# AERIAL BREEDING PAIR SURVEYS OF THE ARCTIC COASTAL PLAIN

# OF

# ALASKA - 1996

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***Abstract:*** In 1996 an aerial breeding pair survey was conducted on the Arctic Coastal Plain of Alaska for the 11th consecutive year. All major species of waterfowl indicated increased population estimates over 1995 except for scaup (-5%), scoter (-35%), red-breasted mergansers (-22.1%), snow goose (-41.6), and brant (-48.2%). The population estimate for northern pintail (252,661) increased 9% over 1995 and 10.2% more than the 11-year mean. Estimates for oldsquaw, greater white-fronted goose, yellow-billed loon, red-throated loon, and tundra swan increased by 7.5%, 60.3%, 16.5%, 60.9% and 18.9%, respectively above 1995 populations.

**31 March 1997**

This report summarizes results of the 1996 aerial breeding pair survey on the Arctic Coastal Plain (ACP) of Alaska. Population estimates for 1986 - 1995 were reported previously (Brackney and King 1994, 1995, 1996).

## STUDY AREA AND METHODS

### Study area and Survey Design

The survey area contained 63,210.6 km$^2$ and encompassed all contiguous waterbird habitat on the ACP 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 and 18.5 km apart. Transects were placed systematically from a randomly selected start, oriented from west to east, and were partitioned into 18.5 km segments. In 1996, we surveyed the 4th of 4 subsets of revised transects established in 1992. The 3rd subset was surveyed in 1994, the 2nd subset in 1993, the 4th subset in 1992, and the 1st subset in 1995. Thus, we repeated the subset of transects flown in 1992. In 1997, we will determine the advantages and disadvantages to repeat other subsets or continue to repeat the same subset in future years. During the 1996 ACP survey we flew 3,231 km of transects on consecutive days from 23-30 June.

### Survey Procedures

Survey procedures followed the U.S. Fish and Wildlife Service protocol for waterfowl breeding pair surveys (U.S. Fish and Wildlife Service and Canadian Wildlife Service, 1987). Observations were recorded such that geographic locations could be determined (Butler et al.1995a). We flew the centerline of each transect in a Cessna 206 aircraft, on amphibious floats, at 30-45 m above ground level and at 160 km/h ground speed. Aircraft navigation and altitude were maintained with the aid of a Global Positioning System (GPS) and a radar altimeter, respectively. All waterbirds and raptors observed within 0.2 km of each side of the aircraft were recorded by the pilot /observer on the left side or the observer on the right side.

We recorded observations directly into laptop computers as sound files using an application

developed by John Hodges (USFWS, Region 7, MBM - Juneau). Each laptop computer (1 for each observer) contained a GPS unit in a removable card. The program simultaneously recorded the coordinates of the observation into an ASCII file linked to the audio location within the sound file. A second program of the application was later used to replay the sound files and transcribe the data into ASCII files. The ASCII data was then converted to dBase files and analyzed with programs developed in this office.

In accordance with the breeding pair survey protocol, all observations of male ducks (drakes) in groups of <5 were doubled. Mixed-sex flocks of >4 ducks where pairs could not be determined and observations of male scaup were not doubled. Female ducks not accompanied by drakes were not counted. We compensated for visibility bias (birds present but not observed) by applying a visibility correction factor (VCF), calculated for each duck species (Table 1). The VCF for each species was developed for coastal tundra habitats (Conant et al. 1991, Brackney and King 1995), and multiplied by the total indicated birds to arrive at the 1996 population estimates. Population size and variance were estimated with the ratio method (Cochran 1977, see also Brackney and King 1994). Scientific names of species mentioned in the text are listed in Appendix 1.

## RESULTS

### Population Estimates

The 1996, population estimates for all species in Table 1 increased over 1995 population estimates except for scaup, scoter, red-breasted merganser, snow goose, brant and Pacific loon. Northern pintail population estimates were 9% higher than the 1995 estimate and 10.2% higher than the 11-year mean. Estimates for oldsquaw were up 7.5% over the 1995 population and 6.2% above the 11-year mean. Scaup were 5% below 1995 estimates, but 4.8% above the long term mean. Of the major duck species on the ACP scoters reflected the largest decrease of 35% from 1995 estimates, but only 7.3% below the 11 year mean (Table 1). However, 1996 scoter population estimates followed the second highest estimate (1995) of the 11 year survey.

Estimates for greater white-fronted goose and tundra swan were higher 60.3% and 18.9%, respectively, than the 1995 estimate and 19.9% and 28.9%, respectively, above the 11-year mean. In addition, yellow-billed and red-throated loon estimates increased 16.5% and 60.9%, respectively above 1995. The pacific loon indicated a decrease of 11.4% from 1995, but was up 17.4% over the 11 year mean. None of the these changes were significant ($P > 0.05$), and may have been due to sampling variability.

Lesser snow geese and Pacific black brant indicated decreases below 1995 levels of 41.6% and 48.2% respectively. However, snow geese are found sporadically on the ACP and brant are found to breed in isolated colonies along the coast and molt in large numbers only in the Teshekpuk Lake area (Figure 1). The clumped distribution of both species make it difficult to produce accurate population estimates from transect type surveys.

### Population Trends

We tested for trends in the major species which displayed a visual trend (Fig. 2, 3, 4). Slopes of loglinear regression on arctic terns, glaucous gull, Sabine's gull, oldsquaw, Pacific loon, and tundra swan were not significant ($P > 0.05$). The number of years in the sample for gulls and arctic terns was 5 and was probably too few to detect a change. Yellow-billed loons continued to

increase through 1996 with a significant 10% annual increase ($P = 0.002$). In addition, we found a significant 10% annual increase in tundra swan nests ($P = 0.006$) .

