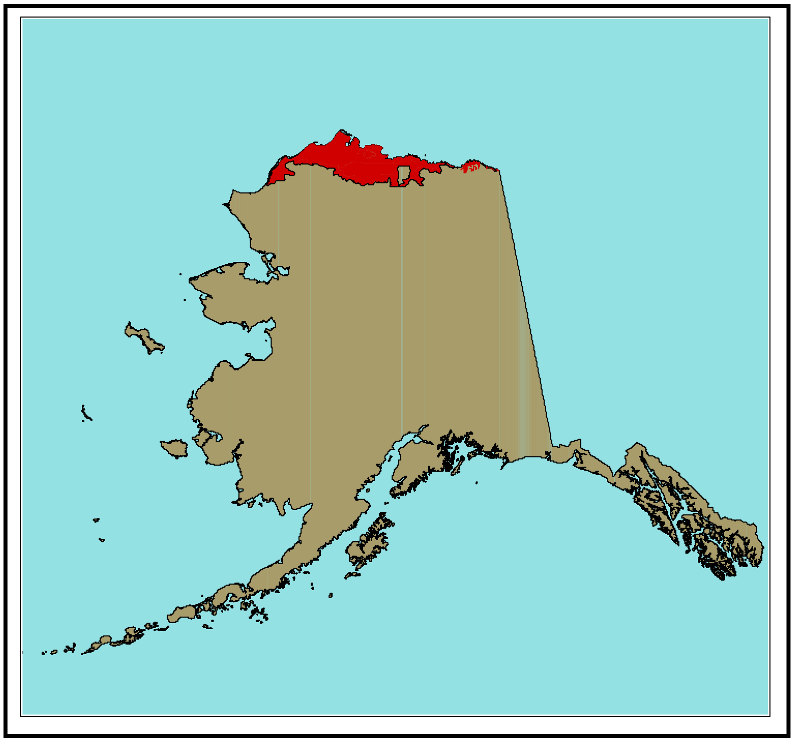
WATERFOWL BREEDING POPULATION SURVEY ARCTIC COASTAL PLAIN, ALASKA 2007



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Waterfowl breeding population survey Arctic Coastal Plain, Alaska 2007

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ABSTRACT. We replaced two annual aerial waterfowl breeding population surveys (ACP Eider Breeding Population Survey and the standard ACP Waterfowl Breeding Population Survey) with a single survey in 2007. This survey was conducted 14-19 June to coincide with the peak presence of males and pairs of eiders and other breeding waterfowl, and covered all major waterfowl habitats within the Arctic Coastal Plain of Alaska (57,335 km^2). Objectives related to monitoring requirements for spectacled eider recovery criteria, harvest levels under the Migratory Bird Treaty Act, and to provide waterbird data for permit requirements for oil and gas exploration and development. Survey methods were unchanged from precedent surveys, except that the 2007 survey used 4 different levels of sampling intensity, versus uniform intensity in the previous surveys. Survey data were analyzed in two different spatial units, using 20 geographical strata for totals of the entire area, and 10 strata for historical context to coincide with the 1992-2006 Eider Survey data. The 1992-2007 population growth rates were calculated using only the 10 eider strata, to minimize bias associated with survey timing effects. We tested for population growth rates significantly greater or less than 1.0 (a=0.10), both for all survey years (1992-2007) and for the most recent 10 years, for 10 primary species. Of these, for all survey years Red-throated loon, and long-tailed duck were <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. While not significant, the 2007 spectacled eider index was the lowest since 1993, which we suspect was related mostly to late survey timing. Pacific loon, king eider, white-fronted goose and tundra swan indices were the highest on record for the eider strata. Some of these high numbers may be attributed to poor interior Alaska nesting conditions due to drought in spring and summer 2007.

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. Accordingly, in anticipation of the listing of spectacled and Steller's eiders under the Endangered Species Act, a second, earlier survey was initiated in 1992 to obtain an accurate 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 local nest failure and influx of molting birds from breeding grounds outside the ACP.

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 date for both historic Standard ACP and Eider Surveys, 1992-2006 (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. Pintails, long-tailed ducks and red-throated loons all showed level trends through and among the two survey periods, suggesting that consistent survey timing within the overall survey period is not critical for tracking trend. Indices for white-fronted geese and tundra swans increased slightly through the period of both surveys, suggesting that a few may arrive in the ACP after the Eider Survey. A sharp increase in percentage of flocked birds in the sample late in the overall survey period (Fig. 2) suggests that some birds may be entering the area from elsewhere to molt. An increase in flocked pintails throughout the period (Fig. 2), however, suggests primarily local failed breeders and post-breeding males, since it is not accompanied by an overall index increase (Fig. 1). Yellow-billed loon data indicate an increase through the overall survey period (Fig. 1), which could be due to late arrival, or may be an artifact of small sample size in the historic Standard ACP Survey (two percent aerial coverage, vs. four percent for the Eider Survey).

For the objective of best describing the breeding distribution of birds we examined flocked birds as a proportion of total indicated birds by median survey date, assuming most waterfowl in post-breeding flocks are unlikely to remain long in the vicinity of breeding territories. Data for pintails, long-tailed ducks, white-fronted geese and tundra swans all exhibited increasing trends in flocking behavior through June and early July (Fig. 2), which supports the early (Eider Survey) period as the best timing for breeding distribution data.

In consideration of the above, we consolidated the two surveys into one in 2007, incorporating all historically productive ACP habitat, but timed in early to mid June to coincide with peak presence of male eiders. The new survey will be titled as the “Waterfowl Breeding Population Survey, Arctic Coastal Plain, Alaska”, and referred to in this report as the "2007 ACP Survey". This report describes the methods and results of the latter survey. For the sake of continuity, long-term trends were calculated and presented using historical data from the Eider Survey and 2007 data from the 10 survey strata matching the geographic extent of the Eider Survey, since the timing of the 2007 ACP Survey matches that of the Eider Survey. Long-term means and 2006 indices from the historic Standard ACP Survey and 2007 totals from all strata are also provided for total ACP context. Analyses are underway to reconcile and perhaps model differences in trends that are attributed to different survey timing and will be reported in a separate document.

OBJECTIVES

Objectives for the 2007 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*

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Study area, survey design, navigation, and observation

The 2007 ACP Survey area consisted of a 57,335 km^2 portion of the 61,645 km^2 historic Standard ACP Survey area. Figure 3 shows this area (coast and green lines) with portions deleted (black lines), and the former Eider Survey area superimposed (red lines). 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 straight-line transects, oriented in an east-west direction (Fig. 4), 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 200 m either side of the flight path. Observers used tape markers placed on the aircraft lift struts to aid in estimating 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. Survey centerlines, along with end-point coordinates, distance figures and segment end indicators, were machine-plotted on 1:250,000 scale U.S. Geological Survey topographic maps, which were used in conjunction with GPS for navigation. Transects were spaced systematically in each of 20 geographic strata

(Fig. 4, 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 was flown in 2007. As in the Eider Survey, the sampling frame will be shifted incrementally each year hereafter, requiring four years for coverage of all transects, then repeated; thus transects flown in 2007 will be flown again in 2011. Stratification slightly decreased variance of estimates of some species, and facilitate comparisons among geographic areas. Transects flown in 2007 are depicted in Fig. 4.

Flight time required to complete the 2007 ACP Survey was 41.2 hours, plus 2.0 hours for reconnaissance. These hours did not include ferry time from Anchorage to and from the survey area. The two crewmembers alternated pilot/port observer and starboard observer duties daily, which reduced pilot fatigue and enabled us to safely increase efficiency by flying slightly longer days.

Data recording and transcription

All bird observations were entered vocally into a microphone connected to a laptop computer. The computer received position data concurrently from a GPS receiver mounted in the aircraft instrument panel. These two 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 may be used to produce maps, tables and other products describing population trends and distribution of the various taxa surveyed. A separate computer was used by each observer, and each computer was connected to the GPS and supplied with power via a 28-volt DC to 110-volt AC inverter connected to the aircraft's electrical system. 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

In general, waterfowl data were treated according to 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. The standard protocol requires the indices for scaup, which have sex ratios strongly skewed toward males (ibid.) and all other waterbird species (monomorphics) to consist of total birds recorded, geographically extrapolated, with single birds not doubled. However, we have 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.

We have attempted to 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, based on adult males for eiders and other sexually dimorphic species, and on individuals seen for monomorphics. While unknown, the proportion is assumed to be constant among years, and the index is used to help track population changes through time. To be consistent with the standard protocol, we have provided 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. detectability of ducks in the Yukon-Kuskokwim Delta is similar to that in the Arctic Slope. Eiders were not included in the study, so no VCF is applied.

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 a mismatch between sampling design and spatial distribution of birds, 2. *mistiming* of the survey relative to bird breeding phenology or asynchronous bird phenology, and 3. variation in *detection* of birds within the sample. In this survey s*ampling error* was addressed using 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 Survey and the 2007 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 and survey timing

Spring breakup began a little later than normal in 2007, with reports of 60 percent snow cover remaining in the Deadhorse/Kuparuk/Colville Delta area on 5 June. Imagery from the NASA Modis Rapid Response website (http://rapidfire.sci.gsfc.nasa.gov/) showed extensive snow and ice cover until 5 June, but warmer sunny weather on 7 and 8 June melted most of the snow, and the 9 June image showed most tundra clear of snow over the entire survey area. Technical and scheduling factors delayed our arrival in Deadhorse until 12 June. Results of a brief aerial reconnaissance that day, limited to the Deadhorse/Kuparuk/Nuiqsut area, showed habitat and waterfowl phenology well advanced, but fog and wind kept us from flying our first transects until 14 June. Both crewmembers were pilots, and alternating pilot duties enabled us to reduce pilot fatigue and safely fly longer days, finishing on 19 June. During the survey, water levels seemed about average, and availability of nesting cover and open water were not limited by residual snow and ice.

The overall ratio of lone males to total males during the survey, a rough measure of survey timing in relation to nest initiation, was well above average, suggesting the 2007 survey was conducted later in relation to nesting than most years (Table 2). The daily trend in this measure showed a gentle upward slope for long-tailed duck and pintail, consistent with other recent years, while both spectacled and king eiders had downward trends, which for eiders in our opinion is consistent with the beginning of post-nest-initiation departure of males (Figure 5). In summary, we feel satellite imagery, observations during the survey, and LDI interpretation all suggest a survey slightly past the optimal period for describing the breeding abundance and distribution of most ducks and geese, but probably timed well for other waterbirds such as loons, gulls and jaegers.

Population indices for selected species

Totals for 2007 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 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 (2007) with 2006 indices and 1986-2005 means from the historic Standard ACP Survey (Mallek et al. 2007). Figures 6-23 include stacked bar graphs and tables describing the size and composition of the 2007 and historic population indices for selected species for the 10 eider strata. We used Eider Survey data for trend because of its similarity to 2007 in timing and spatial coverage. Population growth rates are given both for the full 16 years of data (15 for eiders, see figs. 16 & 17) and for the most recent 10 years. Please note that only bias 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 blue lines represent indices from observer Larned, who observed on all Eider Surveys 1992-2007, mostly from the left (pilot) seat, while the yellow lines trace indices from various other observers who usually occupied the right seat. The discussion section contains some general observations about apparent observer effects suggested by these graphics. Spatial breeding distribution for all of 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 2007 design is new, we did not have adequate data to generate equivalent figures showing density isopleths for the various species this year, and will likely not do so until we accumulate a 4-year data set. Maps showing locations of 2007 observations by species are available by 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 2007 yellow-billed loon index (1,405) was the second highest since 1992, and the population growth rate indicated a significant positive trend over the most recent 10 years (Tables 3-6, Figure 6). The large number of singles in the sample (Fig. 6) is consistent with a phenologically late survey when nest initiation should be well under way (North and Ryan 1988). Distribution was similar to other years: densest in the area between Teshekpuk Lake and Mead River. The Pacific loon index (30,507) was the highest on record for the Eider Survey, and 46 percent higher than the long-term average (Tables 3-6, Fig. 7). The 16 year and 10 year growth rates still do not differ significantly from 1.0 (Table 5). The high densities of Pacific loons occur as far from the coast as we have sampled wherever there were adequate pond densities. The 2007 red-throated loon index (2,846) was the highest since 1996, and more than double the 2006 index (Tables 3-6, Fig. 8). 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 small shallow wetlands, apparently due to competition with the larger and more abundant Pacific loons, and mostly within about 20 km of the coast.

Jaegers

Jaeger species are combined for this survey to help avoid diversion of observer focus from eiders and other higher priority species. The jaeger index fluctuates widely following prey abundance (primarily North American brown lemming, *Lemmus trimucronatus*). Lemming populations spiked across much of the arctic coastal plain in 2006, and were still present in good numbers in many areas in 2007. The 2007 jaeger index (5,502) was 38 percent lower than that of 2006, but still well above the mean of 4,156 (Tables 3-6, Fig. 9). The extremely variable annual index does not indicate a significant trend in either short or long term (Fig. 9).

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 (Fig. 10). This year's index of 19,345 was the highest yet, particularly the single component, possibly due to the lateness of the survey, with many birds observed incubating. The Sabine's gull index (10,113) was also the highest on record, and 47 percent above the 16-year mean (Tables 3, 5). This species shows a significant positive growth rate (1.098, 90%CI=1.041-1.158) over the past 10 years. The arctic tern index increased steadily through 2000, resulting in a significant positive growth rate from 1992-2007, but the trend has been more level since 2000 (Fig. 11, Table 5). The 2007 index (15,040, Table 3) is the highest on record.

