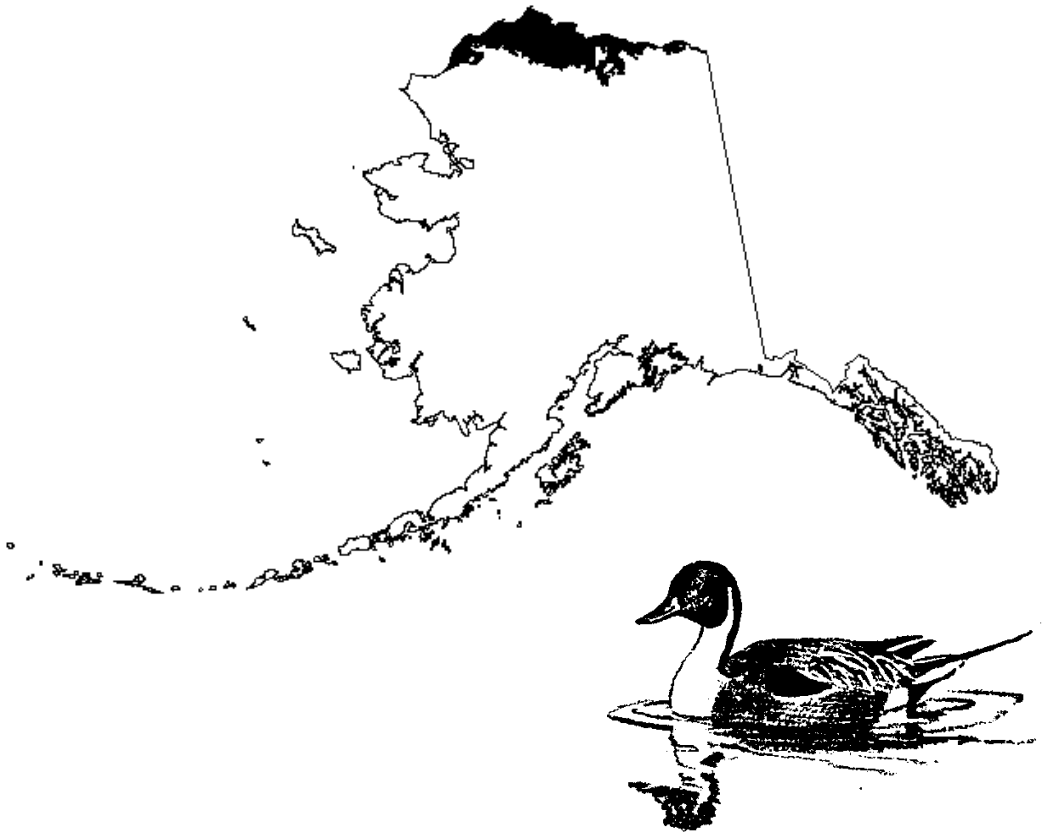
AERIAL BREEDING PAIR SURVEYS OF THE ARCTIC COASTAL PLAIN OF ALASKA - 2003



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AERIAL BREEDING PAIR SURVEYS OF THE ARCTIC COASTAL PLAIN OF ALASKA - 2003

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Abstract: An aerial breeding pair survey was conducted on the Arctic Coastal Plain of Alaska for the 18th consecutive year from 24-27 June 2003. Weather conditions during the survey were relatively normal, providing typical bird concentrations and breeding effort in the survey area. The population index for northern pintails (227,678) was 0.5% greater than the previous 17-year mean (226,612). The long-tailed duck population index (87,893) was 20% below the previous 17-year mean (109,896) and the 18-year population trend indicates a significant decline. The scaup population index (37,438) was 13% greater than the previous 17-year mean. The population indices for white-fronted geese (108,146) and Canada geese (11,373) were below their 17-year means (124,328 and 18,759, respectively). The population index for tundra swans (9,118) was 8% below the previous 17-year mean. The tundra swan nest index (1,236) was very similar to the 17-year mean (1,275). Red-throated and yellow-billed loon population indices (3,599 and 3,270, respectively) were above their 17-year means (3,065 and 2,898, respectively). The Pacific loon population index (22,539) was down 18% from the previous 17-year mean.

Key Words: aerial survey, Alaska, Arctic Coastal Plain, breeding pair survey, waterfowl **March 2004**

INTRODUCTION

This report summarizes results from the 2003 aerial breeding pair survey on the Arctic Coastal Plain (ACP) of Alaska. Population indices for 1986-2002 were reported previously (Brackney and King 1993, 1994, 1995, 1996, King and Brackney 1997, Mallek and King 2000, Mallek 2001, Mallek et al. 2002. Mallek et al. 2003). This survey, conducted for 18 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 timed to precede the rapid and "early" departure of males (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 Hodges 2003). This survey provides population indices 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 2003).

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 for the 2001 and 2002 surveys and this report incorporate a stratified analysis of the survey area which is described in the methods section. All waterbird population indices 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 for the 2001 and 2002 surveys and this report incorporate this change in analysis and previous survey population indices have been updated accordingly in the tables and figures. Since the majority of geese are observed

in flocks and in pairs, this change in analysis techniques will not greatly affect previous population indices. However, the fact that we have put more emphasis on the recording (during surveys) of paired geese since 2001, this change may affect trend data of observed paired geese but will not affect the population index.

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 (Figure 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 (Figure 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 0.2 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 singles 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 indices and variances. Population indices and variances 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 12 strata with transect placement based on a random systematic coverage of the entire survey area (Figures 1-2). 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 Indices

The 2003 survey was conducted from 24-27 June. A total of 1.266.8 km^2 was sampled, which comprised 100% of the designed sample area (Figure 1). Weather conditions were normal during the survey, although low mid-June temperatures prior to this survey caused some of the ponds to re-freeze.

Population indices 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 indices and trends for all survey years are shown in Figures 3-20 and Tables 6-18 for primary species.

The 2003 northern pintail population index (227,678) was less than 0.5% greater than the previous 17-year mean (1986-2002, mean = 226,612), and data indicates a flat growth rate (Figure 4). Northern pintail observations were comprised of a high number of single males (single males or flocked drakes <5) and a low number of grouped birds (flocks). The number of observed singles was the highest on record for this survey (526) and the number of pintails observed in groups was the second lowest on record (Table 6 and Figure 3). This was also affirmed by the indicated breeding ratio ((singles + pairs) * 2 / flocks + (singles + pairs) * 2) for pintails (0.84) which is the highest on record for this survey.

The 2003 long-tailed duck population index (87,893) was 20% below the previous 17-year mean (109,896). This was primarily attributed to a low number of long-tailed ducks observed in groups (Table 7 and Figure 5). Indeed, only 55 long-tailed ducks were recorded in groups during the 2003 survey, while the 10-year mean (1986-1995) was 352. Furthermore, the long-tailed duck trend (Figure 6) indicates a significant decline over the length of this survey, which appears to be driven by survey results from 1997 to 2003.

The scaup population index for 2003 (37,438) was 13% greater than the previous 17-year mean (33,074). The long-term growth rate for scaup is rather flat and indicates no significant trend (Table 8 and Figures 7-8).

White-fronted and Canada goose population indices (108,146 and 11,373, respectively) were below their previous 17-year means (124,328 and 18,759, respectively). For white-fronted geese, the difference from the long-term mean was primarily attributed to a decrease in flocked birds (Table 9 and Figure 9). While white-fronted goose indices have been variable over the years of this survey, Figure 10 indicates a non-significant positive growth rate. Snow geese and brant are colonial breeders and this survey was not designed to accurately monitor their ACP population levels. Data

presented in this report for these species are ancillary and do not indicate accurate population indices or trends.

The 2003 tundra swan population index (9,118) was approximately 8% below the 17-year mean. The population growth rate for tundra swans appears to be positive and significant (Figure 12), although this growth rate is driven by estimates from the 1997-2000 surveys. A total of 25 tundra swan nests were observed during the 2003 survey, providing a population index of 1,236 nests for the ACP (Tables 2 and 11 and Figure 13). The 2003 tundra swan nest index was very similar to the 1986-2002 mean of 1,275.

The jaeger population index (6,697), which includes all jaeger species, was down approximately 6% from the 17-year mean. The long term data for these species (Table 12 and Figure 14) indicate a non-significant growth rate.

The Pacific loon population index (22,539) was down 18% from the 17-year mean, although the long-term data indicate a relatively flat growth rate (Table 13 and Figure 15) Red-throated and yellow-billed loon population indices (3,599 and 3,270, respectively) were above their 1986-2002 means (3,065 and 2,898, respectively). These species are observed in low numbers during the survey, so variability in estimates due to high spatial variability is to be expected. The estimated growth rate for red-throated loons is positive and significant (Table 14 and Figure 16), although this is driven by high estimates from 1999-2001 surveys. The long-term growth rate estimate for yellow-billed loons (Table 15 and Figure 17) indicates a very flat mean growth rate.

