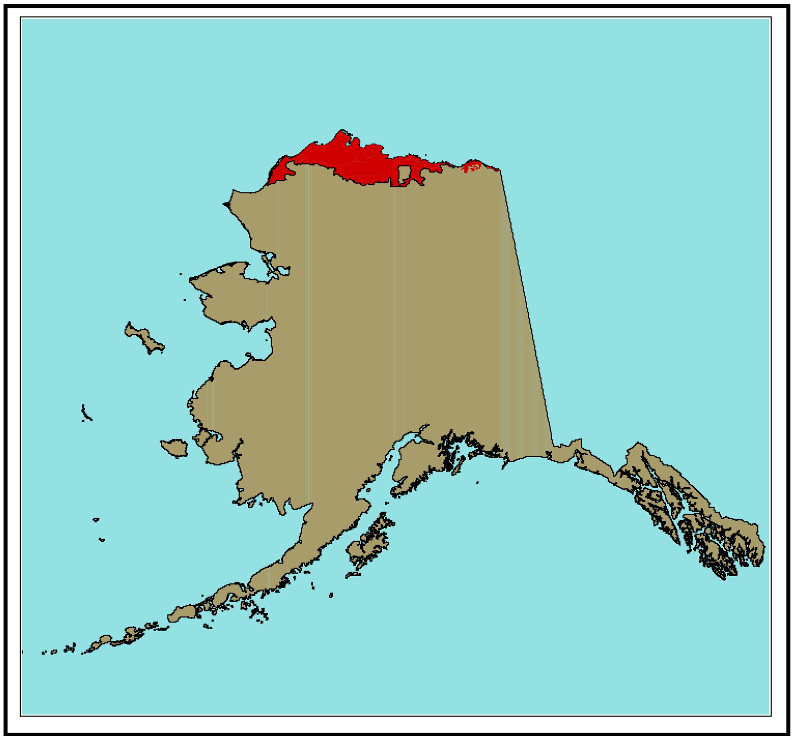
WATERFOWL BREEDING POPULATION SURVEY
ARCTIC COASTAL PLAIN, ALASKA
2011



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Waterfowl breeding population survey, Arctic Coastal Plain, Alaska 2011

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ABSTRACT. Waterfowl breeding population surveys have been completed annually on the Arctic Coastal Plain of Alaska since 1986. Methods for the 2011 Arctic Coastal Plain Waterfowl Breeding Population Survey (ACP survey) were similar to those employed since 2007, when a single survey was implemented to address objectives of two pre-existing surveys: the geographically comprehensive 1986 ACP survey conducted in mid-June to early July, and the geographically limited 1992-2006 North Slope Eider Survey, conducted in early to mid June to target the early phenology and breeding range of eiders. The current ACP survey covers 57,336 km^2, an area similar to the 1986 ACP survey but timed similar to the 1992-06 North Slope Eider Survey. The current design incorporates an annually-shifting transect grid, completed and repeated on a 4-year rotational basis. The survey flown in 2011 began the second 4-year set. Data collection methods follow the Standard Operating Standards (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987) adopted for breeding pair surveys by natural resource agencies throughout North America. Here, we present waterfowl spatial distribution, breeding densities, and comparisons with average 1986-2006 indices, using data from the entire ACP survey area (57,336 km^2). For long-term consistency in phenological survey timing we restrict trend analysis to data from the northern coastal region that corresponds to the former North Slope Eider Survey area (30,465 km^2). We test for population growth rates significantly greater or less than 1.0 (with significance probability <0.10) for all survey years (1992-2011) and for the most recent 10 years (2002-2011). Of these, the 1992-2011 growth rates for red-throated loon, mallard and green-winged teal were <1.0, while those for yellow-billed loon, Sabine's gull, Arctic tern, red-breasted merganser, scaup, king eider, white-winged scoter, lesser snow goose, greater white-fronted goose, black brant, tundra swan, sandhill crane, and Golden eagle were >1.0. During the most recent 10 years, growth rates of jaegers, glaucous gulls, Sabine's gulls, green-winged teal, scaup, king eider, black scoter, greater white-fronted geese, tundra swans and sandhill cranes were >1.0. Indices for greater white-fronted geese and tundra swans have been well above earlier levels for 5 consecutive years.

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

INTRODUCTION

From 1992-2006, the Fish and Wildlife Service Migratory Bird Management Division (Alaska Region) conducted two annual aerial waterfowl breeding pair surveys on the Arctic Coastal Plain (ACP). The "Standard ACP Survey was a comprehensive aerial waterfowl breeding population survey conducted from 1986-06 from late June through early July. This timing was selected to assess the abundance and breeding distribution of most waterfowl species and avoid scheduling conflicts with other spring surveys. However, it soon became evident that late June missed the optimal timing for eiders, the males of which depart the breeding grounds for the post-nuptial molt soon after nest initiation, typically about 20 June ± one week, but at that time there was relatively little management interest in those species. However, in response to a 1990 petition to list spectacled and Steller's eiders under the Endangered Species Act, the North Slope Eider Survey was initiated in 1992, timed in early to mid June to coincide with the peak presence of adult males on the breeding grounds, and designed to assess and monitor the abundance and distribution of spectacled and Steller's eiders. This survey consistently provided precise data for spectacled eiders and king eiders; however, data on Steller's eiders had relatively low power to detect trends due to small sample size.

Subsequent comparison of data sets from the two surveys (Larned et al. 2009) suggested that the earlier timing window of the North Slope Eider Survey was actually optimal for most waterfowl species because the survey occurred prior to the main period of nest failure and subsequent local and regional redistribution of birds from breeding to molting areas both within and outside the survey area. In 2007, the two surveys were combined into a single survey similar in size to the prior ACP survey, but conducted in early to mid-June.

The present survey is titled the "Waterfowl Breeding Population Survey, Arctic Coastal Plain, Alaska", and referred to in this report as the "ACP Survey". The survey design consists of four sets of equally-spaced parallel transects which are surveyed on a four-year rotational basis. This report describes the methods and results of the 2011 ACP survey and the 5th year of the current design. For trend analysis, we combined the 1992-2006 North Slope Eider Survey data set with a geographically identical subset of the ACP survey 2007-2011 (hereafter referred to as the "northern coastal strata"). This subset provides a spatially and phenologically consistent data available for trend, while the data set from the total ACP survey area describes the more spatially comprehensive distribution. We also include long-term means from the Standard ACP Survey (1986-2006) for comparison with current ACP indices for comprehensive coastal plain geographic context.

OBJECTIVES

Data from the ACP Survey: (i) provide annual population indices and trend data to monitor spectacled eider recovery status against criteria described in the Spectacled Eider Recovery Plan (U. S. Fish and Wildlife Service 1996), (ii) provide quantitative bases for evaluating potential impacts of proposed resource development projects, and (iii) provide information enabling the U.S. Department of Interior obligations to annually assess waterfowl populations under the Migratory Bird Treaty Act of 1918. Specific uses of ACP Survey data follow.

Spectacled Eider Recovery Plan

Task 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 potential future de-listing or reclassifying from Threatened to Endangered. These criteria are based on population growth rate and the minimum abundance estimate, which are 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 view 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 waterbirds within all known important waterfowl habitat on a rotational basis each 4 years using a systematic grid sampling frame. Produce point location and density polygon maps describing location of observed waterbirds and areas with specified ranges of multi-year, mean peak breeding densities.

Migratory Bird Treaty Act obligations

Estimate the annual breeding population of 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 2011:

William Larned, Biologist-Pilot (Left Seat Observer), *US Fish and Wildlife Service, Migratory Bird Management, Soldotna, Alaska*

Wade Schock, M.S. Candidate (Right Seat Observer), *University of Alaska, Anchorage, Alaska*

Study area, survey design, navigation, and observation

The ACP Survey area covers 57,336 km^2 of the 61,645 km^2 Standard ACP Survey area (1986-2006) (Fig. 1). The 4,309 km^2 deleted from the Standard ACP survey is comprised of mostly upland habitat that we determined to be relatively poor waterfowl nesting habitat based on historical (1986-2006) ACP data. Procedures followed the standard protocol described in the "Standard Operating Procedures for Aerial Waterfowl Breeding Ground Population and Habitat Surveys in North America" (U. S. Fish and Wildlife Service and Canadian Wildlife Service 1987). A series of transects, oriented in an east-west direction (Fig. 1), were flown at 38 m altitude and 176±19km/hr ground speed. We used a turbine-powered Quest Kodiak amphibian in 2011, whereas previously a Cessna 206 amphibian was used.

Both the left seat biologist-pilot observer and the right seat observer recorded all waterbirds and avian predators seen within 200m either side of the flight path. To estimate the outer transect boundary, we determined the required viewing angle trigonometrically and marked a reference point on the wing strut for each observer using a clinometer and marking tape.

Transects consisted of computer-generated great circle segments, for compatibility with Global Positioning System (GPS) navigation. Transects were spaced systematically in each of 20 geographic strata (Fig. 1, Table 1) from a randomly-selected starting point. Distance between transects varied by stratum, in four categories of sampling intensity: Low (7.2 km), Medium (4.8 km), High (2.4 km) and Very High (1.2 km). Stratification and spacing assignments were based on a combination of physiographic (mostly hydrographic) characteristics, waterfowl breeding density data (from previous North Slope Eider and ACP surveys), and boundaries of different management units, such as planning areas for current and proposed oil and gas leases. In each stratum every fourth transect was flown in a given year, thus four years were required to cover all transects, after which the cycle was repeated. Stratification allows comparisons among geographic areas and provides a framework for more efficient sample allocation to decrease the magnitude of total sample variance. Transects flown in 2011 are depicted in Fig. 1.

Flight time required to complete the 2011 ACP Survey was 46 hours, not including ferry time to and from the survey area.

Data recording and transcription

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

Data Analysis

We provide an index to the number of individuals of each waterfowl species and other selected bird species present within the survey area. The term index as used here is defined as a number that represents an unknown proportion of the population of birds occupying the survey area during the nesting season and detected by the observers. While unknown, the proportion is assumed to be consistent enough among years to provide trend information sufficient to inform management decisions relative to spectacled eiders and other waterbird species.

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

We present population estimates where applicable in Tables 3, 4 and 6. The term population estimate as used here is based on index estimates expanded using visibility correction factors 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 convert population indices to population estimates by accounting for birds present but not detected by observers in fixed wing aircraft. Untested assumptions were: (i) the helicopter crew recorded all birds present; (ii)observers are equal in performance, and (iii)detection rates of ducks in the Yukon-Kuskokwim Delta are similar to those in the ACP. Eiders were not included in the YK delta study, so no VCF is applied for eiders.

Bias

Indices are subject to biases typically associated with aerial survey data collection. Bias in this survey comes primarily from three sources: (i) *sampling error* due to variability among the transects within each sampling stratum, (ii) *mis-timing* of the survey relative to bird breeding phenology, and (iii) variation in *detection rate* of birds. In this survey, s*ampling error* was estimated by ratio estimate procedures described by Cochran (1977). 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 intact pairs on breeding territories of all surveyed species. Proper timing is especially important for eiders and other sea ducks that 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;). 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 (Troy 1997). Most spectacled eider males depart the tundra for offshore molting areas by 20 to 25 June.

Aerial observations from the North Slope Eider Survey strata since 1992 suggest timing of male departure is constant 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 king eiders utilize a greater diversity of wetland types which thaw at different times, and king eiders that breed on the ACP are widely distributed during the winter (Phillips et al 2006), 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 (Phillips et al 2007)). In Canada, king eider males departed Bathurst Island, N.W.T. rather abruptly and synchronously from one week to 10 days after clutch initiation (Lamothe 1973). For the North Slope Eider Survey and current ACP Survey we assumed that proper timing for spectacled eiders is adequate for king eiders.

Our procedure for determining proper survey timing consists of the following: (i) we monitor weather, and ice and snow cover data, planning to arrive in the survey area when ponds and tundra vegetation are just becoming available to nesting eiders over most of the arctic slope; (ii) we contact biologists in Prudhoe Bay and Barrow for their observations on eider phenology; and (iii) we fly a reconnaissance survey to determine whether or not waterfowl including spectacled eiders appear to be occupying breeding territories as pairs, rather than in mixed-sex/species flocks. Our observations suggest eiders occupy breeding territories as pairs when there is ice-free water in most shallow vegetated wetlands, and tundra vegetation is mostly snow-free around pond margins.

To determine retrospectively the accuracy of our survey timing for spectacled and king eiders, long-tailed ducks and northern pintails, we used a ratio of males unaccompanied by females to total males (with and without females), averaged over the entire survey. Our sample for this statistic included all unaccompanied males in groups of 1 to 4 only. This ratio, called the lone-drake index (LDI), was 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. The index is easy to interpret for many dabbling ducks that 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 soon 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 that stay on the breeding grounds beyond peak departure of successful males as observed near Prudhoe Bay (Warnock and Troy 1992). 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.

Detection bias is unaccounted for in the current survey analysis, though as noted above we present some duck indices adjusted using standard tundra Visibility Correction Factors developed on the YK Delta primarily to enable readers to more easily compare ACP populations with those from other parts of North America. This survey is designed to track the populations of large waterbirds that breed in the ACP. Of this total, some birds will not be represented in the sample because they: (i) have not yet arrived in the survey area; (ii) have left the survey area; (iii) flushed from the sample transect before detection due to disturbance by the survey aircraft; (iv) are not visible from the aircraft, being hidden by vegetation, terrain or aircraft fuselage etc (v) are misidentified and/or (vi) observers fail to see them due to fatigue, experience level, visual acuity, distractions, sunlight conditions, presence or absence of snow and ice, bird behavior, and/or the density of survey subjects and other objects competing for the observer's attention. We attempt to minimize the bias caused by arrival and departure of birds into and out of the study area by adjusting 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 (U.S. 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 the study were unsatisfactory in that our fixed-wing count often exceeded the helicopter count, suggesting a flaw in design or implementation. Therefore we resorted to an unadjusted annual index of abundance, for which we strive to minimize effects of observer bias by using the same observers (or those thoroughly trained to a common standard) and methods.

RESULTS

Habitat conditions, survey schedule

Directly measured snow depth data on the Alaskan arctic are scarce. According to the Alaska Climate Research Center (ACRC, University of Alaska, Fairbanks), Kuparuk is the only station that has kept records annually since 1990. Average snow depth in May 2011 at Kuparuk was 9 inches, slightly below the 1990-2011 average (National Climate Data Center, courtesy of Kevin Galloway, ACRC). Imagery from the NASA MODIS satellite indicated much of our survey area was snow free the week of 2-9 June except for the coastal fringe, while most of the remaining snow melted the following week (Fig. 2). Abundant small snow patches and extensive lake ice persisted in the coastal area, especially in the Teshekpuk Lake and Barrow areas, until about 15 June, limiting detection of eiders and other white-marked birds in those areas more than normal. Water was abundant over most of the survey area, but flooding of ponds and nesting cover was about average for the survey period. NASA Modis satellite imagery revealed continuous sea ice with almost no open water along the Beaufort sea coast from Barrow to the Canadian border during the entire survey period, while the Chukchi coast from Point

Hope to Barrow was completely ice free, providing an excellent coastal migration corridor for access to Alaskan arctic breeding habitat. Overall, ice distribution was similar to 2010, and probably more favorable to Alaskan breeding waterfowl than birds continuing their migration for the Canadian Arctic.

The survey was initiated on 10 June 2011, suspended until 13 June 2011 due to strong gusty winds, and then completed on 19 June 2011. Generally favorable survey conditions prevailed after 13 June.

Of the four species selected as timing indicators, the eiders both exhibited average (king eider) to high (spectacled eider) total Lone-drake Index (LDI, the overall ratio of lone males to total males during the survey, a rough measure of survey timing in relation to nest initiation in ducks, Table 2), suggesting that phenology was advanced but most males had not yet departed the survey area to molt; thus, survey timing was likely optimal for these species (Table 2). Though somewhat erratic, the graphs of daily LDI for these species ended higher than the earlier portions, also suggesting proper survey timing. In contrast, in 2010, when completion of the survey was delayed until 22 June due to crew change, declining eider average daily LDI suggested that some males had departed the breeding area prior to the last survey days. The overall LDIs for long tailed ducks and pintails were both about average (Table 2), and the daily LDI graphs suggested stable and about average values through the survey period, so we believe the survey was accurately timed for these species as well.

Population indices for selected species

Following are results and comments by species. Indices and trends refer to data from the northern coastal strata and North Slope Eider Survey only, unless otherwise noted.

Loons

The 2011 yellow-billed loon index (1,487, 95%CI=923-2,051) is second highest for the survey, below the record of 2009 (1,693, CI=1,188-2,198, Larned et al 2010), and 27% above the 1992-2011 mean (1,171). The population growth rate (1.020, CI=1.007-1.034) indicates a significant positive trend over the long term (Table 3, Fig. 4). In contrast, the 2007-2010 average index for all ACP strata (2,465) is 11% below that of the 1986-2006 Standard ACP survey (2,778, Table 6). We believe the higher estimates attributed to the Standard ACP survey are due to that survey's later timing relative to the current ACP survey (Earnst et al. 2005), allowing time for an influx of non-breeding yellow-billed loons arrive on the ACP in late June.

The 2011 Pacific loon index (28,111) is the second highest for the survey, 32% above the 1992-2011 average (Tables 3-5, Fig. 5). The Pacific loon index has been very erratic since 2007, after 13 years of relative stability, but still shows a level trend over both 1992-2011 and 2002-2011 time periods (Fig. 5). The 2007-2010 average for all strata is 18% above that of the ACP survey from 1986-2006.

The 2011 red-throated loon northern coastal strata index (1,912) is 21% above that of 2010 (1,578), but still 23% below the 1992-2011 mean. From 1992 to 2010, the red-throated loon population index in the northern coastal strata declined significantly (growth rate 0.963, CI=0.942-0.985, Table 5, Fig. 6) (Tables 3 & 5, Fig. 6); however, the recent 10-year (2002-11) trend is stable (growth rate=0.993, CI=0.946-1.042, Fig. 6). The ACP 2011 index is 2,209, 32% below that of the ACP 1986-06) mean (3,240; Table 6)**.**

Jaegers

Pomarine, parasitic and long-tailed jaegers all breed on the Arctic Coastal Plain of Alaska. Observations for all three species are combined for this survey to reduce diversion of observer focus from eiders and other high priority species. The jaeger index varies among survey years, likely due to the dependence of jaegers (especially pomarine and long-tailed) on the irruptive cycles of microtine prey, including the North American brown lemming, *Lemmus trimucronatus;* Wiley and Lee 1998, 2000). Pomarine and long-tailed Jaegers may forgo breeding or breed elsewhere when lemmings are in short supply, while parasitic jaegers normally breed every year, depending more on small birds and eggs (Wiley and Lee 1999). While highly variable among years, the combined jaeger index has a level 1992-2011 trend, and a barely significant upward trend during the period from 2002-2011 (Fig. 7). The 2011 jaeger index (5,871) is 39% above the 1992-2011 mean (Tables 3,5; Fig. 7), which may have resulted at least in part from the apparent widespread abundance of lemmings reported by other investigators and north slope residents.

Gulls & terns

The glaucous gull long-term (1992-2011) trend is stable but significant positive growth is indicated during the most recent 10 years (2002-11,Table 5, Fig. 8). The 2011 total index (14,087) is 11% above the long-term (1992-2011) mean (12,663).

The 2011 Sabine's gull index (9,456) is 13% lower than indices averaged over the preceding 4 years (2007-2010), but 24% above the long-term mean (Table 3 Fig. 9). This species showed a positive growth rate from 1992-2011. (Table 5). High variability in numbers depicted in Fig. 9 indicates a level trend prior to the 2007 survey transition, followed by a consistently high index, suggesting that the slightly later average timing of the current survey design may be more appropriate for this species, compared to that of the 1992-2006 Eider Survey.

The arctic tern index increased from 1992 to 2000, resulting in a positive long-term growth rate (Table 5); however, the growth rate has been stable from 2000-11 (Table 5, Fig. 10). The 2011 index (11,325, Table 3) is 4% above the 20-year mean (10,875).

Ducks

Red-breasted mergansers are found mostly in or near river corridors, and primarily away from the coast in the south-central portion of the survey area. Indices increased from 1992 to 2002, then leveled off at an average of about 700 (Fig. 11). The 2011 index (887) is 70% greater than the long-term average for the northern coastal strata (Table 3, Fig. 11).

Mallard, American wigeon, green-winged teal and northern shoveler are recorded in low numbers and thus have high sampling errors and low power to detect meaningful trends (Tables 3-5, Figs. 12-14, 16).

The northern pintail is one of the most abundant duck species recorded on the ACP survey. The 2011 northern coastal strata northern pintail index (29,094) is 39% below the long-term (1992-2011) average (47,344, Table 3, Fig. 15). The expanded 2011 all-ACP pintail index (125,717, Table 4) is 43% below the average of the 1986-2006 ACP survey (220,494, Table 6).

North Slope scaup, which appear to be entirely or mostly greater scaup based on our long-term aerial observations of wing plumage of birds in flight, are found predominately in wetlands associated with river and small stream corridors. Comparing the 2011 index from the northern coastal strata (7,487, Table 3) with that from all strata (26,364, Table 4) suggests that most scaup nest south of the coastal strata. The 2011 scaup index is 49% above the long-term (1992-2011) average (5036, Table 3, Fig. 17) and the growth rate is positive throughout both reference periods (1992-2011: 1.067, 90%CI=1.049-1.086; and 2002-11: 1.060, 90%CI=1.000-1.123,Table 5). The 2011 expanded total ACP scaup index ranks third highest among ACP ducks, behind northern pintail and long-tailed duck (50,883, Table 6).

The long-tailed duck was the most abundant duck in 2011. The northern coastal strata long tailed duck population index (44,382) is 43% above the 20-year mean, and the highest on record for the survey (Table 3, Fig. 18). The long-tailed duck population growth rate (1992-2011, 0.995, 90%CI=0.981-1.010,) is stable (Table 5, Fig. 18).

The 2011 spectacled eider index (7,952) is 21% higher than the 19-year mean (6,580, Table 3, Fig. 19). The index growth rate is stable over the long term and last 10 years (Table 5, Fig. 19).

The 2011 common eider index (354) is 30% below the 1992-2011 average, and survey results suggest a level trend over this period (Fig. 20). However, most ACP common eiders nest more or less colonially on barrier islands; habitats not sampled by this survey. Consequently, the annual ACP survey sample consists of very low numbers, occasionally inflated by observations of large flocks (Fig. 20), thus not providing data useful for management purposes. To fill this gap, the U. S. Fish and Wildlife Service Waterfowl Management Branch conducted an aerial survey for common eiders along the Alaskan Arctic coast and barrier islands, annually 1999-2009. Results indicated average annual population growth rates of -1.4% (R=0.138) for total birds and +3.0% (R=0.374) for indicated breeding pairs (Dau and Bollinger 2009, available online at http://alaska.fws.gov/mbsp/mbm/waterfowl/surveys/pdf/coei09rpt.pdf).

The 2011 king eider index for the northern coastal strata (18,942) is 33% above the long-term (1992-2011) mean (14,236; Table 3, Fig. 21) and the second highest index since the survey was initiated in 1992. King eider indices have increased over the long term and recent 10-year survey periods (1992-2011 growth rate=1.027, 90%CI=1.018-1.037, 2002-2011 growth rate=1.040, 90%CI=1.019-1.061, Table 5, Fig. 21).

