Mid-continent Greater White-fronted Geese in Alaska – 2005 Project Updates

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Introduction

In Alaska, mid-continent greater white-fronted geese (*Anser albifrons frontalis*) breed in boreal habitats in the interior and northwest portions of the state, and in tundra habitats on the Arctic Coastal Plain. Both groups of geese are joined by Canadian breeders in fall as they migrate through the Central and Mississippi Flyways. Throughout their range these geese are an important resource for subsistence and sport hunters, and non-consumptive users. Waterfowl biologists with the U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, U.S. Geological Survey, and the University of Alaska have designed numerous studies on white-fronted geese in Alaska to provide relevant data to wildlife managers. Most of the recent work has been focused on boreal nesting white-fronts in interior and northwest Alaska due to concerns of low survival and apparent regional declines in abundance in the 1990s (Spindler et al. 1999). This report is an update of ongoing projects that monitor abundance, harvest, distribution, disease, and survival of mid-continent greater white-fronted geese that breed in Alaska, both in boreal, and tundra habitats. Recent changes in management strategies are also described.

Population Trends

Continental Breeding Pair Survey – Several surveys provide data to monitor population trends of mid-continent greater white-fronted geese in Alaska. Since 1964, the Continental Breeding Pair Survey has been flown in key waterfowl production areas in Alaska (Conant and Groves 2005). This survey provides breeding and total population indices for mid-continent greater white-fronted geese in principal waterfowl production areas of interior and northwest Alaska (Fig. 1). The breeding pair index (2*singles + paired birds) and the total bird index (2*singles + paired birds + flocks) increased ten-fold during the period of 1964-1986 (Fig. 2) outpacing population growth seen on fall and winter surveys in the Central and Mississippi Flyways during the same period (Graber 2005). Despite increases in the continental population as a whole, both Alaska indices dropped rapidly from the mid-1980s to the early 1990s. Since the mid 1990s, the breeding pair and total bird indices in Alaska appear to have stabilized.

In the mid-continent population, the total bird index is prone to high variability resulting from occasional observations of large flocks that are on route to tundra breeding sites outside the survey area. This effect was particularly apparent in 1986 and 2000 when several large flocks observed in the Yukon Flats stratum significantly inflated the total bird index for the entire interior and northwest Alaska region. For this reason the breeding pair index may be a more reliable long-term index to monitor the status of mid-continent white-fronts in Alaska.

2005 Experimental Breeding Pair Survey, Northwest Alaska – In an attempt to estimate the size of the white-front breeding population in northwest Alaska, MBM and Selawik NWR conducted a breeding pair survey timed to coincide with nest initiation (Fig. 3; Fischer et al. 2005). The survey was conducted on May 25-28, timed approximately two weeks earlier than the average survey data of the Continental Breeding Pair Survey in the Kotzebue Sound stratum (June 9). The design of this experimental survey was based on the 1996-1997 expanded breeding pair survey effort (Platte 1999) which was intended to provide detailed distribution data within primary waterfowl production areas.

Estimates of white-front density, number of indicated pairs, and total birds is presented on Table 1. The survey yielded an estimate of 6,685 total indicated white-fronts, of which 2,160 were indicated pairs. Relative to the 1996-1997 surveys, the estimate of pairs was highest in 2005 but indicated total was lowest. Distribution of geese in 2005 was similar to previous surveys with highest goose densities in the Selawik strata (Table 1, Fig. 4). While the 1996 and 2005 surveys were timed over three weeks apart, the 1997 and 2005 surveys were just 10 days apart, and may be more comparable. The difference in estimates of total pairs between 1997 and 2005 was essentially the same. The number of total geese was lower in 2005 compared to 1997, but 95% confidence intervals overlap, suggesting no significant change has occurred. In all three years, the highest density and abundance estimates were seen in the Selawik strata. The Noatak and Deltas strata also had relatively high densities, but the overall contribution to population estimates was minimal given the smaller total size of those strata.

