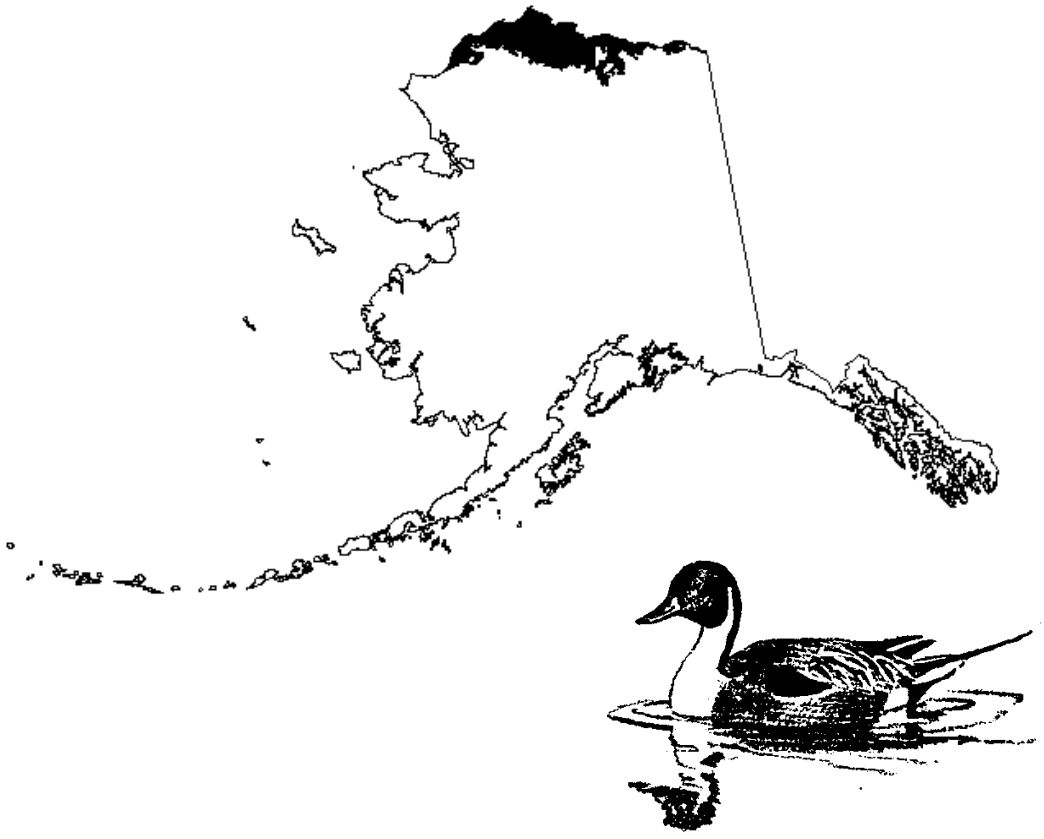
# AERIAL BREEDING PAIR SURVEYS OF THE ARCTIC COASTAL PLAIN OF ALASKA - 2002



**U.S. Fish and Wildlife Service**
**Waterfowl Management**
**1412 Airport Way, Fairbanks, AK 99701**

# AERIAL BREEDING PAIR SURVEYS OF THE ARCTIC COASTAL PLAIN OF ALASKA - 2002

Edward J. Mallek, *U.S. Fish and Wildlife Service, Waterfowl Management, 1412 Airport Way, Fairbanks, AK, 99701*

Robert Platte and Robert Stehn, *U.S. Fish and Wildlife Service, Waterfowl Management, 1011 E. Tudor Rd., Anchorage, AK, 99503*

**Abstract:** An aerial breeding pair survey was conducted on the Arctic Coastal Plain of Alaska for the 17th consecutive year on 20-24 June 2002. Spring break-up was relatively normal providing typical bird concentrations and breeding effort in the survey area. The population estimate for northern pintails (178,635) was 22% below the previous 16-year mean (229,611). The estimate for long-tailed ducks (96,946) was 13% below the 16-year mean (111,768). Estimates for greater white-fronted geese and tundra swans were down by 3 and 6% from their long term means, respectively. The total loon estimate was 18% below the long term mean with Yellow-billed loons (1,948) 46% above last year's estimate but still 34% below the long-term mean (2,957).

**Key Words:** aerial survey, Alaska, Arctic Coastal Plain, breeding pair survey, waterfowl **February 2003**

## INTRODUCTION

This report summarizes results from the 2002 aerial breeding pair survey on the Arctic Coastal Plain (ACP) of Alaska. Population estimates for 1986-2001 were reported previously (Brackney and King 1993, 1994, 1995, 1996, King and Brackney 1997, Mallek and King 2000, Mallek 2001, Mallek et al. 2002). This survey, conducted for 17 consecutive years, monitors the majority of waterfowl populations on the ACP. Some waterfowl species (i.e., spectacled eiders) are more appropriately monitored by surveys that are temporally designed to focus on early breeders (Larned et al. 2003). Similarly, breeding waterfowl which have limited spatial distributions (i.e., Pacific brant and common eiders) are more appropriately monitored by surveys which focus efforts to specific areas (Ritchie 2001, Dau and Taylor 2000). This survey provides population estimates for breeding waterbird species that are found throughout the ACP, and is supplemental to continental breeding pair survey area coverage in Alaska (Conant and Groves 2002).

Several modifications of analysis techniques were initiated with the 2001 survey. Previous analyses of survey data were conducted with a non-stratified approach. The reports from last year (2001 survey, Mallek et al. 2002) and this year incorporate a stratified analysis of the survey area which is described in the methods section. All waterbird estimates from previous years remain unchanged from their non-stratified approach. This stratified analysis was initiated in an attempt to decrease estimates of variance and to simplify comparisons between this survey and the survey conducted by Larned et al. 2003, which is conducted prior to this survey and samples a smaller portion of the ACP.

In an effort to standardize analysis techniques of goose observations during breeding pair surveys conducted by the U.S. Fish and Wildlife Service (USFWS) in Alaska, all lone goose observations will be doubled for analysis. The rationale for doubling lone goose observations is that an observation of a lone goose implies a pair with the unseen goose on a nest. The reports from last year (2001 survey, Mallek et al. 2002) and this year incorporate this change in analysis and previous survey estimates have been updated accordingly in the tables and figures. Since the majority of geese are observed in flocks, this change in analysis techniques will not greatly affect previous estimates.

## STUDY AREA AND METHODS

### Study Area and Survey Design

The survey area (61,645.2 $km^2$) included all contiguous waterfowl habitat north of the Brooks Range, from the northwest coast of Alaska east to the U.S.-Canada border (Fig. 1). Survey design (Brackney and King 1995) was similar to that used for the North American Waterfowl Breeding Pair Survey. Survey transects were 0.4 km wide, with each observer responsible for ½ of the transect width. Transects were placed systematically from a randomly selected start in an east-west orientation and were 18.8 km apart (Fig. 1). Slightly over 2% of the survey area was sampled.

### Survey Procedures

Survey procedures followed U.S. Fish and Wildlife Service protocol for waterfowl breeding pair surveys (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987). The centerline of each transect was flown in an amphibious configured Cessna 206 aircraft at 30-45 m (100-150 ft) above ground level and at 145-170 km/hr (90-105 mph). Airplane navigation and altitude were maintained with a Global Positioning System (GPS) and a radar altimeter, respectively. All waterbirds and raptors observed within 0.20 km of the transect centerline were recorded by the pilot/observer and observer for their respective sides.

Observations were recorded directly into laptop computers as sound files using a program developed by John Hodges (USFWS, Region 7, MBM-Juneau). Each laptop computer (one for each observer) was linked to the aircraft GPS unit. The program simultaneously recorded observations and their coordinates into linked sound and ASCII files, respectively. A second computer program, also developed by John Hodges, was used on the ground to replay the linked sound files and produce transcribed ASCII files. The transcribed ASCII files were then used for data analysis.

Observations of waterfowl were recorded according to established survey protocol (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987). All observations of lone male ducks (drakes) were recorded as singles. Drakes in flocks were recorded as flocked drakes. A male duck in close association with a female was recorded as a pair. Ducks in mixed-sex groupings of 3 or more of the same species which could not be separated into singles and pairs were recorded as groups (a hen and two drakes were recorded as a pair and a lone drake). All observations of lone geese were recorded as singles, two geese in close association were recorded as a pair, and geese in groups of 3 or more of the same species that could not be separated into singles and pairs were recorded as groups.

### Statistical Procedures

Statistical procedures followed those reported by Smith (1995). For ducks, all observations of lone drakes, flocked drakes (<5), and pairs were doubled. Groups of ducks and observations of male scaup were not doubled. For geese, all observations of lone geese and pairs were doubled for analysis. Groups of geese were not doubled. For non-duck and non-goose observations, only the observations of pairs were doubled for analysis. We corrected for visibility bias (ducks present but not observed in the area sampled) by applying visibility correction factors, developed for coastal tundra habitats (Conant et al. 1991, Smith 1995), to the population estimates and variances. Population size and variance were estimated with the ratio method (Cochran 1977, Smith 1995).

Data were analyzed with computer programs developed by Bob Stehn and Bob Platte (USFWS,

Region 7, MBM-Anchorage) using standard statistical techniques for strip-survey analysis. For analysis purposes the survey area was divided into 16 strata with transect placement based on a random systematic coverage of the entire survey area (Figs. 1 and 2). Strata boundaries were based on geomorphic/aquatic features delineated from satellite imagery of the ACP. A geographic information system (GIS) was used to cut continuous transects at stratum boundaries for analysis.

## RESULTS & DISCUSSION

### Population Estimates

The 2002 survey was conducted on 20-24 June. A total of 1,277.2 $km^2$ was sampled, which comprised 100% of the designed sample area (Fig. 1). Spring break-up on the ACP was normal to slightly early, providing typical distribution of waterfowl species and breeding behavior. Population estimates are listed in Tables 1-4. Sampling effort and strata information are listed in Table 5. Number of observations of singles, pairs, and flocks as well as population estimates and trends for all survey years are shown in Figs. 3-20 and Tables 6-18 for primary species.

