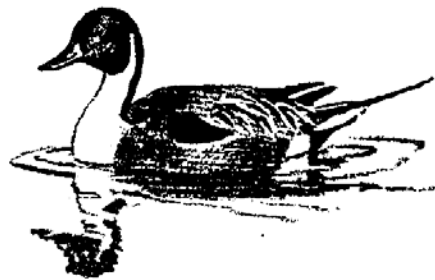




**AERIAL BREEDING PAIR SURVEYS OF THE ARCTIC COASTAL PLAIN
OF
ALASKA - 2005**



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Waterfowl Management
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AERIAL BREEDING PAIR SURVEYS OF THE ARCTIC COASTAL PLAIN OF ALASKA - 2005

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Abstract: An aerial breeding pair survey was conducted on the Arctic Coastal Plain of Alaska for the 20th consecutive year from 24-27 June 2005. Weather conditions during the survey were relatively normal, although early June temperatures prior to this survey may have resulted in non-typical bird concentrations and breeding effort for some species in the survey area. The total duck index (290,413) was well below the previous 19-year mean (1986-2004, 397,762) primarily caused by a decline in northern pintail observations. The northern pintail index (156,754) was down 31% from the previous 19-year mean. The scaup index (26,967) was down 19% from the 19-year mean. The long-tailed duck index (84,241) was still below the 19-year mean (109,169) by 23%. The long-term index trend for long-tailed ducks remains significantly negative. The index for white-fronted geese (129,403) was 4% above the 19-year mean. The tundra swan index (12,002) was 22% above the 19-year mean, while the tundra swan nest index (1,709) was 34% above its mean. The yellow-billed loon index (1,871) was 35% below the 19-year mean although the long-term trend for this species remains near zero.

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

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INTRODUCTION

This report summarizes results from the 2005 aerial breeding pair survey on the Arctic Coastal Plain (ACP) of Alaska. Population indices for 1986-2004 were reported previously (Brackney and King 1993, 1994, 1995, 1996, King and Brackney 1997, Mallek and King 2000, Mallek 2001, Mallek et al. 2002, 2003, 2004, 2005). This survey, conducted for 20 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. 2005). 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 and Shook 2005, Dau and Larned 2004). 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 2005).

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 2001-2004 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. 2005, 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 2001-2004 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.

STUDY AREA AND METHODS

Study Area and Survey Design

The survey area (61,645.2 km²) 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-geese 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 2005 survey was conducted from 24-27 June. A total of 1,292.8 km² was sampled, which comprised 100% of the designed sample area (Figure 1). Weather conditions were normal during the survey, although low early June temperatures prior to this survey caused significant amounts of ice to remain on lakes until after mid-June. The low early June temperatures may have affected density and distribution of some waterfowl species.

Population indices are listed in Tables 1-4. Sampling effort and strata information are listed in Table 5. Numbers 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 total duck index for 2005 was 290,413 and was 27% below the previous 19-year (1986-2004) mean of 397,762. Northern pintails comprised the greatest proportion of ducks observed and were the primary cause for the below average total duck index. The northern pintail index of 156,754 was 31% below the long-term mean (1986-2004) and was comprised of a large proportion of singles and pairs. The group component (flocked birds) was the smallest on record during the 20 years of the survey and was the primary cause for low index in 2005. The 20-year trend for northern pintails was flat and not significant (Figure 4).

The long-tailed duck index for 2005 was 84,241 and was 23% below the previous 19-year mean of 109,169. The 20-year trend for long-tailed ducks was negative and significant (Figure 6). The major factor in this negative trend was the flock or group component. The number of grouped long-tailed ducks has decreased considerably since 1989 (Figure 5, Table 7).

The index for scaup in 2005 was 26,967 and was 19% below the 19-year mean. The long-term growth rate estimate for scaup was not significant (Figure 8).

The white-fronted goose population index was 129,403 and was 4% above the previous 19-year mean. The long-term trend for white-fronted geese was slightly positive and not significant (Figure 10). The index for Canada geese was 21,200, which was 17% above the previous 19-year mean of 18,179. 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 tundra swan population index was 12,002 and was 22% above the previous 19-year mean of 9,854. The population growth rate for tundra swans was positive and significant (Figure 12), although this growth rate estimate is primarily driven by results from the 1997-2000 surveys. A total of 36 tundra swan nests were observed on the 2005 survey. This resulted in an index of 1,709 nests, which was 34% above the 19-year mean of 1273.

The jaeger index for 2005 was 5,804 and was 17% below the previous 19-year mean. The long-term growth rate estimate for jaegers was not significant and negative (Figure 14).

Pacific loon and yellow-billed loon indices, 24,955 and 1,871, respectively, were below their previous 19-year means by 7% and 35%, respectively. The long-term growth rate estimates for these species are rather flat and not significant (Figures 15 and 17). The red-throated loon index was 3,038, and was 4% below the previous 19-year mean. While red-throated loon indices have been highly variable over the years this survey has been conducted, the long-term growth rate estimate was positive and significant (Figure 16).

Arctic tern data from 1992-2005 indicates a positive and significant growth rate for this species, (Table 16 and Figure 18). Data for glaucous gull and Sabine's gull (1992-2005) indicates non-significant growth rates for these species (Tables 17-18 and Figures 19-20).

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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 indices of ducks from an aerial breeding pair survey on the Arctic Coastal Plain of Alaska, 24-27 June 2005.

Species	VCF	Drakes^a	Pairs	Groups	Indicated Birds	Pop. Index	SE
Mallard	4.01	0	0	0	0	0	0
American Wigeon	3.84	0	0	0	0	0	0
American GW Teal	8.36	0	1	0	2	794	1,025
Northern Shoveler	3.79	0	0	0	0	0	0
Northern Pintail	3.05	375	78	152	1,058	156,754	24,051
Dabbling Total						157,548	
Scaup	1.93	96	40	116	292	26,967	5,341
Long-tailed Duck	1.87	306	139	58	948	84,241	13,529
Black Scoter	1.17	0	1	8	10	543	575
Surf Scoter	1.17	0	0	0	0	0	0
White Winged Scoter	1.17	13	14	76	130	7,190	2,798
Unknown Scoter	1.17	0	0	0	0	0	0
R. B. Merganser	1.27	13	2	8	38	2,385	932
King Eider	1.0	50	24	13	161	7,578	986
Common Eider	1.0	2	2	0	8	380	185
Steller's Eider	1.0	0	1	0	2	110	123
Spectacled Eider	1.0	30	3	8	74	3,471	555
Unknown Eider	1.0	0	0	0	0	0	0
Diver Total						132,865	
Ducks Total						290,413	

^aIndicates 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 km², Sample area = 1,292.8 km²

Visibility correction factor = VCF, Number of transects (n) = 93

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 2005.

Species	VCF	Singles	Pairs	Groups	Indicated Birds	Pop. Index	SE
White Fronted Goose	1	213	376	1,158	2,736	129,403	14,795
Small Canada Goose	1	24	27	328	430	21,200	6,041
Lesser Snow Goose	1	15	35	199	299	14,695	7,891
Brant	1	44	11	234	344	15,609	9,123
Geese total						180,907	
Tundra Swan	1	90	53	52	248	12,002	1,664
Tundra Swan nest	1	36	0	0	36	1,709	247
Sandhill Crane	1	0	2	6	10	479	308
Pacific Loon	1	246	138	11	533	24,955	1,541
Red Throated Loon	1	33	15	0	63	3,038	555
Common Loon	1	0	0	0	0	0	0
Yellow-billed Loon	1	25	7	0	39	1,871	493
Unidentified Loon	1	0	0	0	0	0	0
Loons total						29,864	
Jaeger sp.	1	97	10	6	123	5,804	555
Golden Eagle	1	1	0	0	1	48	NA
Snowy Owl	1	7	0	0	7	334	123
Arctic Tern	1	235	90	226	641	30,688	2,774
Glaucous Gull	1	186	27	166	406	18,955	3,514
Sabine's Gull	1	92	27	97	243	11,657	1,541

Survey area = 61,645.2 km², Sample area = 1,292.8 km²
 Visibility correction factor = VCF, Number of transects (n) = 93

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 1996-2005.

