta*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

SCAU **Unidentified Scaup** North Slope early-June survey



NSE 10 strata =30,465 km2

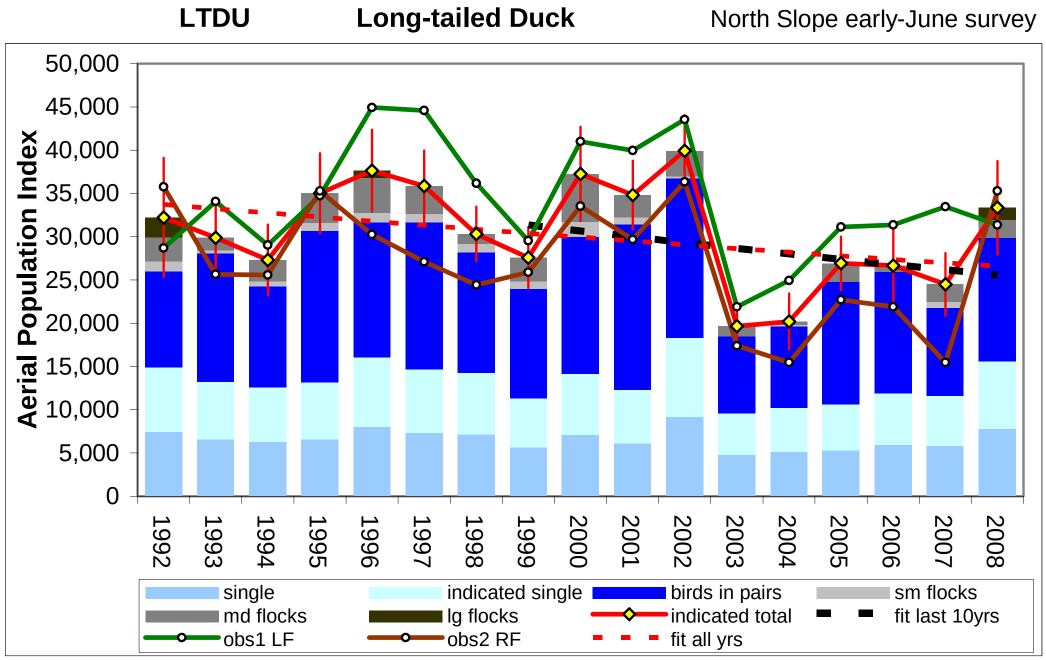
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	539	607	400	563	0	**2109**	572
1993	455	1946	192	411	0	**3004**	636
1994	594	1486	0	0	0	**2080**	366
1995	560	2453	209	912	0	**4133**	719
1996	1437	2292	120	0	0	**3849**	526
1997	948	2396	245	145	0	**3735**	661
1998	1035	2240	0	582	0	**3857**	470
1999	576	1847	0	143	0	**2565**	452
2000	579	2659	87	0	0	**3325**	556
2001	766	3556	0	480	0	**4802**	784
2002	1306	4147	120	2342	0	**7915**	982
2003	655	2266	0	483	0	**3403**	545
2004	1079	2319	119	524	0	**4041**	611
2005	507	3404	0	421	937	**5269**	1043
2006	988	3103	125	1177	976	**6370**	1550
2007	1685	3567	0	2237	0	**7488**	1514
2008	2072	4709	0	3290	1397	**11468**	3418

SCAU

Aerial index: Total birds

n yrs =	17
mean pop index =	**4671**
std dev =	2433
std error =	590
low 90%ci =	3515
high 90%ci =	5828
ln linear slope =	0.0732
SE slope =	0.0143
Growth Rate =	**1.076**
low 90%ci GR =	1.051
high 90%ci GR =	1.102
regression resid CV =	0.290
avg sampling err CV =	0.185
Power (yrs to detect -50%/20yr rate) :	
w/ regression resid CV =	17.4
w/ sample error CV =	13.0
most recent 10 years :	
Growth Rate =	**1.126**
low 90%ci GR =	1.064
high 90%ci GR =	1.191

Figure 13. Population trend for Scaup (*Aythya marila, A. affinis*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.



NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	14896	11116	1123	2818	2268	**32221**	3513
1993	13208	14871	346	1432	0	**29858**	1989
1994	12570	11684	623	2434	0	**27312**	2090
1995	13206	17440	913	3463	0	**35021**	2361
1996	16046	15597	1099	4023	849	**37614**	2419
1997	14607	17009	1021	3215	0	**35853**	2087
1998	14244	13963	942	1162	0	**30310**	1612
1999	11329	12640	872	2742	0	**27584**	1811
2000	14154	15833	1737	5529	0	**37252**	2773
2001	12270	19161	807	2572	0	**34810**	2016
2002	18317	18405	257	2953	0	**39931**	2097
2003	9579	8894	0	1168	0	**19642**	1227
2004	10230	9380	198	391	0	**20199**	1658
2005	10594	14197	0	2122	0	**26912**	1583
2006	11917	14036	0	716	0	**26669**	2150
2007	11597	10191	645	2046	0	**24479**	1857
2008	15579	14283	0	2078	1405	**33345**	2755