The northern pintail estimate (178,635) was 22% below the long-term mean (1986-2001). The low pintail estimate can be attributed to a below average flock component (Fig. 3). Indeed, the number of pintails observed in flocks (222) was the smallest since the survey started. Pintail estimates have varied considerably over the years, but the long term trend suggests a flat growth rate (Table 6, Figs. 3 and 4). The long-tailed duck estimate (96,946) remains 13% below the long-term mean but was the second highest estimate in the last five years. While the number of long-tailed ducks observed as pairs has remained relatively similar throughout the years of this survey and the number of birds observed as singles has varied throughout the years, in recent years, the flock component of observations has been quite low when compared to earlier survey results from the late 80's and early 90's. This has resulted in an estimated negative growth rate for long-tailed ducks (Table 7, Figs. 5 and 6). This years scaup estimate (27,509) is 18% below the long-term mean, but is very similar to the 2001 survey results (28,327). Similar to pintails, the low scaup estimate can be attributed to a low number of birds observed in flocks. In fact, only 35 scaup were observed in flocks, which is the lowest number ever recorded for this survey. (Table 8, Fig. 7). Similar to pintails, the estimated growth rate for scaup is also flat (Fig. 8).

All goose estimates were below their long-term means with the exception of black brant. Since black brant and snow geese are colonial nesters and most observations are of flocked birds, their numbers are only reported incidently and their estimates and trends are probably not reflective of their true values across the Arctic Coastal Plain. The estimate for white-fronted geese (120,314) was 3% below the long-term mean (124,579) and contained a large component of paired birds. Furthermore, white-fronted goose estimates suggest a significant growth rate over the years this survey has been conducted (Table 9, Figs. 9 and 10). Canada geese were estimated at 9,324 which is 52% below the long-term mean of 19,349.

The tundra swan estimate (9,389) was 6% below the long-term mean (9,998, Table 10, Figs. 11 and 12). The tundra swan nest estimate (1,084) was 16% below the long-term mean (1,287, Table 11, Fig. 13).

All three loon species were estimated below their long-term means. Pacific (22,702) and yellow-billed (1,948) loons were 18 and 34% below their long-term means, respectively. These two species have remained below their long-term means for the past 3 and 4 years, respectively, although long-term growth rates were not significant and are quite flat (Tables 13 and 15, Figs. 15 and 17). Red-

throated loons (2,945) were 4% below their long-term mean (Table 14, Fig. 16).

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*Data and conclusions presented here are preliminary and are not for publication or citation in published manuscripts without permission from the authors.*

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Table 1. Population estimates of ducks from an aerial breeding pair survey on the Arctic Coastal Plain of Alaska, 20-24 June 2002.

| Species | VCF | Drakes[a] | Pairs | Groups | Indicated Birds | Pop. Index | SE |
|---|---|---|---|---|---|---|---|
| Mallard | 4.01 | 1 | 2 | 0 | 6 | 1,071 | 749 |
| American Wigeon | 3.84 | 1 | 0 | 0 | 2 | 361 | 239 |
| American GW Teal | 8.36 | 0 | 0 | 0 | 0 | -- | -- |
| Northern Shoveler | 3.79 | 4 | 0 | 0 | 0 | 1,365 | 716 |
| Northern Pintail | 3.05 | 389 | 109 | 222 | 1,218 | 178,635 | 19,978 |
| Dabbler | | | | | | 181,432 | |
| Scaup | 1.93 | 141 | 61 | 35 | 298 | 27,509 | 5,776 |
| Long-tailed Duck | 1.87 | 295 | 168 | 96 | 1,177 | 96,946 | 16,053 |
| Black Scoter | 1.17 | 4 | 3 | 0 | 14 | 771 | 295 |
| Surf Scoter | 1.17 | 0 | 0 | 0 | 0 | -- | -- |
| White Winged Scoter | 1.17 | 20 | 26 | 25 | 117 | 6,324 | 2,223 |
| Unknown Scoter | 1.17 | 12 | 4 | 57 | 89 | 4,835 | 1,774 |
| R. B. Merganser | 1.27 | 12 | 4 | 9 | 41 | 2,468 | 846 |
| King Eider | 1.0 | 18 | 25 | 9 | 95 | 4,525 | 1,048 |
| Common Eider | 1.0 | 0 | 0 | 0 | 0 | -- | -- |
| Steller's Eider | 1.0 | 0 | 0 | 0 | 0 | -- | -- |
| Spectacled Eider | 1.0 | 4 | 3 | 0 | 14 | 729 | 185 |
| Unknown Eider | 1.0 | 0 | 0 | 0 | 0 | -- | -- |
| Diver Total | | | | | | 144,107 | |
| Ducks Total | | | | | | 325,539 | |

[a]Indicates drakes only in flocks of 4 or less. This number is doubled to estimate indicated birds, except for scaup drakes which are not doubled in value.
Survey area = 61,645.2 $km^2$, Sample area = 1,277.2 $km^2$
Visibility correction factor = VCF, Number of transects (n) = 76

Table 2. Population estimates of waterfowl and related species from an aerial breeding pair survey on the Arctic Coastal Plain of Alaska, 20-24 June 2002.

| Species | VCF | Singles | Pairs | Groups | Indicated Birds | Pop. Index | SE |
|---|---|---|---|---|---|---|---|
| White Fronted Goose | 1 | 126 | 253 | 1,787 | 2,545 | 120,314 | 11,404 |
| Small Canada Goose | 1 | 14 | 11 | 142 | 192 | 9,324 | 4,069 |
| Lesser Snow Goose | 1 | 2 | 4 | 0 | 12 | 529 | 185 |
| Brant | 1 | 6 | 5 | 191 | 213 | 10,233 | 7,151 |
| Geese total | | | | | | 140,400 | |
| Tundra Swan | 1 | 88 | 45 | 16 | 194 | 9,389 | 925 |
| Tundra Swan nest | 1 | 22 | 0 | 0 | 22 | 1,084 | 185 |
| Sandhill Crane | 1 | 1 | 1 | 3 | 1 | 144 | 123 |
| Pacific Loon | 1 | 208 | 133 | 3 | 477 | 22,702 | 1,418 |
| Red Throated Loon | 1 | 41 | 10 | 0 | 61 | 2,945 | 555 |
| Common Loon | 1 | 0 | 0 | 0 | 0 | -- | -- |
| Yellow-billed Loon | 1 | 31 | 5 | 0 | 41 | 1,948 | 370 |
| Unidentified Loon | 1 | 4 | 1 | 0 | 6 | 290 | 123 |
| Loons total | | | | | | 27,885 | |
| Jaeger sp. | 1 | 68 | 14 | 12 | 108 | 5,301 | 555 |
| Golden Eagle | 1 | 11 | 0 | 0 | 11 | 497 | 123 |
| Snowy Owl | 1 | 13 | 0 | 0 | 13 | 626 | 185 |
| Arctic Tern | 1 | 119 | 27 | 281 | 454 | 21,248 | 2,836 |
| Glaucous Gull | 1 | 158 | 32 | 99 | 321 | 18,472 | 1,418 |
| Sabine's Gull | 1 | 43 | 19 | 122 | 203 | 9,298 | 1,418 |

Survey area = 61,645.2 $km^2$, Sample area = 1,277.2 $km^2$
Visibility correction factor = VCF, Number of transects (n) = 76

Table 3. Population estimates of waterfowl and related species on the Arctic Coastal Plain, Alaska 1986-1995.

| Species | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mallard | 357 | 1,070 | 1,427 | 1,784 | 1,784 | 1,076 | 2,294 | 1,128 | 781 | 1,120 |
| Gadwall | 0 | 0 | 0 | 0 | 0 | 0 | 290 | 0 | 0 | 0 |
| Wigeon | 2,050 | 5,467 | 342 | 1,538 | 7,005 | 3,091 | 10,252 | 360 | 3,840 | 1,787 |
| GW Teal | 5,951 | 6,323 | 1,488 | 3,719 | 4,463 | 748 | 2,391 | 2,351 | 1,592 | 1,556 |
| Shoveler | 2,023 | 0 | 1,349 | 337 | 1,012 | 678 | 1,446 | 1,421 | 361 | 706 |
| Pintail | 123,622 | 253,486 | 223,768 | 307,494 | 230,824 | 313,562 | 239,201 | 212,449 | 137,402 | 231,815 |
| Dabblers | 134,003 | 226,346 | 228,374 | 314,872 | 245,088 | 319,155 | 255,874 | 217,709 | 143,976 | 236,984 |
| Scaup | 21,639 | 21,811 | 42,848 | 45,596 | 33,918 | 27,014 | 36,070 | 27,864 | 30,054 | 35,662 |
| Goldeneye | 321 | 0 | 321 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bufflehead | 166 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long-tailed Duck | 114,649 | 120,389 | 148,178 | 142,603 | 114,233 | 115,985 | 103,507 | 110,884 | 120,576 | 120,196 |
| Scoter Sp.[a] | 6,871 | 9,266 | 10,567 | 21,915 | 8,381 | 15,434 | 17,787 | 11,242 | 7,799 | 17,970 |
| RB Merganser | 1,186 | 2,091 | 904 | 904 | 1,808 | 3,014 | 1,332 | 1,905 | 1,693 | 5,024 |
| Common Eider | 0 | 712 | 267 | 178 | 356 | 358 | 191 | 0 | 95 | 745 |
| King Eider | 2,536 | 1,646 | 1,068 | 3,871 | 3,115 | 6,931 | 1,049 | 3,984 | 1,619 | 1,303 |
| Steller's Eider | 0 | 0 | 0 | 2,002 | 534 | 1,118 | 954 | 1,313 | 2,524 | 931 |
| Spectacled Eider | —[b] | --- | --- | --- | --- | 268 | 0 | 1,125 | 476 | 279 |
| Unidentified Eider | 1,379 | 2,358 | 1,023 | 1,157 | 178 | 0 | 0 | 0 | 0 | 186 |
| Divers | 148,747 | 158,273 | 205,176 | 218,226 | 162,523 | 170,122 | 160,890 | 158,317 | 164,836 | 182,296 |
| Total Ducks | 282,750 | 384,619 | 433,550 | 533,098 | 407,611 | 489,277 | 416,764 | 376,026 | 308,812 | 419,280 |
| WF Goose | 119,905 | 91,385 | 98,237 | 148,646 | 90,318 | 121,321 | 122,479 | 100,311 | 93,386 | 84,213 |
| Canada Goose | 47,161 | 20,825 | 5,828 | 2,180 | 12,458 | 9,5570 | 27,366 | 4,875 | 3,619 | 7,037 |
| Snow Goose | 223 | 0 | 889 | 4,005 | 0 | 89 | 286 | 656 | 524 | 926 |
| Black Brant | 8,943 | 4,049 | 11,390 | 18,331 | 3,826 | 2,371 | 10,012 | 12,796 | 4,619 | 13,426 |
| Total Geese | 176,232 | 116,259 | 116,344 | 173,162 | 106,602 | 133,351 | 160,143 | 118,638 | 102,148 | 105,602 |
| Swans | 6,718 | 7,163 | 6,895 | 10,544 | 6,229 | 7,334 | 9,726 | 6,937 | 9,000 | 8,843 |
| Pacific Loon | 23,047 | 23,847 | 31,278 | 27,674 | 23,714 | 29,559 | 20,071 | 27,890 | 26,620 | 36,304 |
| RT Loon | 3,070 | 2,447 | 2,225 | 1,690 | 3,693 | 3,443 | 1,812 | 1,828 | 2,857 | 2,188 |
| YB Loon | 3,203 | 1,468 | 1,913 | 3,337 | 2,091 | 3,354 | 3,147 | 2,578 | 3,429 | 4,282 |
| Common Loon | 0 | 44 | 44 | 0 | 0 | 45 | 143 | 141 | 48 | 0 |
| Unidentified Loon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Loons | 29,320 | 27,806 | 35,460 | 32,701 | 29,498 | 36,401 | 25,173 | 32,437 | 32,954 | 42,774 |
| Jaegers | 9,432 | 6,585 | 12,769 | 3,470 | 8,765 | 9,123 | 7,103 | 9,094 | 5,573 | 4,422 |

