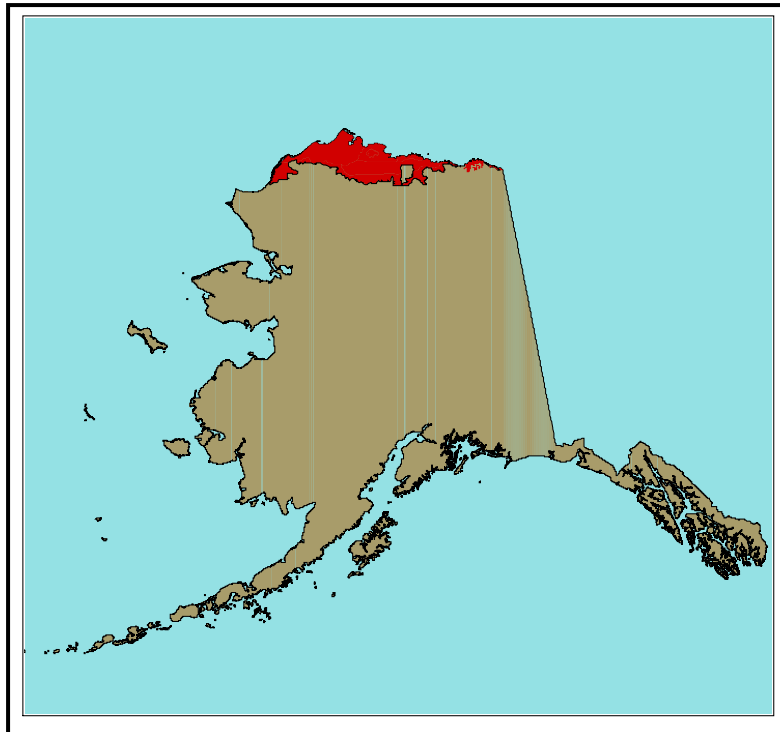


WATERFOWL BREEDING POPULATION SURVEY
ARCTIC COASTAL PLAIN, ALASKA
2011



William Larned¹
Robert Stehn²
Robert Platte²

U.S. Fish and Wildlife Service
Division of Migratory Bird Management

¹Waterfowl Mgt. Branch, 43655 KBeach Rd., Soldotna, AK 99669

²Waterfowl Mgt. Branch, 1011 E. Tudor Rd., Anchorage, AK 99503

August 21, 2012

Waterfowl breeding population survey, Arctic Coastal Plain, Alaska 2011

WILLIAM W. LARNED, *U.S. Fish and Wildlife Service, Migratory Bird Management, Waterfowl Management Branch, 43655 Kalifornsky Beach Rd., Soldotna, Alaska 99669*

ROBERT S. STEHN, ROBERT M. PLATTE, *U.S. Fish and Wildlife Service, Migratory Bird Management, Waterfowl Management Branch, 1011 E. Tudor Rd., Anchorage, Alaska 99503.*

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 km², 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 km²). 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 km²). 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 \pm 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 km² of the 61,645 km² Standard ACP Survey area (1986-2006) (Fig. 1). The 4,309 km² 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, *sampling 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 km² 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 km² 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 km²). 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.

ACKNOWLEDGMENTS

The authors would like to thank Wade Schock for his two years of excellence as waterfowl observer. Special thanks also to Debbie Nigro and others in the Bureau of Land Management who have steadfastly supported increased sampling in the Teshekpuk Lake region. We also appreciate the generous

sharing of information critical to proper survey timing by Bob Ritchie and other personnel from ABR Inc.

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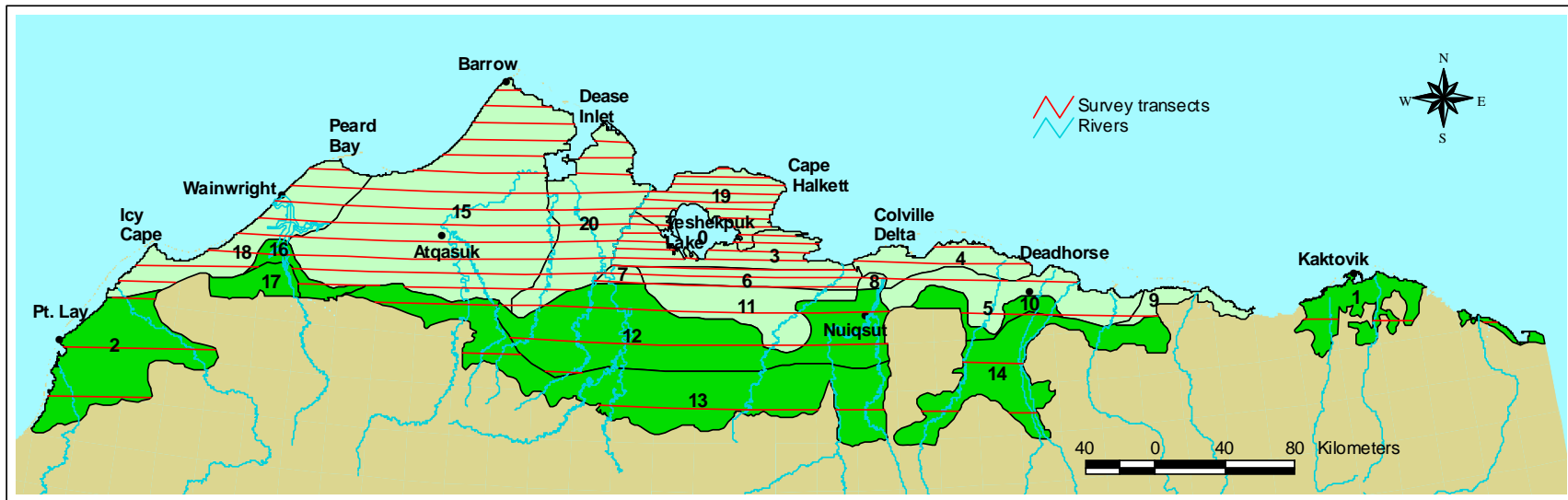


Figure 1. Spatial design of the 2011 Arctic Coastal Plain waterfowl breeding population survey. Northern coastal strata are shown in light green, strata outside the northern coastal strata area are shown in dark green. Red lines show locations of the 2011 design transects. Numbered strata are described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

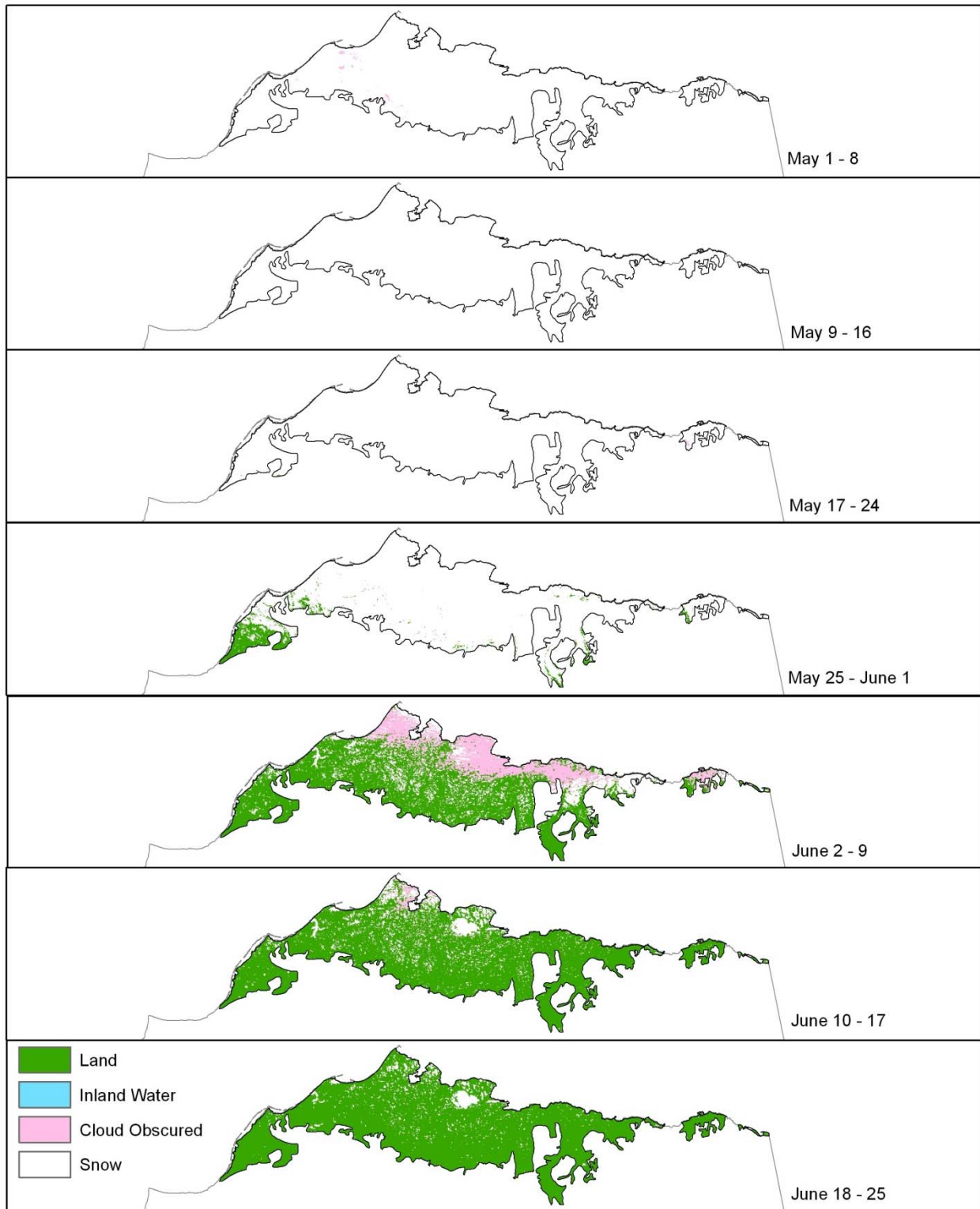


Figure 2. 2011 spring snow melt on the Arctic Coastal Plain, Alaska, from Terra satellite MODIS 8-day maximum snow extent data.

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

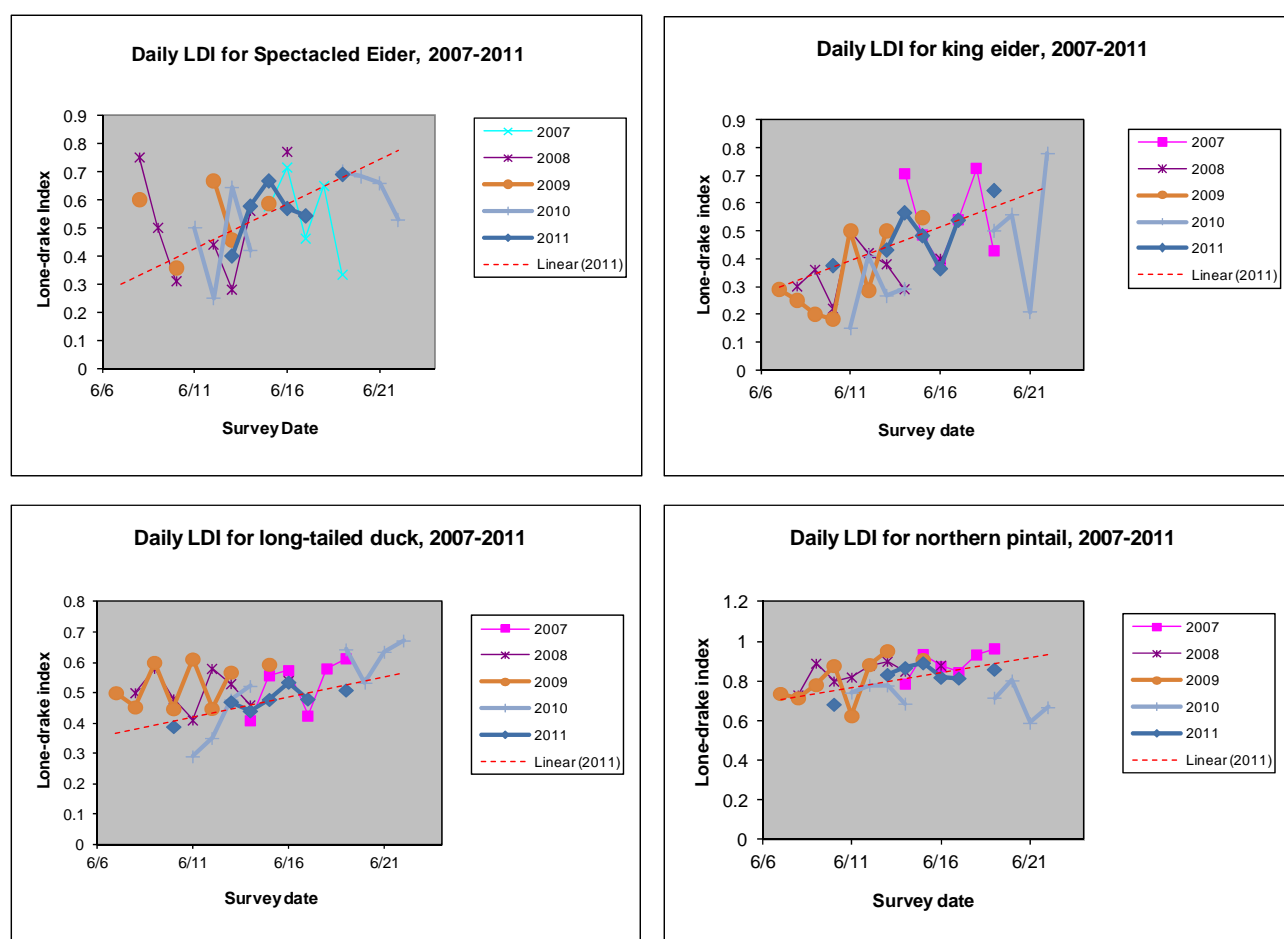


Figure 3. Daily ratio of lone males to total males (males single to 4 plus males in pairs) of selected duck species observed during the 2007-11 Waterfowl Breeding Population (ACP) survey, Arctic Coastal Plain, Alaska. A higher value indicates a more advanced stage of the breeding cycle.

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

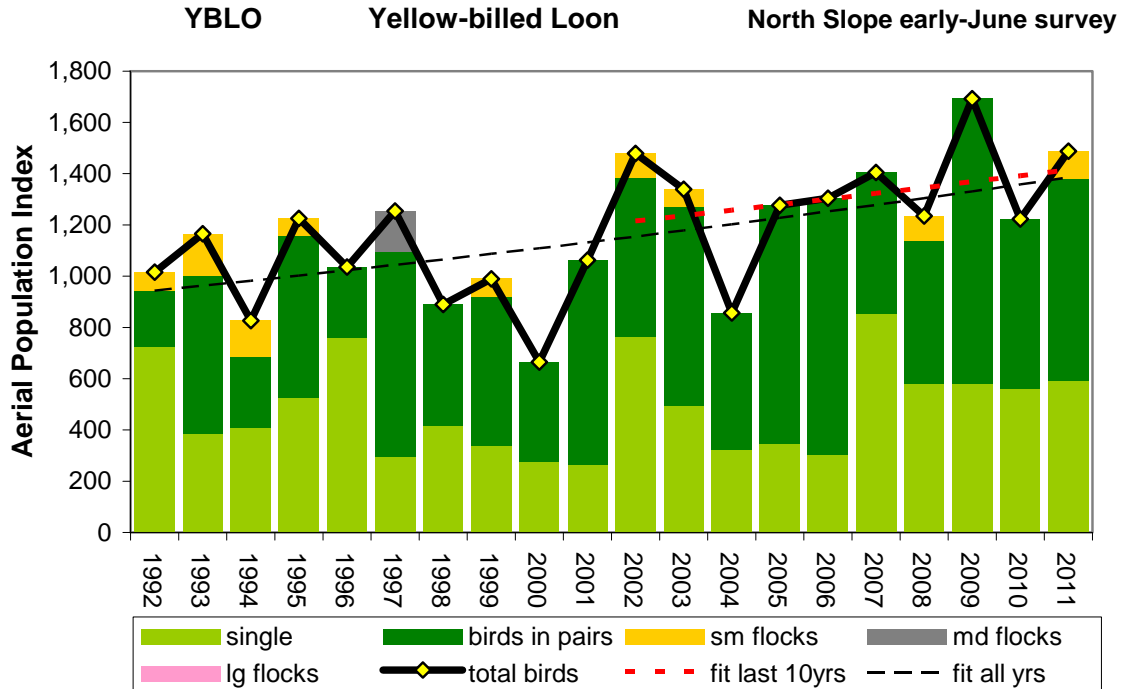
1. singles+(2*pairs)+flocked 2. 2*(singles+pairs)+flocked 3. *Stercorarius longicaudus*, *S. parasiticus*, *S. pomarinus* 4. *Charadrius sp.*, *Pluvialis spp.*, *Calidris spp.*, *Arenaria sp.*, *Numenius sp.*, *Limnodromus sp.* et al. 5. Data from left-side observer only.

