

MBM

Memorandum

02 July 2008

To: Chief, Migratory Bird Management
Region 7

From: Karen S. Bollinger, Pilot/Biologist
William D. Eldridge, Wildlife Biologist

Through: Chief, Waterfowl Management Branch

Subject: Report to the Pacific Flyway Committee on the 1985-2008 Coastal Zone
Yukon-Kuskokwim Delta Goose Survey of geese, swans, and sandhill cranes.

INTRODUCTION AND METHODS

Aerial surveys of geese, tundra swans (*Cygnus columbianus*), and sandhill cranes (*Grus canadensis*) were conducted from 2-10 June 2008, in the coastal zone of the Yukon-Kuskokwim Delta (YKD) for the 24th consecutive year. Goose species surveyed include cackling cackling Canada geese (*Branta hutchinsii minima*), black brant (*Branta bernicla nigracans*), emperor geese (*Chen canagica*), greater white-fronted geese (*Anser albifrons frontalis*), and Taverner's cackling geese (*Branta hutchinsii taverneri*). To simplify terminology, these species will be referenced as cackling Canada geese, black brant, emperor geese, white-fronted geese, and Taverner's Canada geese, respectively, throughout the remainder of this document. A Cessna 206 on amphibious floats was flown using standard Department of Interior survey methodology, similar to previous years. The 106 transects flown comprised 2,369 km linear distance. Sample survey coverage measured approximately 7.4% of the total 12,852 km² study area. William Eldridge served as right seat observer for the 22nd consecutive year and Karen Bollinger flew the aircraft as pilot/observer for the third year.

The survey design of transects (Fig. 1), initiated in 1998, was designed to obtain optimal distribution data. This is achieved by a four-year rotation design of unique sets of transect lines for each year. The years 1998-2001 comprised the first complete four-year rotation; 2002-2005, the second; and 2008 represents the third year of the third, four-year rotation. Standardized methodology for data collection involves a pilot and right-seat observer recording observations within a 200 m transect on each side of the plane, flying at an altitude of approximately 45 m and a speed of 150 km/hr. Observations were recorded directly into a laptop computer connected to the airplane global positioning system, so that each observation was matched with a latitude/longitude coordinate location.

Spring phenology on the Yukon-Kuskokwim Delta in 2008 was estimated to be three days earlier than the long term average for the years 1984-2007 (Stehn, pers. comm.). This estimate is based on three variables calculated from temperature and thaw degree day data obtained from seven weather stations including Bethel and Nome and five others located on the Yukon-Kuskokwim Delta. The three variables used for estimation were those found to be most closely correlated to spring phenology in previous years. It should be noted that the sample sizes of each weather station data upon which these estimates are based vary.

Nesting phenology for geese and eiders on the Yukon-Kuskokwim Delta in 2008 was estimated to be one to two days earlier than the long-term average of 1982-2007 (Fischer et al. 2008). For 2008, the average hatch dates for cackling Canada geese, black brant, emperor geese, and white-fronted geese were estimated to be 22 June, 20 June, 21 June, and 22 June, respectively. The long-term average hatch dates for these four goose species are 24 June, 21 June, 22 June, and 23 June, respectively (Fischer et al. 2008).

Population Indices

Population indices used in this report are calculated for the following species or groups of species as follows:

All Geese and Sandhill Cranes

$$\begin{aligned} \textit{indicated pairs} &= 2 \times (\textit{singles} + \textit{pairs}^*) \\ \textit{indicated total birds} &= 2 \times (\textit{singles} + \textit{pairs}) + \textit{birds in flocks} \end{aligned}$$

Tundra Swans

$$\begin{aligned} \textit{total birds} &= \textit{singles} + (2 \times \textit{pairs}) + \textit{birds in flocks} \\ \textit{singles and pairs} &= \textit{singles} + (2 \times \textit{pairs}) \\ \textit{nests} &= \textit{number of active nests observed} \end{aligned}$$

$$*\textit{pairs} = \textit{no. of pairs (for all references)}$$

Stratification Design

Stratification of this survey is based on sampling effort, that is, the distances between transects which are 1, 2, 4, and 8 miles (Fig. 1). There are four primary strata with one small additional stratum in a high-density area. This additional stratum was created to better accommodate historical data for that area which had variable spacing between transects for several years (Fig. 1).

RESULTS

The survey dates of 02 – 10 June for 2008 coincided well with peak incubation dates obtained from ground plots (Fischer et al. 2008). The effect of different timing of the survey relative to nesting phenology is not completely understood, but it is generally assumed that the relative number of failed breeders increases as the nesting season progresses. Therefore, surveys timed later relative to nesting phenology could result in greater numbers of flocked birds and fewer pairs observed than if the survey had been flown earlier in the nesting season. Differences in nesting success could complicate that correlation because heavy predation increases the number of birds seen in flocks due to failed breeding attempts. In 2008, fox predation was heavy in localized areas, but not significant for the entire area where nest plots searches were conducted (Fischer, pers. comm.). In recent years the survey has been flown in fewer days and somewhat earlier in the nesting season than in the initial, developmental years of the survey. Although there has been some variation in timing of the survey relative to nesting phenology during recent years, we do not think those variations have had a significant impact on results.

Cackling Canada Geese

The 2008 cackling Canada goose index for indicated total birds (84,699) increased compared to the 2007 estimate (74,152), and was the second-highest recorded since the survey began in 1985 (Table 1, Fig. 2). Only the 1997 index of 88,018 total birds has been higher during the 24-year history of the survey. The 2008 index for indicated pairs (52,368) also increased slightly compared to the 2007 estimate (51,194), and was also the second-highest estimate recorded during the 24-year history of the survey (Table 2, Fig. 2). The 2000 estimate of 52,855 indicated pairs is the highest recorded for the years 1985-2008. The growth rate for indicated total birds and pairs exhibited exponential growth rates from 1985 through at least 1997 (Fig. 2). Annual growth rates were estimated to be 1.17 and 1.15 for indicated total birds and pairs, respectively. However, data from 1998-2008 indicate only a slightly increasing or stable growth rate for both indices (Fig. 2). Annual growth rates for total birds measured 1.01; and that for pairs, 1.00. Yearly estimates have been much more variable over this period, however, and do not show a definite trend (Fig. 2). An estimate of the fall population based on the 1985-98 correlation between the indicated total index and fall count is listed in Appendix 1. The 2008 fall estimate of 193,321 birds is second only to the 1997 estimate of 199,672 birds. The 3-year running average fall count is the primary harvest management index, and currently numbers 178,654.