[a] Includes all scoters identified and unidentified
[b] -- Indicates that observations of this species not delineated during that year

Table 4. Population estimates of waterfowl and related species on the Arctic Coastal Plain, Alaska 1996-2002.

| Species | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | Mean 1986-01 | % )[a] Mean - 02 |
|---|---|---|---|---|---|---|---|---|---|
| Mallard | 2,353 | 1,417 | 5,253 | 11,135 | 1,230 | 1,877 | 1,071 | 2,255 | -53 |
| Gadwall | 0 | 0 | 853 | 0 | 0 | 0 | 0 | 71 | -100 |
| Wigeon | 7,887 | 14,923 | 7,905 | 7,730 | 4,712 | 369 | 361 | 4,954 | -93 |
| GW Teal | 5,315 | 1,969 | 14,081 | 5,803 | 855 | 778 | 0 | 3,711 | -100 |
| Shoveler | 3,336 | 0 | 2,482 | 4,209 | 0 | 0 | 1,365 | 1,210 | 13 |
| Pintail | 252,661 | 226,636 | 268,131 | 283,076 | 131,121 | 238,529 | 178,635 | 229,611 | -22 |
| Dabblers | 271,552 | 244,945 | 298,705 | 311,953 | 137,918 | 241,553 | 181,432 | 239,313 | -24 |
| Scaup | 33,883 | 40,796 | 33,139 | 32,824 | 43,311 | 28,327 | 27,509 | 33,422 | -18 |
| Goldeneye | 1,765 | 0 | 0 | 0 | 0 | 0 | 0 | 150 | -100 |
| Bufflehead | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | -100 |
| Long-tailed Duck | 129,214 | 98,655 | 92,478 | 85,676 | 67,010 | 104,055 | 96,946 | 111,768 | -13 |
| Scoter Sp.[b] | 11,672 | 7,991 | 8,102 | 5,442 | 4,608 | 14,318 | 11,930 | 11,210 | 6 |
| RB Merganser | 3,913 | 748 | 3,684 | 6,965 | 130 | 2,133 | 2,468 | 2,340 | 5 |
| Common Eider | 1,956 | 0 | 936 | 0 | 972 | 198 | 0 | 435 | -100 |
| King Eider | 3,521 | 6,359 | 3,649 | 4,165 | 1,738 | 7,887 | 4,525 | 3,403 | 33 |
| Steller's Eider | 2,543 | 1,295 | 281 | 1,250 | 563 | 176 | 0 | 968 | -100 |
| Spectacled Eider | 438 | 589 | 281 | 139 | 0 | 653 | 729 | 386 | 89 |
| Unidentified Eider. | 0 | 589 | 0 | 1,111 | 409 | 0 | 0 | 524 | -100 |
| Divers | 188,905 | 157,022 | 142,550 | 137,572 | 118,741 | 157,747 | 144,107 | 164,496 | -12 |
| Total Ducks | 460,457 | 401,967 | 441,255 | 449,525 | 256,659 | 399,300 | 325,539 | 403,809 | -19 |
| WF Goose | 131,008 | 177,877 | 128,288 | 192,426 | 137,968 | 155,500 | 120,314 | 124,579 | -3 |
| Canada Goose | 20,637 | 18,724 | 33,312 | 47,551 | 24,640 | 23,794 | 9,324 | 19,349 | -52 |
| Snow Goose | 538 | 236 | 94 | 2,568 | 615 | 29,257 | 529 | 2,557 | -79 |
| Black Brant | 7,140 | 16,310 | 11,088 | 8,052 | 1,126 | 22,042 | 10,233 | 9,720 | 5 |
| Total Geese | 159,323 | 213,147 | 172,782 | 250,597 | 164,349 | 230,593 | 140,400 | 156,205 | -10 |
| Swans | 10,514 | 13,601 | 12,632 | 16,105 | 17,227 | 10,504 | 9,389 | 9,998 | -6 |
| Pacific Loon | 32,177 | 34,151 | 29,850 | 34,154 | 19,988 | 22,188 | 22,702 | 27,657 | -18 |
| RT Loon | 3,521 | 2,179 | 2,994 | 5,276 | 4,601 | 5,335 | 2,945 | 3,072 | -4 |
| YB Loon | 4,988 | 3,062 | 3,556 | 3,124 | 2,454[c] | 1,331 | 1,948 | 2,957 | -34 |
| Common Loon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | -100 |
| Unidentified Loon | 0 | 0 | 0 | 0 | 7,515 | 616 | 290 | 508 | -43 |
| Total Loons | 40,686 | 39,392 | 36,400 | 42,554 | 33,587[d] | 29,470 | 27,885 | 34,163 | -18 |
| Jaegers | 7,678 | 6,948 | 7,112 | 6,317 | 5,165 | 5,906 | 5,301 | 7,216 | -27 |

[a] Percent change in population for dates indicated
[b] Includes all scoter identified and unidentified
[c] Estimate based on left-observer data only
[d] Number based on all loon observations from left and right observer

Table 5. Stratum information from an aerial breeding pair survey of the Arctic Coastal Plain of Alaska, 20-24 June 2002.

| Stratum Name | Survey Area $km^2$ | Sample Area $km^2$ | Expansion Factor |
|---|---|---|---|
| Atkasook/Kuk | 2098.3 | 35.5 | 59.1 |
| Barrow | 3884.2 | 82.6 | 47.0 |
| Barter/Demarcation | 1811.2 | 38.1 | 47.5 |
| Colville/Sag | 4622.5 | 94.3 | 49.0 |
| Kuparak | 6570.4 | 129.9 | 50.6 |
| Lower Meade | 3077.9 | 67.8 | 45.4 |
| Marginal | 2408.2 | 55.7 | 43.2 |
| Middle NPA | 3549.3 | 93.1 | 38.1 |
| NPA | 1949.5 | 38.4 | 50.8 |
| Pt. Lay | 4840.5 | 100.4 | 48.2 |
| S. Admiralty | 2806.2 | 64.7 | 43.4 |
| S. Meade | 7065.8 | 143.8 | 49.1 |
| S. NPA | 10602.5 | 224.9 | 47.1 |
| Upper Meade | 4179.7 | 86.4 | 48.4 |
| West NEPA | 729.2 | 8.9 | 81.9 |
| Kogru River | 1450.0 | 12.5 | 116.0 |
| **TOTAL** | 61645.2 | 1277.2 | 48.3 |

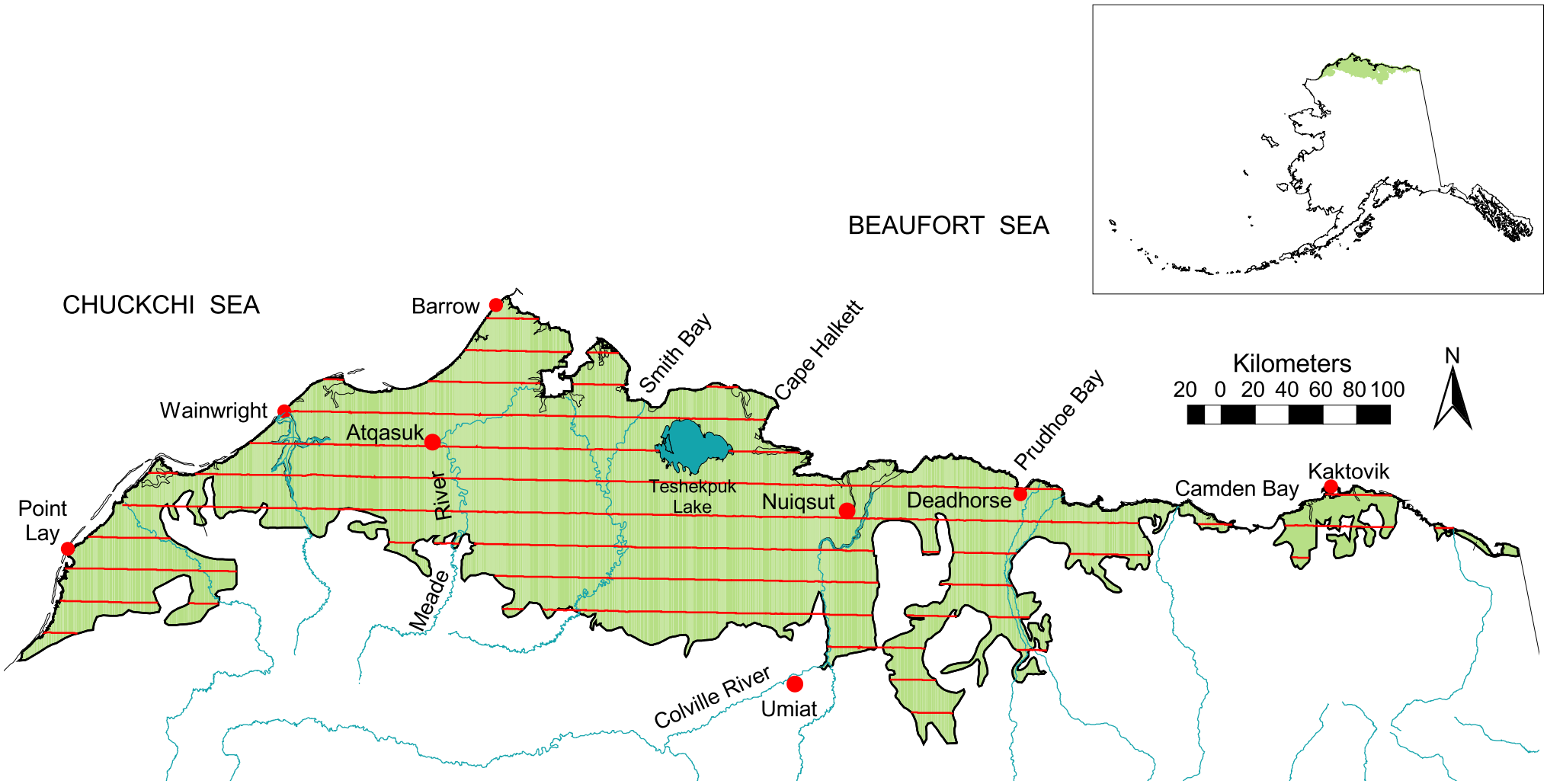


Fig. 1. Major features of the Arctic Coastal Plain in relation to the survey area boundary and the 2002 transect locations (red lines).