Ducks

Most duck indices in 2007 were consistent with trends established over the last several years of the Eider Survey (Figs. 12-19). The 2007 red-breasted merganser index (858), while not the highest on record, is still well above the long-term mean (Table 3, 5, Fig. 12), contributing to the significant positive growth rate over 10 year and 16 year time periods. However, the 2007 all-strata estimate (1,822 expanded using VCF, Table 4) was below both the 2006 and long term average figures for the historic Standard ACP Survey (Table 6), suggesting a late migration pattern for this species. 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, though recording no wigeon this year contributed to a significant negative trend for the most recent 10-year period for that species (Table 5).

Though higher than the preceding two years, the pintail index (44,232) did not rebound enough to break the significant decline over the past 10 years, and was still below the long-term average (Fig. 13). The all-strata 2007 index (185,532, expanded) was well above the 2006 index from the historic Standard ACP Survey (150-161), but below the long-term mean of 224,011 (Table 6)

The 2007 scaup index (7,488) was the second highest on record, and well above the long-term mean (4,246, Fig. 14). ACP scaup, which are assumed to be greater scaup or "unknown" based on wing characteristics when observed flying, continued their increasing trend in 2007. The growth rate is gradual in the long term, but steeper over the most recent 10 years (Fig. 14). The 2007 all-strata scaup index also exceeded both the 2006 and long-term mean figures for the historic Standard ACP Survey (Table 6). Most scaup have been recorded in close association with river systems.

The 2007 long-tailed duck index (24,479) was 19 percent below the long-term mean and the 16-year trend was significantly negative (growth rate 0.980, 90%CI 0.963-0.997, Fig. 15). 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. 15). Assuming the bias of the consistent observer (observer 1, Fig. 15) is more consistent among years, the much steeper slope of the trend line of the starboard observer (obs. 2) suggests that most of the slope of the combined trend is an artifact of the bias of the second observer, and for this species it may be better to use only the data from observer 1.

The 2007 spectacled eider index (4,676) was the lowest on record since 1993, and 30 percent below the long-term mean, but the negative trend in breeding population was not significant in either the long term or 10 year context (Table 5, Fig. 16). Considering the observations made earlier in this report regarding survey timing, it appears likely that the substantial drop in this year's index was at least partly due to late survey timing. Ten of 232 indicated birds in the sample were recorded outside the 10 eider strata.

The king eider index (17,685) was the highest on record for the Eider Survey, and 34 percent above the long-term mean (Table 5, Fig. 17). The positive trend was significant in both long-term and the recent 10 year period.

Common eiders nest primarily on barrier islands and other coastal habitats, most of which are not sampled by this survey. A specific coastal survey is conducted for this species, by C. Dau and others (Dau and Larned 2007).

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. This year was classified by researchers as a "non-breeding year" in the Barrow area and the annual survey by Alaska Biological Research, Inc. was abbreviated (N. Rojek pers. Comm., R. Richie, pers. comm.). Nevertheless, we recorded 7 observations of Steller's eiders, 4 of which were among a group of large lakes about 40 km SE of Barrow, an area reported as the general location of most of the sightings by the ABR aerial crew. Our index (338) was the second highest in the 16 years of the Eider Survey (Fig. 18).

Nearly all scoters recorded on the Eider Survey 1992-2006 were white-winged scoters, and most of those were in stratum 11 (Fig. 4) located south of Teshekpuk Lake, primarily along the drainages of Fish Creek and the Ikpikpuk River. The 2007 white-winged scoter index (596) continued a significant long-term upward trend (Table 5, Fig 19). However, most scoters in 2007 were recorded in strata 12 and 13, south of the eider strata, producing a much higher estimate for the entire survey area (3,437, or 4,021 expanded by VCF, Table 4). The long-term mean for the historic Standard ACP Survey was substantially higher (10,437, Table 6), possibly because the latter survey was flown later and scoters are known to be late breeders, and/or there is normally a late influx of molt migrants. Note that the historic 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.

Geese and swans

This survey does not adequately sample snow geese, which occur mainly in isolated coastal breeding colonies. The spectacular 2007 index (64,110, Table 3) resulted from one transect bisecting a large breeding colony on the Ikpikpuk River Delta.

The white-fronted goose index (162,441, Fig. 20) is also spectacularly high this year – 52 percent higher than that of 2006, 104 percent greater than the long term mean for the Eider Survey, and the 2007 all-strata index (226,952, Tables 4, 6) even exceeds the highest index from the historic Standard ACP Survey (192,426 in 1999, Mallek et al. 2007). The close agreement among observers in 2007 (Fig. 20) lends confidence to this estimate. The high population this year may have resulted from molt migration of non-breeding and failed breeding birds from the interior where low spring and summer water levels depressed breeding.

The 2007 Canada goose indices were 17,285 (eider strata, Table 3) and 28,346 (all strata, Table 4). The 2007 Canada goose index in the eider strata was the highest since the spike in the late Eider Survey year of 1992, and the 2007 all-strata index (28,346) was the highest since 1999 (Mallek 2007).

Most Black brant nest colonially on the North Slope, so trends are difficult to detect with our systematic transect survey design. The 2007 index (10,138) was similar to that of 2006, though quite different in composition (Fig. 21). The all-strata index was also very similar to the long-term average from the historic Standard ACP Survey (Table 6). Our data suggest a significant positive growth rate over the Eider Survey 16-year history and the most recent 10 years (Table 5, Fig. 21), but we suspect this may be spurious, as much of our annual brant sample consists of a variable component of non-breeders or failed breeders from western Alaska (Ritchie et al. 2002) evidenced by the high proportion of flocked birds in our sample most years (Fig. 21). Ritchie et al. (2002) 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 2007 tundra swan index (10,231) was the highest on record for the eider strata (Fig. 22), and the all-strata index (13,444) was well above that of 2006 and the long-term mean (10,174, 9,961 respectively, Table 6). Tundra swan indices indicate a significant positive growth rate for both long-term (1.027) and 10-year (1.038) reference periods (Table 5, Fig. 22).

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, using our small 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. Although brown lemmings were apparently much less abundant in 2007 than in 2006 (personal observation and numerous contacts in Barrow), we still recorded above-average numbers of short-eared and snowy owls (eider strata indices 120 and 1,602, respectively, Table 3, Fig. 23). Most of the snowy owl observations were within 30 km of the coast, from Harrison Bay to Barrow, with a few others widely scattered elsewhere.

We have recorded very few sandhill cranes during the Eider Survey (2007 ACP Survey index from 10 eider strata = 73, Eider Survey 1992-2007 mean = 122, Table 5). We began recording shorebirds during the Eider Survey in 1997, largely as a measure of timing of 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 (0.973) is not significantly different from 1.0 (Table 5).

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 changes related to expanding human populations. 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 as 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).

Since 2007 was the first year of the design combining the Eider and the historic Standard ACP Survey, and apparently an anomalous year for phenological timing, it is premature to evaluate its efficacy compared to its predecessors. However, we are confident that the primary survey objectives are adequately addressed.

The trends for individual observers in the population trend graphs for these focal species (Figs. 6-8, 13-17, 20) 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. 16 and 17), 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. 6-8) 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 record more loons. Pintails (Fig. 13) and long-tailed ducks (Fig. 15) 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. 20), 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 insight 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 as in 2007, except for the following:

Due to the "low" sampling intensity selected for Stratum 1 (Arctic National Wildlife Refuge, Fig. 3), and its size and configuration, there will often be only a single transect flown, which ends far away from our field base at Deadhorse, and leaves the stratum poorly sampled. This area has very low densities of waterfowl and the coastal zone, which is most important, is sampled during the late-June common eider survey. We plan to either drop the stratum altogether, or apply "medium" sampling intensity, which in most years should result in one transect each direction, replacing "deadhead" with productive survey flight time on the return trip to Deadhorse.

We welcome comments on these proposals, or other suggestions for improving the survey.

ACKNOWLEDGMENTS

The authors would like to thank Rob MacDonald for the excellent job during his first season as observer and alternate pilot 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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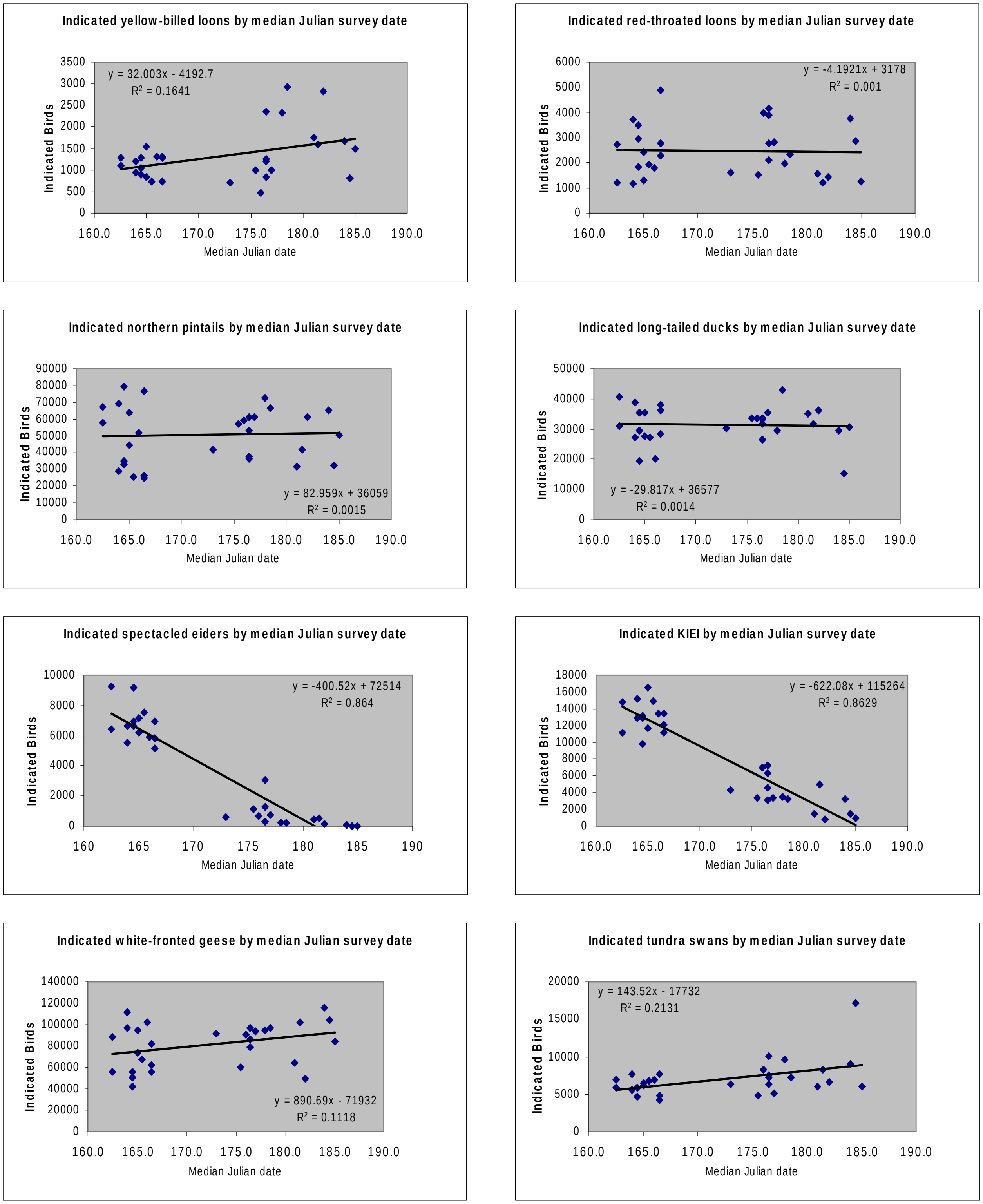


Figure 1. Indicated birds of selected species by median Julian survey date, Eider and Standard ACP Surveys, arctic coastal plain of Alaska, 1992-2006.

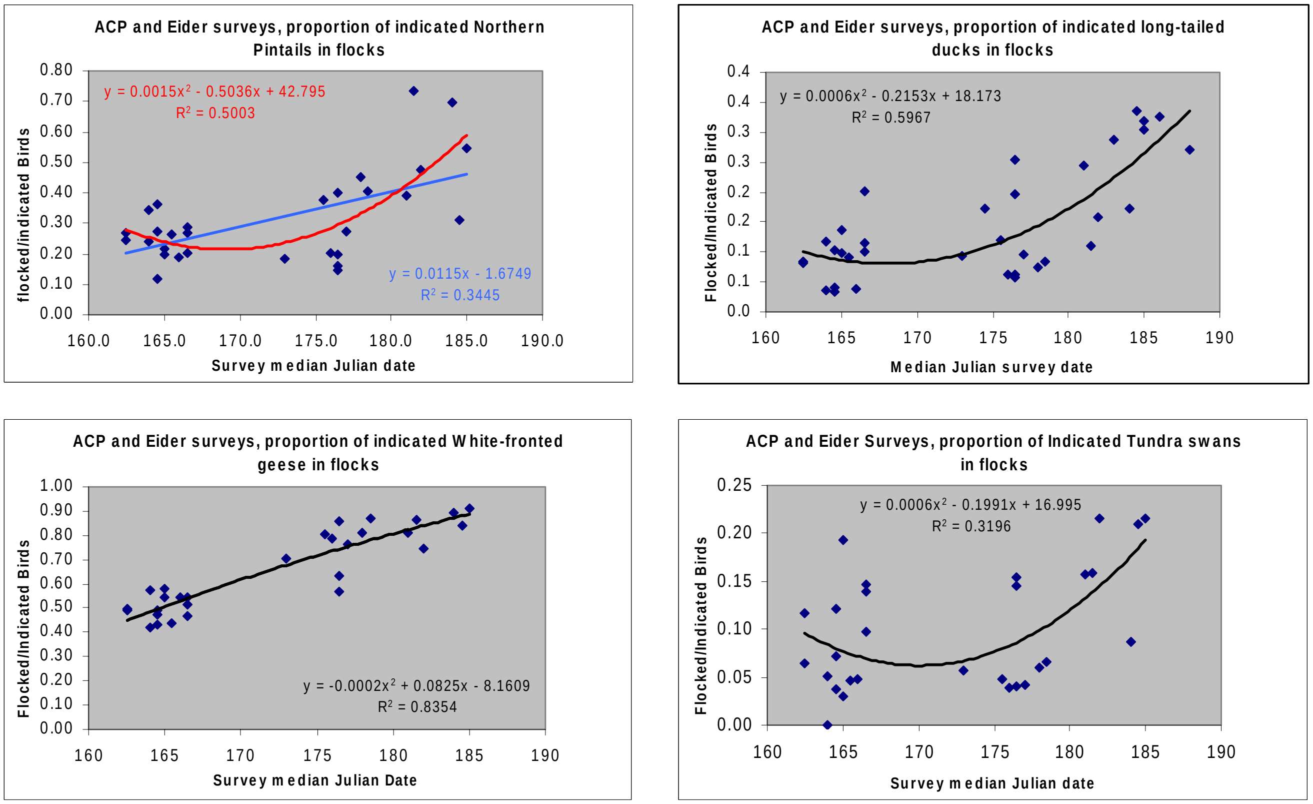


Figure 2. Proportion of birds in groups of 3 or more in the survey sample, Eider and Standard ACP Surveys, arctic coastal plain, Alaska, 1986-2006.

