

Abundance and Trend of Waterbirds on Alaska's Yukon-Kuskokwim Delta Coast based on 1988 to 2005 Aerial Surveys



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Abundance and Trend of Waterbirds on Alaska's Yukon-Kuskokwim Delta Coast based on 1988 to 2005 Aerial Surveys

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Abstract: We summarized eighteen years of aerial survey observations 1988 to 2005 that indexed abundance, trend, and distribution of waterbird nesting populations in the Yukon-Kuskokwim delta coastal zone. In 2005, the three most numerous waterfowl species were northern pintails (*Anas acuta*) with a visibility corrected estimate of 129,198 birds, greater scaup (*Aythya marila*) with 83,075, and northern shovelers (*Anas clypeata*) at 38,829 birds. Other waterfowl species in decreasing order of abundance were mallard (*Anas platyrhynchos*), American green-winged teal (*Anas crecca*), black scoter (*Melanitta nigra*), spectacled eider (*Somateria fischeri*), long-tailed duck (*Clangula hyemalis*), American wigeon (*Anas americana*), common eider (*Somateria mollissima*), red-breasted merganser (*Mergus serrator*), and canvasback (*Aythya valisineria*). The estimated population sizes for species of special concern were 14,929 birds for the threatened spectacled eider, 12,119 long-tailed duck, 15,766 black scoter, and 3,462 red-throated loon (*Gavia stellata*). The 2005 estimates were above the 1988-2004 long-term average (LTA) population size for most waterfowl species including spectacled eider (+70% above LTA), mallard (+69%), common eider (+59%), black scoter (+33%), greater scaup (+18%), shoveler (+4%), and long-tailed duck (+1%). Species below the long-term average were wigeon (-58%), pintails (-16%), and green-winged teal (-3%). Of the gull species in 2005, Sabine's gulls (*Xema sabini*) were most numerous with an estimated 25,061 birds (40% above LTA) followed by 24,694 (-65%) glaucous gulls (*Larus hyperboreus*), and 13,262 (+10%) mew gulls (*Larus canus*). The estimated population size for Arctic terns (*Sterna paradisaea*) was 21,121 (+14%). Pacific loons (*Gavia pacifica*) were estimated at 16,052 birds (-4%).

Population trends based on log-linear regression showed significant decline ($p < 0.10$) only for American wigeon. Significant increase occurred for spectacled eider, common eider, greater scaup, long-tailed duck, red-breasted merganser, Pacific loon, mew gull, Sabine's gull, and arctic tern. Change in survey timing can contribute to trend in the population index as illustrated by our previous analysis of spectacled eider numbers. With survey timing included as a second variable, the indicated annual population growth rate for spectacled eiders was 1.01, much lower than the uncorrected trend of 1.065.

Seasonal chronology of snowmelt revealed by satellite data and mean May temperatures were examined to document spring phenology relative to survey timing. In 2005, the coastal zone became snow-free around the third week of May indicating early spring, but this was later than the earliest snow-melt of 2004.

We continued to compile individual geographic locations for sightings of 23 species of waterbirds and now have over 95,000 locations in a geographic information system useful for research and management.

Key words: aerial survey, Alaska, geographic information system, GIS, population index, *Somateria fischeri*, spectacled eider, trend, waterbird, waterfowl, Yukon-Kuskokwim delta.

Annual aerial survey observations on the Yukon-Kuskokwim delta (YKD) coastal zone in western Alaska provide population indices, trend, and distribution data for many species of breeding waterbirds that are used by the Pacific Flyway Council, the Alaska Migratory Bird Co-management Council, USFWS refuge managers, and other biologists. This intensive aerial survey was initiated in 1985 to monitor populations of geese that had shown substantial declines in fall population counts in California. The initial YKD surveys were flown with a pilot/observer in the left front seat and an additional observer in the right front seat, each counting geese, swans, and cranes (Eldridge 2003). Data on these species are reported in July each year in the Pacific Flyway Data Book (USFWS, Portland, Oregon).

In 1988, an additional observer in the right rear seat began to monitor populations of other waterbird species. The high density of geese of the YKD made it too difficult for front seat observers to also observe and record all species. The objective for the back seat observer was to document the relative abundance, trend, and distribution of ducks, loons, grebes, gulls, terns, and jaegers. These survey data have become a primary source to monitor the threatened population of spectacled eider and other species of concern such as the red-throated loon, black scoter, and long-tailed duck. The objective in this report is to summarize the population indices and trends for all species recorded from 1988 to 2005 by the rear seat observer.

METHODS

Survey Design

The survey area included the coastal tundra from Norton Sound in the north to Kuskokwim Bay in the south, extending from the west coast to about 50 km inland, and encompassing 12,832 km². This area was divided into 18 strata by identifying areas of generally homogeneous physiographic features from an unclassified LANDSAT image mosaic at 1:250,000 scale (Fig. 1). We used a custom TrueBASIC program and ARC/INFO[®] (Environmental Systems Research Institute, Inc., Redlands, California) geographic information system (GIS) software to generate systematic transects from a random coordinate within the survey area. Transects were oriented east west along great circle routes. Annual flights totaled about 2,500 linear km on roughly 100 transects (Fig. 1) with an observed sample area of about 500 km². The survey design has changed slightly over the years in the number and placement of transects. Strata known to have higher numbers of waterfowl were allocated more transects. Prior to 1998, we used 1.61 km transect spacing in the higher density areas, and in strata with fewer waterfowl, intervals of 3.22, 6.44, or 12.88 km. Since 1998, transects have been spaced at 1.60, 3.20, 6.40, or 12.80 km within the various strata, and we designed a 4-year rotating panel of transect coverage. A different set of transects was flown in each year, 1998-2001, such that we obtained complete coverage of the habitat at the 1.60 km interval after combining adjacent transects from four years. In 2002, we began a second replicate of each set of transects by flying the same lines as in 1998. In 2005, we flew the same transects as in 2001, and completed the second 4-year rotation.

Data Collection

Survey methods followed the standard protocol established for waterfowl breeding ground surveys in North America (USFWS and CWS 1987). We generally flew the surveys within the first 2 weeks of June to coincide with egg-laying or early incubation stages for breeding waterfowl, although prior to 1993, surveys extended for a longer period and nesting was

late in some years (Fig. 2). A Cessna 206 amphibious aircraft was flown at 145-170 km per hour, 30-46 m of altitude, with wind speed <24 km per hour, ceilings >152 m, and visibility >16 km. The pilot used a LORAN (1985-1991) or global positioning system (GPS, 1992-2005) and reference to topographic maps to maintain a precise course while flying transects.

Data collection prior to 1998 used voice recording of observations to a cassette tape recorder running continuously while on transect (Butler et al. 1995). Since 1998, the observer used a computerized data collection program called GPS Voice Survey written by John Hodges (USFWS, Migratory Bird Management, Juneau, Alaska). This system consisted of a notebook computer connected with the aircraft's GPS receiver, a remote microphone, and mouse. The observer voice records each transect number, start and stop point, cardinal direction of the transect start, and every bird observed within the 200 m wide strip to the right side of the aircraft into a *.WAV sound file using the remote computer microphone and mouse click. The observer identified birds to species and recorded single, pair, or number of birds in flocks. Simultaneously, at the mouse click for each observation, the latitude/longitude coordinates were automatically downloaded from the aircraft GPS to a computer file. We then used a computer transcription program to replay the sound files, enter header information (e.g. year, month, day, observer initials, etc.), enter species and group size, and combine these with the geographic coordinates to produce a final data file. Leslie Slater was the observer in 1988, Karen Bollinger observed in 1989 and 1990, and Bob Platte has collected the data every year since 1991.

We have eighteen years (1988 to 2005) of counts on ducks but data on other waterbird species were not complete for all years. Jaegers were recorded in 1989, then 1993 to 2005. We began counting loons in 1989, and gulls and terns in 1992. The back seat observer was unable to collect data on 13 transects north of the Askinuk Mountains in 1997, therefore we duplicated the data from the 1996 survey for those transects to include in the 1997 data set to make up for the missing transects. Twenty-three transects were not flown in 1999, and population indices were calculated with fewer transects in some strata. Because the survey was generally flown without covering every adjacent transect in sequence (e.g. some transects were skipped early in the survey and flown later to geographically spread the survey effort over time), the transects that were flown still sampled each stratum at reasonably systematical intervals. In 2001, the back seat observer was unable to fly 13 transects in the central coastal zone and 23 transects north of the Askinuk Mountains. For the missing northern transects, William Eldridge, the right front seat observer, was able to record observations for all species because of the relatively low density of geese, swans, and cranes north of the Askinuk Mountains. In 2003, eleven transects north of the Askinuk Mountains had no data due to a microphone malfunction. In 2004, two short transects in the Scammon Coast stratum and one transect crossing the South Yukon and North Yukon strata were skipped due to wind. All transects were flown in 2005 and a complete data set was obtained.

The relative timing of snowmelt was determined by examination of sequential 8-day mosaics of snow extent reported by Terra satellite MODIS data with a 500 m grid cell resolution. Mean temperature and total snowfall data was available from the National Weather Service station in Bethel.

Data Analysis

We calculated densities, population indices, and variability for each species using a ratio estimate (Cochran 1977). Duck population indices were based on indicated total birds: $2 * (S + P) + F$, where S = number of single birds observed, P = number of pairs observed, and F =

number of birds in flocks. A flock was defined as 5 or more ducks occurring together. A single male duck was assumed to represent a breeding pair because the nesting hen was usually not observable, and therefore a single male duck was doubled for all observed species except scaup. Scaup tend to have an unbalanced sex ratio with an excess of males in the population, therefore a single male scaup does not reliably indicate an unseen female. We did not double single birds for other waterbird species such as grebes, loons, terns, and gulls where the sexes are not obviously dimorphic and their population indices only included total birds observed. Within each stratum, the sum of indicated total or observed total birds divided by the sum of sampled transect area estimated the average density. The variance of density was based on the variability among sampling units (transect sections) within each stratum. Density multiplied by stratum area calculated the population index. The sum of the population indices and sum of the variances for each of the 18 strata provided the total population index and variance for each year. For most species, the stratified analysis reduced the variance of the total population index in comparison to analysis using only the minimum four sampling intensity strata.

We plotted the species population index for each year as a column shaded to indicate single, pair, and flock components (Figs. 5 thru 24). The range shown with a vertical line indicated the 95% confidence interval (1.96 times the standard error) of the indicated total or total observed index. The standard error of the sample divided by its mean estimated the coefficient of variation (CV) of the annual population index. The average across all annual CVs provided a measure of average survey precision, the sampling error CV.

Log-linear least squares regression determined the average slope of annual population indices across years. Following exponentiation, the log-linear slope is the rate of annual change or the growth rate. Annual % change is the $(\text{growth rate} - 1) * 100$. The residuals around the log-linear regression provided another estimate of survey precision. The estimated standard error of growth rate is the residual mean square error from log-linear regression multiplied by the growth rate. The residual CV, that included both regression model lack-of-fit error and sampling error, was usually larger than the estimated sampling error CV. We calculated a standardized measure of the relative precision of the aerial survey for each species using the approximate formula of Gerrodette (1987) that links the sample size, slope, CV, and probabilities for Type 1 and Type 2 errors. With alpha set at 0.10 and beta at 0.20, assuming a population growth with a slope of 0.0341 (50% change over 20 years), and using the observed average sampling error CV, the minimum years to detect a slope significantly different from zero was calculated for each species.

Timing of snowmelt and temperature can affect the breeding chronology of waterfowl (Batt et al. 1992). This variation, possibly in combination with differences in survey timing, may have an influence on population indices. The number of Spectacled eiders observed on the YKD aerial survey is strongly influenced by the survey timing relative to nest chronology because male eiders depart to marine habitat as females begin incubation. In this report, we included the observed population indices and data on survey timing and nesting chronology, but a full analysis remains necessary to account for correlation between the two and the potential bias in the trend. When completed, this will be reported separately.

Similarly, any change in detection rate may introduce bias in the trend of observed population indices. From 1995 to 2002, the right-front seat, as well as the right-rear seat observer, recorded Spectacled and Common eiders, and using this independent double-count data, we calculated annual spectacled eider detection rates.

RESULTS

Survey conditions

The 2005 survey was flown from June 1 – 8 (Fig. 2). The average May 2005 temperature in Bethel (about 140km east of survey area) was 46.2° F, one of the warmest in the history of the survey (Fig. 3). Weather conditions varied among days of the 2005 survey but they were within the normal range and not expected to affect results.

Spring phenology in 2005 was relatively early although later than the very early conditions of 2004. The progression of snowmelt (Fig. 4) showed the coastal zone became snow-free around the third week of May. With 5 years of MODIS satellite data on snow melt, the time when the coastal zone became snow-free has varied by as much as about 4 weeks. In 2000 and 2001, the coastal zone was snow free by around the last week of May. Snow in the survey area had melted around the third week of May in 2002 and 2005. Early snowmelt occurred in 2003 by the second week of May and in 2004 by the first week of May.

Relative abundance

Number of birds sighted on each sampled transect and the sampling effort in each strata provided the data to calculate the aerial population indices expanded to the entire survey area, and the visibility-corrected population estimates for 2005 (Table 1). To convert the aerial index to estimated populations, we used the standard visibility correction factors determined by the ratio of helicopter to fixed-wing aircraft observations for tundra Alaska species (Conant et al. 2000). Pintails (129,198 birds), scaup (83,075), and shovelers (38,829) were the most numerous waterfowl species in 2005. Pintails were 11% below the 2004 estimate and 16% below the LTA (Table 2). In contrast, greater scaup were 5% higher than 2004 and 18% higher than the LTA. Shoveler numbers were similar to 2004 and the LTA. The Spectacled eider population with 14,292 birds was the highest estimate for the history of the survey. This species index showed the largest percent change, an increase of 70% from the LTA, as well as a 53% increase above 2004. Mallards, common eiders, and black scoters also showed increased numbers from 2004 and the LTA. Long-tailed ducks were 9% above the 2004 estimate but unchanged from the LTA. Red-throated loons were around 30% above both the 2004 estimate and the LTA.

The aerial population indices, with no correction for visibility bias, showed the relative abundance by group size category for all survey years (Figs. 5 thru 24). Cautious interpretation is necessary for those species with relatively low numbers of sightings that can fluctuate greatly in estimated population size. For example with two species in 2004, an observation of a single flock of 50 birds for each species, that was expanded to 3942 birds, greatly influenced the canvasback and red-breasted merganser population indices and trends.

Population trend

American wigeon showed a consistent strong decreasing trend (Fig. 13 and Table 3). Significantly increasing trends occurred for greater scaup, spectacled eiders, long-tailed ducks, common eiders, Pacific loons, mew gulls, Sabine's gulls, and arctic terns. The rest of the species showed relatively stable trends over the survey period. We calculated the most recent 7-year trends for all species as well. Mallards, scaup, red-throated loons, mew gulls, Sabine's gulls and arctic terns showed significantly increasing trends during the last 7 years. Only Pacific loons showed a significantly decreasing trend.

Spectacled eider population and trend

The number of indicated total spectacled eiders from the aerial survey in 2005 was 4,170 birds or 2,085 pairs, uncorrected for visibility bias. The spectacled eider nest estimate for the entire coastal zone based on the ground plot sample in 2005 was 4,541 (Fischer et al. 2005). Corrected with a nest detection rate of 78% (T. Bowman, unpubl. data), the nest population estimate was 5,822. The ratio of aerial pairs to nests was 0.36 ($=2085/5822$), or stated as the inverse, 2.79 nests were estimated for each pair of spectacled eiders seen by aerial observations. Spectacled eider nesting phenology in 2005 was about a week earlier than the long-term ground plot average (Fischer et al. 2005). The population growth rate from 1988 to 2005 for aerial indicated total bird index was 1.065 (Fig. 11). The growth rate from the nest populations estimated from ground studies during this same period was 0.999. When the aerial survey indices were adjusted for changes in survey timing, the aerial index population trend was reduced to 1.01. Similarly, when trend was calculated from only the last 7 years of data, a period with consistent survey timing, the annual growth rate averaged 1.016 (Fig. 11).