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

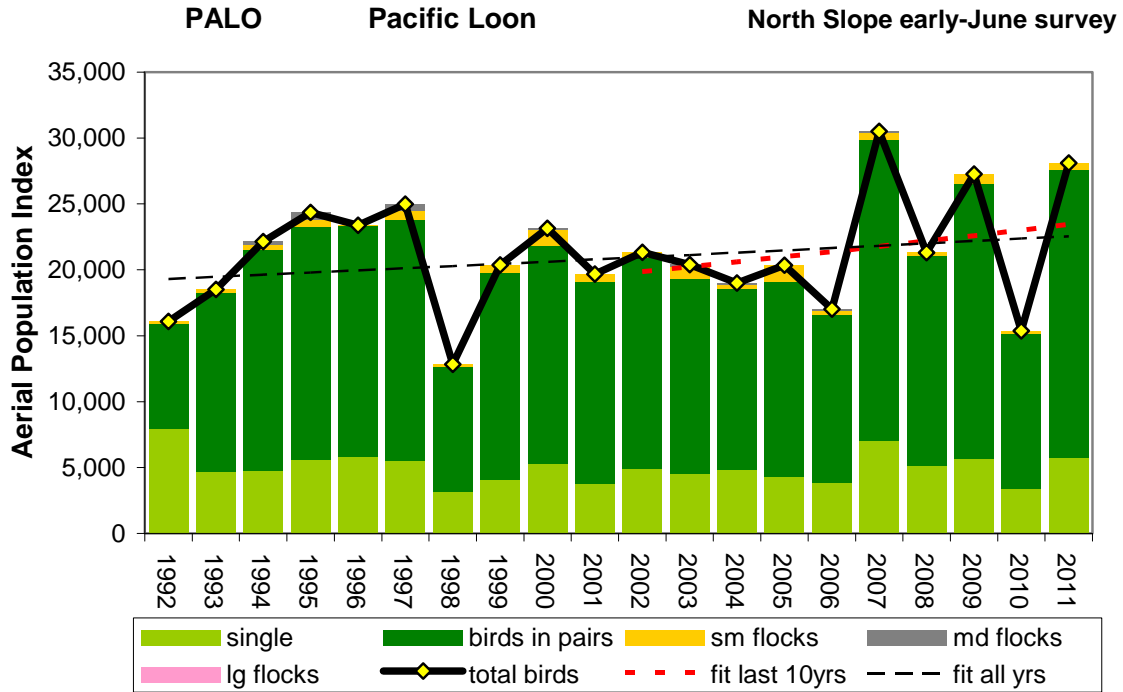
Table 6. Breeding population estimates, standard Alaska ACP Survey, 1986-2006 means (Mallek et al. 2007) compared with estimates from the current ACP survey, 2011 and averages from 2007-2010. Duck indices were converted to population estimates by multiplying by tundra visibility correction factors calculated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



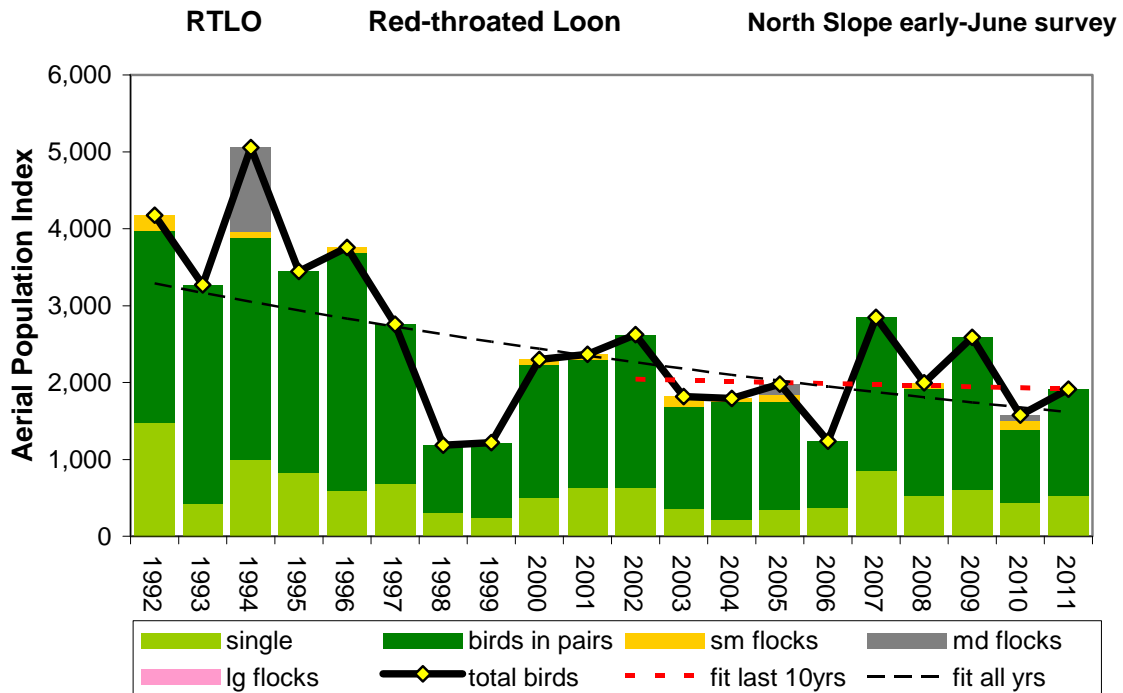
NSE 10 strata =30,465 km2									YBLO	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds		
1992	725	219	71	0	0	1015	179	n yrs =	20	
1993	386	617	162	0	0	1165	267	mean pop index =	1171	
1994	408	277	141	0	0	826	190	std dev =	255	
1995	527	628	70	0	0	1226	308	std error =	57	
1996	761	275	0	0	0	1036	191	low 90%ci =	1059	
1997	297	801	0	157	0	1254	573	high 90%ci =	1283	
1998	416	474	0	0	0	890	200	<u>trend over all years :</u>		
1999	340	579	70	0	0	989	229	In linear slope =	0.0202	
2000	277	388	0	0	0	665	165	SE slope =	0.0078	
2001	262	800	0	0	0	1062	196	Growth Rate =	1.020	
2002	762	620	97	0	0	1479	231	low 90%ci GR =	1.007	
2003	495	773	71	0	0	1339	236	high 90%ci GR =	1.034	
2004	323	533	0	0	0	856	170	regression resid CV =	0.202	
2005	344	932	0	0	0	1277	253	avg sampling err CV =	0.214	
2006	302	1002	0	0	0	1304	337	<u>trend of most recent 10 years :</u>		
2007	854	551	0	0	0	1405	251	Growth Rate =	1.017	
2008	582	556	97	0	0	1235	216	low 90%ci GR =	0.984	
2009	582	1111	0	0	0	1693	258	high 90%ci GR =	1.051	
2010	559	664	0	0	0	1223	209	<u>min yrs to detect -50%/20yr rate :</u>		
2011	592	787	108	0	0	1487	288	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.



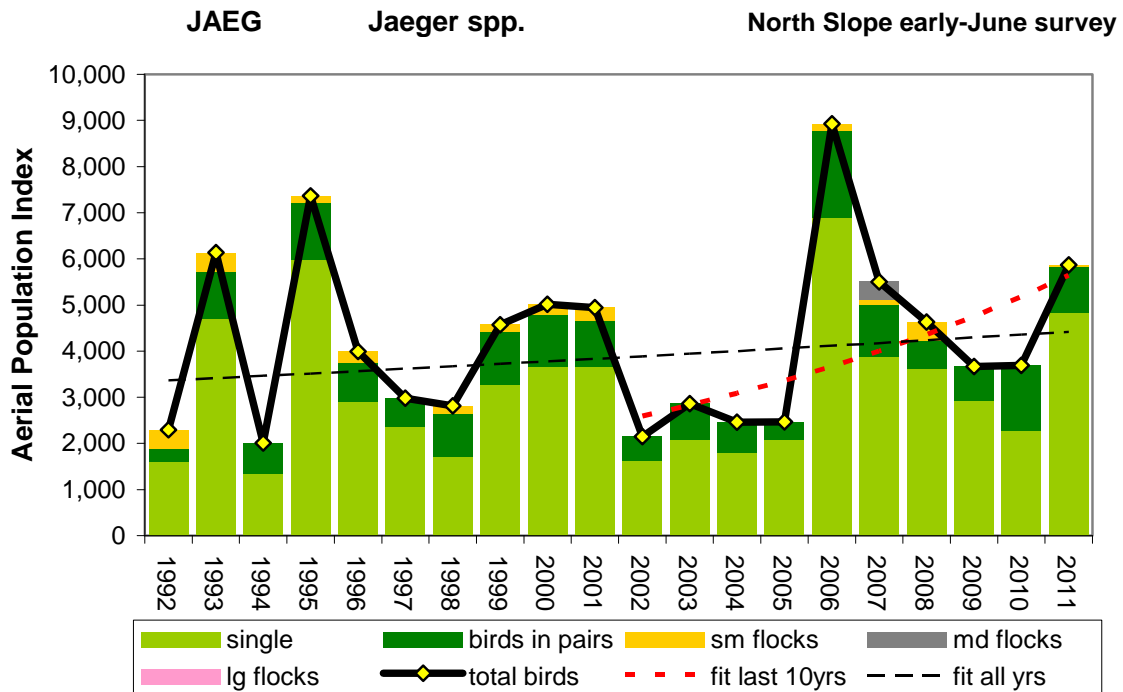
NSE 10 strata =30,465 km2									PALO	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds		
1992	7931	7944	227	0	0	16103	1174	n yrs =	20	
1993	4669	13592	251	0	0	18512	958	mean pop index =	21310	
1994	4773	16753	354	266	0	22146	1329	std dev =	4405	
1995	5592	17703	467	584	0	24347	1438	std error =	985	
1996	5821	17495	71	0	0	23387	1193	low 90%ci =	19379	
1997	5497	18298	696	490	0	24981	1848	high 90%ci =	23241	
1998	3220	9392	222	0	0	12833	1370	<u>trend over all years :</u>		
1999	4070	15690	625	0	0	20385	1386	In linear slope =	0.0082	
2000	5299	16556	1161	137	0	23152	1364	SE slope =	0.0082	
2001	3767	15326	581	0	0	19675	1330	Growth Rate =	1.008	
2002	4880	16020	431	0	0	21330	1250	low 90%ci GR =	0.995	
2003	4536	14842	842	177	0	20397	1701	high 90%ci GR =	1.022	
2004	4802	13751	312	148	0	19014	1269	regression resid CV =	0.212	
2005	4340	14728	1283	0	0	20351	1760	avg sampling err CV =	0.070	
2006	3839	12783	250	147	0	17018	1532	<u>trend of most recent 10 years :</u>		
2007	7051	22807	505	144	0	30507	1525	Growth Rate =	1.019	
2008	5172	15853	290	0	0	21315	1647	low 90%ci GR =	0.978	
2009	5647	20878	751	0	0	27276	1736	high 90%ci GR =	1.061	
2010	3410	11777	175	0	0	15362	1233	<u>min yrs to detect -50%/20yr rate :</u>		
2011	5780	21866	466	0	0	28111	2107	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.



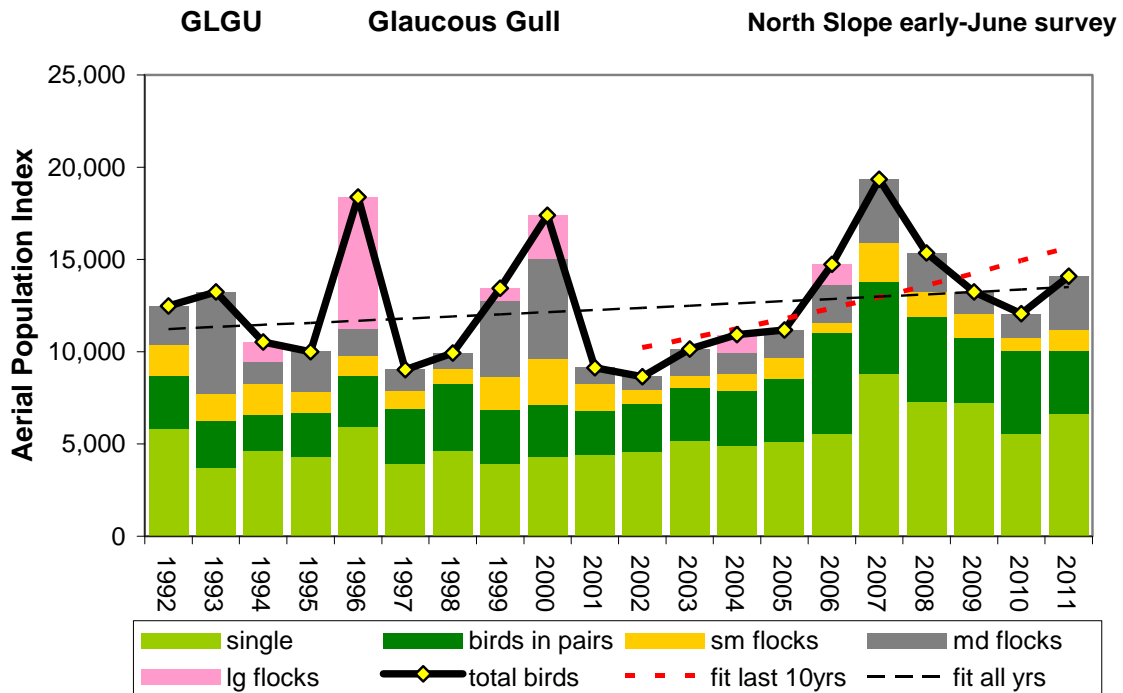
NSE 10 strata =30,465 km2								RTLO	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds	
1992	1487	2495	196	0	0	4177	453	n yrs =	20
1993	421	2850	0	0	0	3271	434	mean pop index =	2495
1994	993	2888	75	1099	0	5054	990	std dev =	1034
1995	827	2617	0	0	0	3445	476	std error =	231
1996	596	3087	73	0	0	3756	390	low 90%ci =	2041
1997	683	2075	0	0	0	2758	415	high 90%ci =	2948
1998	306	879	0	0	0	1185	251	trend over all years :	
1999	234	983	0	0	0	1216	176	In linear slope =	-0.0374
2000	502	1727	69	0	0	2298	330	SE slope =	0.0137
2001	634	1663	71	0	0	2367	387	Growth Rate =	0.963
2002	627	1994	0	0	0	2621	335	low 90%ci GR =	0.942
2003	363	1315	140	0	0	1818	194	high 90%ci GR =	0.985
2004	217	1528	49	0	0	1793	294	regression resid CV =	0.354
2005	348	1398	94	141	0	1980	399	avg sampling err CV =	0.154
2006	374	862	0	0	0	1236	264	trend of most recent 10 years :	
2007	860	1986	0	0	0	2846	388	Growth Rate =	0.993
2008	530	1395	70	0	0	1996	367	low 90%ci GR =	0.946
2009	605	1980	0	0	0	2585	342	high 90%ci GR =	1.042
2010	445	943	118	72	0	1578	247	min yrs to detect -50%/20yr rate :	
2011	530	1382	0	0	0	1912	310	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.



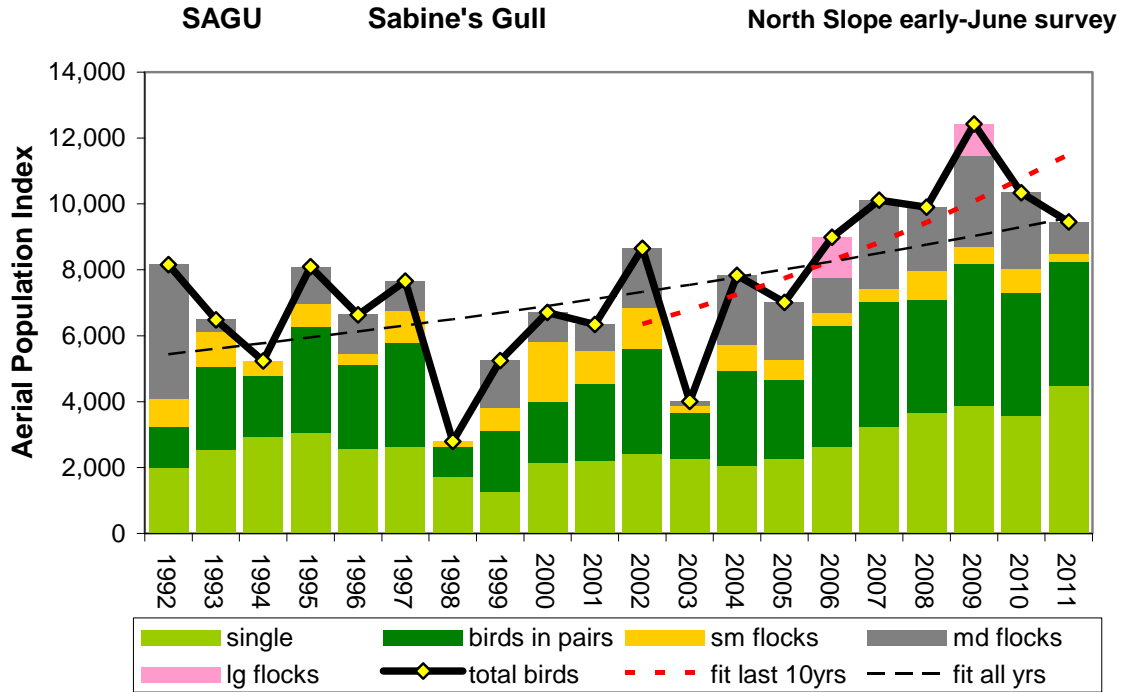
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year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds		
1992	1588	301	409	0	0	2298	297	n yrs =	20	
1993	4713	1014	405	0	0	6131	706	mean pop index =	4218	
1994	1335	671	0	0	0	2007	353	std dev =	1872	
1995	5989	1232	144	0	0	7365	650	std error =	419	
1996	2897	842	253	0	0	3992	485	low 90%ci =	3398	
1997	2346	638	0	0	0	2984	316	high 90%ci =	5038	
1998	1702	952	164	0	0	2817	384	trend over all years :		
1999	3276	1143	154	0	0	4572	477	In linear slope =	0.0143	
2000	3673	1124	221	0	0	5018	526	SE slope =	0.0168	
2001	3655	1005	286	0	0	4946	604	Growth Rate =	1.014	
2002	1622	525	0	0	0	2147	232	low 90%ci GR =	0.987	
2003	2078	785	0	0	0	2863	300	high 90%ci GR =	1.043	
2004	1793	666	0	0	0	2459	242	regression resid CV =	0.434	
2005	2081	390	0	0	0	2471	278	avg sampling err CV =	0.117	
2006	6893	1891	147	0	0	8930	589	trend of most recent 10 years :		
2007	3886	1125	99	392	0	5502	909	Growth Rate =	1.090	
2008	3618	620	392	0	0	4630	717	low 90%ci GR =	1.014	
2009	2929	737	0	0	0	3666	335	high 90%ci GR =	1.171	
2010	2267	1423	0	0	0	3690	514	min yrs to detect -50%/20yr rate :		
2011	4821	1008	41	0	0	5871	563	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.