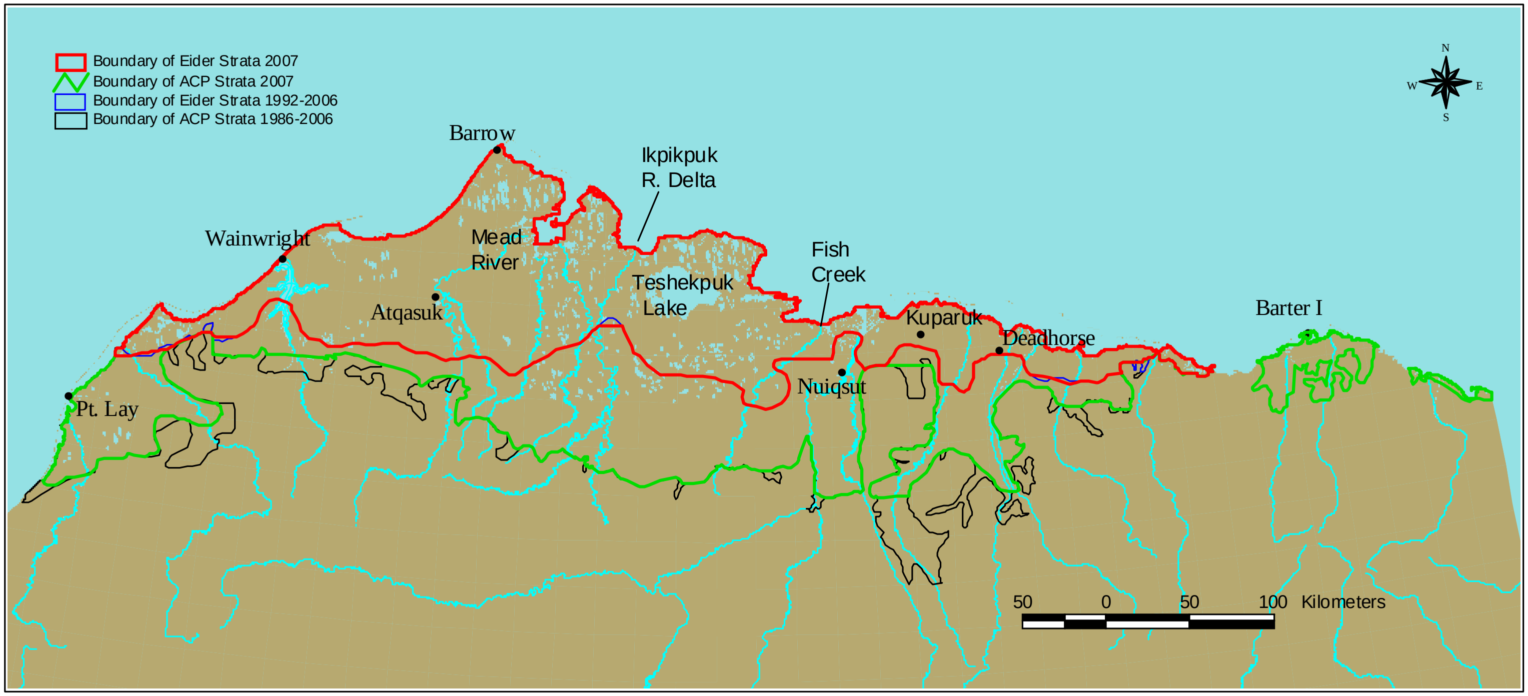


Figure 3. Boundaries of the 2007 ACP Survey, Arctic Coastal Plain, Alaska (green lines, total 57,335 km^2), with boundary of eider strata (red lines, total 30,465 km^2) used for comparison with 1992-2006 Eider Survey for trend analysis. Also shown are portions of the 1986-2006 historic Standard ACP Survey (black lines).and the Eider Survey (blue lines) which were eliminated from the current design.

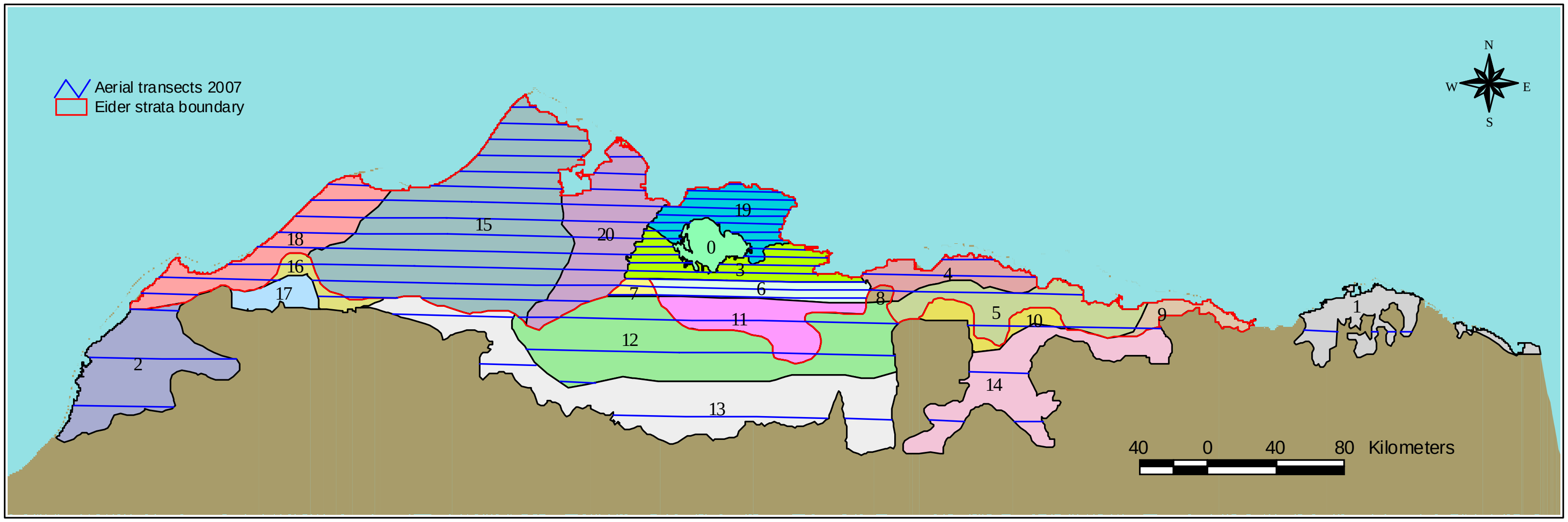


Figure 4. Spatial design of the aerial waterfowl breeding population survey, Arctic Coastal Plain, Alaska, June 2007.

Table 1. Sampling design by stratum, aerial waterfowl breeding population survey, Arctic Coastal Plain, Alaska, June 2007. ID numbers refer to Fig. 3, above.

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				13	S Central Low	7,652	104	1.4
1	Arctic NWR Low	1,812	17	0.9	14	Sag Low	3,571	33	0.9
2	Pt Lay Low	3,916	68	1.7	15	Barrow Hi	11,358	473	4.2
3	Teshekpuk SHi	2,019	187	9.3	16	S Kuk Hi	582	20	3.4
4	Colville Hi	1,423	57	4.0	17	S. Kuk Low	748	2	0.3
5	Prudhoe Med	2,581	62	2.4	18	Icy Wain Hi	3,093	127	4.1
6	S Teshekpuk SHi	1,362	99	7.3	19	N Teshekpuk SHi	2,044	171	8.3
7	SW Teshekpuk SHi	226	20	8.6	20	E Dease Hi	3,768	155	4.1
8	S Colville Hi	128	6	4.5					
9	Canning Low	577	5	0.8	All Low:1,2,9,13,14,17		18,276	228	1.2
10	Sag Med	784	11	1.4	All Med:5,10,11,12		13,058	247	1.9
11	Central Med	2,240	41	1.8	All Hi: 4,8,15,16,18,20		20,351	838	4.1
12	S Eid Med	7,453	133	1.8	All SHi: 3,6,7,19		5,650	477	8.4

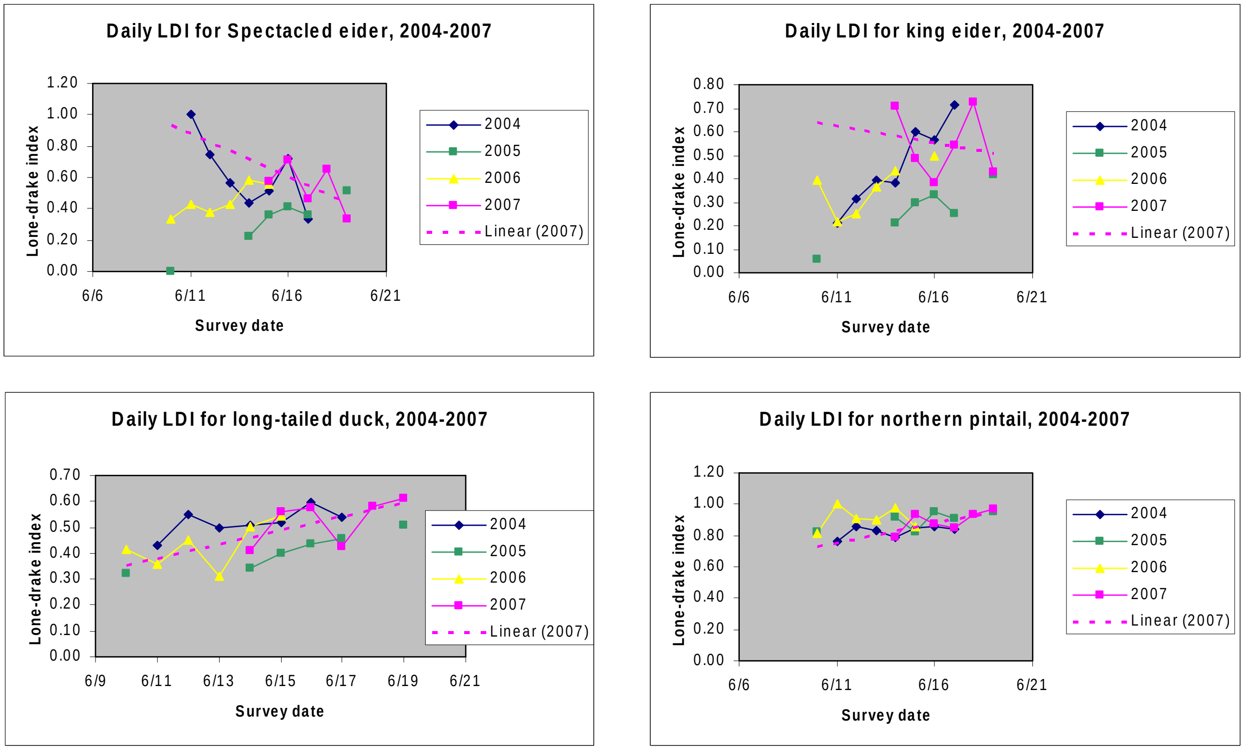


Figure 5. Daily ratio of lone males to total males (lone males plus males in pairs) of selected duck species observed during the Eider Survey (2004-2006) and the 2007 aerial waterfowl breeding population survey, arctic coastal plain, Alaska.

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 ratios for the 2007 aerial waterfowl breeding population survey, arctic coastal plain, Alaska.