Arctic Coastal Plain Survey – The Continental Breeding Pair Survey in Alaska provides population indices in many waterfowl production areas, but it does not sample waterfowl habitats on the North Slope where many mid-continent white-fronted geese breed. In 1986, a new survey effort was initiated on the Alaskan Arctic Coastal Plain (ACP) to fill this data gap (Mallek et al. 2005). Breeding pair and total bird indices have varied considerably since the inception of the survey, but both show long-term growth (Fig. 5). In the last several years the number of birds classified breeding birds (singles or pairs) has risen, whereas total birds have declined somewhat indicating a reduction in numbers of large flocks. In 2004 the estimates of breeding birds and total indicated birds were 32,705 and 138,163, respectively. The estimates for 2005 have not yet been calculated.

North Slope Eider Survey – In 1992 an additional breeding pair survey was initiated on the North Slope designed specifically to monitor spectacled eider populations, but all waterfowl are recorded when encountered (Larned et al. 2005). This survey is timed approximately two weeks earlier than the ACP Survey and is restricted to the spectacled eider breeding range in northern Alaska. In 2005 the estimates of white-fronted goose breeding birds and total indicated birds were 38,048 and 67,499, respectively (Larned et al. 2005). Trends in both indices are relatively flat and show no significant trend (Fig 6).

Despite its more limited range, the North Slope Eider Survey may be better timed for geese, particularly for the local breeding component of the population. For example, the white-front pair index represents just 20% of the total indicated population in the

ACP Survey, compared to 50% in the North Slope Eider Survey. Presumably the later timed ACP Survey experiences a flush of failed breeders that are counted as flocked birds. An alternative explanation is that the portion of the ACP survey area that is not covered by the North Slope Eider Survey provides habitat for a large contingent of non-breeding geese. Regardless of the cause, the North Slope Eider Survey provides another index to the breeding population of the mid-continent population of white-fronted geese.

Interior/Northwest Alaska Molting Survey – Boreal nesting mid-continent greater white-fronted geese molt in predictable locations in interior and northwest Alaska including Koyukuk, Kanuti, Innoko, and Selawik National Wildlife Refuges. Standardized aerial molting goose surveys have been conducted annually at Koyukuk NWR since 1994 (Spindler et al. 1999, Bryant 2004) and in Innoko and Selawik NWRs since 2000 (Fig. 7). In 2001 the molt survey was expanded to include Kanuti NWR, but no surveys were completed in 2004 and 2005 due to forest fires in the region; thus annual counts are comparable only among Koyukuk/Nowitna, Innoko, and Selawik. Experimental survey efforts were attempted in the Noatak and Seward Peninsula in 2003 and 2004, but this expansion was discontinued in 2005 due to cost and scheduling conflicts. Annual estimates of adults and young from these survey efforts are presented in Tables 2-3. Comparable estimates were obtained for Canada Geese at these sites and are reported in Tables 4-5.

Region-wide abundance of white-fronts (as measured by the molt survey in three index sites) has varied considerably in the six years of the molt survey, ranging from 14,310 in 2002 to 30,159 in 2003 (Fig. 8, Table 3). Of the index sites, Innoko supports 77% of total white-fronts on average (Fig. 8); thus, the abundance of molting geese at Innoko drives the trend for the interior/northwest region. The 2005 estimate at Innoko was down from 2004, and was below the 6-year average (Table 3). At Koyukuk NWR, abundance of molting white-fronted geese declined steadily from 1994-2001 raising concerns of local depletion (Fig. 8). By 2004, however, molt surveys at Koyukuk indicated an increase to levels observed in the mid 1990s. In 2005, the Koyukuk index dropped somewhat but remained above the 12-year average. In contrast, white-fronts molting at Selawik NWR declined between 2001 and 2003 (Fig. 8), but increased substantially in 2004. Estimates in 2005 were nearly unchanged from the previous year.