Distribution

The geographic locations of over 95,000 sightings of 23 species of waterbirds have been collected over the 18 years of this survey. These spatial data have been incorporated into a GIS database for research and management purposes. Average location accuracy of the observations when the surveys were flown using LORAN for navigation was within 367 meters along transect compared to 214 meters when using the GPS (Butler et al. 1995). Locations from GPS in recent years are expected to be more accurate. Density polygons estimating spectacled eider relative density distribution were created for 3 time periods (Fig. 26.) and these show virtually no change in the distribution of this species over the history of the survey.

DISCUSSION

Three different observers have collected data for this survey, although the same observer has collected the last 15 years data. All observers were experienced at identifying and counting birds from aircraft, however especially for the less common species, a "learning curve" effect is possible during the first 2 or 3 years for each observer and the first 5 years in this data set. Observers become more skilled over time resulting in increasingly more reliable information. As observers gain experience with a specific survey, we expect that improvements were possible in several aspects of aerial observations. First, accuracy of species identification improves with development of "search images" for each species seen in various distance, light, behavior, and habitat conditions. Second, skill in counting large flocks increases. Third, complete coverage of a 200 m strip width becomes less variable, both within a survey and between years, even though survey flights did include some training by flying over known-width marks or checking sight angles with an inclinometer. Fourth, with more practice, observers improve in their ability to quickly detect, identify, and record each observation and then mentally switch back to all possible search images over the full width of the transect. It is possible that less-experienced observers contributed relatively lower counts in the first years of this survey. Because a single observer completed the last 15 years of survey, the magnitude of possible bias in long-term trends becomes very small.

Some variation in detection rate occurs each day due to weather conditions, with higher wind speed and bright sun causing glare likely to be the most detrimental factors. The average of

all conditions experienced over the 8-day survey is much less variable among years than are the day-to-day changes. We assumed no long-term trend in detection rate. Preliminary analysis of 8 years of double-count data where the front-seat observer independently recorded spectacled eiders showed little variation and no significant trend in the detection rate for the rear-seat observer (Platte, Eldridge, and Stehn, unpubl. data). The average detection rate for the right-rear seat observer was 67.8%. A non-significant increase of 1.6% per year was noted, however based on this preliminary analysis, the small magnitude of change in detection rate strengthens the validity of the observed trend index for eiders and probably other species.

Seasonal timing of surveys was also a factor potentially affecting the number of observations and the trend. Behavior and the visibility of many species changes with the stage of incubation; therefore, to get the best trend information, the surveys should be timed consistently relative to nesting chronology. Different stages of nesting may correlate with changes in the flocking behavior, single:pair ratio, or tendency to flush from the aircraft. The intended survey timing was to fall within the first half of incubation for the average of nesting geese. Although the date of earliest nests found were available from field camp observations, when we begin the aerial survey we do not know the degree of nesting synchrony and the average date of nest initiation, and we cannot always time our survey optimally. Weather, pilot flight hours, and aircraft mechanical problems can also have an influence. For most species both birds of a nesting pair remain in the nesting area, but for spectacled eiders, the much more visible males begin their departure from the breeding grounds shortly after the hens begin incubation, and depending on timing, the survey can miss a variable proportion of the males. If the survey timing were late relative to phenology, a greater proportion of spectacled eider males would have departed which results in a lower population index in that year (Platte et al. 1999). The discrepancy between population trends shown by the population of nests as measured by ground sampling (Fischer et al. 2004) and the trend of aerial population indices was analyzed more fully in 2004. Increased aerial counts were strongly correlated with a change to slightly earlier average survey timing beginning in 1998. When survey date was added as a second explanatory variable in log-linear regression, the average growth rate changed from 1.065 to 1.01 and there was no significant difference in trends between the aerial and ground data (Platte and Stehn, unpublished data).

The number of spectacled eider pairs observed during the aerial survey in 2001 was the highest in the history of the survey. This may have been caused by increased visibility of the birds due to high fox predation on nests and/or late nesting chronology. Predation was also high in 2003 but the nest initiation was relatively early. Predation may account for relatively higher numbers of pairs of spectacled eiders observed in 2003. Spring chronology and nesting was very early in 2004, however the survey was flown 1-7 June relatively closer to average timing, and that may have caused the index to be lower. In 2005, the survey was flown earlier relative to average hatch date that may have contributed to the larger population index for eiders. We plan to examine the complex relationship among survey timing, spring phenology, breeding chronology, and the number of spectacled eiders observed. This analysis will be reported at a future date.

The geographic locations of birds collected over the 18 years of this survey have been used for a number of purposes. Distribution information was included in evaluation of YKD coastal zone areas for inclusion as designated critical habitat for spectacled eiders. Relative density distribution maps help illustrate and evaluate impacts of potential land ownership exchange on waterbirds. Survey information was incorporated into the Birds of North America

species account for Sabine's gulls. Loon information has contributed to the Loon Working Group for baseline monitoring and in plans for red-throated loon sampling. Population trends were used to compare with other information in a review of seaduck population status.

The survey was designed to monitor geese, however because the distribution of Cackling geese (*Branta hutchinsii*) largely coincided with that of the spectacled eider, the survey also was appropriate for monitoring spectacled eiders. For species such as scoter and scaup with relatively higher numbers farther inland, where the sampling is less intense, the allocation of sampling effort is not optimal.

RECOMMENDATIONS

Currently there are two survey efforts to monitor the spectacled eider population on the Yukon Delta, the coastal zone aerial survey and the ground plot sampling for nests. Because it is impractical for the nest plot survey to sample the entire coast, it is necessary to continue the aerial survey to gather data necessary to expand the nest population to the entire YKD coast. We believe these two surveys are highly complementary. Together they provide a unique combination of detailed information at two scales of geographic extent and intensity of coverage. Both are better than either one alone for monitoring the spectacled eider population.

The aerial survey also provides information on many other species of interest, although interpretation must be qualified if a significant part of the range of those species extends beyond the coastal zone. Long-tailed ducks, scoters, and scaup are abundant in the more inland strata that were not sampled as intensively, and even further inland, not sampled at all. For better information on these species, we could allocate more effort in this area. We should consider expanding coverage and adding transects in inland areas to obtain better information on seaducks. Because the survey aircraft is flown from Bethel, much of this area must be traversed anyway, just to reach the coast. With the considerable change in populations of some geese since the late 1980s, a re-examination of the allocation of sampling effort might reveal that a moderate decrease in the number of transects in the high-intensity strata may result in a minimal decrease in precision for geese and eiders.

We have begun to collect information on temperature and snowmelt for the survey area. Future analyses will focus on examining relationships among spring chronology, nesting chronology, survey timing, numbers of birds observed, and waterfowl population dynamics.

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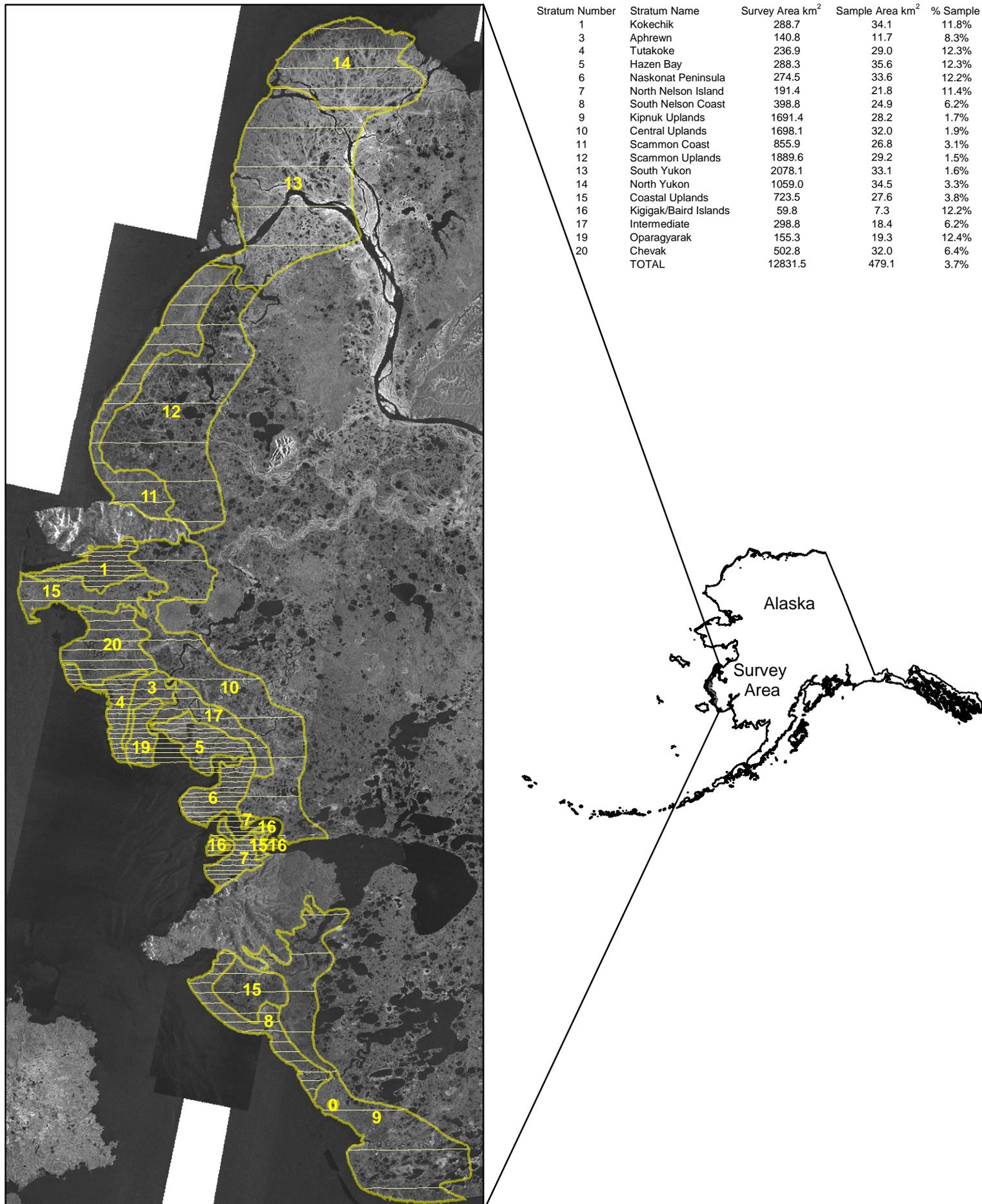


Fig. 1. Flightlines and strata for aerial waterbird survey, June 2005, Yukon Delta coastal zone, Alaska.

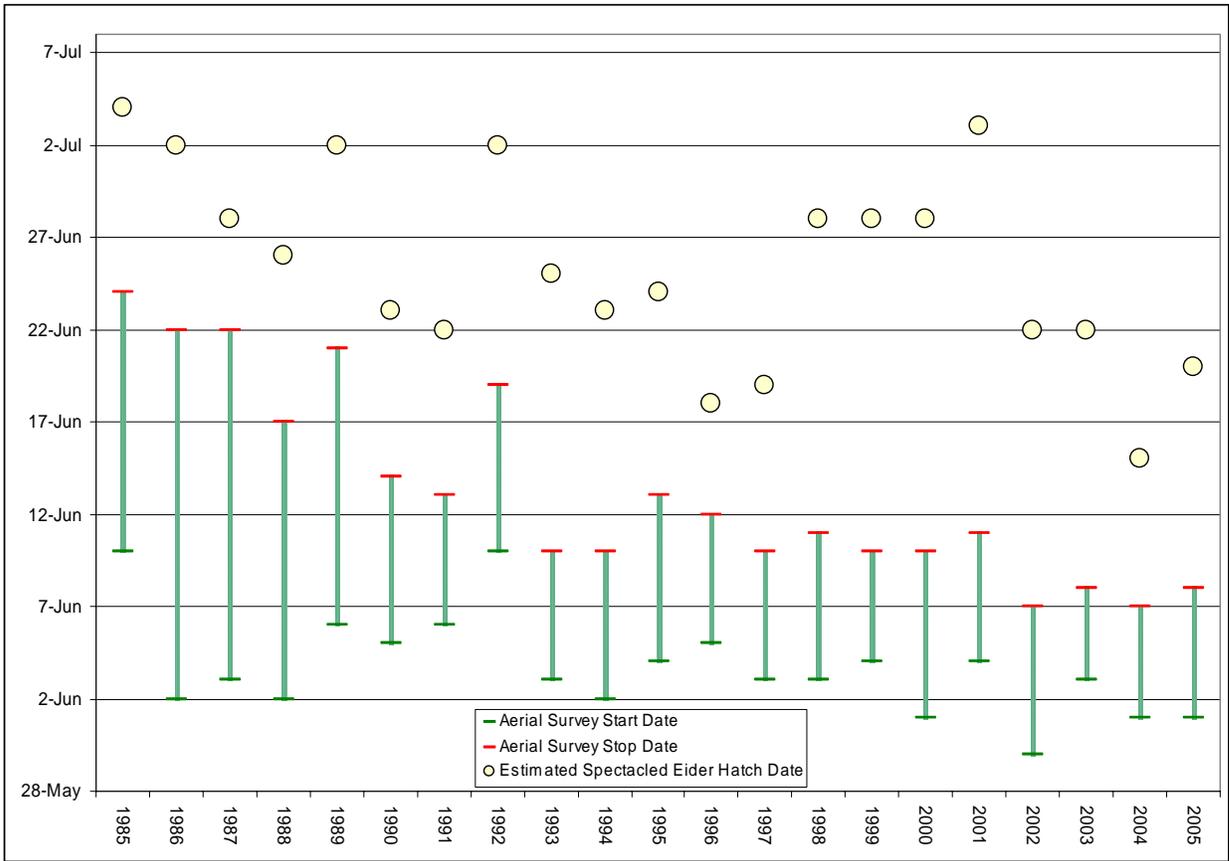


Fig. 2. Timing and duration of the coastal zone aerial survey in relation to average spectacled eider hatch date from ground surveys (Fischer et al. 2005), Yukon-Kuskokwim Delta, Alaska, 1985-2005.