Steller's eiders occur in very low densities throughout much of the ACP. The most important nesting area is near Barrow where they have been studied extensively since 1991 (see Safine 2012). Intensive (25-50% coverage) aerial surveys for Steller's eiders were conducted annually from 1999 to 2010 in a 2800 km^2 study area near Barrow by ABR Inc., using survey protocol similar to ours (Safine 2012). Indicated pair density estimates from our north coastal strata during the 1992-2006 North Slope Eider and 2007-2011 ACP surveys averaged 0.0023 (calculated from data in Fig. 22), whereas the pair density estimated by ABR in the Barrow study area averaged 0.016 (Safine 2012). This suggests the Steller's eider density in the Barrow area may be approximately 7 times higher than that in the entire north coastal strata (30,465 km^2). In 2011, we observed only 1 pair of Steller's eiders on the ACP survey, for an index of 49 (Fig. 22).

Black scoters are uncommon on the ACP survey. One indicated pair was recorded in 2011 (Tables 3- 4, Fig. 23).

The white-winged scoter northern coastal strata population index (1,240) is nearly double the long-term average of 629 (Table 3, Fig. 24). Most of the observations occurred in the central arctic, south of Teshekpuk Lake. The 2011 white-winged scoter index (1,240) is 97% higher than the 1992-2011 average, but greatly reduced (-76%) from the record high of 2010 (Fig. 24). We suspect that much of the increase seen in white-winged scoters observed during the 2010 and 2011 surveys consisted of an influx of males staging to molt along the Beaufort coast. Please note that the large apparent discrepancy in white-winged scoters between the ACP survey 1986-2006 and 2007-2011 is mostly due to most scoters from the earlier period being recorded as "unidentified scoters" (Table 6).

Geese and swans

This survey does not adequately sample snow geese, which occur mainly in isolated coastal breeding colonies. ACP estimates have fluctuated because of annually-shifting transects relative to nesting colonies (Fig. 25). However, we have noted a recent increase in scattered observations of small groups of snow geese throughout much of the survey area within 80 km of the coast. Specific aerial snow goose surveys have been conducted since the early 1990s by ABR Inc. (see Ritchie and Rose 2009). Both ABR Inc. surveys (Ritchie et al 2007) and the ACP survey (Fig. 25) indicate positive growth rates for most individual colonies and the overall ACP snow goose breeding population since about 2000.

The 2011 white-fronted goose population index for the northern coastal strata (157,481) exceeds the 20-year mean (95,546) by 65%. White-fronted geese have increased over the long term (1992-2011, growth rate=1.057, 90%CI=1.037-1.077) and during the last 10 years (2002-2011, growth rate=1.113, 90%CI=1.065-1.164, Fig. 26). We can offer no explanation for the sudden large jump in the ACP whitefront breeding population after 2006, after a long gentle increase since 1992 (Fig. 26).

The 2011 Taverner's Canada goose index for the northern coastal strata is 7,906, which is 5% below the long-term mean (8,285, Fig. 27). The Taverner's Canada goose growth rate for the northern coastal strata from 1992-11 is stable (Tables 3, 5). The 2011 ACP all-strata index is 9,859, 46% below the 1986-2006 ACP survey mean (Table 6). The later timing of the 1986-2006 survey likely included a large proportion of molt migrants from other breeding areas.

Most black brant nest in colonies on the Arctic Coastal Plain, and trends are difficult to detect with our systematic survey design. Periodic aerial brant nesting and brood-rearing surveys between Barrow and the Colville Delta, reported 32 colonies in 2001 (Ritchie et al. 2002) and 2006 (Ritchie et al. 2007), with active nest counts of 386 and 346. In contrast, our data suggest the breeding population of brant increased from 2001-04, and was stable thereafter (Table 5, Fig. 28). The proportion of brant recorded as "flocks" increased from 2002-11; therefore, the overall increase could be the result of early failed breeders arriving from other breeding areas. However, pairs and small flocks of brant are being observed farther from the coast suggesting expansion of the breeding range (Fig. 28).

The 2011 tundra swan index is 9,792 (Fig. 29, Table 3) and has incurred a positive growth in long-term (1986-2011) and the recent 10-year periods (Table 5). The 2007-2010 average all-strata index (14,458) is 45% above the ACP survey 1986-2006 mean (9,971, Table 6).

Raptors, Ravens, other birds

Based on 10 northern coastal strata, the 2011 ACP sandhill crane population index is 367 (Table 3), and 576 in the all-strata area (Table 4). The 1992-2011 northern coastal strata population index mean is 178 (Tables 3, 5). The long-term and recent 10-year population growth rates are positive (Table 5).

Since 1997, shorebirds have been recorded, only by the left side pilot/observer, to identify important shorebird habitats and track the ACP long-term population trend (Fig. 30). We pooled all species due to difficulty in identifying shorebirds reliably from the air.

Despite concerns about raven populations expanding on the North Slope in response to increased presence of buildings and other artificial structures used as nesting habitat, and the availability of garbage as a year-round food source, ACP survey data do not indicate a positive growth rate nor a geographic shift (Table 5). However, the probability of detecting ravens is low in settled areas, as ravens normally spend a large part of their time on or near industrial and residential structures, which we deliberately avoid during our surveys due to regulatory and safety considerations.

Owl populations are extremely variable on the ACP, with peaks typically associated with spikes in lemming populations over major portions of their range. The 2011 northern coastal strata short-eared and snowy owl indices were (239) and (2,226), respectively (Figs. 31, 32), both among the highest on record for the survey; results consistent with the apparent widespread abundance of lemmings noted above (Figs. 31, 32). We also observed several active snowy owl nests; a rare occurrence on the ACP survey. The sightings were all in the area between Teshekpuk Lake and Nuiqsut.

Golden eagle sightings are typically few during the ACP survey, probably due to low detection (cryptic coloration, usually sedentary, and not usually associated with water bodies where we focus our attention). The 2011 index for the northern coastal strata (92) is double the 1992-2011 average (46, Fig. 33), and the growth rate for that period is positive (1.059, 90%CI=1.005-1.116), but the all-ACP index (220) is 48% below the 1986-2006 ACP average (Table 6).

CONCLUSIONS

This report describes results of spatially comprehensive aerial breeding population survey data for all common waterbirds, owls, eagles and ravens on the Arctic Coastal Plain of Alaska, collected by the U. S. Fish and Wildlife Service from 1986 to 2011. The 2011 survey is the first year of the second 4-year cycle since the survey's redesign in 2007, and appeared to be well-timed for most species adequately addressed by the survey. The 2010 ACP survey report, available on the Alaska Region U. S. Fish and Wildlife Service website, summarized the long-term status and illustrated the distribution of most surveyed species over the first 4-year cycle of the current design, while this report provided the 2011 annual update, without distribution maps.

Our data from 1992-2011 indicate that red-throated loon, mallard, and American green-winged teal have declined, while 13 others have increased (Table 5). Though global concern is low for red-throated loons (Birdlife International does not consider it "vulnerable", based on broad range and large global population of 200,000-590,000), the trend we detected should evoke at least local concern for the species, as statistical power is fairly robust for this species (11.5 survey years to detect a trend equivalent to a decline of 50% in 20 years), and the ACP population represents approximately 15% of the current estimated Alaska breeding population (proportion calculated from data from Mallek and Groves 2011 and this report). Results for mallard and green-winged teal are of lesser concern as ACP populations constitute an insignificant proportion of their continental breeding populations. The

As designed, with sampling frame the maximum possible for a single crew to complete within the phenological window of eiders, the ACP survey is nonetheless adequate to provide the data to confidently manage most North Slope species (Table 5). At a minimum, we recommend continuing the ACP survey as designed particularly in view of potential effects of climate change on the arctic environment.

The findings and conclusions in this document are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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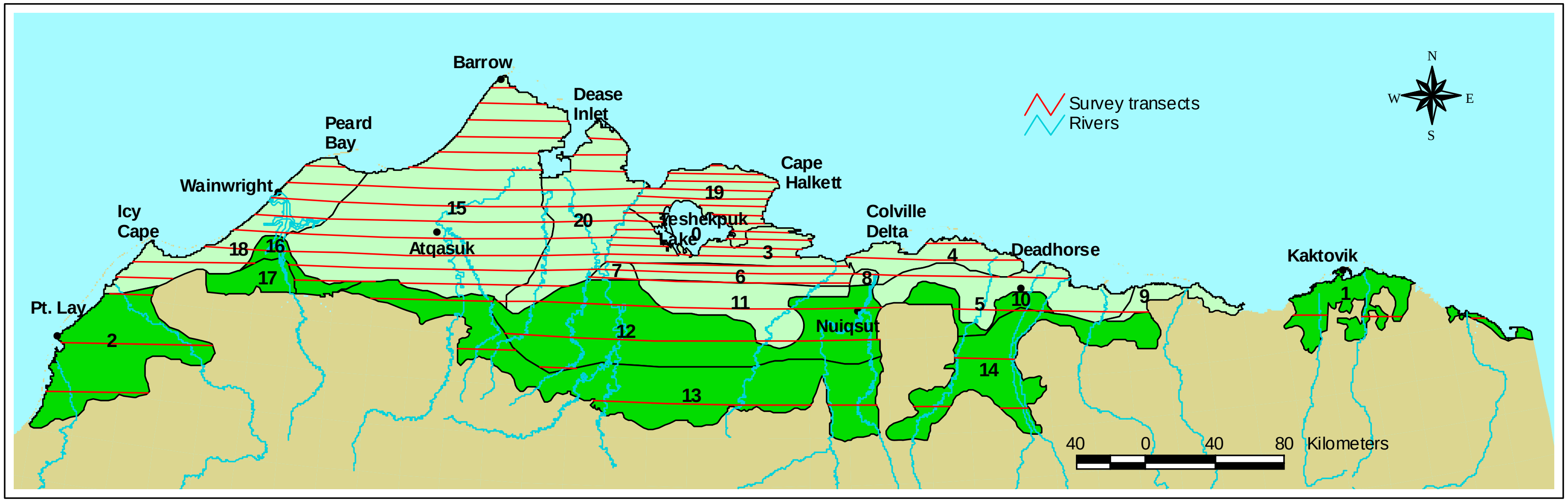


Figure 1. Spatial design of the 2011 Arctic Coastal Plain waterfowl breeding population survey. Northern coastal strata are shown in light green, strata outside the northern coastal strata area are shown in dark green. Red lines show locations of the 2011 design transects. Numbered strata are described in Table 1 below.

Table 1. Sampling design, aerial waterfowl breeding population survey, Arctic Coastal Plain, Alaska, June 2011. ID numbers refer to Fig. 1 above.

ID	Sampling Intensity	Stratum Area km^2	ID	Sampling Intensity	Stratum Area km^2		Stratum Area km^2	Sample Area km^2	Sample % of Stratum Area
0	Non-habitat		11	Medium	2,240	All Low	18,276	228.0	1.2
1	Low	1,812	12	Medium	7,453	All Medium	13,058	246.8	1.9
2	Low	3,916	13	Low	7,652	All High	20,351	837.9	4.1
3	Teshekpuk High	2,019	14	Low	3,571	Teshekpuk High	5,650	476.5	8.4
4	High	1,423	15	High	11,358	Eider Strata	30,465	1,401.2	4.6
5	Medium	2,581	16	High	582	All Strata	57,335	1,789.2	3.1
6	Teshekpuk High	1,362	17	Low	748				
7	Teshekpuk High	226	18	High	3,093				
8	High	128	19	Teshekpuk Hig	2,044				
9	Low	577	20	High	3,768				
10	Medium	784							

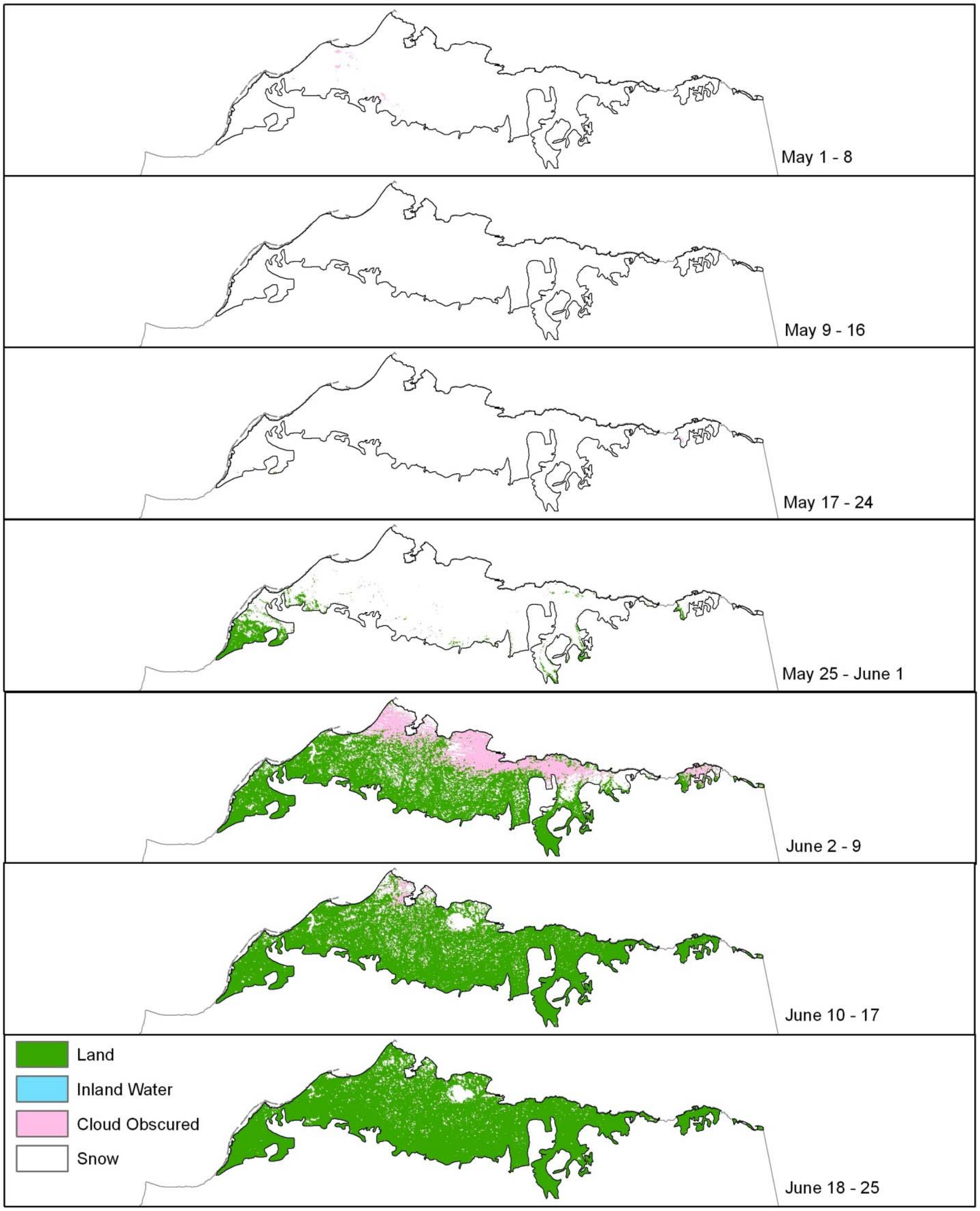


Figure 2. 2011 spring snow melt on the Arctic Coastal Plain, Alaska, from Terra satellite MODIS 8-day maximum snow extent data.

Table 2. Average and range of ratios of lone males (single to 4) to total males (males 1-4 plus males in pairs) of selected duck species observed during the Eider Survey (1992-2006) and the ACP survey (2007-2011), Arctic Coastal Plain, Alaska.

Species	LDI Avg. 1992-2010	LDI SD 1992-2010	LDI range 1992-2010	LDI 2011
Spectacled eider	0.50	0.08	0.28-0.58	0.58
King eider	0.35	0.11	0.14-0.57	0.44
Long-tailed duck	0.49	0.04	0.39-0.58	0.47
Northern pintail	0.83	0.08	0.67-0.91	0.83

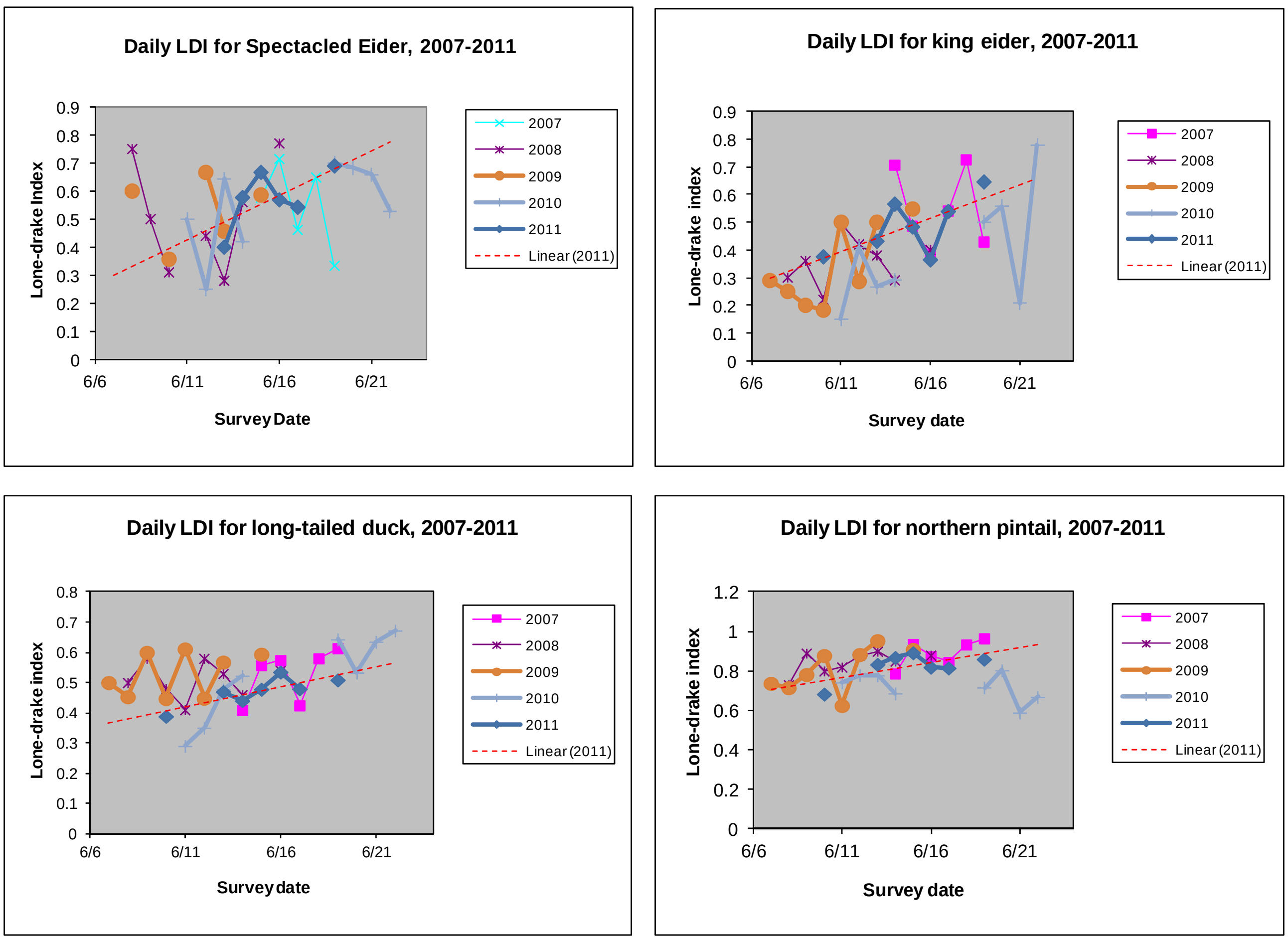


Figure 3. Daily ratio of lone males to total males (males single to 4 plus males in pairs) of selected duck species observed during the 2007-11 Waterfowl Breeding Population (ACP) survey, Arctic Coastal Plain, Alaska. A higher value indicates a more advanced stage of the breeding cycle.

Table 3. Combined observations by left and right observers on aerial survey transects, arctic coastal plain, Alaska, June 2011, with observable population indices. Includes observations from northern coastal 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	28	20	6	74[1]	0.0488	1,487	923-2,051			19.4
Pacific Loon	248	491	17	1,247[1]	0.9228	28,111	23,982-32,241			7.5
Red-throated loon	23	31	0	85[1]	0.0628	1,912	1,304-2,520			16.2
Jaeger spp.[3]	206	21	3	251[1]	0.1927	5,871	4,767-6,975			9.6
Glaucous gull	318	73	145	609[1]	0.4624	14,087	8,363-19,810			20.7
Sabine's gull	221	90	60	461[1]	0.3104	9,456	7,370-11,542			11.3
Arctic tern	227	129	47	532[1]	0.3717	11,325	9,446-13,204			8.5
Red-breasted merganser	5	8	0	26[2]	0.0291	887	318-1,457	1.27	1,127	32.7
Mallard	0	0	0	0[2]	0	0	0-	4.01	0	
Am. wigeon	0	0	0	0[2]	0	0	0-	3.84	0	
Am. Green-winged teal	2	1	0	6[2]	0.0048	146	21-271	8.36	1,220	43.7
Northern pintail	377	93	594	1,534[2]	0.955	29,094	23,137-35,051	3.05	88,736	10.4
Northern shoveler	0	0	0	0[2]	0	0	0-	3.79	0	
Greater scaup	40	80	127	327[1]	0.2458	7,487	4,104-10,870	1.93	14,450	23.1
Long-tailed duck	400	411	389	2,011[2]	1.4568	44,382	34,871-53,893	1.87	82,994	10.9
Spectacled eider	115	82	6	400[2]	0.261	7,952	6,258-9,646			10.9
Common eider	3	4	0	14[2]	0.0116	354	14-785			62.1
King eider	217	275	20	1,004[2]	0.6218	18,942	15,986-21,897			8
Steller's eider	0	1	0	2[2]	0.0016	49	2-144			100.2
Black scoter	1	0	0	2[2]	0.0016	49	2-138	1.17	57	94
White-winged scoter	1	8	7	25[2]	0.0407	1,240	25-2,508	1.17	1,450	52.2
Snow goose	23	271	440	1,005[1]	0.7581	23,096	1,005-50,352			60.2
Gr. White-fronted goose	842	1,648	2,699	7,679[2]	5.1693	157,481	139,046-175,917			6
Taverner's Canada goose	38	31	384	522[2]	0.2594	7,902	5,565-10,238			15.1
Black brant	79	100	244	602[2]	0.3118	9,498	5,584-13,411			21
Tundra swan	188	125	9	447[1]	0.3214	9,792	8,479-11,105			6.8
Sandhill crane	10	0	0	20[1]	0.0121	367	107-627			36.1
Unid. Shorebird[4,5]	301	251	769	1,572[1]	2.2032	67,119	44,139-90,098			17.5
Common raven	5	0	0	5[1]	0.0062	188	31-346			42.7
Short-eared owl	11	0	0	11[1]	0.0079	239	118-360			25.8
Snowy owl	107	0	0	107[1]	0.0731	2,226	1,471-2,981			17.3
Golden eagle	3	0	0	3[1]	0.003	92	3-229			76.8

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. 5. Data from left-side observer only.