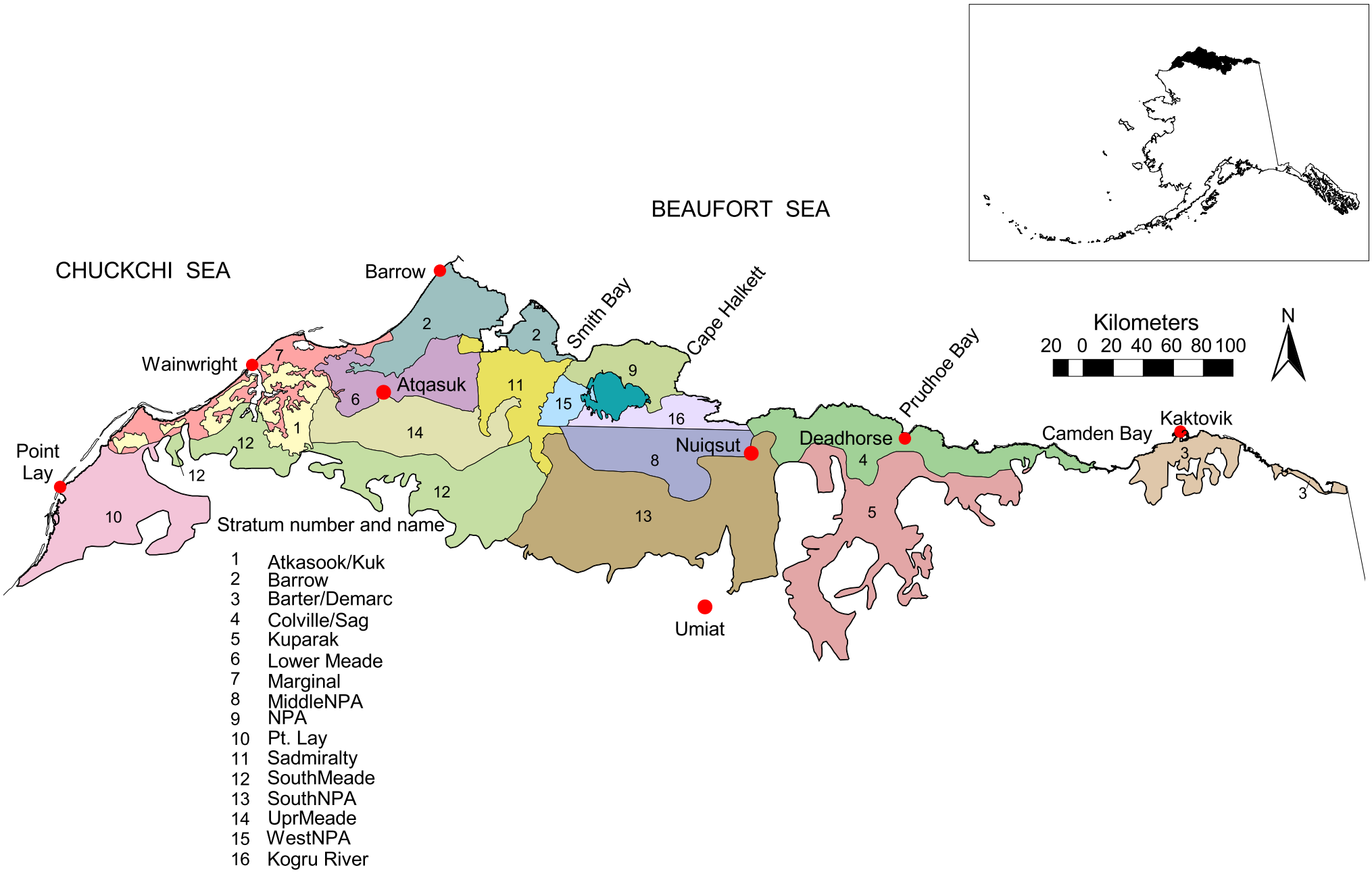


Fig. 2. Stratification of the Arctic Coastal Plain for calculation of waterbird population indices from aerial surveys.

# Northern Pintail

Table 6. Population estimates and observational data for Northern Pintail from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Singles | Pairs | Flocks | Estimate |
|---|---|---|---|---|
| 86 | 165 | 94 | 398 | 123622 |
| 87 | 148 | 97 | 1378 | 253486 |
| 88 | 281 | 110 | 867 | 223768 |
| 89 | 448 | 93 | 1184 | 307494 |
| 90 | 414 | 73 | 727 | 230824 |
| 91 | 516 | 113 | 1041 | 313562 |
| 92 | 279 | 93 | 901 | 239201 |
| 93 | 383 | 80 | 560 | 212449 |
| 94 | 241 | 47 | 370 | 137402 |
| 95 | 328 | 101 | 775 | 231815 |
| 96 | 396 | 109 | 684 | 252661 |
| 97 | 119 | 49 | 926 | 226636 |
| 98 | 405 | 112 | 845 | 268131 |
| 99 | 152 | 52 | 929 | 283076 |
| 00 | 206 | 84 | 261 | 131121 |
| 01 | 511 | 135 | 324 | 238529 |
| 02 | 389 | 109 | 222 | 178635 |

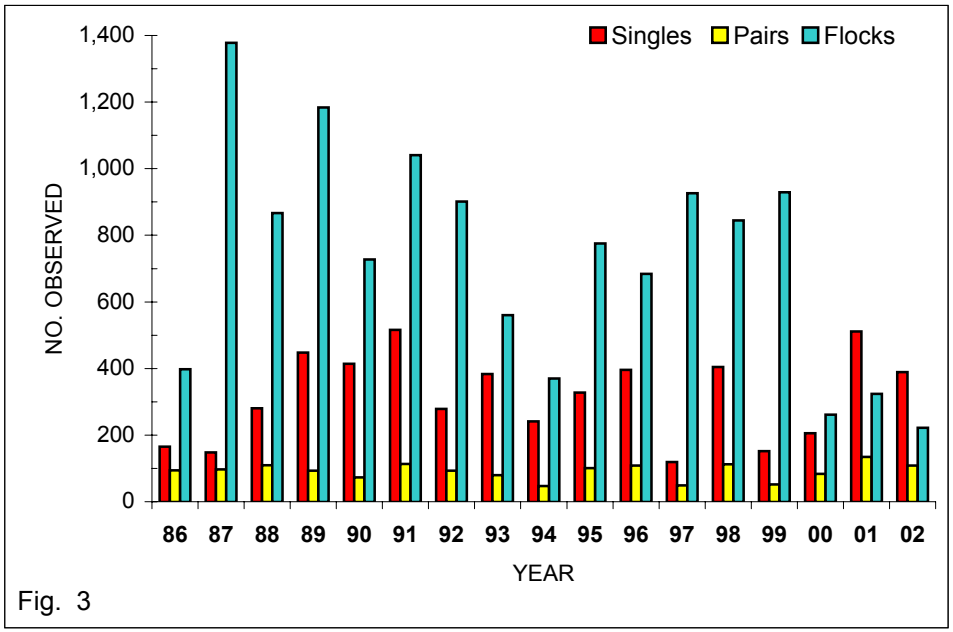

Fig. 3

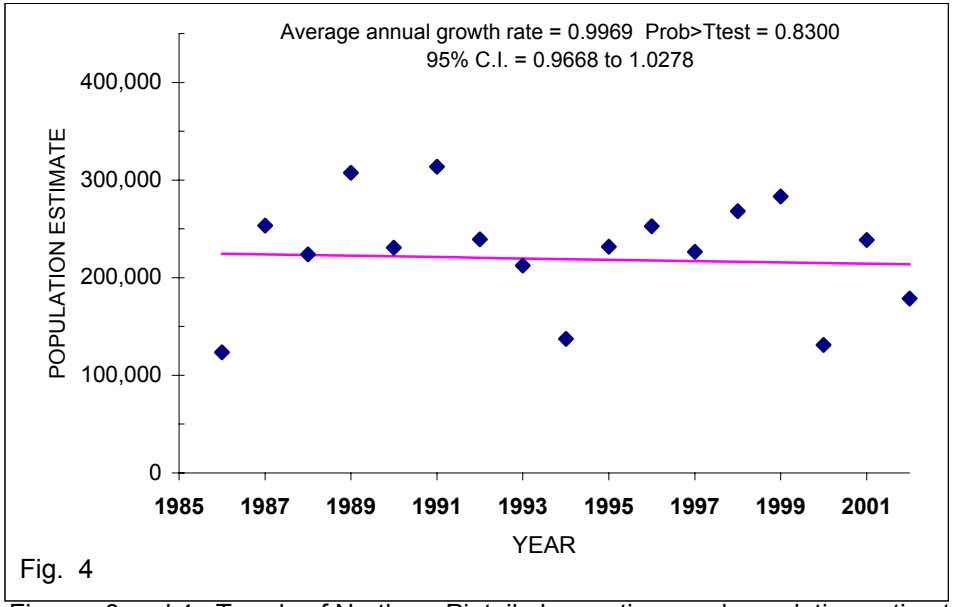

Fig. 4

Figures 3 and 4. Trends of Northern Pintail observations and population estimates from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2202. "Singles" represents the number of males in groups of 4 or less. Average annual growth rate was determined by log-linear regression.