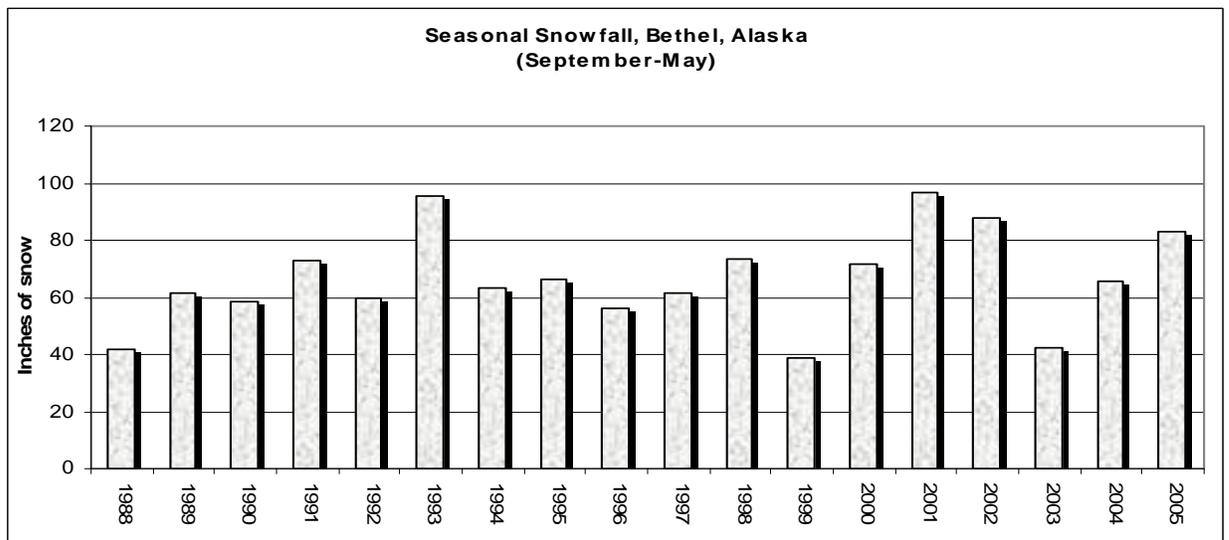
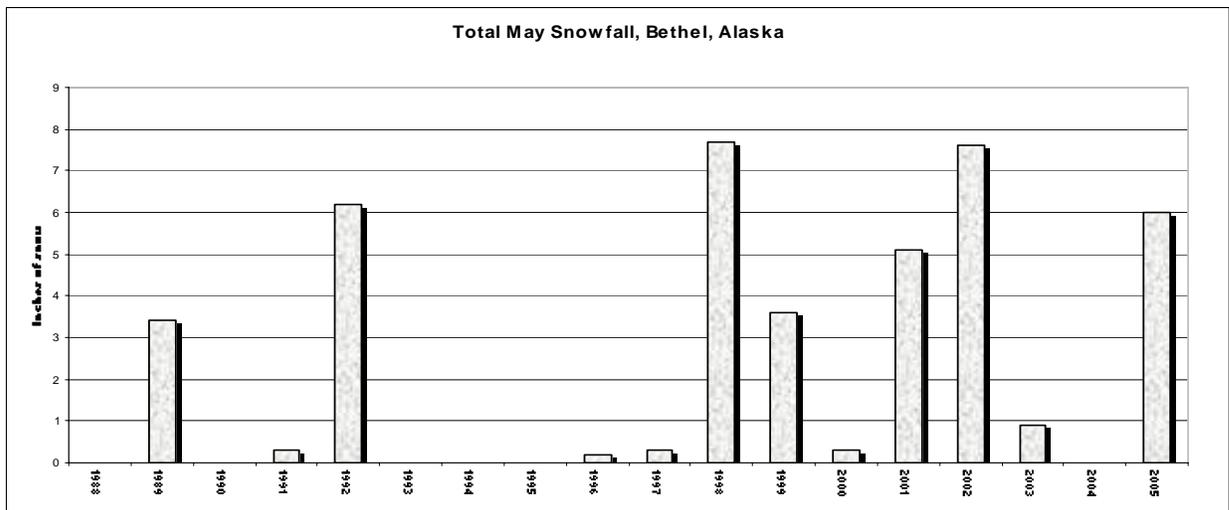
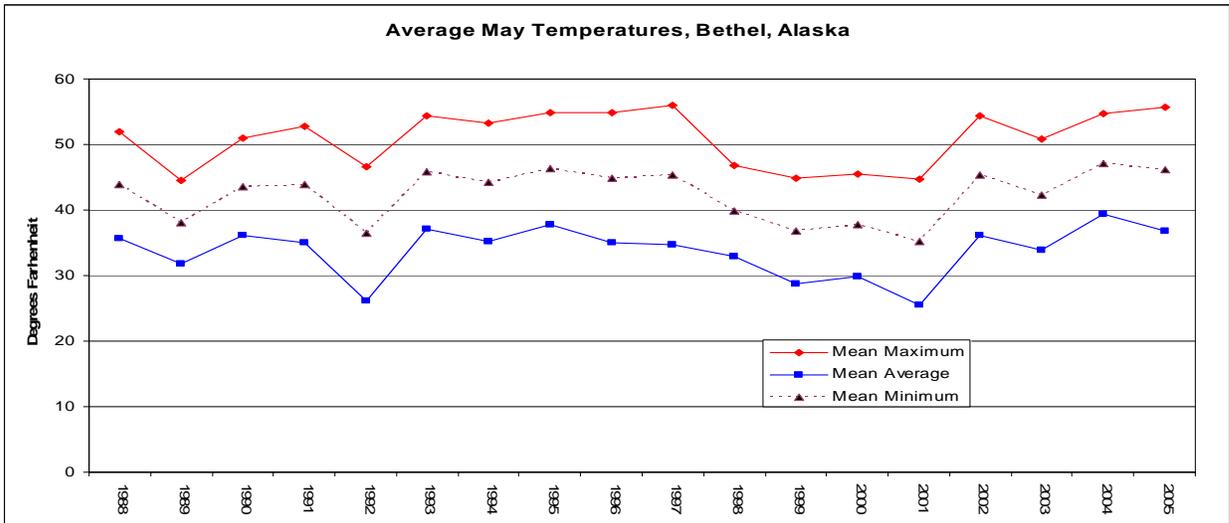


Fig. 3. Mean high, mean low, and mean average May temperatures (top) and snowfall (middle) from Bethel, Alaska, 1988 – 2005. Total snowfall for the season, Bethel, Alaska (bottom). Year on x-axis is the start year of the winter season.

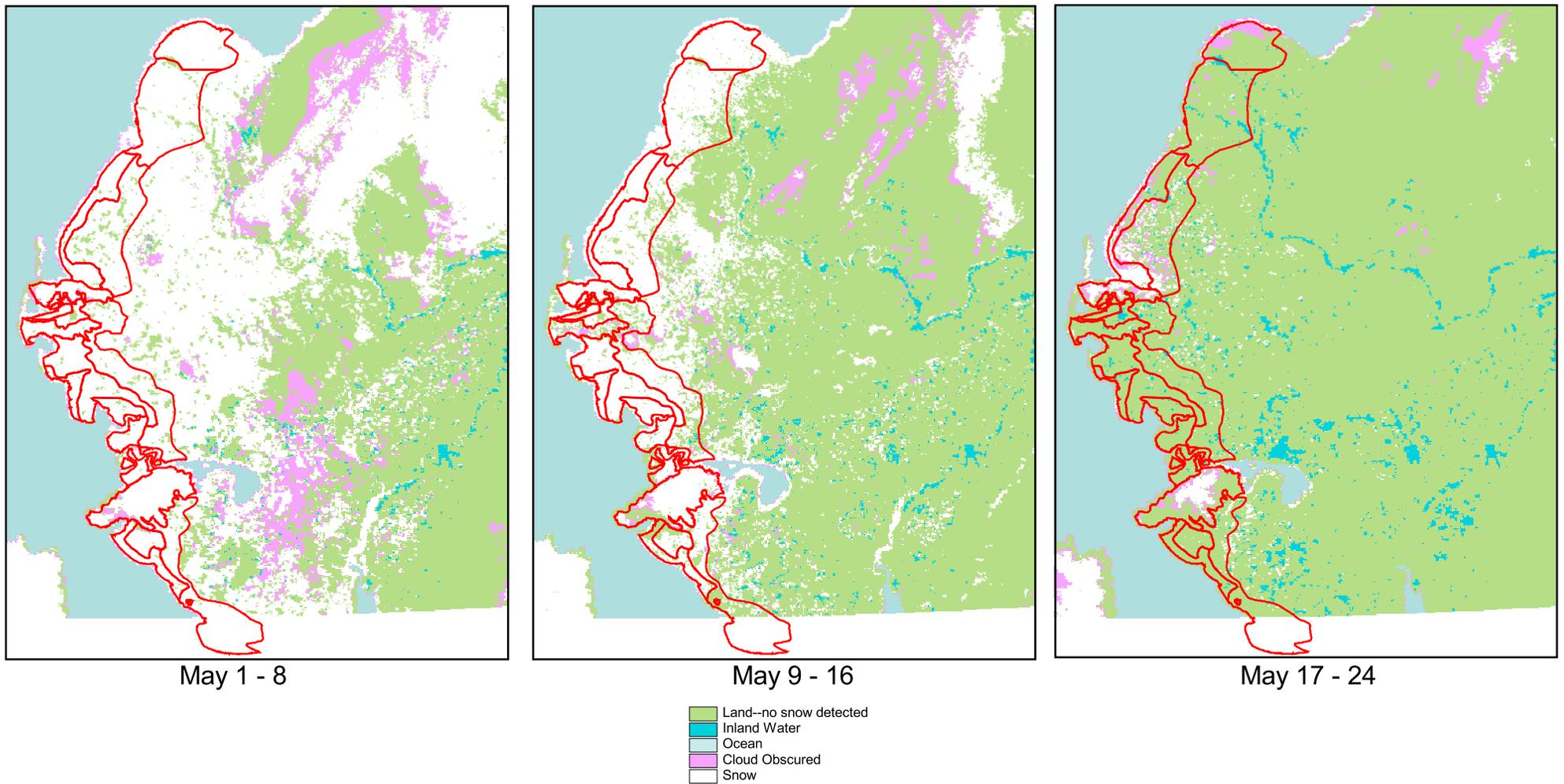
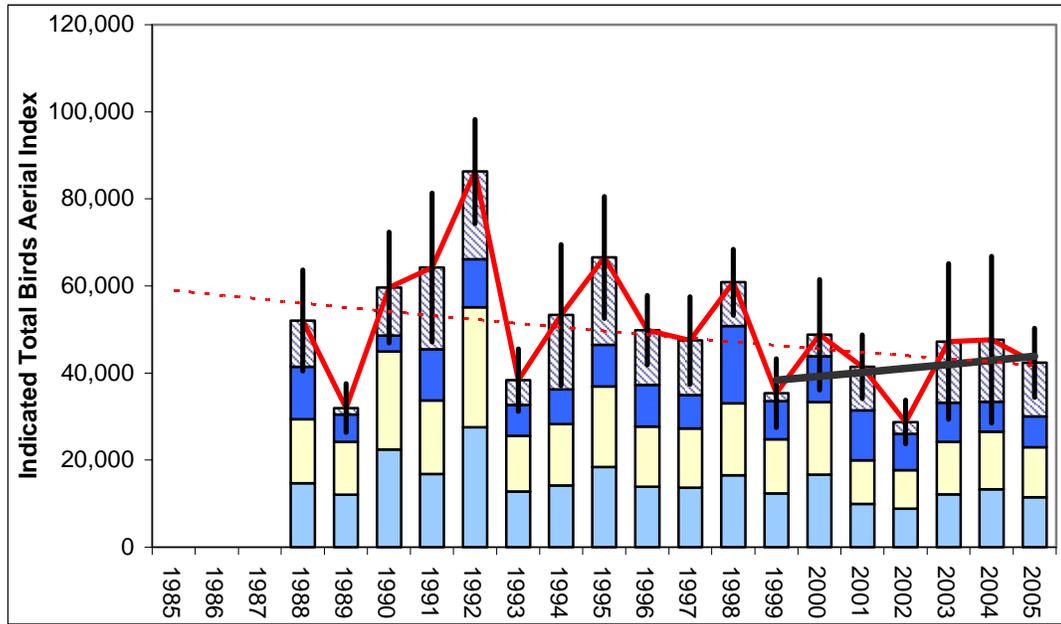


Fig. 4. Snow melt phenology from Terra satellite MODIS 8-day composite maximum snow extent data for 2005. Spatial resolution is a 500 meter pixel. If a pixel was snow covered for any day during the 8-day period, then it was classified as snow. The coastal zone became snow free around the third week of May.

Northern Pintail

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	29350	12110	10593	52052	5916
1989	24168	6324	1470	31962	2842
1990	44940	3638	11085	59663	6490
1991	33658	11812	18780	64250	8719
1992	55086	11048	20139	86273	6082
1993	25554	7122	5703	38379	3644
1994	28292	7988	17055	53336	8254
1995	36894	9570	20095	66559	7133
1996	27708	9590	12549	49847	4055
1997	27284	7670	12521	47476	5128
1998	33010	17790	10064	60863	3861
1999	24752	8776	1855	35381	4025
2000	33328	10490	4973	48791	6474
2001	19950	11492	10010	41452	3727
2002	17702	8322	2725	28749	2547
2003	24200	8980	14057	47236	9108
2004	26546	6870	14212	47628	9767
2005	22948	7082	12330	42360	4037

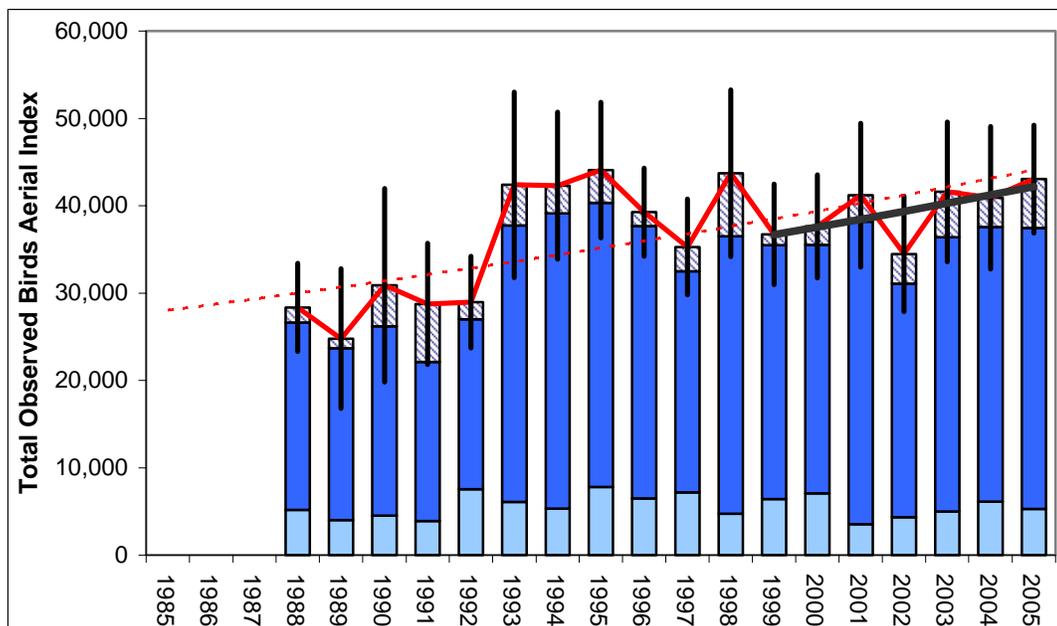
NOPI

n yrs =	18
mean =	50125
std dev =	13928
ln linear slope =	-0.0172
SE slope =	0.0120
Growth Rate =	0.983
low 90%ci GR =	0.964
high 90%ci GR =	1.003
regression resid CV =	0.265
avg sampling err CV =	0.114
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	16.4
w/ sample error CV =	9.4
<u>most recent 7 years :</u>	
Growth Rate =	1.022
low 90%ci GR =	0.960
high 90%ci GR =	1.089

Fig. 5. Population trend for Northern Pintail (*Anas acuta*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Greater Scaup

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Total birds observed

year	sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	5191	21434	1722	28347	2573
1989	3999	19674	1107	24780	4076
1990	4500	21698	4696	30895	5652
1991	3900	18230	6623	28753	3541
1992	7536	19474	1962	28973	2673
1993	6074	31656	4668	42398	5421
1994	5330	33778	3196	42304	4289
1995	7782	32556	3745	44083	3965
1996	6500	31166	1590	39256	2581
1997	7180	25312	2788	35280	2791
1998	4746	31766	7204	43715	4863
1999	6400	29076	1237	36712	2934
2000	7059	28474	2099	37631	3018
2001	3526	34638	3047	41211	4203
2002	4333	26744	3403	34481	3371
2003	4994	31396	5196	41585	4078
2004	6134	31424	3351	40909	4170
2005	5270	32188	5585	43044	3154