Species	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Mallard	2,353	1,417	5,253	11,135	1,230	1,877	1,071	874	778	0
Gadwall	0	0	853	0	0	0	0	0	0	0
Wigeon	7,887	14,923	7,905	7,730	4,712	369	361	3,141	366	0
GW Teal	5,315	1,969	14,081	5,803	855	778	0	3,318	1,571	794
Shoveler	3,336	0	2,482	4,209	0	0	1,365	0	0	0
Pintail	252,661	226,636	268,131	283,076	131,121	238,529	178,635	227,678	243,372	156,754
Dabblers	271,552	244,945	298,705	311,953	137,918	241,553	181,432	235,011	246,087	157,548
Scaup	33,883	40,796	33,139	32,824	43,311	28,327	27,509	37,438	36,588	26,967
Goldeneye	1,765	0	0	0	0	0	0	0	0	0
Bufflehead	0	0	0	0	0	0	0	0	0	0
Long-tailed Duck	129,214	98,655	92,478	85,676	67,010	104,055	96,946	87,893	101,091	84,241
Scoter Sp. ^a	11,672	7,991	8,102	5,442	4,608	14,318	11,930	5,054	4,652	7,733
RB Merganser	3,913	748	3,684	6,965	130	2,133	2,468	1,513	1,501	2,385
Common Eider	1,956	0	936	0	972	198	0	623	1,019	380
King Eider	3,521	6,359	3,649	4,165	1,738	7,887	4,525	6,472	5,031	7,578
Steller's Eider	2,543	1,295	281	1,250	563	176	0	0	0	110
Spectacled Eider	438	589	281	139	0	653	729	263	751	3,471
Unidentified Eider	0	589	0	1,111	409	0	0	0	0	0
Divers	188,905	157,022	142,550	137,572	118,741	157,747	144,107	139,256	150,633	132,865
Total Ducks	460,457	401,967	441,255	449,525	256,659	399,300	325,539	374,267	396,720	290,413
WF Goose	131,008	177,877	128,288	192,426	137,968	155,500	120,314	108,146	138,163	129,403
Canada Goose	20,637	18,724	33,312	47,551	24,640	23,794	9,324	11,373	15,129	21,200
Snow Goose	538	236	94	2,568	615	29,257	529	2,554	3,802	14,695
Black Brant	7,140	16,310	11,088	8,052	1,126	22,042	10,233	12,932	5,305	15,609
Total Geese	159,323	213,147	172,782	250,597	164,349	230,593	140,400	135,005	162,399	180,907
Swans	10,514	13,601	12,632	16,105	17,227	10,504	9,389	9,118	8,745	12,002
Swan Nest	1,809	1,943	1,731	2,846	665	1,134	1,084	1,236	1,283	1,709
Pacific Loon	32,177	34,151	29,850	34,154	19,988	22,188	22,702	22,539	22,948	24,955
RT Loon	3,521	2,179	2,994	5,276	4,601	5,335	2,945	3,599	4,155	3,038
YB Loon	4,988	3,062	3,556	3,124	2,454 ^b	1,331	1,948	3,270	2,262	1,871
Common Loon	0	0	0	0	0	0	0	0	0	0
Unidentified Loon	0	0	0	0	7,515	616	290	0	0	0
Total Loons	40,686	39,392	36,400	42,554	33,587 ^c	29,470	27,885	29,408	29,365	29,864
Jaegers	7,678	6,948	7,112	6,317	5,165	5,906	5,301	6,697	4,812	5,804
Arctic Tern	24,842	26,084	26,247	25,476	21,828	21,320	21,248	28,016	24,738	30,688
Glaucous Gull	19,170	20,549	13,615	23,741	29,751	12,225	18,472	13,116	14,180	18,955
Sabine's Gull	10,465	15,132	6,924	10,413	21,419	10,611	9,298	17,974	10,345	11,657
Golden Eagle	245	530	795	625	461	908	497	190	93	48
Snowy Owl	1,565	589	936	2,013	307	192	626	651	0	334

^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 2005.

Stratum Name	Survey Area km ²	Sample Area km ²	% Sample
Kuk	2,098.3	50.2	2.4
Barrow	3,884.2	79.4	2.0
Colville/Sag	4,622.5	105.0	2.3
Lower Meade	3,077.9	66.1	2.1
Marginal	2,408.2	44.0	1.8
NEPA	1,949.5	35.3	1.8
S. NEPA	10,602.5	223.1	2.1
Upper Meade	4,179.7	94.9	2.3
Ptlaysmead	11,906.3	244.8	2.1
Kogru River	4,999.2	94.7	1.9
Sadmiralwnepa	3,535.4	75.7	2.1
Bardekup	8,381.6	179.7	2.1
TOTAL	61645.2	1292.8	2.1

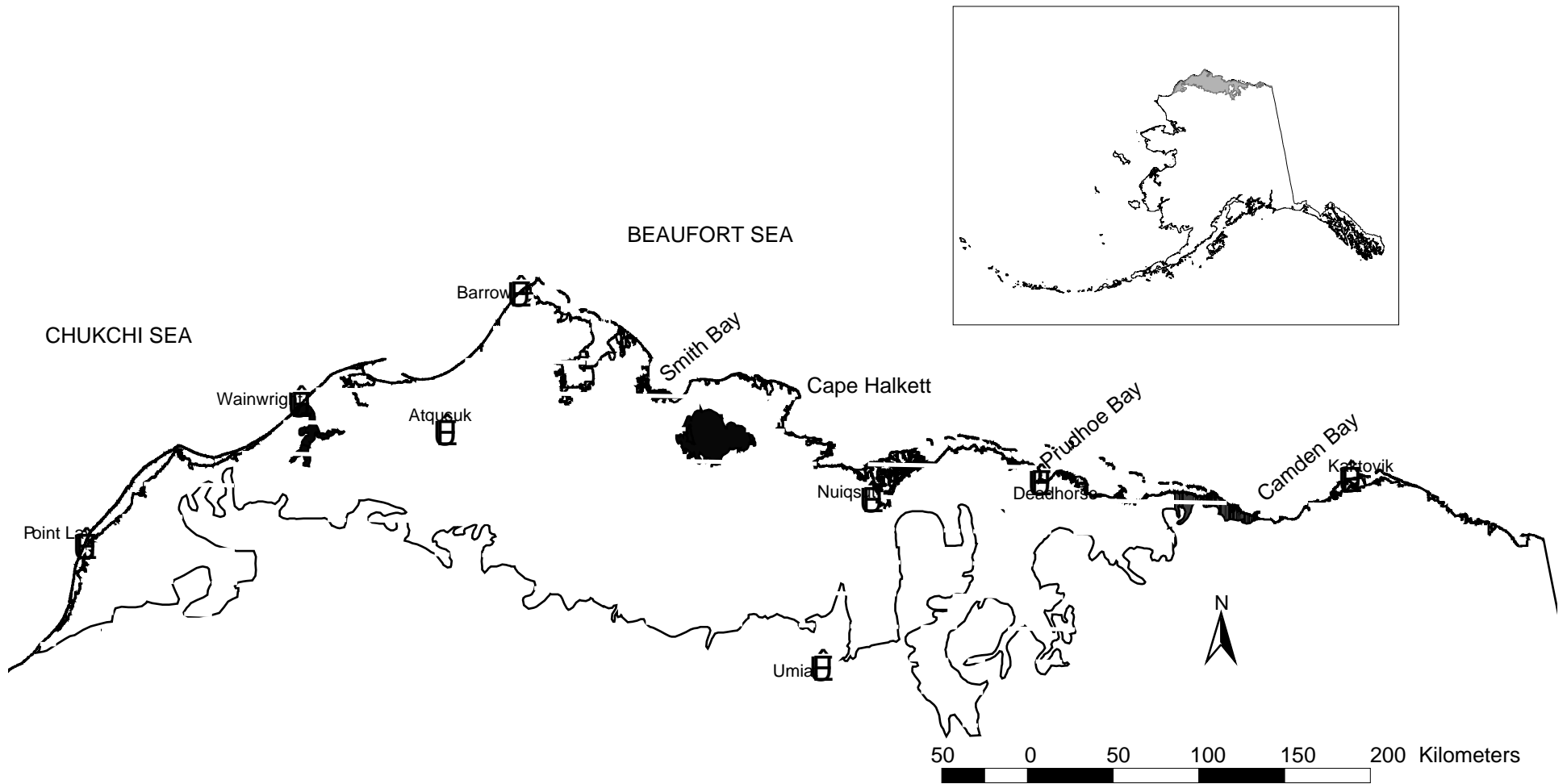


Figure 1. Major features of the Arctic Coastal Plain of Alaska in relation to the waterfowl breeding pair survey boundary and the 2005 transect locations (red lines).

