Relative Abundance and Trends of Waterbirds from Aerial Breeding Pair Surveys, 1988 to 2003, on the coastal zone of the Yukon Kuskokwim Delta, Alaska

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Relative Abundance and Trends of Waterbirds from Aerial Breeding Pair Surveys, 1988 to 2003, on the coastal zone of the Yukon Kuskokwim Delta, Alaska

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Abstract: Sixteen years (1988-2003) of annual aerial surveys for breeding waterfowl have been flown on the coastal zone of the Yukon Kuskokwim delta. This report summarizes data collected by the observer in the back seat of the aircraft. Northern pintails (*Anas acuta*), greater scaup (*Aythya marila*), and northern shovelers (*Anas clypeata*) were the most numerous waterfowl species averaging 154,839, 80,753, and 37,248 birds (with visibility correction), respectively, for the history of the survey. The average number for four species of special concern, the threatened spectacled eider (*Somateria fisheri*), long-tailed duck (*Clangula hyamelis*), black scoter (*Melanitta nigra*) and red-throated loon (*Gavia stellata*), was 8,735, 12,007, 11,681, and 2,343, respectively. The 2003 population estimate for mallards (*Anas platyrhynchos*) was the lowest in the history of the survey as this species population decline continued. After pintails, scaup, and shovelers, other waterfowl species in decreasing order of abundance were American green-winged teal (*Anas crecca*), American wigeon, mallard, long-tailed duck, black scoter, spectacled eider, common eider (*Somateria mollissima*), and canvasback (*Aythya valisineria*). Very small numbers of goldeneyes (*Bucephala* spp), mergansers (*Mergus* spp), common loons (*Gavia immer*), and red-necked grebes (*Podiceps grisegena*) were seen on the surveys. Population trends based on log-linear regression were significantly declining for mallards and American wigeon at the 0.10 level. Significantly increasing populations occurred for spectacled eiders, common eiders, greater scaup, red-breasted mergansers (*Mergus serrator*), and Pacific loons (*Gavia pacifica*). The average population size for glaucous gull (*Larus hyperboreus*), mew gull (*Larus canus*), and Sabine's gull (*Xema sabini*) was 40,883, 11,667, and 14,536, respectively. Mew gulls, Sabine's gulls, and arctic terns(*Sterna paradisaea*) showed an increasing population trend whereas glaucous gulls were stable. Over 84,000 geographic locations of 33 species of waterbirds have been collected and incorporated into a geographic information system for research and management purposes.

January 2004

Annual aerial surveys of breeding waterbirds on the coastal zone of the Yukon-Kuskokwim Delta, Alaska provide population indices, trends, and distributions for use by biologists and land managers. Since 1985, intensive systematic aerial surveys have been conducted to monitor populations of several goose species that had declined . The initial surveys consisted of a pilot/observer in the left front seat and an additional observer in the right front seat of the aircraft, each counting geese, swans, and cranes (Eldridge 2003).

In 1988, an observer in the right rear seat was added to record other species and begin monitoring their populations. This was done because it was too difficult for the front seat observers to record the large numbers of birds of all species on the Yukon Delta. The objective for the back seat observer was to document the relative abundance, trend, and distribution of ducks, gulls, terns, grebes, jaegers (*Stercorarius* spp.), and loons. These surveys have been primarily used to monitor the threatened spectacled eider population and other species of concern such as the red-throated loon, black scoter, and long-tailed duck. Our objective in this report is to summarize the population indices and trends for all species recorded by the rear seat observers from 1988 to 2003.