# Long-tailed Duck

Table 7. Population estimates and observational data for Long-tailed Duck from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Singles | Pairs | Flocks | Estimate |
|---|---|---|---|---|
| 86 | 315 | 165 | 418 | 114649 |
| 87 | 338 | 149 | 473 | 120389 |
| 88 | 482 | 167 | 483 | 148178 |
| 89 | 344 | 267 | 492 | 142603 |
| 90 | 387 | 181 | 237 | 114233 |
| 91 | 358 | 159 | 353 | 115985 |
| 92 | 263 | 133 | 369 | 103507 |
| 93 | 420 | 137 | 151 | 110884 |
| 94 | 381 | 131 | 330 | 120576 |
| 95 | 435 | 147 | 217 | 120196 |
| 96 | 482 | 165 | 119 | 129214 |
| 97 | 258 | 141 | 98 | 98655 |
| 98 | 363 | 126 | 79 | 92478 |
| 99 | 184 | 89 | 114 | 85676 |
| 00 | 174 | 59 | 235 | 67010 |
| 01 | 415 | 137 | 73 | 104055 |
| 02 | 295 | 168 | 96 | 96946 |

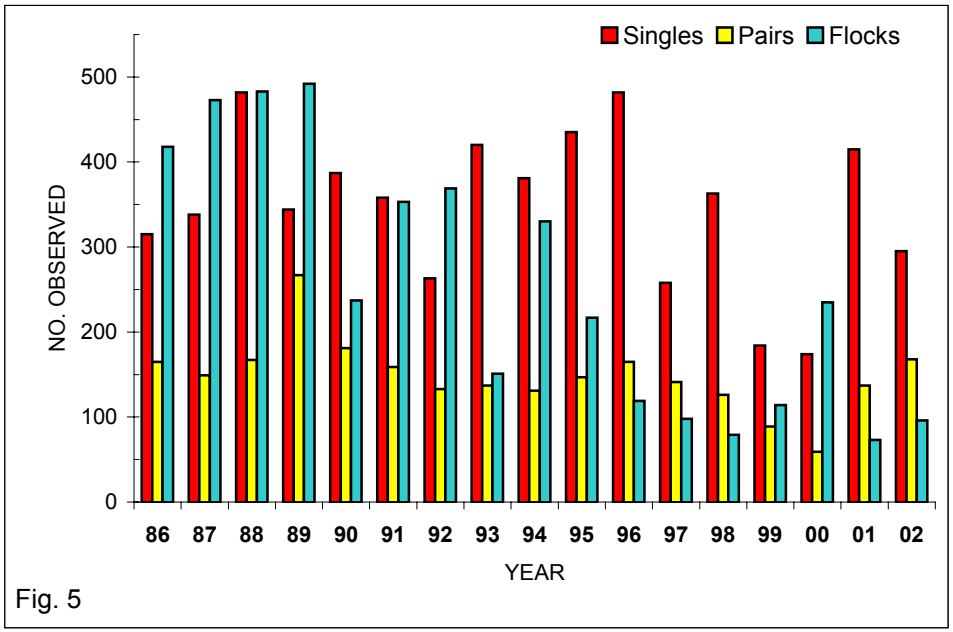

Fig. 5

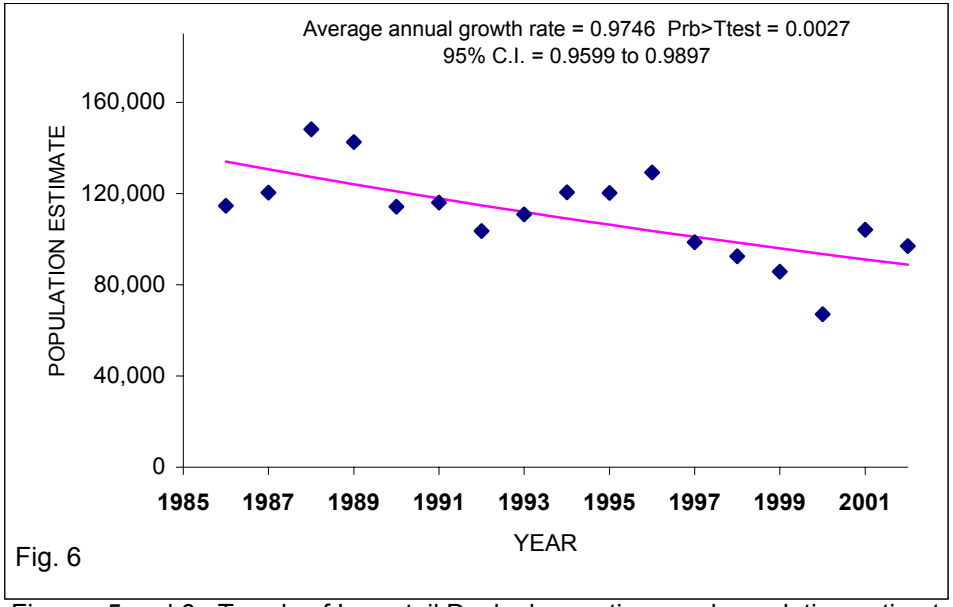

Fig. 6

Figures 5 and 6. Trends of Long-tail Duck observations and population estimates from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2202. "Singles" represents the number of males in groups of 4 or less. Average annual growth rate was determined by log-linear regression.

# Scaup

Table 8. Population estimates and observational data for Scaup from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Singles | Pairs | Flocks | Estimate |
|---|---|---|---|---|
| 86 | 47 | 60 | 85 | 21639 |
| 87 | 26 | 34 | 160 | 21811 |
| 88 | 64 | 38 | 359 | 42848 |
| 89 | 63 | 83 | 302 | 45596 |
| 90 | 102 | 60 | 173 | 33918 |
| 91 | 68 | 48 | 149 | 27014 |
| 92 | 78 | 44 | 226 | 36070 |
| 93 | 121 | 62 | 63 | 27864 |
| 94 | 52 | 57 | 161 | 30054 |
| 95 | 88 | 49 | 211 | 35662 |
| 96 | 126 | 55 | 123 | 33883 |
| 97 | 75 | 46 | 192 | 40796 |
| 98 | 95 | 30 | 212 | 33139 |
| 99 | 47 | 21 | 156 | 32824 |
| 00 | 75 | 28 | 308 | 43311 |
| 01 | 108 | 66 | 69 | 28327 |
| 02 | 141 | 61 | 35 | 27509 |

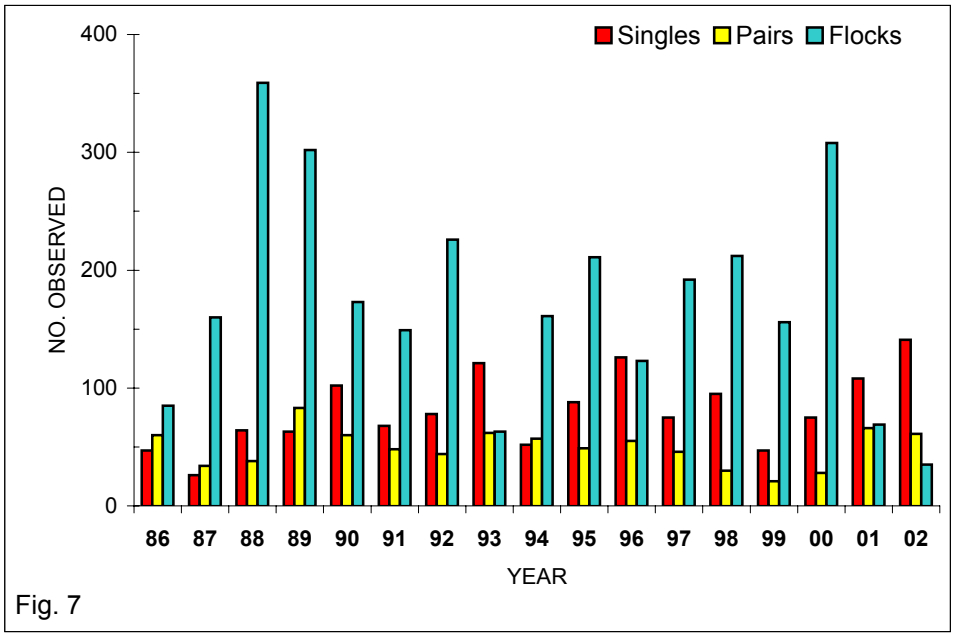

Fig. 7

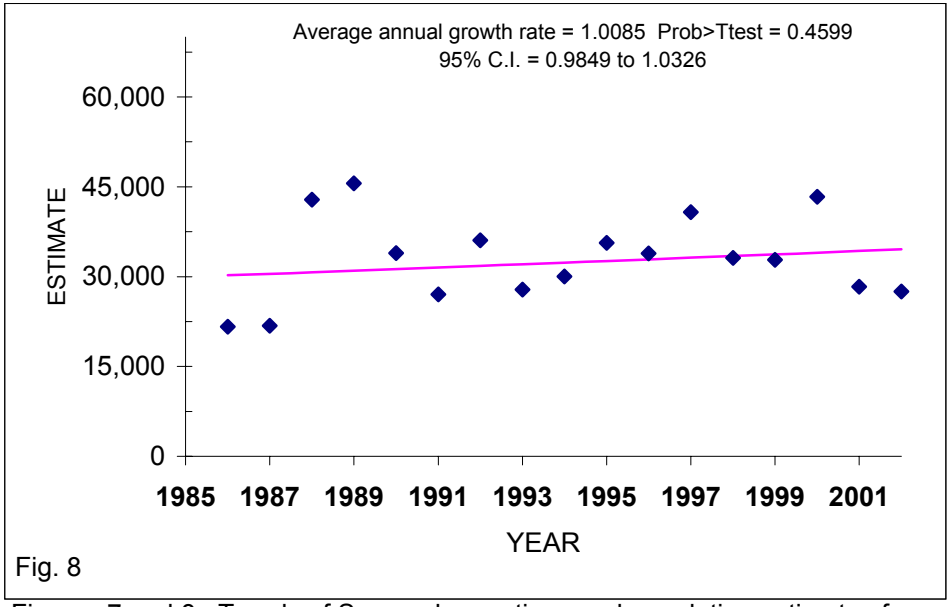

Fig. 8

Figures 7 and 8. Trends of Scaup observations and population estimates from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2202. "Singles" represents the number of males in groups of 4 or less. Average annual growth rate was determined by log-linear regression.