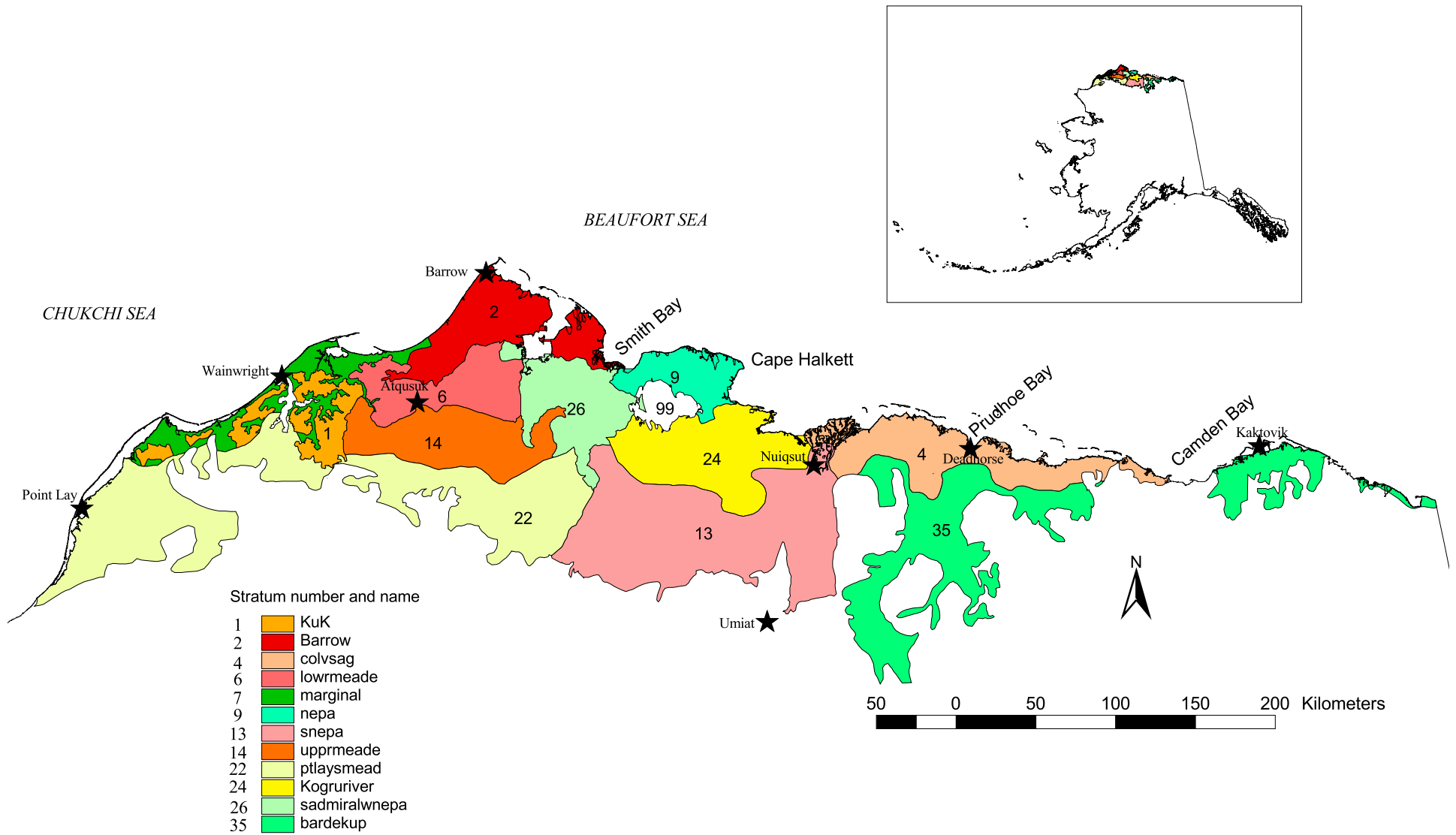


Figure 2. Stratification of the Arctic Coastal Plain of Alaska for calculation of waterbird population indices from an aerial survey conducted in 2005.

Northern Pintail

Table 6. Population indices and observational data for Northern Pintails from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005.

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
04	479	120	454	243372
05	375	78	152	156754

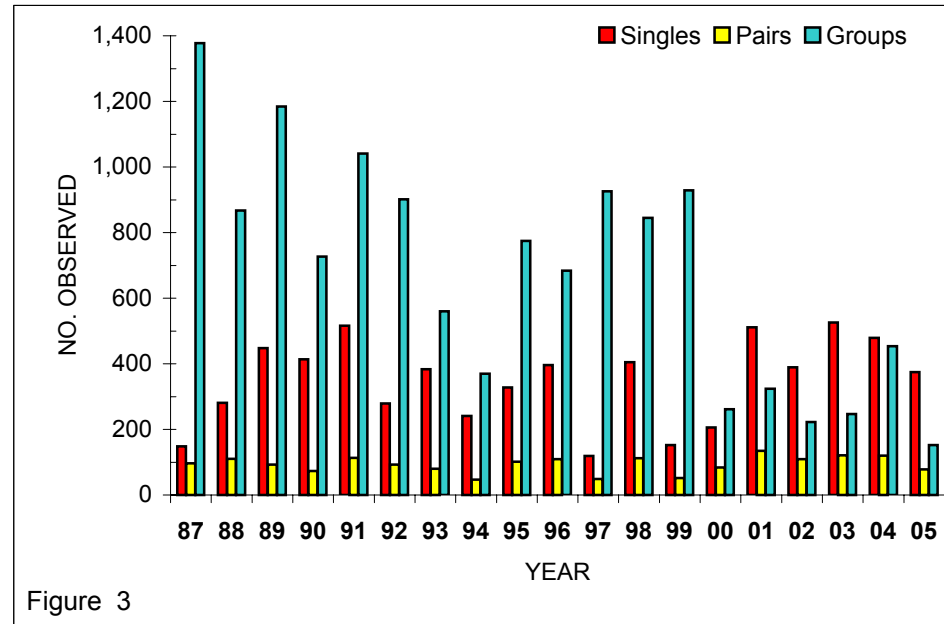


Figure 3

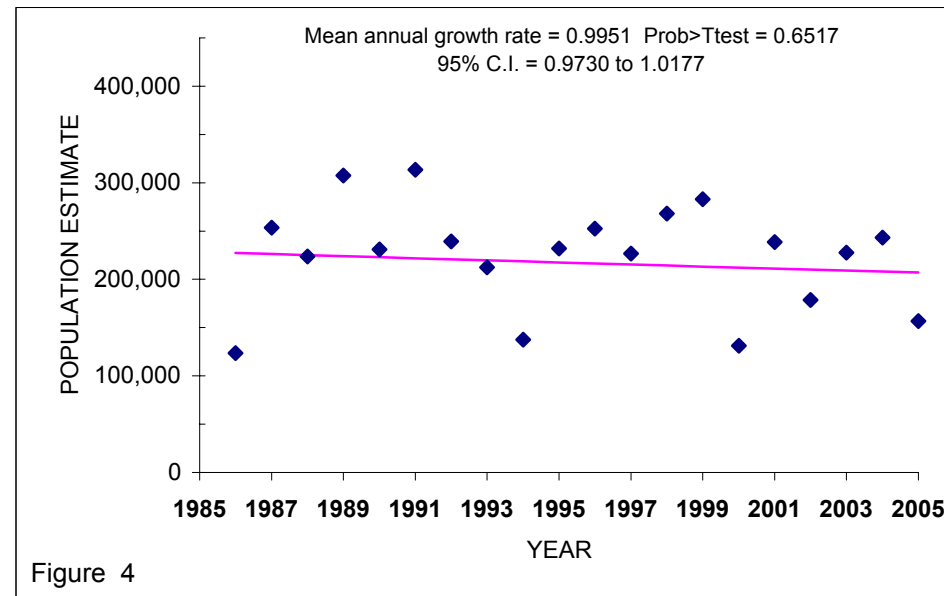


Figure 4

Figures 3 and 4. Trends of Northern Pintail observations and population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005. "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, 1986-2005.