Species	LDI Avg. 1992-2006	LDI SE	LDI range	LDI 2007
Spectacled eider	0.49	0.08	0.29-0.59	0.58
King eider	0.35	0.12	0.14-0.58	0.50
Long-tailed duck	0.49	0.04	0.39-0.57	0.54
Northern pintail	0.82	0.07	0.67-0.90	0.89

Table 3. Combined observations by starboard and port observers on aerial survey transects, arctic coastal plain, Alaska, June 2007, 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	40	16	0	72[1]	0.046	1,405	914-1,896	NA		17.8
Pacific Loon	310	522	29	1383[1]	1.001	30,507	27,517-33,497	NA		5.0
Red-throated loon	40	47	0	134[1]	0.093	2,846	2,085-3,607	NA		13.6
Jaeger spp.[3]	172	23	16	234[1]	0.181	5,502	3,721-7,283	NA		16.5
Glaucous gull	420	121	262	924[1]	0.635	19,345	14,661-24,029	NA		12.4
Sabine's gull	162	100	177	539[1]	0.332	10,113	7,947-12,279	NA		10.9
Arctic tern	345	148	77	718[1]	0.494	15,040	12,634-17,446	NA		8.2
Red-breasted merganser	5	10	5	35[2]	0.028	858	227-1,489	1.27	1,090	37.5
Mallard	4	0	0	8[2]	0.012	359	8-871	4.01	1,440	72.8
Am. wigeon	0	0	0	0[2]				3.84	0	
Am. Green-winged teal	3	0	0	6[2]	0.005	145	6-347	8.36	1,212	71.1
Northern pintail	688	78	737	2269[2]	1.452	44,232	34,770-53,694	3.05	134,908	10.9
Northern shoveler	1	5	0	12[2]	0.008	240	50-430	3.79	910	40.4
Greater scaup	79	77	88	321[1]	0.246	7,488	4,521-10,455	1.93	14,452	20.2
Long-tailed duck	268	232	149	1149[2]	0.804	24,480	20,840-28,120	1.87	45,778	7.6
Spectacled eider	64	47	0	222[2]	0.154	4,677	3,368-5,986	NA		14.3
Common eider	3	3	0	12[2]	0.01	293	12-670	NA		65.7
King eider	213	207	19	859[2]	0.581	17,685	14,178-21,192	NA		10.1
Steller's eider	4	3	0	14[2]	0.011	337	14-829	NA		74.4
Black scoter	1	1	0	4[2]	0.003	97	4-233	1.17	113	71.8
White-winged scoter	2	5	0	14[2]	0.02	596	482-710	1.17	697	9.8
Snow goose	3	99	2486	2687[1]	2.104	64,110	NA	NA		87.4
Gr. White-fronted goose	337	1626	4264	8190[2]	5.332	162,441	141,035-183,847	NA		6.7
Canada goose	36	65	850	1052[2]	0.567	17,285	9,886-24,684	NA		21.8
Black brant	41	29	511	651[2]	0.333	10,138	6,889-13,387	NA		16.3
Tundra swan	218	106	37	467[1]	0.336	10,231	8,914-11,548	NA		6.6
Sandhill crane	2	0	0	2[1]	0.001	36	2-83	NA		65.6
Unid. Shorebird[4]	803	389	484	2065[1]	1.477	44,994	39,214-50,774	NA		6.6
Common raven	1	0	0	1[1]	<0.001	14	1-37	NA		85.3
Short-eared owl	5	0	0	5[1]	0.004	120	5-241	NA		51.5
Snowy owl	66	3	0	72[1]	0.053	1,602	793-2,411	NA		25.8
Golden eagle	4	0	0	4[1]	0.003	96	21-171	NA		39.8

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.

Table 4. Combined observations by starboard and port observers on aerial survey transects, arctic coastal plain, Alaska, June 2007, 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	45	16	0	77[1]	0.03	1,702	1,146-2,258	NA		16.7
Pacific Loon	357	606	29	1598[1]	0.751	43,053	37,834-48,272	NA		6.2
Red-throated loon	45	51	4	151[1]	0.064	3,667	2,660-4,674	NA		14.0
Jaeger spp.[3]	246	30	16	322[1]	0.193	11,088	9,033-13,143	NA		9.5
Glaucous gull	473	133	262	1001[1]	0.433	24,826	20,040-29,612	NA		9.8
Sabine's gull	180	108	177	573[1]	0.202	11,590	9,071-14,109	NA		11.1
Arctic tern	439	172	101	884[1]	0.43	24,646	21,392-27,900	NA		6.7
Red-breasted merganser	7	13	5	45[2]	0.025	1,435	252-2,618	1.27	1,822	42.1
Mallard	4	1	4	14[2]	0.014	801	14-1,599	4.01	3,212	50.8
Am. wigeon	0	1	0	2[2]	<0.001	23	2-56	3.84	88	72.1
Am. Green-winged teal	5	1	0	12[2]	0.01	555	200-910	8.36	4,640	32.7
Northern pintail	782	95	754	2508[2]	1.061	60,830	50,223-71,437	3.05	185,532	8.9
Northern shoveler	1	5	0	12[2]	0.004	240	50-430	3.79	910	40.4
Greater scaup	130	147	88	512[1]	0.341	19,559	15,015-24,103	1.93	37,749	11.9
Long-tailed duck	321	279	149	1349[2]	0.659	37,782	32,835-42,729	1.87	70,652	6.7
Spectacled eider	67	49	0	232[2]	0.092	5,288	3,864-6,712	NA		13.7
Common eider	3	4	0	14[2]	0.008	440	14-908	NA		54.3
King eider	226	222	19	915[2]	0.362	20,783	16,990-24,576	NA		9.3
Steller's eider	4	3	0	14[2]	0.006	337	14-829	NA		74.4
Black scoter	1	1	0	4[2]	0.002	97	4-233	1.17	113	71.8
White-winged scoter	3	24	0	54[2]	0.06	3,437	1,161-5,713	1.17	4,021	33.8
Snow goose	3	99	2486	2687[1]	1.118	64,110	NA	NA		87.4
Gr. White-fronted goose	370	1745	4897	9127[2]	3.958	226,952	199,488-254,416	NA		6.2
Canada goose	49	81	954	1214[2]	0.494	28,346	17,296-39,396	NA		19.9
Black brant	41	29	511	651[2]	0.177	10,138	6,889-13,387	NA		16.3
Tundra swan	240	123	40	526[1]	0.234	13,444	11,822-15,066	NA		6.2
Sandhill crane	3	0	0	3[1]	0.002	110	3-282	NA		79.6
Unid. Shorebird[4]	944	439	547	2369[1]	1.075	61,662	53056-70268	NA		7.1
Common raven	4	0	0	4[1]	0.002	252	14-490	NA		48.2
Short-eared owl	5	0	0	5[1]	0.002	120	5-241	NA		51.5
Snowy owl	67	3	0	73[1]	0.03	1,711	887-2,535	NA		39.2
Golden eagle	6	0	0	6[1]	0.005	262	14-510	NA		48.2

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.

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 1992-2007 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.

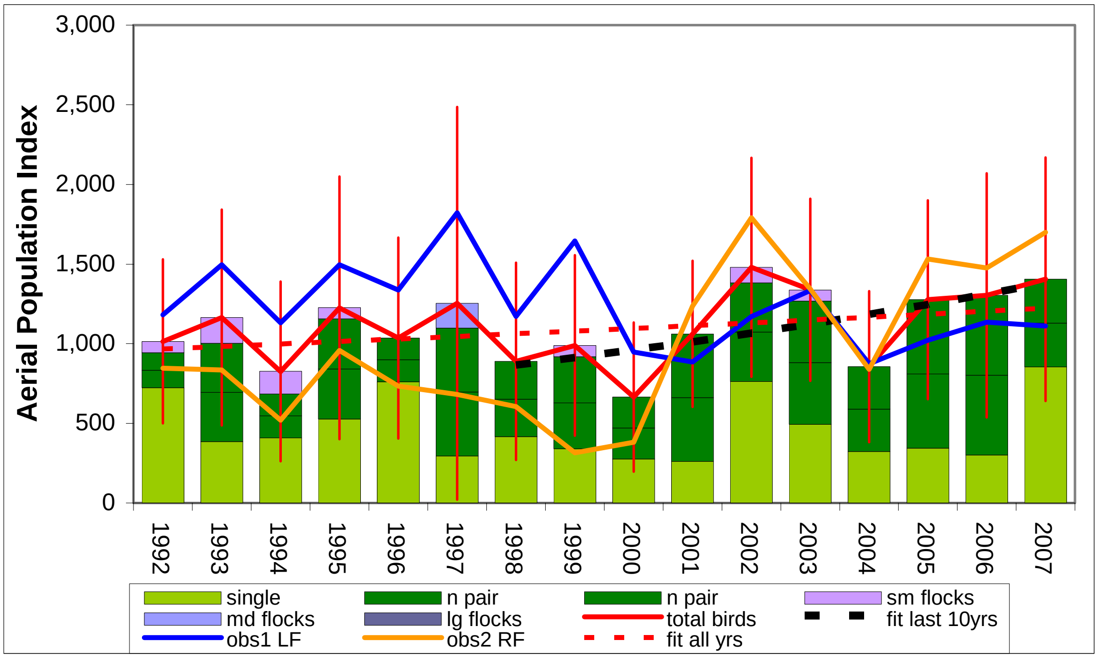
Species	Measure	Years	n years	Mean pop. Index	Log-linear slope	Mean pop. growth rate	Pop. Growth rate 90% CI	Avg. sampling error coef. of variation	Years to detect a slope of 0.0341	Mean pop. growth rate last 10 years	Pop. GR last 10 years 90% CI
Yellow-billed loon	S + 2*Pr + Fl	1992-2007	16	1,107	0.016	1.016	0.996 - 1.036	0.228	15	**1.056**	1.014-1.099
Pacific Loon	S + 2*Pr + Fl	1992-2007	16	20,787	0.008	1.008	0.989 - 1.026	0.071	7	**1.039**	1.002-1.077
Red-throated loon	S + 2*Pr + Fl	1992-2007	16	2,611	-0.054	**0.947**	0.916 - 0.980	0.150	12	1.041	0.980-1.105
Jaeger spp.	S + 2*Pr + Fl	1992-2007	16	4,154	0.012	1.012	0.970 - 1.056	0.116	10	1.033	0.947-1.126
Glaucous gull	S + 2*Pr + Fl	1992-2007	16	12,414	0.007	1.007	0.984 - 1.031	0.155	12	1.031	0.981-1.083
Sabine's gull	S + 2*Pr + Fl	1992-2007	16	6,881	0.015	1.015	0.986 - 1.046	0.137	11	1.098	1.039-1.159
Arctic tern	S + 2*Pr + Fl	1992-2007	16	10,363	0.039	**1.040**	1.025 - 1.054	0.113	9	1.026	0.990-1.063
Red-breasted merganser	2 * (S + Pr) + Fl	1992-2007	16	468	0.108	**1.114**	1.057 - 1.175	0.404	22	**1.137**	1.083-1.193
Mallard	2 * (S + Pr) + Fl	1992-2007	16	212	-0.031	0.970	0.865 - 1.087	0.640	30	0.903	0.702-1.161
Am. wigeon	2 * (S + Pr) + Fl	1992-2007	16	364	-0.051	0.951	0.860 - 1.051	0.679	31	**0.813**	0.680-0.971
Am. Green-winged teal	2 * (S + Pr) + Fl	1992-2007	16	305	-0.138	**0.871**	0.785 - 0.965	0.506	25	1.022	0.839-1.244
Northern pintail	2 * (S + Pr) + Fl	1992-2007	16	49,019	-0.020	0.980	0.944-1.019	0.101	9	**0.912**	0.869-0.956
Northern shoveler	2 * (S + Pr) + Fl	1992-2007	16	211	0.024	1.024	0.901-1.165	0.549	27	0.857	0.661-1.111
Greater scaup	S + 2*Pr + Fl	1992-2007	16	4,227	0.063	**1.065**	1.039-1.092	0.180	13	**1.089**	1.031-1.150
Long-tailed duck	2 * (S + Pr) + Fl	1992-2007	16	30,408	-0.021	**0.980**	0.963-0.997	0.070	7	0.962	0.924-1.002
Spectacled eider	2 * (S + Pr) + Fl	1993-2007	15	6,664	-0.014	0.987	0.969-1.005	0.110	9	0.971	0.942-1.001
Common eider	2 * (S + Pr) + Fl	1992-2007	16	393	-0.014	0.987	0.903-1.078	0.785	34	1.077	0.889-1.303
King eider	2 * (S + Pr) + Fl	1993-2007	15	13,269	0.022	**1.022**	1.009-1.036	0.095	8	**1.030**	1.006-1.054
Steller's eider	2 * (S + Pr) + Fl	1992-2007	16	172	0.058	1.060	0.946-1.188	0.734	32	1.151	0.904-1.466
Black scoter	2 * (S + Pr) + Fl	1992-2007	16	119	-0.066	0.936	0.845-1.037	0.732	32	**1.126**	1.010-1.256
White-winged scoter	2 * (S + Pr) + Fl	1992-2007	16	349	0.083	**1.086**	1.006-1.173	0.591	28	1.042	0.969-1.121
Snow goose	S + 2*Pr + Fl	1992-2007	16	6,714	0.182	**1.199**	1.064-1.351	0.572	28	1.260	0.965-1.646
Gr. White-fronted goose	2 * (S + Pr) + Fl	1992-2007	16	79,725	0.040	**1.041**	1.013-1.070	0.077	7	**1.072**	1.020-1.126
Canada goose	2 * (S + Pr) + Fl	1993-2007	15	8,067	0.005	1.005	0.964-1.049	0.282	17	1.042	0.959-1.131
Black brant	2 * (S + Pr) + Fl	1992-2007	16	6,580	0.112	**1.119**	1.086-1.153	0.255	16	**1.141**	1.086-1.199
Tundra swan	S + 2*Pr + Fl	1992-2007	16	6,310	0.027	**1.027**	1.008-1.046	0.114	9	**1.038**	1.012-1.065
Sandhill crane	S + 2*Pr + Fl	1992-2007	16	123	0.039	1.039	0.974-1.108	0.651	30	0.956	0.843-1.084
Unid. Shorebird	S + 2*Pr + Fl	1997-2007	11	43,583	-0.027	0.974	0.937-1.012	0.086	8	0.960	0.919-1.003
Common raven	S + 2*Pr + Fl	1992-2007	16	57	-0.028	0.972	0.908-1.041	0.669	31	0.922	0.811-1.049
Short-eared owl	S + 2*Pr + Fl	1992-2007	16	85	0.046	1.047	0.963-1.140	0.494	25	1.003	0.831-1.210
Snowy owl	S + 2*Pr + Fl	1992-2007	16	892	-0.009	0.991	0.884-1.111	0.357	20	1.174	0.936-1.473
Golden eagle	S + 2*Pr + Fl	1992-2007	16	45	0.024	1.024	0.963-1.090	0.811	35	1.104	0.982-1.241

Table 6. Breeding population indices, historic Standard ACP Survey of Alaska (2006 and 1986-2005 means, Mallek et al. 2007), and 2007 ACP Survey. Duck Indices are adjusted using the standard Alaska-Yukon visibility correction factors (Conant et al. 1991).