Pacific White-fronted Geese

In this paragraph, we first discuss the results of our survey covering only the coastal Yukon-Kuskokwim Delta for Pacific white-fronted geese. The indicated total bird index for white-fronted geese (161,979) in 2008 decreased from the 2007 index (178,515); while the indicated pairs index (73,022) increased slightly from the 2007 index (70,670) (Table 1-2, Fig. 3). For total geese, 2007 represents the highest estimate recorded during the 24-year history of the survey; and for pairs, 2008 represents the highest estimate recorded during the survey (1985-2007). Overall, the strong, positive growth rates that both indices previously exhibited, especially that of indicated pairs (Fig. 3), appear to be leveling off, especially in the last two to three years. For the entire survey period of 1985-2008, annual growth rates are estimated to be 1.11 for both indicated total birds and pairs. To make comparisons between growth rates during the early part of the survey with those during later years, the log-linear growth rates for the first

11 years of the survey (1985-1995) and last 13 years of the survey (1997-2008) were plotted separately for total indicated birds, (Fig. 4). This comparison shows growth rates for total birds have declined in recent years (annual growth rates of 1.16 vs 1.06 for 1985-1995 and 1997-2008, respectively). As with cackling Canada geese, estimates during the latter half of the survey period have been more variable than those of the early years (Fig. 4).

In this second paragraph, we discuss the estimates for all Pacific white-fronts nesting in Alaska. This estimate for all Pacific white-fronts is determined from combining the results of our coastal Yukon-Kuskokwim Delta aerial survey (Tables 1-2) with results from the Bristol Bay and interior Yukon Delta strata of the statewide Alaska waterfowl breeding pair survey (Mallek and Groves 2008). All these indices are presented in Appendix 2. The Bristol Bay indices are highly variable and during the last two years (2007 and 2008) represent $\leq 1\%$ of the total Pacific white-front index for both the singles and pairs index and the total geese index. As stated above for the coastal Yukon-Kuskokwim Delta, the total geese index declined, while the singles and pair index increased slightly. For Bristol Bay, both indices for 2008 decreased from those of 2007 (App. 2). However, for the Yukon Delta Interior, both indices for 2008 increased sharply from those of 2007 (App. 2). The singles and pairs index increased from 16,503 to 20,040; while the total goose index increased from 28,488 to 54,913, a 48% increase over the previous year. The interior Yukon Delta total geese index accounted for 25.2% of Pacific white-front total geese index in 2008, as compared to only 13.6% in 2007. Percentages for the singles and pairs in 2008 and 2007 were similar, and numbered 21.4% and 18.8% for 2008 and 2007, respectively. The near doubling of the white-front total goose estimate for the interior Yukon Delta accounted for the overall increase in Pacific white-fronts in 2008 shown in Appendix 2. This estimate is the spring (June) estimate used in calculating the 'new fall index' and 3-year average (App. 3). The fall estimates of the Alaska Pacific white-front population, based on a correlation between spring and fall counts from 1985-1998, are presented in Appendix 3. Both the fall estimate and 3-year average are the highest recorded since this survey began. The 3-year running average fall count is the primary harvest management index, and currently numbers 580,334.

Emperor Geese

The emperor goose indices for indicated total birds (22,100) declined slightly from those of 2007 (24,362), but were still comparable to those of the last 12 years (Table 1, Fig. 5). The indicated pairs index (16,110) increased over 2007 (14,562) and is comparable to levels of the last 10 years (Table 2, Fig. 5). Population growth rates are slightly positive for both indices; annual growth rates equaled 1.02 and 1.03 for total birds and pairs, respectively.

Black Brant

This survey is not designed for colonial nesting species such as black brant and because of this highly variable population indices result (Table 3, Fig. 6). However, brant data collected does provide useful information on distribution for the entire coastal area, not just major colonies. The indicated pairs index (13,132) was the highest recorded since the survey began, exceeding the previous 2006 high of 11,279. The indicated total birds index of 29,166 birds was much higher than that of 2007 (19,191) and was the highest recorded since 1997 (Table 3, Fig. 6). The variation noted in indicated pairs among years may reflect differences in survey timing related to black brant nesting phenology, differences in nest predation, and /or a difference in counting brant as pairs or flocks between pilots.

This major increase in black brant numbers, for both indicated total birds and pairs from the aerial survey in 2008, contrasts sharply with the major decline in the estimated number of active nests in 2008. The number of active nests for brant on the Yukon –Kuskokwim Delta is based on aerial videography of major brant colonies (Wilson 2008). Estimated number of nests in 2008 (9995) declined sharply from both 2007 (16,634) and the long-term average based on the years 1992-2007 (16,983). This represented a 40% and 43% decline in number of nests, respectively, from 2007 and the interval 1992-2007. As noted earlier, nest predation was heavy in localized areas; and this was true for some of the brant colonies that were videographed. Predation on nests in the Tutakoke brant colony was almost total (Sedinger, pers. comm.). This divergence in change from 2007 to 2008 in the index for the number of birds counted during the aerial survey versus the estimate for number of active nests possibly makes sense, however. A higher percentage of failed nests would result in fewer birds attending nests. These failed breeders could possibly exhibit different behavior than birds still incubating. Failed breeders might possibly flush more readily and become more visible to be counted during aerial surveys than nesting birds. If one were to make this assumption, then this might explain why the index of birds increased, while the number of nests decreased in 2008 as compared to 2007.

Taverner's Canada Geese

This subspecies is found primarily interior to the coastal zone surveyed, but some overlap occurs on the eastern, northern, and southern portions of the survey area. For these areas, arbitrary lines have been established to divide cackling Canada geese and Taverner's Canada geese observations for population index estimates. We do not consider the range overlap, and resulting misclassification of subspecies, to substantially affect results. Population indices increased from those of 2007 (Table 3, Fig. 7). The total bird index increased from 7,042 to 10,209 and the pair index from 3,800 to 5,663. Both indices are highly variable with slightly positive growth rates (Table 3, Fig. 7). Annual growth rates are estimated to be 1.013 and 1.005 for total birds and pairs, respectively.

Tundra Swans

The total bird index for tundra swans in 2008 (32,184) increased slightly from that of 2007 (30,454), while both the single and pair index and the nest index decreased slightly from those of 2007 (Table 4, Fig. 8). Singles and pairs numbered 20,233 in 2008 as compared to 20,760 in 2007; and nests declined from 4,074 in 2007 to 3,649 in 2008. Both the total bird and single and pairs indices are highly variable, especially the total bird index. The nest index is less variable than either of the bird indices. All three indices indicate slightly positive growth rates, however (Fig. 8). Annual growth rates are estimated to be 1.01, 1.02, and 1.03 for total birds, singles and pairs, and nests, respectively.