Table 4. Combined observations by left and right observers on aerial survey transects, arctic coastal plain, Alaska, June 2011, 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	37	29	6	101[1]	0.0451	2,588	1,726-3,449			17
Pacific Loon	294	581	20	1,476[1]	0.7317	41,955	34,115-49,796			9.5
Red-throated loon	24	34	0	92[1]	0.0385	2,209	1,516-2,903			16
Red-necked grebe	1	0	0	1[1]	0.0009	53	1-134			77.7
Jaeger spp.[3]	257	26	3	312[1]	0.1733	9,937	8,207-11,667			8.9
Glaucous gull	361	85	152	683[1]	0.3354	19,230	11,967-26,493			19.3
Sabine's gull	255	94	60	503[1]	0.2072	11,877	9,245-14,509			11.3
Arctic tern	283	157	69	666[1]	0.3368	19,313	15,445-23,181			10.2
Red-breasted merganser	7	9	0	32[2]	0.0216	1,240	557-1,924	1.27	1,575	28.1
Mallard	0	2	0	4[2]	0.0047	269	4-619	4.01	1,077	66.6
Am. wigeon	2	4	0	12[2]	0.0141	806	12-1,611	3.84	3,095	51
Am. Green-winged teal	5	2	0	14[2]	0.0139	798	78-1,518	8.36	6,670	46
Northern pintail	432	114	611	1,703[2]	0.7189	41,219	32,471-49,967	3.05	125,717	10.8
Northern shoveler	1	0	0	2[2]	0.0018	106	2-268	3.79	402	77.7
Greater scaup	73	188	196	645[1]	0.4598	26,364	18,837-33,892	1.93	50,883	14.6
Long-tailed duck	473	527	401	2,401[2]	1.2059	69,141	55,666-82,616	1.87	129,294	9.9
Spectacled eider	116	86	6	410[2]	0.1468	8,419	6,499-10,339			11.6
Common eider	3	4	0	14[2]	0.006	344	14-859			76.5
King eider	229	287	20	1,052[2]	0.3785	21,703	16,688-26,718			11.8
Steller's eider	0	1	0	2[2]	0.0009	49	2-145			99.4
Black scoter	1	0	0	2[2]	0.0009	49	2-141	1.17	57	95.3
White-winged scoter	6	73	100	258[2]	0.329	18,862	3,601-34,124	1.17	22,069	41.3
Snow goose	23	272	440	1,007[1]	0.4127	23,661	1,007-52,805			62.8
Gr. White-fronted goose	945	1,815	2,976	8,496[2]	3.6388	208,632	174,865-242,399			8.3
Taverner's Canada goose	49	36	384	554[2]	0.1719	9,859	5,282-14,435			23.7
Black brant	79	100	247	605[2]	0.1689	9,684	4,818-14,550			25.6
Tundra swan	219	144	17	524[1]	0.2515	14,421	12,630-16,213			6.3
Sandhill crane	11	1	0	24[1]	0.01	576	275-877			26.7
Unid. Shorebird[4,5]	361	281	851	1,774[1]	1.6385	93,946	68,376-119,515			13.9
Common raven	9	0	0	9[1]	0.0098	562	76-1,048			44.1
Short-eared owl	15	0	0	15[1]	0.0083	475	194-756			30.2
Snowy owl	108	0	0	108[1]	0.0444	2,543	990-4,097			31.2
Golden eagle	6	0	0	61	0.0038	220	6-441			51.3

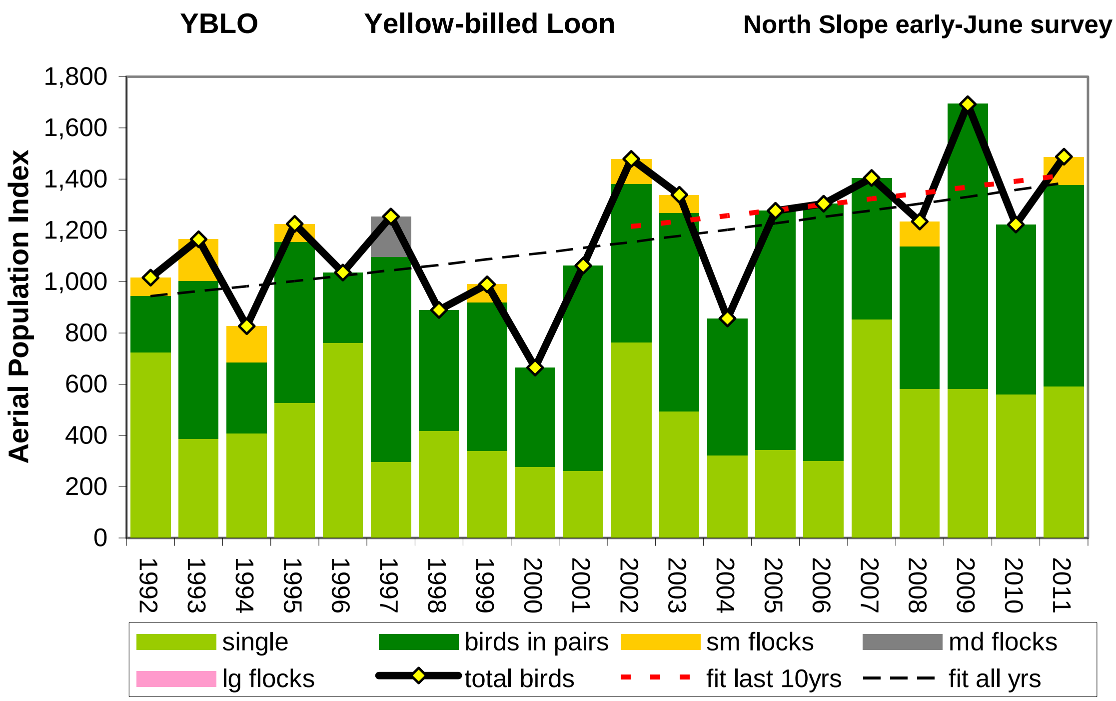
1. singles+(2*pairs)+flocked 2. 2*(singles+pairs)+flocked 3. *Stercorarius longicaudus, S. parasiticus, S. pomarinus* 4. *Charadrius sp., Pluvialis spp., Calidris spp., Arenaria sp., Numenius sp., Limnodromus sp.* et al. 5. Data from left-side observer only.

Table 5. Mean population indices, population growth rates, and years to detect a population trend equivalent to a 50 percent growth or decline in 20 years, for observations of selected bird species in early to mid-June 1992-2011 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 (northern coastal strata). Significant growth rates are highlighted 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	1992-2011	20	1,171	0.020	**1.020**	1.007-1.034	0.214	14.3	1.017	0.984-1.051
Pacific Loon	S + 2*Pr + Fl	1992-2011	20	21,310	0.008	1.008	0.995-1.022	0.070	6.8	1.019	0.978-1.061
Red-throated loon	S + 2*Pr + Fl	1992-2011	20	2,495	-0.037	**0.963**	0.942-0.985	0.154	11.5	0.993	0.946-1.042
Jaeger spp.	S + 2*Pr + Fl	1992-2011	20	4,218	0.014	1.014	0.987-1.043	0.117	9.5	**1.090**	1.014-1.171
Glaucous gull	S + 2*Pr + Fl	1992-2011	20	12,663	0.010	1.010	0.994-1.025	0.148	11.2	**1.048**	1.012-1.086
Sabine's gull	S + 2*Pr + Fl	1992-2011	20	7,604	0.030	**1.030**	1.010-1.051	0.132	10.3	**1.068**	1.021-1.118
Arctic tern	S + 2*Pr + Fl	1992-2011	20	10,875	0.029	**1.030**	1.020-1.040	0.110	9.2	1.003	0.977-1.031
Red-breasted merganser	2 * (S + Pr) + Fl	1992-2011	20	523	0.084	**1.088**	1.051-1.126	0.384	21.1	**1.012**	0.972-1.055
Mallard	2 * (S + Pr) + Fl	1992-2011	20	173	-0.076	0.927	0.862-0.996	0.771	33.5	0.852	0.710-1.021
Am. wigeon	2 * (S + Pr) + Fl	1992-2011	20	348	-0.081	0.922	0.847-1.004	0.685	31.0	0.847	0.641-1.118
Am. Green-winged teal	2 * (S + Pr) + Fl	1992-2011	20	267	-0.070	**0.932**	0.878-0.990	0.531	26.1	**1.175**	1.087-1.270
Northern pintail	2 * (S + Pr) + Fl	1992-2011	20	47,344	-0.017	0.984	0.959-1.009	0.102	8.7	0.982	0.928-1.039
Northern shoveler	2 * (S + Pr) + Fl	1992-2011	20	175	-0.018	0.982	0.893-1.081	0.692	31.2	0.873	0.686-1.110
Greater scaup	S + 2*Pr + Fl	1992-2011	20	5,036	0.065	**1.067**	1.049-1.086	0.183	12.9	**1.060**	1.000-1.123
Long-tailed duck	2 * (S + Pr) + Fl	1992-2011	20	30,935	-0.005	0.995	0.981-1.010	0.071	6.8	1.035	0.986-1.087
Spectacled eider	2 * (S + Pr) + Fl	1993-2011	19	6,580	-0.008	**0.992**	0.980-1.005	0.112	9.2	**0.997**	0.965-1.029
Common eider	2 * (S + Pr) + Fl	1992-2011	20	503	0.024	1.024	0.957-1.095	0.783	33.9	1.125	0.914-1.384
King eider	2 * (S + Pr) + Fl	1993-2011	19	14,236	0.027	**1.027**	1.018-1.037	0.091	8.1	1.040	1.019-1.061
Steller's eider	2 * (S + Pr) + Fl	1992-2011	20	144	-0.010	0.990	0.904-1.084	0.829	35.2	0.966	0.776-1.201
Black scoter	2 * (S + Pr) + Fl	1992-2011	20	126	-0.005	0.995	0.925-1.071	0.862	36.1	**1.172**	1.006-1.366
White-winged scoter	2 * (S + Pr) + Fl	1992-2011	20	629	0.085	1.089	1.028-1.153	0.570	27.4	1.163	0.982-1.377
Snow goose	S + 2*Pr + Fl	1992-2011	20	8,717	0.196	**1.217**	1.126-1.314	0.563	27.2	1.288	0.981-1.691
Gr. White-fronted goose	2 * (S + Pr) + Fl	1992-2011	20	95,546	0.055	**1.057**	1.037-1.077	0.074	7.1	**1.113**	1.065-1.164
Taverner's Canada goose	2 * (S + Pr) + Fl	1993-2011	19	8,285	0.008	1.008	0.976-1.040	0.254	16.0	1.075	0.974-1.188
Black brant	2 * (S + Pr) + Fl	1992-2011	20	7,519	0.089	**1.093**	1.069-1.117	0.250	15.8	**1.016**	0.972-1.062
Tundra swan	S + 2*Pr + Fl	1992-2011	20	7,064	0.037	**1.038**	1.025-1.051	0.108	9.0	**1.070**	1.046-1.095
Sandhill crane	S + 2*Pr + Fl	1992-2011	20	178	0.083	**1.087**	1.039-1.136	0.604	28.5	1.236	1.109-1.378
Unid. Shorebird	S + 2*Pr + Fl	1997-2011	15	52,141	-0.009	0.991	0.968-1.014	0.108	9.0	1.008	0.966-1.051
Common raven	S + 2*Pr + Fl	1992-2011	20	70	0.042	1.043	0.985-1.104	0.660	30.2	1.160	0.997-1.350
Short-eared owl	S + 2*Pr + Fl	1992-2011	20	86	0.079	1.082	0.990-1.183	0.596	28.2	1.195	0.966-1.478
Snowy owl	S + 2*Pr + Fl	1992-2011	20	880	0.004	1.004	0.927-1.086	0.359	20.1	1.082	0.850-1.377
Golden eagle	S + 2*Pr + Fl	1992-2011	20	46	0.057	1.059	1.005-1.116	0.815	34.8	1.033	0.894-1.194

Table 6. Breeding population estimates, standard Alaska ACP Survey, 1986-2006 means (Mallek et al. 2007) compared with estimates from the current ACP survey, 2011 and averages from 2007-2010. Duck indices were converted to population estimates by multiplying by tundra visibility correction factors calculated for the Alaska-Yukon Breeding Population Survey (Conant et al. 1991).

Species	VCF	ACP Survey mean 1986-2006	All ACP strata 2007-2010 (95%CI)	All ACP strata 2011 (95%CI)
Yellow-billed loon	1.00	2,778	2,465 (1,817-3,113)	2,588 (1,726-3,449)
Pacific Loon	1.00	29,756	35,161 (23,031-39,541)	41,955 (34,115-49,796)
Red-throated loon	1.00	3,240	2,820 (2,030-3,610)	2,209 (1,516-2,903)
Jaegers	1.00	7,197	9,571 (7,706-11,436)	9,937 (8,207-11,667)
Glaucous gull	1.00	17,188	20,127 (16,445-23,808)	19,230 (11,967-26,493)
Sabine's gull	1.00	11,810	13,303 (10,074-16,532)	11,877 (9,245-14,509)
Arctic tern	1.00	23,544	22,506 (18,766-26,247)	19,313 (15,445-23,181)
Red-breasted merganser	1.27	2,340	1,900 (714-3,086)	1,575 (707-2,443)
Mallard	4.01	1,848	1,560 (74-3,174)	1,077 (16-2,482)
Am. wigeon	3.84	4,123	1,618 (380-2,905)	3,095 (46-6,186)
Am. Green-winged teal	8.36	3,210	3,781 (1,250-6,308)	6,670 (652-12,690)
Northern pintail	3.05	220,494	197,936 (162,581-233,291)	125,717 (99,037-152,399)
Northern shoveler	3.79	987	2,161 (271-4,247)	402 (8-1,016)
Greater scaup	1.93	32,721	39,450 (29,364-49,537)	50,883 (36,355-65,412)
Long-tailed duck	1.87	107,041	87,642 (76,487-98,796)	129,294 (104,095-154,492)
Spectacled eider	1.00	619	5,987 (4,436-7,537)	8,419 (6,499-10,339)
Common eider	1.00	441	935 (38-2,641)	344 (14-859)
King eider	1.00	3,999	20,444 (16,677-24,210)	21,703 (16,688-26,718)
Steller's eider	1.00	743	102 (6-348)	49 (2-145)
Black scoter	1.17	43	259 (8-579)	57 (2-165)
White-winged scoter	1.17	247	7,362 (2,801-11,924)	22,069 (4,213-39,925)
All scoters	1.17	10,381	7,621 (2,809-12,503)	22,126 (4,215-40,090)
Snow goose	1.00	3,025	27,110 (NA)	23,661 (1,007-52,805)
Gr. White-fronted goose	1.00	123,963	220,202 (175,484-261,903)	208,632 (174,865-242,399)
Taverner's Canada goose	1.00	18,309	17,796 (7,565-21,964)	9,859 (5,282-14,435)
Black brant	1.00	9,792	10,831 (4,621-17,333)	9,684 (4,818-14,550)
Tundra swan	1.00	9,971	14,458 (11,761-18,001)	14,421 (12,630-16,213)
Sandhill crane	1.00		451 (341-974)	576 (275-877)
Common raven	1.00		317 (63-610)	562 (76-1,048)
Short-eared owl	1.00		285 (32-555)	475 (194-756)
Snowy owl	1.00	1,219	814 (234-636)	2,543 (990-4,097)
Golden eagle	1.00	426	273 (122-499)	220 (6-441)



NSE 10 strata =30,465 km2

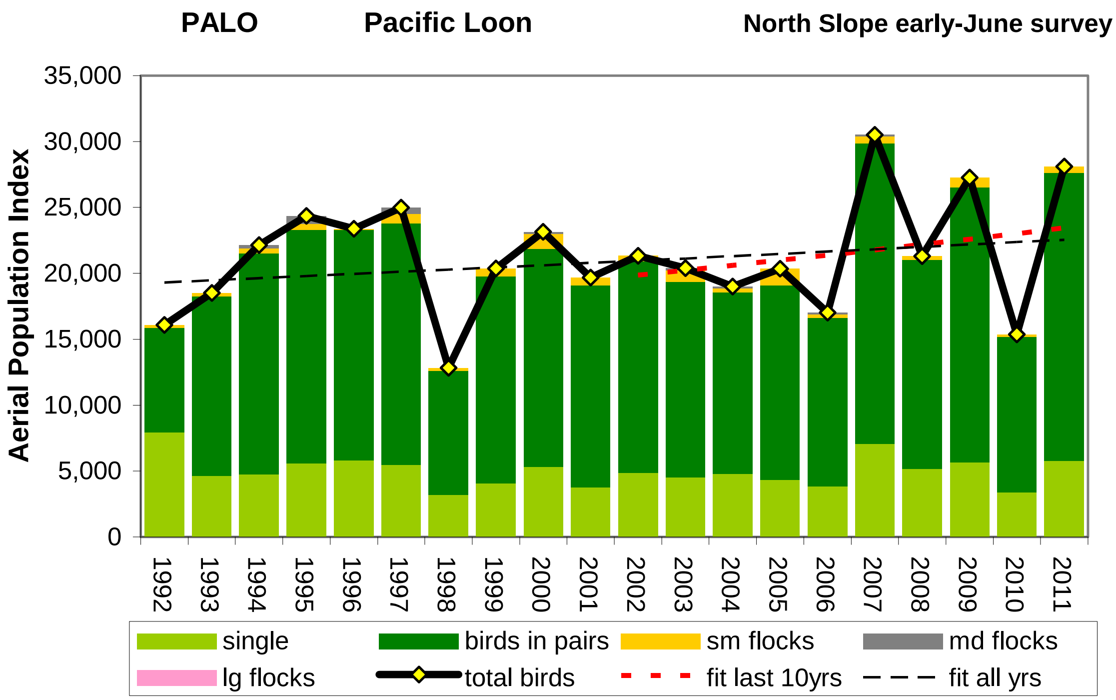
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	725	219	71	0	0	**1015**	179
1993	386	617	162	0	0	**1165**	267
1994	408	277	141	0	0	**826**	190
1995	527	628	70	0	0	**1226**	308
1996	761	275	0	0	0	**1036**	191
1997	297	801	0	157	0	**1254**	573
1998	416	474	0	0	0	**890**	200
1999	340	579	70	0	0	**989**	229
2000	277	388	0	0	0	**665**	165
2001	262	800	0	0	0	**1062**	196
2002	762	620	97	0	0	**1479**	231
2003	495	773	71	0	0	**1339**	236
2004	323	533	0	0	0	**856**	170
2005	344	932	0	0	0	**1277**	253
2006	302	1002	0	0	0	**1304**	337
2007	854	551	0	0	0	**1405**	251
2008	582	556	97	0	0	**1235**	216
2009	582	1111	0	0	0	**1693**	258
2010	559	664	0	0	0	**1223**	209
2011	592	787	108	0	0	**1487**	288

YBLO

Aerial index: Total birds

n yrs =	20
mean pop index =	**1171**
std dev =	255
std error =	57
low 90%ci =	1059
high 90%ci =	1283
trend over all years :	
ln linear slope =	0.0202
SE slope =	0.0078
Growth Rate =	**1.020**
low 90%ci GR =	1.007
high 90%ci GR =	1.034
regression resid CV =	0.202
avg sampling err CV =	0.214
trend of most recent 10 years :	
Growth Rate =	**1.017**
low 90%ci GR =	0.984
high 90%ci GR =	1.051
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	13.7
w/ sample error CV =	14.3

Figure 4. Population trend for Yellow-billed Loons (*Gavia adamsii*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The total birds 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341(equivalent to a 50% decline in 20 years), if it were to occur.



NSE 10 strata =30,465 km2

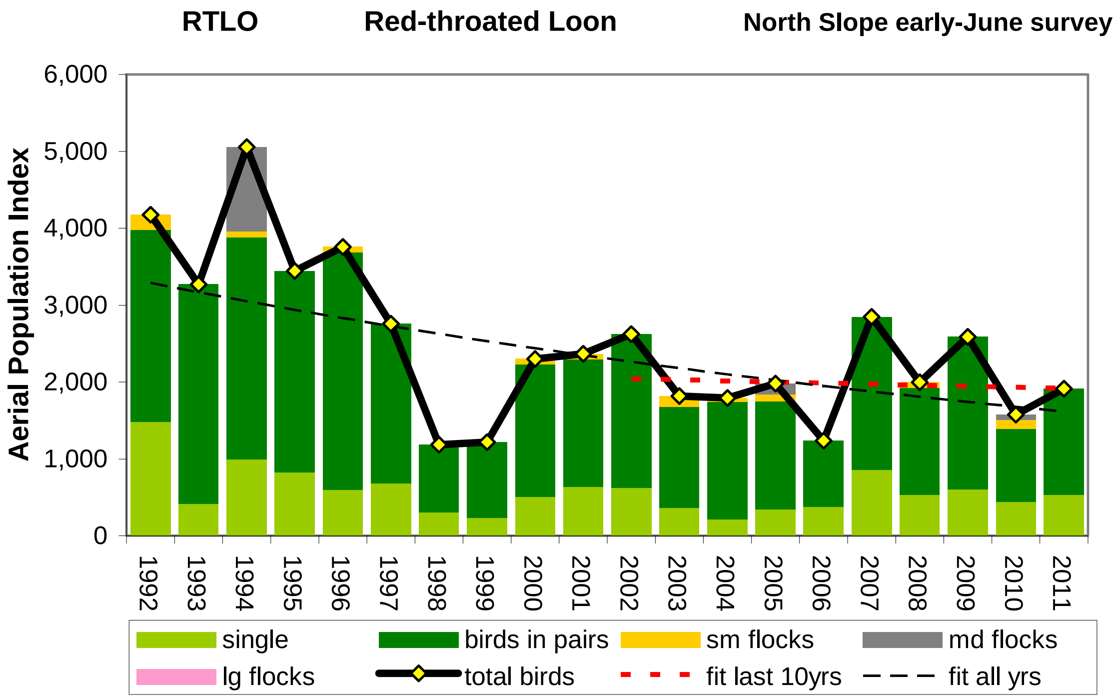
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	7931	7944	227	0	0	**16103**	1174
1993	4669	13592	251	0	0	**18512**	958
1994	4773	16753	354	266	0	**22146**	1329
1995	5592	17703	467	584	0	**24347**	1438
1996	5821	17495	71	0	0	**23387**	1193
1997	5497	18298	696	490	0	**24981**	1848
1998	3220	9392	222	0	0	**12833**	1370
1999	4070	15690	625	0	0	**20385**	1386
2000	5299	16556	1161	137	0	**23152**	1364
2001	3767	15326	581	0	0	**19675**	1330
2002	4880	16020	431	0	0	**21330**	1250
2003	4536	14842	842	177	0	**20397**	1701
2004	4802	13751	312	148	0	**19014**	1269
2005	4340	14728	1283	0	0	**20351**	1760
2006	3839	12783	250	147	0	**17018**	1532
2007	7051	22807	505	144	0	**30507**	1525
2008	5172	15853	290	0	0	**21315**	1647
2009	5647	20878	751	0	0	**27276**	1736
2010	3410	11777	175	0	0	**15362**	1233
2011	5780	21866	466	0	0	**28111**	2107