METHODS

Survey Design

The survey area included the coastal tundra from Norton Sound in the north to Kuskokwim Bay in the south and extended from the west coast to about 50 km inland. This area was divided into 18 strata by identifying areas of generally homogeneous physiographic features from unclassified LANDSAT images at 1:250,000 scale. The survey area encompassed 12,832 km^2. The survey was originally designed to optimize monitoring of declining goose populations. We used a True BASIC program and ARC/INFO geographic information system (GIS) software to generate systematically-spaced transects from a random coordinate within the survey area. Transects were oriented east west along great circle routes and totaled about 2,500 kms (Fig. 1) for a sample of about 500 km^2. Strata known to have higher numbers of waterfowl were allocated more transects. Prior to 1998, we used a 1.61-kilometer transect spacing in the higher density areas. Transects in other strata with fewer waterfowl were spaced at 3.22, 6.44, or 12.88 kilometers. The survey design changed slightly in number and placement of transects over the years. In 1998, we generated four distinct sets of transects. Since 1998, transects have been spaced at 1.60, 3.20, 6.40, or 12.80 km within the various strata. A different set of transects was flown in each year, 1998-2001, such that we obtained complete coverage in the 1.60 km interval strata when combining data from those four years. In 2002, we began repeating the sets of transects by flying the same lines as in 1998 and in 2003 we flew the same transects as in 1999.

Data Collection

Survey methods followed the conventions established for breeding ground surveys in North America (USFWS and CWS 1987). The surveys were generally flown during the first 2 weeks of June to coincide with egg-laying or early incubation stages of breeding waterfowl (Fig. 2). The 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, 1992-2003) and survey maps to maintain a precise course while flying transects.

Data collection prior to 1998 used cassette recorders running continuously while on the transects (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 a GPS receiver and a remote microphone and mouse. The observer recorded transect numbers, start and stop points, cardinal direction of the transect start, and bird observations out to 200 meters into the computer to a .WAV sound file using the remote microphone and mouse. Birds observed were identified to species and counted as a single, pair, or number in flock. Simultaneously, latitude/longitude coordinates for each observation were automatically downloaded from the GPS to a text file. A computer transcription program was used to replay the sound files, enter header information (e.g. year, month, day, observer initials, etc), species codes, and group sizes and combine these with the coordinate information to produce a final data file. Karen Bollinger was the observer in 1988 and 1989, Leslie Slater observed in 1990, and Bob Platte has collected the data since 1991.

We collected sixteen years (1988 to 2003) of aerial counts of duck species but data on other waterbird species were not collected in all years. Jaegers were recorded in 1989, then 1993 to 2003. Loons were recorded from 1989 to 2003. Gulls and terns were recorded from 1992 to 2003. The back seat observer was unable to collect data on thirteen transects north of the Askinuk Mountains in 1997. Data from the 1996 survey for those transects were added to the 1997 data set to make up for the missing transects. Twenty-three transects were not flown in 1999. Thus, the 1999 population indices may be biased for some strata with missing transects. However, the survey was generally flown by skipping some transects early in the survey, then doing them later to spread the effort out over time. Thus while some transects were missed in some strata in 1999, the transects flown were relatively systematically spaced. The back seat observer was unable to fly thirteen transects in the central coastal zone and the 23 transects north of the Askinuk Mountains in 2001. No data were collected for the 13 mid-coast transects, however, William Eldridge, in the right front seat, recorded observations for all species on the 23 transects north of the Askinuk Mountains. This was accomplished because of the relatively lower number of geese, swans, and cranes north of the Askinuk Mountains. Finally, eleven transects north of the Askinuk Mountains had no data for the 2003 survey due to a malfunctioning microphone.

Data Analysis

We calculated densities, population indices, and variability for each species using a ratio estimate described by 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 bird pairs observed, and F = number of birds in flocks. For ducks, a single male was assumed to represent a breeding pair with the nesting hen not easily observable. Single male ducks were doubled for all observed species except scaup. Single observations of other waterbird species (grebes, loons, terns, and gulls) were not doubled. Population indices were calculated for each year for 18 strata and summed for the entire survey area. This stratified analysis was done to try to reduce the variance of the indices. Population index variance was based on the variation among sampling units (entire transects). Population indices in this report were not corrected for visibility bias unless noted.