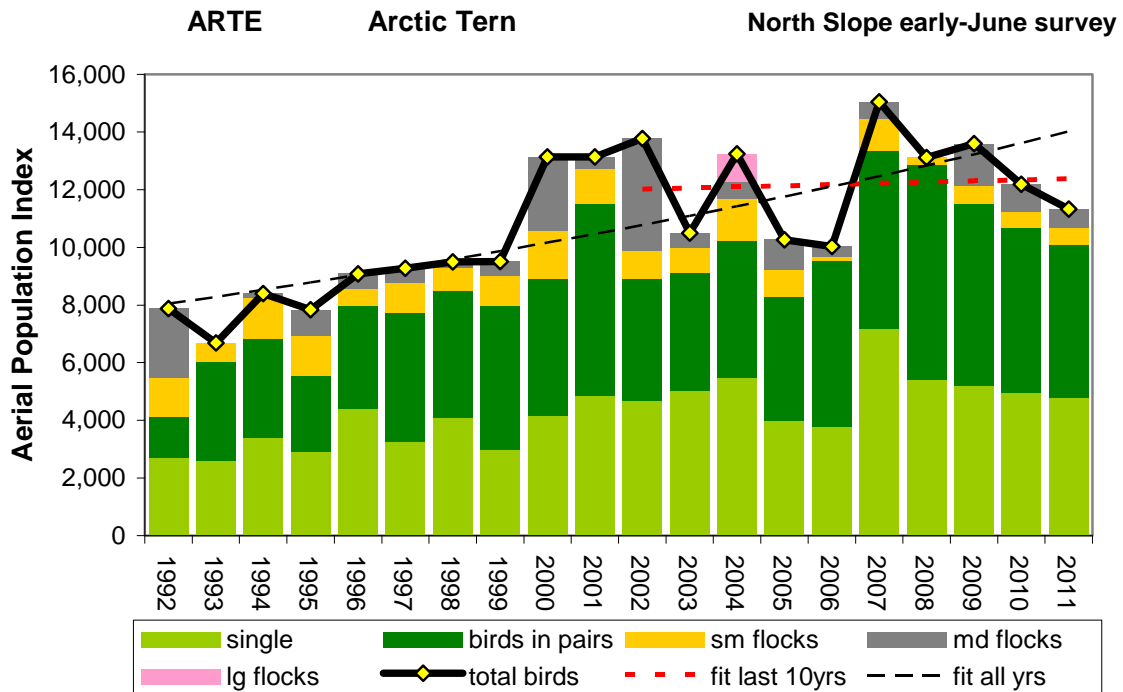
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year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds	
1992	5840	2875	1704	2050	0	12469	1385	n yrs =	20
1993	3724	2536	1489	5490	0	13238	3151	mean pop index =	12663
1994	4648	1964	1640	1223	1057	10532	1794	std dev =	3140
1995	4300	2396	1119	2185	0	10000	1522	std error =	702
1996	5959	2772	1034	1501	7107	18372	7868	low 90%ci =	11286
1997	3919	2979	973	1158	0	9028	1289	high 90%ci =	14039
1998	4645	3636	786	859	0	9926	1097	trend over all years :	
1999	3932	2900	1780	4168	656	13435	1343	In linear slope =	0.0097
2000	4303	2832	2464	5454	2342	17394	3095	SE slope =	0.0093
2001	4423	2391	1429	886	0	9130	1124	Growth Rate =	1.010
2002	4596	2615	706	732	0	8649	788	low 90%ci GR =	0.994
2003	5182	2878	645	1449	0	10153	1325	high 90%ci GR =	1.025
2004	4921	2971	898	1181	951	10921	1164	regression resid CV =	0.239
2005	5162	3376	1134	1503	0	11175	1255	avg sampling err CV =	0.148
2006	5573	5465	505	2098	1102	14743	1976	trend of most recent 10 years :	
2007	8807	4945	2169	3424	0	19345	2390	Growth Rate =	1.048
2008	7304	4615	1326	2101	0	15346	1220	low 90%ci GR =	1.012
2009	7236	3494	1335	1181	0	13246	1460	high 90%ci GR =	1.086
2010	5562	4508	710	1284	0	12064	1314	min yrs to detect -50%/20yr rate :	
2011	6645	3406	1138	2898	0	14087	2920	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.



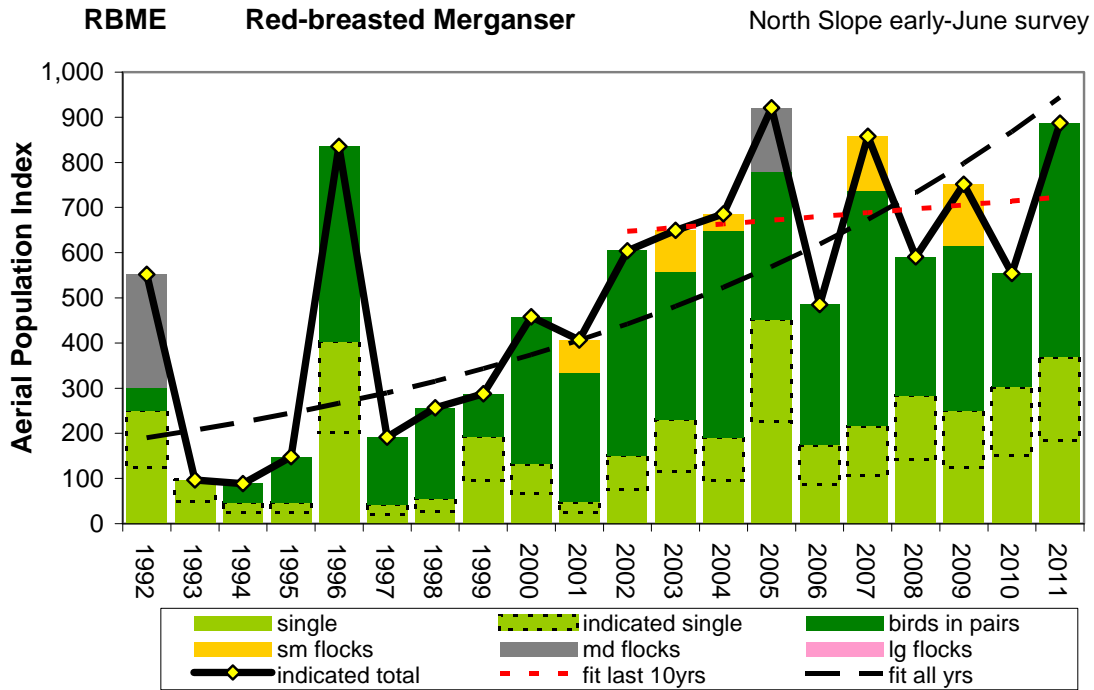
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year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds		
1992	1974	1276	833	4076	0	8158	1264	n yrs =	20	
1993	2546	2525	1043	372	0	6487	737	mean pop index =	7604	
1994	2935	1852	446	0	0	5234	624	std dev =	2312	
1995	3059	3221	696	1122	0	8098	1482	std error =	517	
1996	2567	2547	335	1184	0	6632	954	low 90%ci =	6591	
1997	2631	3160	966	898	0	7655	738	high 90%ci =	8617	
1998	1719	909	165	0	0	2793	409	<u>trend over all years :</u>		
1999	1280	1836	689	1443	0	5249	812	In linear slope =	0.0298	
2000	2150	1841	1818	895	0	6705	844	SE slope =	0.0120	
2001	2198	2328	1028	788	0	6342	869	Growth Rate =	1.030	
2002	2423	3179	1232	1816	0	8651	822	low 90%ci GR =	1.010	
2003	2272	1389	196	146	0	4004	448	high 90%ci GR =	1.051	
2004	2040	2909	784	2100	0	7833	1182	regression resid CV =	0.311	
2005	2264	2388	625	1741	0	7018	866	avg sampling err CV =	0.132	
2006	2640	3679	374	1072	1220	8984	1509	<u>trend of most recent 10 years :</u>		
2007	3242	3781	414	2676	0	10113	1105	Growth Rate =	1.068	
2008	3669	3410	893	1929	0	9901	1124	low 90%ci GR =	1.021	
2009	3852	4317	543	2774	944	12429	1633	high 90%ci GR =	1.118	
2010	3565	3750	707	2315	0	10338	1521	<u>min yrs to detect -50%/20yr rate :</u>		
2011	4502	3755	226	973	0	9456	1064	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.



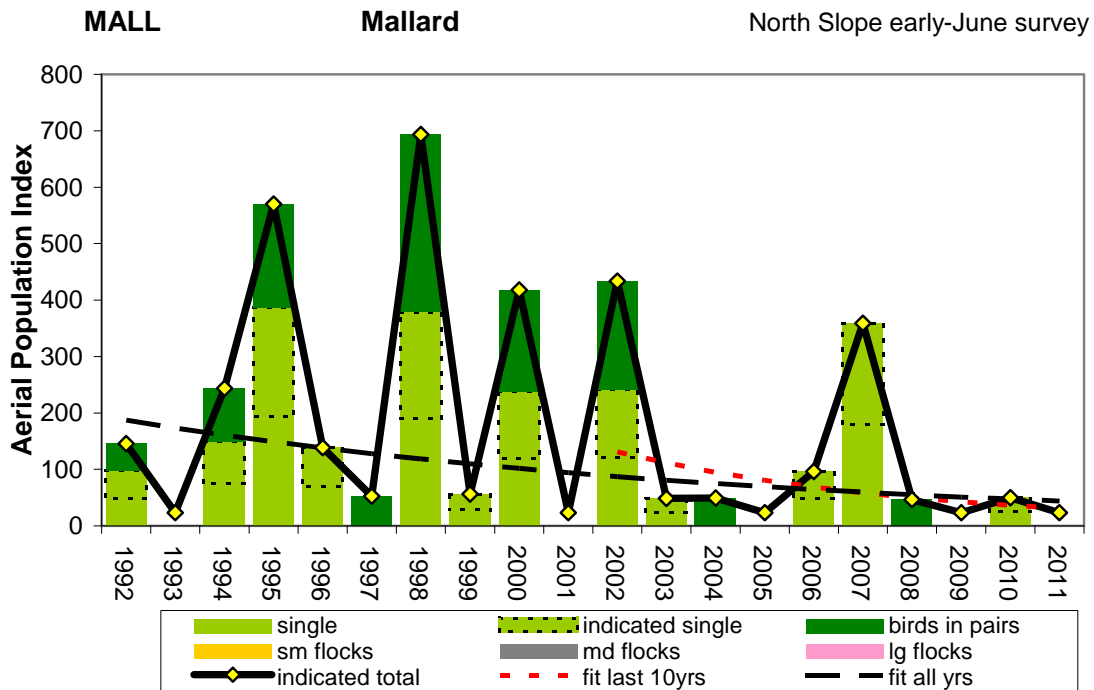
NSE 10 strata =30,465 km2									ARTE	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds		
1992	2691	1449	1327	2411	0	7877	1340	n yrs =	20	
1993	2605	3425	652	0	0	6682	692	mean pop index =	10875	
1994	3419	3417	1418	147	0	8400	933	std dev =	2393	
1995	2905	2655	1393	879	0	7832	1186	std error =	535	
1996	4398	3597	560	528	0	9083	906	low 90%ci =	9826	
1997	3252	4464	1069	488	0	9274	891	high 90%ci =	11923	
1998	4098	4409	806	179	0	9491	838	trend over all years :		
1999	2969	5016	1007	515	0	9508	1230	In linear slope =	0.0292	
2000	4151	4783	1635	2571	0	13141	1361	SE slope =	0.0059	
2001	4844	6685	1217	389	0	13135	1236	Growth Rate =	1.030	
2002	4698	4221	956	3905	0	13778	1800	low 90%ci GR =	1.020	
2003	5033	4077	872	512	0	10493	1128	high 90%ci GR =	1.040	
2004	5491	4735	1441	617	964	13248	1509	regression resid CV =	0.151	
2005	3997	4301	917	1051	0	10266	1195	avg sampling err CV =	0.110	
2006	3779	5752	147	348	0	10026	917	trend of most recent 10 years :		
2007	7173	6186	1107	575	0	15040	1227	Growth Rate =	1.003	
2008	5409	7435	275	0	0	13119	1475	low 90%ci GR =	0.977	
2009	5199	6314	629	1451	0	13593	1369	high 90%ci GR =	1.031	
2010	4941	5738	545	964	0	12188	1377	min yrs to detect -50%/20yr rate :		
2011	4787	5315	582	642	0	11325	959	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.



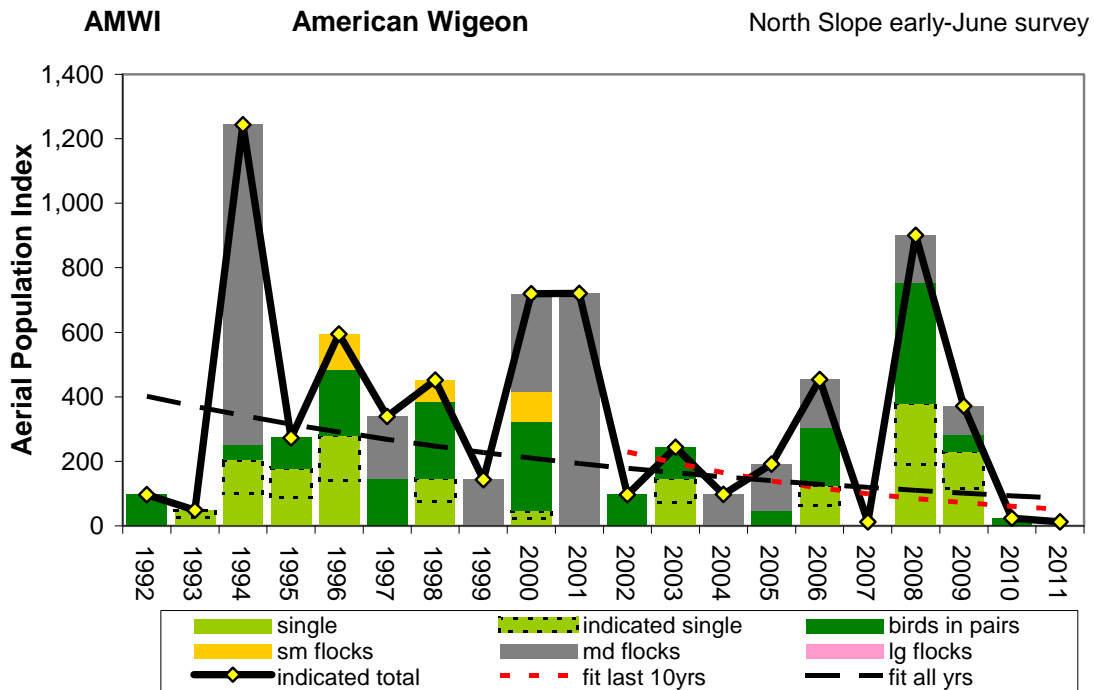
NSE 10 strata =30,465 km2								RBME	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	250	50	0	252	0	552	252	n yrs =	20
1993	97	0	0	0	0	97	68	mean pop index =	523
1994	47	41	0	0	0	88	63	std dev =	265
1995	47	101	0	0	0	148	87	std error =	59
1996	403	433	0	0	0	836	220	low 90%ci =	407
1997	42	149	0	0	0	192	90	high 90%ci =	639
1998	55	202	0	0	0	256	99	<u>trend over all years :</u>	
1999	193	95	0	0	0	287	105	In linear slope =	0.0843
2000	132	326	0	0	0	458	153	SE slope =	0.0210
2001	47	287	72	0	0	407	132	Growth Rate =	1.088
2002	150	454	0	0	0	604	155	low 90%ci GR =	1.051
2003	230	326	93	0	0	650	214	high 90%ci GR =	1.126
2004	191	459	37	0	0	686	179	regression resid CV =	0.543
2005	451	329	0	141	0	921	320	avg sampling err CV =	0.384
2006	174	312	0	0	0	485	158	<u>trend of most recent 10 years :</u>	
2007	216	523	120	0	0	858	322	Growth Rate =	1.012
2008	283	308	0	0	0	591	228	low 90%ci GR =	0.972
2009	250	366	136	0	0	752	200	high 90%ci GR =	1.055
2010	302	252	0	0	0	554	116	<u>min yrs to detect -50%/20yr rate :</u>	
2011	369	518	0	0	0	887	291	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.