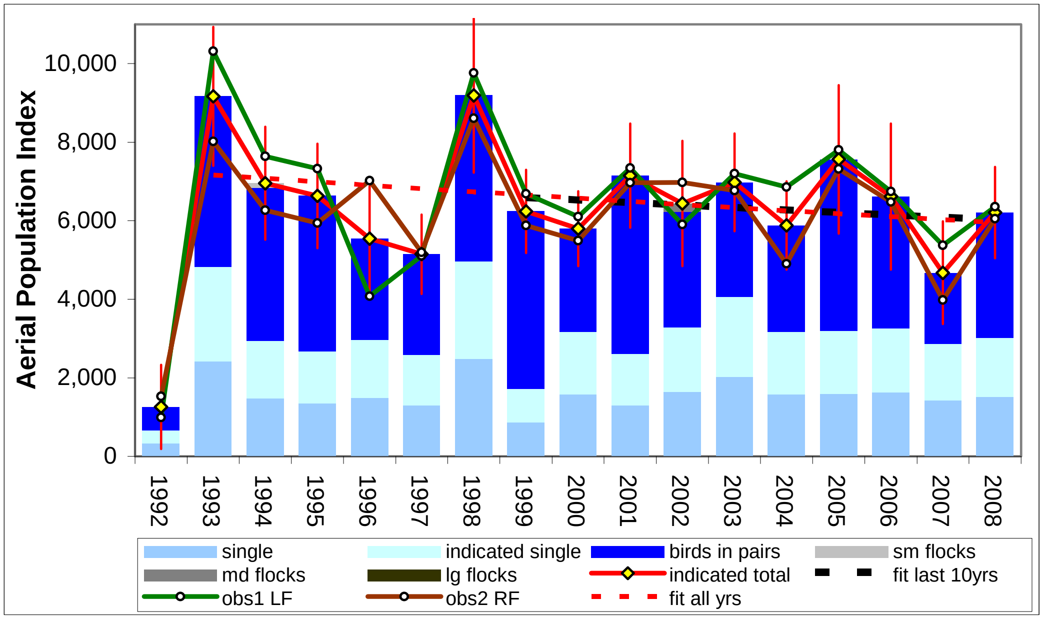
LTDU

Aerial index: Indicated total

n yrs =	17
mean pop index =	**30530**
std dev =	5973
std error =	1449
low 90%ci =	27691
high 90%ci =	33369
ln linear slope =	-0.015
SE slope =	0.0099
Growth Rate =	**0.985**
low 90%ci GR =	0.969
high 90%ci GR =	1.001
regression resid CV =	0.200
avg sampling err CV =	0.070
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	13.7
w/ sample error CV =	6.8
trend of most recent 10 years :	
Growth Rate =	**0.978**
low 90%ci GR =	0.935
high 90%ci GR =	1.023

Figure 14. Population trend for Long-tailed Duck (*Clangula hyemalis*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

SPEI **Spectacled Eider** North Slope early-June survey



NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	657	602	0	0	0		
1993	4828	4339	0	0	0	**9167**	900
1994	2945	3885	122	0	0	**6951**	733
1995	2679	3951	0	0	0	**6630**	677
1996	2964	2580	0	0	0	**5544**	680
1997	2594	2553	0	0	0	**5148**	515
1998	4963	4223	0	0	0	**9186**	1001
1999	1723	4517	0	0	0	**6240**	541
2000	3170	2628	0	0	0	**5798**	487
2001	2611	4537	0	0	0	**7148**	675
2002	3284	2938	0	216	0	**6439**	812
2003	4058	2918	0	0	0	**6976**	635
2004	3165	2716	0	0	0	**5881**	574
2005	3186	4374	0	0	0	**7561**	964
2006	3259	3356	0	0	0	**6615**	947
2007	2864	1813	0	0	0	**4676**	668
2008	3019	3188	0	0	0	**6207**	592

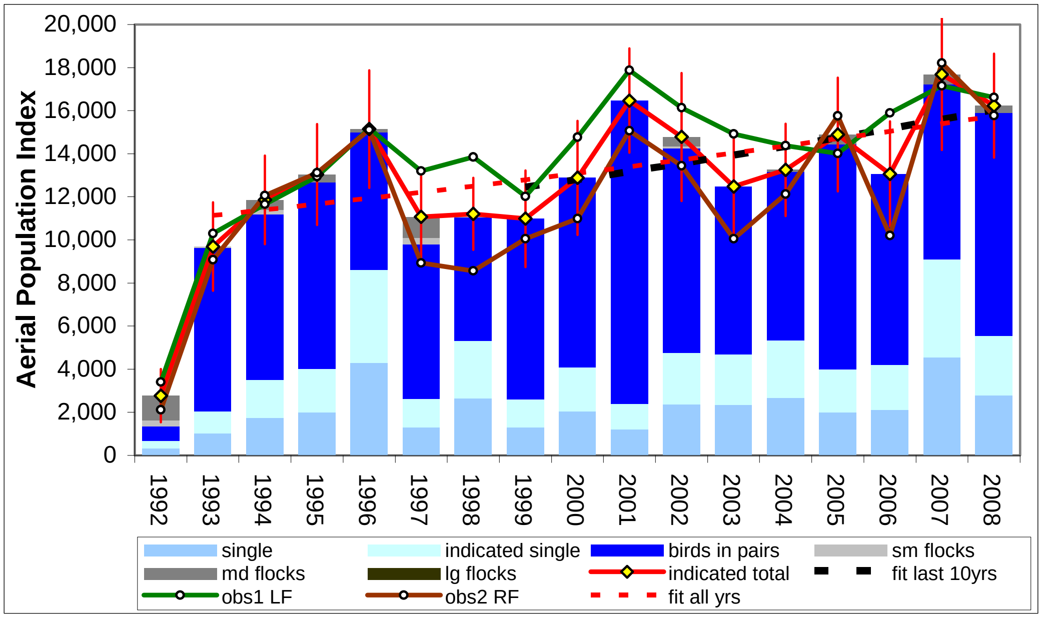
SPEI

<u>Aerial index: Indicated total</u>

n yrs =	16
mean pop index =	**6635**
std dev =	1242
std error =	311
low 90%ci =	6027
high 90%ci =	7244
ln linear slope =	-0.012
SE slope =	0.0096
Growth Rate =	**0.988**
low 90%ci GR =	0.972
high 90%ci GR =	1.004
regression resid CV =	0.178
avg sampling err CV =	0.127
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	12.6
w/ sample error CV =	10.1
<u>trend of most recent 10 years :</u>	
Growth Rate =	**0.990**
low 90%ci GR =	0.966
high 90%ci GR =	1.015

Figure 15. Population trend for Spectacled Eider (*Somateria fischeri*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years. A low index in 1992 was excluded from trend calculation because the survey was flown too late in June.