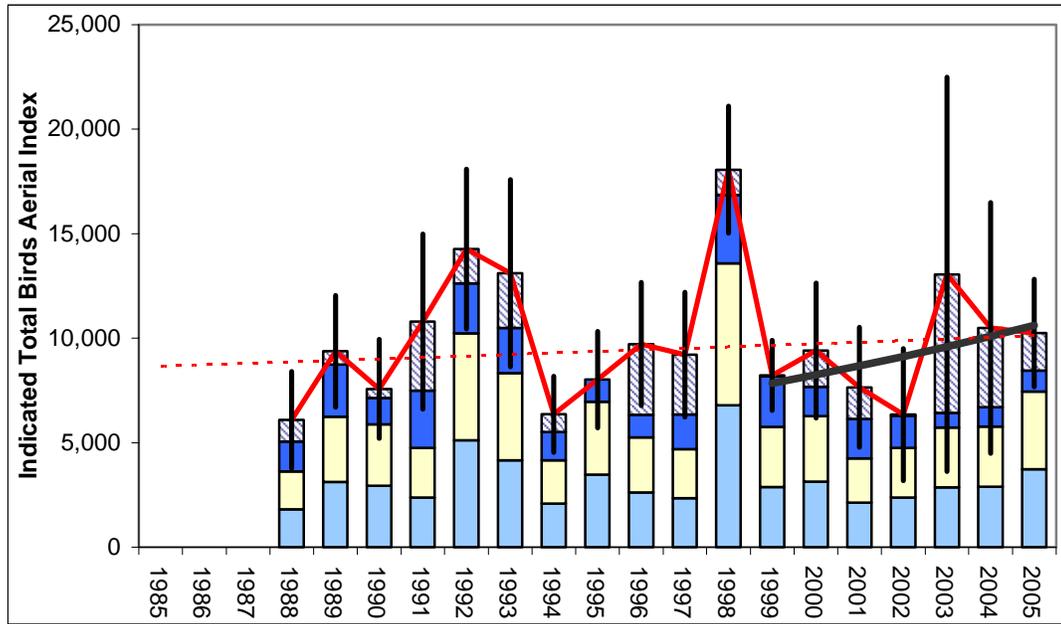
SCAU

n yrs =	18
mean =	36909
std dev =	6192
slope =	0.0227
SE slope =	0.0062
Growth Rate =	1.023
low 90%ci GR =	1.013
high 90%ci GR =	1.033
regression resid CV =	0.136
avg sampling err CV =	0.100
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	10.6
w/ sample error CV =	8.6
<u>most recent 7 years :</u>	
Growth Rate =	1.024
low 90%ci GR =	1.002
high 90%ci GR =	1.046

Fig. 6. Population trend for Greater Scaup (*Aythya marila*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Northern Shoveler

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	3620	1442	1024	6085	1180
1989	6250	2484	639	9373	1363
1990	5882	1260	431	7574	1210
1991	4754	2738	3298	10791	2135
1992	10234	2388	1640	14263	1951
1993	8326	2164	2621	13112	2286
1994	4162	1356	839	6358	927
1995	6952	1066	0	8018	1174
1996	5250	1078	3389	9716	1504
1997	4694	1654	2866	9214	1525
1998	13586	3270	1204	18060	1551
1999	5756	2418	48	8220	853
2000	6274	1396	1740	9409	1645
2001	4252	1888	1510	7650	1465
2002	4754	1540	48	6342	1614
2003	5720	704	6631	13056	4810
2004	5776	926	3792	10495	3061
2005	7448	1006	1791	10245	1310

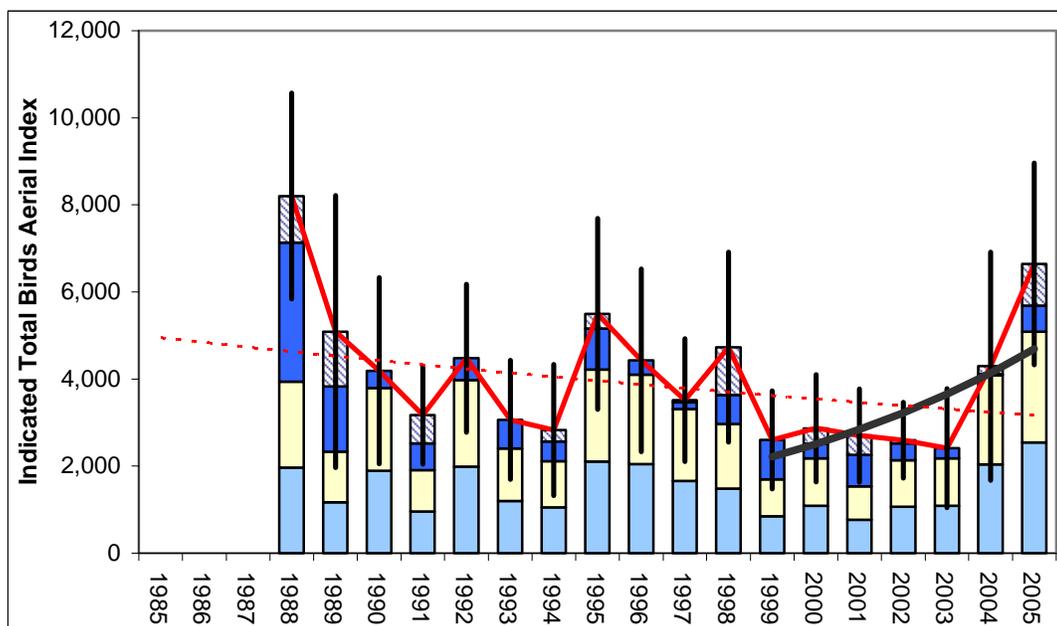
NSHO

n yrs =	18
mean =	9888
std dev =	3113
ln linear slope =	0.0078
SE slope =	0.0137
Growth Rate =	1.008
low 90%ci GR =	0.985
high 90%ci GR =	1.031
regression resid CV =	0.302
avg sampling err CV =	0.179
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	17.9
w/ sample error CV =	12.7
<u>most recent 7 years :</u>	
Growth Rate =	1.052
low 90%ci GR =	0.979
high 90%ci GR =	1.130

Fig. 7. Population trend for Northern Shoveler (*Anas clypeata*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Mallard

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	3936	3200	1066	8203	1205
1989	2334	1498	1258	5090	1593
1990	3790	400	0	4191	1091
1991	1908	614	649	3171	574
1992	3976	502	0	4477	867
1993	2404	658	0	3061	698
1994	2112	454	262	2827	767
1995	4214	946	337	5496	1117
1996	4098	334	0	4432	1070
1997	3314	152	50	3517	719
1998	2964	670	1096	4731	1113
1999	1698	904	0	2602	573
2000	2178	334	356	2870	628
2001	1538	722	441	2702	547
2002	2136	384	74	2593	444
2003	2180	232	0	2412	697
2004	4082	32	181	4296	1337
2005	5086	598	959	6642	1182

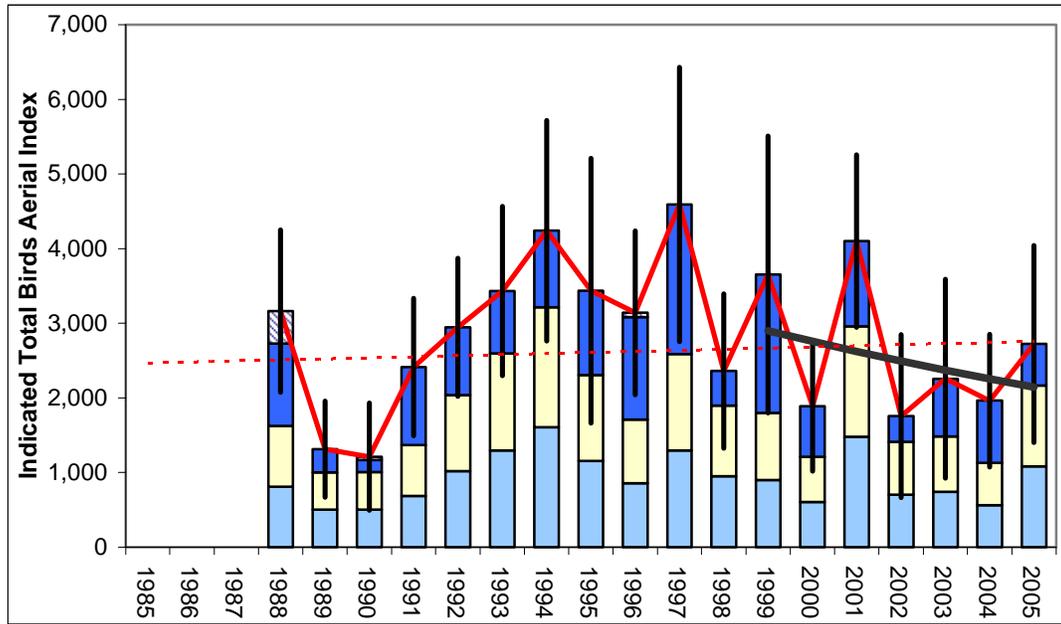
MALL

n yrs =	18
mean =	4073
std dev =	1565
In linear slope =	-0.0223
SE slope =	0.0155
Growth Rate =	0.978
low 90%ci GR =	0.953
high 90%ci GR =	1.003
regression resid CV =	0.342
avg sampling err CV =	0.226
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	19.5
w/ sample error CV =	14.8
<u>most recent 7 years :</u>	
Growth Rate =	1.133
low 90%ci GR =	1.039
high 90%ci GR =	1.236

Fig. 8. Population trend for Mallards (*Anas platyrhynchos*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Green-winged Teal

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	1624	1104	435	3163	554
1989	1002	312	0	1313	328
1990	1006	164	41	1212	367
1991	1370	1042	0	2412	470
1992	2038	908	0	2945	472
1993	2596	836	0	3431	579
1994	3216	1024	0	4240	754
1995	2308	1128	0	3436	904
1996	1710	1372	59	3140	560
1997	2588	2004	0	4592	938
1998	1898	462	0	2360	528
1999	1798	1854	0	3652	946
2000	1212	678	0	1889	444
2001	2960	1142	0	4102	590
2002	1410	348	0	1758	557
2003	1482	774	0	2258	680
2004	1128	836	0	1963	453
2005	2166	556	0	2722	674

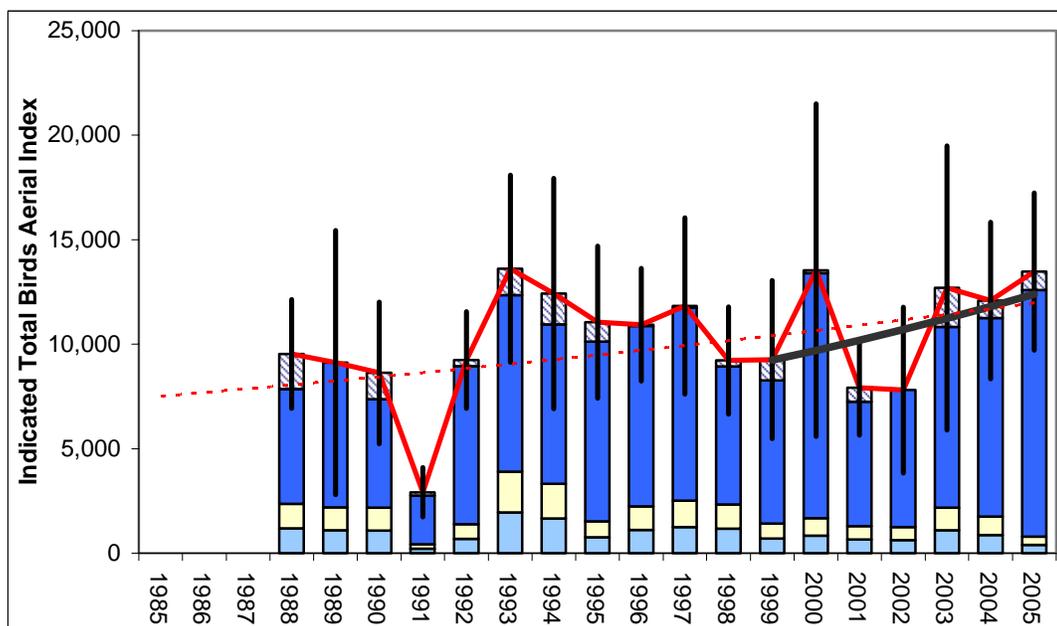
AGWT

n yrs =	18
mean =	2810
std dev =	993
ln linear slope =	0.0056
SE slope =	0.0181
Growth Rate =	1.006
low 90%ci GR =	0.976
high 90%ci GR =	1.036
regression resid CV =	0.398
avg sampling err CV =	0.224
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	21.6
w/ sample error CV =	14.7
<u>most recent 7 years :</u>	
Growth Rate =	0.951
low 90%ci GR =	0.854
high 90%ci GR =	1.059

Fig. 9. Population trend for American Green-winged Teal (*Anas crecca*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Black Scoter

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	2364	5492	1675	9531	1329
1989	2188	6938	0	9124	3225
1990	2172	5194	1267	8631	1729
1991	432	2318	165	2915	599
1992	1380	7574	286	9240	1179
1993	3904	8440	1269	13613	2285
1994	3318	7628	1482	12427	2810
1995	1516	8608	934	11057	1855
1996	2236	8638	59	10934	1374
1997	2506	9240	81	11826	2150
1998	2332	6598	291	9220	1308
1999	1414	6850	999	9264	1928
2000	1668	11732	142	13542	4062
2001	1296	5946	676	7917	1155
2002	1256	6548	0	7804	2025
2003	2178	8646	1868	12692	3468
2004	1750	9500	840	12090	1913
2005	798	11790	888	13475	1922

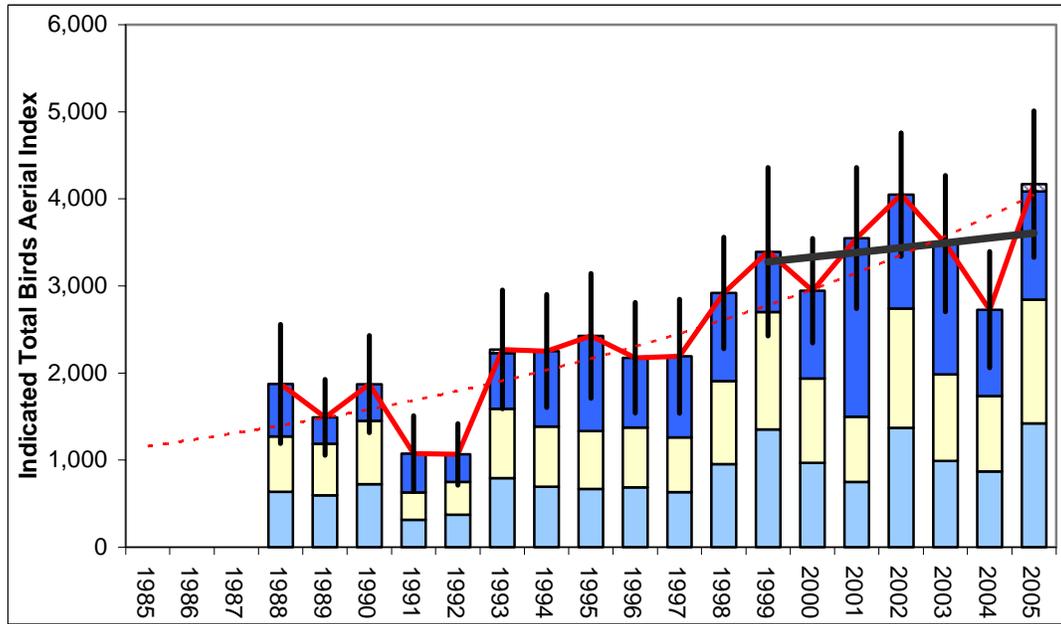
BLSC

n yrs =	18
mean =	10295
std dev =	2689
ln linear slope =	0.0233
SE slope =	0.0156
Growth Rate =	1.024
low 90%ci GR =	0.998
high 90%ci GR =	1.050
regression resid CV =	0.343
avg sampling err CV =	0.196
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	19.5
w/ sample error CV =	13.4
<u>most recent 7 years :</u>	
Growth Rate =	1.050
low 90%ci GR =	0.974
high 90%ci GR =	1.133