Sandhill Cranes

The total bird and pairs indices for sandhill cranes increased over those of 2007 (Table 5, Fig. 9). Total birds increased from 13,138 in 2007 to 14,882 in 2008; and pairs increased from 12,599 to 12,944, respectively. Both indices are highly variable, however, and despite these increases in 2008, both indicate slightly declining trends in growth rates. Annual growth rates were estimated to be 0.989 and 0.994 for total birds and pairs, respectively.

DISCUSSION

Both indicated total indices and indicated pair indices for both cackling Canada and white-fronted geese on the coastal Yukon-Kuskokwim Delta have been much more variable in recent years than when the population was rapidly expanding in the 1990's. Part of the fluctuations in indicated total bird indices may be attributed to factors other than real population changes, such as variation among years in visibility, survey timing, habitat conditions, and nest success, as well as changes in observers.

We encourage managers to evaluate both indicated pairs and total birds in the decision making process. We also want to especially emphasize that population trends over time are the most useful information from this survey, rather than annual variation.

ACKNOWLEDGMENTS

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LITERATURE CITED

- Fischer, J.B., R.A. Stehn and G. Walters. 2008. Nest population size and potential production of geese and spectacled eiders on the Yukon-Kuskokwim Delta, Alaska, 2008. Unpubl. Rep., U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.
- Mallek, E. and D.J. Groves. 2008. Alaska-Yukon waterfowl breeding population survey. Unpubl. Rep. U.S. Fish and Wildlife Service, Migratory Bird Management, Juneau, Alaska, USA.
- Wilson, H.M. 2008. Aerial photographic surveys of brant colonies on the Yukon-Kuskokwim Delta, Alaska 2008. Unpubl. Rep. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Table 1. Indicated total^a population indices for cackling Canada, emperor, and white-fronted geese for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

Year	Cackling Canada Geese		White-fronted Geese		Emperor Geese	
	Index	SE	Index	SE	Index	SE
1985	13,963	1,605	18,914	1,482	19,805	1,960
1986	13,502	1,013	13,400	1,014	12,430	1,008
1987	19,921	1,390	15,717	1,413	13,035	1,121
1988	24,467	1,507	27,191	2,642	16,392	1,402
1989	25,475	1,567	28,004	2,430	16,855	1,220
1990	31,759	2,166	37,836	4,067	17,347	1,401
1991	28,843	1,688	31,286	2,294	14,888	1,284
1992	44,356	2,632	34,671	2,908	15,416	994
1993	45,749	2,534	39,748	3,020	17,147	1,230
1994	65,021	3,181	56,513	3,730	18,733	1,059
1995	69,888	3,756	77,710	5,483	18,764	1,072
1996	74,574	4,008	78,032	5,339	24,413	2,476
1997	88,018	4,359	83,215	5,738	23,287	1,451
1998	64,601	3,701	87,881	7,874	21,741	1,541
1999	72,173	3,509	95,040	8,876	21,406	1,591
2000	74,992	3,352	91,911	6,591	18,667	949
2001	75,620	3,734	113,603	9,358	27,297	1,473
2002	50,187	2,487	90,407	7,537	19,504	1,326
2003	69,867	3,482	117,951	12,034	21,378	1,746
2004	51,390	2,691	100,622	9,611	21,396	1,097
2005	65,484	3,091	121,017	12,000	19,798	1,190
2006	71,985	3,291	138,067	10,648	26,562	1,697
2007	74,152	3,138	178,515	15,035	24,362	1,508
2008	84,699	3,517	161,979	14,831	22,100	1,038

a--Indicated total = 2 x (singles + pairs) + birds in flocks

Table 2. Indicated pair^a indices for cackling Canada, emperor, and white-fronted geese for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

Year	Cackling Canada Geese		White-fronted Geese		Emperor Geese	
	Index	SE	Index	SE	Index	SE
1985	10,313	1,378	9,382	776	9,542	852
1986	10,770	854	6,713	513	7,413	611
1987	14,367	967	7,819	653	9,312	746
1988	16,290	1,009	11,953	890	8,695	829
1989	21,168	1,330	11,982	968	10,737	791
1990	20,330	1,341	11,705	938	9,282	787
1991	22,405	1,290	12,584	902	7,758	590
1992	28,443	1,697	14,077	1,086	9,879	686
1993	33,781	1,828	15,010	1,213	10,183	787
1994	41,200	2,135	20,155	1,432	12,007	712
1995	49,354	2,872	26,985	1,911	12,892	806
1996	39,543	2,371	21,887	1,626	12,433	604
1997	49,254	2,570	27,611	1,521	12,820	741
1998	46,372	2,896	40,872	3,888	15,686	1,136
1999	49,556	2,401	48,207	3,791	16,208	1,285
2000	52,855	2,428	42,558	2,693	12,798	680
2001	49,665	2,451	63,555	5,228	17,112	926
2002	41,982	2,033	51,381	4,491	15,646	1,215
2003	40,993	2,058	51,670	4,797	12,141	869
2004	40,848	2,219	47,928	4,973	14,410	848
2005	44,018	2,220	50,141	4,067	14,490	817
2006	47,500	2,293	71,484	6,104	17,460	936
2007	51,194	2,345	70,670	7,824	14,562	1,004
2008	52,368	2,444	73,022	5,980	16,110	724

a--Indicated pairs = 2 x (singles + pairs)

Table 3. Taverner's Canada geese and black brant population indices for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

Year	Taverner's Canada Geese		Black Brant	
	Indicated Pairs ^a	Indicated Total ^b	Indicated Pairs ^a	Indicated Total ^b
1985	4,285	5,517	1,180	5,164
1986	3,782	5,150	2,030	14,007
1987	3,187	4,059	4,652	14,893
1988	5,191	9,217	3,840	22,713
1989	7,142	8,865	4,220	26,231
1990	6,498	7,819	2,989	28,820
1991	5,454	8,063	4,528	27,151
1992	5,089	8,698	6,144	20,026
1993	6,519	8,643	4,446	32,004
1994	5,536	7,017	5,764	31,278
1995	5,780	6,475	5,858	34,401
1996	3,856	6,644	5,620	29,503
1997	4,466	6,630	6,818	30,738
1998	6,607	8,446	8,252	22,127
1999	7,532	12,532	9,492	22,520
2000	8,232	10,384	8,402	26,381
2001	6,063	7,701	5,686	31,242
2002	5,145	6,204	9,208	20,396
2003	5,426	8,043	3,588	20,621
2004	4,580	7,755	7,641	19,238
2005	3,942	6,385	5,634	20,560
2006	6,523	9,355	11,279	19,495
2007	3,800	7,042	8,937	19,191
2008	5,663	10,209	13,132	29,166

a--Indicated singles and pairs = 2 x (singles + pairs)

b--Indicated total = 2 x (singles + pairs) + birds in flocks

Table 4. Tundra swan population indices for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