Arctic tern, glaucous gull, and Sabine's gull data from 1992-2003 indicates non-significant growth rates for these species (Table 16-18 and Figures 18-20).

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Table 1. Population indices of ducks from an aerial breeding pair survey on the Arctic Coastal Plain of Alaska, 24-27 June 2003.

Species	VCF	Drakes[a]	Pairs	Groups	Indicated Birds	Pop. Index	SE
Mallard	4.01	1	1	0	4	874	504
American Wigeon	3.84	8	1	0	18	3,141	1,686
American GW Teal	8.36	3	1	0	8	3,318	1,617
Northern Shoveler	3.79	0	0	0	0	NA	NA
Northern Pintail	3.05	526	121	247	1,541	227,678	29,296
Dabbler						235,011	
Scaup	1.93	107	79	133	398	37,438	7,540
Long-tailed Duck	1.87	361	96	55	969	87,893	14,356
Black Scoter	1.17	0	0	0	0	NA	NA
Surf Scoter	1.17	2	0	14	18	949	438
White Winged Scoter	1.17	9	4	0	26	1,441	588
Unknown Scoter	1.17	7	1	33	49	2,664	962
R. B. Merganser	1.27	13	0	0	26	1,513	665
King Eider	1.0	33	34	0	134	6,472	1,171
Common Eider	1.0	3	3	0	12	623	308
Steller's Eider	1.0	0	0	0	0	NA	NA
Spectacled Eider	1.0	1	2	0	6	263	185
Unknown Eider	1.0	0	0	0	0	NA	NA
Diver Total						139,256	
Ducks Total						374,267	

[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 = 1,266.8 km^2
Visibility correction factor = VCF, Number of transects (n) = 74

Table 2. Population indices of waterfowl and related species from an aerial breeding pair survey on the Arctic Coastal Plain of Alaska, 24-27 June 2003.

Species	VCF	Singles	Pairs	Groups	Indicated Birds	Pop. Index	SE
White Fronted Goose	1	156	256	1,440	2,264	108,146	10,480
Small Canada Goose	1	29	21	143	243	11,373	1,788
Lesser Snow Goose	1	3	4	38	52	2,554	1,295
Brant	1	12	8	244	284	12,932	4,438
Geese total						135,005	
Tundra Swan	1	86	46	11	189	9,118	1,048
Tundra Swan nest	1	25	0	0	25	1,236	247
Sandhill Crane	1	1	0	0	1	NA	NA
Pacific Loon	1	264	91	18	464	22,539	1,788
Red Throated Loon	1	55	8	3	74	3,599	616
Common Loon	1	0	0	0	0	NA	NA
Yellow-billed Loon	1	44	12	0	68	3,270	493
Unidentified Loon	1	0	0	0	0	NA	NA
Loons total						29,408	
Jaeger sp.	1	100	16	5	137	6,697	616
Golden Eagle	1	4	0	0	4	190	123
Snowy Owl	1	13	0	0	13	651	247
Arctic Tern	1	209	59	255	582	28,016	3,945
Glaucous Gull	1	167	30	44	271	13,116	1,788
Sabine's Gull	1	55	24	279	382	17,974	5,671

Survey area = 61,645.2 km^2, Sample area = 1,266.8 km^2
Visibility correction factor = VCF, Number of transects (n) = 74

Table 3. Population indices 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	—	---	---	---	---	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	9,570	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
Swan Nests	356	934	712	1,290	1,157	1,073	1,192	1,172	1,000	1,574
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	4,401
Arctic Tern	---	---	---	---	---	---	17,688	15,047	22,049	23,797
Glaucous Gull	---	---	---	---	---	---	14,493	11,765	15,144	14,398
Sabine's Gull	---	---	---	---	---	---	6,484	8,250	8,572	14,491
Golden Eagle	801	400	222	133	89	537	667	562	333	417
Snowy Owl	0	400	4,761	1,513	445	313	334	1,500	95	6,574

[a] Includes all scoters identified and unidentified

--- Indicates that observations of this species not delineated during that year

Table 4. Population indices of waterfowl and related species on the Arctic Coastal Plain, Alaska 1996-2003.

Species	1996	1997	1998	1999	2000	2001	2002	2003	Mean 86-02	Mean 86-03
Mallard	2,353	1,417	5,253	11,135	1,230	1,877	1,071	874	2,186	2,123
Gadwall	0	0	853	0	0	0	0	0	67	64
Wigeon	7,887	14,923	7,905	7,730	4,712	369	361	3,141	4,683	4,598
GW Teal	5,315	1,969	14,081	5,803	855	778	0	3,318	3,493	3,483
Shoveler	3,336	0	2,482	4,209	0	0	1,365	0	1,219	1,151
Pintail	252,661	226,636	268,131	283,076	131,121	238,529	178,635	227,678	226,612	226,672
Dabblers	271,552	244,945	298,705	311,953	137,918	241,553	181,432	235,011	235,908	235,858
Scaup	33,883	40,796	33,139	32,824	43,311	28,327	27,509	37,438	33,074	33,317
Goldeneye	1,765	0	0	0	0	0	0	0	142	134
Bufflehead	0	0	0	0	0	0	0	0	10	9
Long-tailed Duck	129,214	98,655	92,478	85,676	67,010	104,055	96,946	87,893	109,896	109,618
Scoter Sp.[a]	11,672	7,991	8,102	5,442	4,608	14,318	11,930	5,054	11,253	10,908
RB Merganser	3,913	748	3,684	6,965	130	2,133	2,468	1,513	2,347	2,301
Common Eider	1,956	0	936	0	972	198	0	623	410	422
King Eider	3,521	6,359	3,649	4,165	1,738	7,887	4,525	6,472	3,469	3,635
Steller's Eider	2,543	1,295	281	1,250	563	176	0	0	911	860
Spectacled Eider	438	589	281	139	0	653	729	263	415	403
Unidentified Eider	0	589	0	1,111	409	0	0	0	494	466
Divers	188,905	157,022	142,550	137,572	118,741	157,747	144,107	139,256	163,297	161,961
Total Ducks	460,457	401,967	441,255	449,525	256,659	399,300	325,539	374,267	399,205	397,820
WF Goose	131,008	177,877	128,288	192,426	137,968	155,500	120,314	108,146	124,328	123,429
Canada Goose	20,637	18,724	33,312	47,551	24,640	23,794	9,324	11,373	18,759	18,349
Snow Goose	538	236	94	2,568	615	29,257	529	2,554	2,437	2,444
Black Brant	7,140	16,310	11,088	8,052	1,126	22,042	10,233	12,932	9,750	9,927
Total Geese	159,323	213,147	172,782	250,597	164,349	230,593	140,400	135,005	155,275	154,149
Swans	10,514	13,601	12,632	16,105	17,227	10,504	9,389	9,118	9,962	9,916
Swan Nest	1,809	1,943	1,731	2,846	665	1,134	1,084	1,236	1,275	1,273
Pacific Loon	32,177	34,151	29,850	34,154	19,988	22,188	22,702	22,539	27,366	27,097
RT Loon	3,521	2,179	2,994	5,276	4,601	5,335	2,945	3,599	3,065	3,095
YB Loon	4,988	3,062	3,556	3,124	2,454[b]	1,331	1,948	3,270	2,898	2,919
Common Loon	0	0	0	0	0	0	0	0	27	26
Unidentified Loon	0	0	0	0	7,515	616	290	0	495	468
Total Loons	40,686	39,392	36,400	42,554	33,587[c]	29,470	27,885	29,408	33,794	33,550
Jaegers	7,678	6,948	7,112	6,317	5,165	5,906	5,301	6,697	7,104	7,081
Arctic Tern	24,842	26,084	26,247	25,476	21,828	21,320	21,248	28,016	22,330	22,804
Glaucous Gull	19,170	20,549	13,615	23,741	29,751	12,225	18,472	13,116	17,575	17,203
Sabine's Gull	10,465	15,132	6,924	10,413	21,419	10,611	9,298	17,974	11,096	11,669
Golden Eagle	245	530	795	625	461	908	497	190	484	467
Snowy Owl	1,565	589	936	2,013	307	192	626	651	1,304	1,267

[a] Includes all scoter identified and unidentified
[b] Estimate based on left-observer data only
[c] 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, 24-27 June 2003.