PALO

Aerial index: Total birds

n yrs =	20
mean pop index =	**21310**
std dev =	4405
std error =	985
low 90%ci =	19379
high 90%ci =	23241
trend over all years :	
ln linear slope =	0.0082
SE slope =	0.0082
Growth Rate =	**1.008**
low 90%ci GR =	0.995
high 90%ci GR =	1.022
regression resid CV =	0.212
avg sampling err CV =	0.070
trend of most recent 10 years :	
Growth Rate =	**1.019**
low 90%ci GR =	0.978
high 90%ci GR =	1.061
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	14.2
w/ sample error CV =	6.8

Figure 5. Population trend for Pacific Loons (*Gavia pacifica*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The total birds 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



NSE 10 strata =30,465 km2

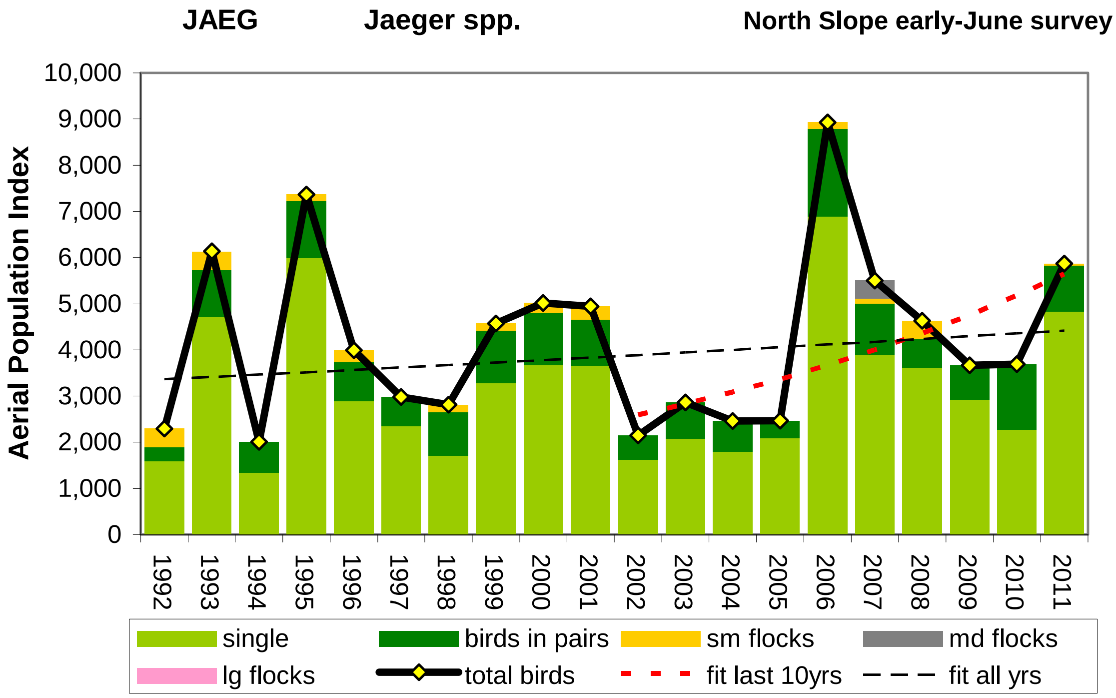
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	1487	2495	196	0	0	**4177**	453
1993	421	2850	0	0	0	**3271**	434
1994	993	2888	75	1099	0	**5054**	990
1995	827	2617	0	0	0	**3445**	476
1996	596	3087	73	0	0	**3756**	390
1997	683	2075	0	0	0	**2758**	415
1998	306	879	0	0	0	**1185**	251
1999	234	983	0	0	0	**1216**	176
2000	502	1727	69	0	0	**2298**	330
2001	634	1663	71	0	0	**2367**	387
2002	627	1994	0	0	0	**2621**	335
2003	363	1315	140	0	0	**1818**	194
2004	217	1528	49	0	0	**1793**	294
2005	348	1398	94	141	0	**1980**	399
2006	374	862	0	0	0	**1236**	264
2007	860	1986	0	0	0	**2846**	388
2008	530	1395	70	0	0	**1996**	367
2009	605	1980	0	0	0	**2585**	342
2010	445	943	118	72	0	**1578**	247
2011	530	1382	0	0	0	**1912**	310

RTLO

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

n yrs =	20
mean pop index =	**2495**
std dev =	1034
std error =	231
low 90%ci =	2041
high 90%ci =	2948
<u>trend over all years :</u>	
ln linear slope =	-0.0374
SE slope =	0.0137
Growth Rate =	**0.963**
low 90%ci GR =	0.942
high 90%ci GR =	0.985
regression resid CV =	0.354
avg sampling err CV =	0.154
<u>trend of most recent 10 years :</u>	
Growth Rate =	**0.993**
low 90%ci GR =	0.946
high 90%ci GR =	1.042
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	19.9
w/ sample error CV =	11.5

Figure 6. Population trend for Red-throated Loons (*Gavia stellata*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The total birds 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



NSE 10 strata =30,465 km2

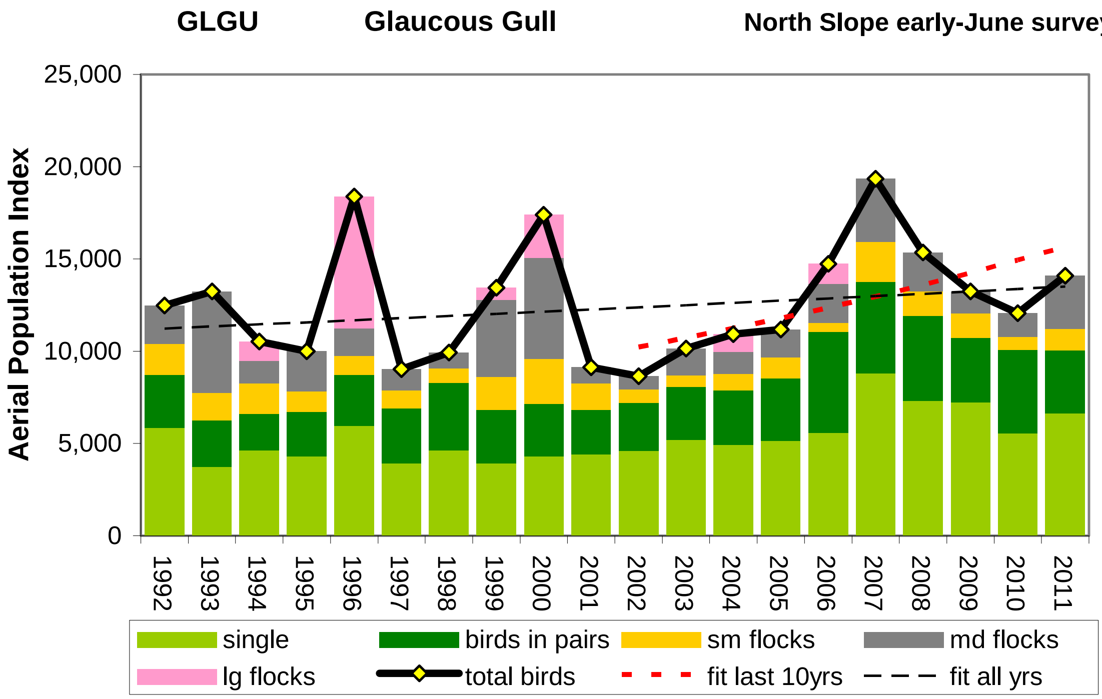
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	1588	301	409	0	0	**2298**	297
1993	4713	1014	405	0	0	**6131**	706
1994	1335	671	0	0	0	**2007**	353
1995	5989	1232	144	0	0	**7365**	650
1996	2897	842	253	0	0	**3992**	485
1997	2346	638	0	0	0	**2984**	316
1998	1702	952	164	0	0	**2817**	384
1999	3276	1143	154	0	0	**4572**	477
2000	3673	1124	221	0	0	**5018**	526
2001	3655	1005	286	0	0	**4946**	604
2002	1622	525	0	0	0	**2147**	232
2003	2078	785	0	0	0	**2863**	300
2004	1793	666	0	0	0	**2459**	242
2005	2081	390	0	0	0	**2471**	278
2006	6893	1891	147	0	0	**8930**	589
2007	3886	1125	99	392	0	**5502**	909
2008	3618	620	392	0	0	**4630**	717
2009	2929	737	0	0	0	**3666**	335
2010	2267	1423	0	0	0	**3690**	514
2011	4821	1008	41	0	0	**5871**	563

JAEG

Aerial index: Total birds

n yrs =	20
mean pop index =	**4218**
std dev =	1872
std error =	419
low 90%ci =	3398
high 90%ci =	5038
trend over all years :	
ln linear slope =	0.0143
SE slope =	0.0168
Growth Rate =	**1.014**
low 90%ci GR =	0.987
high 90%ci GR =	1.043
regression resid CV =	0.434
avg sampling err CV =	0.117
trend of most recent 10 years :	
Growth Rate =	**1.090**
low 90%ci GR =	1.014
high 90%ci GR =	1.171
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	22.9
w/ sample error CV =	9.5

Figure 7. Population trend for jaeger species (*Stercorarius parasiticus, S. pomarinus, S. longicaudus*) observed on aerial survey transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The total birds 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



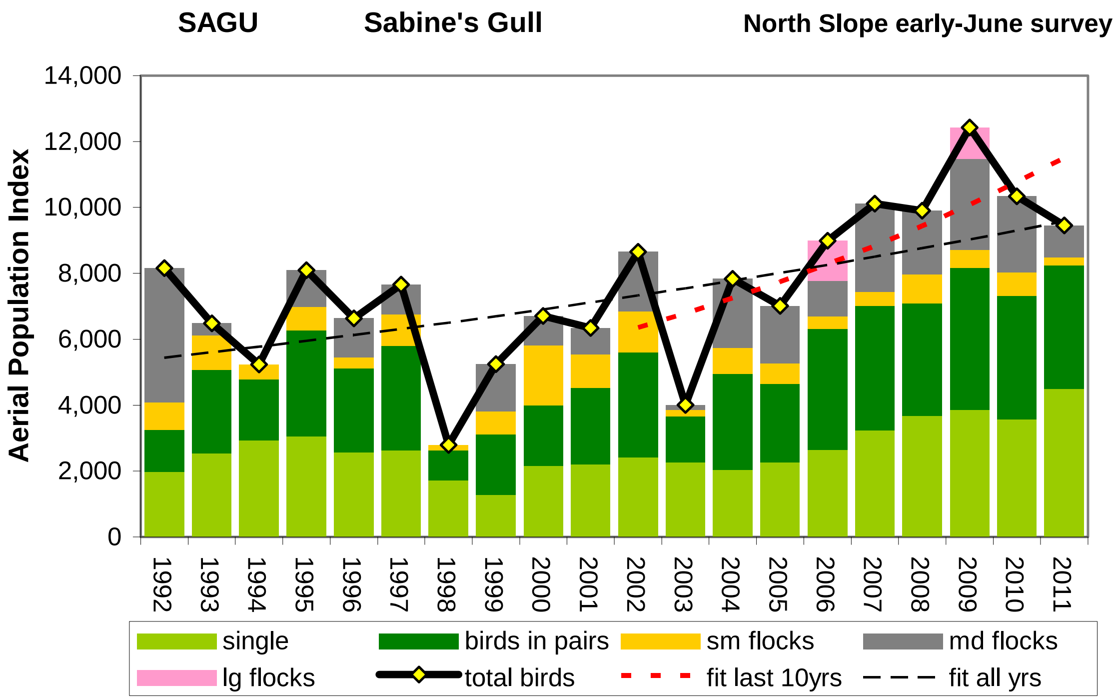
NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	5840	2875	1704	2050	0	**12469**	1385
1993	3724	2536	1489	5490	0	**13238**	3151
1994	4648	1964	1640	1223	1057	**10532**	1794
1995	4300	2396	1119	2185	0	**10000**	1522
1996	5959	2772	1034	1501	7107	**18372**	7868
1997	3919	2979	973	1158	0	**9028**	1289
1998	4645	3636	786	859	0	**9926**	1097
1999	3932	2900	1780	4168	656	**13435**	1343
2000	4303	2832	2464	5454	2342	**17394**	3095
2001	4423	2391	1429	886	0	**9130**	1124
2002	4596	2615	706	732	0	**8649**	788
2003	5182	2878	645	1449	0	**10153**	1325
2004	4921	2971	898	1181	951	**10921**	1164
2005	5162	3376	1134	1503	0	**11175**	1255
2006	5573	5465	505	2098	1102	**14743**	1976
2007	8807	4945	2169	3424	0	**19345**	2390
2008	7304	4615	1326	2101	0	**15346**	1220
2009	7236	3494	1335	1181	0	**13246**	1460
2010	5562	4508	710	1284	0	**12064**	1314
2011	6645	3406	1138	2898	0	**14087**	2920

GLGU

Aerial index: Total birds	
n yrs =	20
mean pop index =	**12663**
std dev =	3140
std error =	702
low 90%ci =	11286
high 90%ci =	14039
trend over all years :	
ln linear slope =	0.0097
SE slope =	0.0093
Growth Rate =	**1.010**
low 90%ci GR =	0.994
high 90%ci GR =	1.025
regression resid CV =	0.239
avg sampling err CV =	0.148
trend of most recent 10 years :	
Growth Rate =	**1.048**
low 90%ci GR =	1.012
high 90%ci GR =	1.086
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	15.3
w/ sample error CV =	11.2

Figure 8. Population trend for Glaucous Gulls (*Larus hyperboreus*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The total birds 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



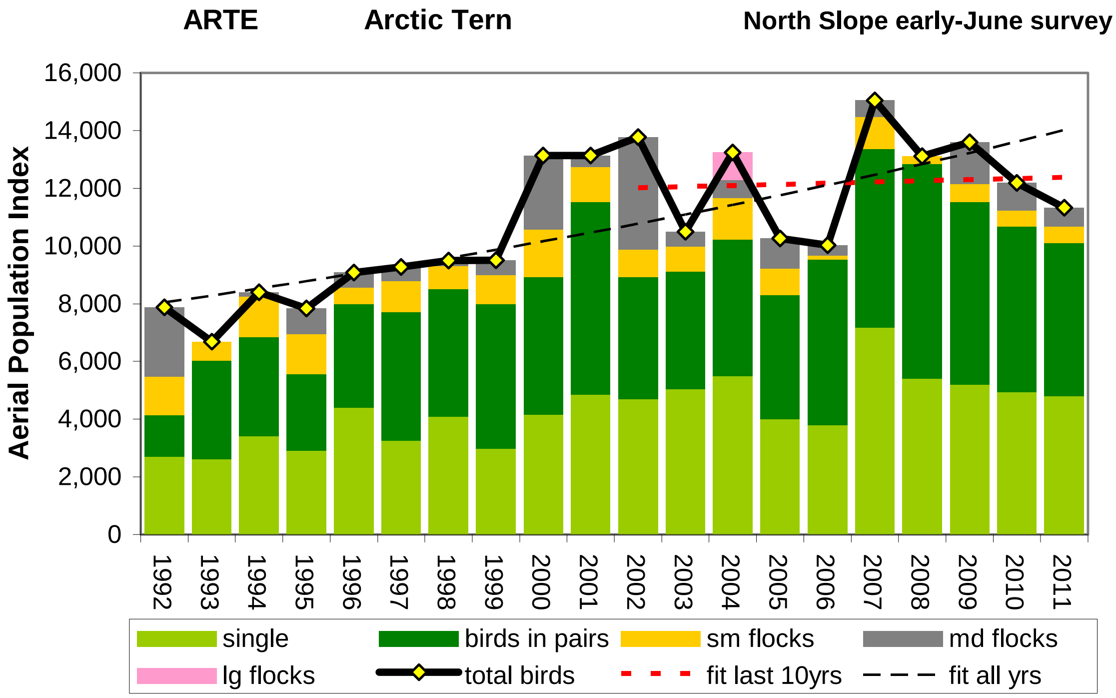
NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	1974	1276	833	4076	0	**8158**	1264
1993	2546	2525	1043	372	0	**6487**	737
1994	2935	1852	446	0	0	**5234**	624
1995	3059	3221	696	1122	0	**8098**	1482
1996	2567	2547	335	1184	0	**6632**	954
1997	2631	3160	966	898	0	**7655**	738
1998	1719	909	165	0	0	**2793**	409
1999	1280	1836	689	1443	0	**5249**	812
2000	2150	1841	1818	895	0	**6705**	844
2001	2198	2328	1028	788	0	**6342**	869
2002	2423	3179	1232	1816	0	**8651**	822
2003	2272	1389	196	146	0	**4004**	448
2004	2040	2909	784	2100	0	**7833**	1182
2005	2264	2388	625	1741	0	**7018**	866
2006	2640	3679	374	1072	1220	**8984**	1509
2007	3242	3781	414	2676	0	**10113**	1105
2008	3669	3410	893	1929	0	**9901**	1124
2009	3852	4317	543	2774	944	**12429**	1633
2010	3565	3750	707	2315	0	**10338**	1521
2011	4502	3755	226	973	0	**9456**	1064

SAGU

Aerial index: Total birds	
n yrs =	20
mean pop index =	**7604**
std dev =	2312
std error =	517
low 90%ci =	6591
high 90%ci =	8617
trend over all years :	
ln linear slope =	0.0298
SE slope =	0.0120
Growth Rate =	**1.030**
low 90%ci GR =	1.010
high 90%ci GR =	1.051
regression resid CV =	0.311
avg sampling err CV =	0.132
trend of most recent 10 years :	
Growth Rate =	**1.068**
low 90%ci GR =	1.021
high 90%ci GR =	1.118
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	18.3
w/ sample error CV =	10.3

Figure 9. Population trend for Sabine's gulls (*Xema sabini*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The total birds 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



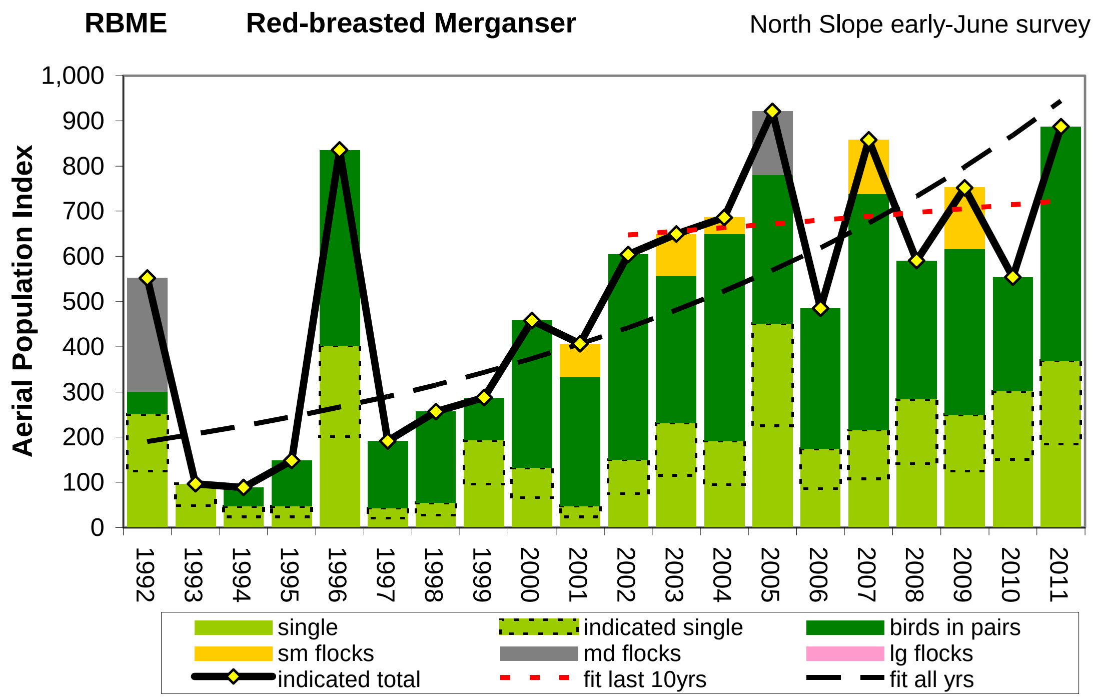
NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	2691	1449	1327	2411	0	**7877**	1340
1993	2605	3425	652	0	0	**6682**	692
1994	3419	3417	1418	147	0	**8400**	933
1995	2905	2655	1393	879	0	**7832**	1186
1996	4398	3597	560	528	0	**9083**	906
1997	3252	4464	1069	488	0	**9274**	891
1998	4098	4409	806	179	0	**9491**	838
1999	2969	5016	1007	515	0	**9508**	1230
2000	4151	4783	1635	2571	0	**13141**	1361
2001	4844	6685	1217	389	0	**13135**	1236
2002	4698	4221	956	3905	0	**13778**	1800
2003	5033	4077	872	512	0	**10493**	1128
2004	5491	4735	1441	617	964	**13248**	1509
2005	3997	4301	917	1051	0	**10266**	1195
2006	3779	5752	147	348	0	**10026**	917
2007	7173	6186	1107	575	0	**15040**	1227
2008	5409	7435	275	0	0	**13119**	1475
2009	5199	6314	629	1451	0	**13593**	1369
2010	4941	5738	545	964	0	**12188**	1377
2011	4787	5315	582	642	0	**11325**	959

ARTE

Aerial index: Total birds	
n yrs =	20
mean pop index =	**10875**
std dev =	2393
std error =	535
low 90%ci =	9826
high 90%ci =	11923
trend over all years :	
ln linear slope =	0.0292
SE slope =	0.0059
Growth Rate =	**1.030**
low 90%ci GR =	1.020
high 90%ci GR =	1.040
regression resid CV =	0.151
avg sampling err CV =	0.110
trend of most recent 10 years :	
Growth Rate =	**1.003**
low 90%ci GR =	0.977
high 90%ci GR =	1.031
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	11.3
w/ sample error CV =	9.2

Figure 10. Population trend for Arctic terns (*Sterna paradisaea*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The total birds 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