		ACP Survey[1]		All ACP strata
Species	VCF	2006 (SE)	mean 1986-2005	2007 (SE)
Yellow-billed loon	1.00	1,676 (432)	2,833	1,702 (284)
Pacific Loon	1.00	43,053 (2,281)	29,091	26,783 (2,663)
Red-throated loon	1.00	5,142 (863)	3,145	3,667 (514)
Jaeger spp.[3]	1.00	13,076 (1,048)	6,903	11,088 (1,048)
Glaucous gull	1.00	18,717 (3,514)	17,112	24,826 (2,442)
Sabine's gull	1.00	16,531 (3,575)	11,574	11,590 (1,285)
Arctic tern	1.00	24,329 (3,699)	23,505	24,646 (1,660)
Red-breasted merganser	1.27	3,835 (1,369)	2,265	1,822 (767)
Mallard	4.01	0	1,940	3,212 (1,632)
Am. wigeon	3.84	3,464 (2,163)	4,156	88 (65)
Am. Green-winged teal	8.36	2,357 (1,086)	3,253	4,640 (181)
Northern pintail	3.05	150,161 (19,511)	224,011	185,532 (16,507)
Northern shoveler	3.79	0	1,036	910 (368)
Greater scaup	1.93	23,890 (4,276)	33,163	37,749 (4,474)
Long-tailed duck	1.87	89,403 (14,870)	107,923	70,652 (4,720)
Spectacled eider	1.00	385 (185)	631	5,288 (727)
Common eider	1.00	279 (185)	449	440 (239)
King eider	1.00	5,932 (1,171)	3,902	20,783 (1,935)
Steller's eider	1.00	0	780	337 (251)
Black scoter	1.17	901 (437)	NA	113 (64)
White-winged scoter	1.17	5,179 (1,371)	NA	4,021 (1,161)
All scoters	1.17	9,265	10,437	4,134
Snow goose	1.00	1,046 (555)	3,124	64,110 (56,016)
Gr. White-fronted goose	1.00	113,932 (9,000)	124,465	226,952 (14,012)
Canada goose	1.00	17,892 (10,048)	18,330	28,346 (5,638)
Black brant	1.00	6,042 (1,479)	9,980	10,138 (1,657)
Tundra swan	1.00	10,174 (863)	9,961	13,444 (828)
Sandhill crane	1.00	NA	NA	110 (88)
Common raven	1.00	NA	NA	252 (122)
Short-eared owl	1.00	NA	NA	120 (62)
Snowy owl	1.00	2,465 (308)	1,157	1,711 (926)
Golden eagle	1.00	380 (185)	428	262 (126)

1. Mallek et al. 2006)

Yellow-billed Loon North Slope early-June survey

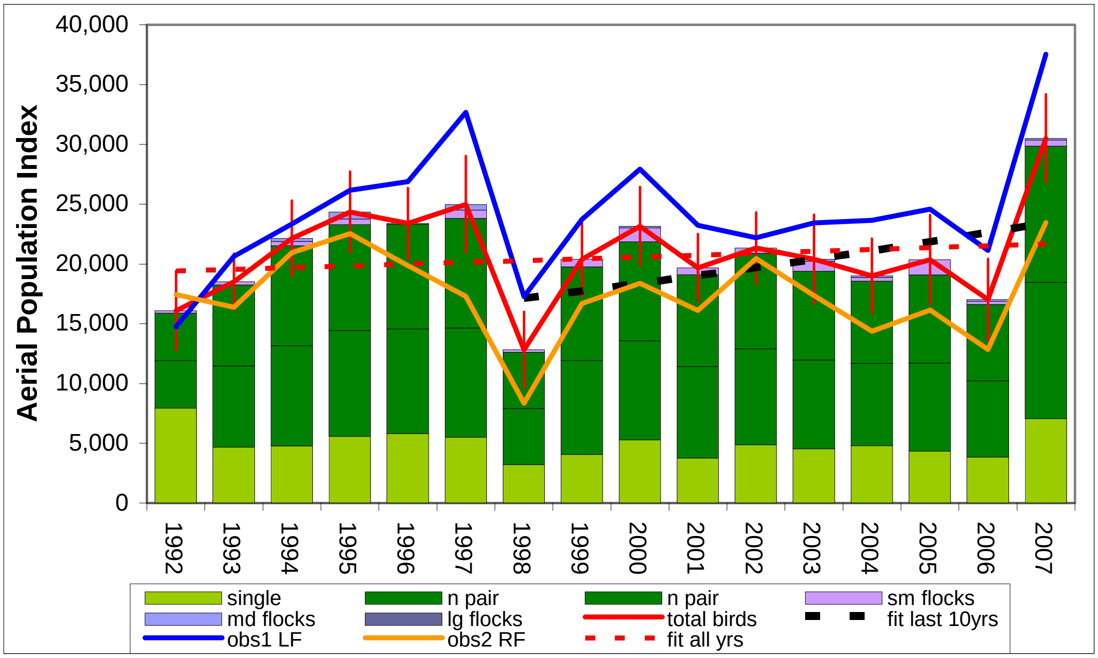


anls (nse 10 strata =30,465 km2) **Aerial index: Total birds** YBLO

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

n yrs =	16
mean =	**1112**
std dev =	231
ln linear slope =	0.0157
SE slope =	0.0117
Growth Rate =	**1.016**
low 90%ci GR =	0.996
high 90%ci GR =	1.035
regression resid CV =	0.215
avg sampling err CV =	0.224
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	14.3
w/ sample error CV =	14.7
most recent 10 years :	
Growth Rate =	**1.053**
low 90%ci GR =	1.012
high 90%ci GR =	1.096

Figure 6. Population trend for Yellow-billed Loons (*Gavia adamsii*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

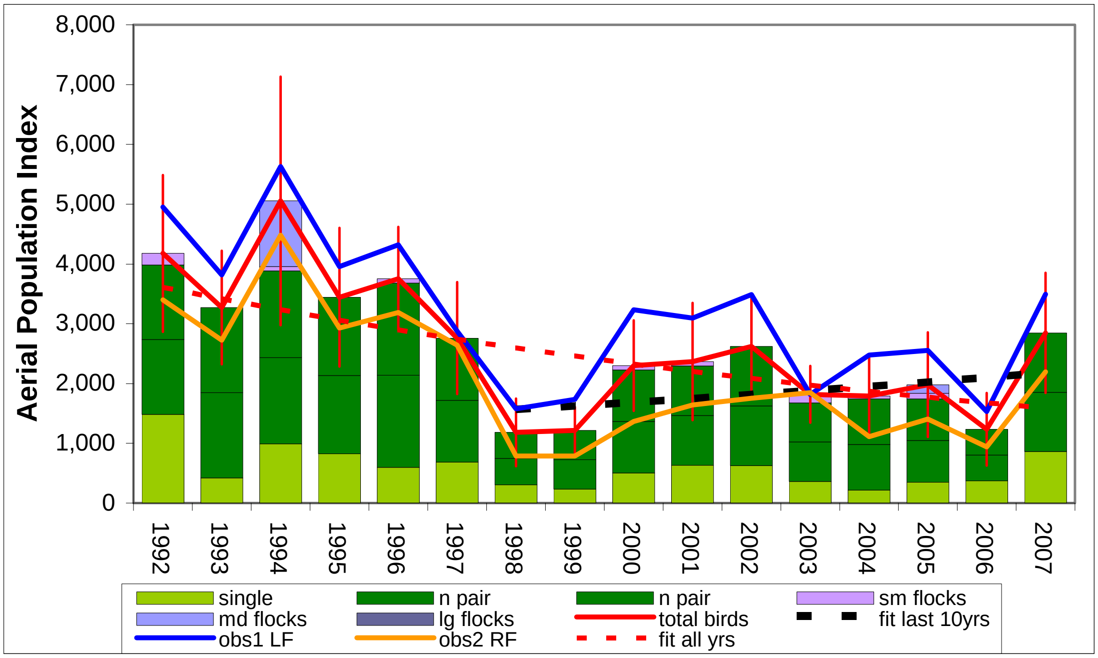


anls (nse 10 strata =30,465 km2) **Aerial index: Total birds** PALO

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

n yrs =	16
mean =	**20884**
std dev =	4071
ln linear slope =	0.0073
SE slope =	0.0110
Growth Rate =	**1.007**
low 90%ci GR =	0.989
high 90%ci GR =	1.026
regression resid CV =	0.203
avg sampling err CV =	0.069
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	13.8
w/ sample error CV =	6.7
most recent 10 years :	
Growth Rate =	**1.035**
low 90%ci GR =	0.998
high 90%ci GR =	1.074

Figure 7. Population trend for Pacific Loons (*Gavia pacifica*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

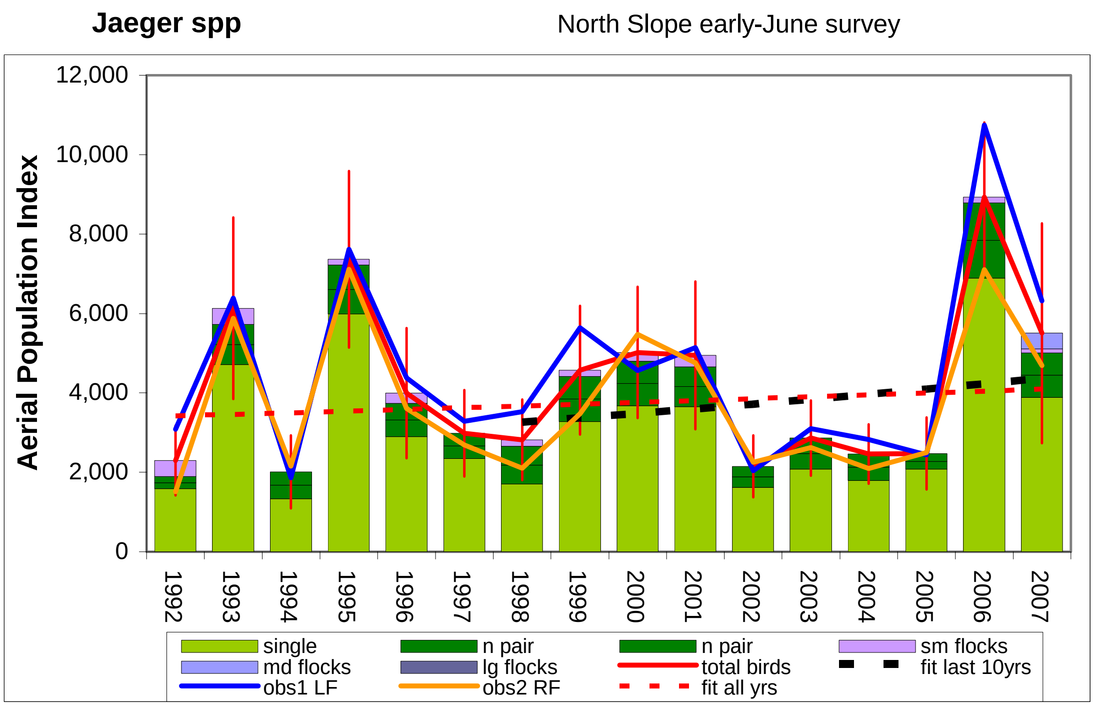


anls (nse 10 strata =30,465 km2) **Aerial index: Total birds** RTLO

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

n yrs =	16
mean =	**2614**
std dev =	1115
ln linear slope =	-0.055
SE slope =	0.0201
Growth Rate =	**0.947**
low 90%ci GR =	0.916
high 90%ci GR =	0.979
regression resid CV =	0.371
avg sampling err CV =	0.153
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	20.6
w/ sample error CV =	11.4
most recent 10 years :	
Growth Rate =	**1.037**
low 90%ci GR =	0.978
high 90%ci GR =	1.100

Figure 8. Population trend for Red-throated Loons (*Gavia stellata*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.