Stratum Name	Survey Area km^2	Sample Area km^2	% Sample
Kuk	2098.3	37.7	1.8
Barrow	3884.2	78.2	2.0
Colville/Sag	4622.5	91.6	2.0
Lower Meade	3077.9	64.3	2.1
Marginal	2408.2	52.9	2.2
NEPA	1949.5	48.5	2.5
S. NEPA	10602.5	227.5	2.1
Upper Meade	4179.7	88.2	2.1
Ptlaysmead	11906.3	245.1	2.1
Kogru River	4999.2	109.5	2.2
Sadmiralwnepa	3535.4	69.6	2.0
Bardekup	8381.6	153.6	1.8
TOTAL	**61645.2**	**1266.8**	**2.1**

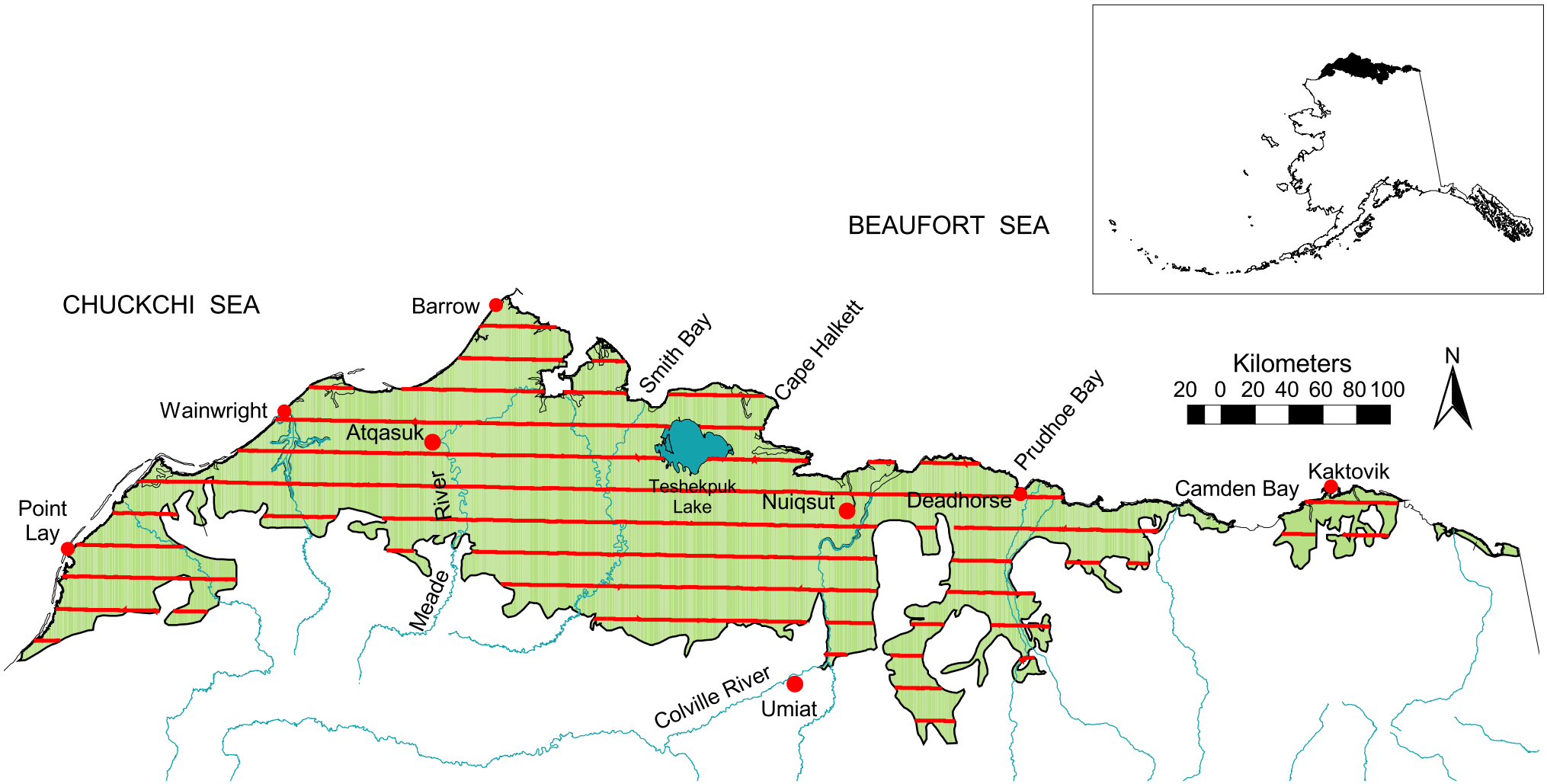


Figure 1. Major features of the Arctic Coastal Plain of Alaska in relation to the waterfowl breeding pair survey boundary and the 2003 transect locations (red lines).

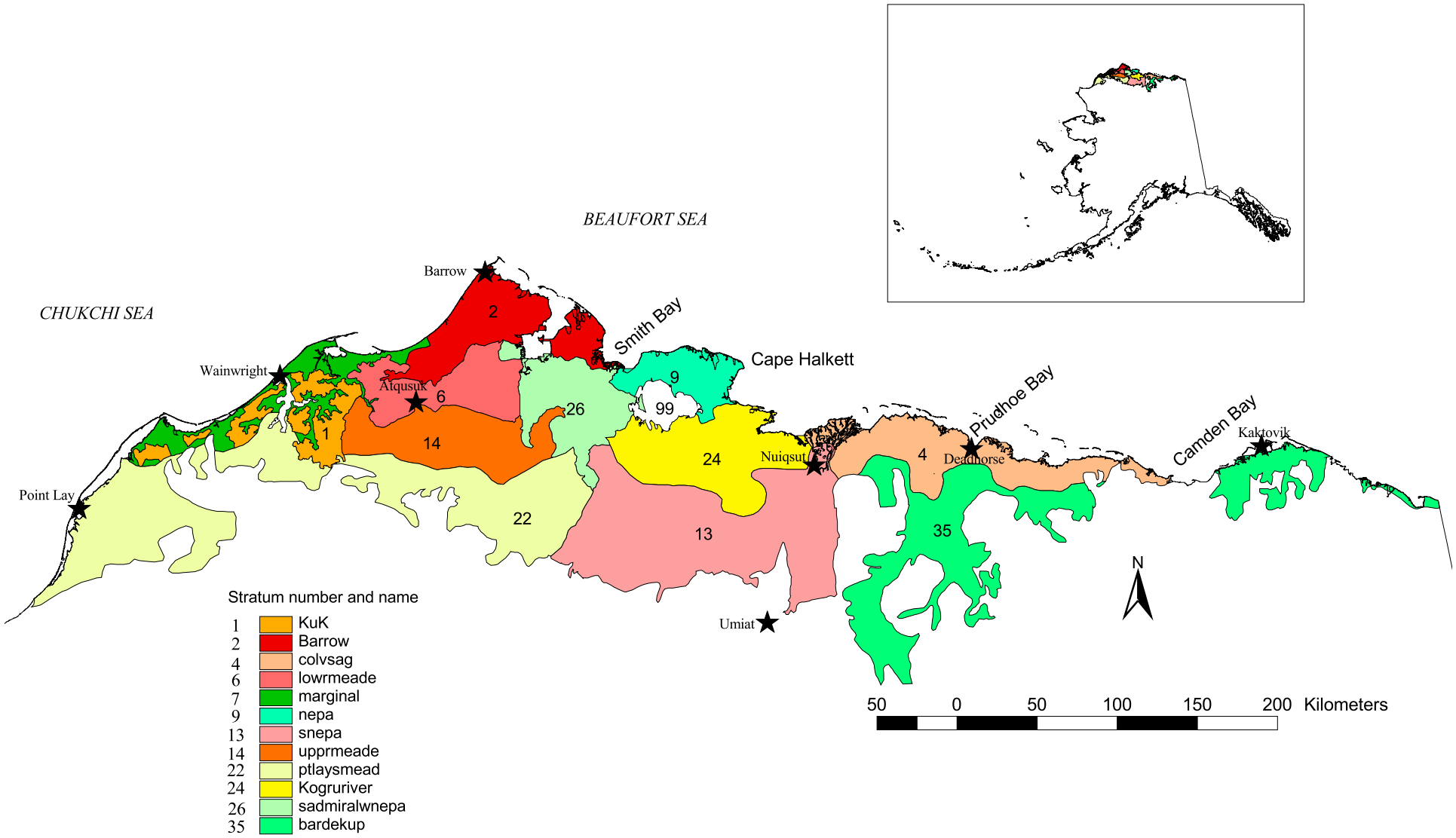


Figure 2. Stratification of the Arctic Coastal Plain of Alaska for calculation of waterbird population indices from aerial surveys conducted in 2003.