KIEI **King Eider** North Slope early-June survey



NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	661	677	290	1142	0		
1993	2029	7587	75	0	0	**9692**	1046
1994	3495	7695	212	451	0	**11853**	1052
1995	4013	8650	0	373	0	**13037**	1197
1996	8598	6400	0	146	0	**15143**	1395
1997	2618	7163	333	958	0	**11072**	962
1998	5295	5746	169	0	0	**11211**	852
1999	2597	8389	0	0	0	**10987**	1143
2000	4079	8803	0	0	0	**12882**	1349
2001	2403	14066	0	0	0	**16469**	1236
2002	4746	9507	94	432	0	**14780**	1518
2003	4689	7796	0	0	0	**12485**	1252
2004	5336	7820	0	95	0	**13251**	1094
2005	3988	10458	0	445	0	**14891**	1348
2006	4206	8862	0	0	0	**13068**	1239
2007	9103	8132	0	450	0	**17685**	1789
2008	5543	10347	0	341	0	**16230**	1230

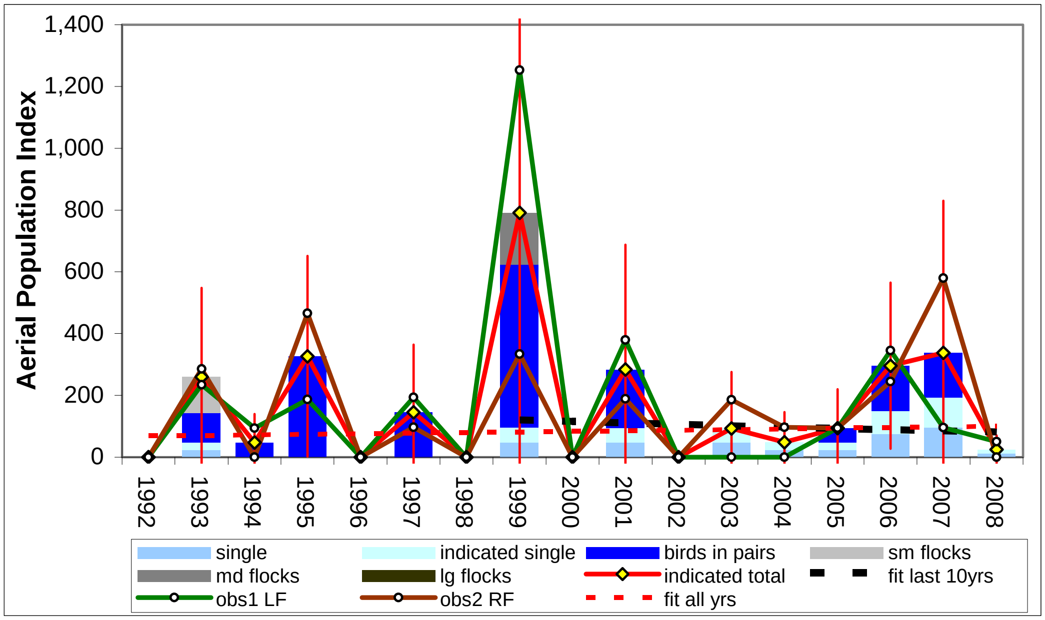
KIEI

<u>Aerial index: Indicated total</u>

n yrs =	16
mean pop index =	**13421**
std dev =	2258
std error =	565
low 90%ci =	12314
high 90%ci =	14527
ln linear slope =	0.0232
SE slope =	0.0071
Growth Rate =	**1.023**
low 90%ci GR =	1.011
high 90%ci GR =	1.036
regression resid CV =	0.132
avg sampling err CV =	0.100
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	10.3
w/ sample error CV =	8.6
<u>trend of most recent 10 years :</u>	
Growth Rate =	**1.029**
low 90%ci GR =	1.005
high 90%ci GR =	1.053

Figure 16. Population trend for King Eider (*Somateria spectabilis*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years. A low index in 1992 was excluded from trend calculation because the survey was flown too late in June.