Year	Singles and		
	Pairs ^a	Total Birds ^b	Nests ^c
1985	13,664	30,874	2,471
1986	14,093	24,299	3,093
1987	12,149	24,180	2,177
1988	13,872	24,459	3,159
1989	12,695	33,115	2,613
1990	12,759	30,006	2,802
1991	11,465	18,663	2,442
1992	13,174	19,411	3,009
1993	12,348	20,180	2,818
1994	13,204	18,787	3,086
1995	16,594	23,052	3,560
1996	17,238	23,121	3,975
1997	18,106	28,683	4,034
1998	19,947	33,355	4,964
1999	20,727	27,211	4,601
2000	20,048	28,306	4,494
2001	17,251	24,395	3,147
2002	21,356	31,193	5,713
2003	14,823	23,015	4,646
2004	17,760	27,099	5,301
2005	14,548	23,645	3,360
2006	22,663	31,545	4,224
2007	20,760	30,454	4,074
2008	20,233	32,184	3,649

a--Singles and Pairs = singles + (2 x pairs)

b--Total Birds = singles + (2 x pairs) + birds in flocks

c--Nests = number of active nest observations

Table 5. Sandhill Crane population indices for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

Year	Indicated	
	Pairs ^a	Total Birds ^b
1985		
1986		
1987	14,246	15,079
1988	12,777	16,549
1989	13,247	16,719
1990	14,228	18,310
1991	14,358	20,601
1992	13,394	17,185
1993	16,012	19,312
1994	13,832	16,548
1995	16,906	18,182
1996	10,220	16,430
1997	11,446	13,530
1998	17,859	24,458
1999	16,236	18,612
2000	15,886	18,144
2001	14,923	16,211
2002	12,605	13,076
2003	10,779	13,778
2004	12,014	14,608
2005	11,468	14,464
2006	12,778	15,298
2007	12,599	13,138
2008	12,944	14,882

a--Indicated Pairs = 2 x (singles + pairs)

b--Indicated Total Birds = 2 x (singles + pairs)
+ birds in flocks

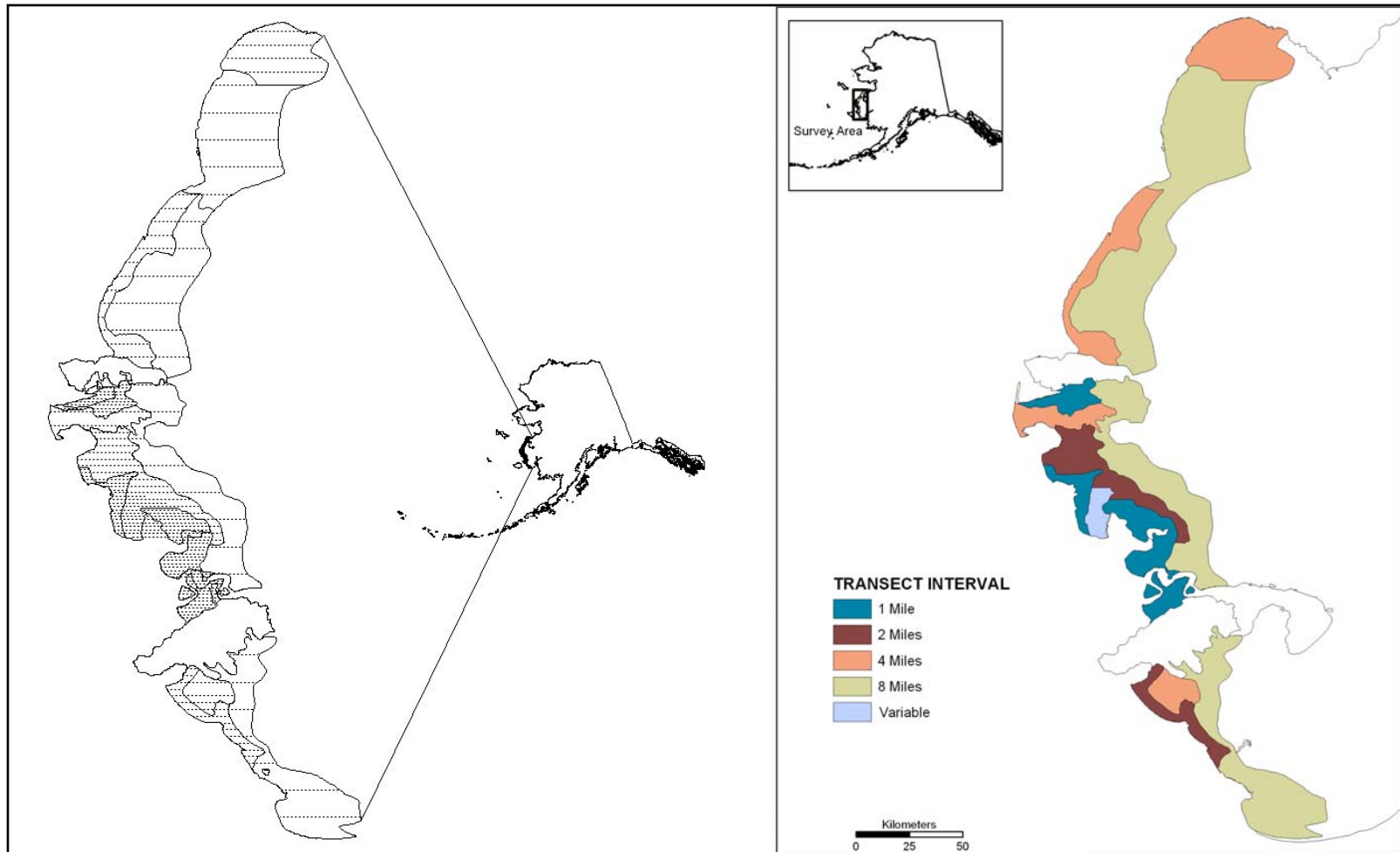


Figure 1. Flight lines (left side) and current 4-strata design (right side) for the coastal Yukon-Kuskokwim Delta aerial surveys.