Northern Pintail

Table 6. Population indices and observational data for Northern Pintails from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Singles	Pairs	Groups	Index
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
03	526	121	247	227678

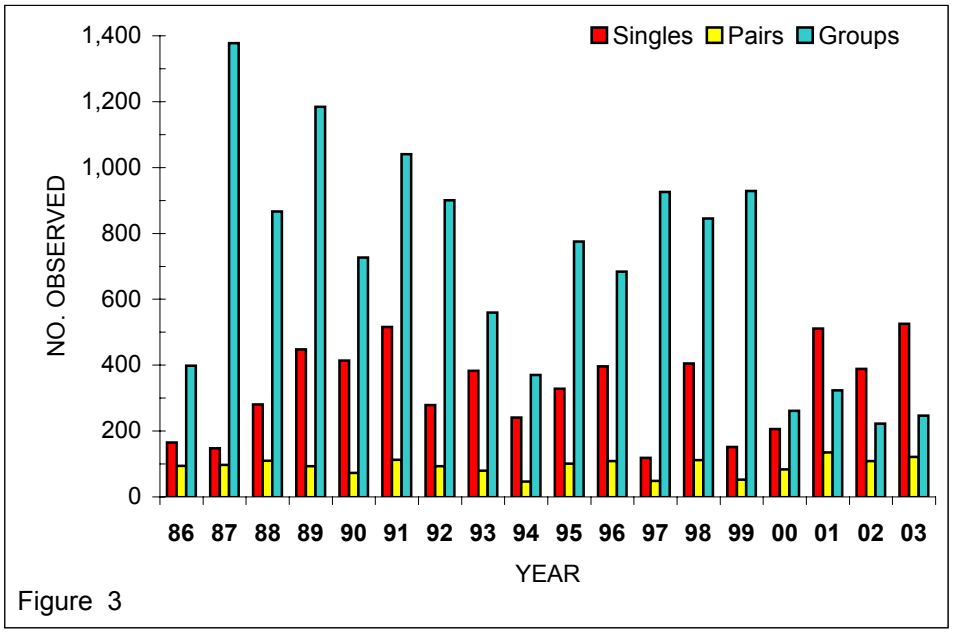


Figure 3

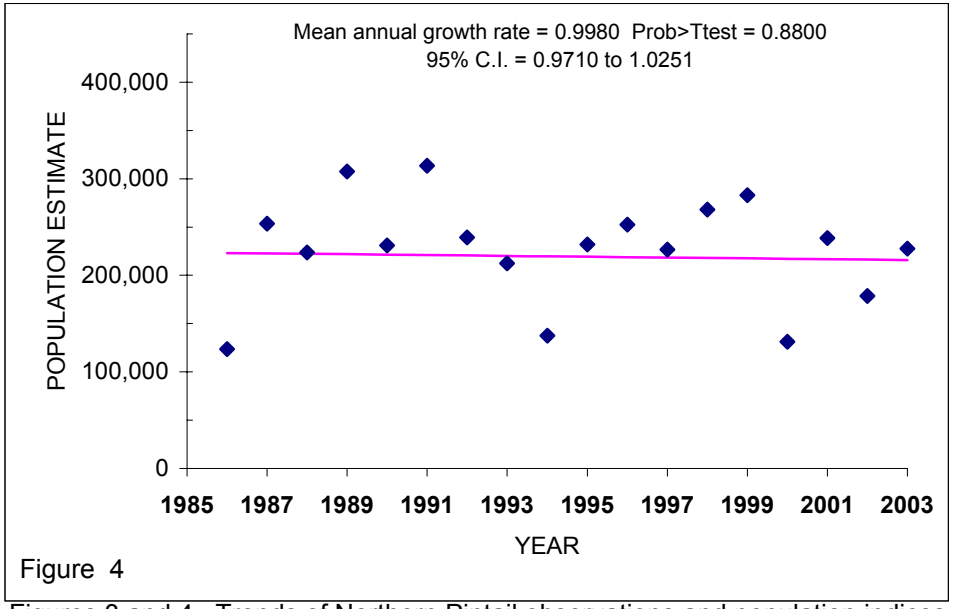


Figure 4

Figures 3 and 4. Trends of Northern Pintail observations and population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003. "Singles" represents the number of males in flocks of 4 or less (flocked drakes and lone drakes). Mean annual growth rate was determined by log-linear regression.

Long-tailed Duck

Table 7. Population indices and observational data for Long-tailed Ducks from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Singles	Pairs	Groups	Index
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
03	361	96	55	87893

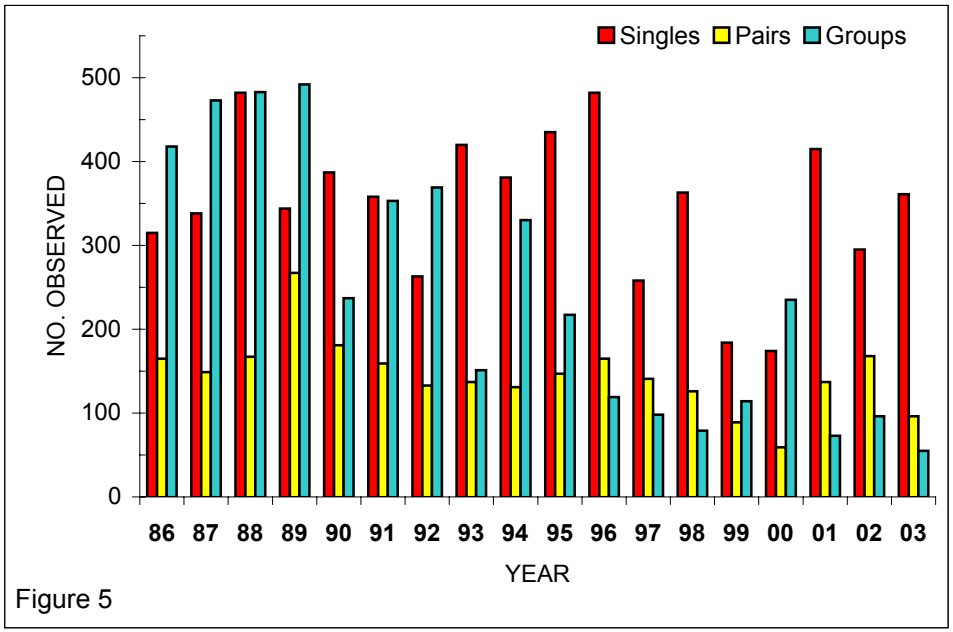


Figure 5

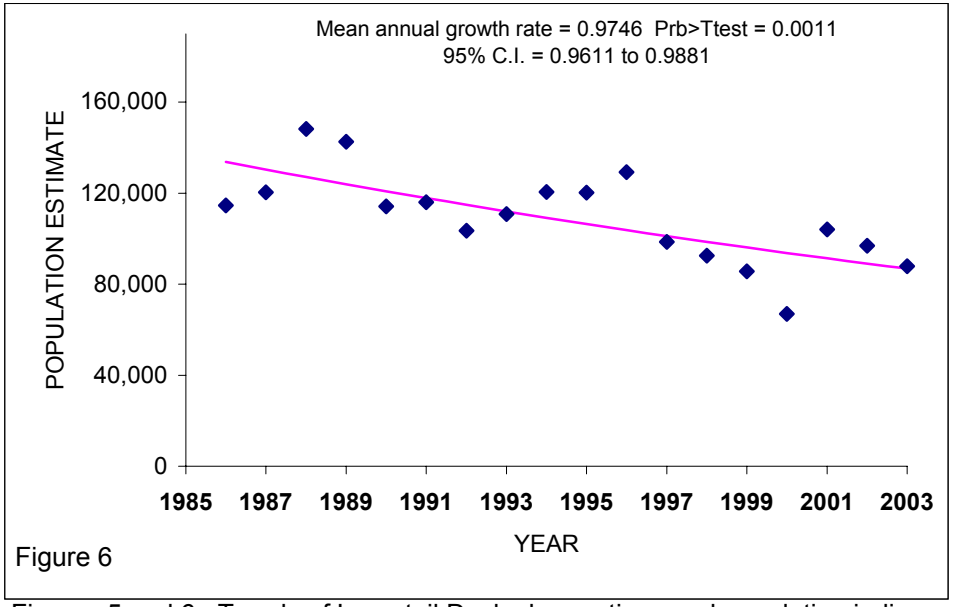


Figure 6

Figures 5 and 6. Trends of Long-tail Duck observations and population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003. "Singles" represents the number of males in flocks of 4 or less (flocked drakes and lone drakes). Mean annual growth rate was determined by log-linear regression.