Fig. 10. Population trend for Black Scoter (*Melanitta nigra*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Spectacled Eider

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	1272	602	0	1874	349
1989	1188	302	0	1490	222
1990	1450	422	0	1872	284
1991	630	446	0	1075	222
1992	748	318	0	1066	180
1993	1588	640	42	2271	347
1994	1386	866	0	2252	331
1995	1334	1092	0	2426	366
1996	1374	802	0	2176	324
1997	1262	930	0	2192	334
1998	1906	1014	0	2920	326
1999	2702	690	0	3393	493
2000	1938	1008	0	2945	305
2001	1500	2048	0	3549	413
2002	2740	1310	0	4049	362
2003	1984	1502	0	3487	399
2004	1736	990	0	2727	340
2005	2842	1244	83	4170	429

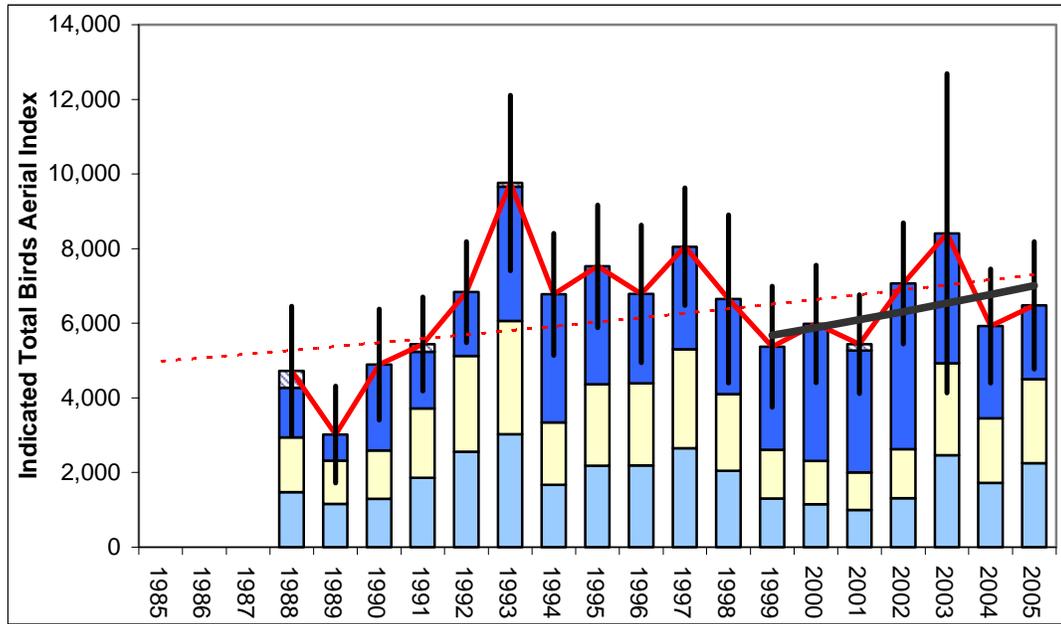
SPEI

n yrs =	18
mean =	2552
std dev =	928
In linear slope =	0.0625
SE slope =	0.0106
Growth Rate =	1.065
low 90%ci GR =	1.046
high 90%ci GR =	1.083
regression resid CV =	0.233
avg sampling err CV =	0.140
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	15.1
w/ sample error CV =	10.8
<u>most recent 7 years :</u>	
Growth Rate =	1.016
low 90%ci GR =	0.965
high 90%ci GR =	1.070

Fig. 11. Population trend for Spectacled Eiders (*Somateria fischeri*) observed on by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Long-tailed Duck

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	2942	1330	451	4723	882
1989	2316	704	0	3020	661
1990	2592	2304	0	4897	757
1991	3720	1512	211	5443	643
1992	5120	1714	0	6834	690
1993	6062	3598	100	9759	1199
1994	3342	3434	0	6776	833
1995	4364	3162	0	7525	838
1996	4388	2400	0	6789	939
1997	5306	2746	0	8053	801
1998	4100	2550	0	6649	1148
1999	2608	2762	0	5370	827
2000	2310	3672	0	5982	801
2001	2002	3268	169	5439	675
2002	2622	4446	0	7068	825
2003	4926	3482	0	8409	2181
2004	3450	2474	0	5924	779
2005	4502	1980	0	6481	869

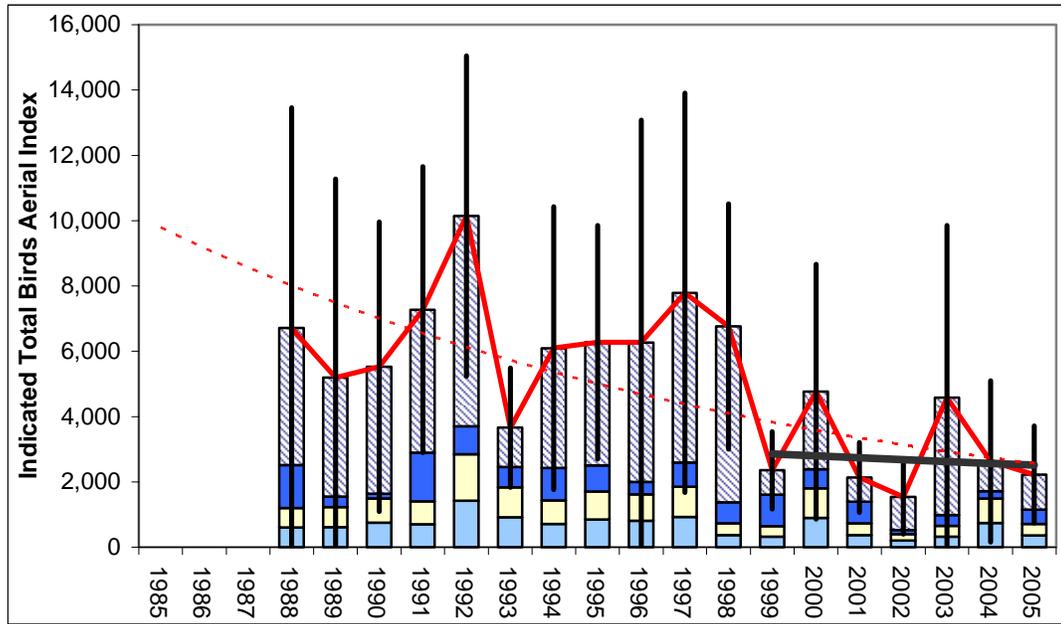
OLDS

n yrs =	18
mean =	6397
std dev =	1536
In linear slope =	0.0191
SE slope =	0.0113
Growth Rate =	1.019
low 90%ci GR =	1.001
high 90%ci GR =	1.038
regression resid CV =	0.248
avg sampling err CV =	0.144
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	15.7
w/ sample error CV =	11.0
<u>most recent 7 years :</u>	
Growth Rate =	1.036
low 90%ci GR =	0.988
high 90%ci GR =	1.086

Fig. 12. Population trend for Long-tailed Duck (*Clangula hyamelis*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

American Wigeon

Yukon-Kuskokwim Delta coastal survey

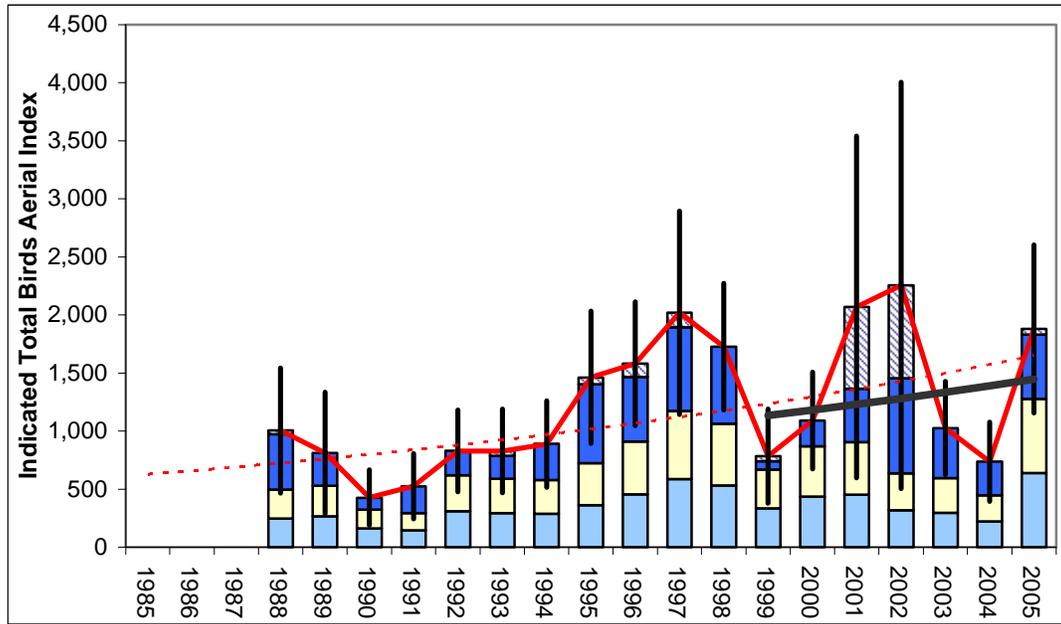


Aerial survey index with 18 strata: Indicated total birds					AMWI	
year	2*sg	2*pr	flocks	Index	Std Err	
1985						n yrs = 18
1986						mean = 5106
1987						std dev = 2332
1988	1202	1312	4196	6708	3445	In linear slope = -0.0670
1989	1228	318	3646	5192	3102	SE slope = 0.0186
1990	1492	142	3890	5524	2261	Growth Rate = 0.935
1991	1404	1494	4374	7270	2235	low 90%ci GR = 0.907
1992	2842	864	6435	10141	2503	high 90%ci GR = 0.964
1993	1830	624	1205	3658	932	
1994	1430	994	3670	6096	2211	regression resid CV = 0.409
1995	1702	804	3769	6275	1825	avg sampling err CV = 0.385
1996	1618	384	4267	6271	3470	
1997	1854	742	5193	7790	3121	<u>min yrs to detect -50%/20yr rate :</u>
1998	732	644	5385	6761	1916	w/ regression resid CV = 22.0
1999	640	970	744	2354	606	w/ sample error CV = 21.1
2000	1798	592	2373	4763	1992	<u>most recent 7 years :</u>
2001	732	666	733	2133	548	Growth Rate = 0.979
2002	402	124	1014	1540	581	low 90%ci GR = 0.851
2003	650	330	3603	4583	2690	high 90%ci GR = 1.126
2004	1488	224	917	2629	1261	
2005	712	436	1077	2225	758	

Fig. 13. Population trend for American Wigeon (*Anas americana*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Common Eider

Yukon-Kuskokwim Delta coastal survey

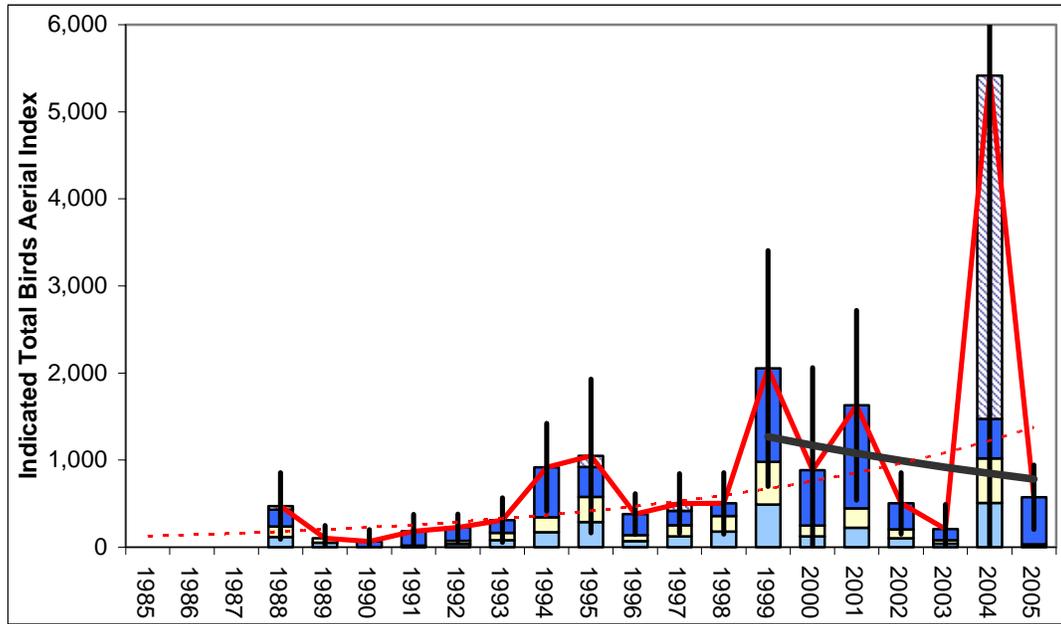


Aerial survey index with 18 strata: Indicated total birds						COEI
year	2*sg	2*pr	flocks	Index	Std Err	
1985						n yrs = 18
1986						mean = 1219
1987						std dev = 571
1988	496	476	33	1005	275	ln linear slope = 0.0484
1989	530	280	0	810	267	SE slope = 0.0193
1990	324	102	0	427	122	Growth Rate = 1.050
1991	292	232	0	525	143	low 90%ci GR = 1.017
1992	620	210	0	829	180	high 90%ci GR = 1.083
1993	588	198	42	829	184	
1994	578	312	0	888	190	regression resid CV = 0.425
1995	724	680	58	1463	291	avg sampling err CV = 0.245
1996	910	556	115	1580	272	
1997	1172	722	126	2019	447	<u>min yrs to detect -50%/20yr rate :</u>
1998	1064	662	0	1727	278	w/ regression resid CV = 22.5
1999	670	70	43	783	207	w/ sample error CV = 15.6
2000	870	222	0	1091	213	<u>most recent 7 years :</u>
2001	904	460	706	2070	751	Growth Rate = 1.042
2002	636	818	801	2255	893	low 90%ci GR = 0.890
2003	594	432	0	1026	205	high 90%ci GR = 1.219
2004	446	290	0	736	174	
2005	1276	554	51	1880	369	

Fig. 14. Population trend for Common Eiders (*Somateria mollissima*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Red-breasted Merganser

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	236	196	41	473	195
1989	104	0	0	104	73
1990	0	66	0	66	68
1991	18	164	0	182	100
1992	74	152	0	226	78
1993	164	146	0	310	131
1994	344	572	0	917	257
1995	576	344	127	1047	450
1996	140	240	0	380	120
1997	252	166	83	500	175
1998	358	146	0	503	180
1999	980	1072	0	2052	690
2000	248	636	0	885	600
2001	446	1184	0	1630	555
2002	206	298	0	504	180
2003	80	130	0	209	143
2004	1018	454	3942	5414	3466
2005	34	540	0	574	188