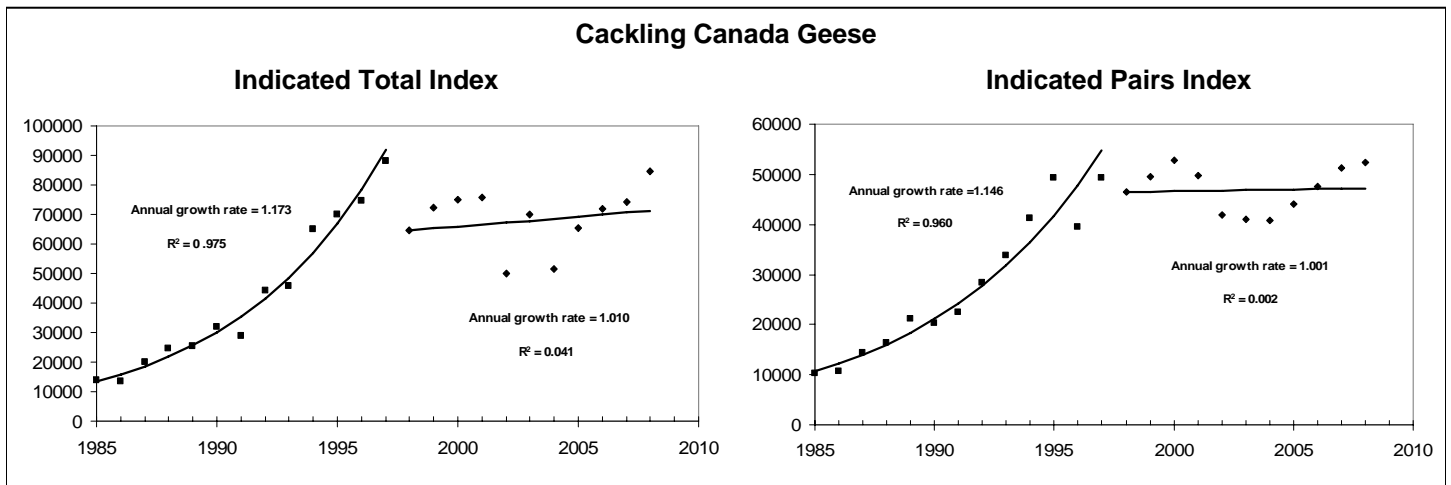


Fig. 2. Population index growth curves and average annual growth rates from log-linear regression for the first 13 and last 11 years for cackling Canada geese for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

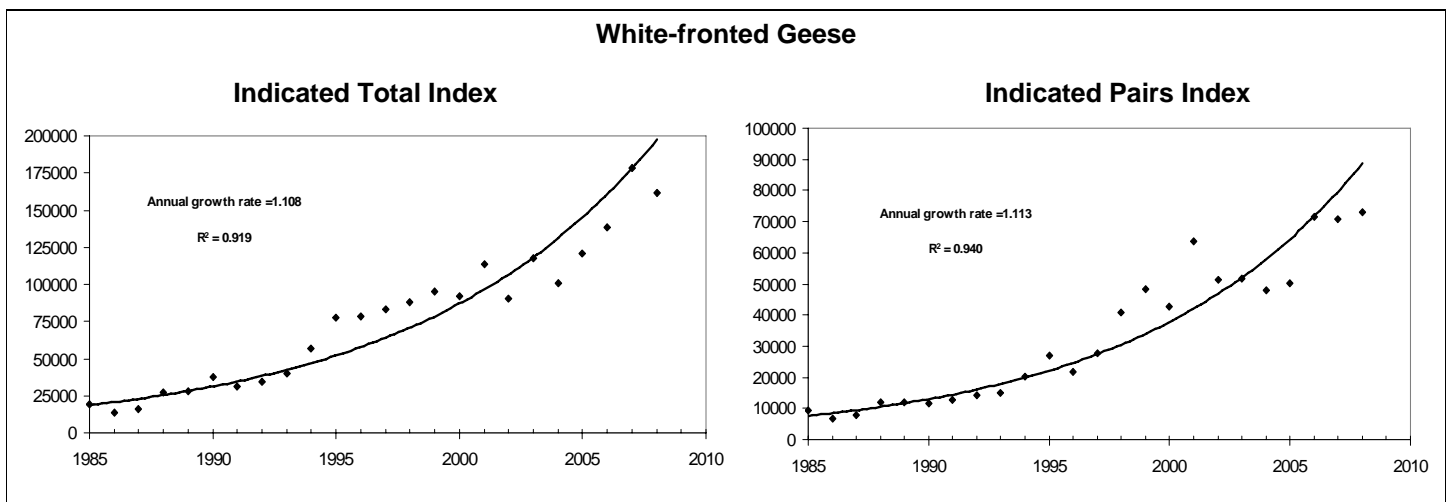


Fig. 3. Population index growth curves and average annual growth rates from log-linear regression for all years for white-fronted geese for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

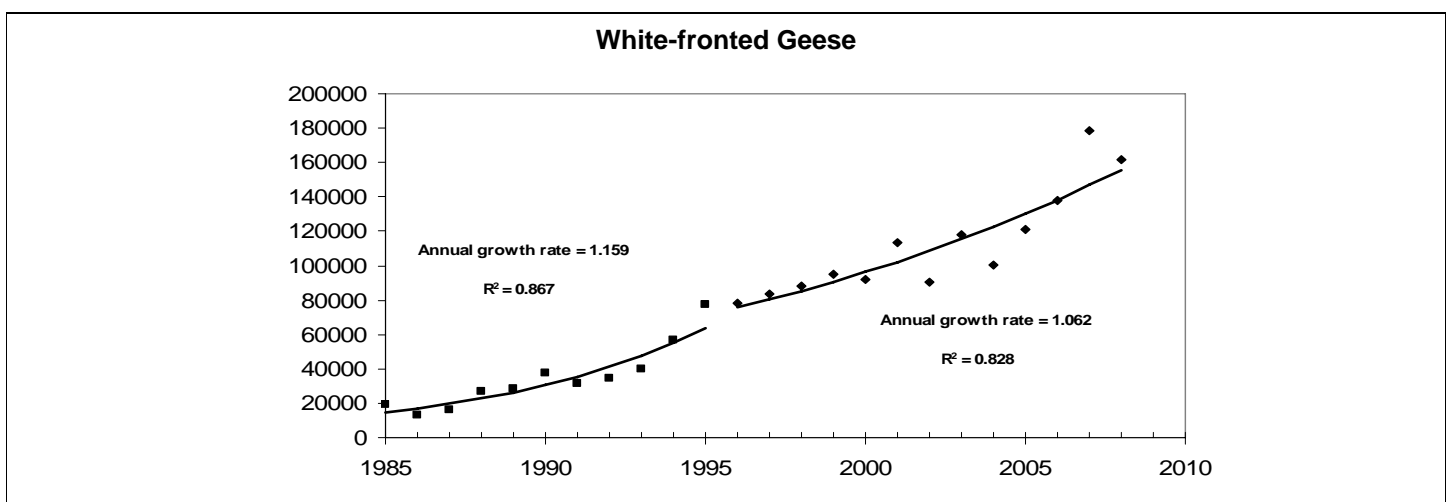


Fig. 4. Indicated total population index growth curves and average annual growth rates from log-linear regression based on the first 11 years and the last 13 years for white-fronted geese for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