Scaup

Table 8. Population indices and observational data for Scaup from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Singles	Pairs	Groups	Index
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
03	107	79	133	37438

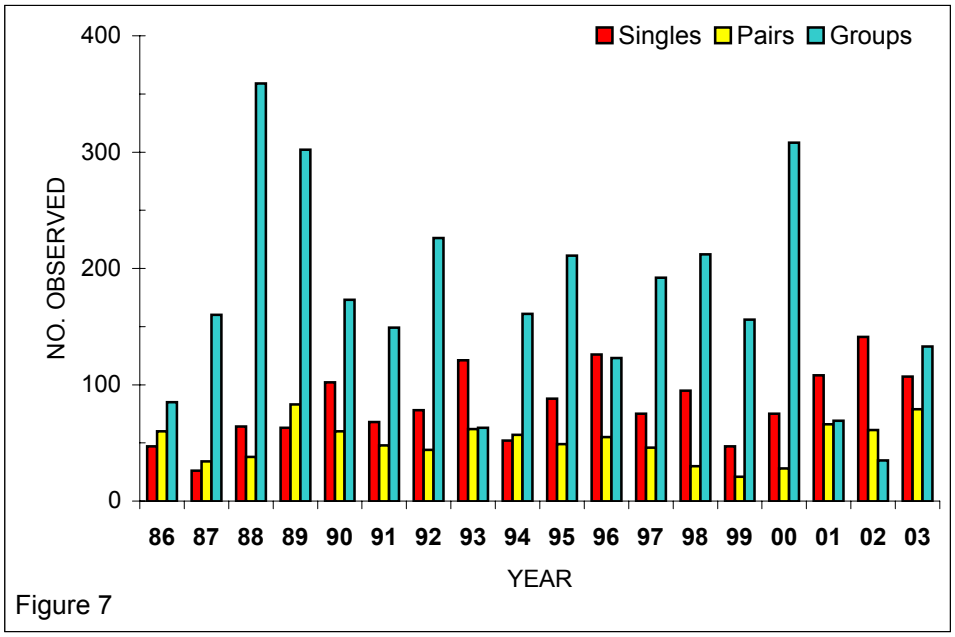


Figure 7

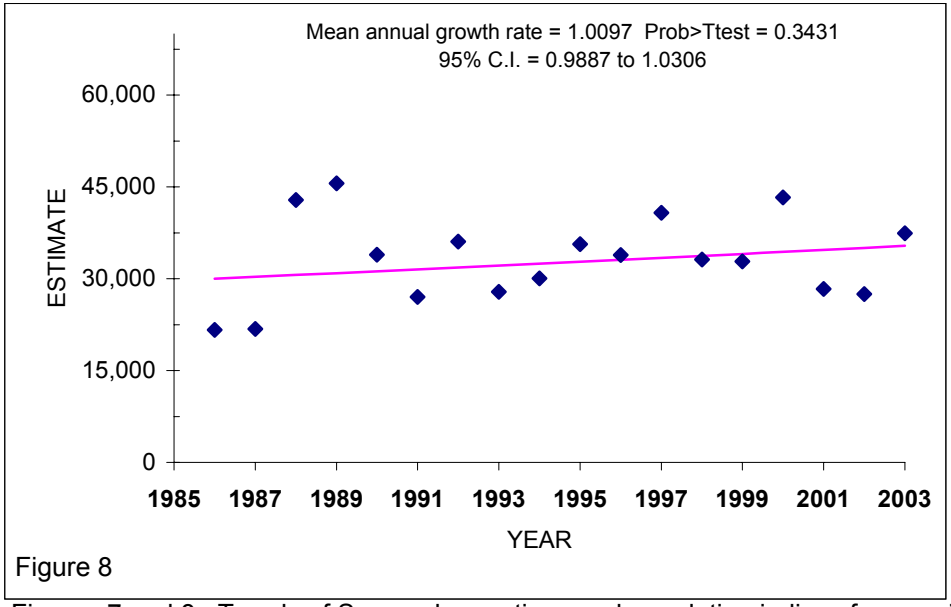


Figure 8

Figures 7 and 8. Trends of Scaup observations and population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003. "Singles" represents the number of males in flocks of 4 or less (flocked drakes and lone drakes). Mean annual growth rate was determined by log-linear regression.

Greater White-fronted Goose

Table 9. Population indices and observational data for Greater White-fronted Geese from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Singles	Pairs	Groups	Index
86	41	65	2483	119905
87	64	62	1802	91385
88	143	96	1730	98237
89	81	103	2973	148646
90	96	81	1676	90318
91	133	103	2241	121321
92	50	65	2339	122479
93	94	114	1724	100311
94	72	112	1593	93386
95	133	96	1361	84213
96	106	66	2335	131088
97	91	111	2617	177877
98	140	123	2216	128288
99	92	57	2474	192426
00	119	96	2269	137968
01	103	240	2567	155500
02	126	253	1787	120314
03	156	256	1440	108146

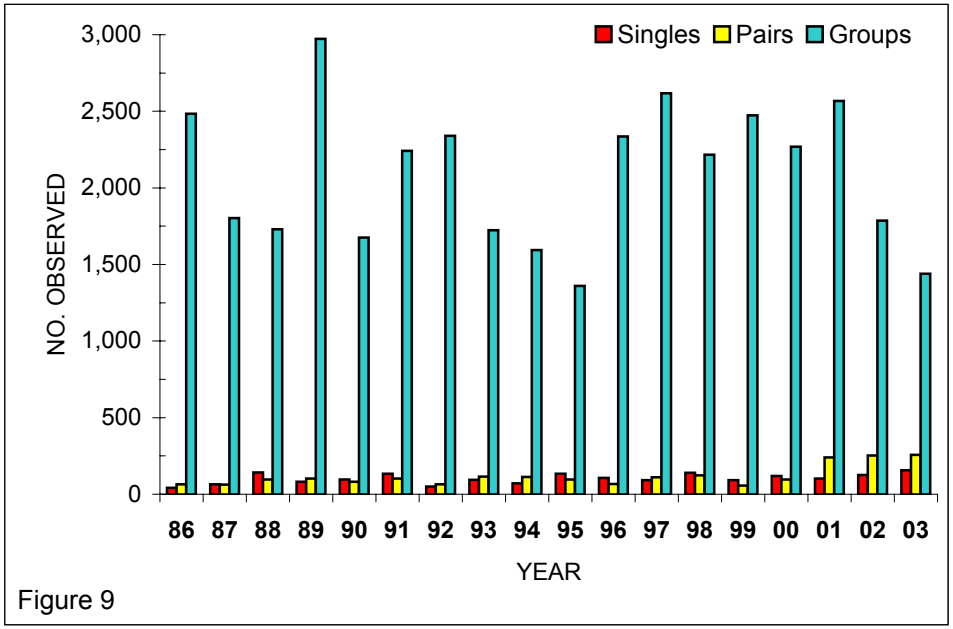


Figure 9

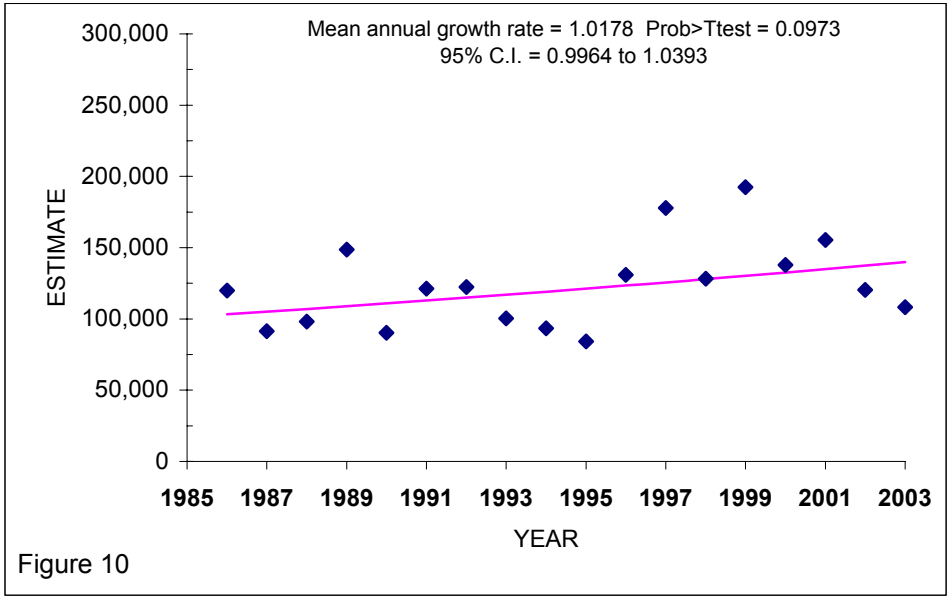


Figure 10

Figures 9 and 10. Trends of Greater White-fronted Goose observations and population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003. Mean annual growth rate was determined by log-linear regression.