The population index was plotted for each year by species and included the singles, pairs, and flock components. The 95% confidence interval, indicated by a vertical line, around each annual index was calculated as the ratio estimator variance among the transects (sampling error) within each of the 18 physiographic strata. This sampling standard error divided by the mean index estimated the annual coefficient of variation (CV) of the population index. The average of the estimated annual CVs provided a measure of average survey precision, the sampling error CV. The trend was the average rate of log-linear population change (Stehn 1993). Trend lines were presented for indicated total birds (ducks) or observed total birds (species other than ducks).

The residuals around the regression line provided another estimate of survey precision, a residual CV that included both sampling error and lack-of-fit error. A standardized measure of the relative precision of the aerial survey for each species can be calculated from the approximate formula of Gerrodette (1987) that relates sample size, slope, CV, and probabilities for Type 1 and Type 2 errors. With alpha and beta at 0.10, if the population grew with a slope of 0.0693 (50% change over 10 years) and the estimated sampling error CV was accurate, the minimum years to detect a slope significantly different from 0.0 was calculated.

The number of Spectacled Eider observations recorded on the early June Yukon-Kuskokwim aerial survey depends on both population size and timing of the survey relative to chronology of nesting. We assumed there was no trend in the observer's detection rates of male eiders over time (both within and between years), and also assumed the proportion of males remaining to be seen progressively declines after clutch completion.

RESULTS

Relative abundance

Relative abundance indices by group category for species with sufficient data are shown in Figs. 3 - 22. None of the population indices in these figures was corrected for visibility bias (detection rate). For the following results, we used the correction factors determined by helicopter/fixed-wing aircraft comparisons (Conant et al. 2000). Based on the sixteen-year average population indices for each species corrected for detection rate, the most abundant species was northern pintail (154,839), followed by greater scaup (80,753), then northern shoveler (37,248). The average number for four species of special concern, the threatened spectacled eider, long-tailed duck, black scoter, and red-throated loon, was 8,735, 12,000, 11,681, and 2,343, respectively. Very small numbers of canvasbacks, goldeneyes, mergansers, common loons, and red-necked grebes were seen on the surveys.

Corrected for visibility, the number of pintails and scaup for 2003 was 144,070 and 89,897, respectively. The 2003 estimate for mallards was the lowest in the history of the survey. Remaining waterfowl species in decreasing order of abundance for 2003 were northern shoveler, American green-winged teal, spectacled eider, long-tailed duck, mallard, black scoter, common eider, American wigeon, canvasback, and red-breasted merganser.

Population trend/power analysis

Mallards and American wigeon showed a relatively strong decreasing trend (Figs. 7 and 8). Significantly increasing trends occurred for common eiders, spectacled eiders, scaup, and Pacific loons. Other species showed relatively stable trends over the survey period.

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Spectacled eider population and trend

The number of indicated total spectacled eiders from the aerial survey in 2003 was 3,487 birds or 1,744 pairs (uncorrected for visibility bias). The spectacled eider nest estimate for the entire coastal zone from the ground study in 2003 was 2,543 (Fischer et al. 2003). Corrected with a nest detection rate of 78% (T. Bowman, unpub. data), the nest population estimate was 3,260. Thus, the proportion of aerial pairs to nests was 0.53. Spectacled eider nesting chronology in 2003 was similar to 2002 but about 1 week earlier than the long-term ground plot average (Fischer et al. 2003). The population growth rate for aerial indicated total birds from 1988 to 2003 was 1.073 (Fig. 23). The growth rate for the nest population from ground studies during this same period was 0.98.

Distribution

The geographic locations of over 84,000 observations of 33 species of waterbirds have been collected over the 16 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 of the various species observed during the 2003 survey are given in Figs. 24-31. Point observations have been used to interpolate bird density polygons to predict overall distribution (Fig. 32) (Platte and Stehn, 2002).