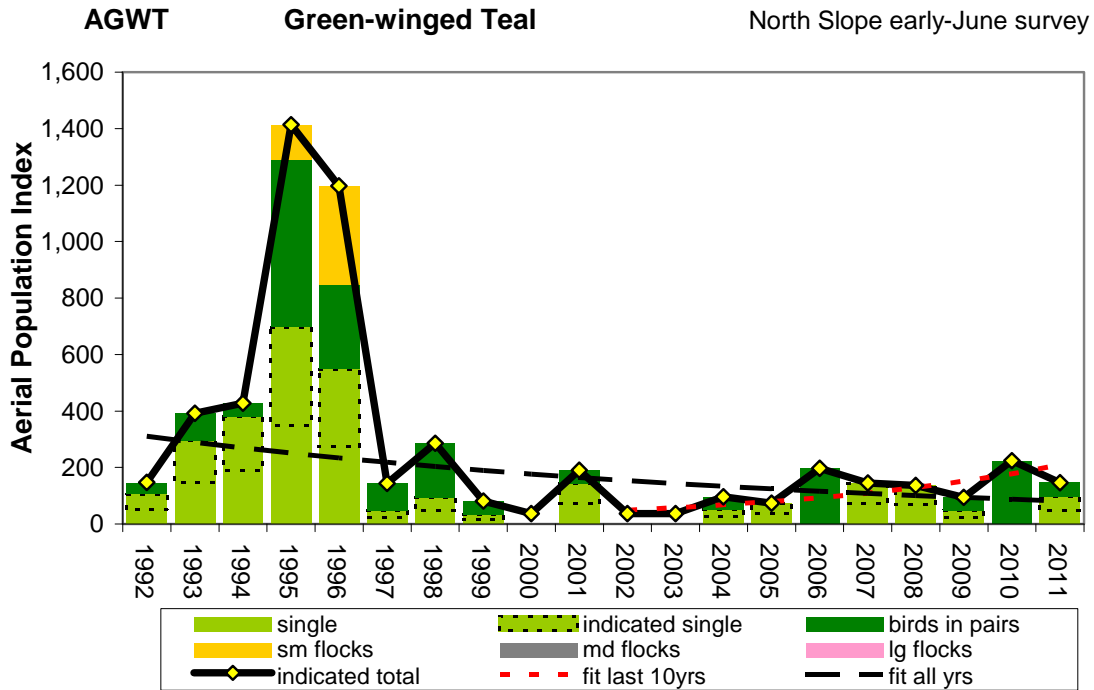
NSE 10 strata =30,465 km2									MALL	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total		
1992	98	48	0	0	0	146	85	n yrs =	20	
1993	0	0	0	0	0	23	24	mean pop index =	173	
1994	149	94	0	0	0	243	127	std dev =	201	
1995	387	183	0	0	0	570	209	std error =	45	
1996	139	0	0	0	0	139	75	low 90%ci =	85	
1997	0	52	0	0	0	52	52	high 90%ci =	262	
1998	378	315	0	0	0	694	180	<u>trend over all years :</u>		
1999	56	0	0	0	0	56	49	In linear slope =	-0.0763	
2000	238	180	0	0	0	418	157	SE slope =	0.0438	
2001	0	0	0	0	0	23	24	Growth Rate =	0.927	
2002	241	193	0	0	0	434	188	low 90%ci GR =	0.862	
2003	49	0	0	0	0	49	48	high 90%ci GR =	0.996	
2004	0	49	0	0	0	49	52	regression resid CV =	1.132	
2005	0	0	0	0	0	23	24	avg sampling err CV =	0.771	
2006	96	0	0	0	0	96	58	<u>trend of most recent 10 years :</u>		
2007	359	0	0	0	0	359	261	Growth Rate =	0.852	
2008	0	47	0	0	0	47	48	low 90%ci GR =	0.710	
2009	0	0	0	0	0	23	24	high 90%ci GR =	1.021	
2010	50	0	0	0	0	50	48	<u>min yrs to detect -50%/20yr rate :</u>		
2011	0	0	0	0	0	23	24	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.



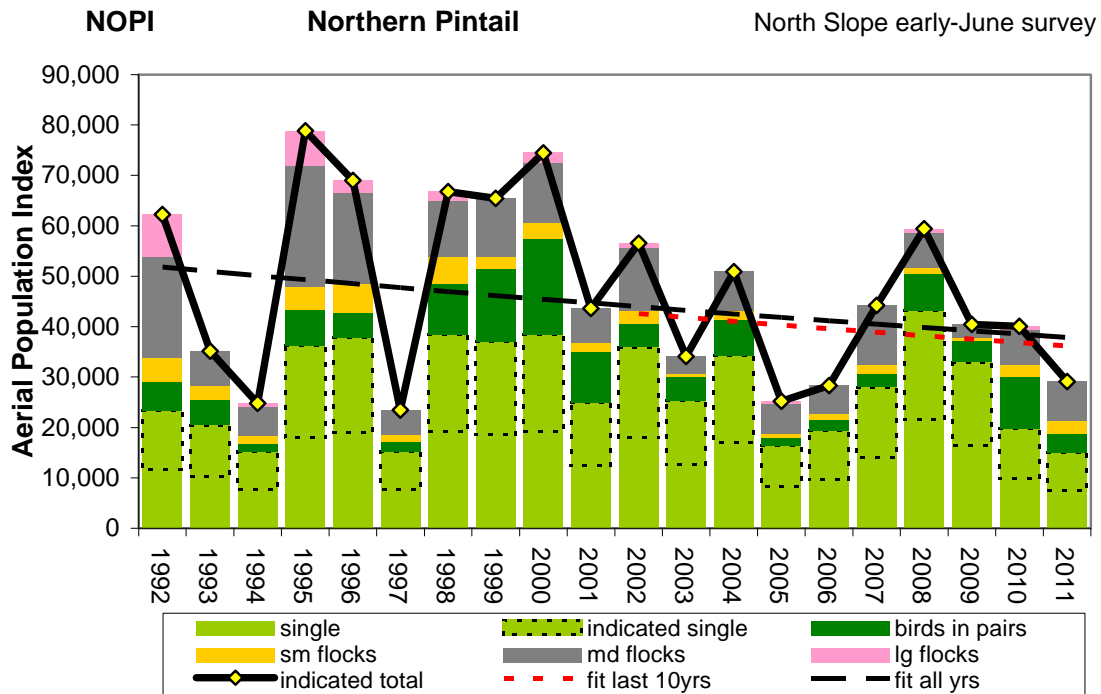
NSE 10 strata =30,465 km2									AMWI	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total		
1992	0	96	0	0	0	96	50	n yrs =	20	
1993	48	0	0	0	0	48	49	mean pop index =	348	
1994	203	47	0	993	0	1244	619	std dev =	329	
1995	179	93	0	0	0	272	130	std error =	74	
1996	280	205	110	0	0	595	210	low 90%ci =	203	
1997	0	145	0	194	0	339	242	high 90%ci =	492	
1998	148	237	67	0	0	452	171	<u>trend over all years :</u>		
1999	0	0	0	143	0	143	138	In linear slope =	-0.0812	
2000	46	276	96	303	0	720	314	SE slope =	0.0516	
2001	0	0	0	720	0	720	906	Growth Rate =	0.922	
2002	0	97	0	0	0	97	70	low 90%ci GR =	0.847	
2003	146	97	0	0	0	243	143	high 90%ci GR =	1.004	
2004	0	0	0	98	0	98	92	regression resid CV =	1.334	
2005	0	48	0	143	0	192	140	avg sampling err CV =	0.685	
2006	124	180	0	151	0	454	285	<u>trend of most recent 10 years :</u>		
2007	0	0	0	0	0	12	11	Growth Rate =	0.847	
2008	380	375	0	146	0	901	341	low 90%ci GR =	0.641	
2009	230	53	0	88	0	371	137	high 90%ci GR =	1.118	
2010	0	24	0	0	0	24	22	<u>min yrs to detect -50%/20yr rate :</u>		
2011	0	0	0	0	0	12	11	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.



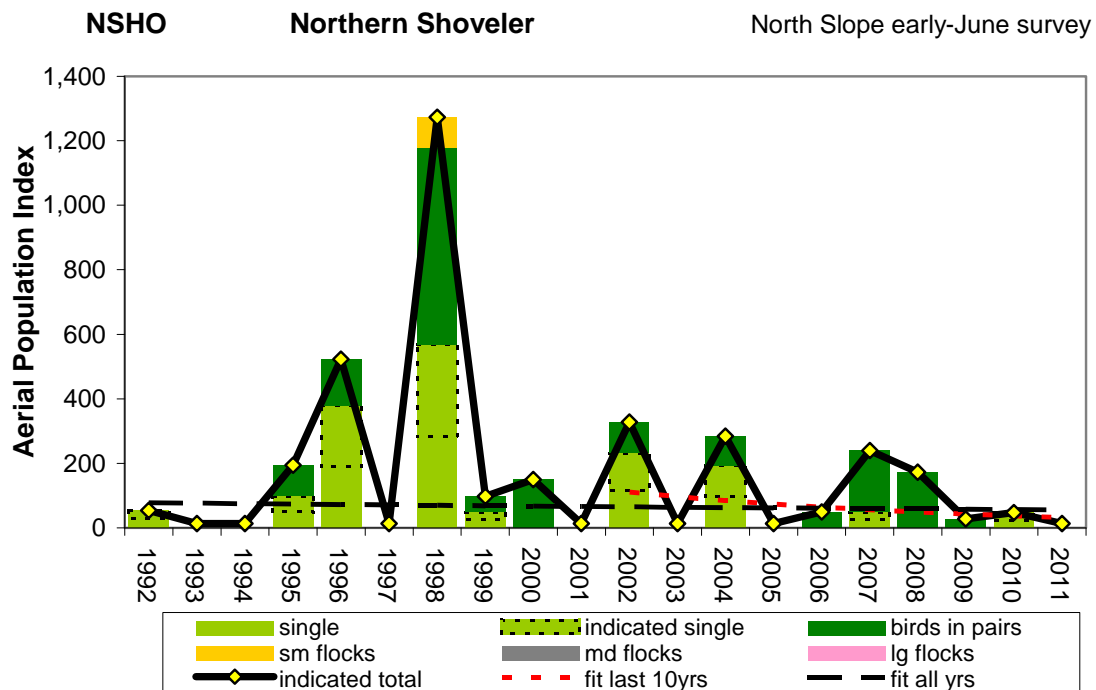
NSE 10 strata =30,465 km ²								AGWT	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	105	41	0	0	0	147	93	n yrs =	20
1993	295	97	0	0	0	392	170	mean pop index =	267
1994	381	47	0	0	0	428	156	std dev =	362
1995	698	593	124	0	0	1414	335	std error =	81
1996	548	299	350	0	0	1197	290	low 90%ci =	109
1997	48	96	0	0	0	144	83	high 90%ci =	426
1998	93	192	0	0	0	286	108	trend over all years :	
1999	33	48	0	0	0	81	58	In linear slope =	-0.0702
2000	0	0	0	0	0	37	27	SE slope =	0.0366
2001	143	48	0	0	0	191	84	Growth Rate =	0.932
2002	0	0	0	0	0	37	27	low 90%ci GR =	0.878
2003	0	0	0	0	0	37	27	high 90%ci GR =	0.990
2004	49	47	0	0	0	97	63	regression resid CV =	0.945
2005	73	0	0	0	0	73	54	avg sampling err CV =	0.531
2006	0	197	0	0	0	197	91	trend of most recent 10 years :	
2007	145	0	0	0	0	145	103	Growth Rate =	1.175
2008	137	0	0	0	0	137	57	low 90%ci GR =	1.087
2009	47	47	0	0	0	94	62	high 90%ci GR =	1.270
2010	0	224	0	0	0	224	73	min yrs to detect -50%/20yr rate :	
2011	97	49	0	0	0	146	64	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.



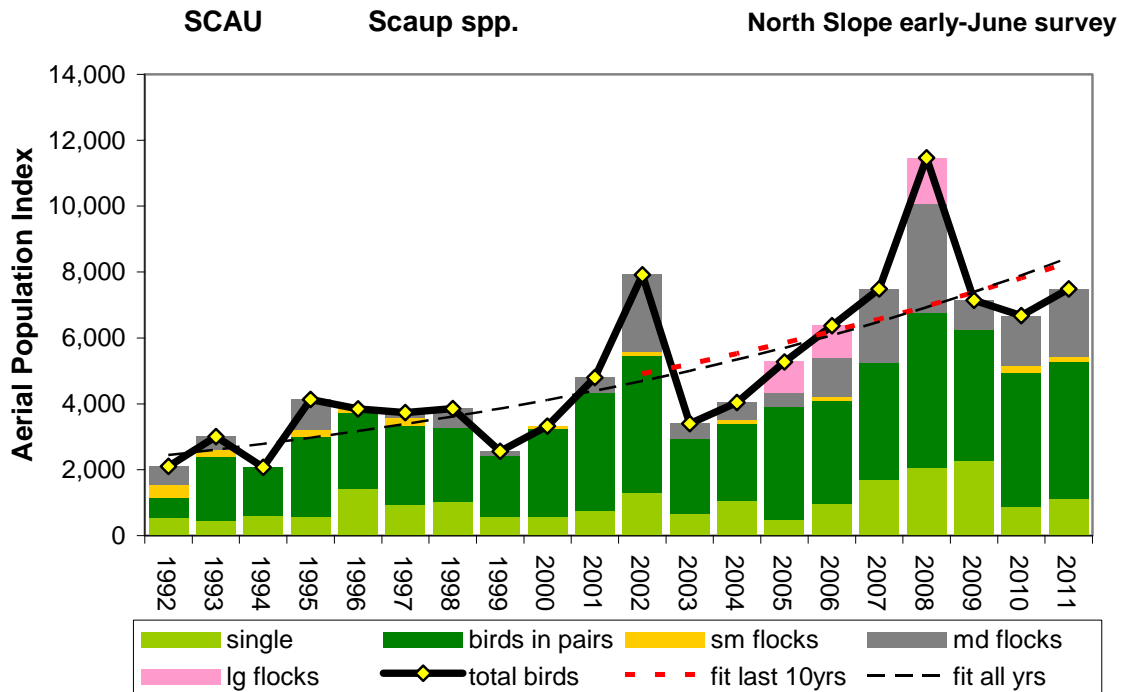
NSE 10 strata =30,465 km2								NOPI	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	23339	5630	4752	20018	8491	62230	6591	n yrs =	20
1993	20441	5126	2668	6905	0	35141	3261	mean pop index =	47344
1994	15254	1573	1550	5590	802	24768	2589	std dev =	17483
1995	36195	7281	4396	24109	6892	78872	8012	std error =	3909
1996	37891	4794	5743	18034	2558	69020	9306	low 90%ci =	39681
1997	15217	1984	1439	4812	0	23452	2624	high 90%ci =	55006
1998	38469	10126	5255	11094	1832	66775	5576	trend over all years :	
1999	37076	14400	2264	11702	0	65443	3896	In linear slope =	-0.0165
2000	38434	19056	3134	11843	1999	74466	6031	SE slope =	0.0153
2001	24965	10029	1749	6882	0	43625	4392	Growth Rate =	0.984
2002	35915	4630	2602	12529	881	56557	6030	low 90%ci GR =	0.959
2003	25320	4725	643	3387	0	34075	3873	high 90%ci GR =	1.009
2004	34272	6991	1804	7817	0	50885	4796	regression resid CV =	0.395
2005	16381	1703	592	6047	481	25205	2544	avg sampling err CV =	0.102
2006	19280	2265	1118	5627	0	28290	2551	trend of most recent 10 years :	
2007	28009	2669	1758	11796	0	44232	4828	Growth Rate =	0.982
2008	43134	7417	1202	6877	820	59450	5222	low 90%ci GR =	0.928
2009	32921	4351	528	2651	0	40451	5521	high 90%ci GR =	1.039
2010	19757	10280	2379	7045	596	40057	4501	min yrs to detect -50%/20yr rate :	
2011	15080	3670	2483	7861	0	29094	3039	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.