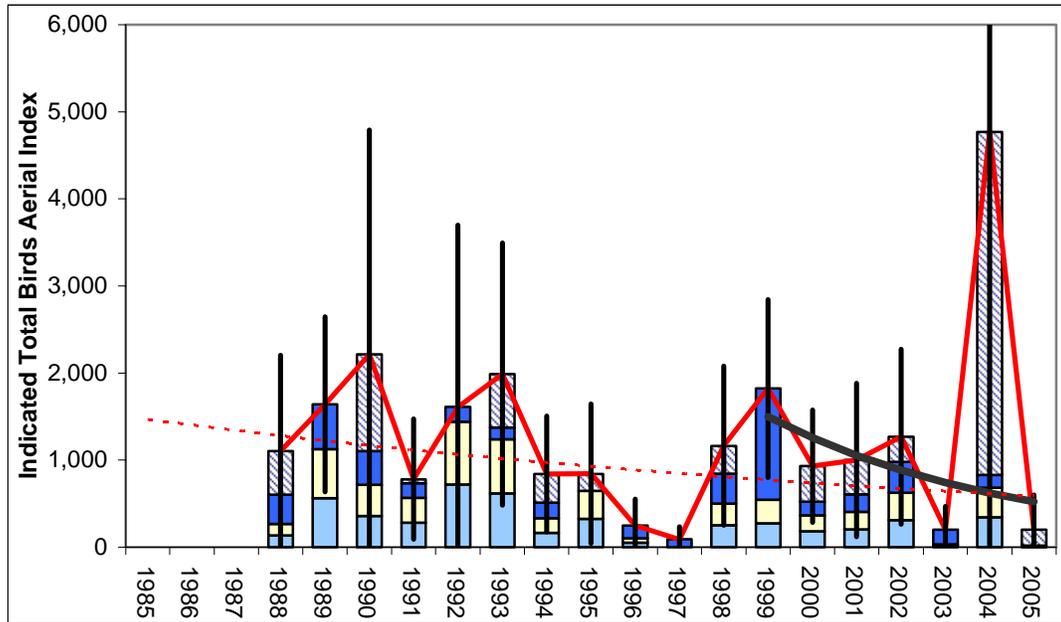
RBME

n yrs =	18
mean =	888
std dev =	1246
ln linear slope =	0.1197
SE slope =	0.0404
Growth Rate =	1.127
low 90%ci GR =	1.055
high 90%ci GR =	1.205
regression resid CV =	0.891
avg sampling err CV =	0.476
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	36.9
w/ sample error CV =	24.3
<u>most recent 7 years :</u>	
Growth Rate =	0.923
low 90%ci GR =	0.644
high 90%ci GR =	1.321

Fig. 15. Population trend for Red-breasted Merganser (*Mergus serrator*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Canvasback

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	268	334	502	1103	561
1989	1124	516	0	1641	512
1990	718	386	1111	2215	1314
1991	566	168	46	781	352
1992	1438	172	0	1609	1066
1993	1238	136	614	1988	768
1994	332	178	331	840	340
1995	648	0	194	843	408
1996	104	144	0	249	154
1997	0	90	0	89	73
1998	502	342	319	1164	466
1999	546	1276	0	1823	521
2000	364	158	409	931	329
2001	406	200	397	1002	449
2002	624	356	289	1268	513
2003	34	168	0	202	136
2004	684	144	3942	4771	3447
2005	18	0	184	202	203

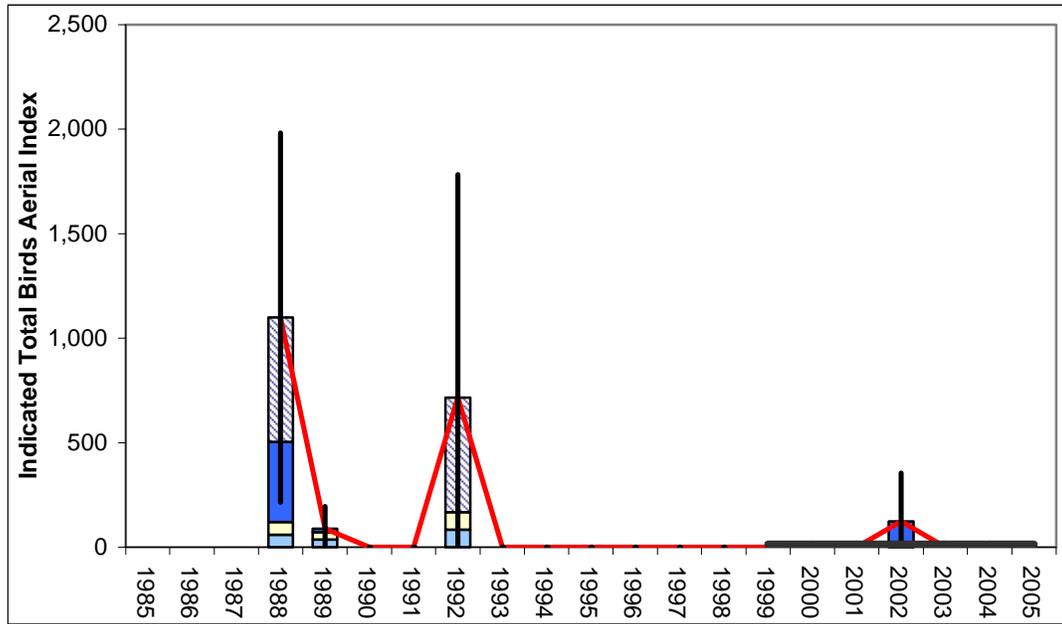
CANV

n yrs =	18
mean =	1262
std dev =	1078
ln linear slope =	-0.0458
SE slope =	0.0456
Growth Rate =	0.955
low 90%ci GR =	0.886
high 90%ci GR =	1.030
regression resid CV =	1.005
avg sampling err CV =	0.530
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	40.0
w/ sample error CV =	26.1
<u>most recent 7 years :</u>	
Growth Rate =	0.838
low 90%ci GR =	0.580
high 90%ci GR =	1.211

Fig. 16. Population trend for Canvasback (*Aythya valisineria*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Barrow's Goldeneye

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Indicated total birds

year	2*sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988	120	384	595	1099	451
1989	72	16	0	89	54
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	168	0	548	717	544
1993	0	0	0	0	0
1994	0	0	0	0	0
1995	0	0	0	0	0
1996	0	0	0	0	0
1997	0	0	0	0	0
1998	0	0	0	0	0
1999	0	0	0	0	0
2000	0	0	0	0	0
2001	0	0	0	0	0
2002	0	124	0	123	118
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0

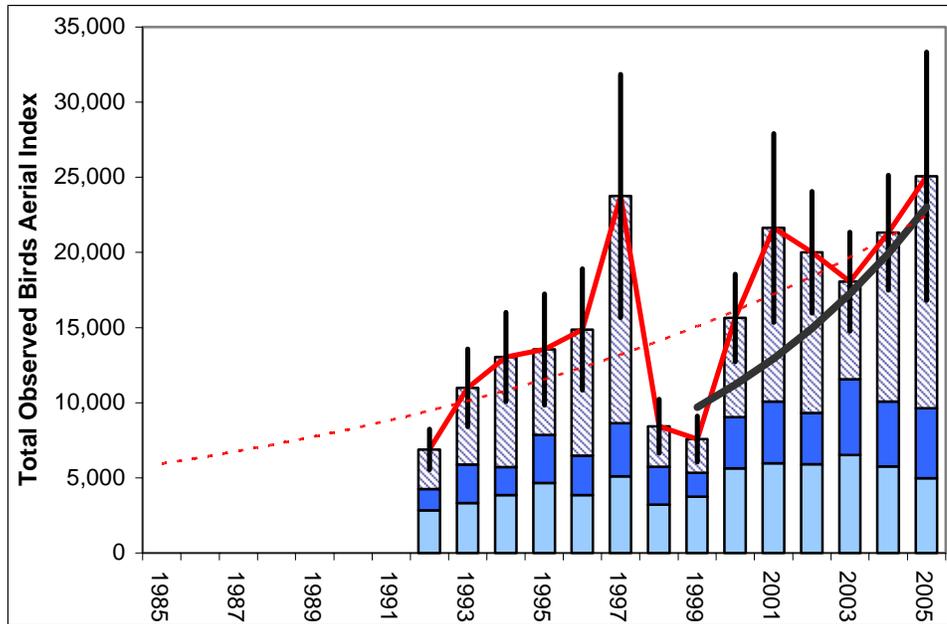
GOLD

n yrs =	18
mean =	113
std dev =	299
ln linear slope =	-0.1275
SE slope =	0.0654
Growth Rate =	0.880
low 90%ci GR =	0.791
high 90%ci GR =	0.980
regression resid CV =	1.445
avg sampling err CV =	0.152
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	50.9
w/ sample error CV =	11.4
<u>most recent 7 years :</u>	
Growth Rate =	1.000
low 90%ci GR =	0.724
high 90%ci GR =	1.381

Fig. 17. Population trend for Barrow's Goldeneye (*Bucephala islandica*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The indicated total birds population index is the sum of birds observed as singles, an equal number of unseen single birds, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Sabine's Gull

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Total birds observed

year	sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988					
1989					
1990					
1991					
1992	2846	1404	2642	6893	688
1993	3327	2560	5099	10986	1318
1994	3847	1860	7330	13036	1511
1995	4650	3212	5682	13543	1887
1996	3863	2622	8388	14874	2060
1997	5108	3532	15113	23754	4125
1998	3226	2502	2706	8435	909
1999	3741	1594	2235	7570	778
2000	5642	3404	6592	15638	1484
2001	5975	4100	11560	21635	3204
2002	5901	3416	10688	20004	2064
2003	6514	5052	6493	18058	1681
2004	5753	4326	11238	21317	1952
2005	4984	4652	15425	25061	4213

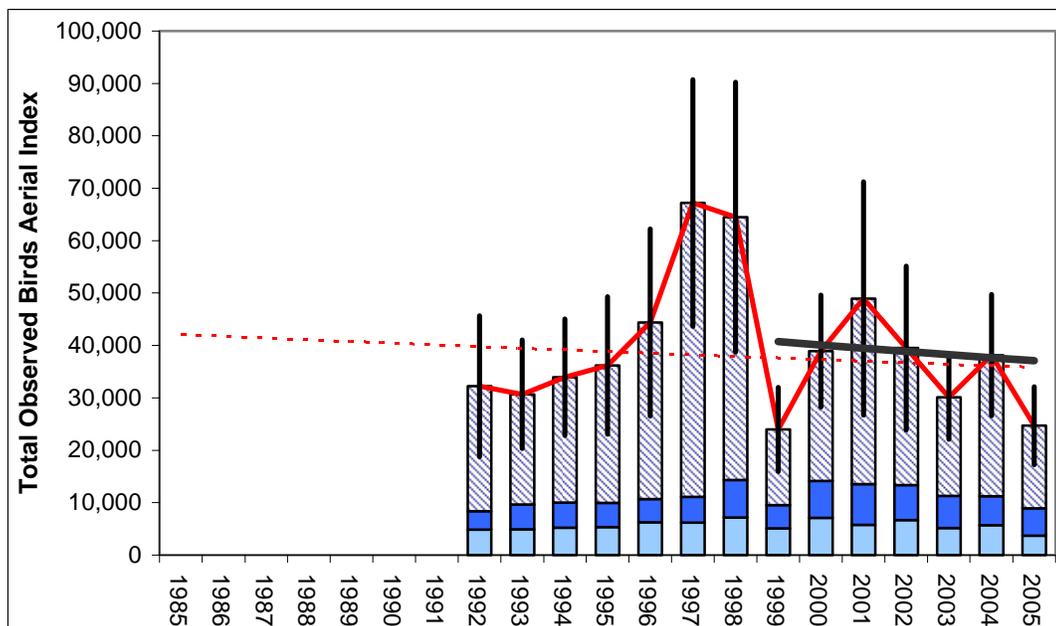
SAGU

n yrs =	14
mean =	15772
std dev =	6041
slope =	0.0665
SE slope =	0.0224
Growth Rate =	1.069
low 90%ci GR =	1.030
high 90%ci GR =	1.109
regression resid CV =	0.337
avg sampling err CV =	0.104
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	19.3
w/ sample error CV =	8.8
<u>most recent 7 years :</u>	
Growth Rate =	1.155
low 90%ci GR =	1.062
high 90%ci GR =	1.256

Fig. 18. Population trend for Sabine's Gulls (*Xema sabini*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Glauous Gull

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Total birds observed

year	sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988					
1989					
1990					
1991					
1992	4881	3480	23861	32221	6858
1993	4938	4726	21023	30688	5275
1994	5243	4790	23914	33946	5663
1995	5336	4634	26213	36183	6691
1996	6283	4384	33718	44384	9110
1997	6170	4960	56059	67188	12002
1998	7180	7178	50135	64492	13138
1999	5101	4442	14448	23992	4083
2000	7082	7042	24810	38934	5455
2001	5797	7728	35424	48950	11358
2002	6697	6648	26178	39524	7978
2003	5148	6158	18788	30094	4064
2004	5734	5504	26922	38158	5892
2005	3733	5162	15799	24694	3800

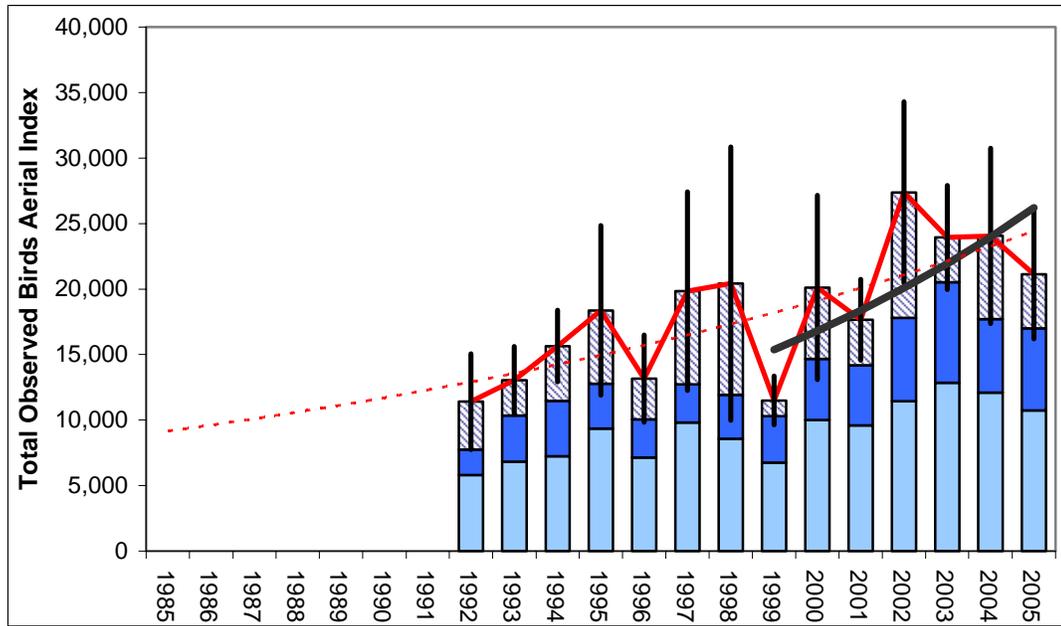
GLGU

n yrs =	14
mean =	39532
std dev =	13089
slope =	-0.0081
SE slope =	0.0211
Growth Rate =	0.992
low 90%ci GR =	0.958
high 90%ci GR =	1.027
regression resid CV =	0.319
avg sampling err CV =	0.162
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	18.6
w/ sample error CV =	11.8
<u>most recent 7 years :</u>	
Growth Rate =	0.984
low 90%ci GR =	0.900
high 90%ci GR =	1.077