## DISCUSSION

Northern Pintails increased for the second consecutive year and continue to arrive on the ACP in numbers of more than 229,000 each year (11 yr mean, Table 1). These unexpected high populations continue to occur despite improved conditions on most breeding areas in the U.S. and Canadian prairies during the last few years. During 1996 duck breeding pair surveys in the prairie potholes of the U.S. and Canada indicated the second highest number of ponds in 22 years. This pond number was 61% above the long time average (Dubovsky,et al, 1996). A closer comparison of ACP numbers with breeding area conditions or numbers within strata of the continental survey is warranted. Although a large breeding effort has not been documented for pintails on the ACP, the numbers of single and paired individuals observed during the survey are a substantial component of the total (Table 2 and Figure 2). Pintail populations tend to fluctuate in concert with the number of flocked individuals observed during the survey. Oldsquaw, however, are generally represented by a high proportion of breeding birds which are believed to nest in large numbers on the ACP (Table 2 and Figure 2). Tundra swan estimates tend to fluctuate primarily in response to the number of flocked birds observed (Table 2 and Figure 3), but single and pair observations are stable and account for the majority of the observations.

In contrast to pintail and oldsquaw, the number of greater white-fronted geese observed are composed almost entirely of flocked birds (Table 2 and Figure 3). Brood surveys on the ACP in 1993 indicated a large breeding population of white-fronted geese. The aerial breeding pair survey generally supports this production estimate when comparing the number of paired and single white-fronted geese (estimated 9,609 breeding pairs in 1993-expanded; compared to 11,676 broods expanded in 1993) and tends to contradict Bromley et al (1995) observation that nesting geese are not highly visible during aerial fixed-wing surveys. The breeding pair survey protocol has not developed a VCF for geese. Therefore, 1.0 VCF is used in population expansions (Table 1). If we assume that there is at least some segment of the breeding white-fronted goose population missed during aerial surveys a very low VCF of 1.2 would make up the difference between the breeding population and broods estimated in 1993. The implications of this comparison to other breeding pair surveys should be investigated.

### ACKNOWLEDGMENTS

We thank Jack Hodges, Migratory Bird Management - Juneau, for use of their specialized laptop computer system and new voice-data entry program, Prudhoe Bay Hotel for accommodating us, NANA Fuel in Deadhorse, the village of Atqasuk, and especially Thomas Brower, Jr., Atqasuk Airport Manager, for his cooperative attitude to accommodate our fuel cache which enables us to conduct a much more efficient survey, adds to the safety of our flights across the vast arctic tundra and relieves some of the pilot stress related to long range in-flight fuel management.

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Appendix 1. Scientific names of species listed in the text.

| | |
|---|---|
| Red-throated Loon | *Gavia stellata* |
| Pacific Loon | *Gavia pacifica* |
| Yellow-billed Loon | *Gavia adamsii* |
| Tundra swan | *Cygnus columbianus* |
| Greater White-fronted Goose | *Anser albifrons* |
| Lesser Snow Goose | *Chen caerulescens* |
| Black Brant | *Branta bernicla nigricans* |
| Small Canada Goose | *Branta canadensis* |
| American Green-winged Teal | *Anas crecca* |
| Mallard | *Anas platyrhychos* |
| Northern Pintail | *Anas acuta* |
| Northern Shoveler | *Anas clypeata* |
| Gadwall | *Anas strepera* |
| American Wigeon | *Anas americana* |
| Scaup (Greater & Lesser) | *Aythya marila, A. affinis* |
| Common Eider | *Somateria mollissima* |
| King Eider | *Somateria spectabilis* |
| Spectacled Eider | *Somateria fisheri* |
| Steller's Eider | *Polysticta stelleri* |
| Oldsquaw | *Clangula hyemalis* |
| Black Scoter | *Melanitta nigra* |
| Surf Scoter | *Melanitta perspicillata* |
| White-winged Scoter | *Mellanitta fusca* |
| Goldeneye (Common & Barrows) | *Bucephala clangula, B. islandica* |
| Red-breasted Merganser | *Mergus serrator* |
| Golden Eagle | *Aquila chrysaetos* |
| Sandhill Crane | *Grus canadensis* |
| Black-bellied Plover | *Pluvialis squatarola* |
| Lesser Golden Plover | *Pluvialis dominica* |
| Whimbrel | *Numenius phaeopus* |
| Hudsonian Godwit | *Limosa haemastica* |
| Bar-tailed Godwit | *Limosa lapponica* |
| Ruddy Turnstone | *Arenaria interpres* |
| Semipalmated Sandpiper | *Calidris pusilla* |
| Pectoral Sandpiper | *Calidris melanotos* |
| Dunlin | *Calidris alpina* |
| Long-billed Dowitcher | *Limnodromus scolopaceus* |
| Red-necked Phalarope | *Phalaropus lobatus* |
| Red Phalarope | *Phalaropus fulicaria* |
| Pomarine Jaeger | *Stercorarius pomarinus* |
| Parasitic Jaeger | *Stercorarius parasiticus* |
| Long-tailed Jaeger | *Stercorarius longicaudus* |
| Glaucous Gull | *Larus hyperboreus* |
| Arctic Tern | *Sterna paradisaea* |
| Sabine's Gull | *Xema sabini* |
| Snowy Owl | *Nyctea scandiaca* |

Table 1. Population estimates of waterfowl and related species on the Arctic Coastal Plain, Alaska 1986-1996.