Tundra Swan

Table 10. Population indices and observational data for Tundra Swans from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Singles	Pairs	Groups	Index
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
03	86	46	11	9118

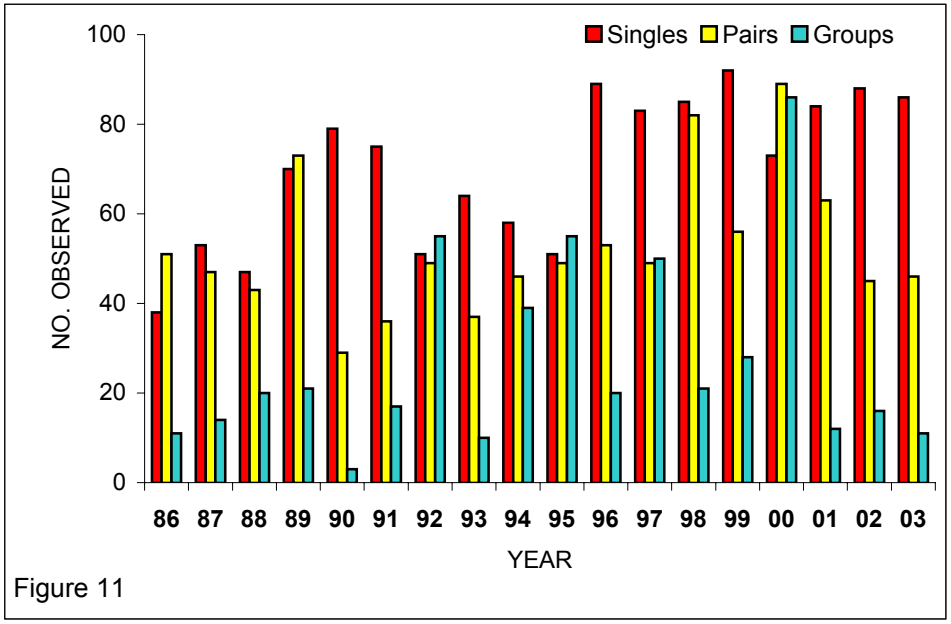


Figure 11

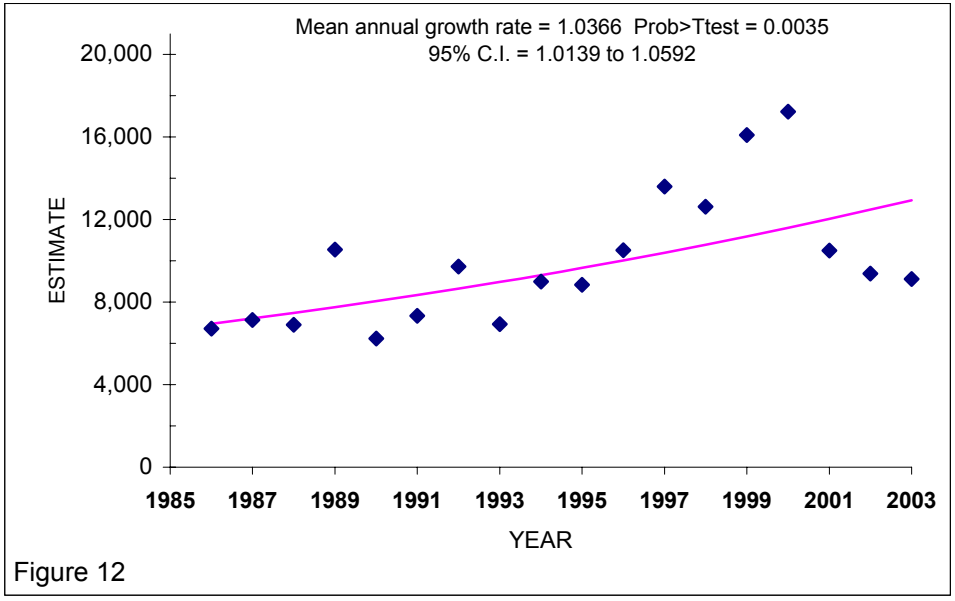


Figure 12

Figures 11 and 12. Trends of Tundra Swan observations and population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003. Mean annual growth rate was determined by log-linear regresion.

Tundra Swan Nests

Table 11. Population indices for Tundra Swan Nests from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Index	Year	Index
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	03	1236

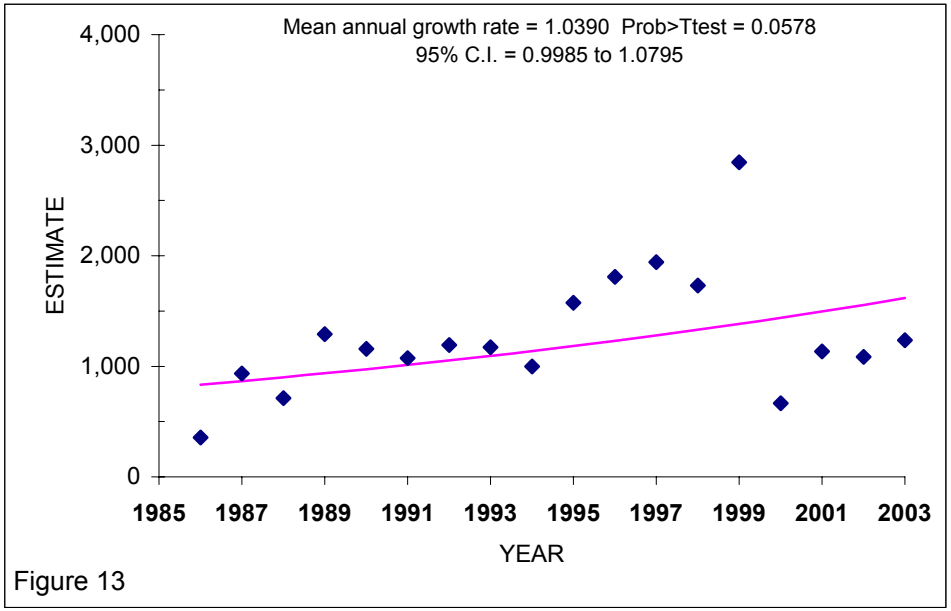


Figure 13

Jaegers

Table 12. Population indices for Jaegers from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Index	Year	Index
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	03	6697

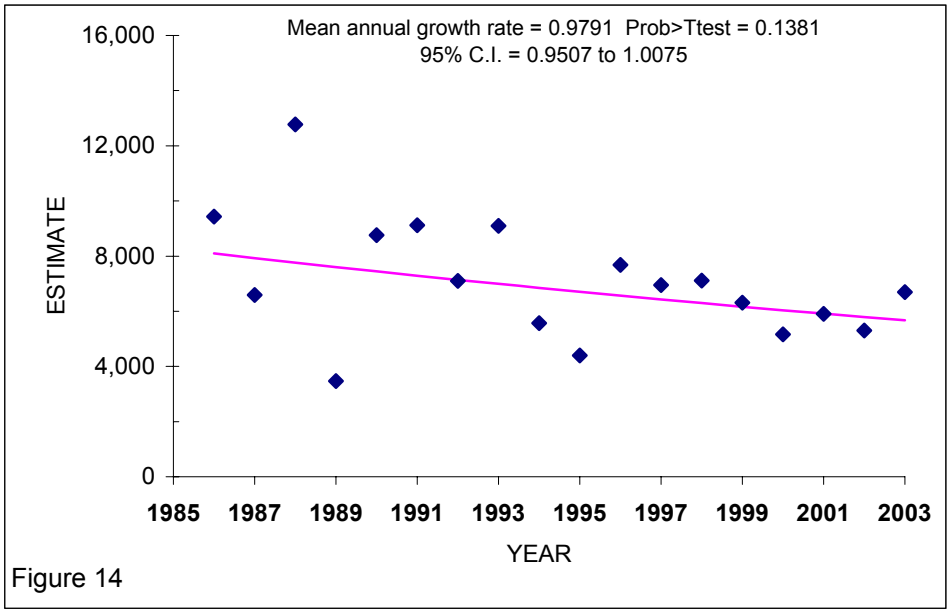


Figure 14

Figures 13 and 14. Trends of Tundra Swan Nest and Jaeger population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003. Mean annual growth rate was determined by log-linear regression.

Pacific Loon

Table 13. Population indices for Pacific Loon from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Index	Year	Index
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	03	22539

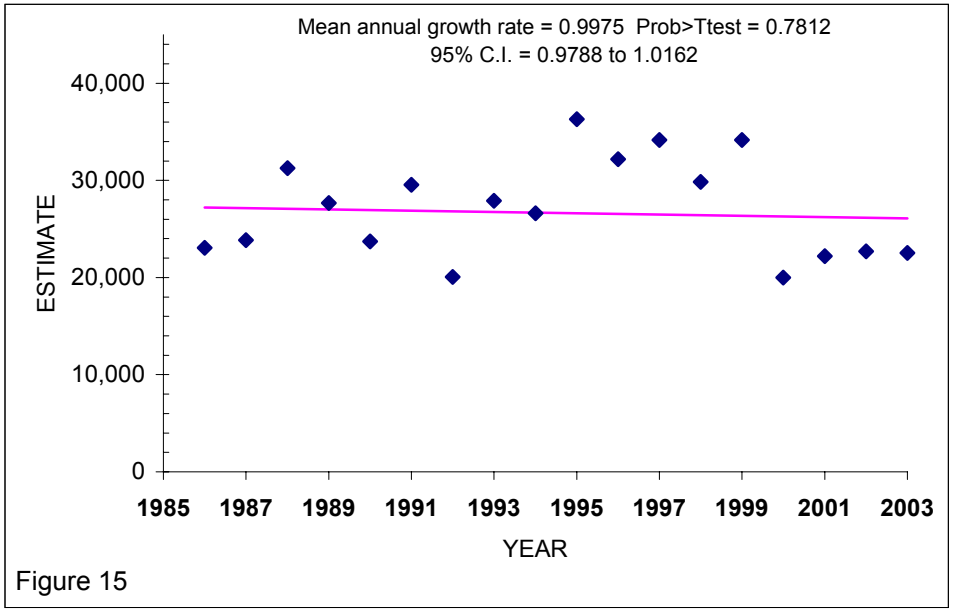


Figure 15

Red-throated Loon

Table 14. Population indices for Red-throated Loon from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Index	Year	Index
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	03	3599