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
04	347	165	108	101091
05	306	139	58	84241

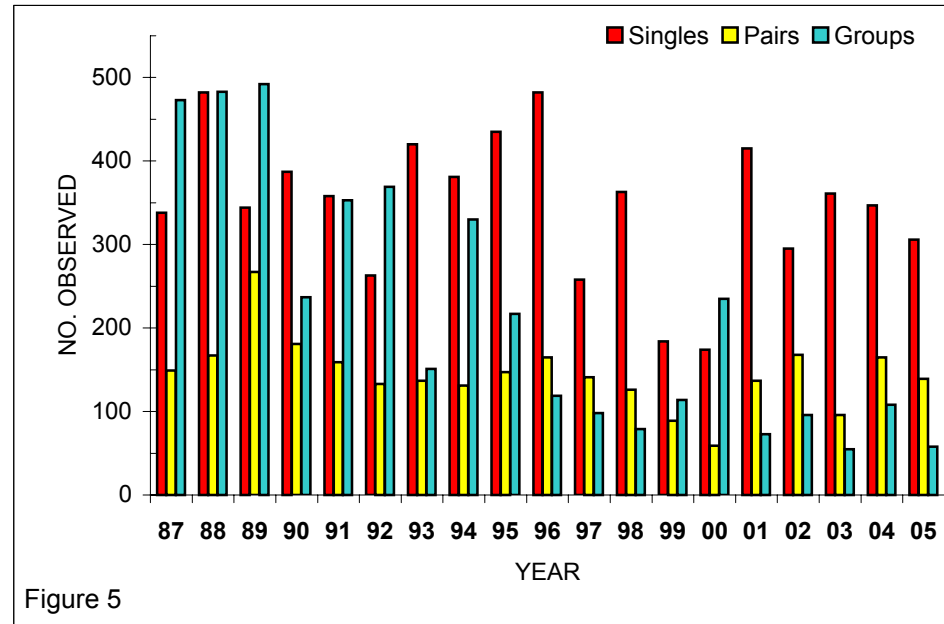


Figure 5

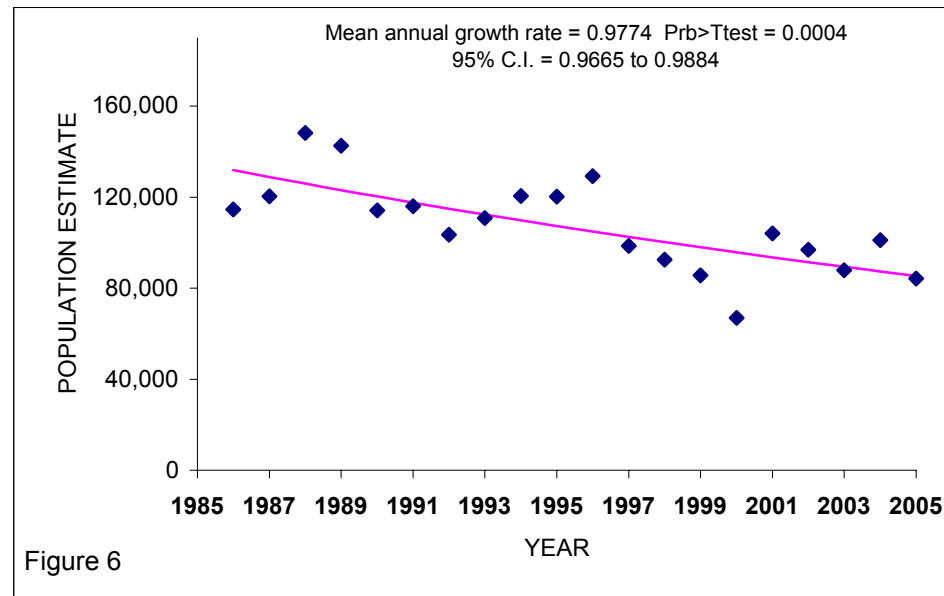


Figure 6

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, 1986-2005. "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, 1986-2005.

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
04	100	85	120	36588
05	96	40	116	26967

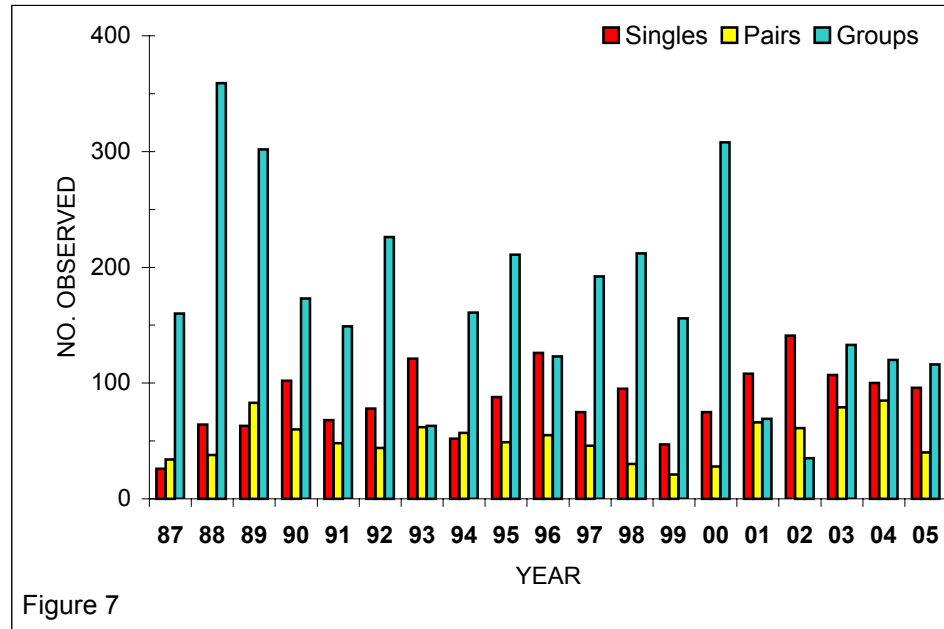


Figure 7

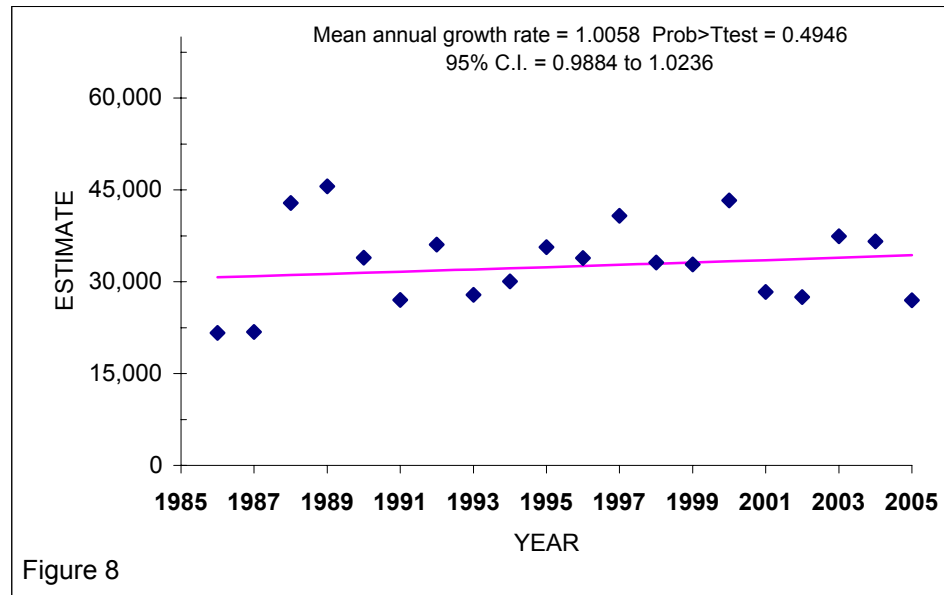


Figure 8

Figures 7 and 8. Trends of Scaup observations and population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005. "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, 1986-2005.