# Greater White-fronted Goose

Table 9. Population estimates and observational data for Greater White-fronted Goose from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Singles | Pairs | Flocks | Estimate |
|---|---|---|---|---|
| 86 | 41 | 65 | 2483 | 118081 |
| 87 | 64 | 62 | 1802 | 88538 |
| 88 | 143 | 96 | 1730 | 91875 |
| 89 | 81 | 103 | 2973 | 145042 |
| 90 | 96 | 81 | 1676 | 86270 |
| 91 | 133 | 103 | 2241 | 115373 |
| 92 | 50 | 65 | 2339 | 120095 |
| 93 | 94 | 114 | 1724 | 95905 |
| 94 | 72 | 112 | 1593 | 89957 |
| 95 | 133 | 96 | 1361 | 78472 |
| 96 | 106 | 66 | 2335 | 125824 |
| 97 | 91 | 111 | 2617 | 172519 |
| 98 | 140 | 123 | 2216 | 121738 |
| 99 | 92 | 57 | 2474 | 186040 |
| 00 | 119 | 96 | 2269 | 131885 |
| 01 | 103 | 240 | 2567 | 155500 |
| 02 | 126 | 253 | 1787 | 120314 |

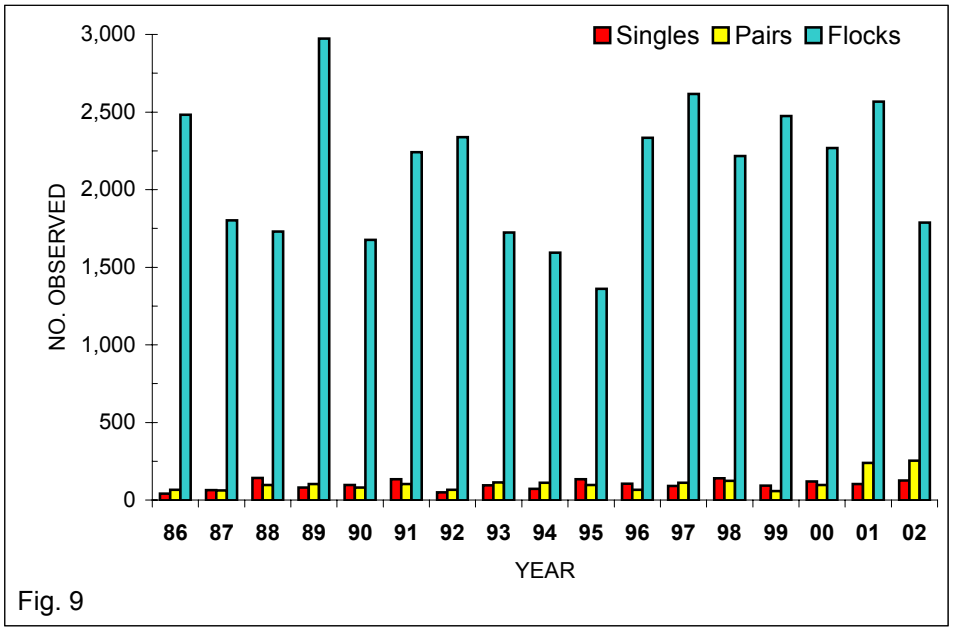

Fig. 9

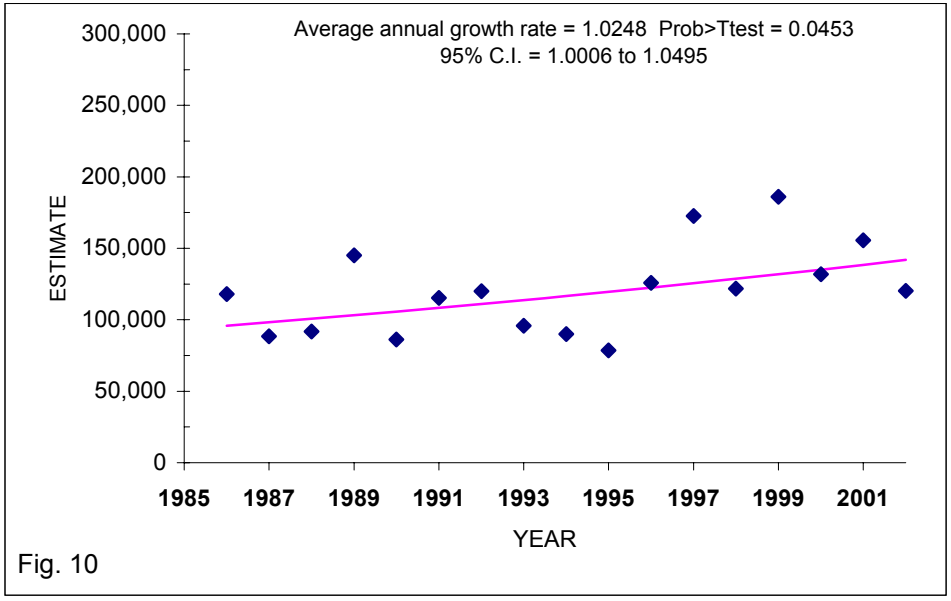

Fig. 10

Figures 9 and 10. Trends of Greater White-fronted Goose observations and population estimates from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1086-2002. Average annual growth rate was determined by log-linear regression.

# Tundra Swan

Table 10. Population estimates and observational data for Tundra Swan from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Singles | Pairs | Flocks | Estimate |
|---|---|---|---|---|
| 86 | 38 | 51 | 11 | 6718 |
| 87 | 53 | 47 | 14 | 7136 |
| 88 | 47 | 43 | 20 | 6895 |
| 89 | 70 | 73 | 21 | 10544 |
| 90 | 79 | 29 | 3 | 6229 |
| 91 | 75 | 36 | 17 | 7334 |
| 92 | 51 | 49 | 55 | 9726 |
| 93 | 64 | 37 | 10 | 6937 |
| 94 | 58 | 46 | 39 | 9000 |
| 95 | 51 | 49 | 55 | 8843 |
| 96 | 89 | 53 | 20 | 10514 |
| 97 | 83 | 49 | 50 | 13601 |
| 98 | 85 | 82 | 21 | 12632 |
| 99 | 92 | 56 | 28 | 16105 |
| 00 | 73 | 89 | 86 | 17227 |
| 01 | 84 | 63 | 12 | 10504 |
| 02 | 88 | 45 | 16 | 9389 |

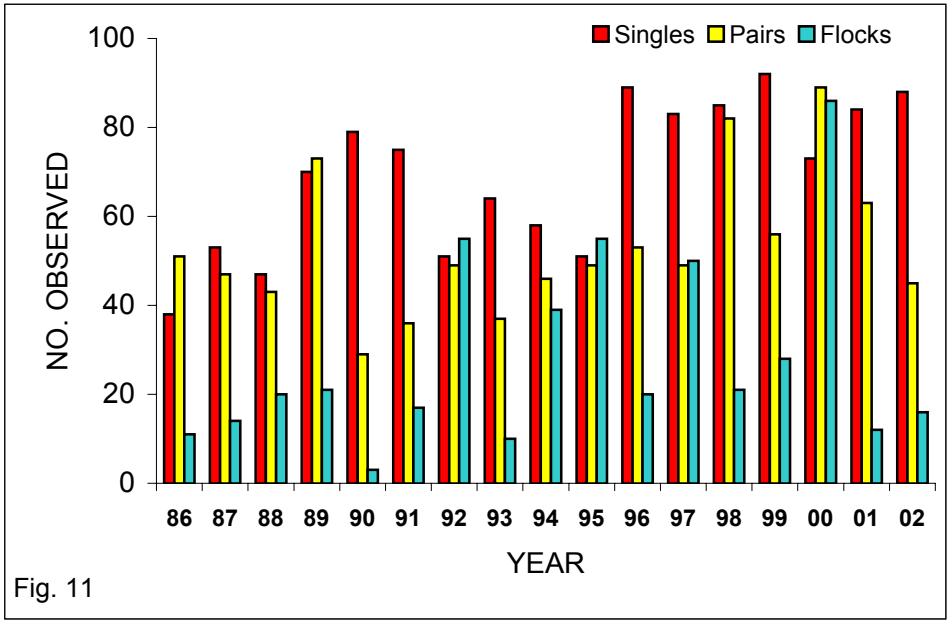

Fig. 11

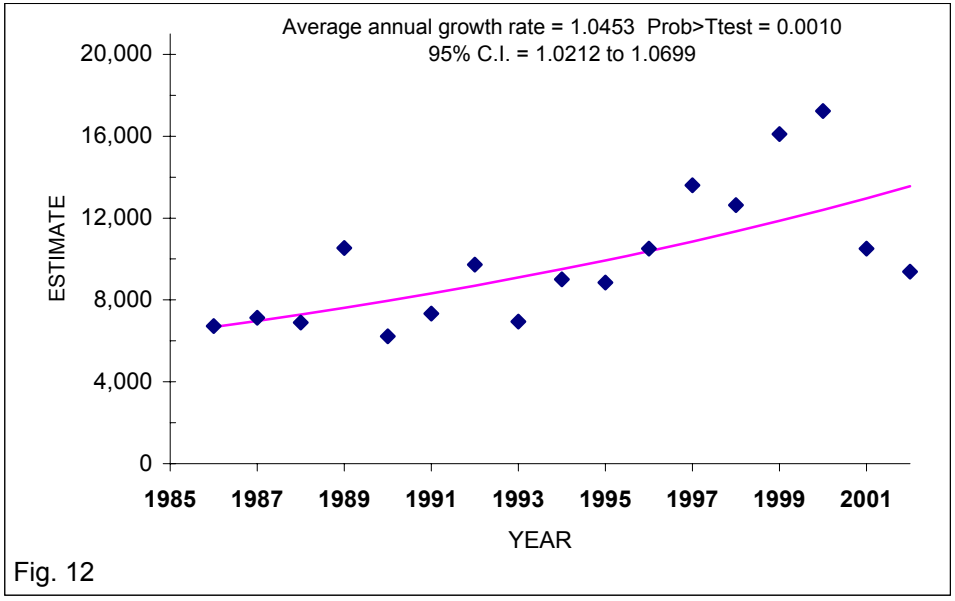

Fig. 12

Figures 11 and 12. Trends of Tundra Swan observations and population estimates from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2202. Average annual growth rate was determined by log-linear regresion.