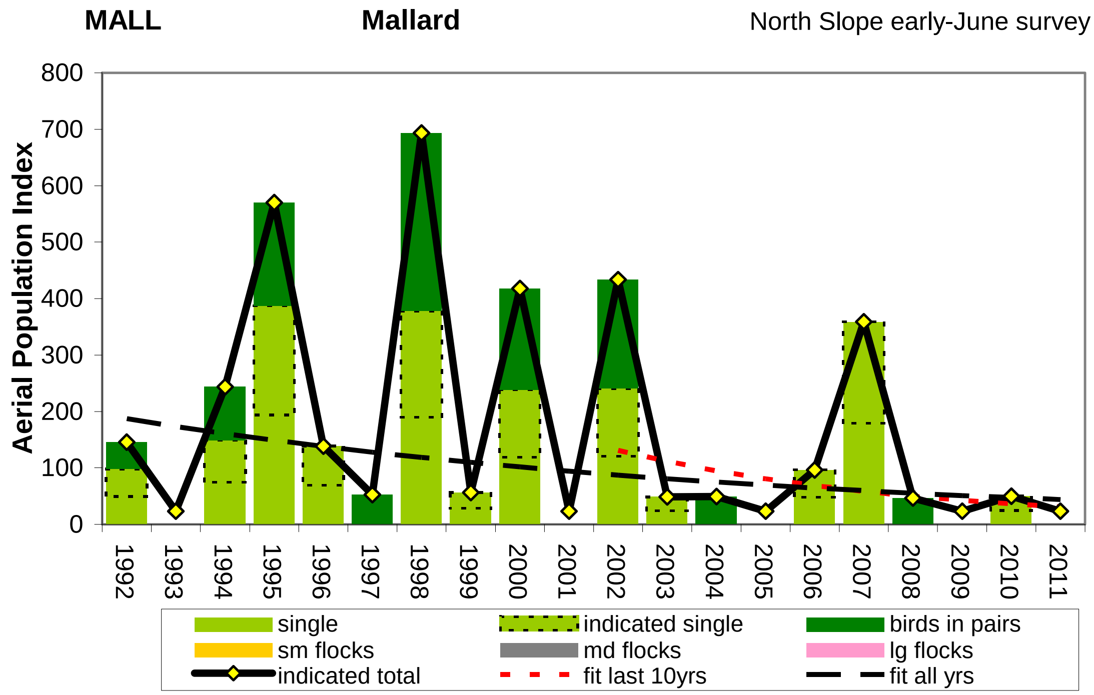
NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	250	50	0	252	0	**552**	252
1993	97	0	0	0	0	**97**	68
1994	47	41	0	0	0	**88**	63
1995	47	101	0	0	0	**148**	87
1996	403	433	0	0	0	**836**	220
1997	42	149	0	0	0	**192**	90
1998	55	202	0	0	0	**256**	99
1999	193	95	0	0	0	**287**	105
2000	132	326	0	0	0	**458**	153
2001	47	287	72	0	0	**407**	132
2002	150	454	0	0	0	**604**	155
2003	230	326	93	0	0	**650**	214
2004	191	459	37	0	0	**686**	179
2005	451	329	0	141	0	**921**	320
2006	174	312	0	0	0	**485**	158
2007	216	523	120	0	0	**858**	322
2008	283	308	0	0	0	**591**	228
2009	250	366	136	0	0	**752**	200
2010	302	252	0	0	0	**554**	116
2011	369	518	0	0	0	**887**	291

RBME

Aerial index: Indicated total	
n yrs =	20
mean pop index =	**523**
std dev =	265
std error =	59
low 90%ci =	407
high 90%ci =	639
trend over all years :	
ln linear slope =	0.0843
SE slope =	0.0210
Growth Rate =	**1.088**
low 90%ci GR =	1.051
high 90%ci GR =	1.126
regression resid CV =	0.543
avg sampling err CV =	0.384
trend of most recent 10 years :	
Growth Rate =	**1.012**
low 90%ci GR =	0.972
high 90%ci GR =	1.055
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	26.5
w/ sample error CV =	21.1

Figure 11. Population trend for red-breasted mergansers (*Mergus serrator*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



NSE 10 strata =30,465 km2

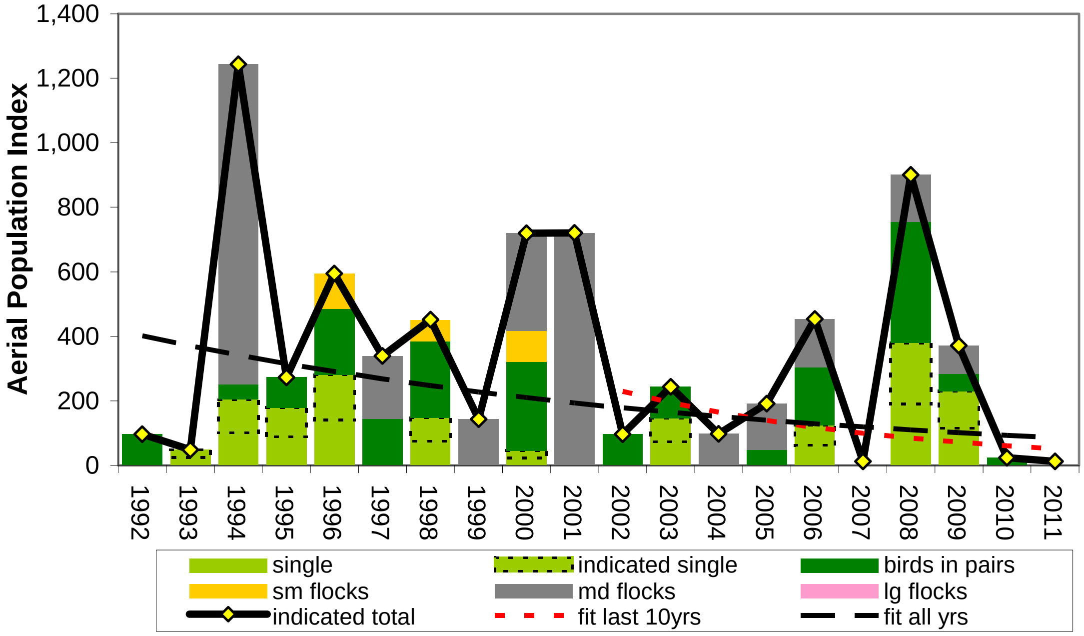
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	98	48	0	0	0	**146**	85
1993	0	0	0	0	0	**23**	24
1994	149	94	0	0	0	**243**	127
1995	387	183	0	0	0	**570**	209
1996	139	0	0	0	0	**139**	75
1997	0	52	0	0	0	**52**	52
1998	378	315	0	0	0	**694**	180
1999	56	0	0	0	0	**56**	49
2000	238	180	0	0	0	**418**	157
2001	0	0	0	0	0	**23**	24
2002	241	193	0	0	0	**434**	188
2003	49	0	0	0	0	**49**	48
2004	0	49	0	0	0	**49**	52
2005	0	0	0	0	0	**23**	24
2006	96	0	0	0	0	**96**	58
2007	359	0	0	0	0	**359**	261
2008	0	47	0	0	0	**47**	48
2009	0	0	0	0	0	**23**	24
2010	50	0	0	0	0	**50**	48
2011	0	0	0	0	0	**23**	24

MALL

Aerial index: Indicated total	
n yrs =	20
mean pop index =	**173**
std dev =	201
std error =	45
low 90%ci =	85
high 90%ci =	262
trend over all years :	
ln linear slope =	-0.0763
SE slope =	0.0438
Growth Rate =	**0.927**
low 90%ci GR =	0.862
high 90%ci GR =	0.996
regression resid CV =	1.132
avg sampling err CV =	0.771
trend of most recent 10 years :	
Growth Rate =	**0.852**
low 90%ci GR =	0.710
high 90%ci GR =	1.021
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	43.3
w/ sample error CV =	33.5

Figure 12. Population trend for mallards (*Anas platyrhynchos*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.

AMWI **American Wigeon** North Slope early-June survey



NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	0	96	0	0	0	**96**	50
1993	48	0	0	0	0	**48**	49
1994	203	47	0	993	0	**1244**	619
1995	179	93	0	0	0	**272**	130
1996	280	205	110	0	0	**595**	210
1997	0	145	0	194	0	**339**	242
1998	148	237	67	0	0	**452**	171
1999	0	0	0	143	0	**143**	138
2000	46	276	96	303	0	**720**	314
2001	0	0	0	720	0	**720**	906
2002	0	97	0	0	0	**97**	70
2003	146	97	0	0	0	**243**	143
2004	0	0	0	98	0	**98**	92
2005	0	48	0	143	0	**192**	140
2006	124	180	0	151	0	**454**	285
2007	0	0	0	0	0	**12**	11
2008	380	375	0	146	0	**901**	341
2009	230	53	0	88	0	**371**	137
2010	0	24	0	0	0	**24**	22
2011	0	0	0	0	0	**12**	11

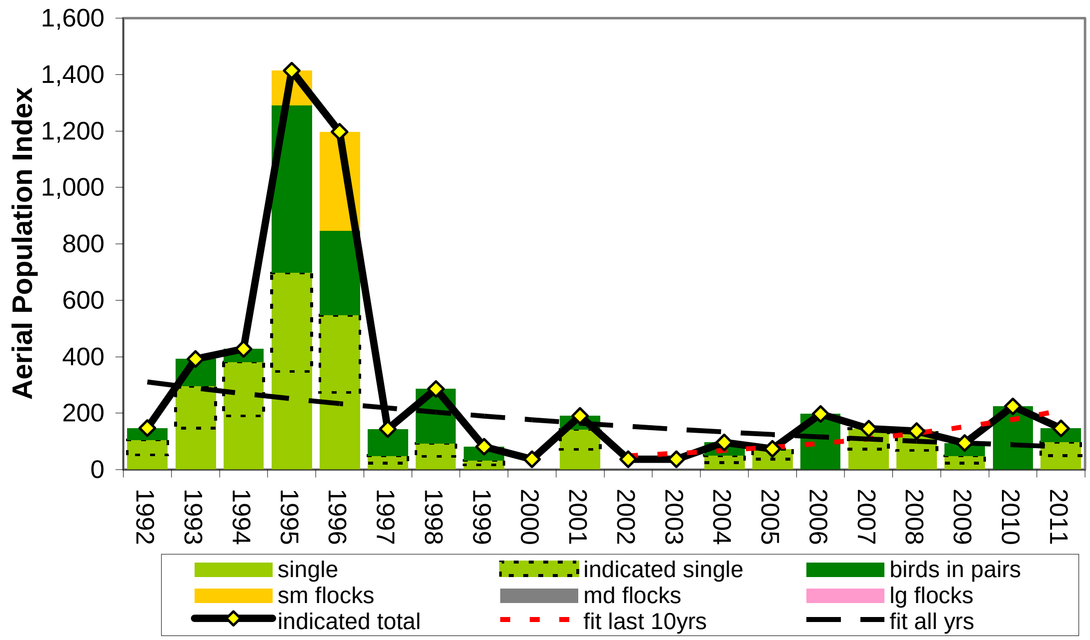
AMWI

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

n yrs =	20
mean pop index =	**348**
std dev =	329
std error =	74
low 90%ci =	203
high 90%ci =	492
<u>trend over all years :</u>	
ln linear slope =	-0.0812
SE slope =	0.0516
Growth Rate =	**0.922**
low 90%ci GR =	0.847
high 90%ci GR =	1.004
regression resid CV =	1.334
avg sampling err CV =	0.685
<u>trend of most recent 10 years :</u>	
Growth Rate =	**0.847**
low 90%ci GR =	0.641
high 90%ci GR =	1.118
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	48.3
w/ sample error CV =	31.0

Figure 13. Population trend for American wigeon (*Anas americana*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.

AGWT **Green-winged Teal** North Slope early-June survey



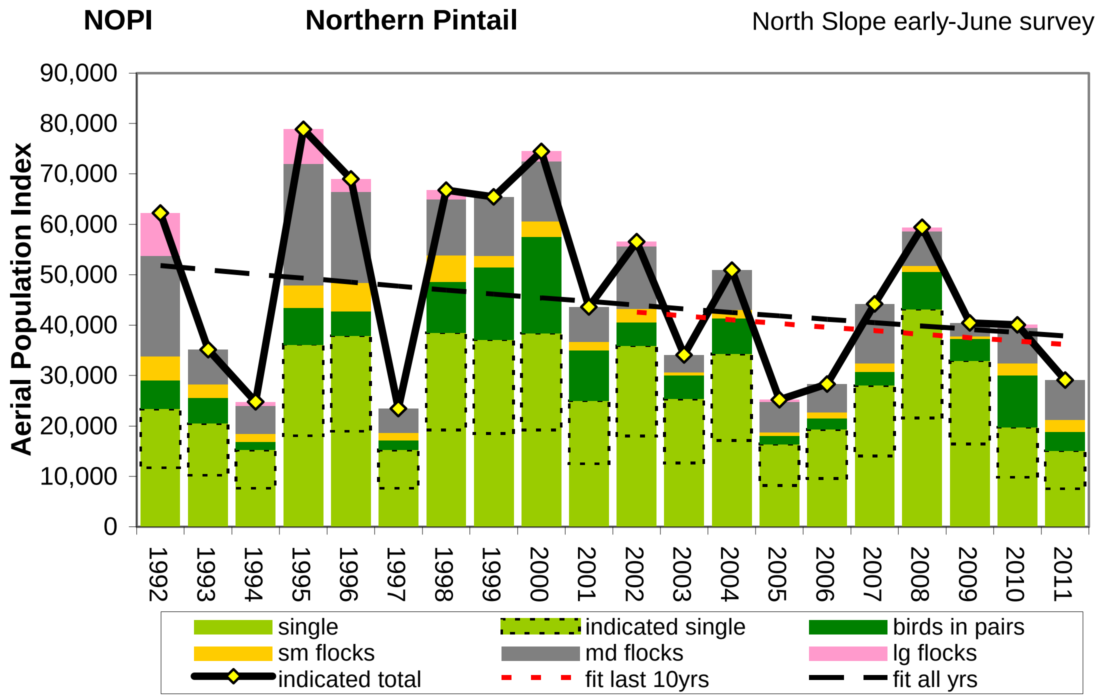
NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	105	41	0	0	0	**147**	93
1993	295	97	0	0	0	**392**	170
1994	381	47	0	0	0	**428**	156
1995	698	593	124	0	0	**1414**	335
1996	548	299	350	0	0	**1197**	290
1997	48	96	0	0	0	**144**	83
1998	93	192	0	0	0	**286**	108
1999	33	48	0	0	0	**81**	58
2000	0	0	0	0	0	**37**	27
2001	143	48	0	0	0	**191**	84
2002	0	0	0	0	0	**37**	27
2003	0	0	0	0	0	**37**	27
2004	49	47	0	0	0	**97**	63
2005	73	0	0	0	0	**73**	54
2006	0	197	0	0	0	**197**	91
2007	145	0	0	0	0	**145**	103
2008	137	0	0	0	0	**137**	57
2009	47	47	0	0	0	**94**	62
2010	0	224	0	0	0	**224**	73
2011	97	49	0	0	0	**146**	64

AGWT

Aerial index: Indicated total	
n yrs =	20
mean pop index =	**267**
std dev =	362
std error =	81
low 90%ci =	109
high 90%ci =	426
trend over all years :	
ln linear slope =	-0.0702
SE slope =	0.0366
Growth Rate =	**0.932**
low 90%ci GR =	0.878
high 90%ci GR =	0.990
regression resid CV =	0.945
avg sampling err CV =	0.531
trend of most recent 10 years :	
Growth Rate =	**1.175**
low 90%ci GR =	1.087
high 90%ci GR =	1.270
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	38.4
w/ sample error CV =	26.1

Figure 14. Population trend for green-winged teal (*Anas crecca*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.



NSE 10 strata =30,465 km2

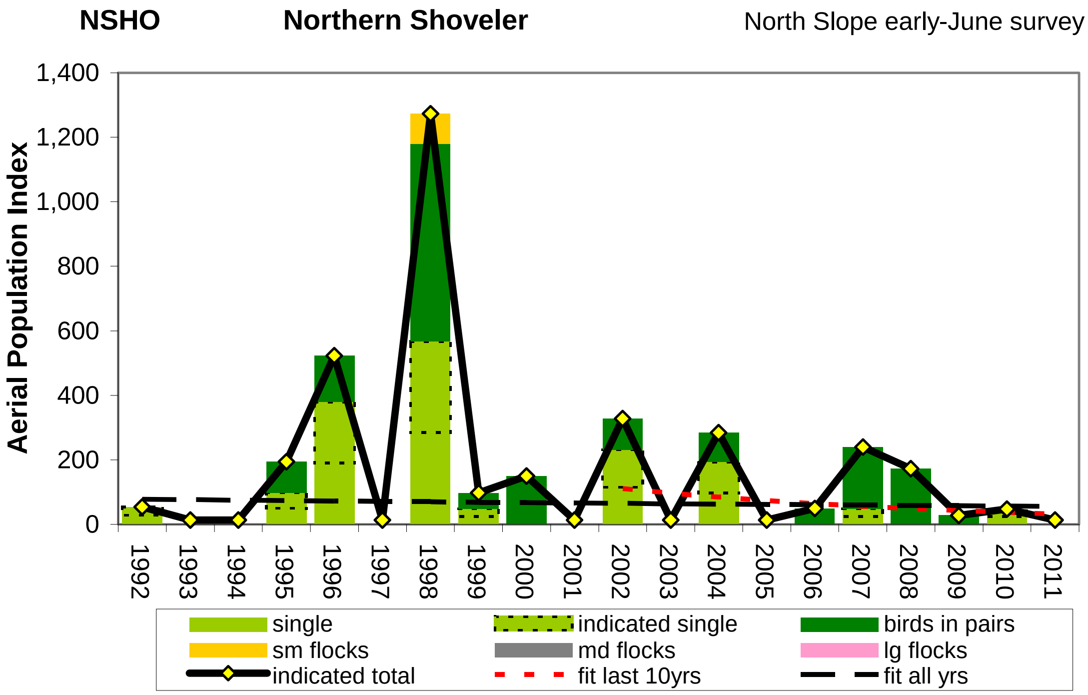
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	23339	5630	4752	20018	8491	**62230**	6591
1993	20441	5126	2668	6905	0	**35141**	3261
1994	15254	1573	1550	5590	802	**24768**	2589
1995	36195	7281	4396	24109	6892	**78872**	8012
1996	37891	4794	5743	18034	2558	**69020**	9306
1997	15217	1984	1439	4812	0	**23452**	2624
1998	38469	10126	5255	11094	1832	**66775**	5576
1999	37076	14400	2264	11702	0	**65443**	3896
2000	38434	19056	3134	11843	1999	**74466**	6031
2001	24965	10029	1749	6882	0	**43625**	4392
2002	35915	4630	2602	12529	881	**56557**	6030
2003	25320	4725	643	3387	0	**34075**	3873
2004	34272	6991	1804	7817	0	**50885**	4796
2005	16381	1703	592	6047	481	**25205**	2544
2006	19280	2265	1118	5627	0	**28290**	2551
2007	28009	2669	1758	11796	0	**44232**	4828
2008	43134	7417	1202	6877	820	**59450**	5222
2009	32921	4351	528	2651	0	**40451**	5521
2010	19757	10280	2379	7045	596	**40057**	4501
2011	15080	3670	2483	7861	0	**29094**	3039

NOPI

Aerial index: Indicated total

n yrs =	20
mean pop index =	**47344**
std dev =	17483
std error =	3909
low 90%ci =	39681
high 90%ci =	55006
trend over all years :	
ln linear slope =	-0.0165
SE slope =	0.0153
Growth Rate =	**0.984**
low 90%ci GR =	0.959
high 90%ci GR =	1.009
regression resid CV =	0.395
avg sampling err CV =	0.102
trend of most recent 10 years :	
Growth Rate =	**0.982**
low 90%ci GR =	0.928
high 90%ci GR =	1.039
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	21.4
w/ sample error CV =	8.7

Figure 15. Population trend for northern pintails (*Anas acuta*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



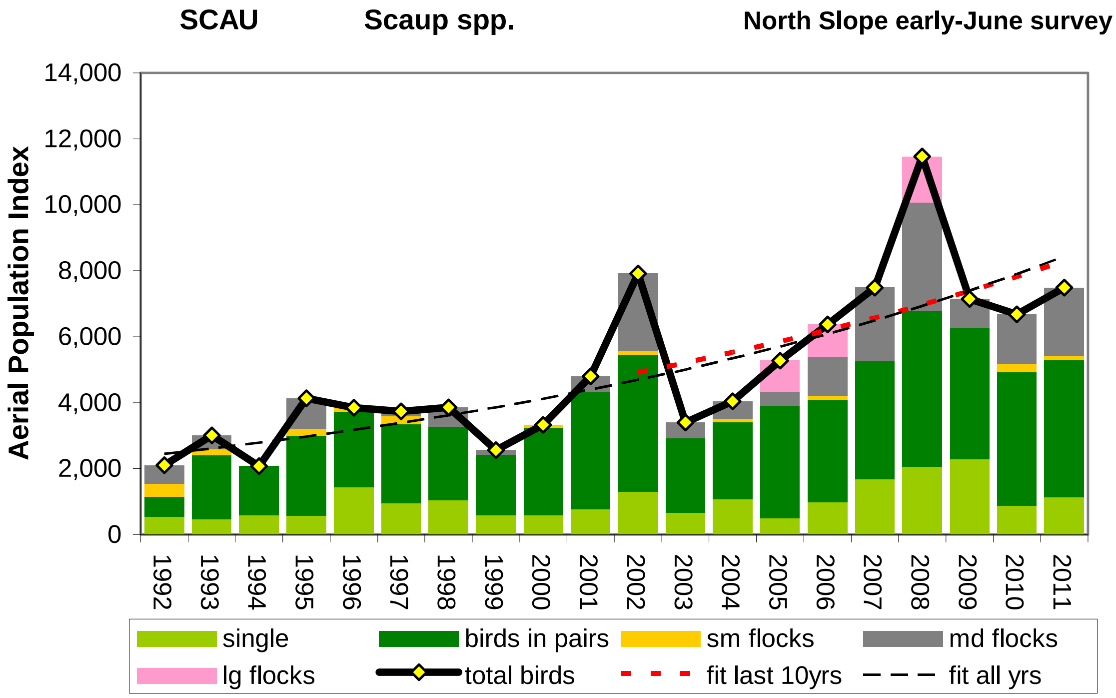
NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	54	0	0	0	0	**54**	49
1993	0	0	0	0	0	**14**	12
1994	0	0	0	0	0	**14**	12
1995	99	95	0	0	0	**194**	95
1996	380	143	0	0	0	**523**	178
1997	0	0	0	0	0	**14**	12
1998	567	612	94	0	0	**1273**	260
1999	48	49	0	0	0	**97**	68
2000	0	150	0	0	0	**150**	72
2001	0	0	0	0	0	**14**	12
2002	231	97	0	0	0	**328**	150
2003	0	0	0	0	0	**14**	12
2004	193	91	0	0	0	**284**	114
2005	0	0	0	0	0	**14**	12
2006	0	49	0	0	0	**49**	51
2007	49	191	0	0	0	**240**	97
2008	0	172	0	0	0	**172**	72
2009	0	27	0	0	0	**27**	24
2010	48	0	0	0	0	**48**	46
2011	0	0	0	0	0	**14**	12

NSHO

Aerial index: Indicated total	
n yrs =	20
mean pop index =	**175**
std dev =	285
std error =	64
low 90%ci =	50
high 90%ci =	300
trend over all years :	
ln linear slope =	-0.0178
SE slope =	0.0582
Growth Rate =	**0.982**
low 90%ci GR =	0.893
high 90%ci GR =	1.081
regression resid CV =	1.506
avg sampling err CV =	0.692
trend of most recent 10 years :	
Growth Rate =	**0.873**
low 90%ci GR =	0.686
high 90%ci GR =	1.110
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	52.3
w/ sample error CV =	31.2

Figure 16. Population trend for northern shovelers (*Anas clypeata*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.