DISCUSSION

Three different observers have collected data for this survey, although the same observer has collected the last 13 years data. All observers were experienced at identifying and counting birds from aircraft, however, there was the possibility of a "learning curve" for some species and that an observer became more skilled over time resulting in more accurate information in later years. Thus, both relative abundance indices and population trends could be affected by this. Trends can be statistically significant but still not reflect actual population change. As the observer gained experience on the area, species identification and counting of groups probably improved. However, the long-term trends were influenced by the low counts in the early years. It is difficult to determine whether the trends reflect actual population growth or are attributable to this or other potential errors in the survey. Strip width may vary both within a survey and between years although an effort was made to be consistent. Some proportion of each species was missed each year due to various factors such as weather. It was assumed that there was no trend in detection rates for the trend calculations. The trends could be biased if this assumption was not true.

Timing of surveys was also a factor potentially affecting trend. The survey was supposed to be timed according to annual phenology to coincide with the first half of incubation for geese nesting in the area. However, we were not always able to time our surveys optimally. In some years, surveys were early relative to breeding chronology and phenology, whereas other years surveys were late relative to these factors. To get the best trend information, the surveys should be timed consistently relative to nesting chronology every year. Spectacled eider males begin to depart the breeding grounds shortly after the hens begin incubating so the survey misses an unknown portion of these males. If the survey timing was late relative to phenology, a greater proportion of spectacled eiders had departed resulting in a lower population index for that year (Platte et al. 1999). Thus, the true growth rate may be lower than reported here.

The discrepancy between the trend in nests (Fischer et al. 2003) and the trend in aerial estimates is due partly to a decline in nests from 1988-1993. The growth rate of number of nests from 1993-2003 has been stable. Since 1993, the nests estimates and aerial birds estimates track very closely, except for 2001 and 2003, poor production years. The number of spectacled eider pairs detected during the aerial survey in 2001 was the highest in the history of the survey. This may have been due to high fox predation on nests and/or late nesting chronology causing increased visibility of the birds. Predation was also high in 2003 but nest initiation was relatively early. This may have accounted for relatively higher numbers of pairs of spectacled eiders being observed in 2003 as well.

The large number of geographic locations of birds has been useful for a number of purposes. Distribution information has been used to evaluate coastal zone areas for potential inclusion as designated critical habitat for spectacled eiders. Density distribution maps have been used to evaluate potential land exchange impacts on waterbirds. Survey information has been incorporated into Birds of North America species accounts for Sabine's gulls. Loon information has been contributed to the Loon Working Group for baseline monitoring and red-throated loon ground work. Seaduck trends were useful for comparison with other information in evaluating population status.

The survey was originally designed to monitor geese. Because the distribution of Cackling Canada geese coincided with that of the spectacled eider, the survey was stratified appropriately for spectacled eiders. However, the sampling intensity was low for other sea duck species because they occurred farther inland, which was sampled only every 12.80 km.

RECOMMENDATIONS

Currently there are two survey efforts to monitor the spectacled eider population on the Yukon Delta: the coastal zone aerial survey and the nest plot survey. Because the nest plot survey does not sample the entire coast, it is necessary to continue the aerial survey to expand the nest estimate. We believe these two surveys are highly complementary and provide more detailed information when analyzed together than either one alone for monitoring the spectacled eider population.

The aerial survey provided information on other species of interest. However, the information is limited because these species range beyond the coastal zone. Long-tailed ducks, scoters, and scaup are abundant in more inland strata that were not sampled as intensively. If more detailed information is desired for these species, we need to allocate more effort in this area. We should examine the effect of decreasing the number of transects in high intensity sample strata to determine effect on precision of cackling Canada goose population estimates by subsampling existing data. If these strata could be sampled at a lower rate, then we could increase sampling in inland strata to obtain better information on seaducks such as long-tailed ducks, black scoters, and greater scaup.

ACKNOWLEDGMENTS

We received funding for the 2003 survey from the Alaska Army National Guard with special thanks to Kent Richter.