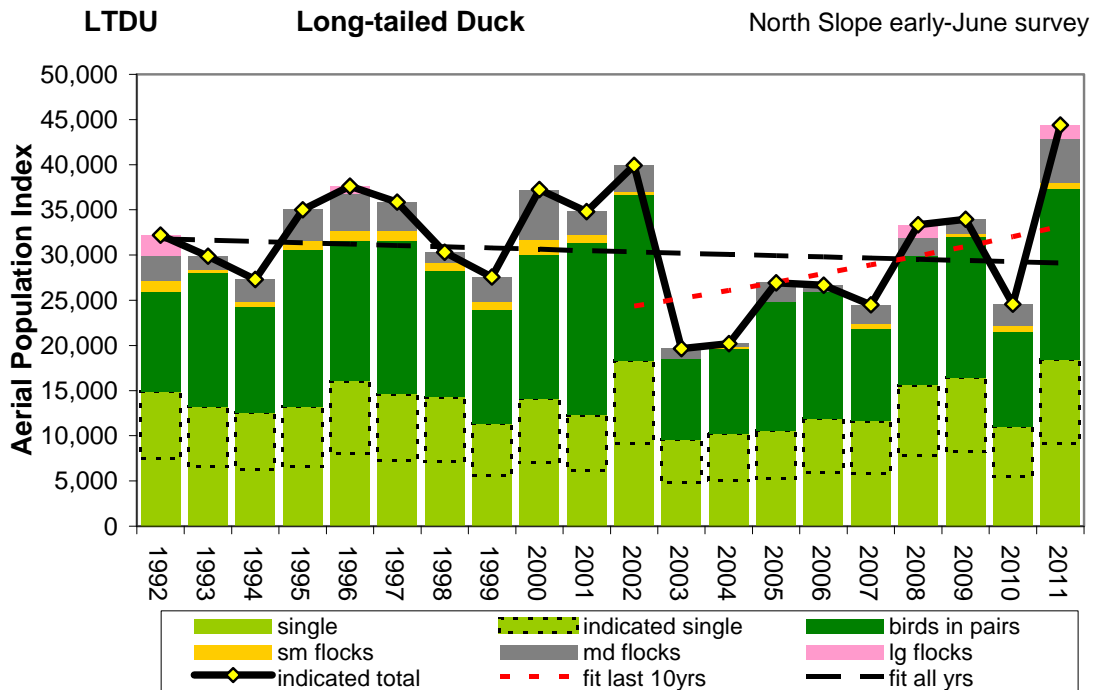
NSE 10 strata =30,465 km ²									NSHO	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total		
1992	54	0	0	0	0	54	49	n yrs =	20	
1993	0	0	0	0	0	14	12	mean pop index =	175	
1994	0	0	0	0	0	14	12	std dev =	285	
1995	99	95	0	0	0	194	95	std error =	64	
1996	380	143	0	0	0	523	178	low 90%ci =	50	
1997	0	0	0	0	0	14	12	high 90%ci =	300	
1998	567	612	94	0	0	1273	260	<u>trend over all years :</u>		
1999	48	49	0	0	0	97	68	In linear slope =	-0.0178	
2000	0	150	0	0	0	150	72	SE slope =	0.0582	
2001	0	0	0	0	0	14	12	Growth Rate =	0.982	
2002	231	97	0	0	0	328	150	low 90%ci GR =	0.893	
2003	0	0	0	0	0	14	12	high 90%ci GR =	1.081	
2004	193	91	0	0	0	284	114	regression resid CV =	1.506	
2005	0	0	0	0	0	14	12	avg sampling err CV =	0.692	
2006	0	49	0	0	0	49	51	<u>trend of most recent 10 years :</u>		
2007	49	191	0	0	0	240	97	Growth Rate =	0.873	
2008	0	172	0	0	0	172	72	low 90%ci GR =	0.686	
2009	0	27	0	0	0	27	24	high 90%ci GR =	1.110	
2010	48	0	0	0	0	48	46	<u>min yrs to detect -50%/20yr rate :</u>		
2011	0	0	0	0	0	14	12	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.



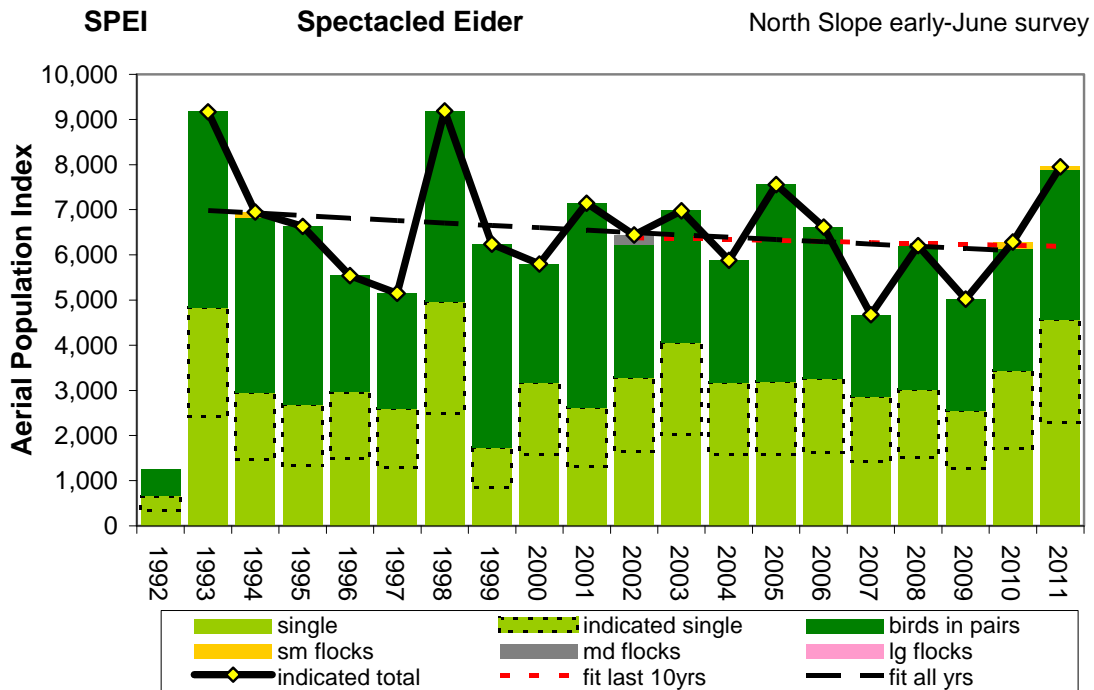
NSE 10 strata =30,465 km2								SCAU	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds	
1992	539	607	400	563	0	2109	572	n yrs =	20
1993	455	1946	192	411	0	3004	636	mean pop index =	5036
1994	594	1486	0	0	0	2080	366	std dev =	2408
1995	560	2453	209	912	0	4133	719	std error =	538
1996	1437	2292	120	0	0	3849	526	low 90%ci =	3981
1997	948	2396	245	145	0	3735	661	high 90%ci =	6091
1998	1035	2240	0	582	0	3857	470	trend over all years :	
1999	576	1847	0	143	0	2565	452	In linear slope =	0.0651
2000	579	2659	87	0	0	3325	556	SE slope =	0.0106
2001	766	3556	0	480	0	4802	784	Growth Rate =	1.067
2002	1306	4147	120	2342	0	7915	982	low 90%ci GR =	1.049
2003	655	2266	0	483	0	3403	545	high 90%ci GR =	1.086
2004	1079	2319	119	524	0	4041	611	regression resid CV =	0.272
2005	507	3404	0	421	937	5269	1043	avg sampling err CV =	0.183
2006	988	3103	125	1177	976	6370	1550	trend of most recent 10 years :	
2007	1685	3567	0	2237	0	7488	1514	Growth Rate =	1.060
2008	2072	4709	0	3290	1397	11468	3418	low 90%ci GR =	1.000
2009	2283	3966	0	895	0	7145	872	high 90%ci GR =	1.123
2010	877	4055	239	1509	0	6680	1068	min yrs to detect -50%/20yr rate :	
2011	1131	4157	146	2053	0	7487	1726	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.



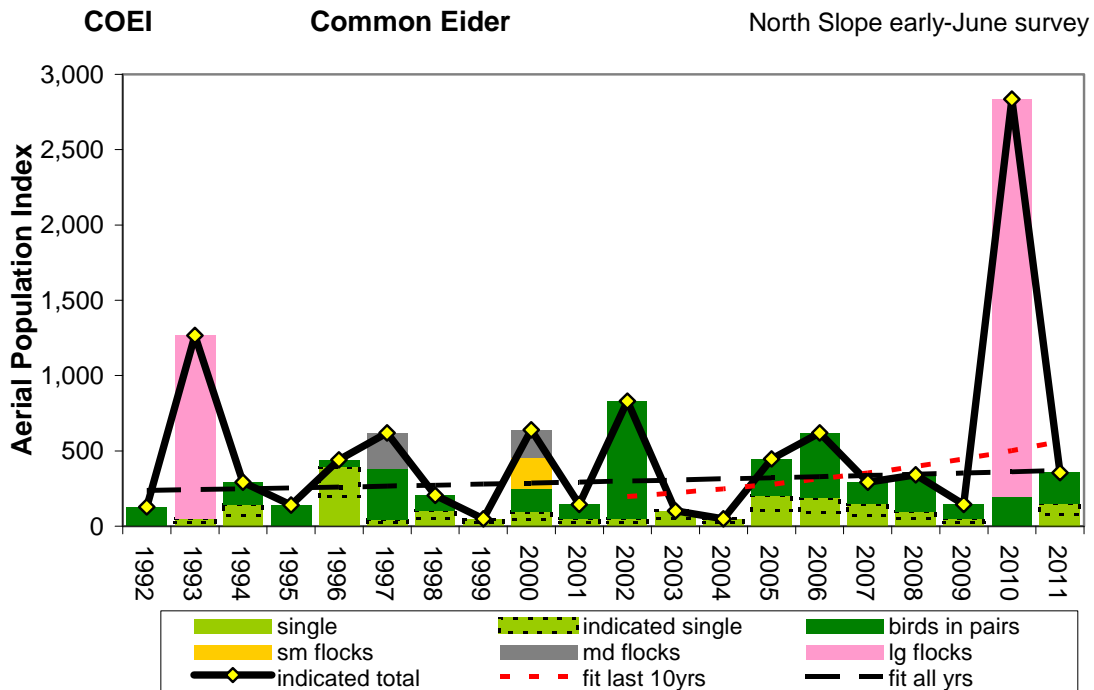
NSE 10 strata =30,465 km2								LTDU	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	14896	11116	1123	2818	2268	32221	3513	n yrs =	20
1993	13208	14871	346	1432	0	29858	1989	mean pop index =	30935
1994	12570	11684	623	2434	0	27312	2090	std dev =	6381
1995	13206	17440	913	3463	0	35021	2361	std error =	1427
1996	16046	15597	1099	4023	849	37614	2419	low 90%ci =	28139
1997	14607	17009	1021	3215	0	35853	2087	high 90%ci =	33732
1998	14244	13963	942	1162	0	30310	1612	<u>trend over all years :</u>	
1999	11329	12640	872	2742	0	27584	1811	In linear slope =	-0.0046
2000	14154	15833	1737	5529	0	37252	2773	SE slope =	0.0086
2001	12270	19161	807	2572	0	34810	2016	Growth Rate =	0.995
2002	18317	18405	257	2953	0	39931	2097	low 90%ci GR =	0.981
2003	9579	8894	0	1168	0	19642	1227	high 90%ci GR =	1.010
2004	10230	9380	198	391	0	20199	1658	regression resid CV =	0.222
2005	10594	14197	0	2122	0	26912	1583	avg sampling err CV =	0.071
2006	11917	14036	0	716	0	26669	2150	<u>trend of most recent 10 years :</u>	
2007	11597	10191	645	2046	0	24479	1857	Growth Rate =	1.035
2008	15579	14283	0	2078	1405	33345	2755	low 90%ci GR =	0.986
2009	16439	15526	425	1561	0	33950	1787	high 90%ci GR =	1.087
2010	11030	10554	567	2405	0	24557	1569	<u>min yrs to detect -50%/20yr rate :</u>	
2011	18401	18921	672	4939	1449	44382	4853	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								SPEI	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	657	602	0	0	0			n yrs =	19
1993	4828	4339	0	0	0	9167	900	mean pop index =	6580
1994	2945	3885	122	0	0	6951	733	std dev =	1209
1995	2679	3951	0	0	0	6630	677	std error =	277
1996	2964	2580	0	0	0	5544	680	low 90%ci =	6037
1997	2594	2553	0	0	0	5148	515	high 90%ci =	7124
1998	4963	4223	0	0	0	9186	1001	<u>trend over all years :</u>	
1999	1723	4517	0	0	0	6240	541	In linear slope =	-0.0080
2000	3170	2628	0	0	0	5798	487	SE slope =	0.0077
2001	2611	4537	0	0	0	7148	675	Growth Rate =	0.992
2002	3284	2938	0	216	0	6439	812	low 90%ci GR =	0.980
2003	4058	2918	0	0	0	6976	635	high 90%ci GR =	1.005
2004	3165	2716	0	0	0	5881	574	regression resid CV =	0.183
2005	3186	4374	0	0	0	7561	964	avg sampling err CV =	0.112
2006	3259	3356	0	0	0	6615	947	<u>trend of most recent 10 years :</u>	
2007	2864	1813	0	0	0	4676	668	Growth Rate =	0.997
2008	3019	3188	0	0	0	6207	592	low 90%ci GR =	0.965
2009	2549	2468	0	0	0	5018	854	high 90%ci GR =	1.029
2010	3435	2714	137	0	0	6286	719	<u>min yrs to detect -50%/20yr rate :</u>	
2011	4568	3312	71	0	0	7952	864	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 km ²								COEI	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	0	128	0	0	0	128	147	n yrs =	20
1993	48	0	0	0	1219	1266	1221	mean pop index =	503
1994	145	148	0	0	0	292	164	std dev =	614
1995	0	140	0	0	0	140	138	std error =	137
1996	391	49	0	0	0	440	224	low 90%ci =	234
1997	48	333	0	238	0	618	542	high 90%ci =	772
1998	103	103	0	0	0	205	168	<u>trend over all years :</u>	
1999	48	0	0	0	0	48	46	In linear slope =	0.0235
2000	93	156	205	184	0	639	223	SE slope =	0.0410
2001	48	97	0	0	0	145	115	Growth Rate =	1.024
2002	49	781	0	0	0	831	807	low 90%ci GR =	0.957
2003	102	0	0	0	0	102	74	high 90%ci GR =	1.095
2004	49	0	0	0	0	49	44	regression resid CV =	1.058
2005	202	245	0	0	0	447	278	avg sampling err CV =	0.783
2006	186	433	0	0	0	620	440	<u>trend of most recent 10 years :</u>	
2007	146	147	0	0	0	293	192	Growth Rate =	1.125
2008	97	243	0	0	0	340	260	low 90%ci GR =	0.914
2009	48	95	0	0	0	143	104	high 90%ci GR =	1.384
2010	0	192	0	0	2644	2836	2843	<u>min yrs to detect -50%/20yr rate :</u>	
2011	152	202	0	0	0	354	220	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 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.