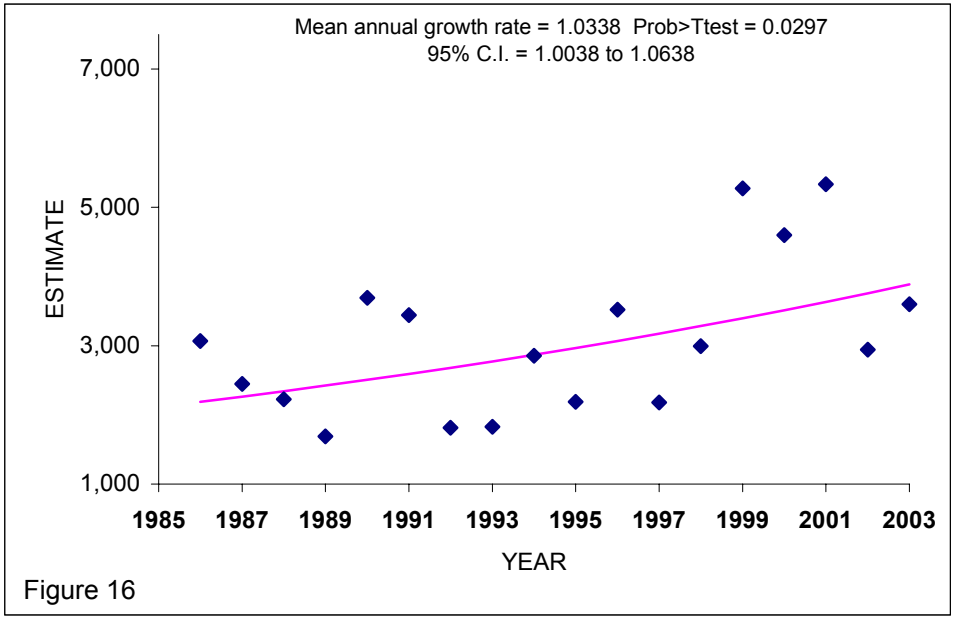


Figure 16

Figures 15 and 16. Trends of Pacific and Red-throated Loon population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003. Mean annual growth rate was determined by log-linear regression.

Yellow-billed Loon

Table 15. Population indices for Yellow-billed Loon from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2003.

Year	Index	Year	Index
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	03	3270

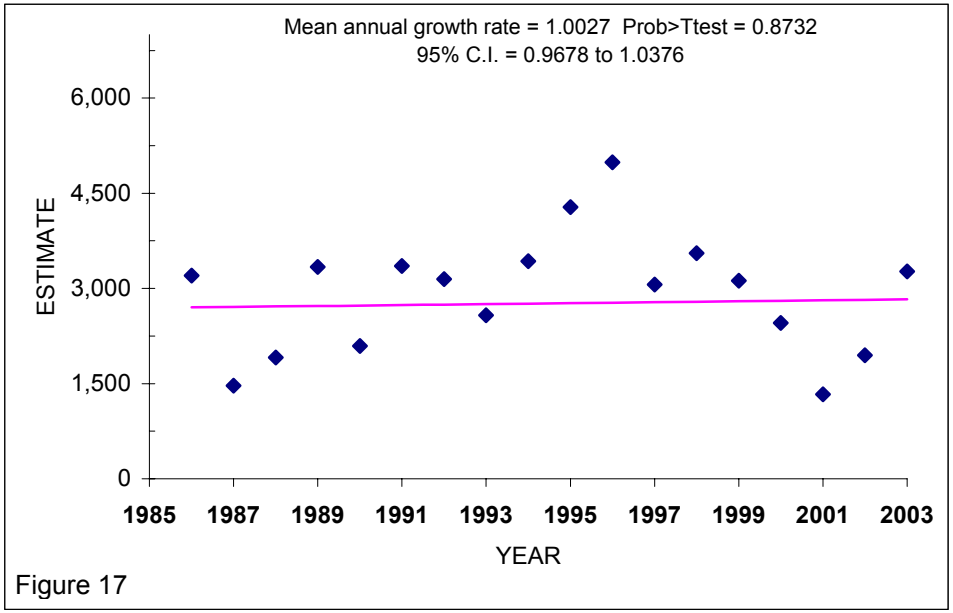


Figure 17

Arctic Tern

Table 16. Population indices for Arctic Tern from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2003.

Year	Index	Year	Index
92	17688	01	21320
93	15047	02	21248
94	22049	03	28016
95	23797		
96	24842		
97	26084		
98	26247		
99	25476		
00	21828		

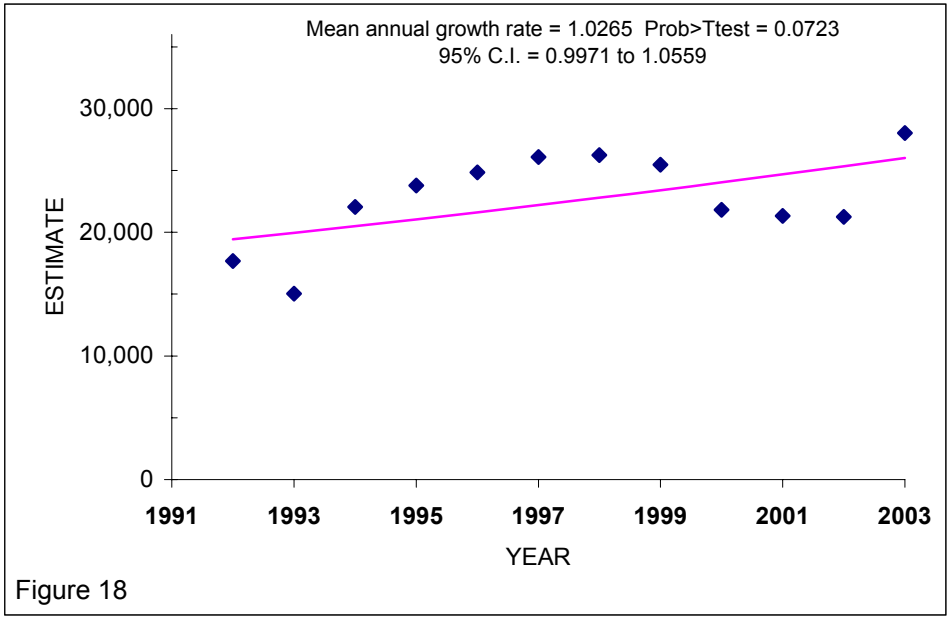


Figure 18

Figures 17 and 18. Trends of Yellow-billed Loon (1986-2003) and Arctic Tern (1992-2003) population indices from aerial breeding pair surveys on the Arctic Coastal Pain of Alaska. Mean annual growth rate was determined by log-linear regression.

Glaucous Gull

Table 17. Population indices for Glaucous Gull from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2003.

Year	Index	Year	Index
92	14493	01	12225
93	11765	02	18472
94	15144	03	13116
95	14398		
96	19170		
97	20549		
98	13615		
99	23741		
00	29751		

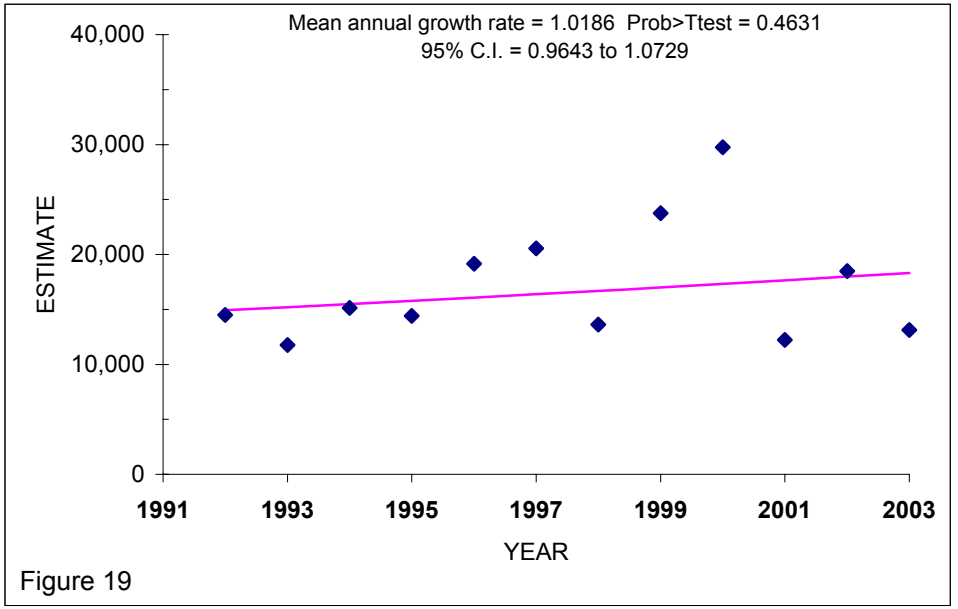


Figure 19

Sabine's Gull

Table 18. Population indices for Sabine's Gull from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2003.