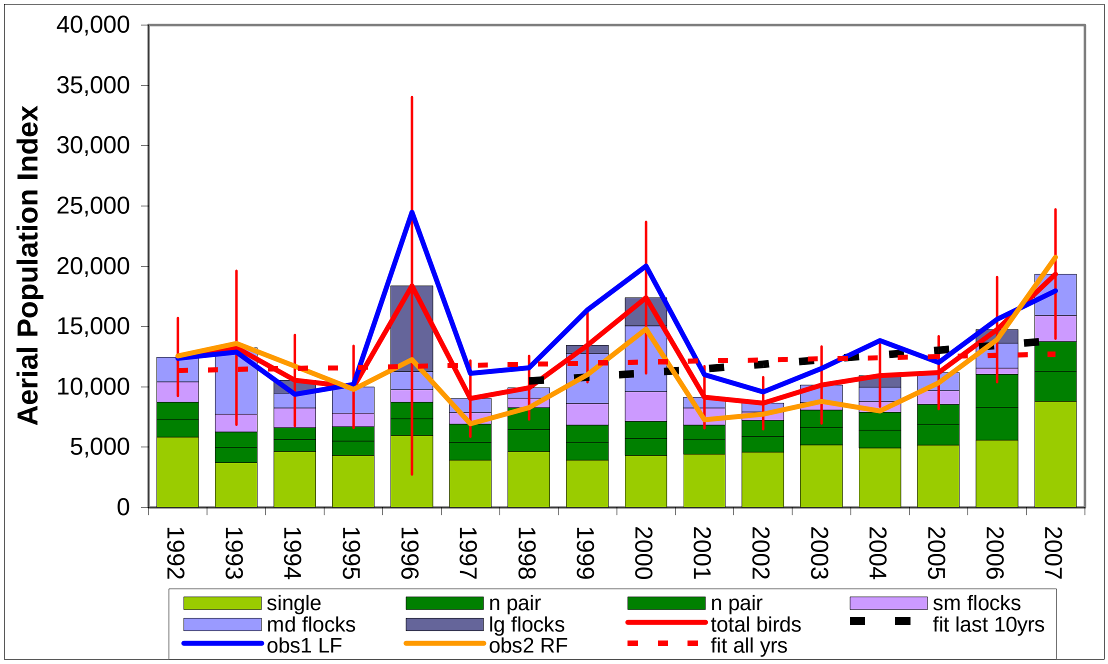
anls (nse 10 strata =30,465 km2) **Aerial index: Total birds** JAEG

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

n yrs =	16
mean =	**4156**
std dev =	2050
ln linear slope =	0.0121
SE slope =	0.0261
Growth Rate =	**1.012**
low 90%ci GR =	0.970
high 90%ci GR =	1.057
regression resid CV =	0.482
avg sampling err CV =	0.116
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	24.5
w/ sample error CV =	9.5
most recent 10 years :	
Growth Rate =	**1.033**
low 90%ci GR =	0.947
high 90%ci GR =	1.126

Figure 9. Population trend for jaeger species (*Stercorarius parasiticus, S. pomarinus, S. longicaudus*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

Glaucous Gull North Slope early-June survey

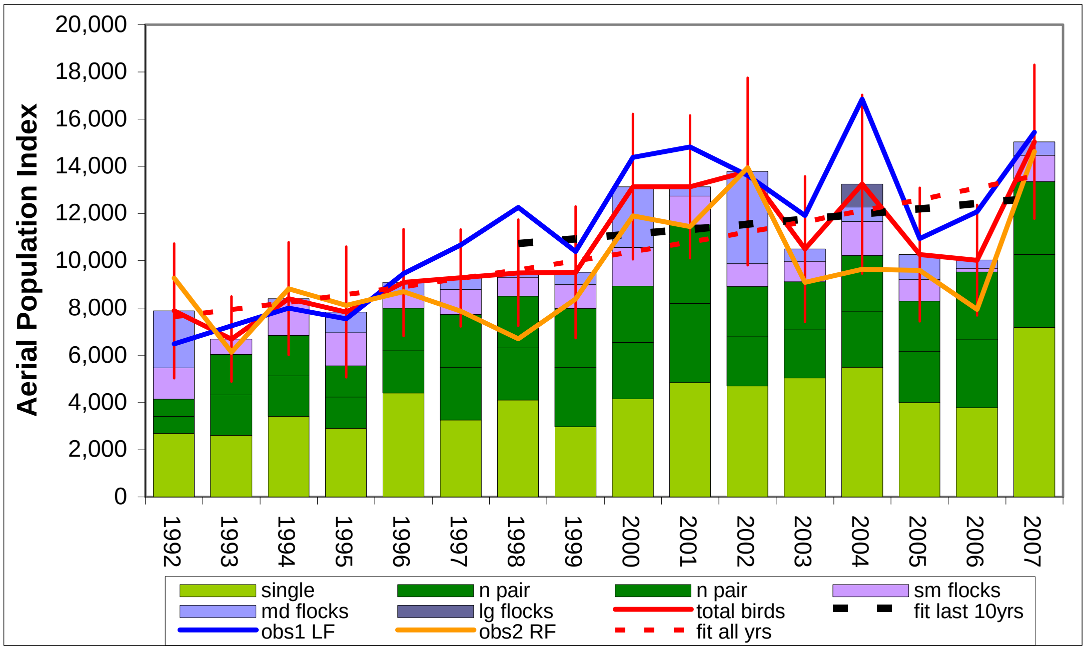


anls (nse 10 strata =30,465 km2) **Aerial index: Total birds** GLGU

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

n yrs =	16
mean =	**12407**
std dev =	3429
ln linear slope =	0.0075
SE slope =	0.0144
Growth Rate =	**1.007**
low 90%ci GR =	0.984
high 90%ci GR =	1.032
regression resid CV =	0.265
avg sampling err CV =	0.153
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	16.5
w/ sample error CV =	11.4
most recent 10 years :	
Growth Rate =	**1.032**
low 90%ci GR =	0.982
high 90%ci GR =	1.084

Figure 10. Population trend for Glaucous Gulls (*Larus hyperboreus*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.



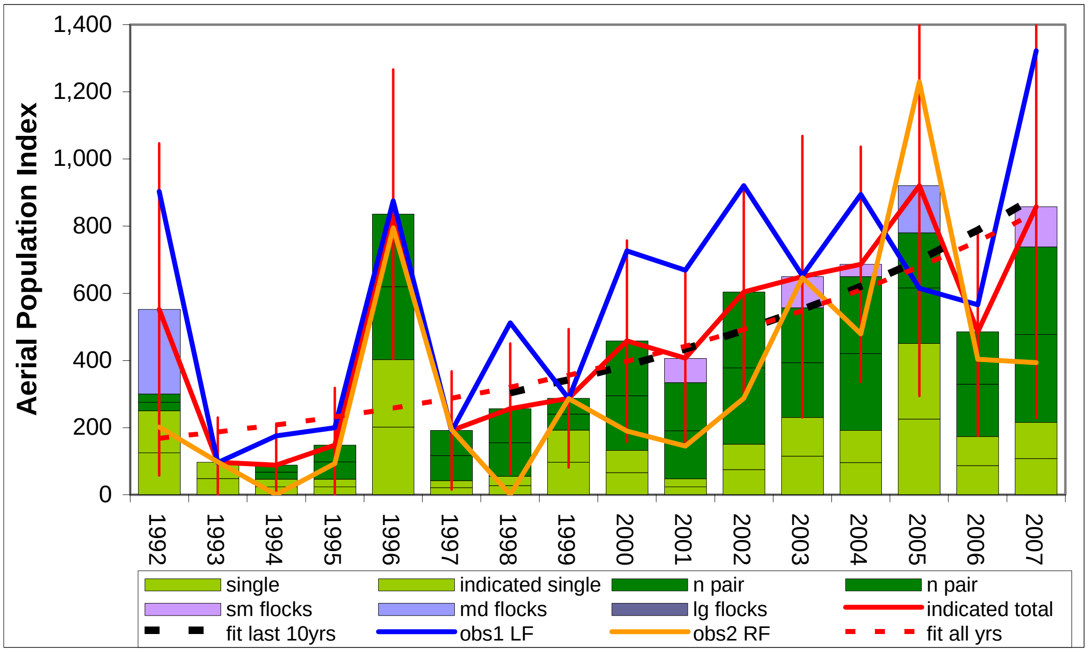
anls (nse 10 strata =30,465 km2) **Aerial index: Total birds** ARTE

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

n yrs =	16
mean =	**10455**
std dev =	2471
ln linear slope =	0.0385
SE slope =	0.0082
Growth Rate =	**1.039**
low 90%ci GR =	1.025
high 90%ci GR =	1.053
regression resid CV =	0.151
avg sampling err CV =	0.112
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	11.3
w/ sample error CV =	9.3
most recent 10 years :	
Growth Rate =	**1.019**
low 90%ci GR =	0.987
high 90%ci GR =	1.051

Figure 11. Population trend for Arctic Terns (*Sterna paradisaea*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

Red-breasted Merganser North Slope early-June survey

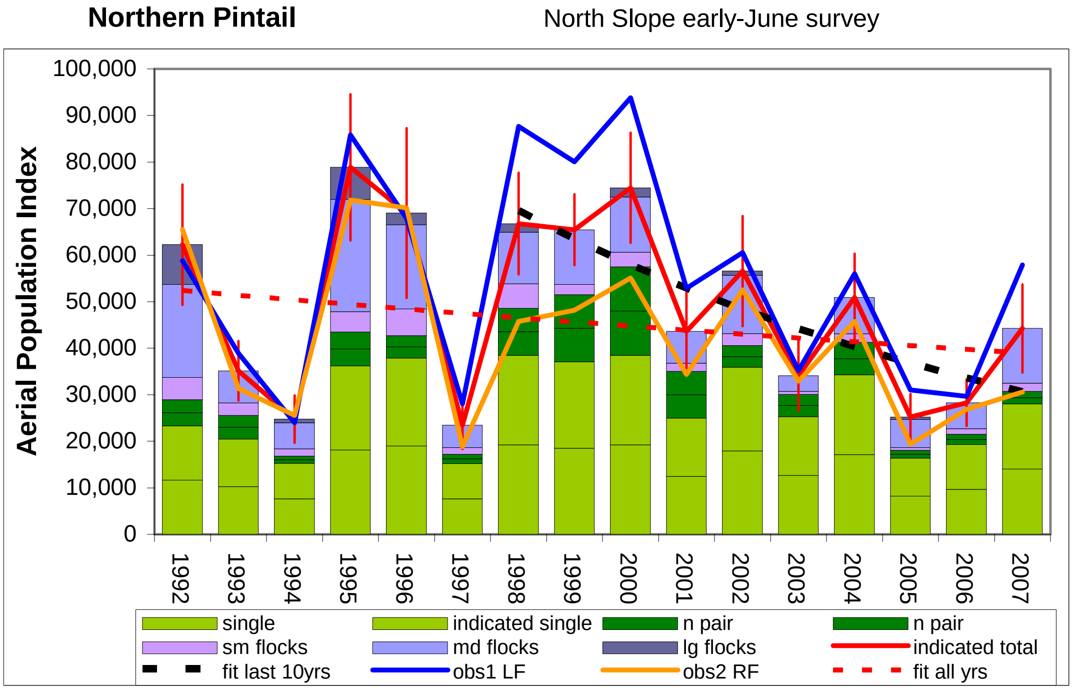


anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** RBME

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

n yrs =	16
mean =	**470**
std dev =	276
ln linear slope =	0.1073
SE slope =	0.0319
Growth Rate =	**1.113**
low 90%ci GR =	1.056
high 90%ci GR =	1.173
regression resid CV =	0.588
avg sampling err CV =	0.406
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	28.0
w/ sample error CV =	21.9
most recent 10 years :	
Growth Rate =	**1.127**
low 90%ci GR =	1.077
high 90%ci GR =	1.178

Figure 12. Population trend for Red-breasted Meganser (*Mergus serrator*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

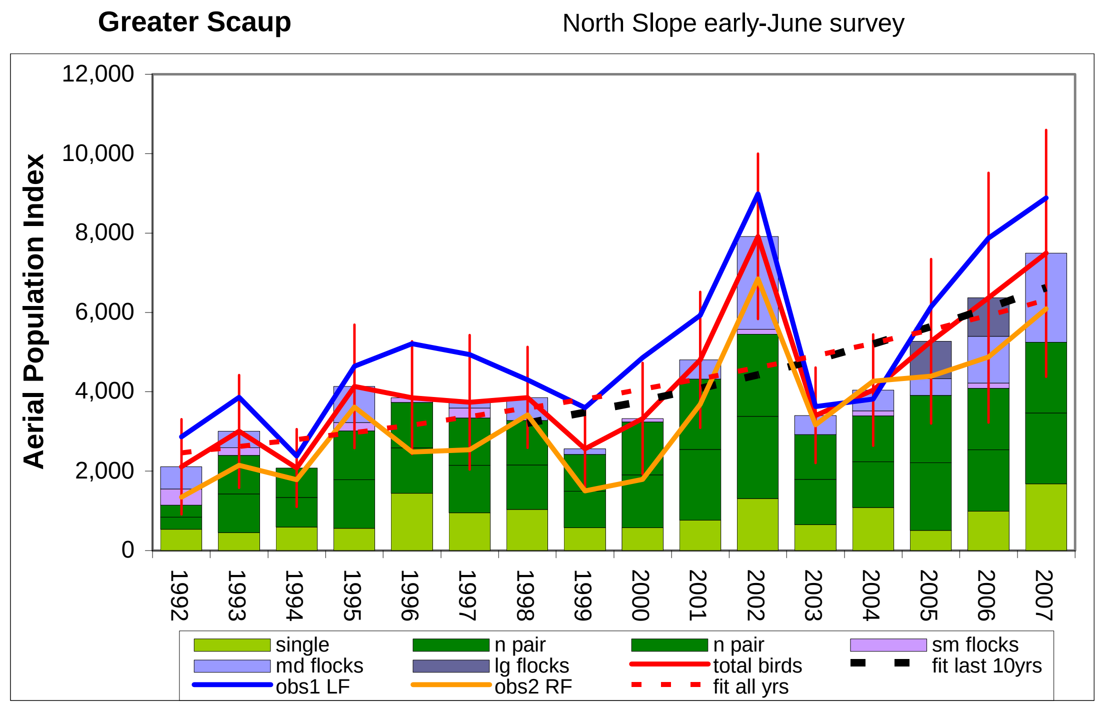


anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** NOPI

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

n yrs =	16
mean =	**48940**
std dev =	19088
ln linear slope =	-0.02
SE slope =	0.0232
Growth Rate =	**0.981**
low 90%ci GR =	0.944
high 90%ci GR =	1.019
regression resid CV =	0.428
avg sampling err CV =	0.099
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	22.6
w/ sample error CV =	8.6
<u>most recent 10 years :</u>	
Growth Rate =	**0.913**
low 90%ci GR =	0.870
high 90%ci GR =	0.957

Figure 13. Population trend for Northern Pintail (*Anas acuta*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.