STEI **Steller's Eider** North Slope early-June survey



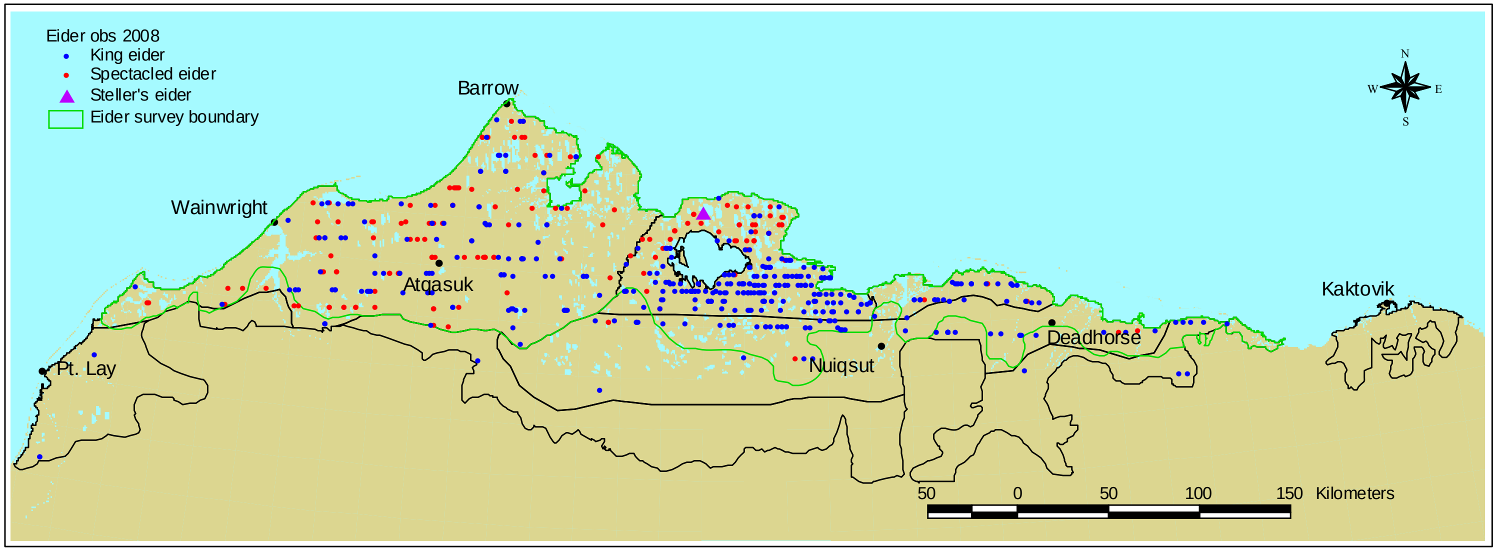
NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	0	0	0	0	0	**20**	0
1993	48	94	118	0	0	**260**	147
1994	0	47	0	0	0	**47**	47
1995	0	327	0	0	0	**326**	166
1996	0	0	0	0	0	**20**	0
1997	0	145	0	0	0	**145**	112
1998	0	0	0	0	0	**20**	0
1999	96	527	0	168	0	**791**	458
2000	0	0	0	0	0	**20**	0
2001	95	189	0	0	0	**284**	206
2002	0	0	0	0	0	**20**	0
2003	93	0	0	0	0	**93**	93
2004	48	0	0	0	0	**48**	50
2005	47	47	0	0	0	**94**	64
2006	150	147	0	0	0	**296**	137
2007	193	145	0	0	0	**338**	251
2008	25	0	0	0	0	**25**	23

STEI

Aerial index: Indicated total	
n yrs =	17
mean pop index =	**168**
std dev =	202
std error =	49
low 90%ci =	72
high 90%ci =	263
ln linear slope =	0.0234
SE slope =	0.0647
Growth Rate =	**1.024**
low 90%ci GR =	0.920
high 90%ci GR =	1.139
regression resid CV =	1.312
avg sampling err CV =	0.750
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	47.7
w/ sample error CV =	32.9
trend of most recent 10 years :	
Growth Rate =	**0.958**
low 90%ci GR =	0.744
high 90%ci GR =	1.232

Figure 17. Population trend for Steller's Eider (*Polysticta stelleri*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years. To calculate slope, an index value of 20 was substituted for years with no observations.