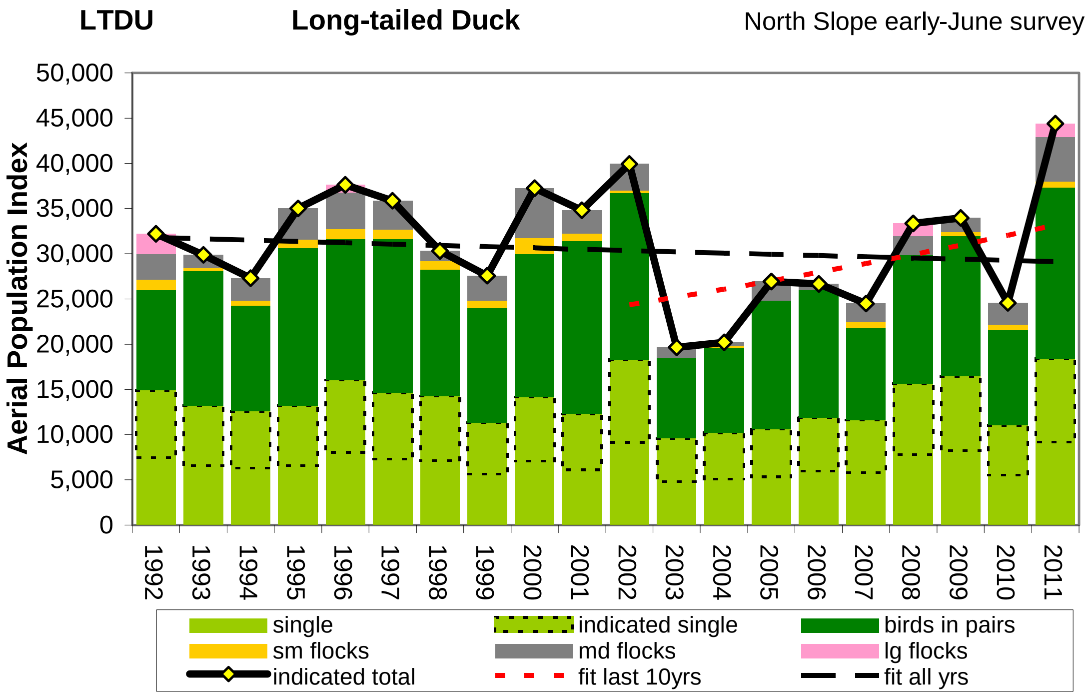
NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	539	607	400	563	0	**2109**	572
1993	455	1946	192	411	0	**3004**	636
1994	594	1486	0	0	0	**2080**	366
1995	560	2453	209	912	0	**4133**	719
1996	1437	2292	120	0	0	**3849**	526
1997	948	2396	245	145	0	**3735**	661
1998	1035	2240	0	582	0	**3857**	470
1999	576	1847	0	143	0	**2565**	452
2000	579	2659	87	0	0	**3325**	556
2001	766	3556	0	480	0	**4802**	784
2002	1306	4147	120	2342	0	**7915**	982
2003	655	2266	0	483	0	**3403**	545
2004	1079	2319	119	524	0	**4041**	611
2005	507	3404	0	421	937	**5269**	1043
2006	988	3103	125	1177	976	**6370**	1550
2007	1685	3567	0	2237	0	**7488**	1514
2008	2072	4709	0	3290	1397	**11468**	3418
2009	2283	3966	0	895	0	**7145**	872
2010	877	4055	239	1509	0	**6680**	1068
2011	1131	4157	146	2053	0	**7487**	1726

SCAU

Aerial index: Total birds	
n yrs =	20
mean pop index =	**5036**
std dev =	2408
std error =	538
low 90%ci =	3981
high 90%ci =	6091
trend over all years :	
ln linear slope =	0.0651
SE slope =	0.0106
Growth Rate =	**1.067**
low 90%ci GR =	1.049
high 90%ci GR =	1.086
regression resid CV =	0.272
avg sampling err CV =	0.183
trend of most recent 10 years :	
Growth Rate =	**1.060**
low 90%ci GR =	1.000
high 90%ci GR =	1.123
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	16.7
w/ sample error CV =	12.9

Figure 17. Population trend for scaup (primarily *Aythya marila*, possibly some *A. affinis*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The total bird 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



NSE 10 strata =30,465 km2

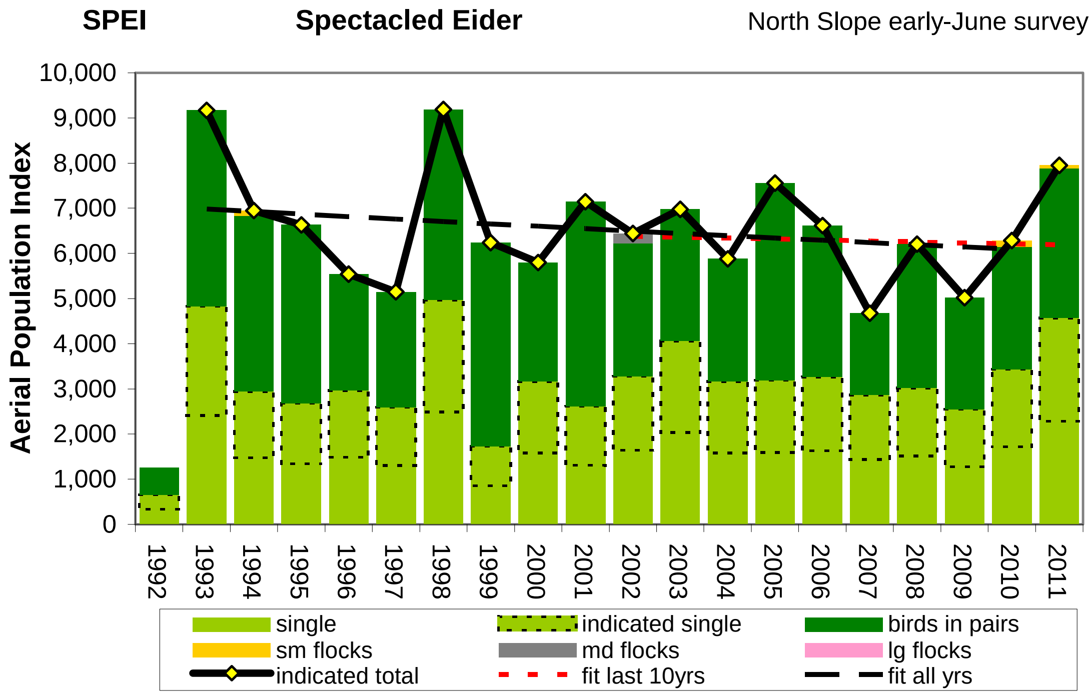
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	14896	11116	1123	2818	2268	**32221**	3513
1993	13208	14871	346	1432	0	**29858**	1989
1994	12570	11684	623	2434	0	**27312**	2090
1995	13206	17440	913	3463	0	**35021**	2361
1996	16046	15597	1099	4023	849	**37614**	2419
1997	14607	17009	1021	3215	0	**35853**	2087
1998	14244	13963	942	1162	0	**30310**	1612
1999	11329	12640	872	2742	0	**27584**	1811
2000	14154	15833	1737	5529	0	**37252**	2773
2001	12270	19161	807	2572	0	**34810**	2016
2002	18317	18405	257	2953	0	**39931**	2097
2003	9579	8894	0	1168	0	**19642**	1227
2004	10230	9380	198	391	0	**20199**	1658
2005	10594	14197	0	2122	0	**26912**	1583
2006	11917	14036	0	716	0	**26669**	2150
2007	11597	10191	645	2046	0	**24479**	1857
2008	15579	14283	0	2078	1405	**33345**	2755
2009	16439	15526	425	1561	0	**33950**	1787
2010	11030	10554	567	2405	0	**24557**	1569
2011	18401	18921	672	4939	1449	**44382**	4853

LTDU

Aerial index: Indicated total

n yrs =	20
mean pop index =	**30935**
std dev =	6381
std error =	1427
low 90%ci =	28139
high 90%ci =	33732
trend over all years :	
ln linear slope =	-0.0046
SE slope =	0.0086
Growth Rate =	**0.995**
low 90%ci GR =	0.981
high 90%ci GR =	1.010
regression resid CV =	0.222
avg sampling err CV =	0.071
trend of most recent 10 years :	
Growth Rate =	**1.035**
low 90%ci GR =	0.986
high 90%ci GR =	1.087
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	14.6
w/ sample error CV =	6.8

Figure 18. Population trend for long-tailed ducks (*Clangula hyemalis*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341(equivalent to a 50% decline in 20 years), if it were to occur.



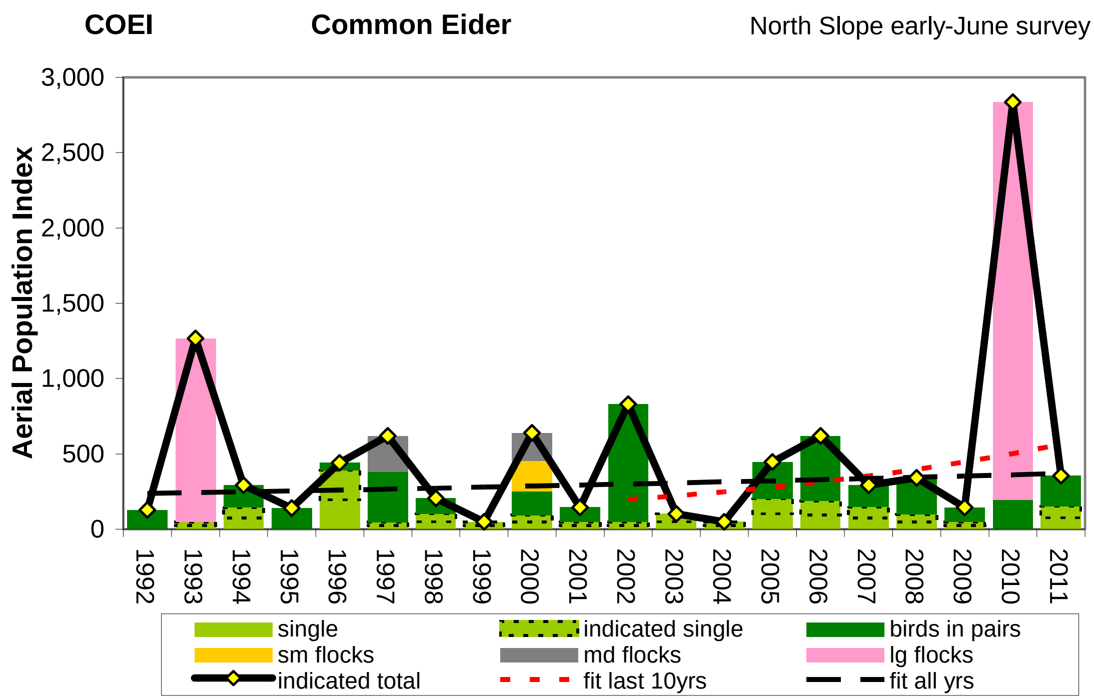
NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	657	602	0	0	0		
1993	4828	4339	0	0	0	**9167**	900
1994	2945	3885	122	0	0	**6951**	733
1995	2679	3951	0	0	0	**6630**	677
1996	2964	2580	0	0	0	**5544**	680
1997	2594	2553	0	0	0	**5148**	515
1998	4963	4223	0	0	0	**9186**	1001
1999	1723	4517	0	0	0	**6240**	541
2000	3170	2628	0	0	0	**5798**	487
2001	2611	4537	0	0	0	**7148**	675
2002	3284	2938	0	216	0	**6439**	812
2003	4058	2918	0	0	0	**6976**	635
2004	3165	2716	0	0	0	**5881**	574
2005	3186	4374	0	0	0	**7561**	964
2006	3259	3356	0	0	0	**6615**	947
2007	2864	1813	0	0	0	**4676**	668
2008	3019	3188	0	0	0	**6207**	592
2009	2549	2468	0	0	0	**5018**	854
2010	3435	2714	137	0	0	**6286**	719
2011	4568	3312	71	0	0	**7952**	864

SPEI

Aerial index: Indicated total	
n yrs =	19
mean pop index =	**6580**
std dev =	1209
std error =	277
low 90%ci =	6037
high 90%ci =	7124
trend over all years :	
ln linear slope =	-0.0080
SE slope =	0.0077
Growth Rate =	**0.992**
low 90%ci GR =	0.980
high 90%ci GR =	1.005
regression resid CV =	0.183
avg sampling err CV =	0.112
trend of most recent 10 years :	
Growth Rate =	**0.997**
low 90%ci GR =	0.965
high 90%ci GR =	1.029
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	12.8
w/ sample error CV =	9.2

Figure 19. Population trend for spectacled eiders (*Somateria fischeri*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341(equivalent to a 50% decline in 20 years), if it were to occur.



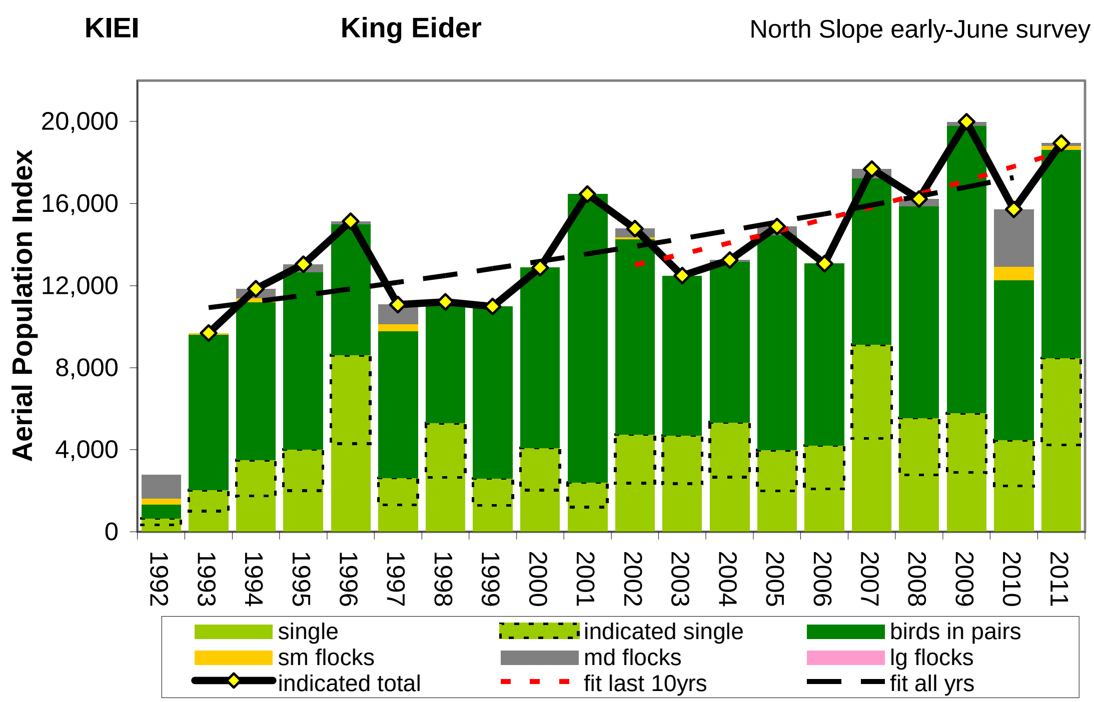
NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	0	128	0	0	0	**128**	147
1993	48	0	0	0	1219	**1266**	1221
1994	145	148	0	0	0	**292**	164
1995	0	140	0	0	0	**140**	138
1996	391	49	0	0	0	**440**	224
1997	48	333	0	238	0	**618**	542
1998	103	103	0	0	0	**205**	168
1999	48	0	0	0	0	**48**	46
2000	93	156	205	184	0	**639**	223
2001	48	97	0	0	0	**145**	115
2002	49	781	0	0	0	**831**	807
2003	102	0	0	0	0	**102**	74
2004	49	0	0	0	0	**49**	44
2005	202	245	0	0	0	**447**	278
2006	186	433	0	0	0	**620**	440
2007	146	147	0	0	0	**293**	192
2008	97	243	0	0	0	**340**	260
2009	48	95	0	0	0	**143**	104
2010	0	192	0	0	2644	**2836**	2843
2011	152	202	0	0	0	**354**	220

COEI

Aerial index: Indicated total	
n yrs =	20
mean pop index =	**503**
std dev =	614
std error =	137
low 90%ci =	234
high 90%ci =	772
trend over all years :	
ln linear slope =	0.0235
SE slope =	0.0410
Growth Rate =	**1.024**
low 90%ci GR =	0.957
high 90%ci GR =	1.095
regression resid CV =	1.058
avg sampling err CV =	0.783
trend of most recent 10 years :	
Growth Rate =	**1.125**
low 90%ci GR =	0.914
high 90%ci GR =	1.384
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	41.4
w/ sample error CV =	33.9

Figure 20. Population trend for common eiders (*Somateria mollissima*) observed on aerial transects sampling 30,465 km^2 of wetland tundra on the North Slope of Alaska during early to mid-June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341(equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.

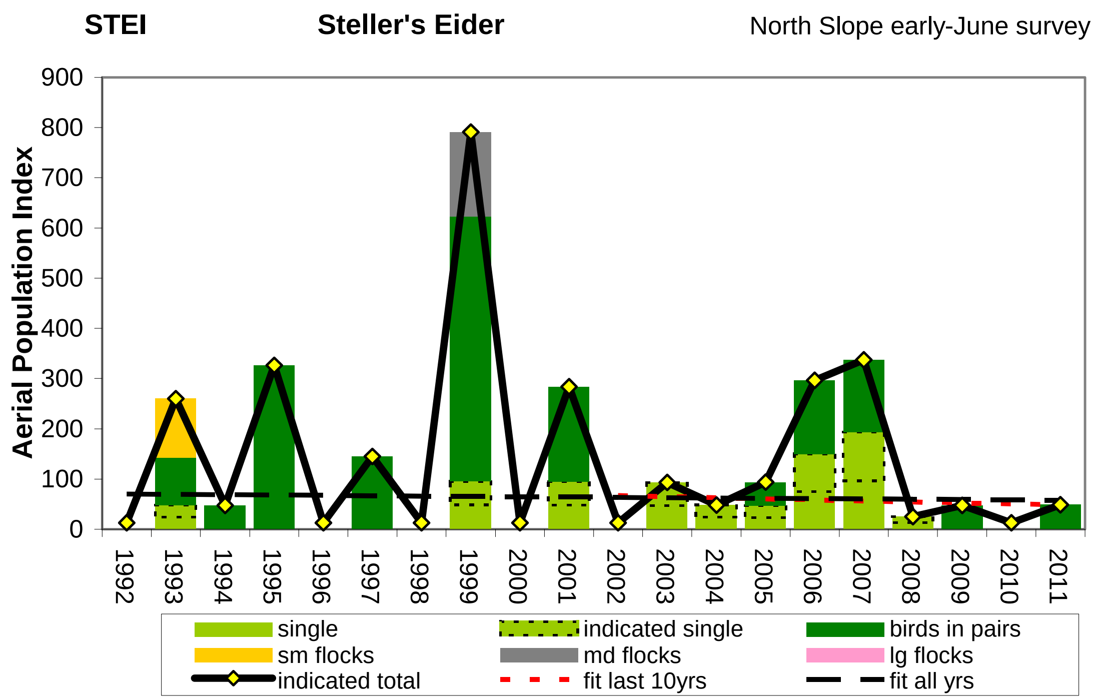


NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	661	677	290	1142	0		
1993	2029	7587	75	0	0	**9692**	1046
1994	3495	7695	212	451	0	**11853**	1052
1995	4013	8650	0	373	0	**13037**	1197
1996	8598	6400	0	146	0	**15143**	1395
1997	2618	7163	333	958	0	**11072**	962
1998	5295	5746	169	0	0	**11211**	852
1999	2597	8389	0	0	0	**10987**	1143
2000	4079	8803	0	0	0	**12882**	1349
2001	2403	14066	0	0	0	**16469**	1236
2002	4746	9507	94	432	0	**14780**	1518
2003	4689	7796	0	0	0	**12485**	1252
2004	5336	7820	0	95	0	**13251**	1094
2005	3988	10458	0	445	0	**14891**	1348
2006	4206	8862	0	0	0	**13068**	1239
2007	9103	8132	0	450	0	**17685**	1789
2008	5543	10347	0	341	0	**16230**	1230
2009	5771	14019	0	199	0	**19989**	1446
2010	4464	7795	673	2782	0	**15715**	1554
2011	8476	10140	195	130	0	**18942**	1508

KIEI	
Aerial index: Indicated total	
n yrs =	19
mean pop index =	**14236**
std dev =	2770
std error =	635
low 90%ci =	12991
high 90%ci =	15482
trend over all years :	
ln linear slope =	0.0269
SE slope =	0.0055
Growth Rate =	**1.027**
low 90%ci GR =	1.018
high 90%ci GR =	1.037
regression resid CV =	0.131
avg sampling err CV =	0.091
trend of most recent 10 years :	
Growth Rate =	**1.040**
low 90%ci GR =	1.019
high 90%ci GR =	1.061
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	10.3
w/ sample error CV =	8.1

Figure 21. Population trend for king eiders (*Somateria spectabilis*) observed on aerial transects sampling 30,465 km^2 of wetland tundra on the North Slope of Alaska during early to mid-June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341(equivalent to a 50% decline in 20 years), if it were to occur.



NSE 10 strata =30,465 km2

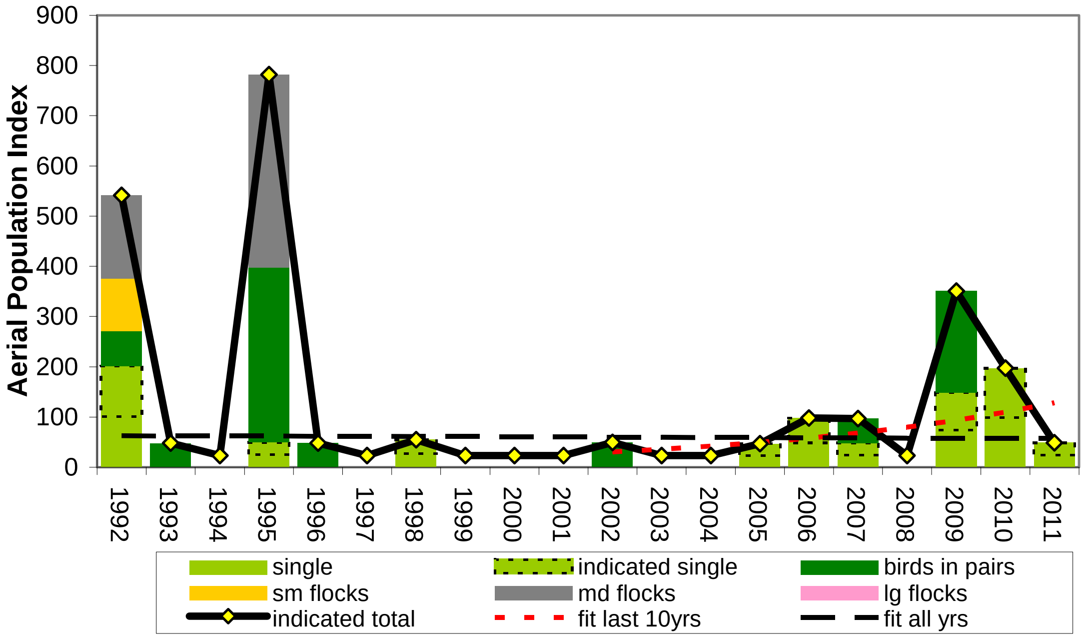
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	0	0	0	0	0	**13**	12
1993	48	94	118	0	0	**260**	147
1994	0	47	0	0	0	**47**	47
1995	0	327	0	0	0	**326**	166
1996	0	0	0	0	0	**13**	12
1997	0	145	0	0	0	**145**	112
1998	0	0	0	0	0	**13**	12
1999	96	527	0	168	0	**791**	458
2000	0	0	0	0	0	**13**	12
2001	95	189	0	0	0	**284**	206
2002	0	0	0	0	0	**13**	12
2003	93	0	0	0	0	**93**	93
2004	48	0	0	0	0	**48**	50
2005	47	47	0	0	0	**94**	64
2006	150	147	0	0	0	**296**	137
2007	193	145	0	0	0	**338**	251
2008	25	0	0	0	0	**25**	23
2009	0	47	0	0	0	**47**	50
2010	0	0	0	0	0	**13**	12
2011	0	49	0	0	0	**49**	49

STEI

Aerial index: Indicated total	
n yrs =	20
mean pop index =	**144**
std dev =	188
std error =	42
low 90%ci =	62
high 90%ci =	226
trend over all years :	
ln linear slope =	-0.0102
SE slope =	0.0551
Growth Rate =	**0.990**
low 90%ci GR =	0.904
high 90%ci GR =	1.084
regression resid CV =	1.427
avg sampling err CV =	0.829
trend of most recent 10 years :	
Growth Rate =	**0.966**
low 90%ci GR =	0.776
high 90%ci GR =	1.201
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	50.5
w/ sample error CV =	35.2

Figure 22. Population trend for Steller's eiders (*Polysticta stelleri*) observed on aerial transects sampling 30,465 km^2 of wetland tundra on the North Slope of Alaska during early to mid-June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341(equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.