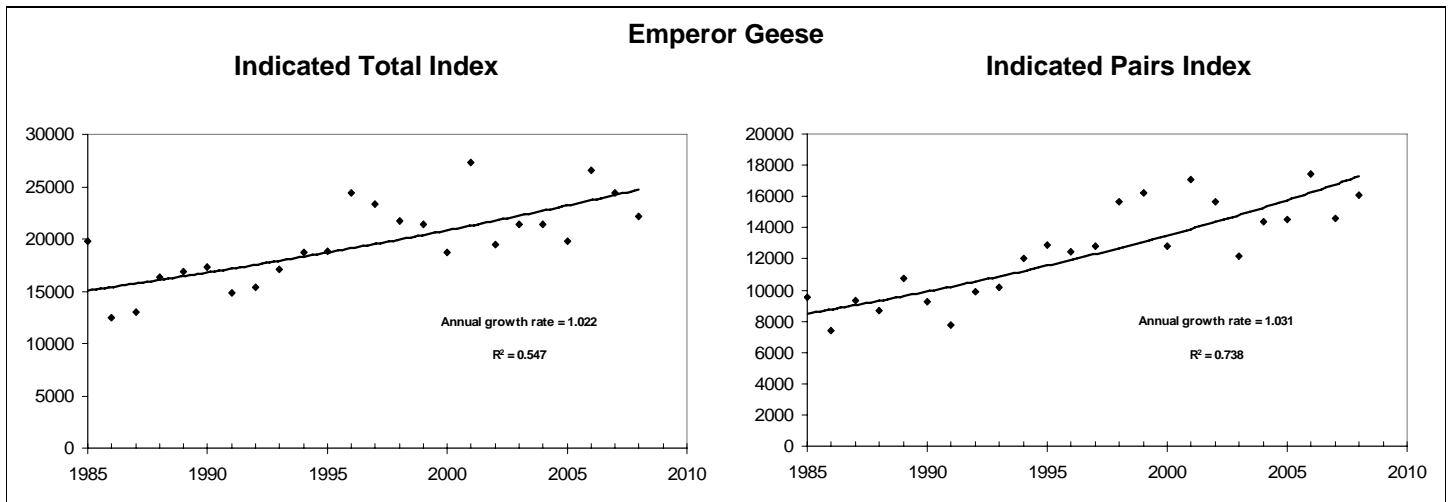


Fig. 5. Population index growth curves and average annual growth rates from log-linear regression for all years for emperor geese for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

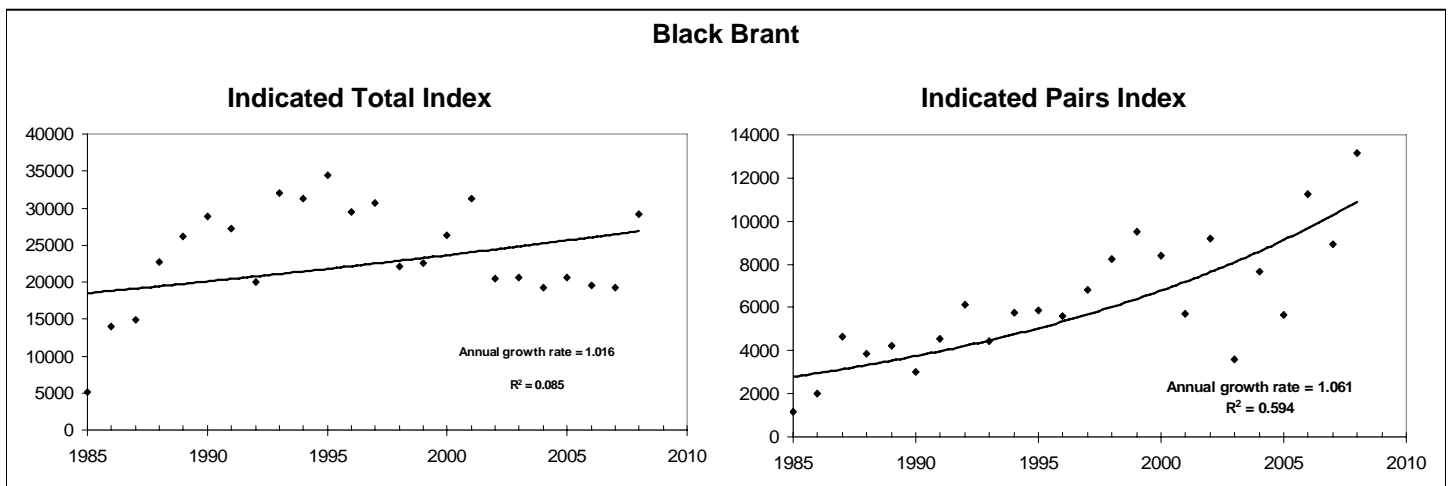


Fig. 6. Population index growth curves and average annual growth rates from log-linear regression for all years for black brant for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

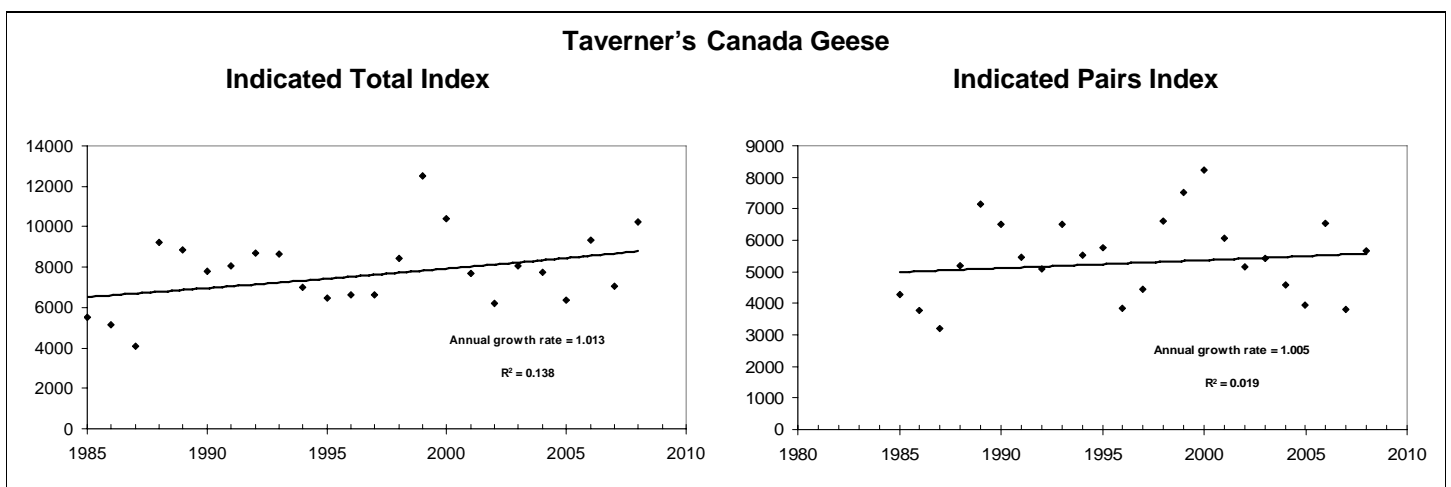


Fig. 7. Population index growth curves and average annual growth rates from log-linear regression for all years for Taverner's Canada geese for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