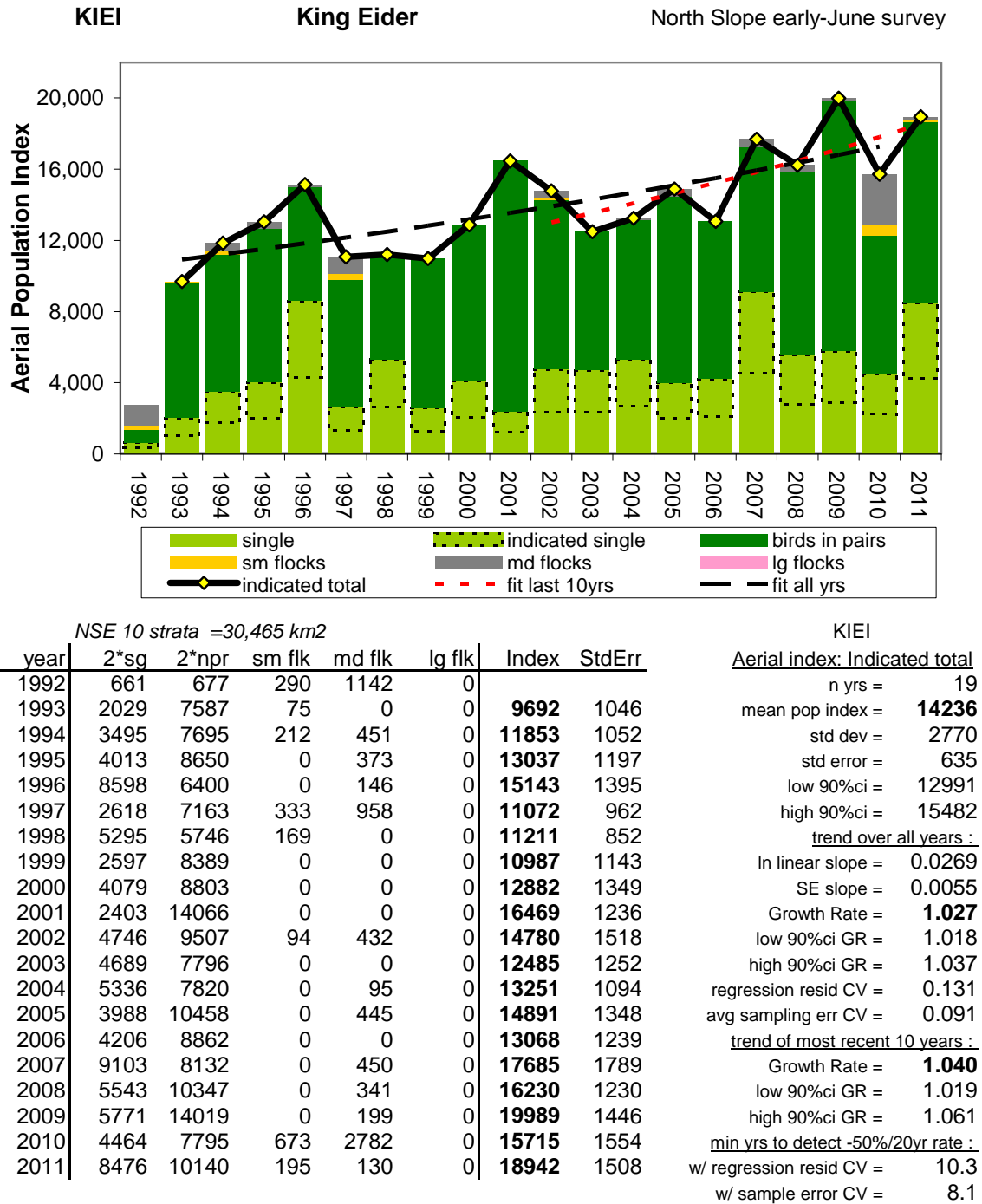
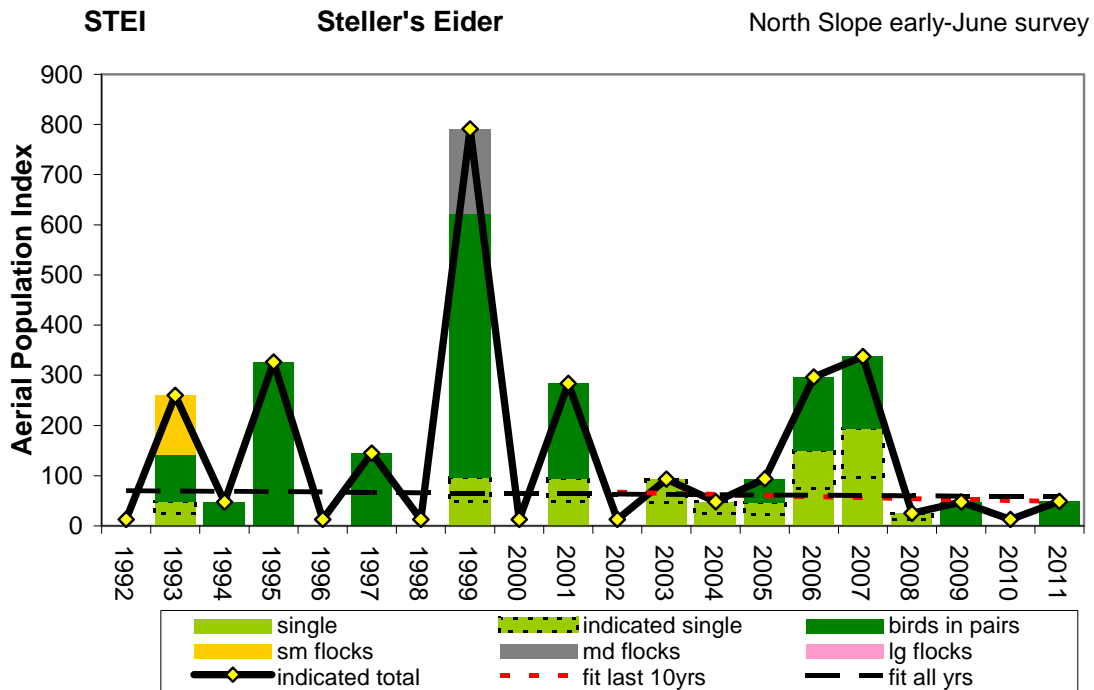
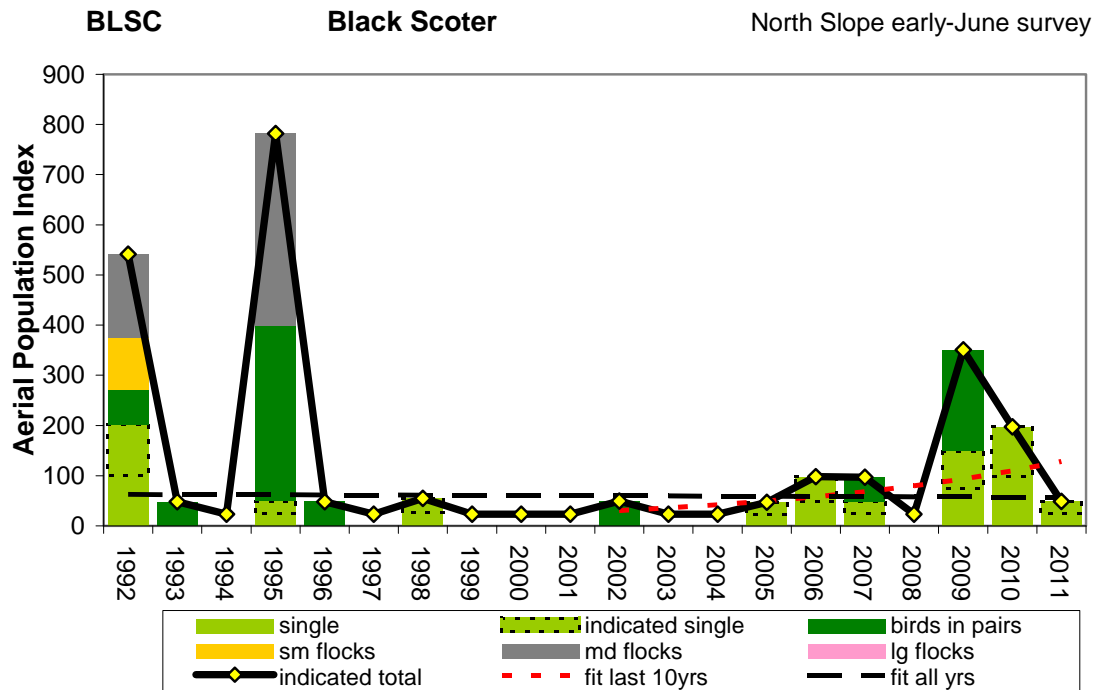


Figure 21. Population trend for king eiders (*Somateria spectabilis*) observed on aerial transects sampling 30,465 km² of wetland tundra on the North Slope of Alaska during early to mid-June, 1992-2011. The indicated total birds population index is the sum of males in groups of <5, an equal number of 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.



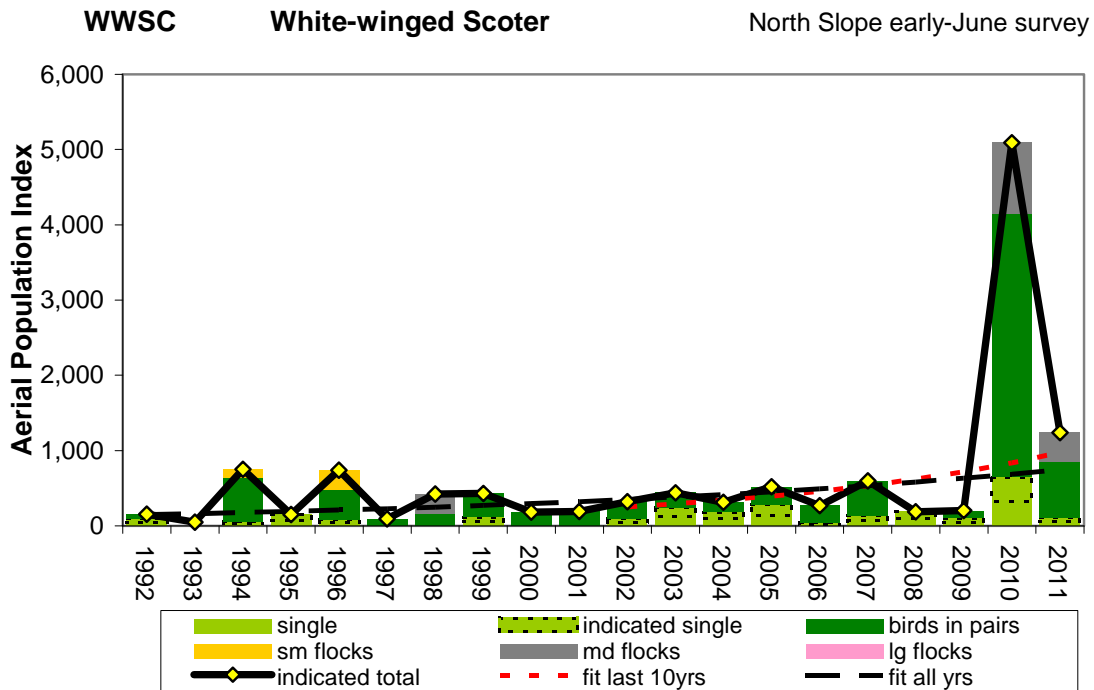
NSE 10 strata =30,465 km2								STEI	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	0	0	0	0	0	13	12	n yrs =	20
1993	48	94	118	0	0	260	147	mean pop index =	144
1994	0	47	0	0	0	47	47	std dev =	188
1995	0	327	0	0	0	326	166	std error =	42
1996	0	0	0	0	0	13	12	low 90%ci =	62
1997	0	145	0	0	0	145	112	high 90%ci =	226
1998	0	0	0	0	0	13	12	<u>trend over all years :</u>	
1999	96	527	0	168	0	791	458	In linear slope =	-0.0102
2000	0	0	0	0	0	13	12	SE slope =	0.0551
2001	95	189	0	0	0	284	206	Growth Rate =	0.990
2002	0	0	0	0	0	13	12	low 90%ci GR =	0.904
2003	93	0	0	0	0	93	93	high 90%ci GR =	1.084
2004	48	0	0	0	0	48	50	regression resid CV =	1.427
2005	47	47	0	0	0	94	64	avg sampling err CV =	0.829
2006	150	147	0	0	0	296	137	<u>trend of most recent 10 years :</u>	
2007	193	145	0	0	0	338	251	Growth Rate =	0.966
2008	25	0	0	0	0	25	23	low 90%ci GR =	0.776
2009	0	47	0	0	0	47	50	high 90%ci GR =	1.201
2010	0	0	0	0	0	13	12	<u>min yrs to detect -50%/20yr rate :</u>	
2011	0	49	0	0	0	49	49	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 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.



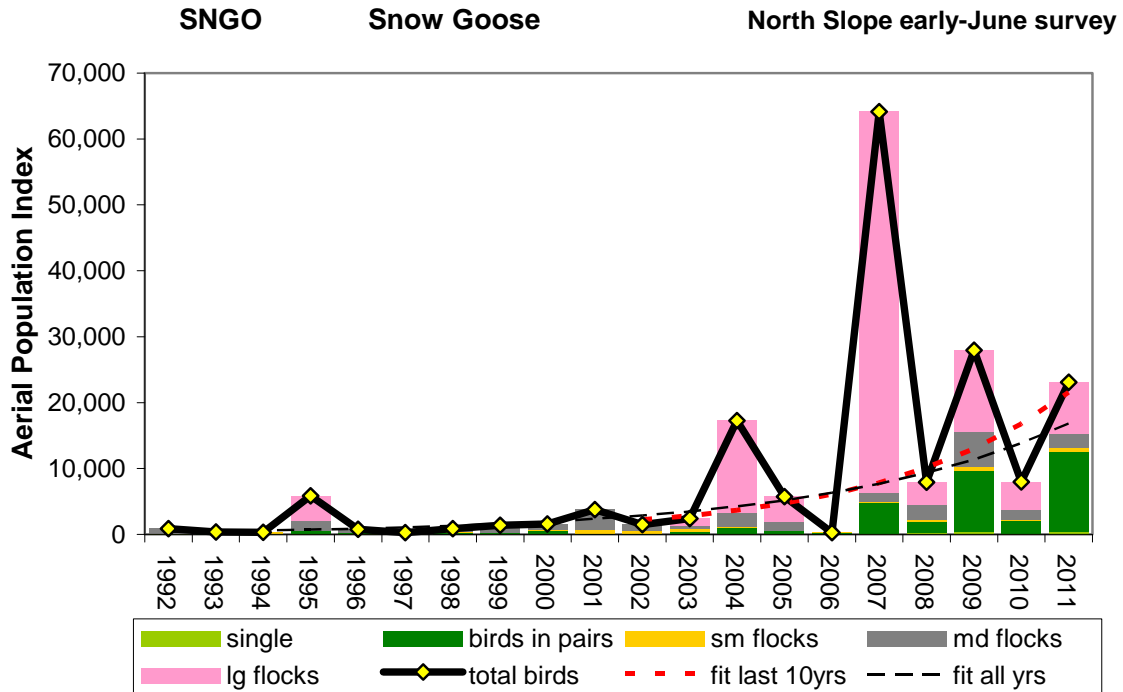
NSE 10 strata =30,465 km ²								BLSC	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	202	69	104	167	0	542	229	n yrs =	20
1993	0	48	0	0	0	48	48	mean pop index =	126
1994	0	0	0	0	0	23	24	std dev =	197
1995	49	348	0	384	0	782	541	std error =	44
1996	0	48	0	0	0	48	48	low 90%ci =	40
1997	0	0	0	0	0	23	24	high 90%ci =	213
1998	55	0	0	0	0	55	24	<u>trend over all years :</u>	
1999	0	0	0	0	0	23	24	In linear slope =	-0.0049
2000	0	0	0	0	0	23	24	SE slope =	0.0446
2001	0	0	0	0	0	23	24	Growth Rate =	0.995
2002	0	49	0	0	0	49	51	low 90%ci GR =	0.925
2003	0	0	0	0	0	23	24	high 90%ci GR =	1.071
2004	0	0	0	0	0	23	24	regression resid CV =	1.151
2005	47	0	0	0	0	47	49	avg sampling err CV =	0.862
2006	98	0	0	0	0	98	67	<u>trend of most recent 10 years :</u>	
2007	48	49	0	0	0	97	70	Growth Rate =	1.172
2008	0	0	0	0	0	23	24	low 90%ci GR =	1.006
2009	149	202	0	0	0	351	182	high 90%ci GR =	1.366
2010	197	0	0	0	0	197	114	<u>min yrs to detect -50%/20yr rate :</u>	
2011	49	0	0	0	0	49	46	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 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.



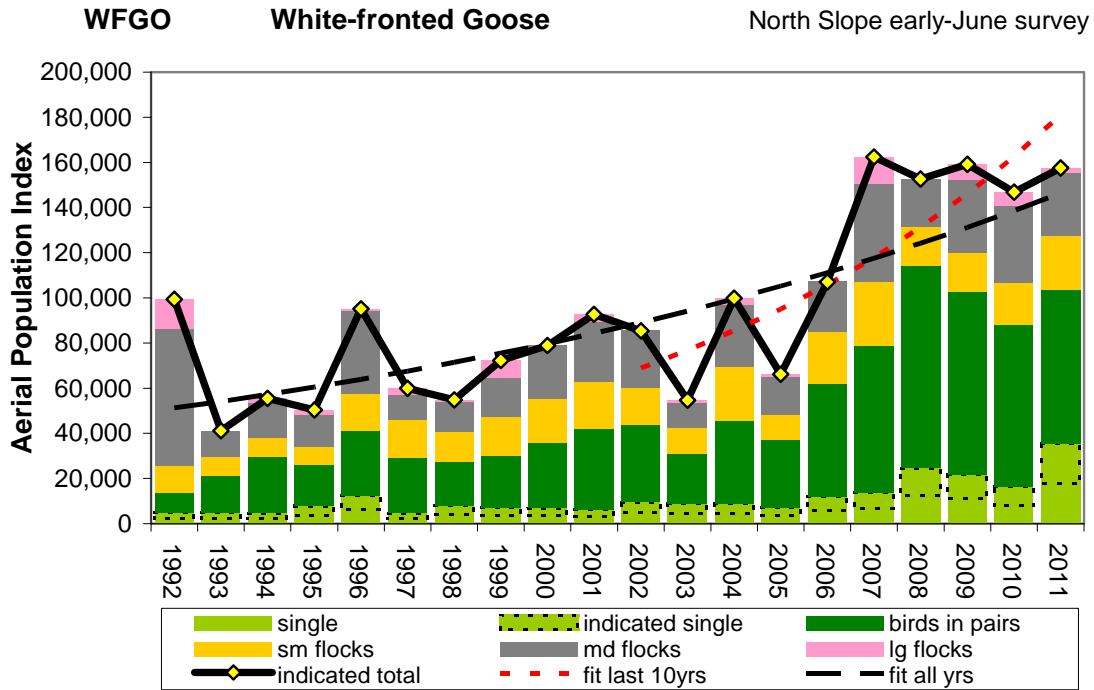
NSE 10 strata =30,465 km ²									WWSC	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total		
1992	98	55	0	0	0	153	85	n yrs =	20	
1993	0	0	0	0	0	47	29	mean pop index =	629	
1994	55	588	109	0	0	752	585	std dev =	1065	
1995	148	0	0	0	0	148	108	std error =	238	
1996	87	392	261	0	0	740	344	low 90%ci =	163	
1997	0	94	0	0	0	94	62	high 90%ci =	1096	
1998	0	160	0	261	0	421	227	trend over all years :		
1999	112	319	0	0	0	431	210	In linear slope =	0.0848	
2000	0	184	0	0	0	184	86	SE slope =	0.0347	
2001	0	191	0	0	0	191	92	Growth Rate =	1.089	
2002	94	225	0	0	0	319	232	low 90%ci GR =	1.028	
2003	242	198	0	0	0	440	294	high 90%ci GR =	1.153	
2004	185	128	0	0	0	313	212	regression resid CV =	0.897	
2005	283	235	0	0	0	519	418	avg sampling err CV =	0.570	
2006	45	225	0	0	0	269	201	trend of most recent 10 years :		
2007	132	464	0	0	0	596	58	Growth Rate =	1.163	
2008	186	0	0	0	0	186	131	low 90%ci GR =	0.982	
2009	101	101	0	0	0	201	99	high 90%ci GR =	1.377	
2010	646	3499	0	946	0	5090	835	min yrs to detect -50%/20yr rate :		
2011	111	741	0	388	0	1240	647	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 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.