BLSC   **Black Scoter**   North Slope early-June survey



NSE 10 strata =30,465 km2

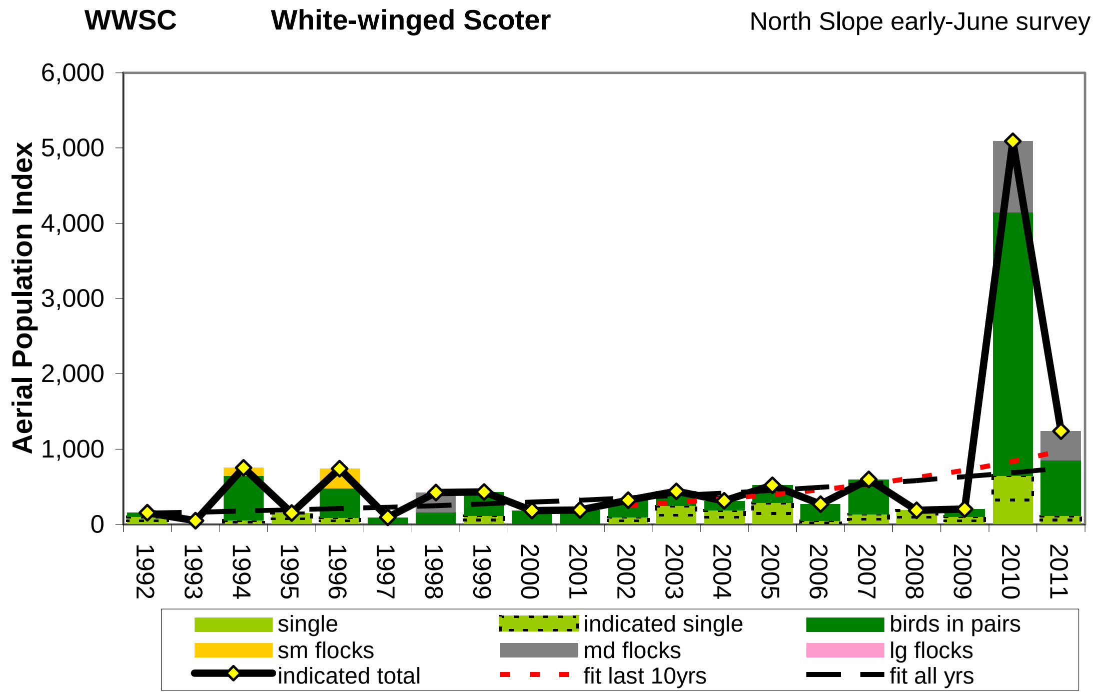
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	202	69	104	167	0	**542**	229
1993	0	48	0	0	0	**48**	48
1994	0	0	0	0	0	**23**	24
1995	49	348	0	384	0	**782**	541
1996	0	48	0	0	0	**48**	48
1997	0	0	0	0	0	**23**	24
1998	55	0	0	0	0	**55**	24
1999	0	0	0	0	0	**23**	24
2000	0	0	0	0	0	**23**	24
2001	0	0	0	0	0	**23**	24
2002	0	49	0	0	0	**49**	51
2003	0	0	0	0	0	**23**	24
2004	0	0	0	0	0	**23**	24
2005	47	0	0	0	0	**47**	49
2006	98	0	0	0	0	**98**	67
2007	48	49	0	0	0	**97**	70
2008	0	0	0	0	0	**23**	24
2009	149	202	0	0	0	**351**	182
2010	197	0	0	0	0	**197**	114
2011	49	0	0	0	0	**49**	46

BLSC

Aerial index: Indicated total

n yrs =	20
mean pop index =	**126**
std dev =	197
std error =	44
low 90%ci =	40
high 90%ci =	213
trend over all years :	
ln linear slope =	-0.0049
SE slope =	0.0446
Growth Rate =	**0.995**
low 90%ci GR =	0.925
high 90%ci GR =	1.071
regression resid CV =	1.151
avg sampling err CV =	0.862
trend of most recent 10 years :	
Growth Rate =	**1.172**
low 90%ci GR =	1.006
high 90%ci GR =	1.366
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	43.8
w/ sample error CV =	36.1

Figure 23. Population trend for black scoters (*Melanitta nigra*) observed on aerial transects sampling 30,465 km^2 of wetland tundra on the North Slope of Alaska during early to mid-June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341(equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.



NSE 10 strata =30,465 km2

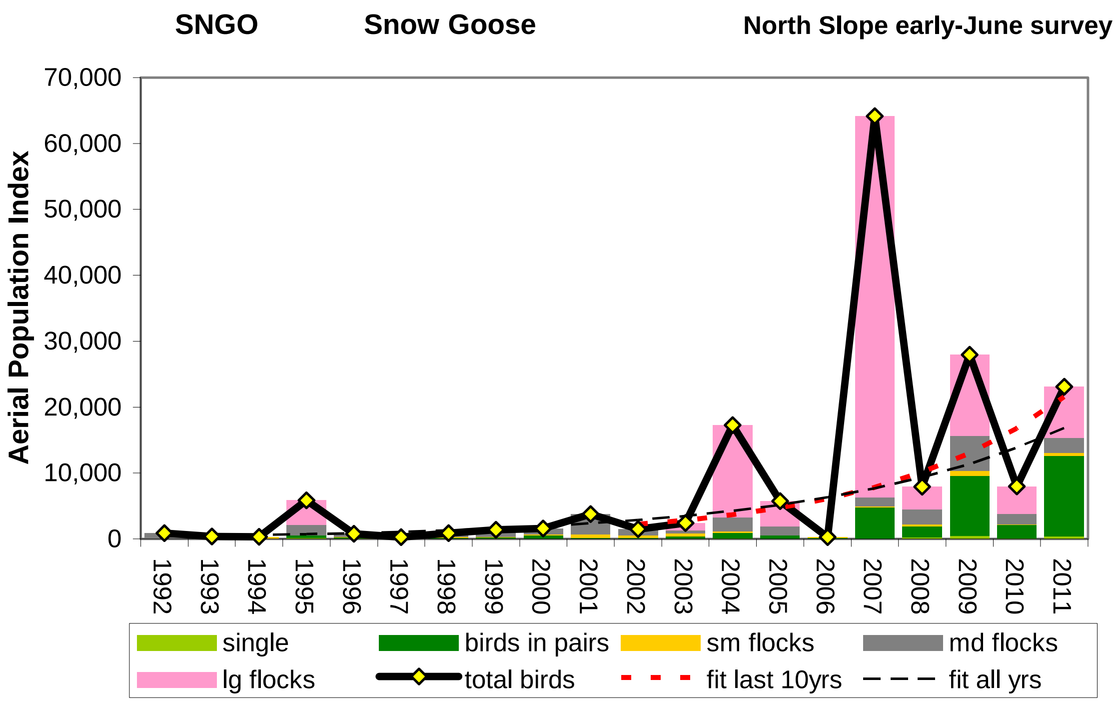
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	98	55	0	0	0	**153**	85
1993	0	0	0	0	0	**47**	29
1994	55	588	109	0	0	**752**	585
1995	148	0	0	0	0	**148**	108
1996	87	392	261	0	0	**740**	344
1997	0	94	0	0	0	**94**	62
1998	0	160	0	261	0	**421**	227
1999	112	319	0	0	0	**431**	210
2000	0	184	0	0	0	**184**	86
2001	0	191	0	0	0	**191**	92
2002	94	225	0	0	0	**319**	232
2003	242	198	0	0	0	**440**	294
2004	185	128	0	0	0	**313**	212
2005	283	235	0	0	0	**519**	418
2006	45	225	0	0	0	**269**	201
2007	132	464	0	0	0	**596**	58
2008	186	0	0	0	0	**186**	131
2009	101	101	0	0	0	**201**	99
2010	646	3499	0	946	0	**5090**	835
2011	111	741	0	388	0	**1240**	647

WWSC

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

n yrs =	20
mean pop index =	**629**
std dev =	1065
std error =	238
low 90%ci =	163
high 90%ci =	1096
<u>trend over all years :</u>	
ln linear slope =	0.0848
SE slope =	0.0347
Growth Rate =	**1.089**
low 90%ci GR =	1.028
high 90%ci GR =	1.153
regression resid CV =	0.897
avg sampling err CV =	0.570
<u>trend of most recent 10 years :</u>	
Growth Rate =	**1.163**
low 90%ci GR =	0.982
high 90%ci GR =	1.377
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	37.1
w/ sample error CV =	27.4

Figure 24. Population trend for white-winged scoters (*Melanitta fusca*) observed on aerial transects sampling 30,465 km^2 of wetland tundra on the North Slope of Alaska during early to mid-June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of unseen but indicated females, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341(equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.



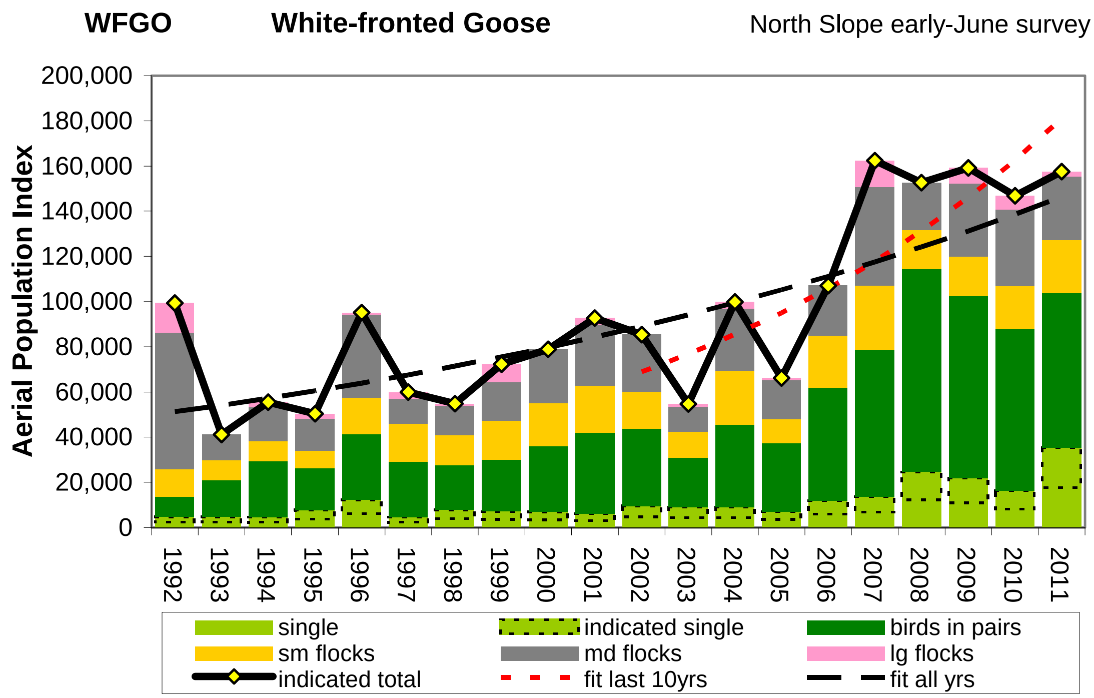
NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	50	0	0	817	0	**867**	590
1993	50	96	73	144	0	**362**	181
1994	24	0	281	0	0	**304**	159
1995	170	379	0	1531	3770	**5850**	5299
1996	114	111	71	497	0	**793**	350
1997	48	143	73	0	0	**263**	122
1998	47	118	181	545	0	**891**	553
1999	80	144	93	1096	0	**1413**	725
2000	45	499	168	868	0	**1579**	511
2001	0	206	481	3098	0	**3785**	2109
2002	47	136	337	990	0	**1510**	697
2003	0	429	396	487	1107	**2419**	1259
2004	104	818	287	2047	14022	**17277**	14159
2005	36	456	36	1385	3827	**5740**	3248
2006	63	101	99	0	0	**262**	99
2007	46	4736	169	1377	57784	**64110**	56019
2008	246	1658	265	2305	3465	**7938**	3661
2009	483	9089	741	5311	12302	**27926**	17120
2010	109	2040	36	1619	4151	**7955**	3478
2011	422	12164	520	2223	7767	**23096**	13906

SNGO

Aerial index: Total birds	
n yrs =	20
mean pop index =	**8717**
std dev =	15261
std error =	3412
low 90%ci =	2029
high 90%ci =	15406
trend over all years :	
ln linear slope =	0.1961
SE slope =	0.0469
Growth Rate =	**1.217**
low 90%ci GR =	1.126
high 90%ci GR =	1.314
regression resid CV =	1.211
avg sampling err CV =	0.563
trend of most recent 10 years :	
Growth Rate =	**1.288**
low 90%ci GR =	0.981
high 90%ci GR =	1.691
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	45.3
w/ sample error CV =	27.2

Figure 25. Population trend for snow geese (*Chen caerulescens*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 2007-2011. The total bird 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



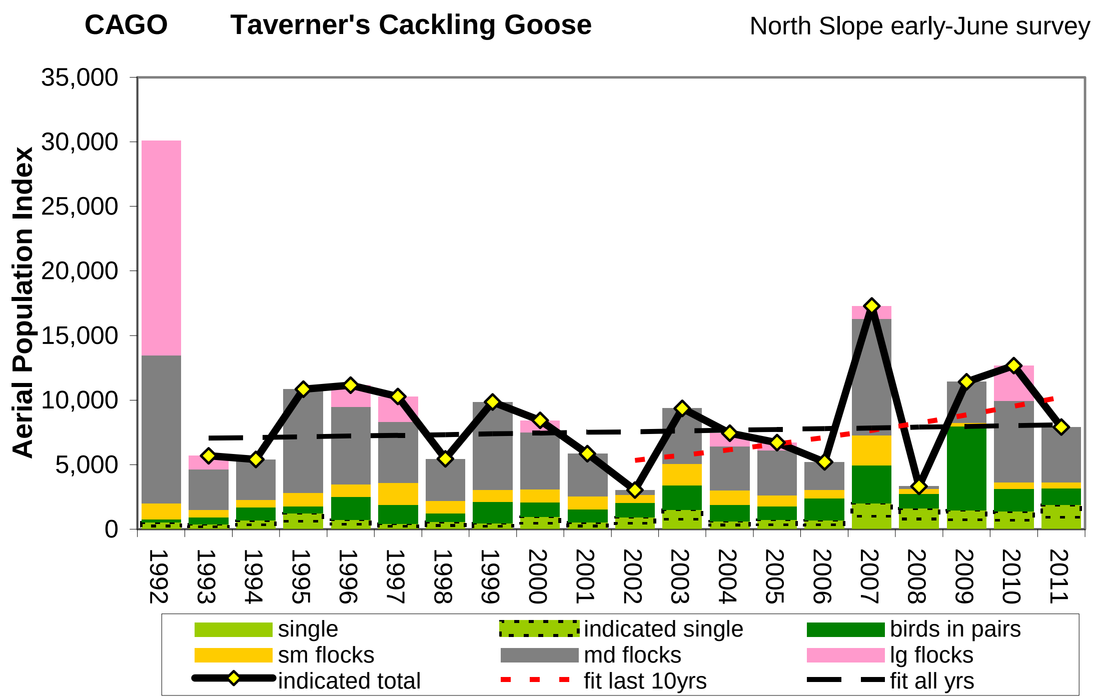
NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	4794	8915	12107	60359	13185	**99361**	9691
1993	4760	16232	8712	11378	0	**41083**	2856
1994	4538	24854	8764	15121	2240	**55517**	4494
1995	7702	18479	7962	14033	2096	**50272**	4464
1996	12280	28850	16325	36897	773	**95125**	5640
1997	4632	24567	16692	11212	2854	**59956**	4413
1998	7884	19632	13290	13178	855	**54839**	4175
1999	7092	22928	17152	17275	7835	**72283**	6579
2000	6898	29138	19078	23780	0	**78895**	5433
2001	6108	35961	20830	26652	3081	**92632**	4963
2002	9522	34232	16392	25217	0	**85363**	6814
2003	8911	22116	11314	11127	1141	**54609**	4023
2004	8928	36562	24046	27344	2979	**99859**	7212
2005	7071	30148	10886	17160	906	**66171**	5033
2006	11929	50076	22780	22240	0	**107025**	8692
2007	13673	65197	28140	43777	11654	**162441**	10921
2008	24665	89655	17445	20870	0	**152634**	10049
2009	21823	80567	17603	32274	6921	**159188**	12025
2010	16352	71498	18957	33884	6136	**146828**	11338
2011	35341	68268	23777	28157	1940	**157481**	9406

WFGO

Aerial index: Indicated total	
n yrs =	20
mean pop index =	**95546**
std dev =	39876
std error =	8916
low 90%ci =	78070
high 90%ci =	113022
trend over all years :	
ln linear slope =	0.0553
SE slope =	0.0112
Growth Rate =	**1.057**
low 90%ci GR =	1.037
high 90%ci GR =	1.077
regression resid CV =	0.290
avg sampling err CV =	0.074
trend of most recent 10 years :	
Growth Rate =	**1.113**
low 90%ci GR =	1.065
high 90%ci GR =	1.164
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	17.5
w/ sample error CV =	7.1

Figure 26. Population trend for white-fronted geese (*Anser albifrons*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 2007-2011. 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 is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.

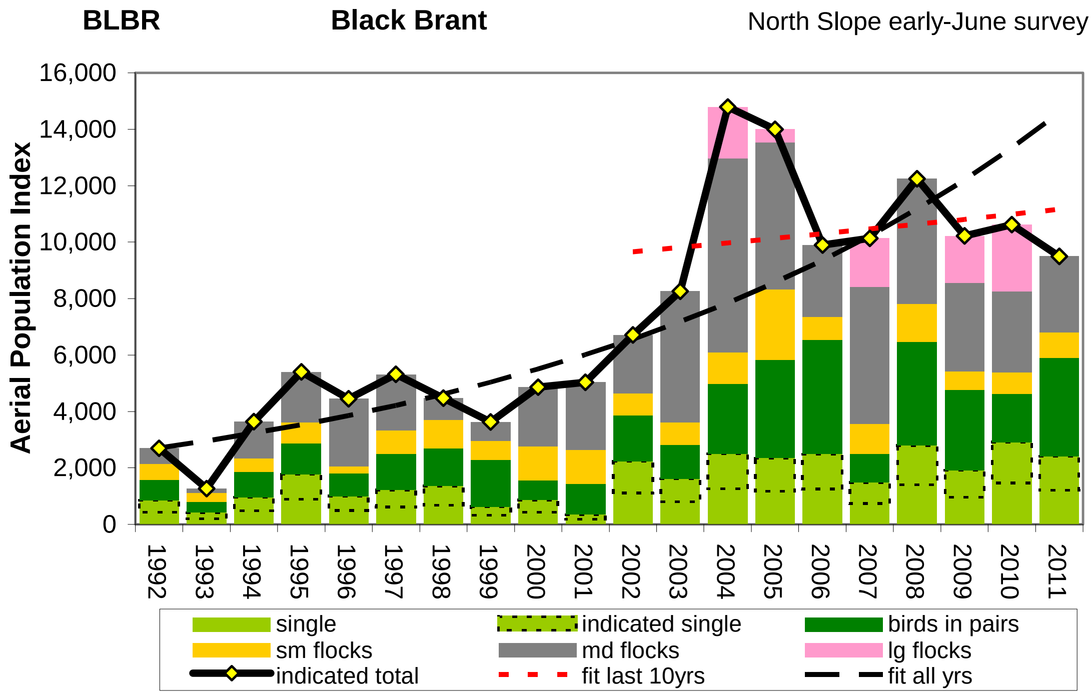


NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	530	260	1211	11482	16621		
1993	387	531	595	3111	1061	**5685**	2514
1994	666	1047	592	3099	0	**5405**	1389
1995	1233	534	1033	8052	0	**10851**	2889
1996	741	1754	991	5981	1678	**11145**	3494
1997	436	1425	1721	4726	1977	**10284**	2911
1998	559	641	1000	3240	0	**5441**	1221
1999	448	1661	912	6822	0	**9843**	2784
2000	960	1128	962	4454	920	**8424**	2810
2001	527	1015	983	3327	0	**5851**	2327
2002	917	1151	596	362	0	**3025**	372
2003	1516	1875	1647	4312	0	**9351**	2192
2004	613	1273	1124	3396	1039	**7444**	1359
2005	730	1016	886	3463	602	**6696**	1933
2006	683	1706	673	2139	0	**5201**	1037
2007	2010	2922	2312	9057	983	**17285**	3775
2008	1608	1134	374	187	0	**3304**	586
2009	1478	6514	224	3192	0	**11408**	2182
2010	1375	1742	500	6316	2742	**12676**	3213
2011	1865	1296	467	4273	0	**7902**	1192

CAGO	
Aerial index: Indicated total	
n yrs =	19
mean pop index =	**8285**
std dev =	3455
std error =	793
low 90%ci =	6732
high 90%ci =	9839
trend over all years :	
ln linear slope =	0.0076
SE slope =	0.0194
Growth Rate =	**1.008**
low 90%ci GR =	0.976
high 90%ci GR =	1.040
regression resid CV =	0.463
avg sampling err CV =	0.254
trend of most recent 10 years :	
Growth Rate =	**1.075**
low 90%ci GR =	0.974
high 90%ci GR =	1.188
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	23.8
w/ sample error CV =	16.0

Figure 27. Population trend for Taverner's Canada geese (*Branta hutchinsii taverneri*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 2007-2011. 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 is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