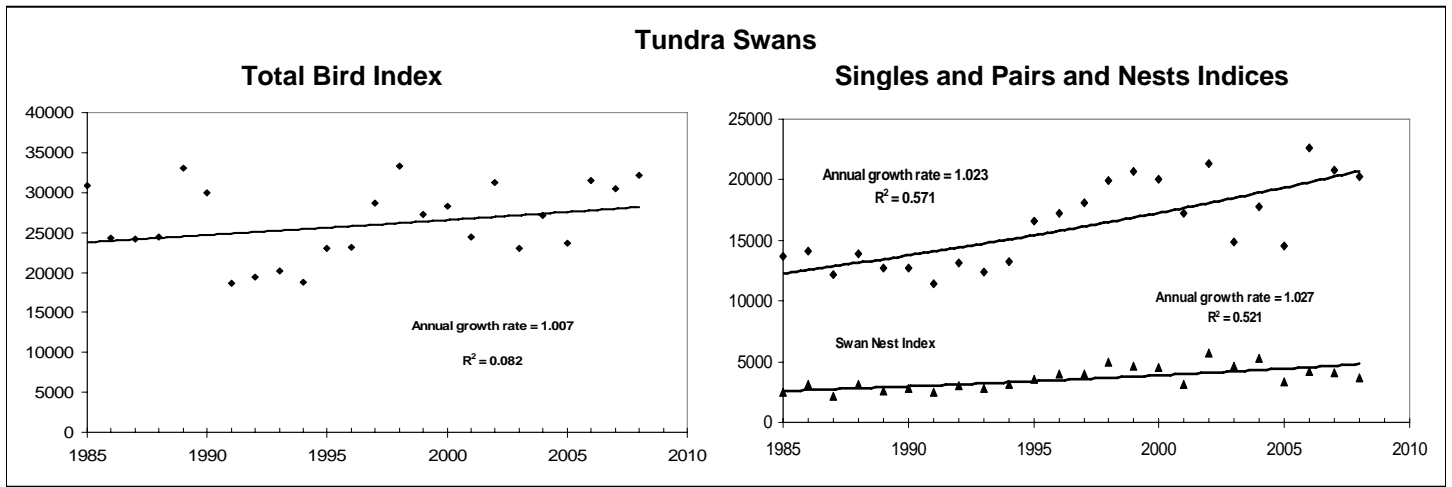


Fig. 8. Population index growth curves and average annual growth rates from log-linear regression for all years for tundra swans for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

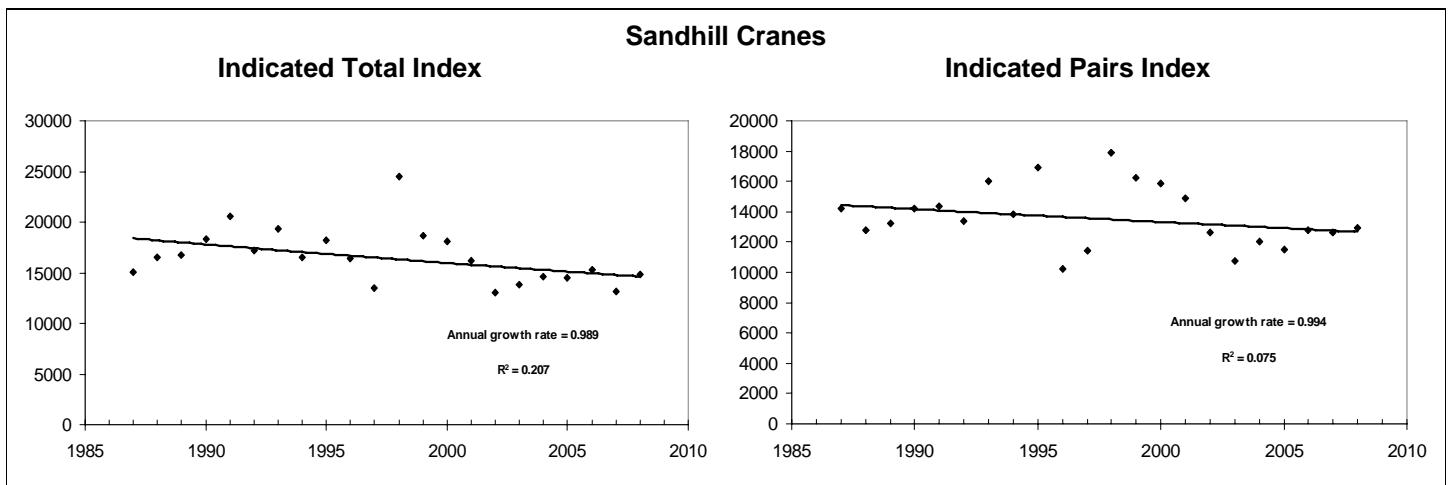
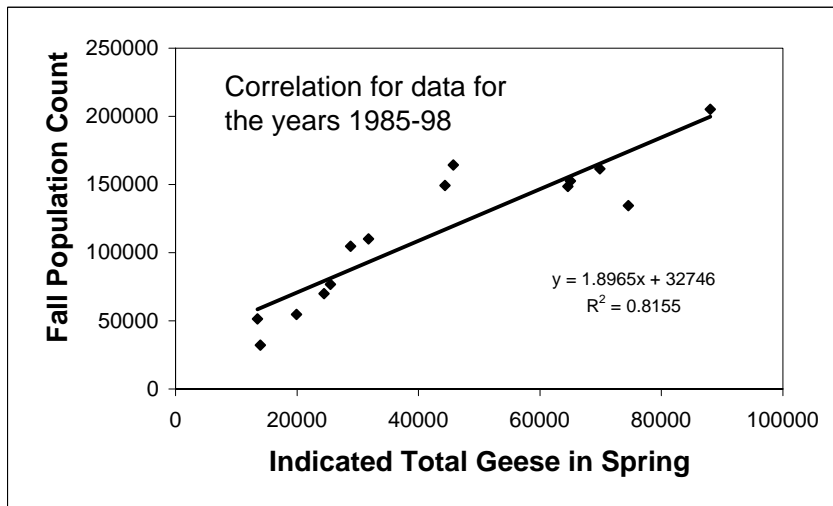


Fig. 9. Population index growth curves and average annual growth rates from log-linear regression for all years for sandhill cranes for the coastal Yukon-Kuskokwim Delta aerial survey, 1985-2008.