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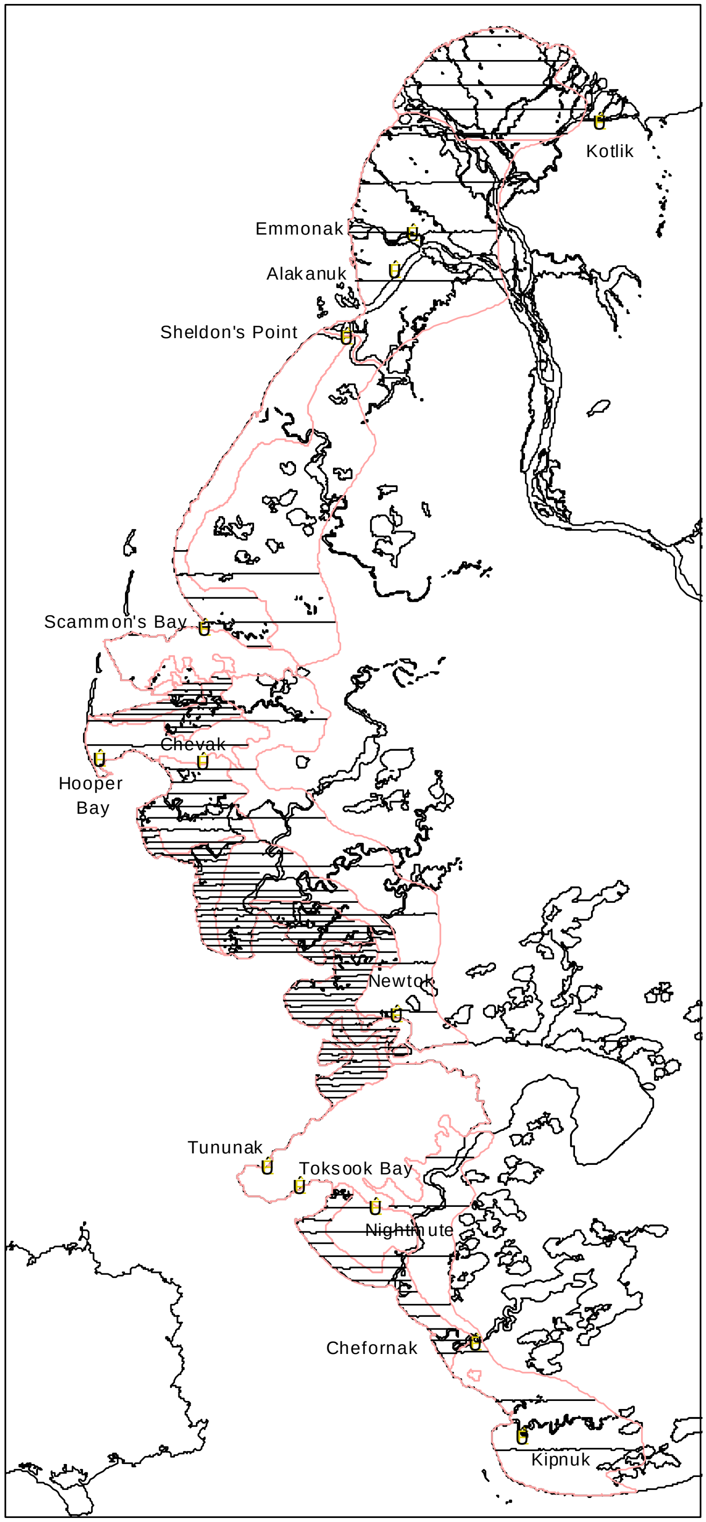

Fig. 1. 2003 aerial strip transects of 200 meter width (horizontal lines) on the coastal zone of Yukon Delta NWR, Alaska. No data were recorded for 11 transects north of Scammon Bay due to microphone malfunction.