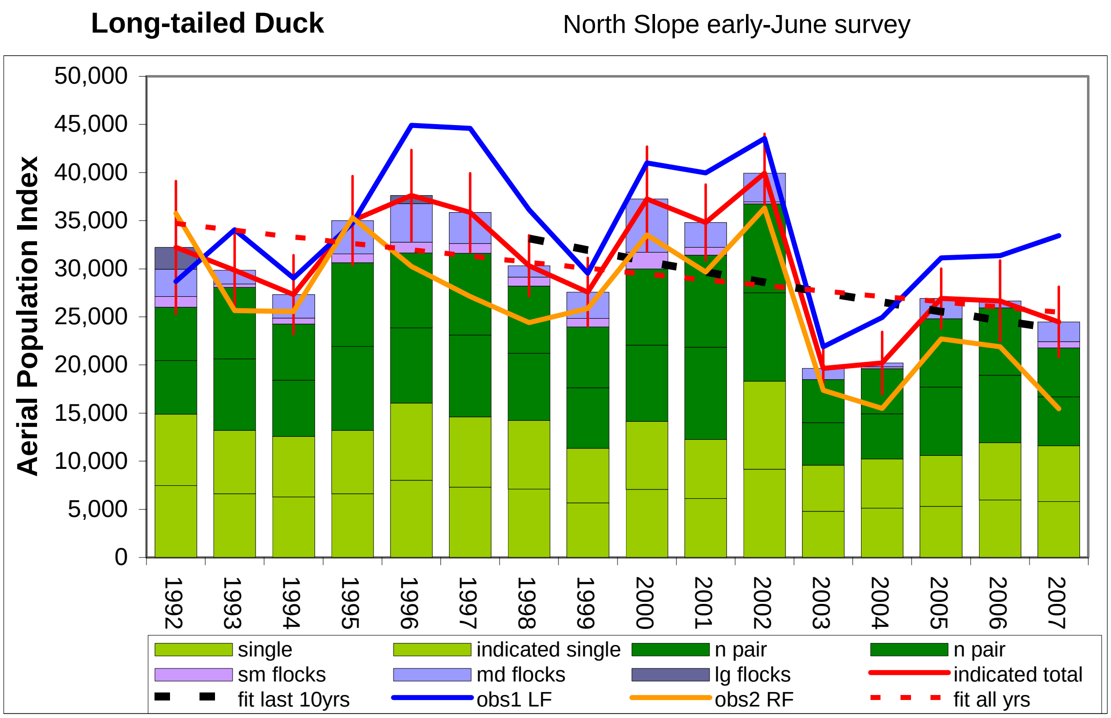
anls (nse 10 strata =30,465 km2) **Aerial index: Total birds**

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

SCAU

n yrs =	16
mean =	**4246**
std dev =	1744
ln linear slope =	0.0627
SE slope =	0.0147
Growth Rate =	**1.065**
low 90%ci GR =	1.039
high 90%ci GR =	1.091
regression resid CV =	0.272
avg sampling err CV =	0.178
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	16.7
w/ sample error CV =	12.6
most recent 10 years :	
Growth Rate =	**1.084**
low 90%ci GR =	1.027
high 90%ci GR =	1.144

Figure 14. Population trend for Greater Scaup (*Aythya marila*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

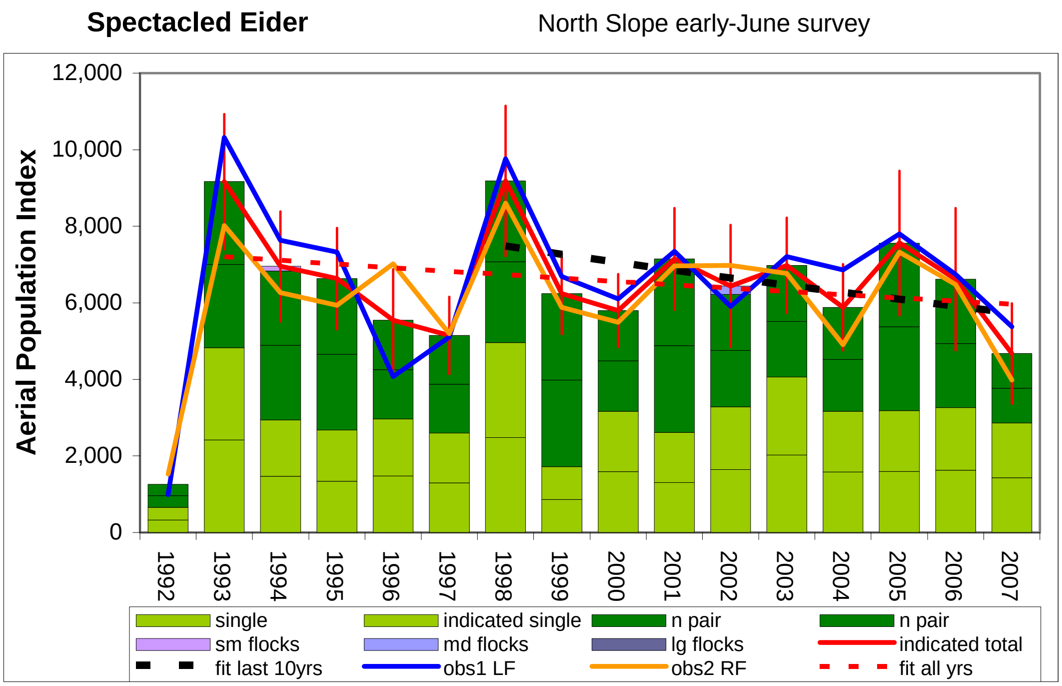


anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** LTDU

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

n yrs =	16
mean =	**30354**
std dev =	6123
ln linear slope =	-0.021
SE slope =	0.0106
Growth Rate =	**0.980**
low 90%ci GR =	0.963
high 90%ci GR =	0.997
regression resid CV =	0.196
avg sampling err CV =	0.069
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	13.4
w/ sample error CV =	6.7
most recent 10 years :	
Growth Rate =	**0.964**
low 90%ci GR =	0.925
high 90%ci GR =	1.003

Figure 15. Population trend for Long-tailed Duck (*Clangula hyemalis*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

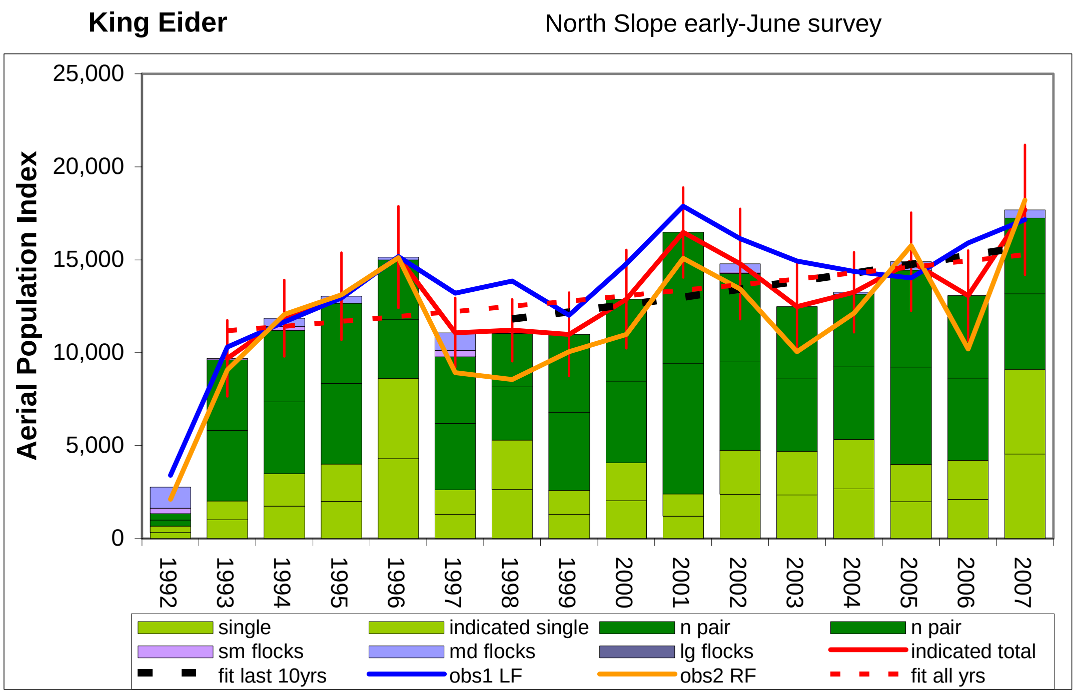


anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** SPEI

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

n yrs =	15
mean =	**6664**
std dev =	1280
ln linear slope =	-0.013
SE slope =	0.0110
Growth Rate =	**0.987**
low 90%ci GR =	0.969
high 90%ci GR =	1.005
regression resid CV =	0.184
avg sampling err CV =	0.109
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	12.9
w/ sample error CV =	9.1
<u>most recent 10 years :</u>	
Growth Rate =	**0.971**
low 90%ci GR =	0.942
high 90%ci GR =	1.001

Figure 16. Population trend for Spectacled Eider (*Somateria fischeri*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.



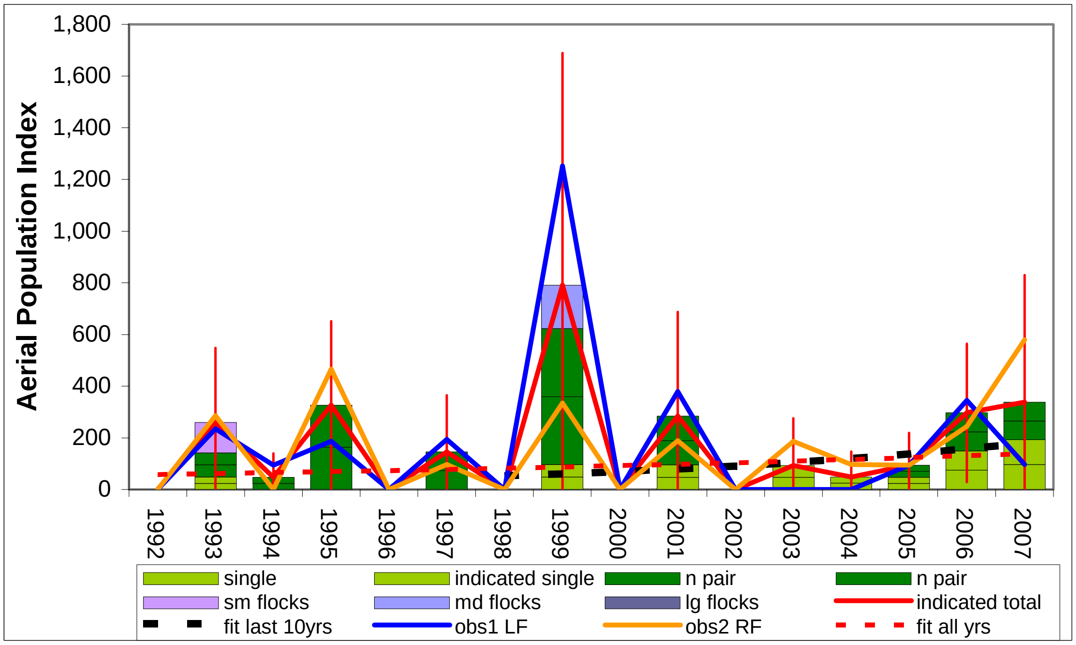
anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** KIEI

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

n yrs =	15
mean =	**13234**
std dev =	2205
ln linear slope =	0.0223
SE slope =	0.0082
Growth Rate =	**1.023**
low 90%ci GR =	1.009
high 90%ci GR =	1.036
regression resid CV =	0.136
avg sampling err CV =	0.093
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	10.6
w/ sample error CV =	8.2
most recent 10 years :	
Growth Rate =	**1.032**
low 90%ci GR =	1.008
high 90%ci GR =	1.057

Figure 17. Population trend for King Eider (*Somateria spectabilis*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

Steller's Eider North Slope early-June survey

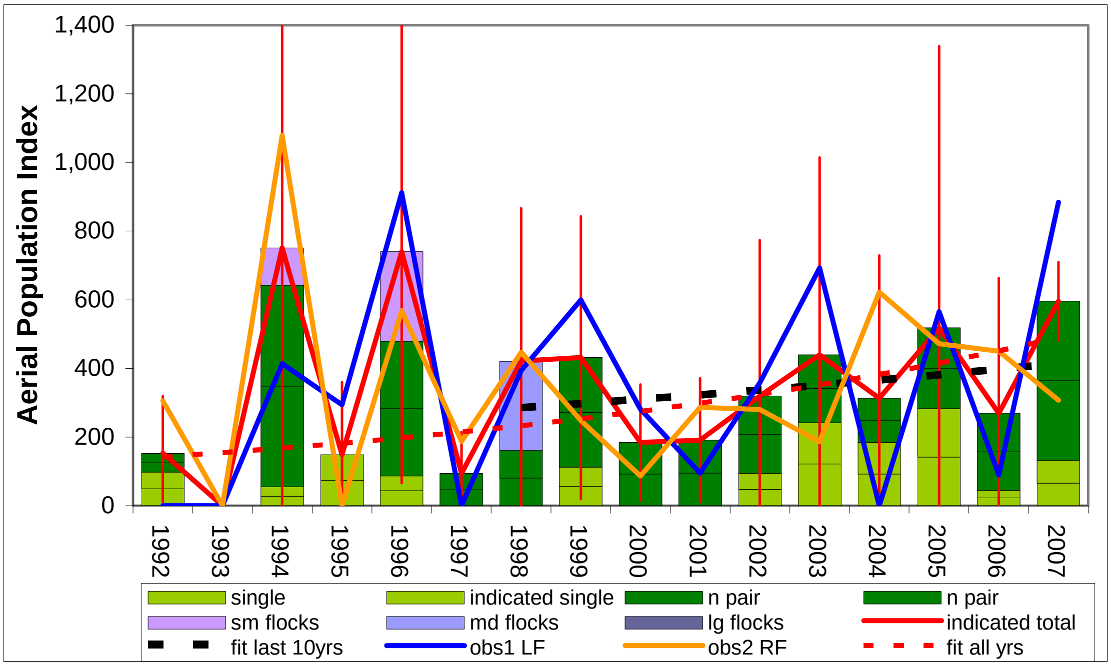


anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** STEI

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

n yrs =	16
mean =	**176**
std dev =	205
ln linear slope =	0.0582
SE slope =	0.0698
Growth Rate =	**1.060**
low 90%ci GR =	0.945
high 90%ci GR =	1.189
regression resid CV =	1.291
avg sampling err CV =	0.734
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	47.2
w/ sample error CV =	32.4
most recent 10 years :	
Growth Rate =	**1.146**
low 90%ci GR =	0.896
high 90%ci GR =	1.466