## Tundra Swan Nests

Table 11. Population estimates for Tundra Swan Nests from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Estimate | Year | Estimate |
|---|---|---|---|
| 86 | 356 | 95 | 1574 |
| 87 | 934 | 96 | 1809 |
| 88 | 712 | 97 | 1943 |
| 89 | 1290 | 98 | 1731 |
| 90 | 1157 | 99 | 2846 |
| 91 | 1073 | 00 | 665 |
| 92 | 1192 | 01 | 1134 |
| 93 | 1172 | 02 | 1084 |
| 94 | 1000 | | |

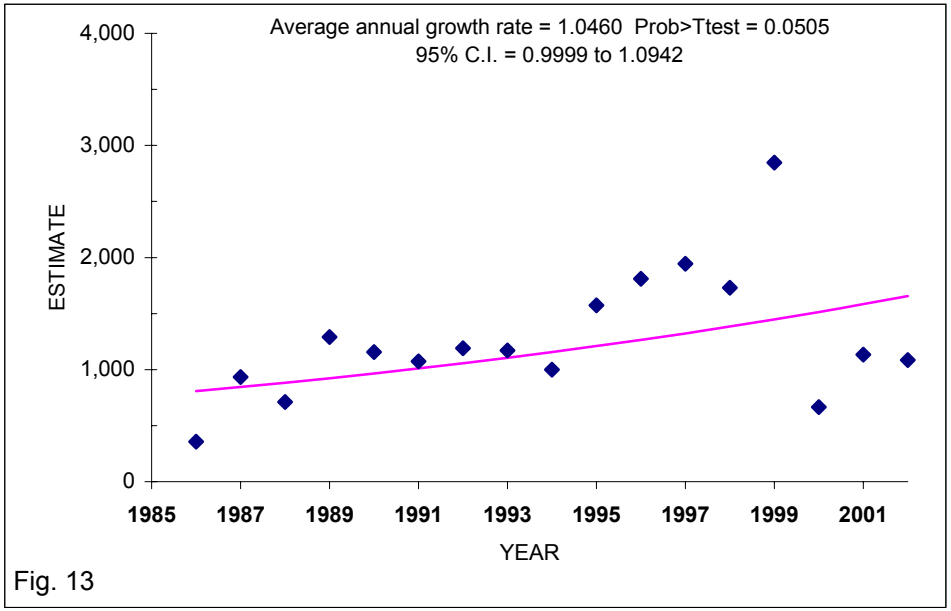

Fig. 13

## Jaegers

Table 12. Population estimates for Jaegers from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Estimate | Year | Estimate |
|---|---|---|---|
| 86 | 9432 | 95 | 4401 |
| 87 | 6585 | 96 | 7678 |
| 88 | 12769 | 97 | 6948 |
| 89 | 3470 | 98 | 7112 |
| 90 | 8765 | 99 | 6317 |
| 91 | 9123 | 00 | 5165 |
| 92 | 7103 | 01 | 5906 |
| 93 | 9094 | 02 | 5301 |
| 94 | 5573 | | |

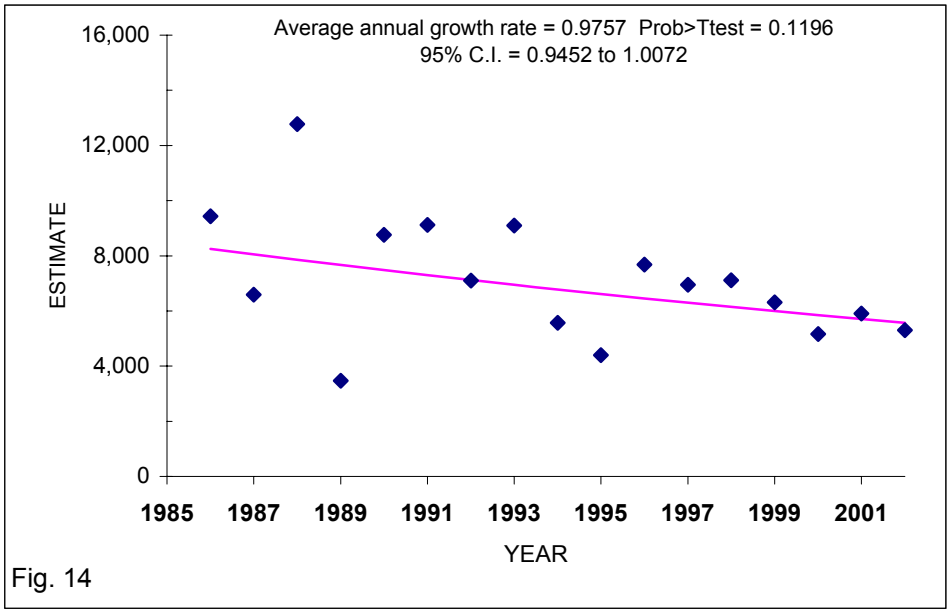

Fig. 14

Figures 13 and 14. Trends of Tundra Swan Nest and Jaeger population estimates from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2202. Average annual growth rate was determined by log-linear regression.

## Pacific Loon

Table 13. Population estimates for Pacific Loon from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2202.

| Year | Estimate | Year | Estimate |
|---|---|---|---|
| 86 | 23047 | 95 | 36304 |
| 87 | 23847 | 96 | 32177 |
| 88 | 31278 | 97 | 34151 |
| 89 | 27674 | 98 | 29850 |
| 90 | 23714 | 99 | 34154 |
| 91 | 29559 | 00 | 19988 |
| 92 | 20071 | 01 | 22188 |
| 93 | 27890 | 02 | 22702 |
| 94 | 26620 | | |

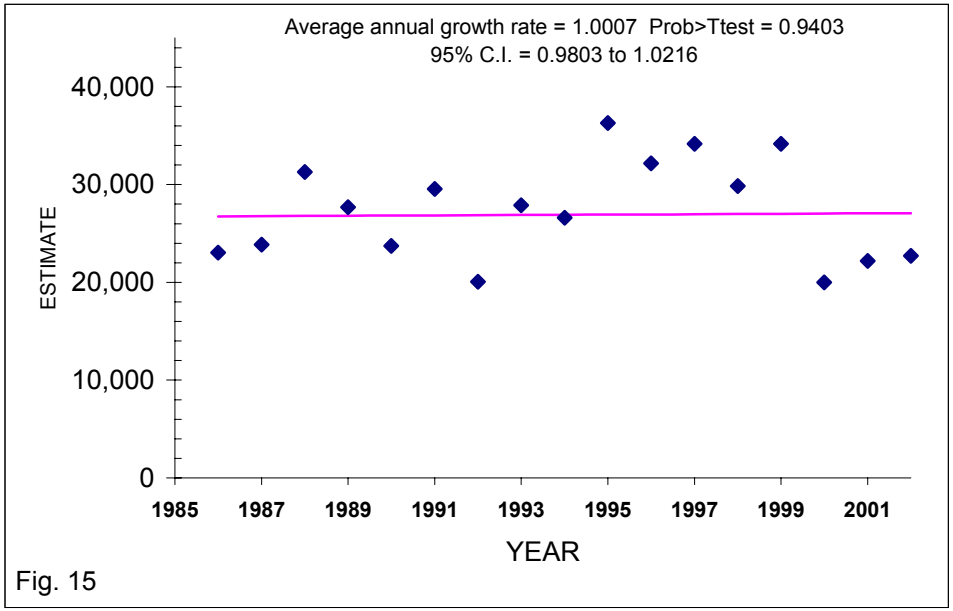

Fig. 15

## Red-throated Loon

Table 14. Population estimates for Red-throated Loon from aerial breedingpair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Estimate | Year | Estimate |
|---|---|---|---|
| 86 | 3070 | 95 | 2188 |
| 87 | 2447 | 96 | 3521 |
| 88 | 2225 | 97 | 2179 |
| 89 | 1690 | 98 | 2994 |
| 90 | 3693 | 99 | 5276 |
| 91 | 3443 | 00 | 4601 |
| 92 | 1812 | 01 | 5335 |
| 93 | 1828 | 02 | 2945 |
| 94 | 2857 | | |

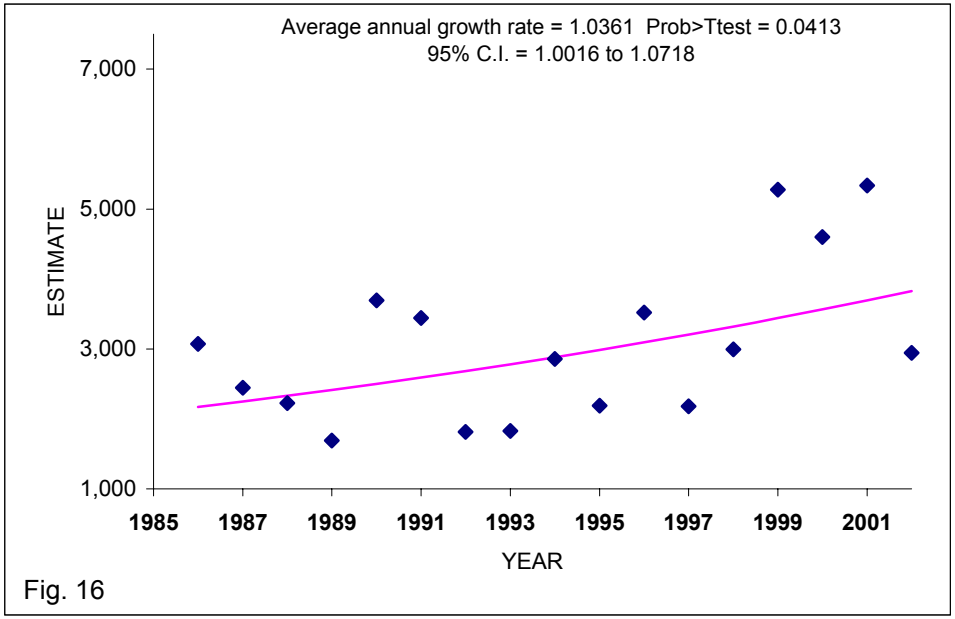

Fig. 16

Figures 15 and 16. Trends of Pacific and Red-throated Loon population estimates from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2202. Average annual growth rate was determined by log-linear regression.