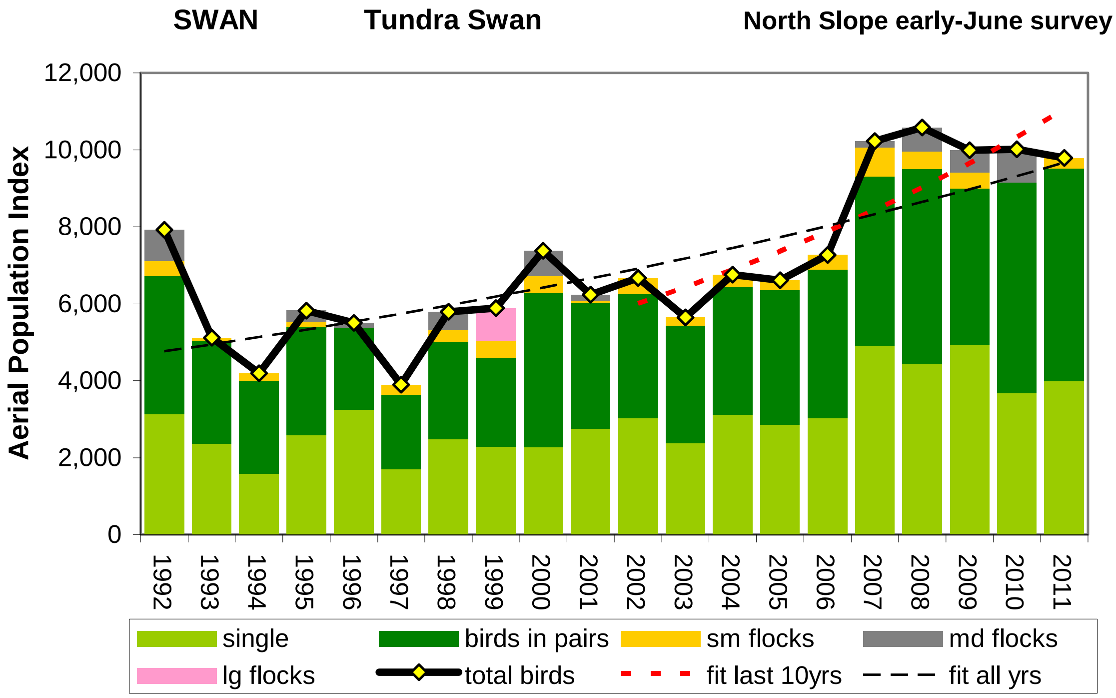
NSE 10 strata =30,465 km2

year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	844	737	566	549	0	**2695**	490
1993	413	376	331	141	0	**1262**	460
1994	960	893	479	1305	0	**3636**	888
1995	1780	1084	748	1795	0	**5407**	2452
1996	996	815	247	2387	0	**4445**	1439
1997	1224	1264	849	1983	0	**5320**	1758
1998	1357	1333	1015	768	0	**4473**	731
1999	633	1647	677	674	0	**3630**	698
2000	863	692	1217	2093	0	**4864**	821
2001	344	1097	1198	2391	0	**5030**	1494
2002	2235	1628	782	2065	0	**6710**	1251
2003	1609	1208	792	4655	0	**8263**	2844
2004	2505	2476	1102	6885	1816	**14783**	2650
2005	2354	3467	2499	5217	457	**13994**	2951
2006	2486	4041	820	2553	0	**9900**	1808
2007	1481	1022	1068	4841	1726	**10138**	1657
2008	2798	3673	1333	4443	0	**12247**	3140
2009	1912	2849	653	3150	1656	**10221**	2047
2010	2913	1713	750	2872	2368	**10615**	3769
2011	2401	3496	905	2696	0	**9498**	1997

BLBR

Aerial index: Indicated total	
n yrs =	20
mean pop index =	**7519**
std dev =	3847
std error =	860
low 90%ci =	5833
high 90%ci =	9205
trend over all years :	
ln linear slope =	0.0886
SE slope =	0.0132
Growth Rate =	**1.093**
low 90%ci GR =	1.069
high 90%ci GR =	1.117
regression resid CV =	0.341
avg sampling err CV =	0.250
trend of most recent 10 years :	
Growth Rate =	**1.016**
low 90%ci GR =	0.972
high 90%ci GR =	1.062
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	19.5
w/ sample error CV =	15.8

Figure 28. Population trend for black brant (*Branta bernicla*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 2007-2011. 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 is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.

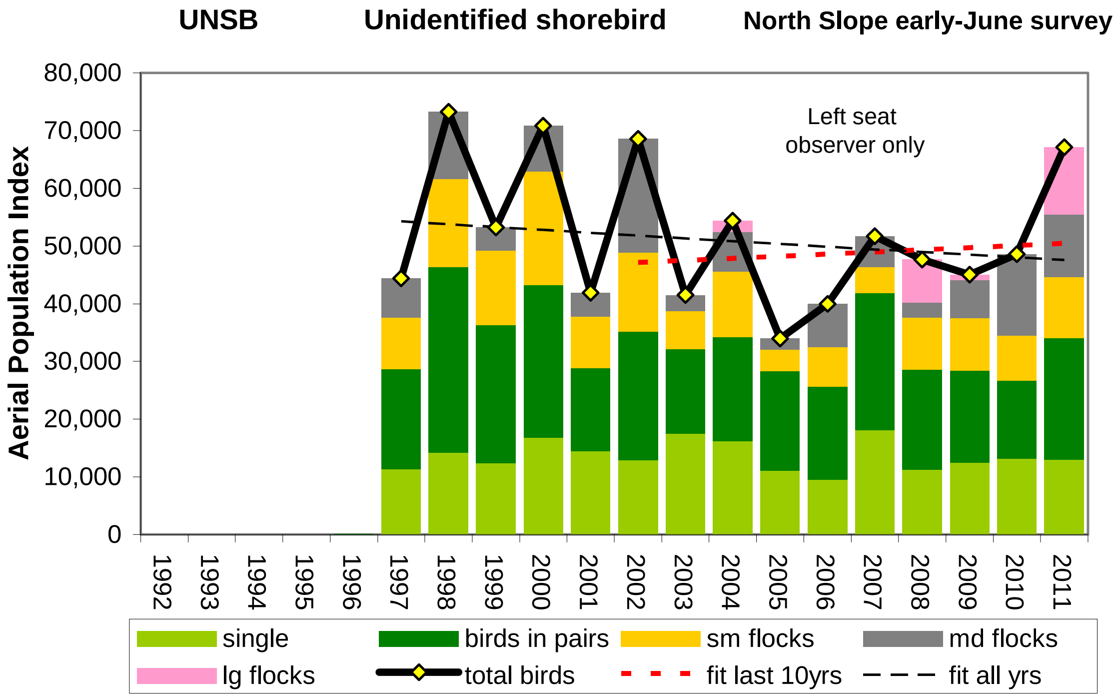


NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	3129	3591	394	809	0	**7924**	1219
1993	2366	2682	72	0	0	**5120**	534
1994	1582	2429	177	0	0	**4188**	444
1995	2581	2826	138	280	0	**5824**	690
1996	3246	2126	0	131	0	**5503**	583
1997	1697	1942	260	0	0	**3898**	504
1998	2476	2525	314	473	0	**5788**	656
1999	2282	2317	449	0	839	**5887**	1029
2000	2276	3989	461	655	0	**7380**	1037
2001	2758	3265	71	142	0	**6237**	645
2002	3025	3223	420	0	0	**6668**	758
2003	2381	3050	211	0	0	**5641**	629
2004	3112	3320	322	0	0	**6754**	529
2005	2862	3495	250	0	0	**6607**	566
2006	3024	3862	376	0	0	**7262**	667
2007	4894	4414	749	174	0	**10231**	672
2008	4428	5073	453	622	0	**10575**	1126
2009	4923	4071	413	584	0	**9991**	706
2010	3672	5480	0	860	0	**10012**	1132
2011	3980	5540	272	0	0	**9792**	670

SWAN	
Aerial index: Total birds	
n yrs =	20
mean pop index =	**7064**
std dev =	2054
std error =	459
low 90%ci =	6164
high 90%ci =	7964
trend over all years :	
ln linear slope =	0.0372
SE slope =	0.0076
Growth Rate =	**1.038**
low 90%ci GR =	1.025
high 90%ci GR =	1.051
regression resid CV =	0.196
avg sampling err CV =	0.108
trend of most recent 10 years :	
Growth Rate =	**1.070**
low 90%ci GR =	1.046
high 90%ci GR =	1.095
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	13.4
w/ sample error CV =	9.0

Figure 29. Population trend for tundra swans observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 2007-2011. The total bird 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



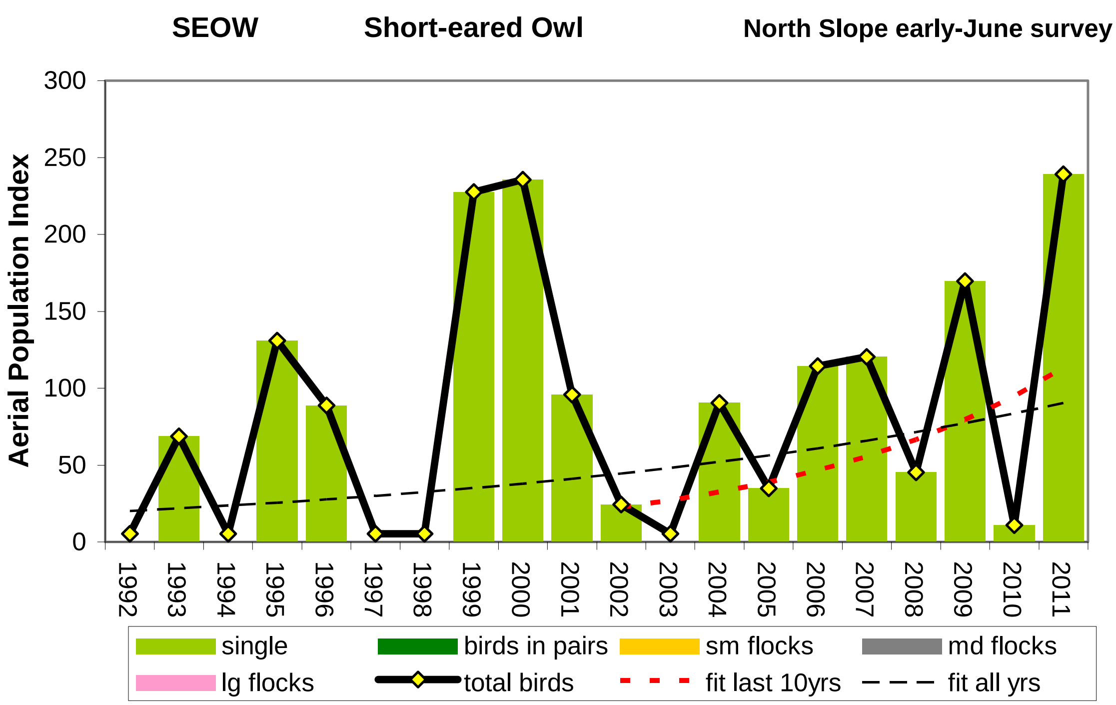
NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	0	0	0	0	0		
1993	0	0	0	0	0		
1994	0	0	0	0	0		
1995	0	0	0	0	0		
1996	0	97	0	0	0		
1997	11327	17384	8915	6748	0	**44375**	3022
1998	14222	32064	15357	11577	0	**73220**	5578
1999	12348	23893	13001	3991	0	**53234**	4010
2000	16769	26467	19686	7946	0	**70868**	6454
2001	14487	14352	8932	4115	0	**41885**	3966
2002	12905	22261	13675	19729	0	**68571**	7595
2003	17435	14692	6634	2782	0	**41543**	3652
2004	16205	18000	11399	6856	1929	**54390**	5417
2005	11087	17256	3642	1981	0	**33965**	3410
2006	9550	16109	6797	7525	0	**39980**	6123
2007	18098	23719	4551	5303	0	**51671**	3900
2008	11242	17275	9120	2524	7503	**47663**	8183
2009	12476	15889	9097	6676	883	**45020**	5624
2010	13161	13436	7899	14116	0	**48613**	5488
2011	12999	21062	10555	10852	11652	**67119**	11724

UNSB

Aerial index: Total birds	
n yrs =	15
mean pop index =	**52141**
std dev =	12349
std error =	3189
low 90%ci =	45892
high 90%ci =	58391
trend over all years :	
ln linear slope =	-0.0094
SE slope =	0.0142
Growth Rate =	**0.991**
low 90%ci GR =	0.968
high 90%ci GR =	1.014
regression resid CV =	0.237
avg sampling err CV =	0.108
trend of most recent 10 years :	
Growth Rate =	**1.008**
low 90%ci GR =	0.966
high 90%ci GR =	1.051
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	15.3
w/ sample error CV =	9.0

Figure 30. Population trend for shorebirds (families *Charadriidae*, *Scolopacidae*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 2007-2011. The total bird 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur. We did not record shorebirds prior to 1997.



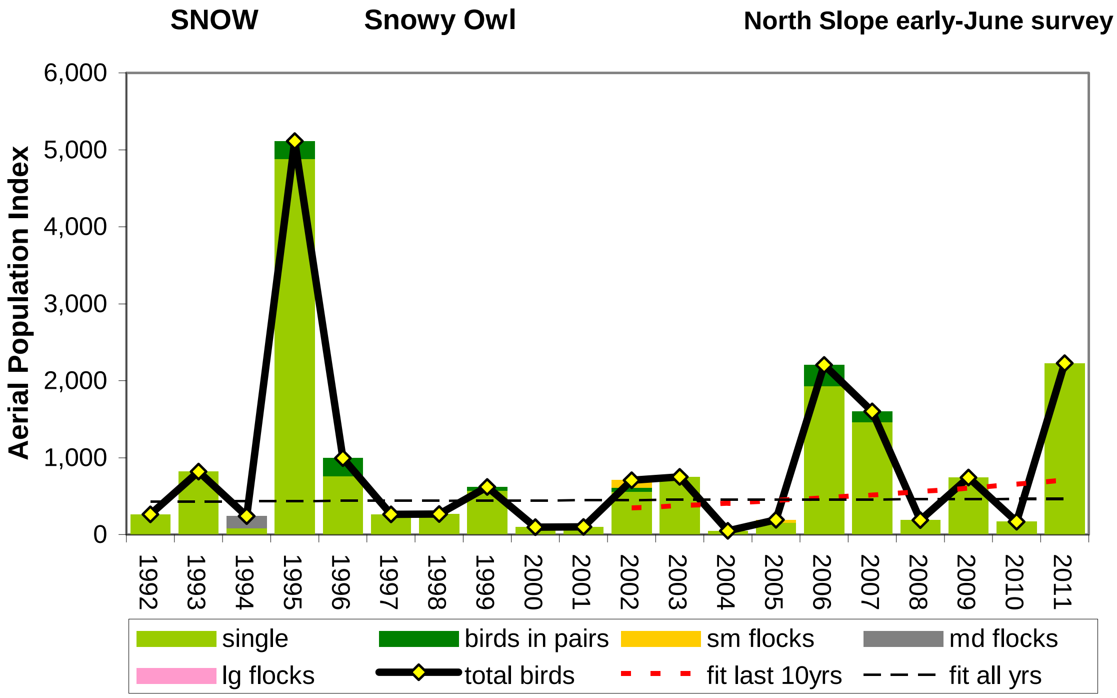
NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	0	0	0	0	0	**5**	5
1993	69	0	0	0	0	**69**	39
1994	0	0	0	0	0	**5**	5
1995	131	0	0	0	0	**131**	56
1996	89	0	0	0	0	**89**	44
1997	0	0	0	0	0	**5**	5
1998	0	0	0	0	0	**5**	5
1999	228	0	0	0	0	**228**	66
2000	236	0	0	0	0	**236**	74
2001	96	0	0	0	0	**96**	44
2002	24	0	0	0	0	**24**	24
2003	0	0	0	0	0	**5**	5
2004	91	0	0	0	0	**91**	29
2005	35	0	0	0	0	**35**	24
2006	114	0	0	0	0	**114**	40
2007	120	0	0	0	0	**120**	62
2008	45	0	0	0	0	**45**	18
2009	170	0	0	0	0	**170**	69
2010	11	0	0	0	0	**11**	10
2011	239	0	0	0	0	**239**	62

SEOW

Aerial index: Total birds	
n yrs =	20
mean pop index =	**86**
std dev =	81
std error =	18
low 90%ci =	51
high 90%ci =	122
trend over all years :	
ln linear slope =	0.0788
SE slope =	0.0542
Growth Rate =	**1.082**
low 90%ci GR =	0.990
high 90%ci GR =	1.183
regression resid CV =	1.402
avg sampling err CV =	0.596
trend of most recent 10 years :	
Growth Rate =	**1.195**
low 90%ci GR =	0.966
high 90%ci GR =	1.478
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	49.9
w/ sample error CV =	28.2

Figure 31. Population trend for short-eared owls (*Asio flammeus*) observed on aerial transects sampling 30,465 km^2 of wetland tundra on the North Slope of Alaska during early to mid-June, 1992-2011. 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.



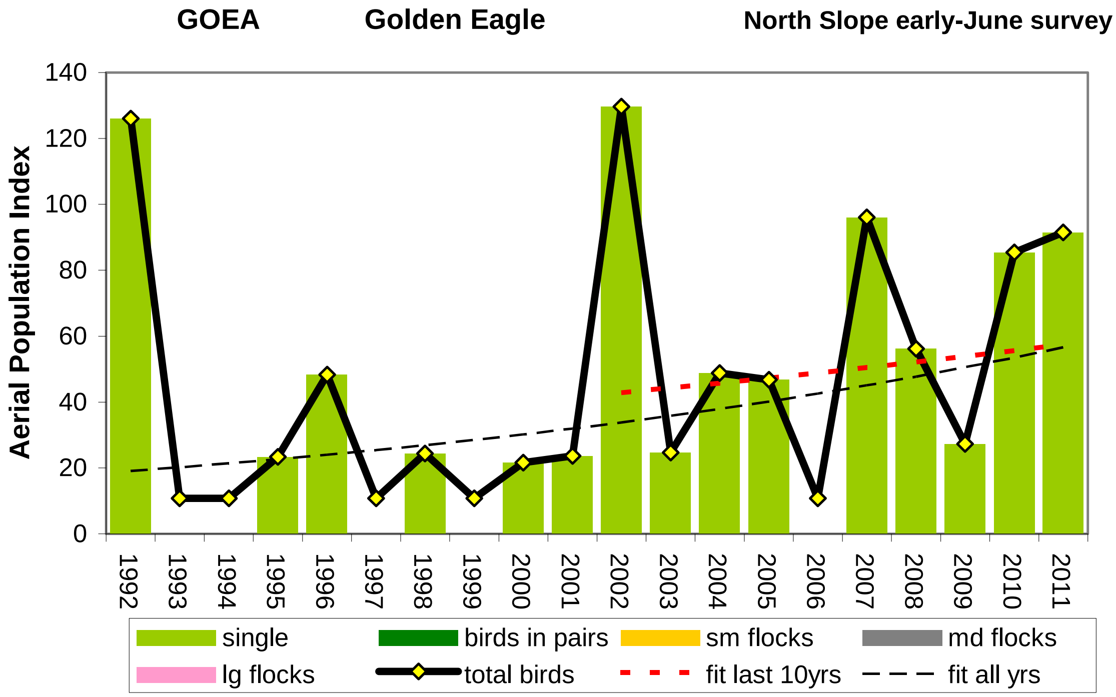
NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	264	0	0	0	0	**264**	112
1993	817	0	0	0	0	**817**	180
1994	80	0	0	160	0	**240**	158
1995	4880	234	0	0	0	**5113**	780
1996	759	236	0	0	0	**995**	227
1997	265	0	0	0	0	**265**	94
1998	267	0	0	0	0	**267**	72
1999	570	48	0	0	0	**618**	155
2000	95	0	0	0	0	**95**	51
2001	101	0	0	0	0	**101**	60
2002	559	48	99	0	0	**706**	176
2003	751	0	0	0	0	**751**	154
2004	49	0	0	0	0	**49**	36
2005	157	0	36	0	0	**194**	74
2006	1927	277	0	0	0	**2203**	421
2007	1458	144	0	0	0	**1602**	412
2008	188	0	0	0	0	**188**	122
2009	741	0	0	0	0	**741**	169
2010	167	0	0	0	0	**167**	70
2011	2226	0	0	0	0	**2226**	385

SNOW

Aerial index: Total birds	
n yrs =	20
mean pop index =	**880**
std dev =	1194
std error =	267
low 90%ci =	357
high 90%ci =	1403
trend over all years :	
ln linear slope =	0.0037
SE slope =	0.0481
Growth Rate =	**1.004**
low 90%ci GR =	0.927
high 90%ci GR =	1.086
regression resid CV =	1.243
avg sampling err CV =	0.359
trend of most recent 10 years :	
Growth Rate =	**1.082**
low 90%ci GR =	0.850
high 90%ci GR =	1.377
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	46.1
w/ sample error CV =	20.1

Figure 32. Population trend for snowy owls (*Bubo scandiacus*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341 (equivalent to a 50% decline in 20 years), if it were to occur.



NSE 10 strata =30,465 km2

year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr
1992	126	0	0	0	0	**126**	62
1993	0	0	0	0	0	**11**	11
1994	0	0	0	0	0	**11**	11
1995	23	0	0	0	0	**23**	23
1996	48	0	0	0	0	**48**	34
1997	0	0	0	0	0	**11**	11
1998	24	0	0	0	0	**24**	24
1999	0	0	0	0	0	**11**	11
2000	22	0	0	0	0	**22**	21
2001	24	0	0	0	0	**24**	30
2002	130	0	0	0	0	**130**	63
2003	25	0	0	0	0	**25**	22
2004	49	0	0	0	0	**49**	33
2005	47	0	0	0	0	**47**	48
2006	0	0	0	0	0	**11**	11
2007	96	0	0	0	0	**96**	38
2008	56	0	0	0	0	**56**	23
2009	27	0	0	0	0	**27**	23
2010	85	0	0	0	0	**85**	38
2011	92	0	0	0	0	**92**	70

GOEA

Aerial index: Total birds	
n yrs =	20
mean pop index =	**46**
std dev =	39
std error =	9
low 90%ci =	29
high 90%ci =	63
trend over all years :	
ln linear slope =	0.0572
SE slope =	0.0318
Growth Rate =	**1.059**
low 90%ci GR =	1.005
high 90%ci GR =	1.116
regression resid CV =	0.822
avg sampling err CV =	0.815
trend of most recent 10 years :	
Growth Rate =	**1.033**
low 90%ci GR =	0.894
high 90%ci GR =	1.194
min yrs to detect -50%/20yr rate :	
w/ regression resid CV =	35.0
w/ sample error CV =	34.8

Figure 33. Population trend for Golden Eagle (*Aquila chrysaetos*) observed on aerial transects sampling 30,465 km2 of wetland tundra on the North Slope of Alaska during early to mid June, 1992-2011. 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. Average annual growth rate is calculated by log-linear regression. Power calculations use 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 a significant trend can be compared among species as the estimated minimum number of years needed to detect a growth rate of -0.0341, a 50% decline in 20 years, if it were to occur. To calculate slope, an index value equal to one-half the minimum index >0 was substituted for years with no observations.

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*
Taverner's Canada goose	*Branta hutchinsii taverneri*
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 chrysaetos*