Figure 18. Population trend for Steller's Eider (*Polysticta stelleri*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

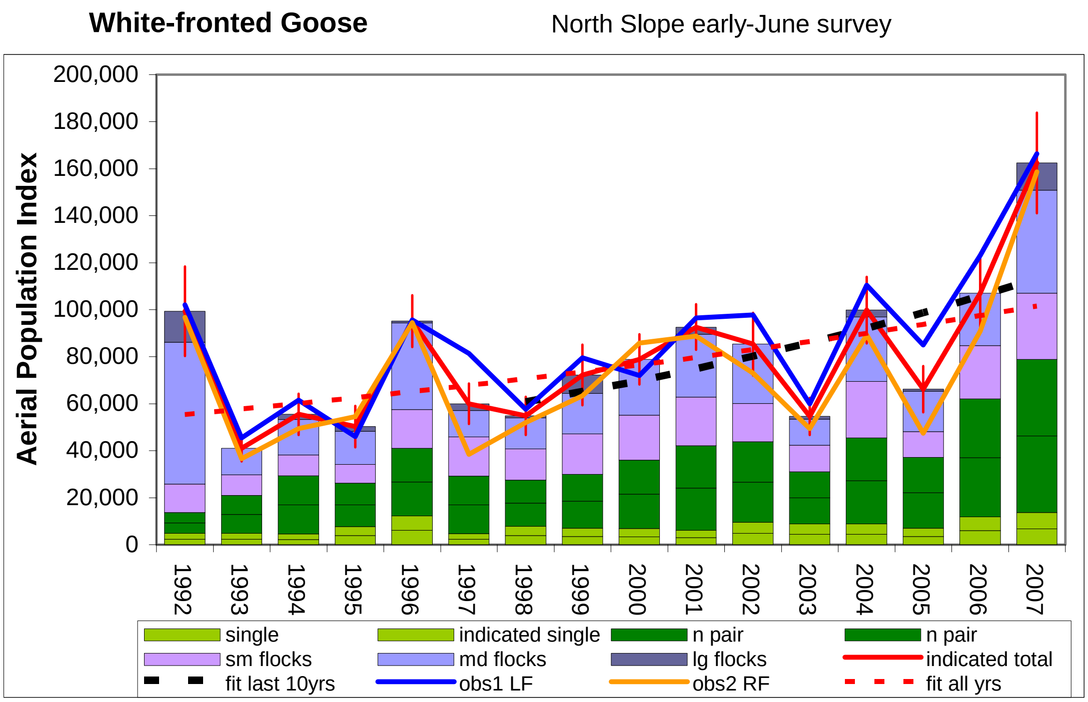


anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** WWSC

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

n yrs =	16
mean =	**349**
std dev =	222
ln linear slope =	0.0825
SE slope =	0.0466
Growth Rate =	**1.086**
low 90%ci GR =	1.006
high 90%ci GR =	1.173
regression resid CV =	0.861
avg sampling err CV =	0.593
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	36.1
w/ sample error CV =	28.1
<u>most recent 10 years :</u>	
Growth Rate =	**1.042**
low 90%ci GR =	0.969
high 90%ci GR =	1.121

Figure 19. Population trend for White-winged Scoters (*Melanitta fusca*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

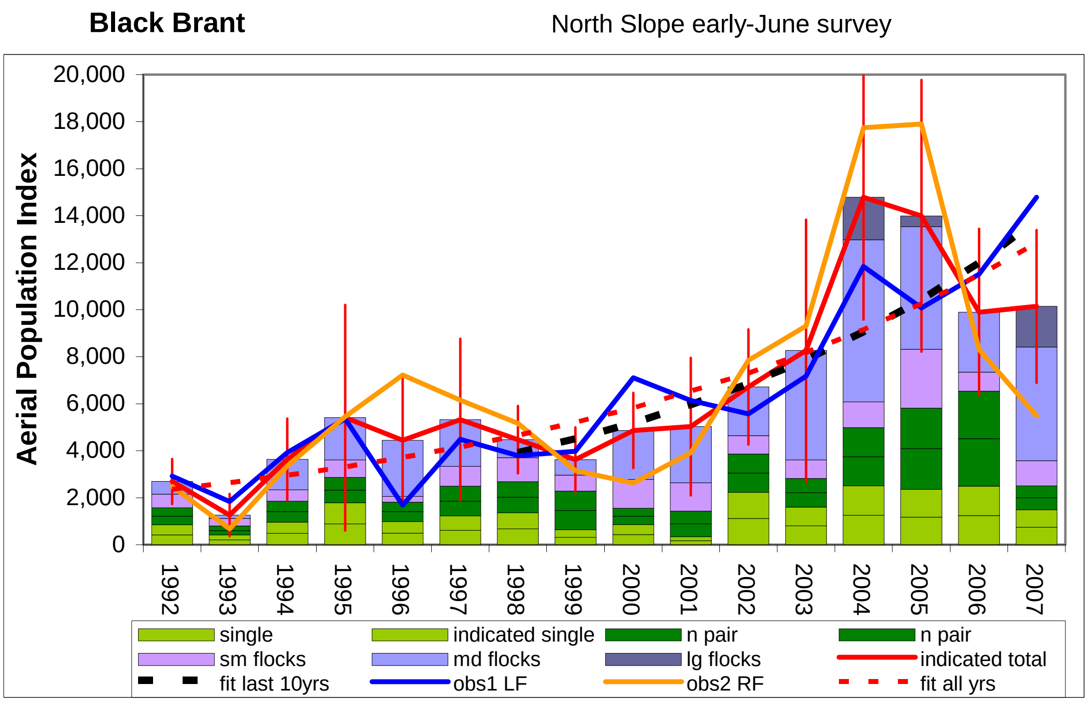


anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** WFGO

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

n yrs =	16
mean =	**79714**
std dev =	30156
ln linear slope =	0.0404
SE slope =	0.0167
Growth Rate =	**1.041**
low 90%ci GR =	1.013
high 90%ci GR =	1.070
regression resid CV =	0.308
avg sampling err CV =	0.076
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	18.2
w/ sample error CV =	7.1
most recent 10 years :	
Growth Rate =	**1.072**
low 90%ci GR =	1.020
high 90%ci GR =	1.126

Figure 20. Population trend for Greater White-fronted Geese (*Anser albifrons frontalis*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.



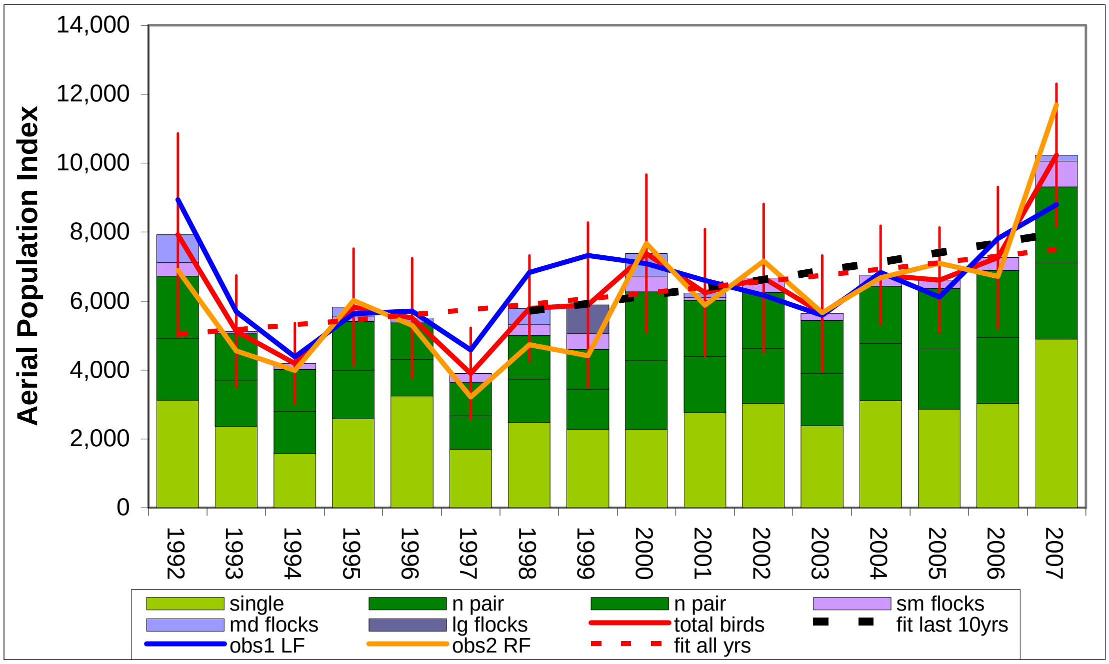
anls (nse 10 strata =30,465 km2) **Aerial index: Indicated total** BRAN

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

n yrs =	16
mean =	**6534**
std dev =	3888
ln linear slope =	0.1128
SE slope =	0.0182
Growth Rate =	**1.119**
low 90%ci GR =	1.086
high 90%ci GR =	1.153
regression resid CV =	0.336
avg sampling err CV =	0.249
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	19.3
w/ sample error CV =	15.8
most recent 10 years :	
Growth Rate =	**1.150**
low 90%ci GR =	1.097
high 90%ci GR =	1.207

Figure 21. Population trend for Pacific Black Brant (*Branta bernicla nigricans*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

Tundra Swan North Slope early-June survey



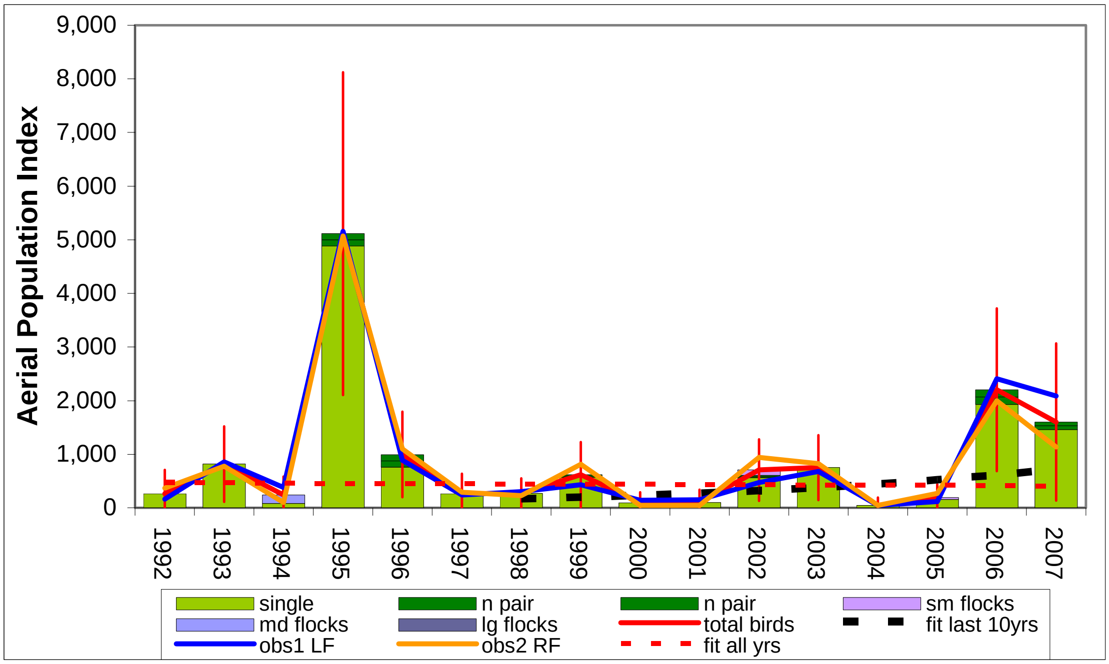
anls (nse 10 strata =30,465 km2) **Aerial index: Total birds** SWAN

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

n yrs =	16
mean =	**6307**
std dev =	1505
ln linear slope =	0.0265
SE slope =	0.0111
Growth Rate =	**1.027**
low 90%ci GR =	1.008
high 90%ci GR =	1.046
regression resid CV =	0.204
avg sampling err CV =	0.112
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	13.8
w/ sample error CV =	9.3
most recent 10 years :	
Growth Rate =	**1.038**
low 90%ci GR =	1.012
high 90%ci GR =	1.064

Figure 22. Population trend for Tundra Swans (*Cygnus columbianus*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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.

Snowy Owl North Slope early-June survey



anls (nse 10 strata =30,465 km2) **Aerial index: Total birds** SNOW

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

n yrs =	16
mean =	**892**
std dev =	1272
ln linear slope =	-0.009
SE slope =	0.0696
Growth Rate =	**0.991**
low 90%ci GR =	0.884
high 90%ci GR =	1.111
regression resid CV =	1.288
avg sampling err CV =	0.357
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	47.1
w/ sample error CV =	20.1
<u>most recent 10 years :</u>	
Growth Rate =	**1.174**
low 90%ci GR =	0.936
high 90%ci GR =	1.473

Figure 23. Population trend for Snowy Owls (*Bubo scandiacus*) observed on aerial survey transects sampling 30,465 km2 (eider strata only) 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*