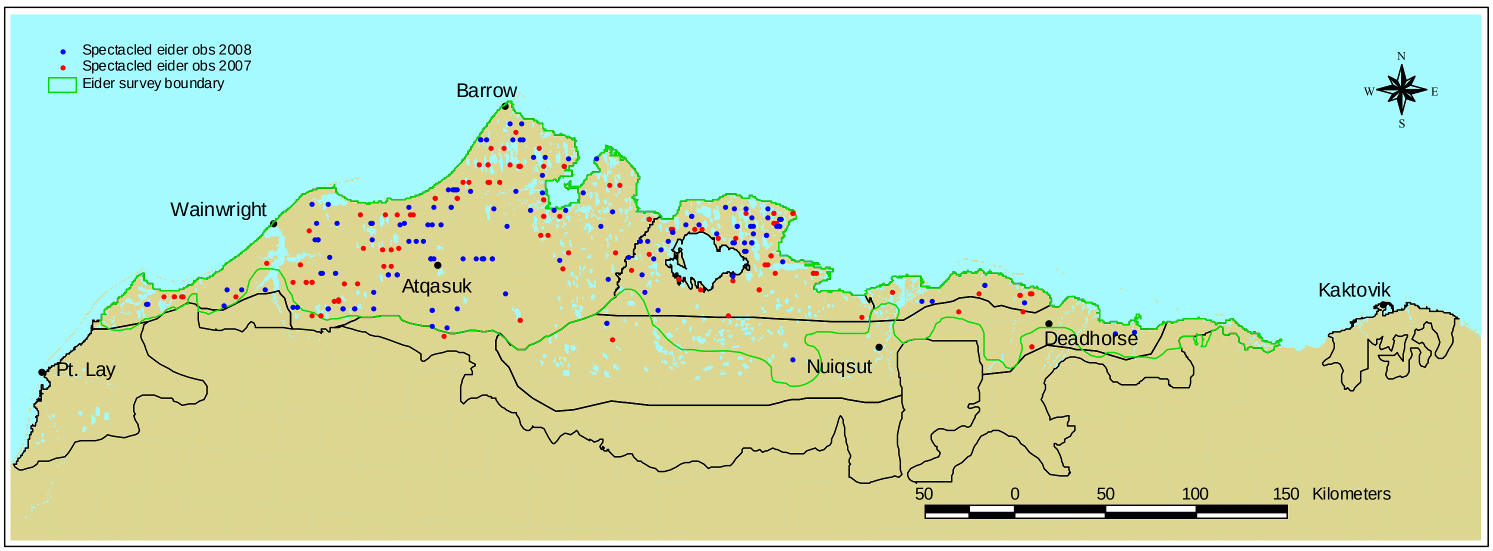
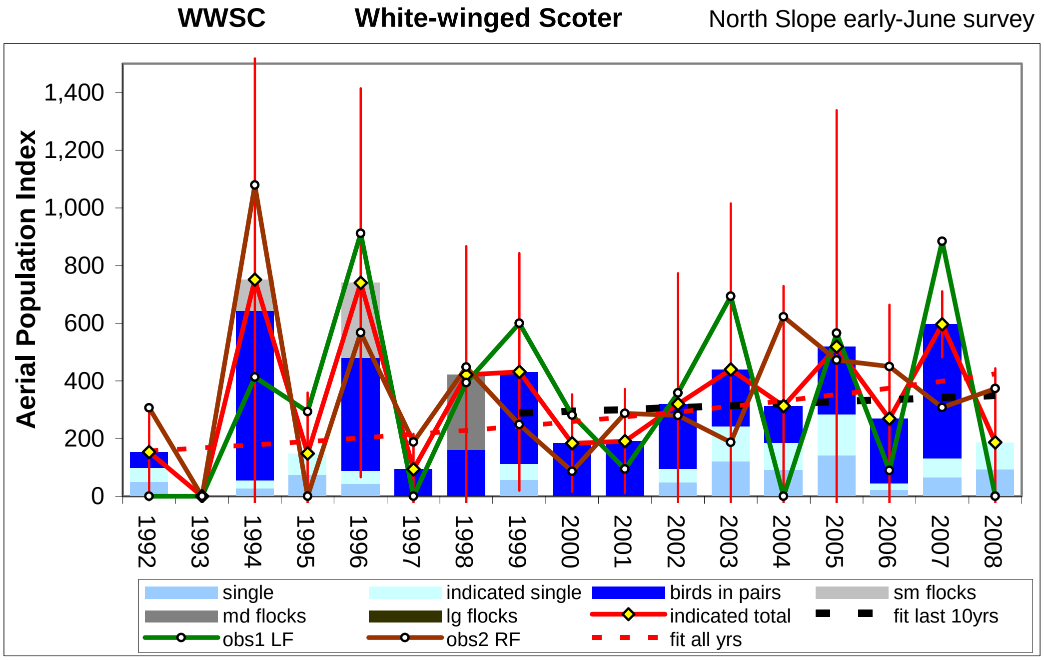


Figure 18.(top). Location of spectacled, king and Steller's eiders observed during aerial surveys, Arctic Coastal Plain, Alaska, June 2008.
Figure 19 (bottom) Location of spectacled eiders observed during aerial surveys, Arctic Coastal Plain, Alaska, June 2007 and 2008.



NSE 10 strata =30,465 km2

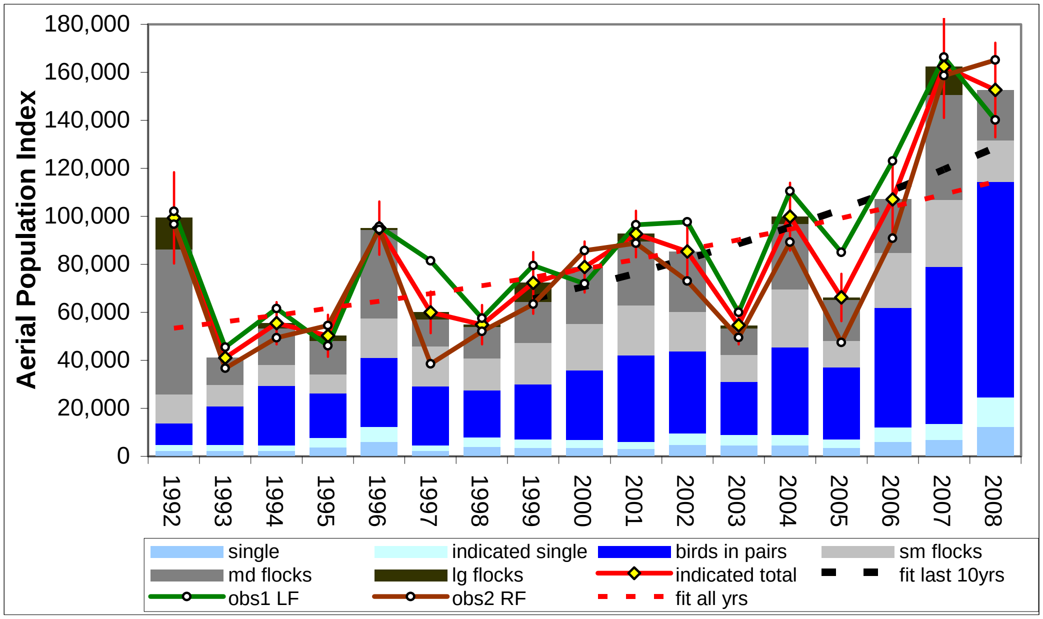
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	98	55	0	0	0	**153**	85
1993	0	0	0	0	0	**20**	0
1994	55	588	109	0	0	**752**	585
1995	148	0	0	0	0	**148**	108
1996	87	392	261	0	0	**740**	344
1997	0	94	0	0	0	**94**	62
1998	0	160	0	261	0	**421**	227
1999	112	319	0	0	0	**431**	210
2000	0	184	0	0	0	**184**	86
2001	0	191	0	0	0	**191**	92
2002	94	225	0	0	0	**319**	232
2003	242	198	0	0	0	**440**	294
2004	185	128	0	0	0	**313**	212
2005	283	235	0	0	0	**519**	418
2006	45	225	0	0	0	**269**	201
2007	132	464	0	0	0	**596**	58
2008	186	0	0	0	0	**186**	131