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
04	94	248	2184	138163
05	213	376	1558	129403

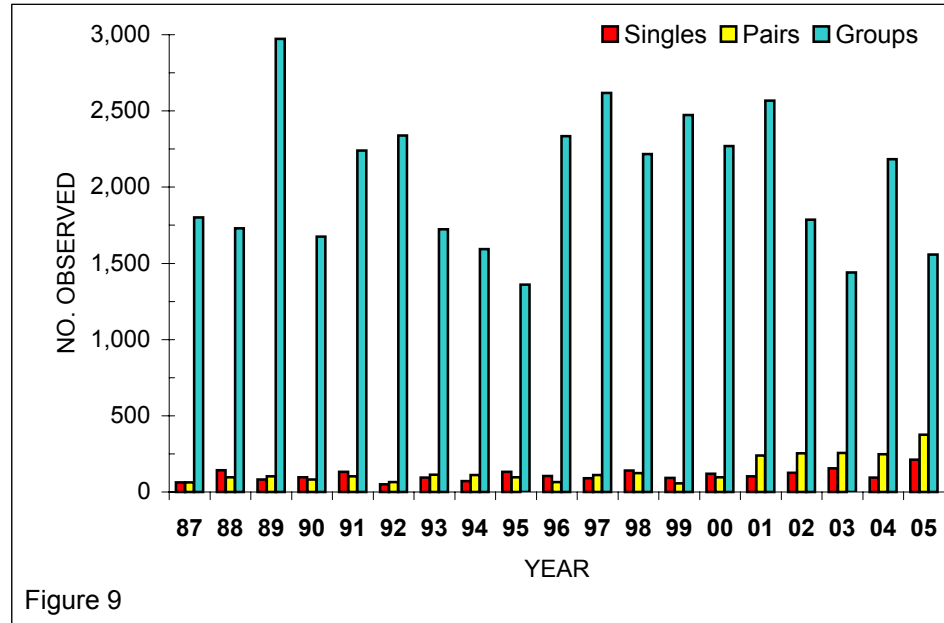


Figure 9

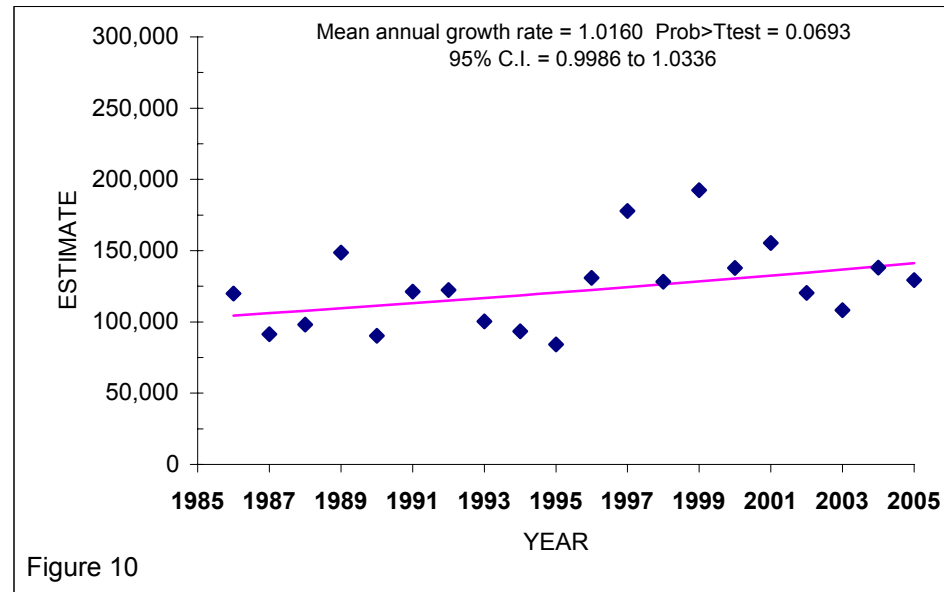


Figure 10

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, 1986-2005. 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, 1986-2005.

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
04	82	44	11	8745
05	90	53	52	12002