| Species | VCF | Population Index 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 11-Year Mean | % Change 1995-96 | %Change from Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mallard | 4.01 | 357 | 1,070 | 1,427 | 1,784 | 1,784 | 1,076 | 2,294 | 1128 | 781 | 1,120 | 2,353 | 1,379 | 110.1 | 70.8 |
| Gadwall | 3.04 | 0 | 0 | 0 | 0 | 0 | 0 | 290 | 0 | 0 | 0 | 0 | 26 | nc | nc |
| Wigeon | 3.84 | 2,050 | 5467 | 342 | 1,538 | 7,005 | 3,091 | 10,252 | 360 | 3,840 | 1,787 | 7,887 | 3,966 | 341.4 | 99.0 |
| G.W. Teal | 8.36 | 5,951 | 6323 | 1,488 | 3,719 | 4,463 | 748 | 2,391 | 2351 | 1,592 | 1,556 | 5,315 | 3,263 | 241.6 | 63.0 |
| Shoveler | 3.79 | 2,023 | 0 | 1,349 | 337 | 1,012 | 678 | 1,446 | 1,421 | 361 | 706 | 3,336 | 1152 | 372.5 | 189.8 |
| Pintail | 3.05 | 123,622 | 253,486 | 223,768 | 307,494 | 230,824 | 313,562 | 239,201 | 212,449 | 137,402 | 231,815 | 252,661 | 229,662 | 9.0 | 10.2 |
| Dabblers | | 134,003 | 266,346 | 228,374 | 314,872 | 245,088 | 319,155 | 255,874 | 217,709 | 143,976 | 236,984 | 271,552 | 239,448 | 14.6 | 13.6 |
| Scaup | 1.93 | 21,639 | 21,811 | 42,848 | 45,596 | 33,918 | 27,014 | 36,070 | 27,864 | 30,054 | 35,662 | 33,883 | 32,396 | -5.0 | 4.8 |
| Goldeneye | 3.61 | 321 | 0 | 321 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,765 | 319 | nc | nc |
| Bufflehead | 1.86 | 166 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | nc | nc |
| Oldsquaw | 1.87 | 114,649 | 120,389 | 148,178 | 142,603 | 114,233 | 115,985 | 103,507 | 110,884 | 120,576 | 120,196 | 129,214 | 121,855 | 7.5 | 6.2 |
| Scoter Sp. | 1.17 | 6,871 | 9,266 | 10,567 | 21,915 | 8,381 | 15,434 | 17,787 | 11,242 | 7,799 | 17,970 | 11,672 | 12,627 | -35.0 | -7.3 |
| RB Merganser | 1.27 | 1,186 | 2,091 | 904 | 904 | 1,808 | 3,014 | 1,332 | 1,905 | 1,693 | 5,024 | 3,913 | 2,161 | -22.1 | 81.7 |
| Com. Eider | 3.58 | 0 | 2,548 | 956 | 637 | 1274 | 1281 | 683 | 0 | 341 | 2,666 | 7,003 | 1,578 | 162.7 | 344.9 |
| King Eider | 3.58 | 9,079 | 5,893 | 3,823 | 13,857 | 11,150 | 24,814 | 3,755 | 14,264 | 5,796 | 4,665 | 12,605 | 9,973 | 170.2 | 26.5 |
| St. Eider | 3.58 | 0 | 0 | 0 | 7,168 | 1,911 | 4,002 | 3,414 | 4,699 | 9,036 | 3,332 | 9,104 | 3,878 | 173.2 | 135.1 |
| Spec. Eider | 3.58 | --[a] | -- | -- | -- | -- | 961 | 0 | 4,027 | 1,705 | 1,000 | 1,576 | 1,544 | 57.6 | 2.2 |
| Eider Sp.[b] | 3.58 | 4,938 | 8,443 | 3,663 | 4,141 | 637 | -- | -- | -- | -- | 666 | 0 | 3,210 | nc | nc |
| Divers | | 158,849 | 170,441 | 211,252 | 236,821 | 173,285 | 192,505 | 164,211 | 174,885 | 175,385 | 191,181 | 210,735 | 189,556 | 10.2 | 11.8 |
| Total Ducks | | 292,852 | 436,786 | 439,626 | 551,693 | 418,373 | 511,660 | 420,085 | 392,594 | 319,361 | 428,165 | 482,287 | 429,004 | 12.6 | 11.0 |
| W.F. Goose | 1.0 | 118,081 | 88,538 | 91,875 | 145,042 | 86,270 | 115,373 | 120,095 | 95,905 | 89,957 | 78,472 | 125,824 | 105,039 | 60.3 | 19.9 |
| Can. Goose | 1.0 | 46,360 | 20,110 | 5,606 | 1,913 | 12,102 | 9,033 | 27,080 | 4,453 | 3,381 | 6,795 | 19,903 | 14,249 | 192.9 | 39.8 |
| Snow Goose | 1.0 | 178 | 0 | 845 | 4,004 | 0 | 89 | 143 | 609 | 524 | 838 | 489 | 701 | -41.6 | -30.1 |
| Brant | 1.0 | 8,765 | 3,604 | 11,390 | 18,331 | 3,515 | 1,655 | 10,012 | 11,859 | 4,381 | 12,846 | 6,651 | 8,456 | -48.2 | -21.1 |
| Total Geese | | 173,384 | 112,252 | 109,848 | 169,290 | 101,887 | 126,150 | 157,330 | 112,826 | 98,243 | 98,951 | 152,867 | 128,445 | 54.5 | 19.2 |
| Swans | 1.0 | 6,718 | 7,163 | 6,895 | 10,544 | 6,229 | 7,334 | 9,726 | 6,937 | 9,000 | 8,843 | 10,514 | 8,172 | 18.9 | 28.9 |
| P. Loon | 1.0 | 23,047 | 23,847 | 31,278 | 27,674 | 23,714 | 29,559 | 20,071 | 27,890 | 26,620 | 36,304 | 32,177 | 27,470 | -11.4 | 17.4 |
| R.T. Loon | 1.0 | 3,070 | 2,447 | 2,225 | 1,690 | 3,693 | 3,443 | 1,812 | 1,828 | 2,857 | 2,188 | 3,521 | 2,617 | 60.9 | 34.7 |
| Y.B. Loon | 1.0 | 3,203 | 1,468 | 1,913 | 3,337 | 2,091 | 3,354 | 3,147 | 2,578 | 3,429 | 4,282 | 4,988 | 3,072 | 16.5 | 62.7 |
| Com. Loon | 1.0 | 0 | 44 | 44 | 0 | 0 | 45 | 143 | 141 | 48 | 0 | 0 | 42 | nc | nc |
| Jaegers | 1.0 | 9,432 | 6,585 | 12,769 | 3,470 | 8,765 | 9,123 | 7,103 | 9,094 | 5,573 | 4,422 | 7,678 | 7,637 | 73.6 | 0.6 |