APPENDIX 1. Cackling Canada goose fall count, indicated total bird spring index, estimated fall population from the 1985-98 spring/fall correlation (see graph) and 3-year moving average of the estimated fall population.



Year	Fall Count	Indicated Total Bird		3-year Average
		Spring Index ^a	Fall Estimate ^b	
1985	32,100	13,963	59,227	
1986	51,400	13,502	58,353	
1987	54,800	19,921	70,526	62,702
1988	69,900	24,467	79,148	69,342
1989	76,800	25,475	81,059	76,911
1990	110,200	31,759	92,977	84,395
1991	104,600	28,843	87,447	87,161
1992	149,300	44,356	116,867	99,097
1993	164,300	45,749	119,509	107,941
1994	152,500	65,021	156,058	130,811
1995	161,400	69,888	165,289	146,952
1996	134,600	74,574	174,176	165,174
1997	205,100	88,018	199,672	179,712
1998	148,600	64,601	155,262	176,370
1999		72,173	169,622	174,852
2000		74,992	174,968	166,617
2001		75,620	176,159	173,583
2002		50,187	127,926	159,684
2003		69,867	165,249	156,445
2004		51,390	130,207	141,127
2005		65,484	156,936	150,797
2006		71,985	169,266	152,136
2007		74,152	173,375	166,526
2008		84,669	193,321	178,654

a--Indicated total based on new stratification

b--Fall estimate based on indicated total bird spring index

Fall population estimate = (TIB x 1.8965 + 32746)

APPENDIX 2. Indices of Pacific white-fronted geese as indicated breeding birds (2 x singles + paired) and indicated total geese from June aerial surveys of the Yukon-Kuskokwim Delta and Bristol Bay Lowlands (Bollinger and Eldridge 2008; Mallek and Groves 2008).

Year	Y-K Delta Coastal		Y-K Delta Interior		Bristol Bay		Y-K Delta Total		All Pacific Total	
	Singles + Pairs	Total Geese	Singles + Pairs	Total Geese	Singles + Pairs	Total Geese	Singles + Pairs	Total Geese	Singles + Pairs	Total Geese
1985	9,382	18,914	5,698	12,082	1,219	5,050	15,080	30,996	16,299	36,046
1986	6,713	13,400	5,894	10,019	1,915	4,266	12,607	23,419	14,522	27,685
1987	7,819	15,717	4,715	7,564	1,045	3,657	12,534	23,281	13,579	26,938
1988	11,953	27,191	9,037	14,145	522	3,918	20,990	41,336	21,512	45,254
1989	11,982	28,004	5,108	16,307	1,045	5,398	17,090	44,311	18,135	49,709
1990	11,705	37,836	8,841	18,468	871	2,003	20,546	56,304	21,417	58,307
1991	12,584	31,286	6,287	13,262	1,741	4,527	18,871	44,548	20,612	49,075
1992	14,077	34,671	6,287	16,110	522	7,052	20,364	50,781	20,886	57,833
1993	15,010	39,748	8,055	22,790	697	1,306	23,065	62,538	23,762	63,844
1994	20,155	56,513	6,680	12,966	871	4,092	26,835	69,479	27,706	73,571
1995	26,985	77,710	7,859	10,215	1,393	2,612	34,844	87,925	36,237	90,537
1996	21,887	78,032	15,914	36,543	697	4,353	37,801	114,575	38,498	118,928
1997	27,611	83,215	15,521	30,452	871	3,657	43,132	113,667	44,003	117,324
1998	40,872	87,881	16,307	34,381	1,567	1,915	57,179	122,262	58,746	124,177
1999	48,207	95,040	10,806	27,800	1,393	3,483	59,013	122,840	60,406	126,323
2000	42,558	91,911	8,841	16,798	871	1,654	51,399	108,709	52,270	110,363
2001	63,555	113,603	10,806	24,460	348	6,095	74,361	138,063	74,709	144,158
2002	51,381	90,407	14,146	17,387	1,219	5,311	65,527	107,794	66,746	113,105
2003	51,670	117,951	11,002	17,387	522	2,177	62,672	135,338	63,194	137,515
2004	47,928	100,622	9,234	16,601	1,045	1,828	57,162	117,223	58,207	119,051
2005	50,141	121,017	10,216	18,566	174	6,530	60,357	139,583	60,531	146,113
2006	71,484	138,067	13,360	28,979	3,309	4,702	84,844	167,046	88,153	171,748
2007	70,670	178,515	16,503	28,488	697	2,177	87,173	207,003	87,870	209,180
2008	73,022	161,979	20,040	54,913	522	1,045	93,062	216,892	93,584	217,937

APPENDIX 3. Derivation of the annual fall population index for Pacific white-fronted geese from the relationship between June total indicated geese in Bristol Bay and the Yukon-Kuskokwim Delta (both coastal and inland surveys) to previous reliable fall surveys (1985-1998).

Year	Total Indicated Birds ¹	Fall Survey	New Fall Index ²	3-Year Average
1985	36,046	93,800	163,249	
1986	27,685	107,100	141,930	
1987	26,938	130,600	140,026	148,402
1988	45,254	161,500	186,728	156,228
1989	49,709	218,800	198,087	174,947
1990	58,307	240,800	220,010	201,608
1991	49,075	236,500	196,470	204,856
1992	57,833	230,900	218,802	211,761
1993	63,844	295,100	234,128	216,467
1994	73,571	324,800	258,930	237,287
1995	90,537	277,500	302,190	265,083
1996	118,928	344,100	374,582	311,901
1997	117,324	319,000	370,492	349,088
1998	124,177	413,100	387,966	377,680
1999	126,323		393,437	383,965
2000	110,363		352,743	378,048
2001	144,158		438,913	395,031
2002	113,105		359,734	383,797
2003	137,515		421,975	406,874
2004	119,051		374,895	385,535
2005	146,113		443,898	413,589
2006	171,748		509,262	442,685
2007	209,180		604,706	519,289
2008	217,937		627,035	580,334

¹ TIB = 2 x (pairs + singles) + group birds for Bristol Bay and the Yukon-Kuskokwim Delta, both coastal and inland survey areas, during spring June surveys

² Fall Population Index = (TIB x 2.5498) + 71,339