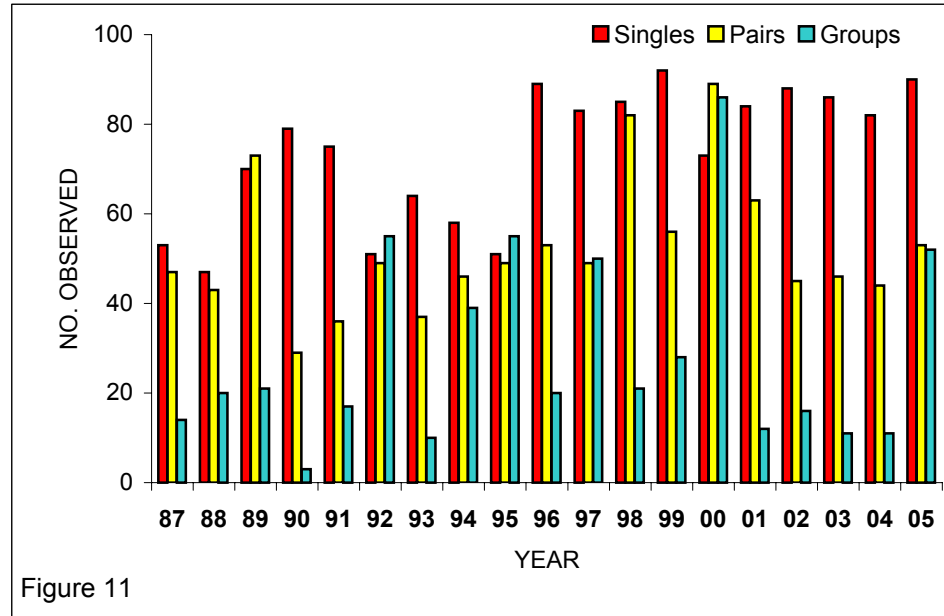


Figure 11

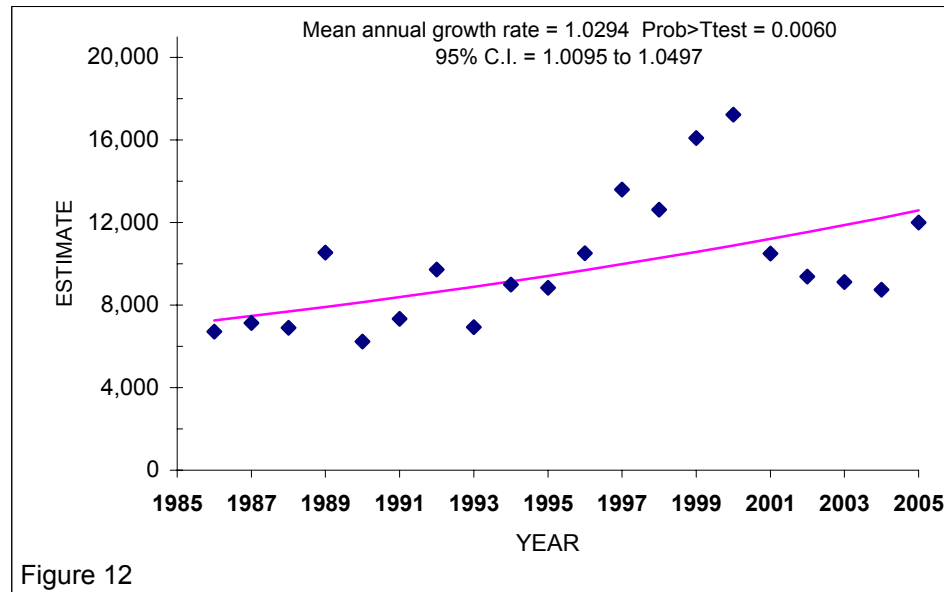


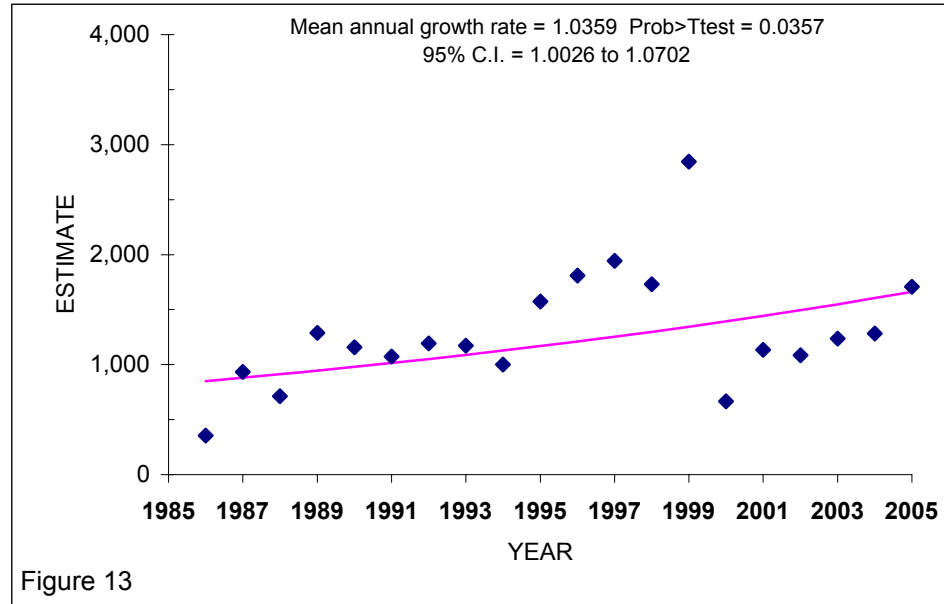
Figure 12

Figures 11 and 12. Trends of Tundra Swan observations and population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005. Mean annual growth rate was determined by log-linear regression.

Tundra Swan Nests

Table 11. Population indices for Tundra Swan Nests from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005.

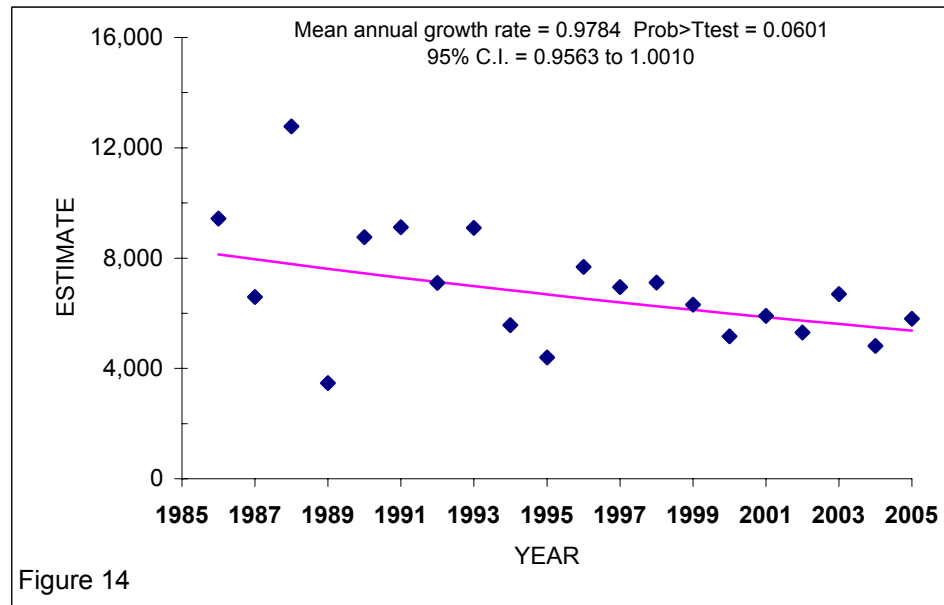
Year	Index	Year	Index
86	356	96	1809
87	934	97	1943
88	712	98	1731
89	1290	99	2846
90	1157	00	665
91	1073	01	1134
92	1192	02	1084
93	1172	03	1236
94	1000	04	1283
95	1574	05	1709



Jaegers

Table 12. Population indices for Jaegers from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005.

Year	Index	Year	Index
86	9432	96	7678
87	6585	97	6948
88	12769	98	7112
89	3470	99	6317
90	8765	00	5165
91	9123	01	5906
92	7103	02	5301
93	9094	03	6697
94	5573	04	4812
95	4401	05	5804

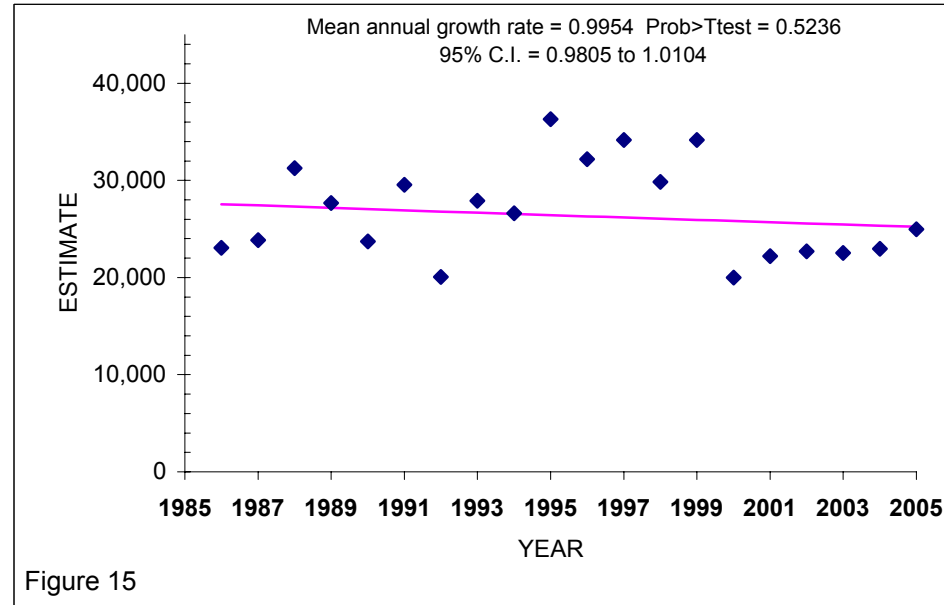


Figures 13 and 14. Trends of Tundra Swan Nest and Jaeger population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005. Mean annual growth rate was determined by log-linear regression.

Pacific Loon

Table 13. Population indices for Pacific Loon from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005.