[a]--Indicates that observations of this species not delineated during that year.
[b]Includes unidentified Eiders and Spectacled Eiders.
nc = not calculated

Table 2. Population estimates of ducks from the annual aerial breeding pair survey on the Arctic Coastal Plain of Alaska, 23-30 June, 1996.

| Species | VCF | Drakes[a] | Pairs | Birds in Flocks | Indicated Birds | Pop. Estimate[d] | 95%CI[b] | *SE*[c] |
|---|---|---|---|---|---|---|---|---|
| Mallard | 4.01 | 3 | 3 | 0 | 12 | 2,353 | 1782 | 892.2 |
| Wigeon | 3.84 | 2 | 1 | 36 | 42 | 7,887 | 6,328 | 3,167.8 |
| GW Teal | 8.36 | 1 | 1 | 9 | 13 | 5,315 | 7,645 | 3,826.8 |
| Shoveler | 3.79 | 8 | 1 | 0 | 18 | 3,336 | 2,169 | 1,085.6 |
| Pintail | 3.05 | 396 | 109 | 684 | 1694 | 252,661 | 100,232 | 50,173.3 |
| Dabbler total | | | | | | 271,552 | | |
| Scaup | 1.93 | 126 | 55 | 123 | 359 | 33,883 | 14,683 | 7,350.1 |
| Goldeneye | 3.61 | 5 | 0 | 0 | 10 | 1,765 | 1,907 | 955.0 |
| Oldsquaw | 1.87 | 482 | 165 | 119 | 1413 | 129,214 | 17,973 | 8,996.9 |
| Black Scoter | 1.17 | 21 | 13 | 105 | 173 | 9,898 | 6,229 | 3,118.3 |
| Surf Scoter | 1.17 | 0 | 0 | 9 | 9 | 515 | 1,043 | 522.4 |
| White W Scoter | 1.17 | 5 | 2 | 8 | 22 | 1,259 | 1,185 | 593.3 |
| R. B. Merganser | 1.27 | 18 | 8 | 11 | 63 | 3,913 | 1,584 | 793.4 |
| King Eider | 3.58 | 10 | 6 | 40 | 72 | 12,605 | 6,049 | 3,027.9 |
| Common Eider | 3.58 | 0 | 0 | 40 | 40 | 7,003 | 14,256 | 7,136.5 |
| Steller's Eider | 3.58 | 6 | 4 | 32 | 52 | 9,104 | 6,237 | 3,122.2 |
| Spectacled Eider | 3.58 | 2 | 0 | 5 | 9 | 1,576 | 1,784 | 893.1 |
| Diver total | | | | | | 210,735 | | |
| Ducks total | | | | | | 482,287 | | |

[a] Drakes only in groups of 4 or less. Number of drakes and pairs are doubled for indicated birds (except scaup drakes are not doubled).

[b] One half of the 95% confidence interval, actual interval = population index $\pm$ 95%CI.

[c] Study area = A = 63210.6 km$^2$; Sample area ($\sum$a) = S = 1292.6 km$^2$; No. transects (n) = 65.
Expansion factor = E = A / S = 48.9019
Indicated Birds = I
Visibility Correction Factor = VCF

[d] Population Estimate = I x E x VCF

Table 2 (continued). Population estimates of waterfowl and related species from the annual aerial breeding pair survey on the Arctic Coastal Plain of Alaska, 23-30 June 1996.

| Species | VCF | Singles | Pairs | Birds in Flocks | Indicated Birds | Pop. Estimate[c] | 95%CI[a] | *SE*[b] |
|---|---|---|---|---|---|---|---|---|
| White-fronted Goose | 1.0 | 106 | 66 | 2335 | 2,573 | 125,824 | 39,392 | 19,718.6 |
| Small Canada Goose | 1.0 | 15 | 16 | 360 | 407 | 19,903 | 20,771 | 10,397.4 |
| Lesser Snow goose | 1.0 | 1 | 1 | 7 | 10 | 489 | 750 | 375.8 |
| Brant | 1.0 | 10 | 9 | 108 | 136 | 6,651 | 7,729 | 3,869.1 |
| Geese total | | | | | 152,867 | | | |
| Tundra Swan | 1.0 | 89 | 53 | 20 | 215 | 10,514 | 2,254 | 1,128.1 |
| Tundra Swan nest | 1.0 | 37 | 0 | 0 | 37 | 1,809 | 843 | 421.9 |
| Sandhill Crane | 1.0 | 1 | 0 | 0 | 1 | 49 | 96 | 48.3 |
| Pacific Loon | 1.0 | 384 | 121 | 32 | 658 | 32,177 | 6,899 | 3,453.6 |
| Red-throated Loon | 1.0 | 40 | 16 | 0 | 72 | 3,521 | 1,057 | 529.1 |
| Common Loon | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yellow-billed Loon | 1.0 | 61 | 16 | 9 | 102 | 4,988 | 1,690 | 845.9 |
| Unknown Loon | 1.0 | 2 | 0 | 0 | 2 | 98 | 113 | 56.6 |
| Loons total | | | | | | 40,784 | | |
| Long-tailed Jaeger | 1.0 | 53 | 8 | 3 | 72 | 3,521 | 1,150 | 575.9 |
| Parasitic Jaeger | 1.0 | 52 | 6 | 6 | 70 | 3,423 | 1,220 | 610.7 |
| Pomarine Jaeger | 1.0 | 11 | 2 | 0 | 15 | 734 | 454 | 227.3 |
| Unknown Jaeger | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jaegers total | | | | | | 7,678 | | |
| Golden Eagle | 1.0 | 5 | 0 | 0 | 5 | 245 | 202 | 101.3 |
| Snowy Owl | 1.0 | 26 | 3 | 0 | 32 | 1,565 | 1,244 | 622.7 |
| Arctic Tern | 1.0 | 164 | 47 | 250 | 508 | 24,842 | 7,619 | 3,814.0 |
| Glaucous Gull | 1.0 | 176 | 31 | 154 | 382 | 19,170 | 6,367 | 3,186.9 |
| Sabine's Gull | 1.0 | 38 | 16 | 144 | 214 | 10,465 | 5,722 | 2,864.2 |