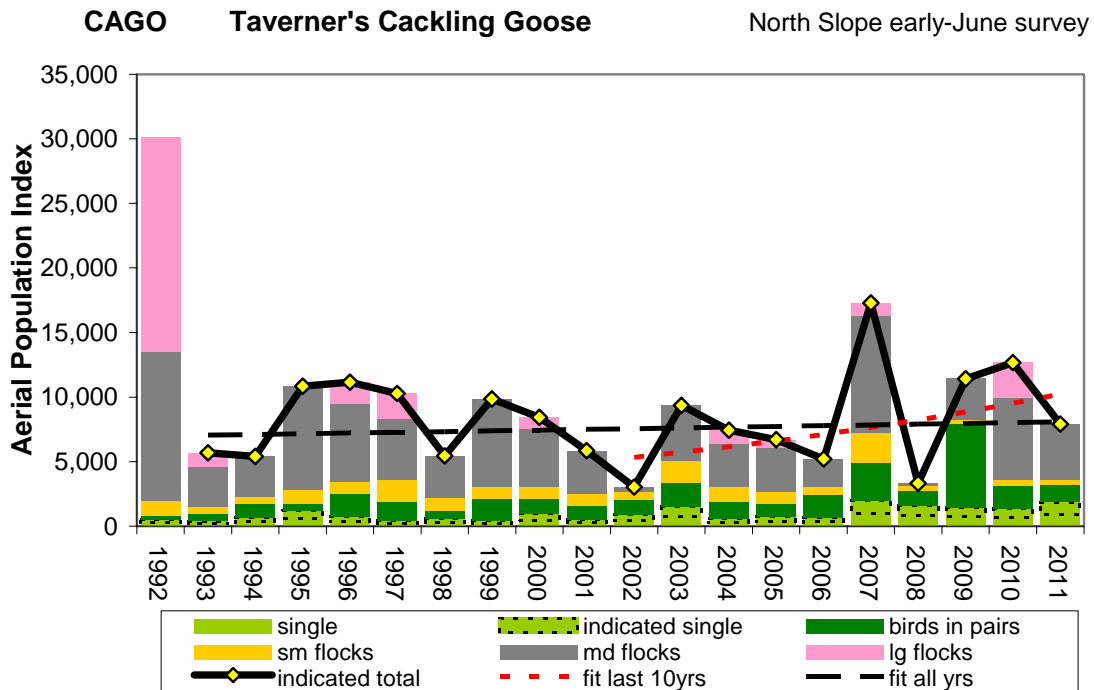
NSE 10 strata =30,465 km2									SNGO	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds		
1992	50	0	0	817	0	867	590	n yrs = 20		
1993	50	96	73	144	0	362	181	mean pop index = 8717		
1994	24	0	281	0	0	304	159	std dev = 15261		
1995	170	379	0	1531	3770	5850	5299	std error = 3412		
1996	114	111	71	497	0	793	350	low 90%ci = 2029		
1997	48	143	73	0	0	263	122	high 90%ci = 15406		
1998	47	118	181	545	0	891	553	<u>trend over all years :</u>		
1999	80	144	93	1096	0	1413	725	ln linear slope = 0.1961		
2000	45	499	168	868	0	1579	511	SE slope = 0.0469		
2001	0	206	481	3098	0	3785	2109	Growth Rate = 1.217		
2002	47	136	337	990	0	1510	697	low 90%ci GR = 1.126		
2003	0	429	396	487	1107	2419	1259	high 90%ci GR = 1.314		
2004	104	818	287	2047	14022	17277	14159	regression resid CV = 1.211		
2005	36	456	36	1385	3827	5740	3248	avg sampling err CV = 0.563		
2006	63	101	99	0	0	262	99	<u>trend of most recent 10 years :</u>		
2007	46	4736	169	1377	57784	64110	56019	Growth Rate = 1.288		
2008	246	1658	265	2305	3465	7938	3661	low 90%ci GR = 0.981		
2009	483	9089	741	5311	12302	27926	17120	high 90%ci GR = 1.691		
2010	109	2040	36	1619	4151	7955	3478	<u>min yrs to detect -50%/20yr rate :</u>		
2011	422	12164	520	2223	7767	23096	13906	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.



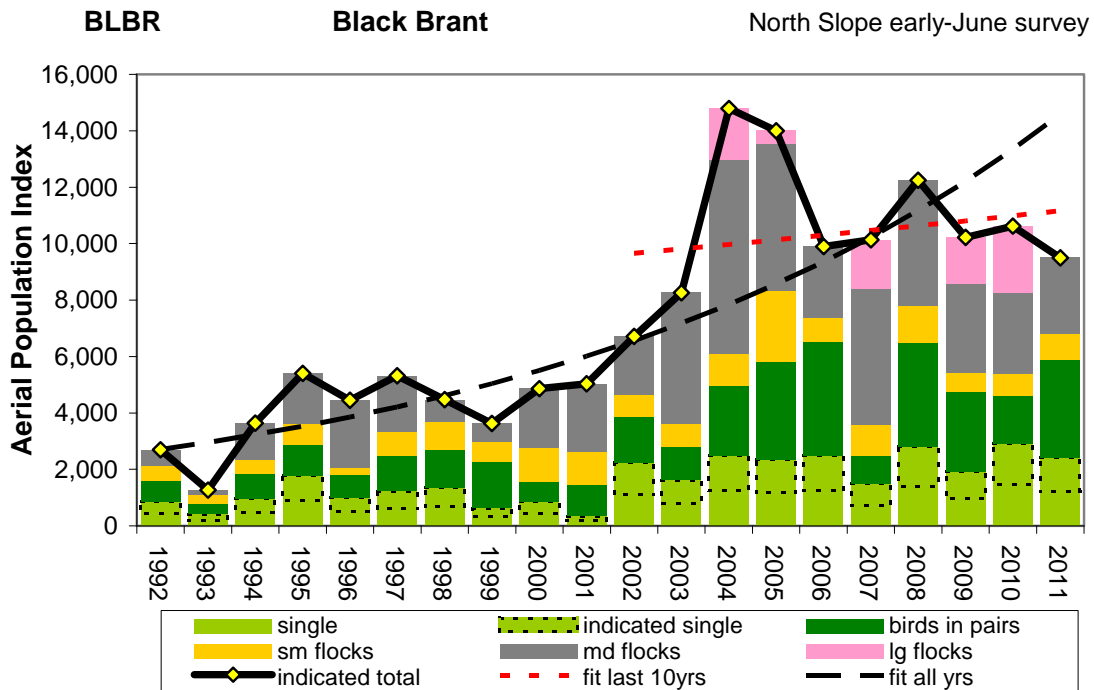
NSE 10 strata =30,465 km2								WFGO	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	4794	8915	12107	60359	13185	99361	9691	n yrs =	20
1993	4760	16232	8712	11378	0	41083	2856	mean pop index =	95546
1994	4538	24854	8764	15121	2240	55517	4494	std dev =	39876
1995	7702	18479	7962	14033	2096	50272	4464	std error =	8916
1996	12280	28850	16325	36897	773	95125	5640	low 90%ci =	78070
1997	4632	24567	16692	11212	2854	59956	4413	high 90%ci =	113022
1998	7884	19632	13290	13178	855	54839	4175	trend over all years :	
1999	7092	22928	17152	17275	7835	72283	6579	ln linear slope =	0.0553
2000	6898	29138	19078	23780	0	78895	5433	SE slope =	0.0112
2001	6108	35961	20830	26652	3081	92632	4963	Growth Rate =	1.057
2002	9522	34232	16392	25217	0	85363	6814	low 90%ci GR =	1.037
2003	8911	22116	11314	11127	1141	54609	4023	high 90%ci GR =	1.077
2004	8928	36562	24046	27344	2979	99859	7212	regression resid CV =	0.290
2005	7071	30148	10886	17160	906	66171	5033	avg sampling err CV =	0.074
2006	11929	50076	22780	22240	0	107025	8692	trend of most recent 10 years :	
2007	13673	65197	28140	43777	11654	162441	10921	Growth Rate =	1.113
2008	24665	89655	17445	20870	0	152634	10049	low 90%ci GR =	1.065
2009	21823	80567	17603	32274	6921	159188	12025	high 90%ci GR =	1.164
2010	16352	71498	18957	33884	6136	146828	11338	min yrs to detect -50%/20yr rate :	
2011	35341	68268	23777	28157	1940	157481	9406	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.



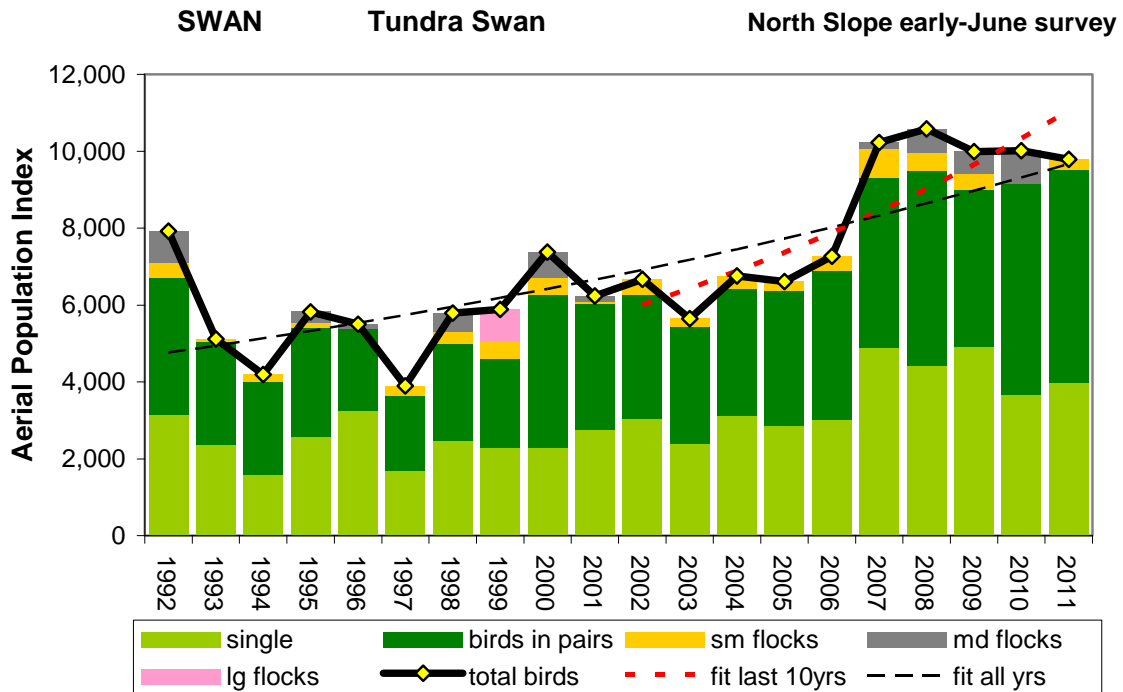
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year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	530	260	1211	11482	16621			n yrs =	19
1993	387	531	595	3111	1061	5685	2514	mean pop index =	8285
1994	666	1047	592	3099	0	5405	1389	std dev =	3455
1995	1233	534	1033	8052	0	10851	2889	std error =	793
1996	741	1754	991	5981	1678	11145	3494	low 90%ci =	6732
1997	436	1425	1721	4726	1977	10284	2911	high 90%ci =	9839
1998	559	641	1000	3240	0	5441	1221	<u>trend over all years :</u>	
1999	448	1661	912	6822	0	9843	2784	In linear slope =	0.0076
2000	960	1128	962	4454	920	8424	2810	SE slope =	0.0194
2001	527	1015	983	3327	0	5851	2327	Growth Rate =	1.008
2002	917	1151	596	362	0	3025	372	low 90%ci GR =	0.976
2003	1516	1875	1647	4312	0	9351	2192	high 90%ci GR =	1.040
2004	613	1273	1124	3396	1039	7444	1359	regression resid CV =	0.463
2005	730	1016	886	3463	602	6696	1933	avg sampling err CV =	0.254
2006	683	1706	673	2139	0	5201	1037	<u>trend of most recent 10 years :</u>	
2007	2010	2922	2312	9057	983	17285	3775	Growth Rate =	1.075
2008	1608	1134	374	187	0	3304	586	low 90%ci GR =	0.974
2009	1478	6514	224	3192	0	11408	2182	high 90%ci GR =	1.188
2010	1375	1742	500	6316	2742	12676	3213	<u>min yrs to detect -50%/20yr rate :</u>	
2011	1865	1296	467	4273	0	7902	1192	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.



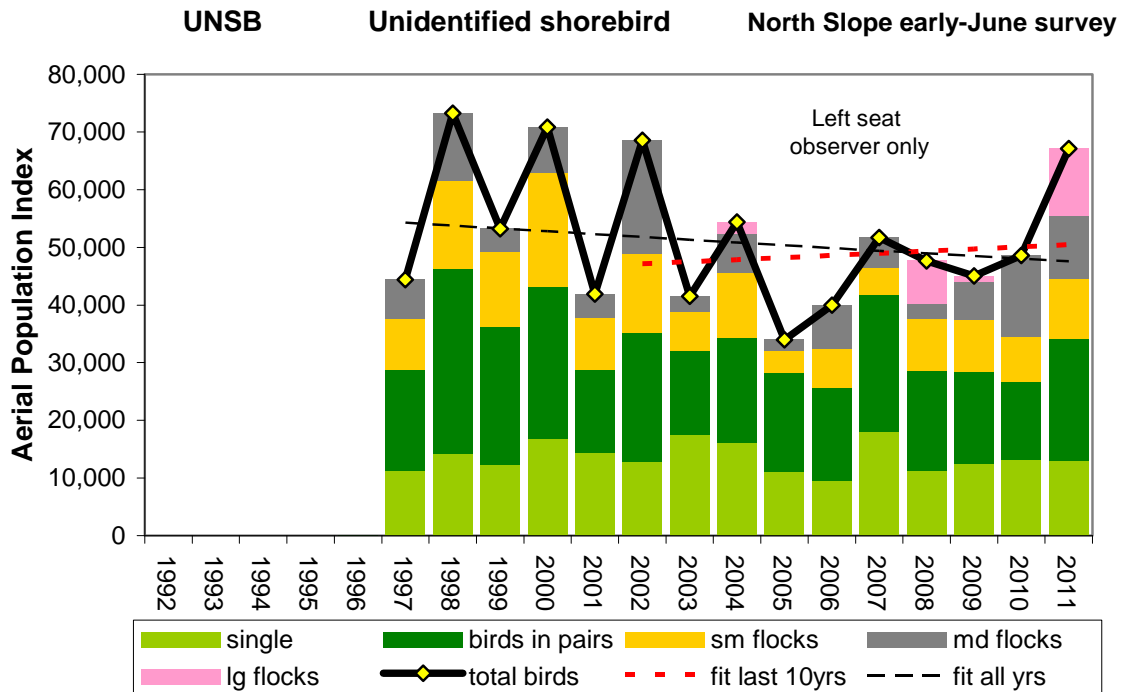
NSE 10 strata =30,465 km ²								BLBR	
year	2*sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Indicated total	
1992	844	737	566	549	0	2695	490	n yrs =	20
1993	413	376	331	141	0	1262	460	mean pop index =	7519
1994	960	893	479	1305	0	3636	888	std dev =	3847
1995	1780	1084	748	1795	0	5407	2452	std error =	860
1996	996	815	247	2387	0	4445	1439	low 90%ci =	5833
1997	1224	1264	849	1983	0	5320	1758	high 90%ci =	9205
1998	1357	1333	1015	768	0	4473	731	<u>trend over all years :</u>	
1999	633	1647	677	674	0	3630	698	In linear slope =	0.0886
2000	863	692	1217	2093	0	4864	821	SE slope =	0.0132
2001	344	1097	1198	2391	0	5030	1494	Growth Rate =	1.093
2002	2235	1628	782	2065	0	6710	1251	low 90%ci GR =	1.069
2003	1609	1208	792	4655	0	8263	2844	high 90%ci GR =	1.117
2004	2505	2476	1102	6885	1816	14783	2650	regression resid CV =	0.341
2005	2354	3467	2499	5217	457	13994	2951	avg sampling err CV =	0.250
2006	2486	4041	820	2553	0	9900	1808	<u>trend of most recent 10 years :</u>	
2007	1481	1022	1068	4841	1726	10138	1657	Growth Rate =	1.016
2008	2798	3673	1333	4443	0	12247	3140	low 90%ci GR =	0.972
2009	1912	2849	653	3150	1656	10221	2047	high 90%ci GR =	1.062
2010	2913	1713	750	2872	2368	10615	3769	<u>min yrs to detect -50%/20yr rate :</u>	
2011	2401	3496	905	2696	0	9498	1997	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.