WWSC

Aerial index: Indicated total	
n yrs =	17
mean pop index =	**340**
std dev =	218
std error =	53
low 90%ci =	236
high 90%ci =	444
ln linear slope =	0.0619
SE slope =	0.0428
Growth Rate =	**1.064**
low 90%ci GR =	0.992
high 90%ci GR =	1.141
regression resid CV =	0.866
avg sampling err CV =	0.600
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	36.2
w/ sample error CV =	28.3
trend of most recent 10 years :	
Growth Rate =	**1.022**
low 90%ci GR =	0.940
high 90%ci GR =	1.110

Figure 20. Population trend for White-winged Scoters (*Melanitta fusca*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years. To calculate slope, an index value of 20 was substituted for years with no observations.

WFGO **White-fronted Goose** North Slope early-June survey



NSE 10 strata =30,465 km2

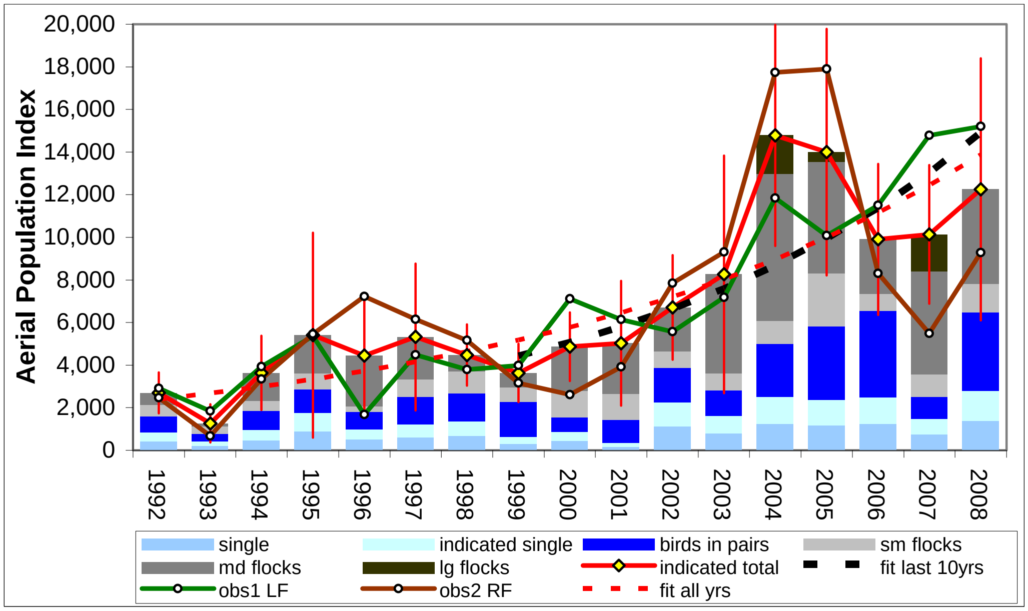
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	4794	8915	12107	60359	13185	**99361**	9691
1993	4760	16232	8712	11378	0	**41083**	2856
1994	4538	24854	8764	15121	2240	**55517**	4494
1995	7702	18479	7962	14033	2096	**50272**	4464
1996	12280	28850	16325	36897	773	**95125**	5640
1997	4632	24567	16692	11212	2854	**59956**	4413
1998	7884	19632	13290	13178	855	**54839**	4175
1999	7092	22928	17152	17275	7835	**72283**	6579
2000	6898	29138	19078	23780	0	**78895**	5433
2001	6108	35961	20830	26652	3081	**92632**	4963
2002	9522	34232	16392	25217	0	**85363**	6814
2003	8911	22116	11314	11127	1141	**54609**	4023
2004	8928	36562	24046	27344	2979	**99859**	7212
2005	7071	30148	10886	17160	906	**66171**	5033
2006	11929	50076	22780	22240	0	**107025**	8692
2007	13673	65197	28140	43777	11654	**162441**	10921
2008	24665	89655	17445	20870	0	**152634**	10049

WFGO

Aerial index: Indicated total	
n yrs =	17
mean pop index =	**84004**
std dev =	34137
std error =	8280
low 90%ci =	67776
high 90%ci =	100232
ln linear slope =	0.0476
SE slope =	0.0153
Growth Rate =	**1.049**
low 90%ci GR =	1.023
high 90%ci GR =	1.075
regression resid CV =	0.309
avg sampling err CV =	0.075
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	18.2
w/ sample error CV =	7.1
trend of most recent 10 years :	
Growth Rate =	**1.078**
low 90%ci GR =	1.025
high 90%ci GR =	1.133

Figure 21. Population trend for Greater White-fronted Geese (*Anser albifrons frontalis*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