[a]One half of the 95% confidence interval, actual interval = population index ± 95%CI
[b]Study area = **A** = 63210.6 km$^2$; Sample area ($\sum$a)= **S** = 1292.6 km$^2$; No. transects (n) = 65
Expansion factor = **E** = **A** / **S** =48.9019
Indicated birds = **I**
Visibility Correction Factor = **VCF**
[c]Population Estimate = **I** x **E** x **VCF**

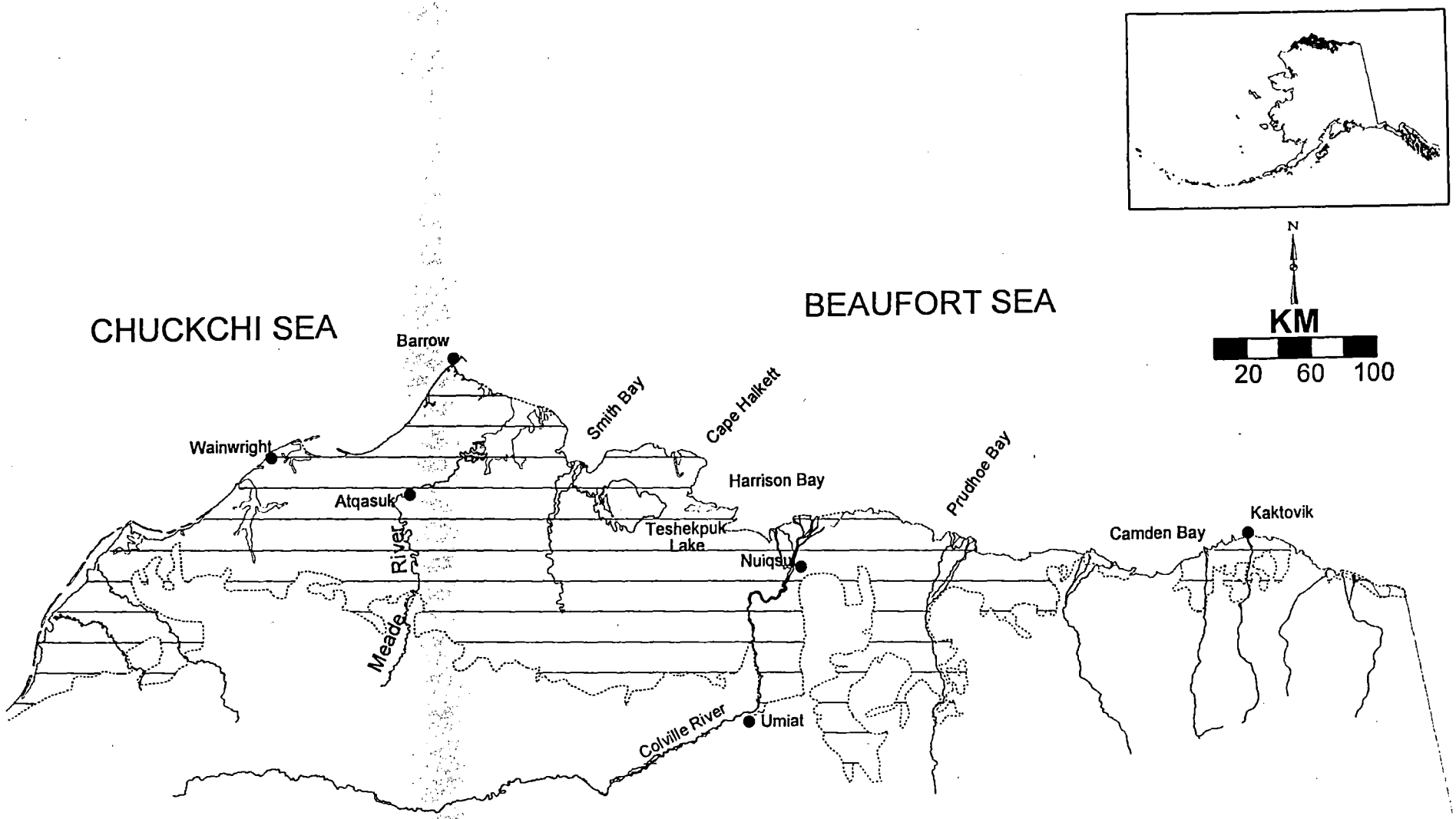
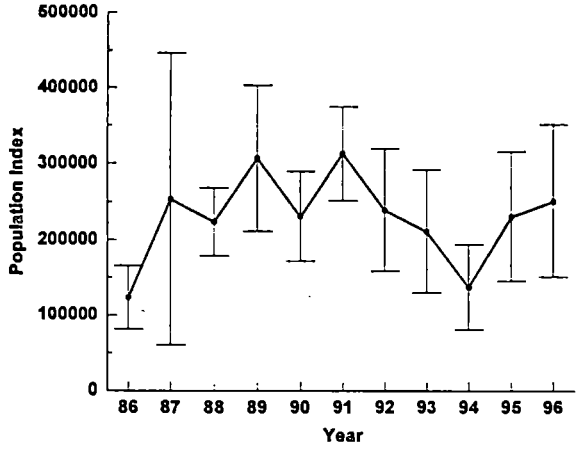
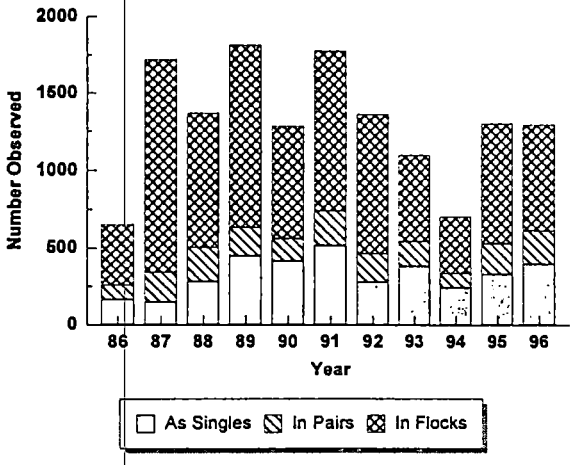