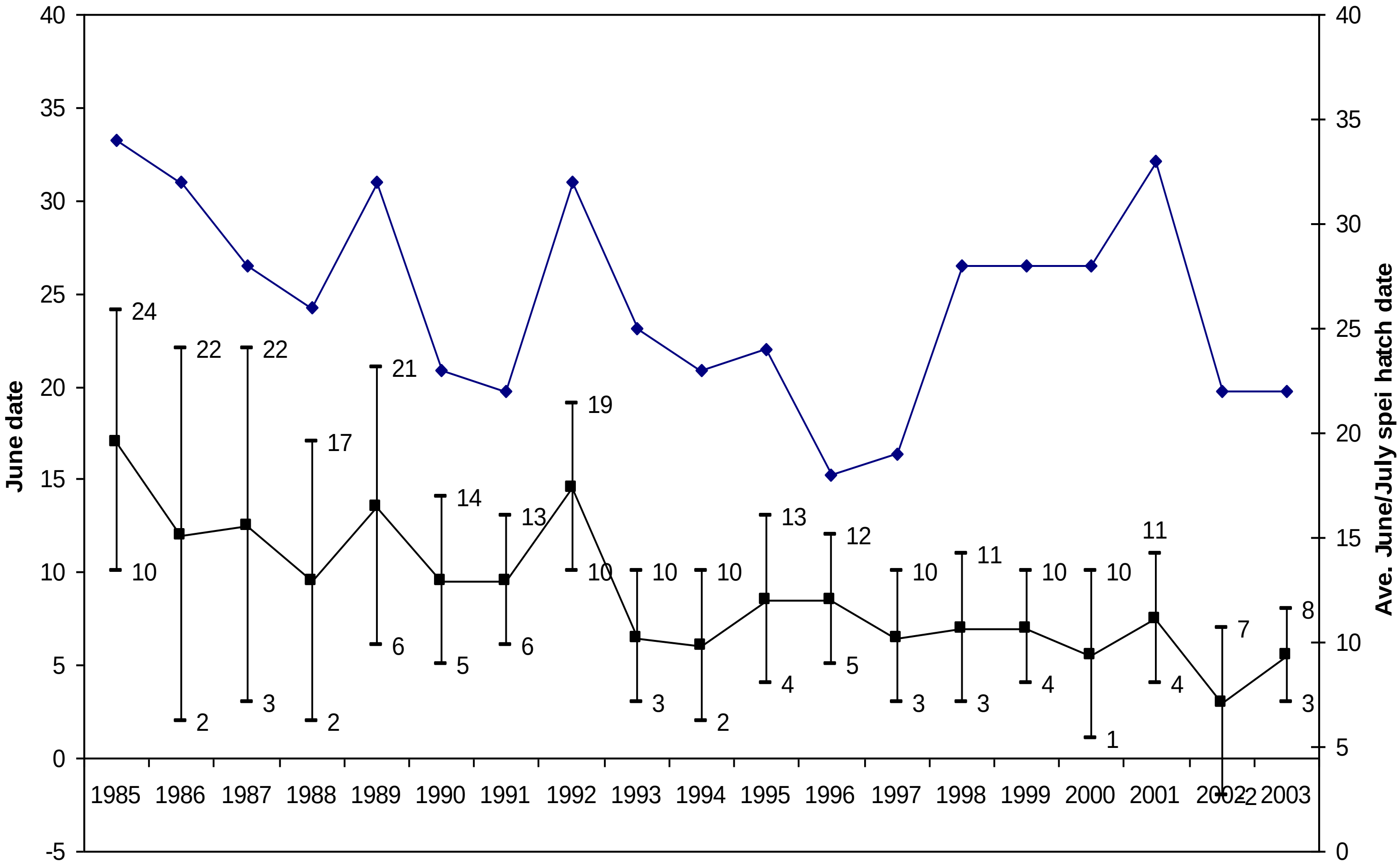

Fig. 2. Timing and duration of the coastal zone aerial survey in relation to average spectacled eider hatch date from ground surveys (Fischer et al. 2003), Yukon-Kuskokwim Delta, Alaska, 1985-2003.