Fig. 19. Population trend for Glauous Gulls (*Larus hyperboreus*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Arctic Tern

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Total birds observed

year	sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988					
1989					
1990					
1991					
1992	5816	1936	3662	11414	1865
1993	6820	3518	2693	13031	1319
1994	7226	4240	4181	15648	1391
1995	9347	3424	5601	18372	3301
1996	7133	2922	3106	13161	1696
1997	9802	2934	7112	19848	3866
1998	8585	3348	8480	20413	5317
1999	6757	3548	1193	11497	952
2000	10000	4680	5440	20120	3584
2001	9592	4580	3486	17659	1577
2002	11437	6372	9563	27372	3536
2003	12840	7694	3403	23937	2027
2004	12085	5612	6359	24055	3418
2005	10723	6276	4121	21121	2505

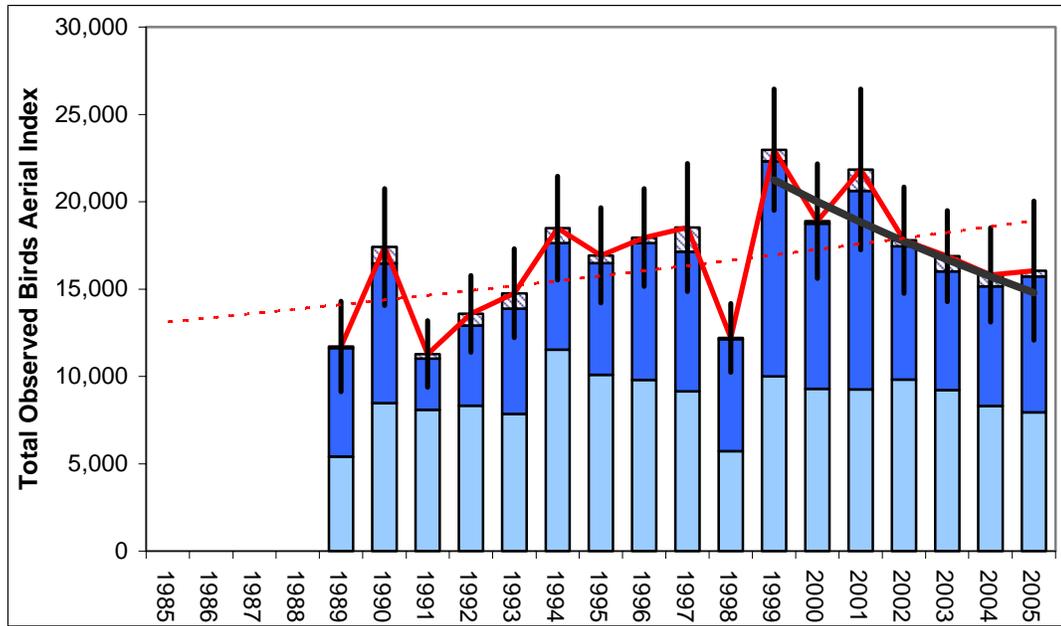
ARTE

n yrs =	14
mean =	18403
std dev =	4965
slope =	0.0490
SE slope =	0.0134
Growth Rate =	1.050
low 90%ci GR =	1.027
high 90%ci GR =	1.074
regression resid CV =	0.201
avg sampling err CV =	0.109
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	13.7
w/ sample error CV =	9.1
<u>most recent 7 years :</u>	
Growth Rate =	1.093
low 90%ci GR =	1.017
high 90%ci GR =	1.174

Fig. 20. Population trend for Arctic Terns (*Sterna paradisaea*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Pacific Loon

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Total birds observed

year	sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988					
1989	5408	6216	90	11712	1317
1990	8469	7994	943	17407	1703
1991	8096	2928	257	11281	969
1992	8317	4592	671	13581	1121
1993	7849	6036	874	14759	1298
1994	11526	6104	855	18485	1517
1995	10087	6402	440	16929	1389
1996	9808	7820	317	17945	1427
1997	9148	7986	1389	18523	1871
1998	5728	6402	81	12212	1004
1999	10004	12304	661	22970	1770
2000	9295	9446	151	18891	1673
2001	9248	11366	1229	21842	2346
2002	9826	7628	337	17792	1553
2003	9224	6778	884	16886	1331
2004	8313	6838	656	15807	1373
2005	7938	7774	340	16052	2029

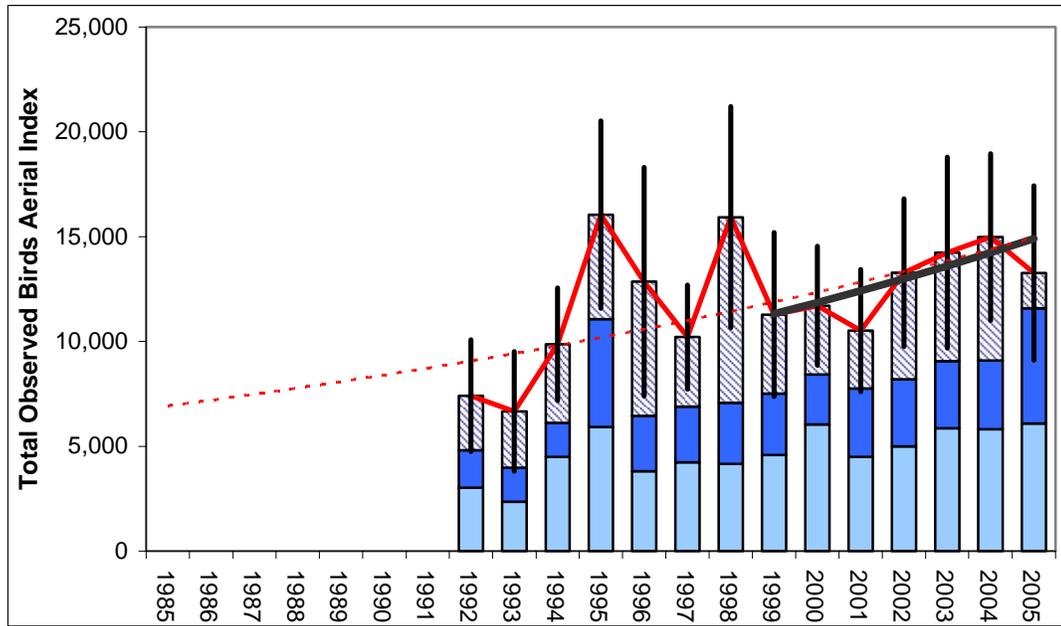
PALO

n yrs =	17
mean =	16651
std dev =	3254
slope =	0.0183
SE slope =	0.0092
Growth Rate =	1.018
low 90%ci GR =	1.003
high 90%ci GR =	1.034
regression resid CV =	0.186
avg sampling err CV =	0.085
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	13.0
w/ sample error CV =	7.7
<u>most recent 7 years :</u>	
Growth Rate =	0.941
low 90%ci GR =	0.920
high 90%ci GR =	0.963

Fig. 21. Population trend for Pacific Loons (*Gavia pacifica*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Mew Gull

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Total birds observed

year	sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988					
1989					
1990					
1991					
1992	3025	1792	2594	7411	1359
1993	2349	1634	2679	6663	1459
1994	4494	1626	3746	9866	1368
1995	5915	5146	4990	16051	2279
1996	3806	2652	6392	12849	2785
1997	4232	2656	3326	10213	1266
1998	4157	2914	8853	15925	2691
1999	4588	2928	3767	11284	1997
2000	6041	2390	3272	11704	1449
2001	4500	3252	2760	10512	1487
2002	4997	3194	5093	13283	1795
2003	5857	3208	5180	14244	2323
2004	5819	3266	5897	14984	2030
2005	6082	5498	1683	13262	2122

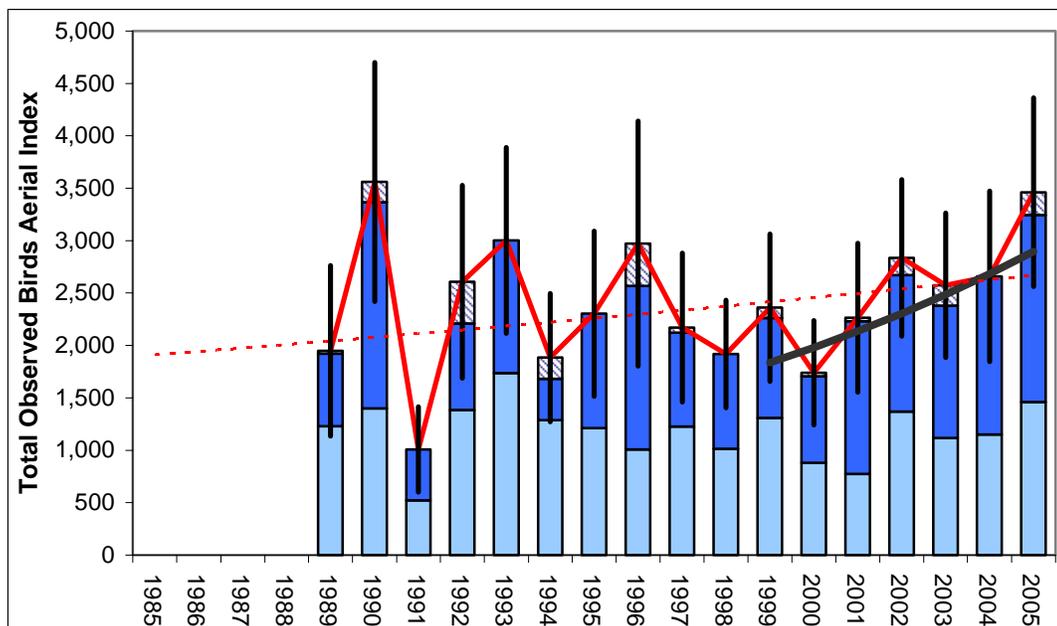
MEGU

n yrs =	14
mean =	12018
std dev =	2906
slope =	0.0385
SE slope =	0.0146
Growth Rate =	1.039
low 90%ci GR =	1.015
high 90%ci GR =	1.065
regression resid CV =	0.221
avg sampling err CV =	0.133
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	14.6
w/ sample error CV =	10.4
<u>most recent 7 years :</u>	
Growth Rate =	1.047
low 90%ci GR =	1.017
high 90%ci GR =	1.077

Fig. 22. Population trend for Mew Gulls (*Larus canus*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Red-throated Loon

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Total birds observed

year	sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988					
1989	1231	692	25	1949	415
1990	1400	1966	194	3560	582
1991	522	486	0	1008	207
1992	1385	826	398	2608	469
1993	1737	1266	0	3002	452
1994	1288	394	202	1884	312
1995	1212	1092	0	2304	402
1996	1008	1560	404	2972	597
1997	1227	894	51	2171	363
1998	1014	904	0	1919	262
1999	1307	954	100	2360	358
2000	879	828	32	1739	254
2001	775	1456	34	2265	362
2002	1369	1302	163	2834	381
2003	1117	1264	194	2575	352
2004	1150	1510	0	2659	415
2005	1461	1784	216	3462	459

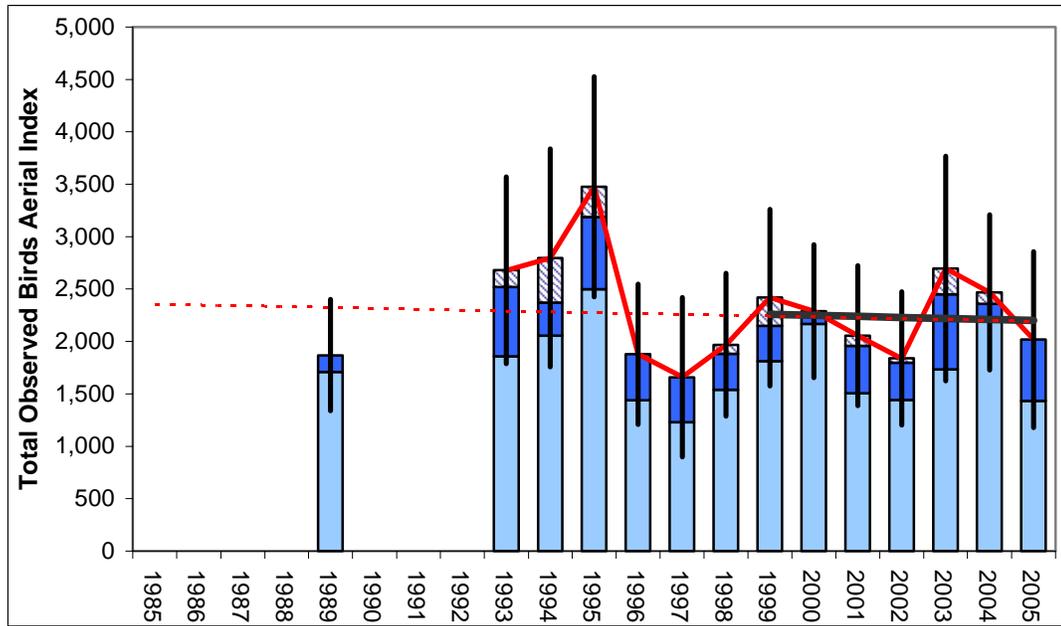
RTLO

n yrs =	17
mean =	2428
std dev =	644
slope =	0.0168
SE slope =	0.0148
Growth Rate =	1.017
low 90%ci GR =	0.993
high 90%ci GR =	1.042
regression resid CV =	0.298
avg sampling err CV =	0.157
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	17.8
w/ sample error CV =	11.6
<u>most recent 7 years :</u>	
Growth Rate =	1.079
low 90%ci GR =	1.030
high 90%ci GR =	1.130

Fig. 23. Population trend for Red-throated Loons (*Gavia stellata*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

Jaeger spp

Yukon-Kuskokwim Delta coastal survey



Aerial survey index with 18 strata: Total birds observed

year	sg	2*pr	flocks	Index	Std Err
1985					
1986					
1987					
1988					
1989	1708	160	0	1869	271
1990					
1991					
1992					
1993	1857	664	159	2679	455
1994	2055	316	426	2797	530
1995	2498	690	289	3477	536
1996	1438	440	0	1878	342
1997	1231	428	0	1660	388
1998	1539	342	87	1968	348
1999	1812	338	269	2419	430
2000	2169	120	0	2289	324
2001	1505	454	97	2055	341
2002	1443	354	42	1838	325
2003	1732	718	246	2696	547
2004	2198	162	108	2468	378
2005	1434	584	0	2018	428

JAEG

n yrs =	14
mean =	2294
std dev =	497
slope =	-0.0036
SE slope =	0.0129
Growth Rate =	0.996
low 90%ci GR =	0.975
high 90%ci GR =	1.018
regression resid CV =	0.214
avg sampling err CV =	0.168
<u>min yrs to detect -50%/20yr rate :</u>	
w/ regression resid CV =	14.3
w/ sample error CV =	12.1
<u>most recent 7 years :</u>	
Growth Rate =	0.996
low 90%ci GR =	0.951
high 90%ci GR =	1.042

Fig. 24. Population trend for Parasitic Jaegers (*Stercorarius parasiticus*) and Long-tailed Jaegers (*Stercorarius longicaudus*) observed by the right-rear-seat observer on aerial transects sampling 12,832 km² of the coastal Yukon-Kuskokwim Delta in western Alaska. The total birds observed population index is the sum of birds observed as singles, birds in pairs, and all birds in flocks, indicated by column divisions from bottom to top. Vertical lines indicate 95% confidence intervals based on sampling error calculated among transects. Stratification included 18 physiographic regions. Average annual growth rate is calculated by log-linear regression. Power calculations use alpha set at p=0.10, beta set at p=0.20, and a coefficient of variation based on either regression residuals or sampling errors. The power of the survey to detect trends for each species can be compared using an estimate of the minimum number of years of data needed to detect a significant annual rate of change of -0.034, a 50% decline in 20 years.