Fig. 1. Major features of the Arctic Coastal Plain in relation to the survey area boundary (dashed line) and the 1996 transect locations (horizontal lines).

## NORTHERN PINTAIL

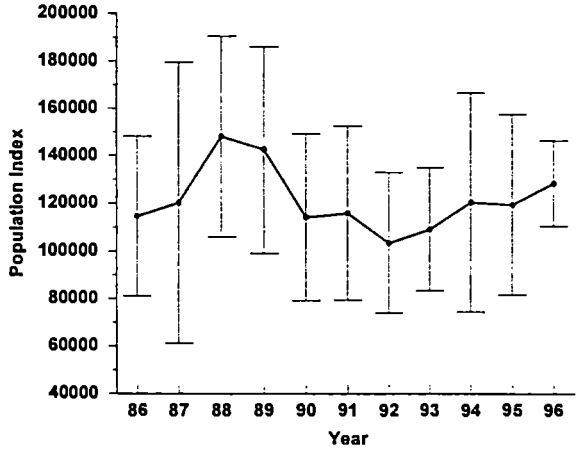


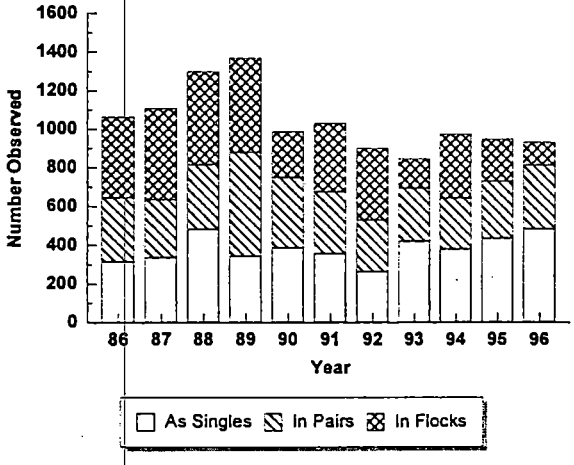







## OLDSQUAW

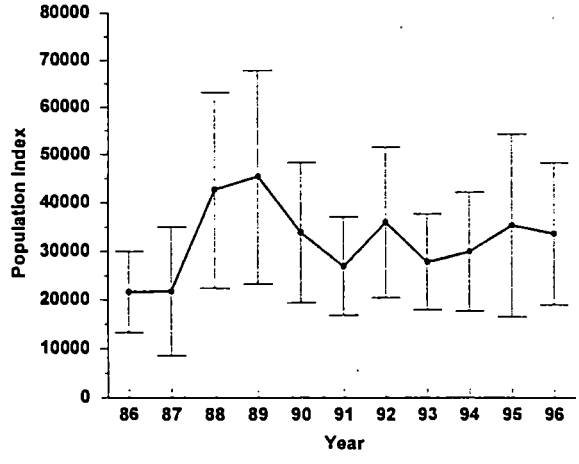






## SCAUP



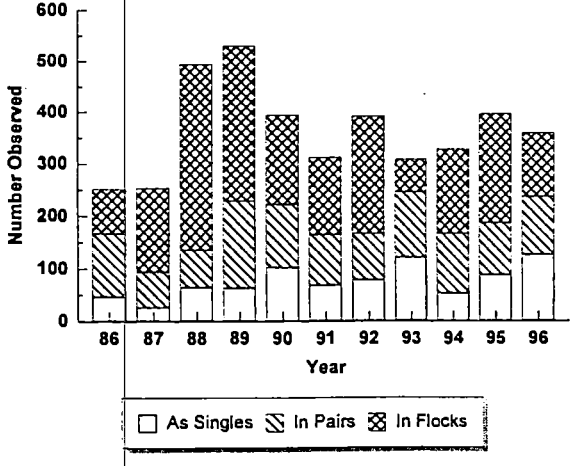
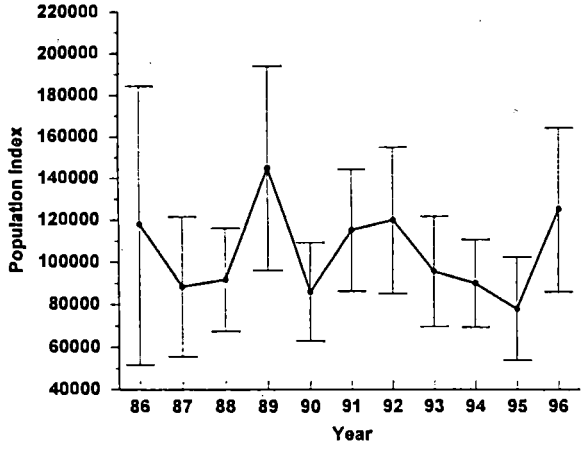