BLBR **Black Brant** North Slope early-June survey



NSE 10 strata =30,465 km2

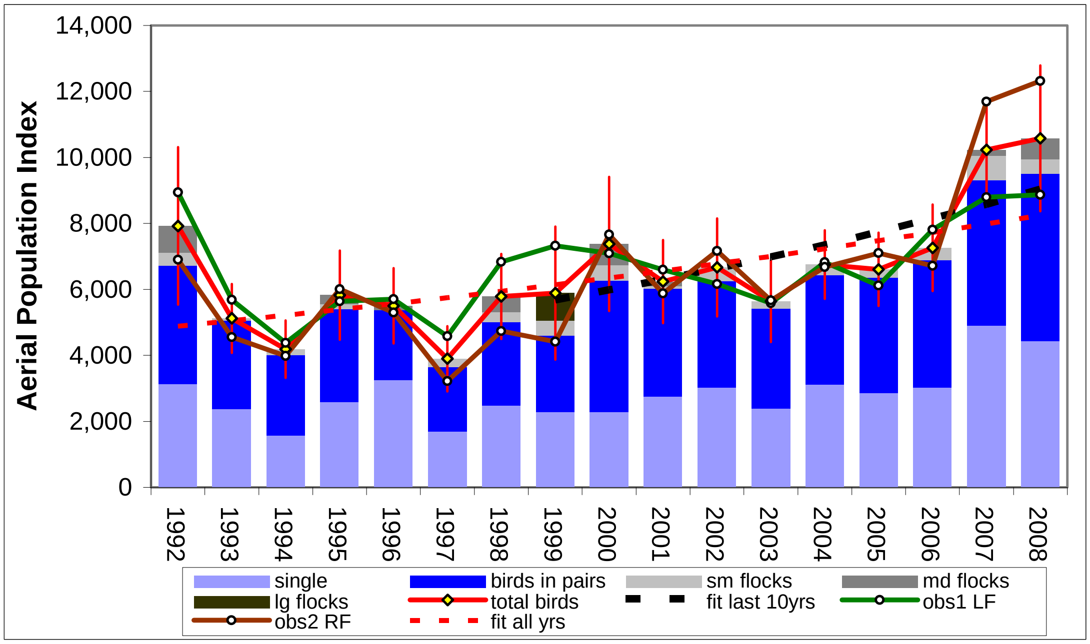
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	844	737	566	549	0	**2695**	490
1993	413	376	331	141	0	**1262**	460
1994	960	893	479	1305	0	**3636**	888
1995	1780	1084	748	1795	0	**5407**	2452
1996	996	815	247	2387	0	**4445**	1439
1997	1224	1264	849	1983	0	**5320**	1758
1998	1357	1333	1015	768	0	**4473**	731
1999	633	1647	677	674	0	**3630**	698
2000	863	692	1217	2093	0	**4864**	821
2001	344	1097	1198	2391	0	**5030**	1494
2002	2235	1628	782	2065	0	**6710**	1251
2003	1609	1208	792	4655	0	**8263**	2844
2004	2505	2476	1102	6885	1816	**14783**	2650
2005	2354	3467	2499	5217	457	**13994**	2951
2006	2486	4041	820	2553	0	**9900**	1808
2007	1481	1022	1068	4841	1726	**10138**	1657
2008	2798	3673	1333	4443	0	**12247**	3140

BLBR

Aerial index: Indicated total	
n yrs =	17
mean pop index =	**6870**
std dev =	4012
std error =	973
low 90%ci =	4963
high 90%ci =	8777
ln linear slope =	0.1096
SE slope =	0.0162
Growth Rate =	**1.116**
low 90%ci GR =	1.087
high 90%ci GR =	1.146
regression resid CV =	0.327
avg sampling err CV =	0.250
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	18.9
w/ sample error CV =	15.8
trend of most recent 10 years :	
Growth Rate =	**1.144**
low 90%ci GR =	1.090
high 90%ci GR =	1.202

Figure 22. Population trend for Pacific Black Brant (*Branta bernicla nigricans*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen but indicated single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

SWAN **Tundra Swan** North Slope early-June survey



NSE 10 strata =30,465 km2

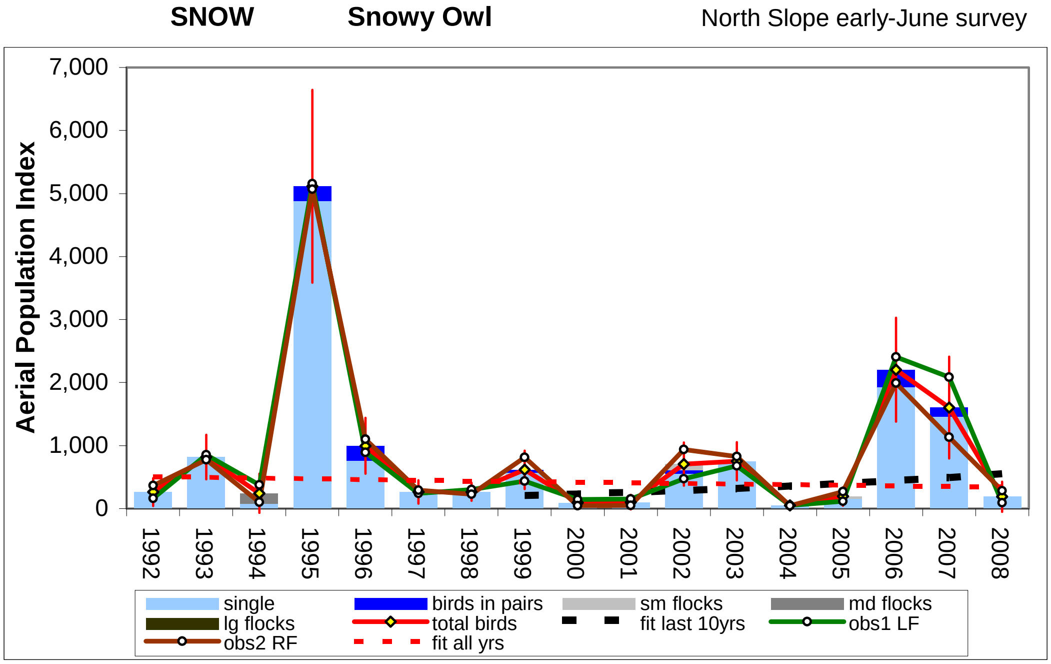
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	3129	3591	394	809	0	**7924**	1219
1993	2366	2682	72	0	0	**5120**	534
1994	1582	2429	177	0	0	**4188**	444
1995	2581	2826	138	280	0	**5824**	690
1996	3246	2126	0	131	0	**5503**	583
1997	1697	1942	260	0	0	**3898**	504
1998	2476	2525	314	473	0	**5788**	656
1999	2282	2317	449	0	839	**5887**	1029
2000	2276	3989	461	655	0	**7380**	1037
2001	2758	3265	71	142	0	**6237**	645
2002	3025	3223	420	0	0	**6668**	758
2003	2381	3050	211	0	0	**5641**	629
2004	3112	3320	322	0	0	**6754**	529
2005	2862	3495	250	0	0	**6607**	566
2006	3024	3862	376	0	0	**7262**	667
2007	4894	4414	749	174	0	**10231**	672
2008	4428	5073	453	622	0	**10575**	1126