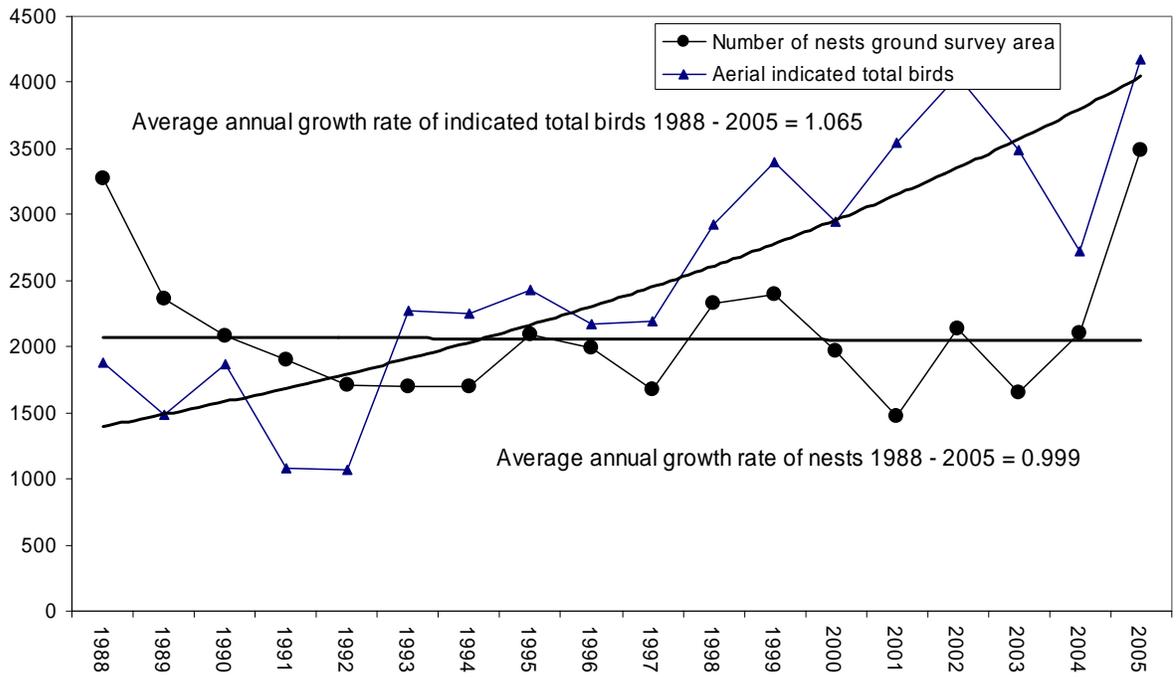


Fig. 25. Population estimates and trends for spectacled eider nests from the ground-sampled area (Fischer et al. 2005) and indicated total birds from aerial surveys of the Yukon Delta coastal zone, 1988 - 2005.

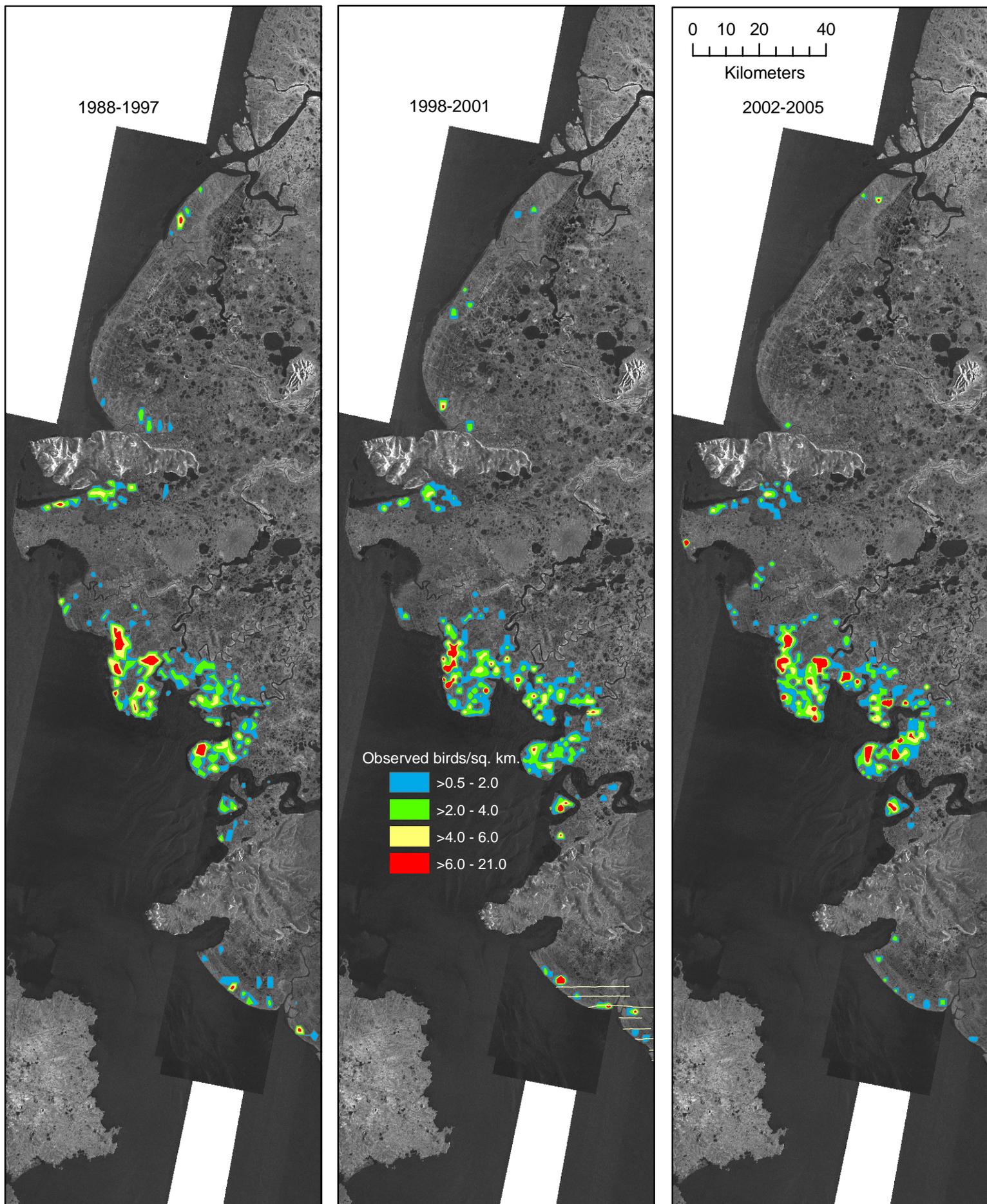


Fig. 26. Estimated relative density of spectacled eiders from 3 different sets of years of aerial survey data on the Yukon Delta coastal zone, Alaska.

Table 1. Number of birds sighted by category and expanded numbers for waterbirds counted by the right-rear-seat observer on the June 2005 Yukon Delta Coastal Zone aerial survey, Alaska. Species sorted in order of decreasing abundance for ducks, then for other species. Survey area = 12,831.5 km² and sampled area = 438.7 km². Number of transects (n) = 199. Density was calculated using 18 strata and therefore is not simply the indicated total divided by the sampled area.

Species	No. of single birds sighted	No. of pairs sighted	No. of grouped birds sighted ^a	Indicated total birds ^b	Sample density Birds/km ²	Population index (No. of birds)	Standard error	Visibility correction factor	Population estimate (No. of birds)
Northern pintail	607	250	1007	2721	3.301	42,360	4,037	3.05	129,198
Greater scaup	138	495	84	1350 ^c	3.355	43,044	3,154	1.93	83,075
Northern shoveler	123	16	94	372	0.798	10,245	1,310	3.79	38,829
Mallard	114	9	33	279	0.518	6,642	1,182	4.01	26,634
American green-winged teal	21	9	0	60	0.212	2,722	674	8.36	22,756
Black scoter	15	104	43	281	1.050	13,475	1,922	1.17	15,766
Spectacled eider	169	74	10	496	0.325	4,170	429	3.58	14,929
Long-tailed duck	69	35	0	208	0.505	6,481	869	1.87	12,119
American wigeon	25	8	70	136	0.173	2,225	758	3.84	8,544
Common eider	63	30	6	192	0.147	1,880	369	3.58	6,730
Red-breasted merganser	2	14	0	32	0.045	574	188	1.27	729
Canvasback	1	0	6	8	0.016	202	203	2.43	491
Sabine's gull	487	220	1450	2377	1.953	25,061	4,213	unknown	n/a
Glaucous gull	283	195	1173	1846	1.924	24,694	3,800	unknown	n/a
Arctic tern	581	141	187	1050	1.646	21,121	2,505	unknown	n/a
Pacific loon	306	130	25	591	1.251	16,052	2,029	unknown	n/a
Mew gull	301	118	153	690	1.034	13,262	2,122	unknown	n/a
Red-throated loon	66	44	18	172	0.270	3,462	459	unknown	n/a
Jaeger species	61	11	0	83	0.157	2,018	428	unknown	n/a

^a For ducks, groups are 5 or more birds, for other species, groups are 3 or more birds per sighting.

^b For ducks, Indicated total birds = 2 * (singles + pairs) + birds in groups, for other species, observed totals = singles + (2 * pairs) + birds in groups.

^c Greater scaup singles are not doubled, scaup number is observed total.

Table 2. Change in population estimates from previous year and from the long-term average, sorted in decreasing order of percent change from long-term average for waterfowl.

Species	2004	2005	Change from 2004	Long-term average	Change from long term average
Spectacled eider	9,763	14,929	53%	8,792	70%
Mallard	17,227	26,634	55%	15,727	69%
Common eider	2,635	6,730	155%	4,224	59%
Black scoter	14,145	15,766	11%	11,825	33%
Greater scaup	78,954	83,075	5%	70,538	18%
Northern shoveler	39,776	38,829	-2%	37,396	4%
Long-tailed duck	11,078	12,119	9%	11,953	1%
Green-winged teal	16,411	22,756	39%	23,542	-3%
Northern pintail	145,265	129,198	-11%	154,275	-16%
Red-breasted merganser	6,876	729	-89%	1,151	-37%
American wigeon	10,095	8,544	-15%	20,260	-58%
Canvasback	11,594	491	-96%	3,220	-85%
Sabine's gull	21,317	25,061	18%	15,057	40%
Mew gull	14,984	13,262	-11%	11,922	10%
Glaucous gull	38,158	24,694	-35%	40,673	-65%
Arctic tern	24,055	21,121	-12%	18,194	14%
Pacific loon	15,807	16,052	2%	16,689	-4%
Red-throated loon	2,659	3,462	30%	2,363	32%
Jaeger spp.	2,468	2,018	-18%	2,315	-15%

Table 3. Summary of trends for waterbird species counted by the right-rear-seat observer on the Yukon-Kuskokwim Delta coastal zone aerial survey Alaska. Ducks have been counted since 1988. Other species have been added to the survey as indicated. Geographic stratification into 18 regions represents a balance determined by sampling intensity, similar physiographic areas, and reasonable gains in precision for most of the species. Green-shaded cells indicate growth rates significantly above 1.0 and yellow-shaded cells indicate significantly declining trends.

Fig. #	Species	No. of years	Average pop. Index	Standard deviation pop. Index	Log slope	SE slope	Growth Rate	Low 90%CI GR	High 90%CI GR	CV regress. Resids.	CV sampling error	Yrs. to detect change w/ regress. Resid. CV	Yrs. to detect change w/ sample error CV	Growth rate last 7 yrs.	Low 90%CI GR last 7 yrs.	High 90%CI GR last 7 yrs.
5	Northern pintail	18	50,125	13928	-0.0172	0.0120	0.9829	0.9637	1.0026	0.265	0.114	16.4	9.4	1.0225	0.9597	1.0894
6	Greater scaup	18	36,909	6192	0.0227	0.0062	1.0229	1.0126	1.0334	0.136	0.100	10.6	8.6	1.0236	1.0019	1.0458
7	Northern Shoveler	18	9,888	3113	0.0078	0.0137	1.0078	0.9853	1.0308	0.302	0.179	17.9	12.7	1.0518	0.9791	1.1298
8	Mallard	18	4,073	1565	-0.0223	0.0155	0.9779	0.9533	1.0032	0.342	0.226	19.5	14.8	1.1333	1.0393	1.2359
9	Green-winged teal	18	2,810	993	0.0056	0.0181	1.0056	0.9761	1.0359	0.398	0.224	21.6	14.7	0.9512	0.8543	1.0590
10	Black scoter	18	10,295	2689	0.0233	0.0156	1.0236	0.9977	1.0501	0.343	0.196	19.5	13.4	1.0501	0.9735	1.1327
11	Spectacled eider	18	2,552	928	0.0625	0.0106	1.0645	1.0461	1.0832	0.233	0.140	15.1	10.8	1.0161	0.9653	1.0695
12	Long-tailed duck	18	6,397	1536	0.0191	0.0113	1.0193	1.0006	1.0384	0.248	0.144	15.7	11.0	1.0356	0.9876	1.0860
13	American wigeon	18	5,106	2332	-0.0670	0.0186	0.9352	0.9070	0.9641	0.409	0.385	22.0	21.1	0.9791	0.8510	1.1264
14	Common eider	18	1,219	571	0.0484	0.0193	1.0496	1.0168	1.0834	0.425	0.245	22.5	15.6	1.0415	0.8902	1.2186
15	Red-breasted merganser	18	888	1246	0.1197	0.0404	1.1272	1.0547	1.2047	0.891	0.476	36.9	24.3	0.9227	0.6444	1.3212
16	Canvasback	18	1,262	1078	-0.0458	0.0456	0.9552	0.8862	1.0296	1.005	0.530	40.0	26.1	0.8385	0.5804	1.2113
17	Goldeneye spp.	18	113	299	-0.1275	0.0654	0.8803	0.7905	0.9803	1.445	0.152	50.9	11.4	1.0000	0.7240	1.3813
18	Sabine's gull	14	15,772	6041	0.0665	0.0224	1.0687	1.0301	1.1088	0.337	0.104	19.3	8.8	1.1548	1.0616	1.2562
19	Glaucous gull	14	39,532	13089	-0.0081	0.0211	0.9920	0.9581	1.0271	0.319	0.162	18.6	11.8	0.9844	0.8997	1.0771
20	Arctic tern	14	18,403	4965	0.0490	0.0134	1.0502	1.0274	1.0735	0.201	0.109	13.7	9.1	1.0928	1.0169	1.1745
21	Pacific loon	17	16,651	3254	0.0183	0.0092	1.0185	1.0032	1.0340	0.186	0.085	13.0	7.7	0.9415	0.9200	0.9635
22	Mew gull	14	12,018	2906	0.0385	0.0146	1.0393	1.0146	1.0646	0.221	0.133	14.6	10.4	1.0469	1.0175	1.0771
23	Red-throated loon	17	2,428	644	0.0168	0.0148	1.0169	0.9925	1.0419	0.2980	0.1571	17.79	11.61	1.079	1.0304	1.1297
24	Jaeger spp.	14	2,294	497	-0.0036	0.0129	0.9964	0.9755	1.0178	0.214	0.168	14.3	12.1	0.9957	0.9514	1.0420