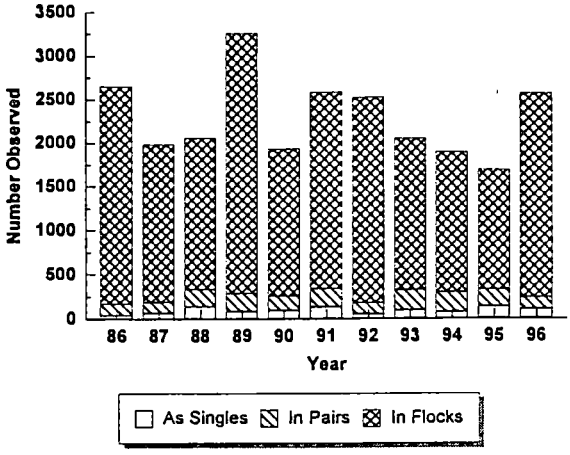




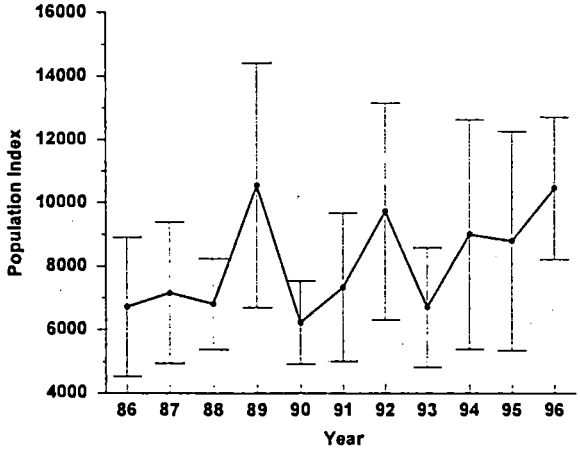
**Figure 2. Population estimates and number of observations of northern pintail, oldsquaw, and scaup from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-1996. Vertical lines indicate 95% confidence intervals.**