## Yellow-billed Loon

Table 15. Population estimates for Yellow-billed Loon from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2002.

| Year | Estimate | Year | Estimate |
|---|---|---|---|
| 86 | 3203 | 95 | 4282 |
| 87 | 1468 | 96 | 4988 |
| 88 | 1913 | 97 | 3062 |
| 89 | 3337 | 98 | 3556 |
| 90 | 2091 | 99 | 3124 |
| 91 | 3354 | 00 | 2454 |
| 92 | 3147 | 01 | 1331 |
| 93 | 2578 | 02 | 1948 |
| 94 | 3429 | | |

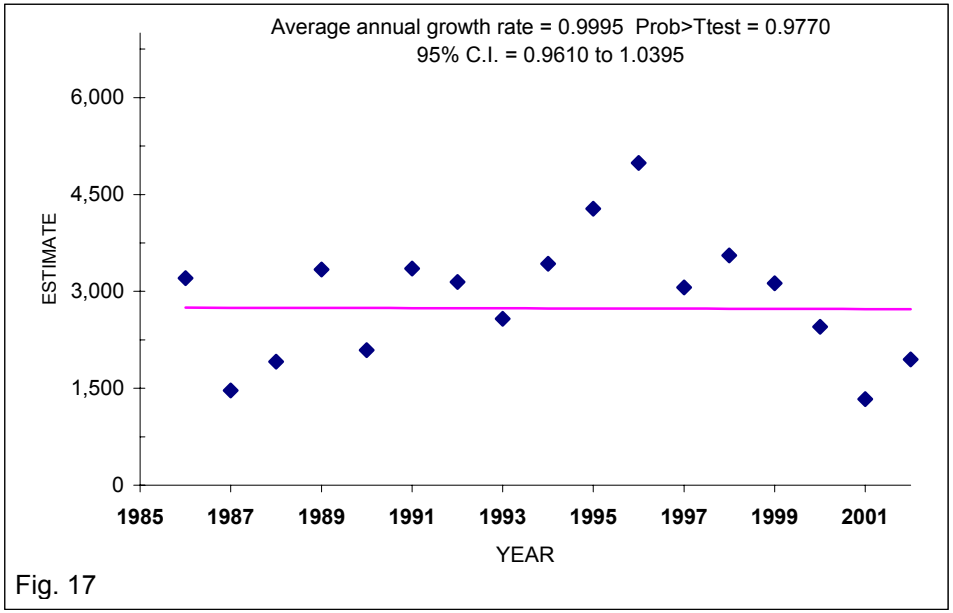

Fig. 17

## Arctic Tern

Table 16. Population estimates for Arctic Tern from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2002.

| Year | Estimate | Year | Estimate |
|---|---|---|---|
| 92 | 17688 | 01 | 21320 |
| 93 | 15047 | 02 | 21248 |
| 94 | 22049 | | |
| 95 | 23797 | | |
| 96 | 24842 | | |
| 97 | 26084 | | |
| 98 | 26247 | | |
| 99 | 25476 | | |
| 00 | 21828 | | |

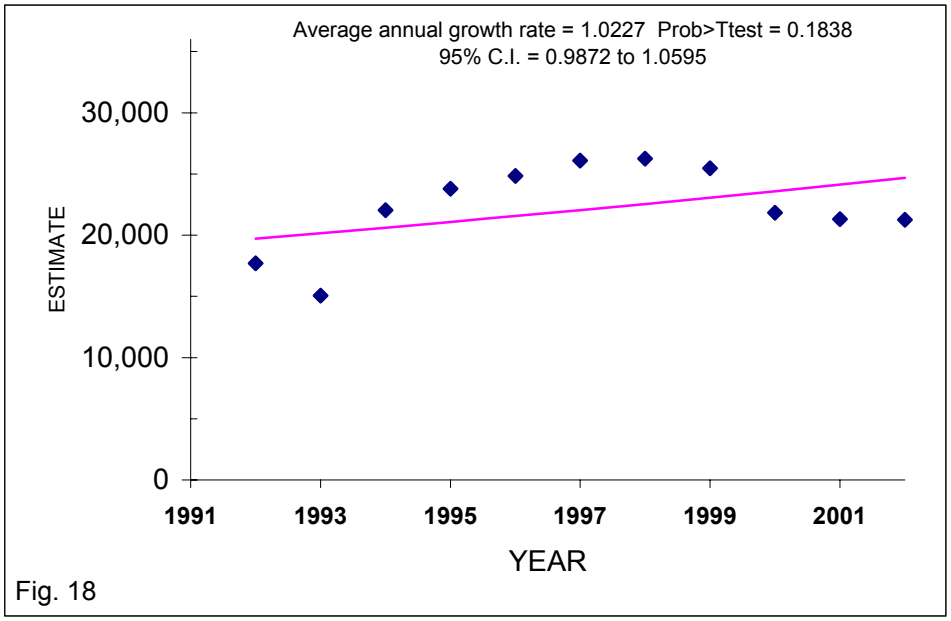

Fig. 18

Figures 17 and 18. Trends of Yellow-billedLoon (1986-2202) and Arctic Tern (1992-2002) population estimates from aerial breeding pair surveys on the Arctic Coastal Pain of Alaska. Average annual growth rate was determined by log-linear regression.

## Glaucous Gull

Table 17. Population estimates for Glaucous Gull from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2002.

| Year | Estimate | Year | Estimate |
|---|---|---|---|
| 92 | 14493 | 01 | 12225 |
| 93 | 11765 | 02 | 18472 |
| 94 | 15144 | | |
| 95 | 14398 | | |
| 96 | 19170 | | |
| 97 | 20549 | | |
| 98 | 13615 | | |
| 99 | 23741 | | |
| 00 | 29751 | | |

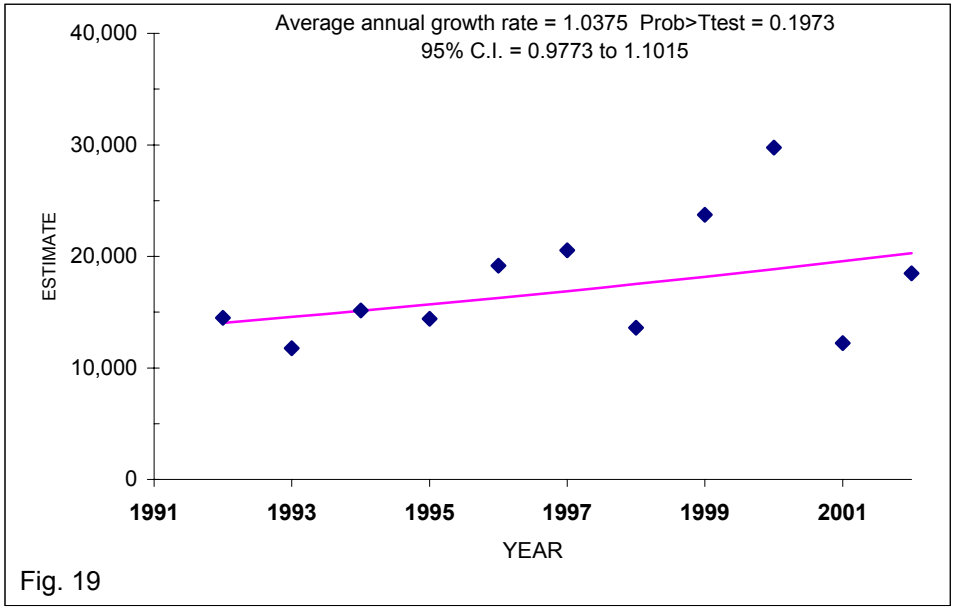

Fig. 19

## Sabine's Gull

Table 18. Population estimates for Sabine's Gull from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2002.

| Year | Estimate | Year | Estimate |
|---|---|---|---|
| 92 | 6484 | 01 | 10611 |
| 93 | 8250 | 02 | 9298 |
| 94 | 8572 | | |
| 95 | 14491 | | |
| 96 | 10465 | | |
| 97 | 15132 | | |
| 98 | 6924 | | |
| 99 | 10413 | | |
| 00 | 21419 | | |

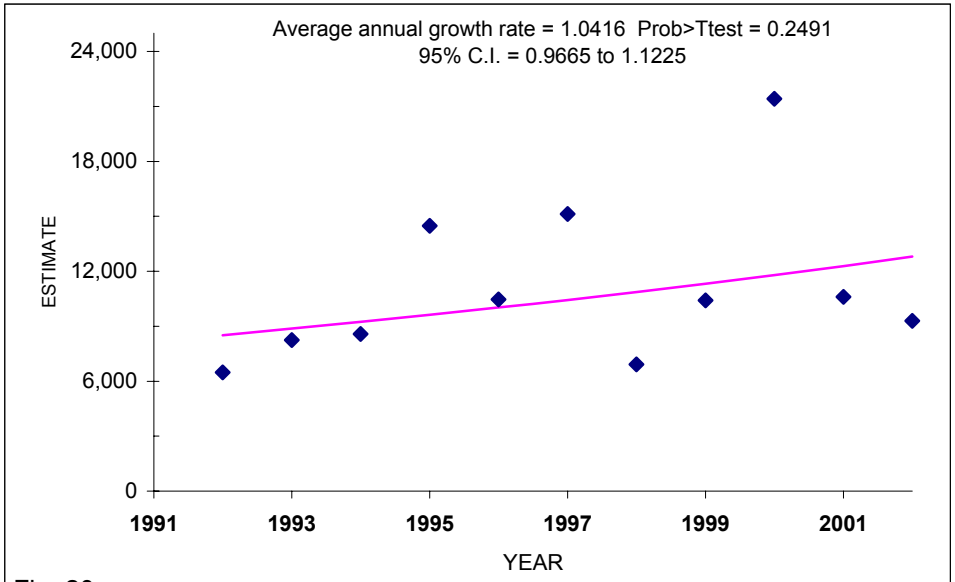

Fig. 20

Figures 19 and 20. Trends of Glaucous and Sabine's Gull population estimates from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2002. Average annual growth rate was determined by log-linear regression.

Appendix 1. Scientific names of species listed in text, figures or tables.

| | | | |
|---|---|---|---|
| Red-throated Loon | *Gavia stellata* | Goldeneye (Com. & Barrows) | *Bucephala clangula, B. islandica* |
| Pacific Loon | *Gavia pacifica* | Scaup (Greater & Lesser) | *Aythya marila, A. affinis* |
| Yellow-billed Loon | *Gavia adamsii* | | |
| | | | |
| Tundra swan | *Cygnus columbianus* | Sandhill Crane | *Grus canadensis* |
| Greater White-fronted Goose | *Anser albifrons* | | |
| Lesser Snow Goose | *Chen caerulescens* | Golden Eagle | *Aquila chrysaetos* |
| Black Brant | *Branta bernicla nigricans* | | |
| Small Canada Goose | *Branta canadensis* | Pomarine Jaeager | *Stercorarius pomarinus* |
| | | Parasitic Jaeger | *Stercorarius parasiticus* |
| American Green-winged Teal | *Anas crecca* | Long-tailed Jaeger | *Stercorarius longicaudus* |
| Mallard | *Anas platyrhychos* | | |
| Northern Pintail | *Anas acuta* | Glaucous Gull | *Larus hyperboreus* |
| Northern Shoveler | *Anas clypeata* | Arctic Tern | *Sterna paradisaea* |
| Gadwall | *Anas strepera* | Sabine's Gull | *Xema sabini* |
| American Wigeon | *Anas americana* | | |
| | | Snowy Owl | *Nyctea scandiaca* |
| Common Eider | *Somateria mollissima* | | |
| King Eider | *Somateria spectabilis* | | |
| Spectacled Eider | *Somateria fisheri* | | |
| Steller's Eider | *Polysticta stelleri* | | |
| | | | |
| Long-tailed duck | *Clangula hyemalis* | | |
| Black Scoter | *Melanitta nigra* | | |
| Surf Scoter | *Melanitta perspicillata* | | |
| White-winged Scoter | *Mellanitta fusca* | | |
| Red-breasted Merganser | *Mergus serrator* | | |