SWAN

Aerial index: Total birds

n yrs =	17
mean pop index =	**6558**
std dev =	1787
std error =	434
low 90%ci =	5708
high 90%ci =	7408
ln linear slope =	0.0327
SE slope =	0.0104
Growth Rate =	**1.033**
low 90%ci GR =	1.016
high 90%ci GR =	1.051
regression resid CV =	0.210
avg sampling err CV =	0.112
Power (yrs to detect -50%/20yr rate) :	
w/ regression resid CV =	14.1
w/ sample error CV =	9.3
most recent 10 years :	
Growth Rate =	**1.053**
low 90%ci GR =	1.024
high 90%ci GR =	1.083

Figure 23. Population trend for Tundra Swans (*Cygnus columbianus*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Calculations of power used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.



NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	264	0	0	0	0	**264**	112
1993	817	0	0	0	0	**817**	180
1994	80	0	0	160	0	**240**	158
1995	4880	234	0	0	0	**5113**	780
1996	759	236	0	0	0	**995**	227
1997	265	0	0	0	0	**265**	94
1998	267	0	0	0	0	**267**	72
1999	570	48	0	0	0	**618**	155
2000	95	0	0	0	0	**95**	51
2001	101	0	0	0	0	**101**	60
2002	559	48	99	0	0	**706**	176
2003	751	0	0	0	0	**751**	154
2004	49	0	0	0	0	**49**	36
2005	157	0	36	0	0	**194**	74
2006	1927	277	0	0	0	**2203**	421
2007	1458	144	0	0	0	**1602**	412
2008	188	0	0	0	0	**188**	122

SNOW

Aerial index: Total birds

n yrs =	17
mean pop index =	**851**
std dev =	1243
std error =	301
low 90%ci =	260
high 90%ci =	1442
ln linear slope =	-0.0242
SE slope =	0.0620
Growth Rate =	**0.976**
low 90%ci GR =	0.881
high 90%ci GR =	1.081
regression resid CV =	1.256
avg sampling err CV =	0.374
Power (yrs to detect -50%/20yr rate) :	
w/ regression resid CV =	46.4
w/ sample error CV =	20.7
most recent 10 years :	
Growth Rate =	**1.115**
low 90%ci GR =	0.877
high 90%ci GR =	1.416

Figure 24. Population trend for Snowy Owls (*Bubo scandiacus*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 10 physiographic regions. Average annual growth rate was calculated by log-linear regression. Power calculations used alpha with p=0.10, beta at p=0.20, and a coefficient of variation based on either regression residuals or averaged sampling error. The power of the survey to detect trends can be compared across species using the estimated minimum number of years necessary to detect a slope of -0.0341, a 50% decline in 20 years.

APPENDIX 1. Common and scientific names of species mentioned in this report.

Common Name	**Scientific Name**
Loons: (Family *Gaviidae*)	
Yellow-billed loon	*Gavia adamsii*
Pacific loon	*G. pacifica*
Red-throated loon	G. *stellata*
Gulls, terns, jaegers: (Family *Laridae*)	
Glaucous gull	*Larus glaucescens*
Sabine's gull	*Xema sabini*
Arctic tern	*Sterna paradisaea*
Long-tailed jaegers	*Stercorarius longicaudus*
Parasitic jaeger	*S. parasiticus*
Pomarine jaeger	*S. pomarinus*
Ducks, geese, swans: (Family *Anatidae*)	
Red-breasted merganser	*Mergus serrator*
Mallard	*Anas platyrhynchos*
American wigeon	*A. americana*
Am. Green-winged teal	*A. crecca*
Northern pintail	*A. acuta*
Northern shoveler	*A. clypeata*
Greater scaup	*Aythya marila,*
Lesser scaup	*A. affinis*
Long-tailed duck	*Clangula hyemalis*
Spectacled eider	*Somateria fischeri*
Common eider	*S. mollissima*
King eider	*S. spectabilis*
Steller's eider	*Polysticta stelleri*
Black scoter	*Melanitta nigra*
White-winged scoter	*M. fusca*
Snow goose	*Chen caerulescens*
Canada goose	*Branta canadensis*
Black brant	*B. bernicla*
Greater white-fronted goose	*Anser albifrons*
Tundra swan	*Cygnus columbianus*
Shorebirds: (Families *Scolopacidae*, *Charadriidae*)	
	Charadrius spp., Pluvialis spp., Calidris spp., Arenaria spp., Numenius spp., Limnodromus sp
Cranes: (Family *Gruidae*)	
Sandhill crane	*Grus canadensis*
Ravens: (Family *Corvidae*)	
Common raven	*Corvus corax*
Owls: (Family *Strigidae*)	
Short-eared owl	*Asio flammeus*
Snowy owl	*Bubo scandiacus*
Eagles: (Family *Accipitridae*)	
Golden eagle	*Haliaeetus leucocephalus*