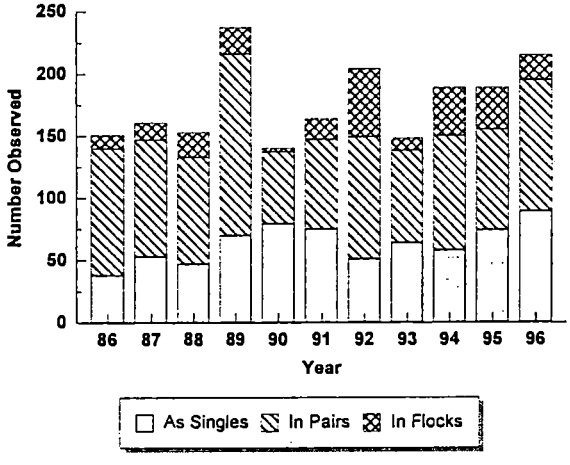
## GREATER WHITE-FRONTED GOOSE



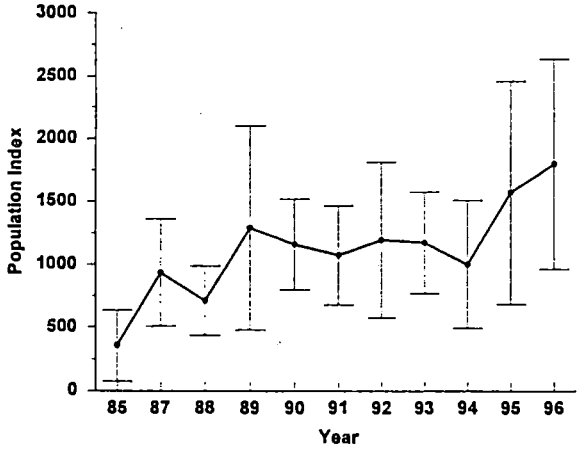




## TUNDRA SWAN




## TUNDRA SWAN NESTS




## SNOWY OWL

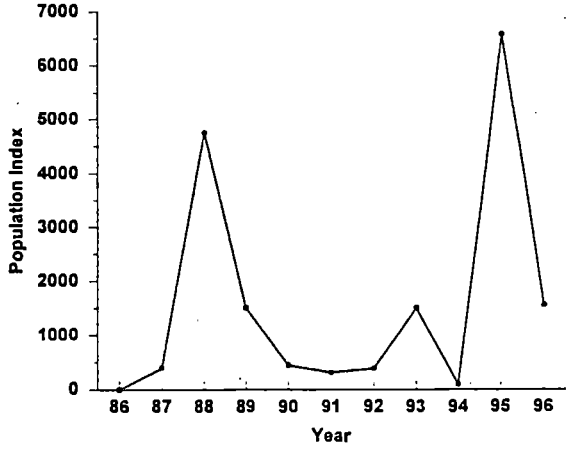
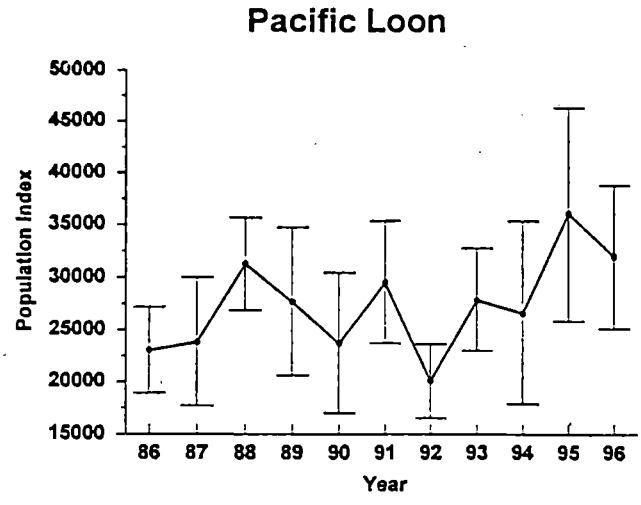
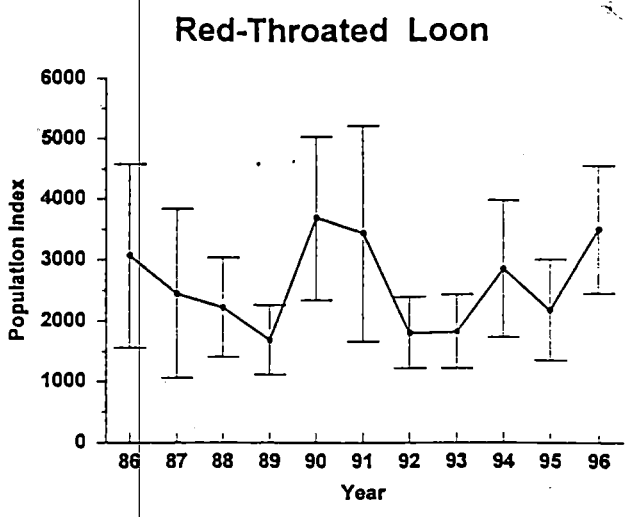
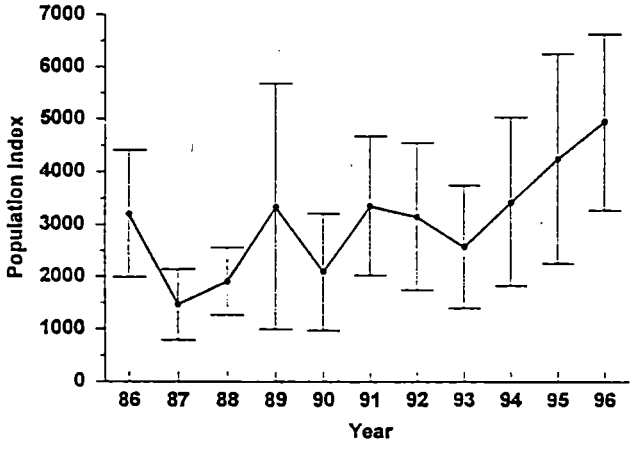
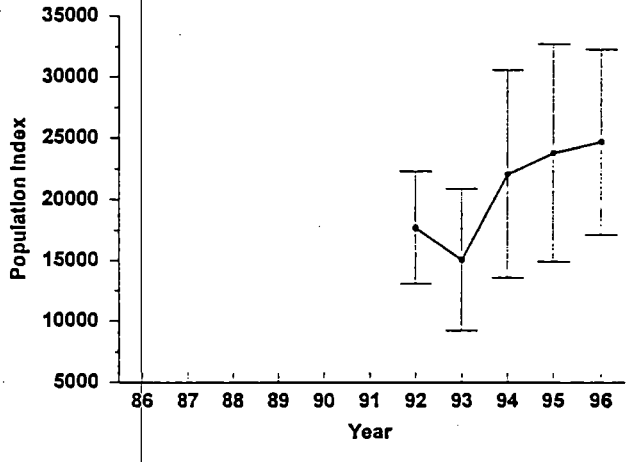


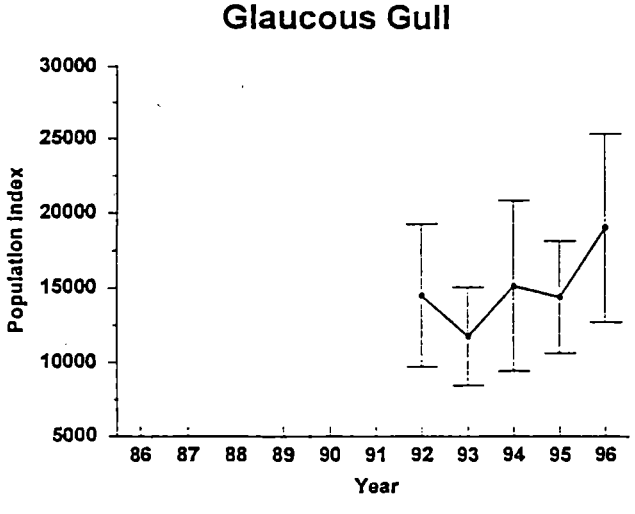

**Fig. 3. Population estimates and number of observations of greater white-fronted goose, tundra swan, and snowy owl from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-1996. Vertical lines indicate 95% confidence intervals.**



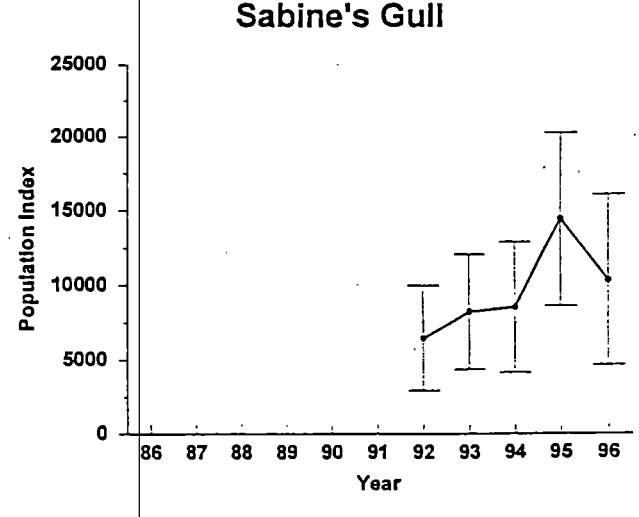




Fig. 4. Population estimates of various waterbirds from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska 1986-1996. Vertical lines indicate 95% confidence intervals.