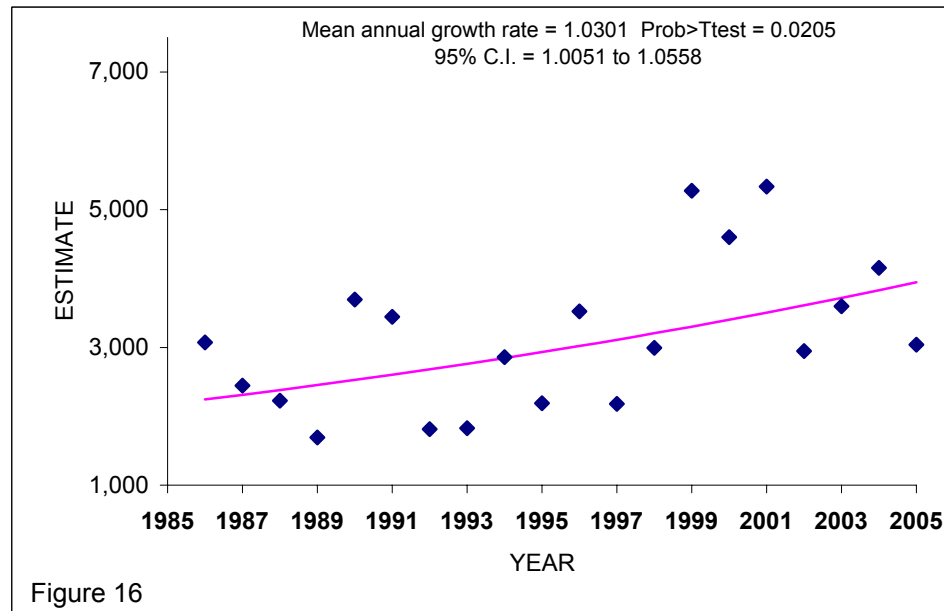
Year	Index	Year	Index
86	23047	96	32177
87	23847	97	34151
88	31278	98	29850
89	27674	99	34154
90	23714	00	19988
91	29559	01	22188
92	20071	02	22702
93	27890	03	22539
94	26620	04	22948
95	36304	05	24955



Red-throated Loon

Table 14. Population indices for Red-throated Loon from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005.

Year	Index	Year	Index
86	3070	96	3521
87	2447	97	2179
88	2225	98	2994
89	1690	99	5276
90	3693	00	4601
91	3443	01	5335
92	1812	02	2945
93	1828	03	3599
94	2857	04	4155
95	2188	05	3038

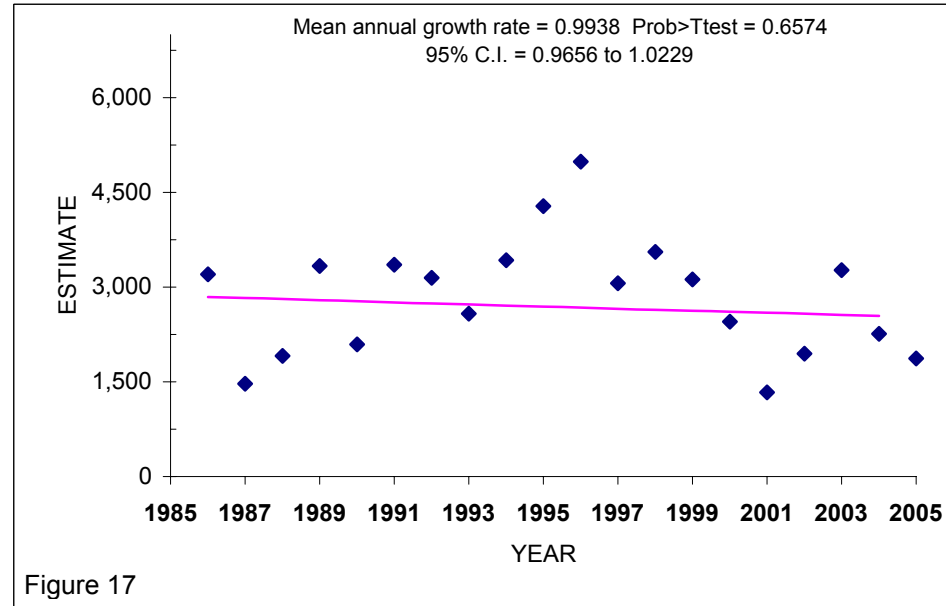


Figures 15 and 16. Trends of Pacific and Red-throated Loon population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005. Mean annual growth rate was determined by log-linear regression.

Yellow-billed Loon

Table 15. Population indices for Yellow-billed Loon from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1986-2005.

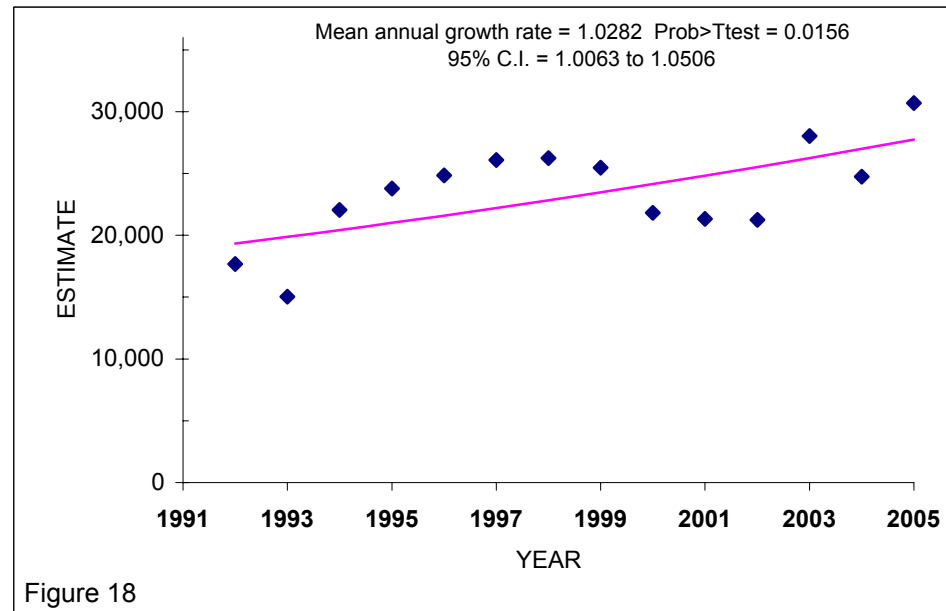
Year	Index	Year	Index
86	3203	96	4988
87	1468	97	3062
88	1913	98	3556
89	3337	99	3124
90	2091	00	2454
91	3354	01	1331
92	3147	02	1948
93	2578	03	3270
94	3429	04	2262
95	4282	05	1871



Arctic Tern

Table 16. Population indices for Arctic Tern from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2005.

Year	Index	Year	Index
92	17688	01	21320
93	15047	02	21248
94	22049	03	28016
95	23797	04	24738
96	24842	05	30688
97	26084		
98	26247		
99	25476		
00	21828		



Figures 17 and 18. Trends of Yellow-billed Loon (1986-2005) and Arctic Tern (1992-2005) population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska. Mean annual growth rate was determined by log-linear regression.

Glaucaous Gull

Table 17. Population indices for Glaucaous Gull from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2005.