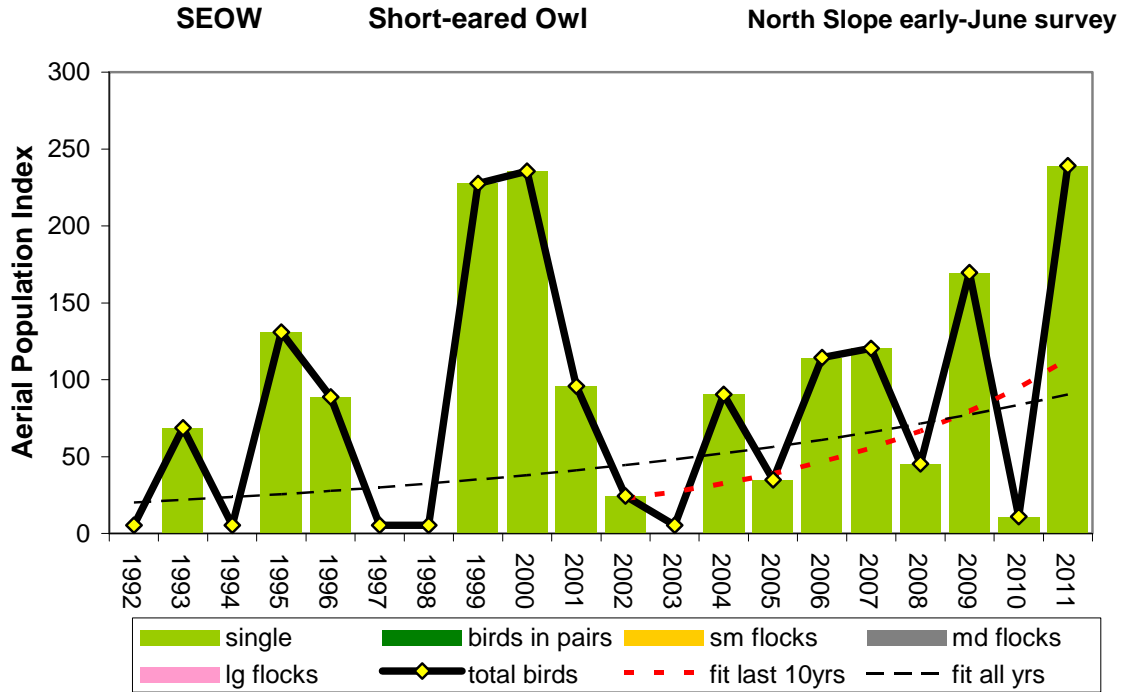
NSE 10 strata =30,465 km2								SWAN	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds	
1992	3129	3591	394	809	0	7924	1219	n yrs =	20
1993	2366	2682	72	0	0	5120	534	mean pop index =	7064
1994	1582	2429	177	0	0	4188	444	std dev =	2054
1995	2581	2826	138	280	0	5824	690	std error =	459
1996	3246	2126	0	131	0	5503	583	low 90%ci =	6164
1997	1697	1942	260	0	0	3898	504	high 90%ci =	7964
1998	2476	2525	314	473	0	5788	656	trend over all years :	
1999	2282	2317	449	0	839	5887	1029	In linear slope =	0.0372
2000	2276	3989	461	655	0	7380	1037	SE slope =	0.0076
2001	2758	3265	71	142	0	6237	645	Growth Rate =	1.038
2002	3025	3223	420	0	0	6668	758	low 90%ci GR =	1.025
2003	2381	3050	211	0	0	5641	629	high 90%ci GR =	1.051
2004	3112	3320	322	0	0	6754	529	regression resid CV =	0.196
2005	2862	3495	250	0	0	6607	566	avg sampling err CV =	0.108
2006	3024	3862	376	0	0	7262	667	trend of most recent 10 years :	
2007	4894	4414	749	174	0	10231	672	Growth Rate =	1.070
2008	4428	5073	453	622	0	10575	1126	low 90%ci GR =	1.046
2009	4923	4071	413	584	0	9991	706	high 90%ci GR =	1.095
2010	3672	5480	0	860	0	10012	1132	min yrs to detect -50%/20yr rate :	
2011	3980	5540	272	0	0	9792	670	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.



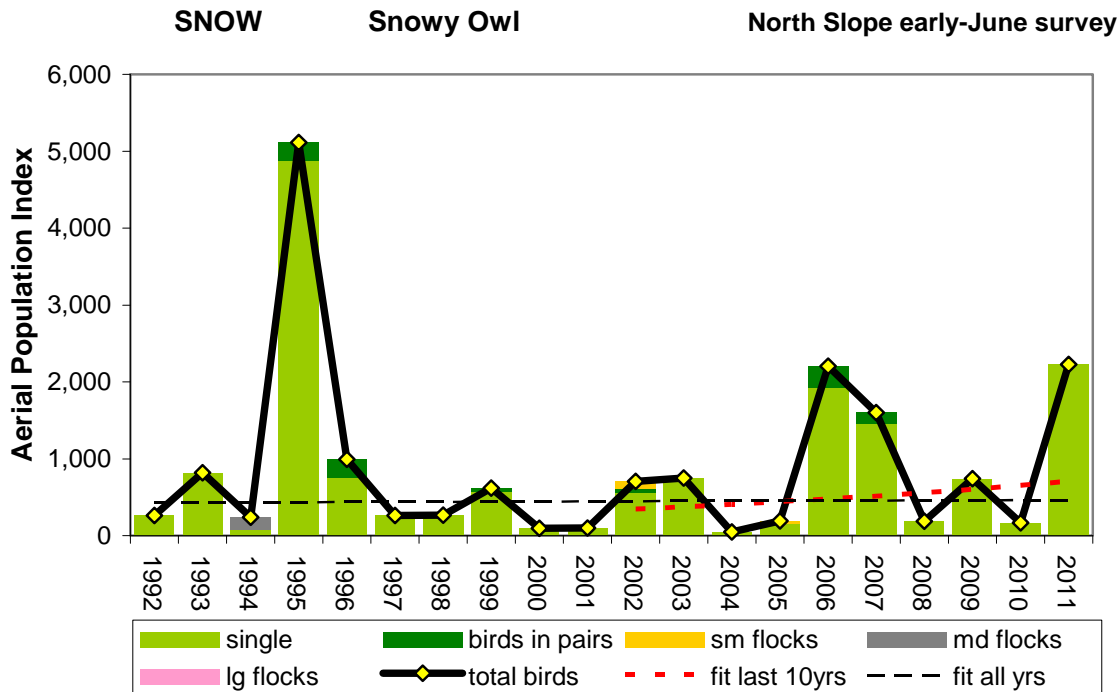
NSE 10 strata =30,465 km2								UNSB	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds	
1992	0	0	0	0	0			n yrs =	15
1993	0	0	0	0	0			mean pop index =	52141
1994	0	0	0	0	0			std dev =	12349
1995	0	0	0	0	0			std error =	3189
1996	0	97	0	0	0			low 90%ci =	45892
1997	11327	17384	8915	6748	0	44375	3022	high 90%ci =	58391
1998	14222	32064	15357	11577	0	73220	5578	trend over all years :	
1999	12348	23893	13001	3991	0	53234	4010	In linear slope =	-0.0094
2000	16769	26467	19686	7946	0	70868	6454	SE slope =	0.0142
2001	14487	14352	8932	4115	0	41885	3966	Growth Rate =	0.991
2002	12905	22261	13675	19729	0	68571	7595	low 90%ci GR =	0.968
2003	17435	14692	6634	2782	0	41543	3652	high 90%ci GR =	1.014
2004	16205	18000	11399	6856	1929	54390	5417	regression resid CV =	0.237
2005	11087	17256	3642	1981	0	33965	3410	avg sampling err CV =	0.108
2006	9550	16109	6797	7525	0	39980	6123	trend of most recent 10 years :	
2007	18098	23719	4551	5303	0	51671	3900	Growth Rate =	1.008
2008	11242	17275	9120	2524	7503	47663	8183	low 90%ci GR =	0.966
2009	12476	15889	9097	6676	883	45020	5624	high 90%ci GR =	1.051
2010	13161	13436	7899	14116	0	48613	5488	min yrs to detect -50%/20yr rate :	
2011	12999	21062	10555	10852	11652	67119	11724	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.



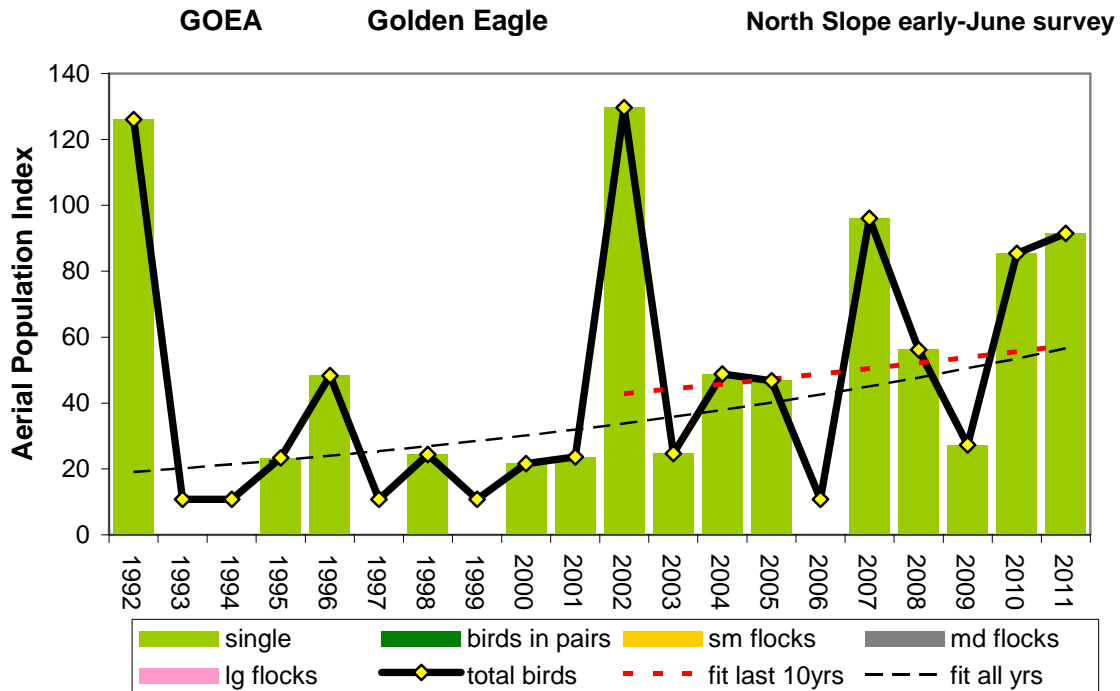
NSE 10 strata =30,465 km ²									SEOW	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	<u>Aerial index: Total birds</u>		
1992	0	0	0	0	0	5	5	n yrs =	20	
1993	69	0	0	0	0	69	39	mean pop index =	86	
1994	0	0	0	0	0	5	5	std dev =	81	
1995	131	0	0	0	0	131	56	std error =	18	
1996	89	0	0	0	0	89	44	low 90%ci =	51	
1997	0	0	0	0	0	5	5	high 90%ci =	122	
1998	0	0	0	0	0	5	5	<u>trend over all years :</u>		
1999	228	0	0	0	0	228	66	In linear slope =	0.0788	
2000	236	0	0	0	0	236	74	SE slope =	0.0542	
2001	96	0	0	0	0	96	44	Growth Rate =	1.082	
2002	24	0	0	0	0	24	24	low 90%ci GR =	0.990	
2003	0	0	0	0	0	5	5	high 90%ci GR =	1.183	
2004	91	0	0	0	0	91	29	regression resid CV =	1.402	
2005	35	0	0	0	0	35	24	avg sampling err CV =	0.596	
2006	114	0	0	0	0	114	40	<u>trend of most recent 10 years :</u>		
2007	120	0	0	0	0	120	62	Growth Rate =	1.195	
2008	45	0	0	0	0	45	18	low 90%ci GR =	0.966	
2009	170	0	0	0	0	170	69	high 90%ci GR =	1.478	
2010	11	0	0	0	0	11	10	<u>min yrs to detect -50%/20yr rate :</u>		
2011	239	0	0	0	0	239	62	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 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. 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									SNOW	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds		
1992	264	0	0	0	0	264	112	n yrs =	20	
1993	817	0	0	0	0	817	180	mean pop index =	880	
1994	80	0	0	160	0	240	158	std dev =	1194	
1995	4880	234	0	0	0	5113	780	std error =	267	
1996	759	236	0	0	0	995	227	low 90%ci =	357	
1997	265	0	0	0	0	265	94	high 90%ci =	1403	
1998	267	0	0	0	0	267	72	<u>trend over all years :</u>		
1999	570	48	0	0	0	618	155	In linear slope =	0.0037	
2000	95	0	0	0	0	95	51	SE slope =	0.0481	
2001	101	0	0	0	0	101	60	Growth Rate =	1.004	
2002	559	48	99	0	0	706	176	low 90%ci GR =	0.927	
2003	751	0	0	0	0	751	154	high 90%ci GR =	1.086	
2004	49	0	0	0	0	49	36	regression resid CV =	1.243	
2005	157	0	36	0	0	194	74	avg sampling err CV =	0.359	
2006	1927	277	0	0	0	2203	421	<u>trend of most recent 10 years :</u>		
2007	1458	144	0	0	0	1602	412	Growth Rate =	1.082	
2008	188	0	0	0	0	188	122	low 90%ci GR =	0.850	
2009	741	0	0	0	0	741	169	high 90%ci GR =	1.377	
2010	167	0	0	0	0	167	70	<u>min yrs to detect -50%/20yr rate :</u>		
2011	2226	0	0	0	0	2226	385	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								GOEA	
year	sg	2*npr	sm flk	md flk	lg flk	Index	StdErr	Aerial index: Total birds	
1992	126	0	0	0	0	126	62	n yrs =	20
1993	0	0	0	0	0	11	11	mean pop index =	46
1994	0	0	0	0	0	11	11	std dev =	39
1995	23	0	0	0	0	23	23	std error =	9
1996	48	0	0	0	0	48	34	low 90%ci =	29
1997	0	0	0	0	0	11	11	high 90%ci =	63
1998	24	0	0	0	0	24	24	<u>trend over all years :</u>	
1999	0	0	0	0	0	11	11	In linear slope =	0.0572
2000	22	0	0	0	0	22	21	SE slope =	0.0318
2001	24	0	0	0	0	24	30	Growth Rate =	1.059
2002	130	0	0	0	0	130	63	low 90%ci GR =	1.005
2003	25	0	0	0	0	25	22	high 90%ci GR =	1.116
2004	49	0	0	0	0	49	33	regression resid CV =	0.822
2005	47	0	0	0	0	47	48	avg sampling err CV =	0.815
2006	0	0	0	0	0	11	11	<u>trend of most recent 10 years :</u>	
2007	96	0	0	0	0	96	38	Growth Rate =	1.033
2008	56	0	0	0	0	56	23	low 90%ci GR =	0.894
2009	27	0	0	0	0	27	23	high 90%ci GR =	1.194
2010	85	0	0	0	0	85	38	<u>min yrs to detect -50%/20yr rate :</u>	
2011	92	0	0	0	0	92	70	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
<u>Loons:</u> (Family <i>Gaviidae</i>)	
Yellow-billed loon	<i>Gavia adamsii</i>
Pacific loon	<i>G. pacifica</i>
Red-throated loon	<i>G. stellata</i>
<u>Gulls, terns, jaegers:</u> (Family <i>Laridae</i>)	
Glaucous gull	<i>Larus glaucescens</i>
Sabine's gull	<i>Xema sabini</i>
Arctic tern	<i>Sterna paradisaea</i>
Long-tailed jaegers	<i>Stercorarius longicaudus</i>
Parasitic jaeger	<i>S. parasiticus</i>
Pomarine jaeger	<i>S. pomarinus</i>
<u>Ducks, geese, swans:</u> (Family <i>Anatidae</i>)	
Red-breasted merganser	<i>Mergus serrator</i>
Mallard	<i>Anas platyrhynchos</i>
American wigeon	<i>A. americana</i>
Am. Green-winged teal	<i>A. crecca</i>
Northern pintail	<i>A. acuta</i>
Northern shoveler	<i>A. clypeata</i>
Greater scaup	<i>Aythya marila</i> ,
Lesser scaup	<i>A. affinis</i>
Long-tailed duck	<i>Clangula hyemalis</i>
Spectacled eider	<i>Somateria fischeri</i>
Common eider	<i>S. mollissima</i>
King eider	<i>S. spectabilis</i>
Steller's eider	<i>Polysticta stelleri</i>
Black scoter	<i>Melanitta nigra</i>
White-winged scoter	<i>M. fusca</i>
Snow goose	<i>Chen caerulescens</i>
Taverner's Canada goose	<i>Branta hutchinsii taverneri</i>
Black brant	<i>B. bernicla</i>
Greater white-fronted goose	<i>Anser albifrons</i>
Tundra swan	<i>Cygnus columbianus</i>
<u>Shorebirds:</u> (Families <i>Scolopacidae</i> , <i>Charadriidae</i>)	
	<i>Charadrius spp.</i> , <i>Pluvialis spp.</i> , <i>Calidris spp.</i> , <i>Arenaria spp.</i> , <i>Numenius spp.</i> , <i>Limnodromus sp</i>
<u>Cranes:</u> (Family <i>Gruidae</i>)	
Sandhill crane	<i>Grus canadensis</i>
<u>Ravens:</u> (Family <i>Corvidae</i>)	
Common raven	<i>Corvus corax</i>
<u>Owls:</u> (Family <i>Strigidae</i>)	
Short-eared owl	<i>Asio flammeus</i>
Snowy owl	<i>Bubo scandiacus</i>
<u>Eagles:</u> (Family <i>Accipitridae</i>)	
Golden eagle	<i>Haliaeetus chrysaetos</i>