Year	Index	Year	Index
92	6484	01	10611
93	8250	02	9298
94	8572	03	17974
95	14491		
96	10465		
97	15132		
98	6924		
99	10413		
00	21419		

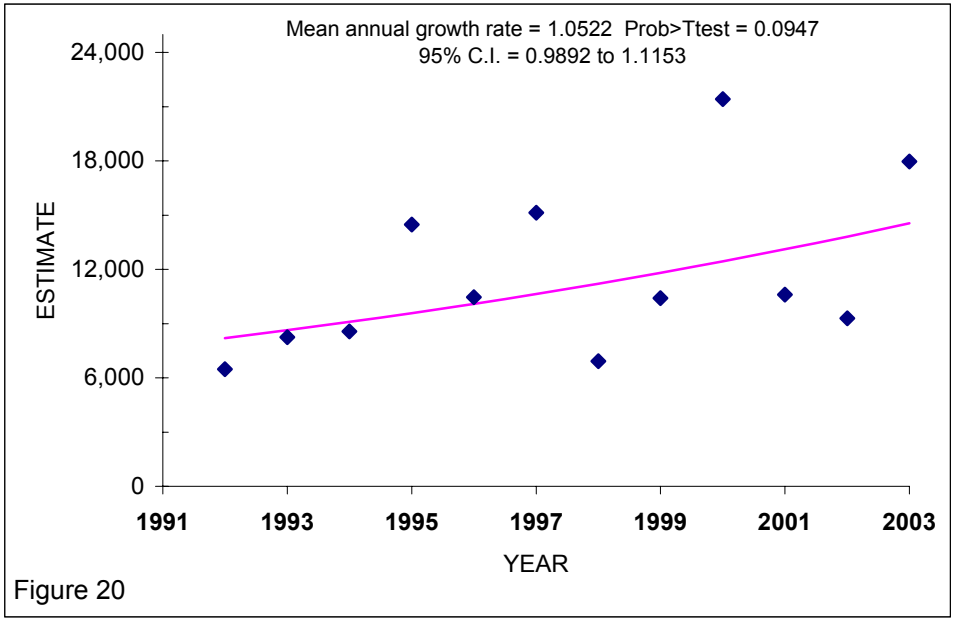


Figure 20

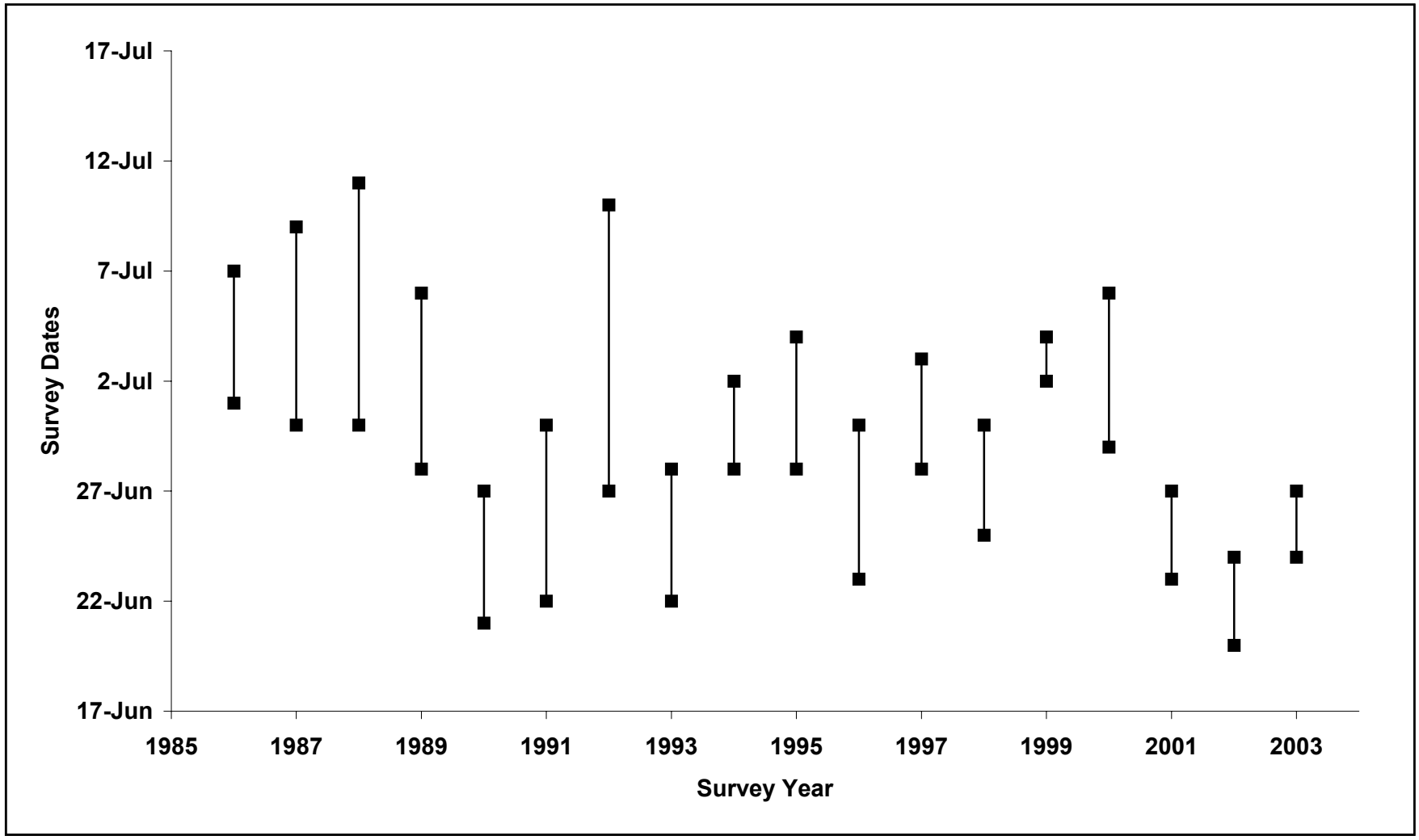
Figures 19 and 20. Trends of Glaucous and Sabine's Gull population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2003. Mean annual growth rate was determined by log-linear regression.

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

Red-throated Loon	*Gavia stellata*
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*
Common Eider	*Somateria mollissima*
King Eider	*Somateria spectabilis*
Spectacled Eider	*Somateria fischeri*
Steller's Eider	*Polysticta stelleri*
Long-tailed duck	*Clangula hyemalis*
Black Scoter	*Melanitta nigra*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Red-breasted Merganser	*Mergus serrator*
Goldeneye (Com. & Barrows)	*Bucephala clangula, B. islandica*
Scaup (Greater & Lesser)	*Aythya marila, A. affinis*
Sandhill Crane	*Grus canadensis*
Golden Eagle	*Aquila chrysaetos*
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*

Appendix 2. List of Arctic Coastal Plain Breeding Pair Survey observers and dates, 1986 - 2003.

YEAR	OBSERVER/PILOT	OBSERVER	DATES
1986	Rodney King	Steve Cane	1-7 July
1987	Rodney King	Steve Cane	30 June-9 July
1988	Rodney King	Marta McWhorter	30 June-11 July
1989	Rodney King	Barbara Gradin	28 June-6 July
1990	Rodney King	Alan Brackney	21-27 June
1991	Rodney King	Alan Brackney	22-30 June
1992	Rodney King	Alan Brackney	27 June-10 July (AC problem)
1993	Rodney King	Alan Brackney	22-28 June
1994	Rodney King	Alan Brackney	28 June-2 July
1995	Rodney King	Alan Brackney	28 June-4 July
1996	Rodney King	Alan Brackney	23-30 June
1997	Rodney King	Chris Dau	28 June-3 July
1998	Rodney King/Chris Dau	Chris Dau/Rod King	25-30 June
1999	Rodney King/Chris Dau	Ed Mallek/Eric Taylor	2-4 July
2000	Ed Mallek	Dennis Marks	29 June-6 July
2001	Ed Mallek	Dennis Marks	23-27 June
2002	Ed Mallek	Dennis Marks	20-24 June
2003	Ed Mallek	Dennis Marks	24-27 June



Appendix 3. Survey duration by year of the Arctic Coastal Plain Breeding Pair Survey, 1986 - 2003.