Year	Index	Year	Index
92	14493	01	12225
93	11765	02	18472
94	15144	03	13116
95	14398	04	14180
96	19170	05	18955
97	20549		
98	13615		
99	23741		
00	29751		

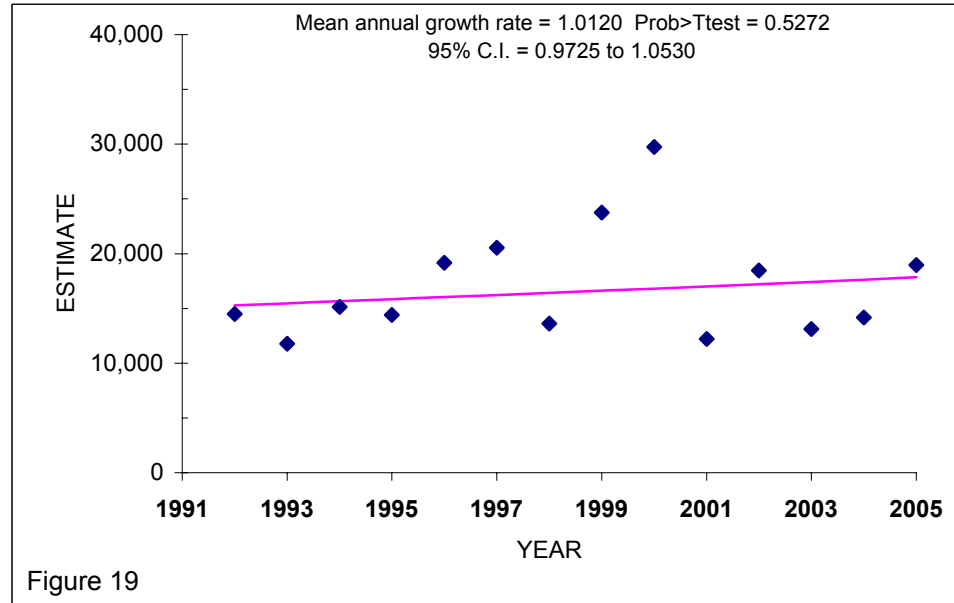


Figure 19

Sabine's Gull

Table 18. Population indices for Sabine's Gull from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2005.

Year	Index	Year	Index
92	6484	01	10611
93	8250	02	9298
94	8572	03	17974
95	14491	04	10345
96	10465	05	11657
97	15132		
98	6924		
99	10413		
00	21419		

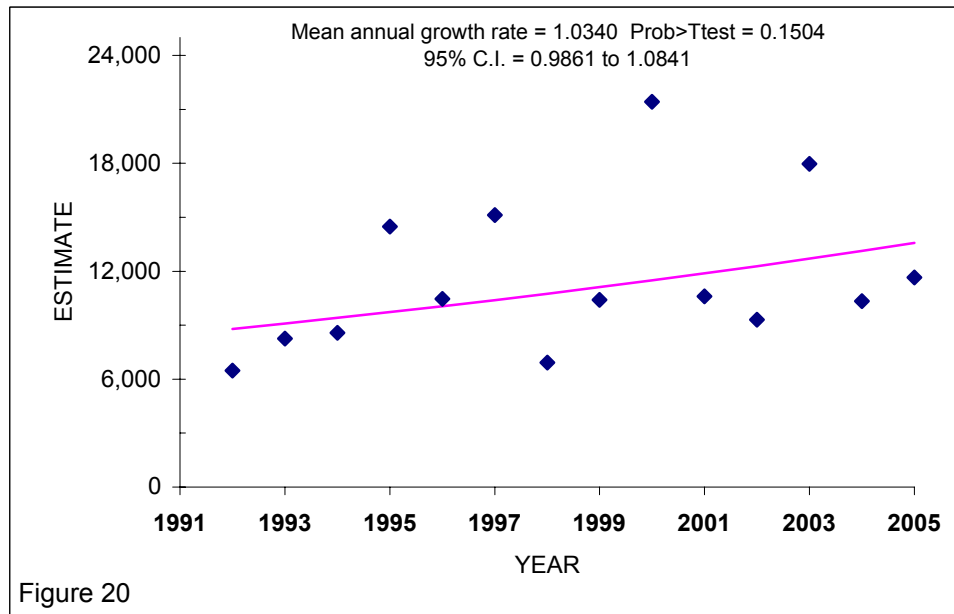


Figure 20

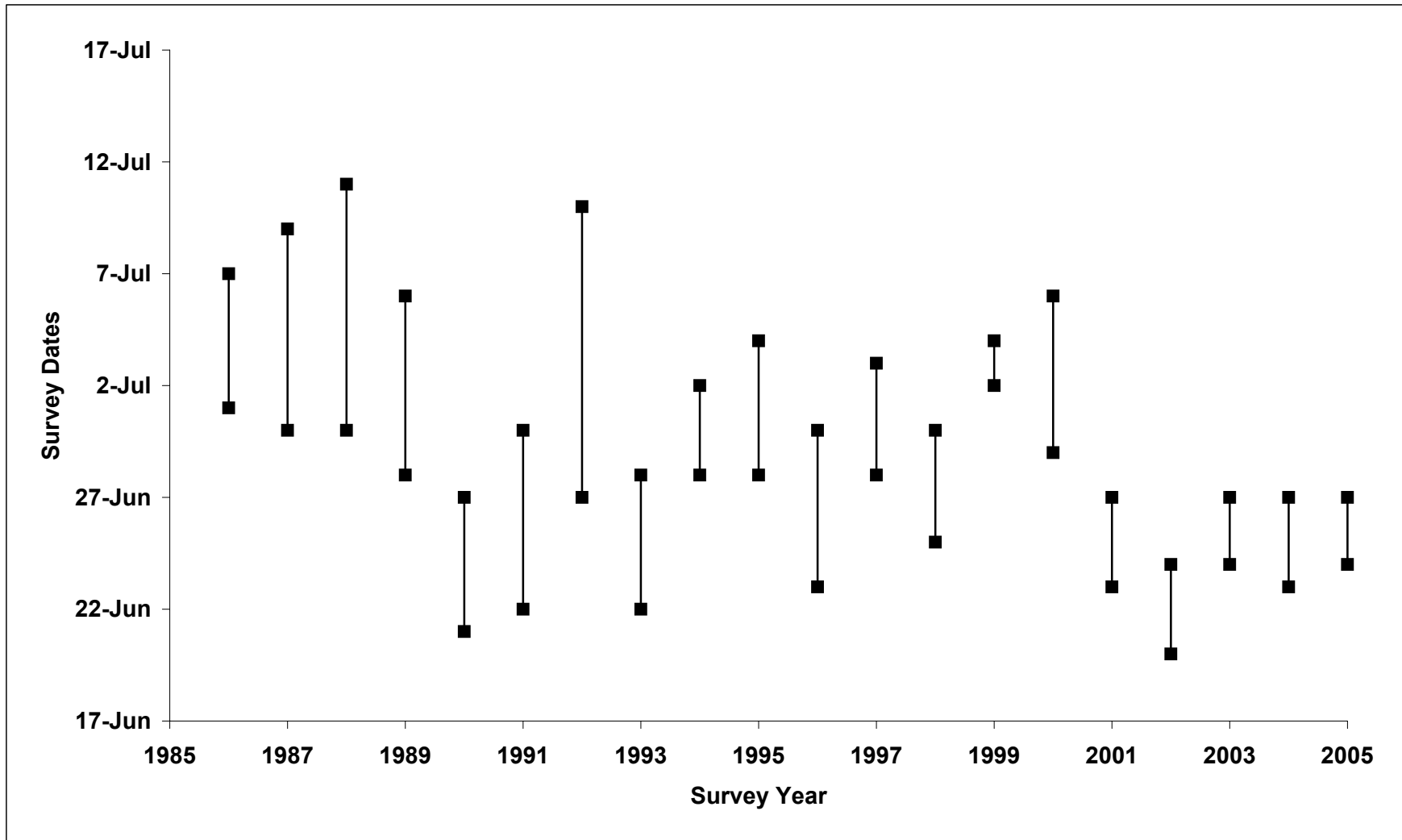
Figures 19 and 20. Trends of Glaucaous and Sabine's Gull population indices from aerial breeding pair surveys on the Arctic Coastal Plain of Alaska, 1992-2005. Mean annual growth rate was determined by log-linear regression.

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

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

Appendix 2. List of Arctic Coastal Plain Breeding Pair Survey observers and dates, 1986 – 2004.

<u>YEAR</u>	<u>OBSERVER/PILOT</u>	<u>OBSERVER</u>	<u>DATES</u>
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	Rodney King/Chris Dau	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
2004	Ed Mallek	Dennis Marks	23-27 June
2005	Ed Mallek	Dennis Marks	24-27 June



Appendix 3. Survey duration by year of the Arctic Coastal Plain Breeding Pair Survey, 1986 - 2005.