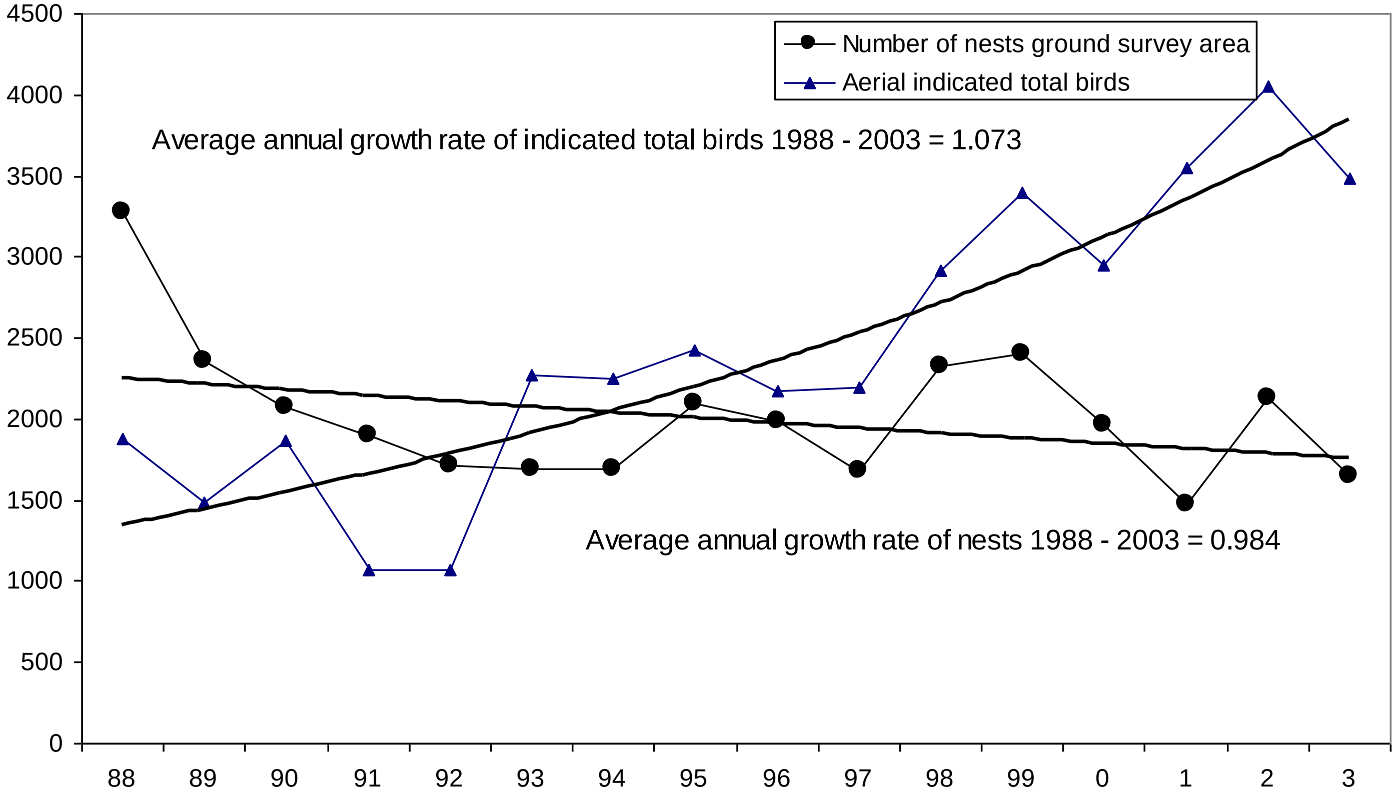

Fig. 23. Population estimates and trends for spectacled eider nests from the ground-sampled area (Fischer et al. 2003) and indicated total birds from aerial surveys of the Yukon Delta coastal zone, 1988 - 2003.