Assessment of population trend using molt survey estimates is difficult. Given the low proportion of goslings in molt survey areas it is likely the molt survey sites are populated by geese that have migrated from breeding sites elsewhere. Molt migration in geese generally involves non-breeders or failed breeders (Salomonsen 1968, Hohman et al. 1992) with highest numbers expected at molt sites in years of poor breeding success (Reed et al. 2003). Thus, abundance estimates derived from molt surveys represents a combination of population size and current breeding conditions, but it is difficult to separate the two. An important exception is Koyukuk NWR, where on average, 34% of white-fronts observed are goslings (Bryant 2005) suggesting that a large proportion of adults present during molt surveys breed locally.

Starting in 2005, efforts were initiated to collect data that will be used to account for variability in the molt survey including age-ratio surveys at Alaskan fall staging areas, and monitoring water level and forage availability at Innoko NWR. These efforts will continue in 2006.

Teshekpuk Lake Molting Goose Survey – The area north and east of Teshekpuk Lake on the Alaskan North Slope has long been known to attract large numbers of molting geese. The first estimates of size and distribution of molting geese near Teshekpuk Lake came from Henry Hanson in 1957 and was later described by King (1970). Additional surveys were conducted during banding efforts in the 1970s (King and Hodges 1979). Since 1982, an aerial survey has been completed annually north and east of Teshekpuk Lake during the July molting period to document distribution and abundance of geese (Fig. 9). The 2004 white-front estimate was 27,651 adults and subadults, and 3,312 goslings (Mallek 2005). The estimates for 2005 have not yet been calculated. This survey has shown a dramatic increase in molting greater white-fronted geese since 1982, particularly within the last 10 years (Fig. 10). The recent 10-year average of 22,255 (1995-2004) is nearly twice the long-term mean of 12,633 (1982-2004; Mallek 2005). It is assumed that white-fronted geese that molt in this area generally breed on the arctic coastal plain of Alaska (Mallek 2005); however, banding studies have shown that interior breeders occasionally migrate to the North Slope to molt (Martin 1998, Marks 2005, Bird Banding Lab unpubl. data).

The Teshekpuk Lake survey area comprises a relatively small portion of white-fronted goose molting habitat on the North Slope; thus, inferences drawn from this survey should be limited to this immediate geographic area. Because white-fronts molt in many locations on the North Slope, changes in abundance as measured by the Teshekpuk survey could be attributed to a change in distribution rather than a change in abundance. Distribution of molting geese in the Teshekpuk Goose Molting area is currently being investigated by the Alaska Science Center.

Fall Inventory Survey- Alberta/Saskatchewan – The management plan for mid-continent greater white-fronted geese identifies the fall staging survey in prairie Canada as the primary tool to assess range-wide population status (Graber 2005). While the fall inventory is not an Alaskan project per se, an unknown portion of the birds counted during the survey breed in Alaska. The results of the fall staging survey impacts hunting regulations that, in turn, affect status of Alaska breeding geese.

The 2005 fall inventory was the lowest in the 14-year history of the survey, yielding 522,800 white-fronted geese, down 19% from 2004 (Nieman et al. 2005). The updated 3-year running average was 565,100, down 9% from the previous 3-year mean (Fig. 11).

Productivity

Float Survey - Beginning in 1983, staff at Koyukuk/Nowitna NWR conducted annual post-breeding float surveys in late June-early July to monitor trends in productivity in greater-white fronted geese (Spindler et al. 2005; Bryant, pers. comm. 2005). Since 1996, portions of the Dulbi, Kaiyuh, and Nowitna rivers (60, 176, and 143 miles, respectively), have been surveyed with consistent methods providing annual estimates of age ratios and an index to productivity. Apparent productivity, as measured by the proportion of young, was well above average in all three river sections (Table 6, Fig. 12). In 2005 the proportion of young was highest on the Nowitna (0.69, mean 0.66) followed by the Kaiyuh (0.67, mean 0.55) and the Dulbi (0.53, mean 0.42). Proportion of young for the entire survey area averaged 0.51, 1996-2005. Age ratios (goslings/adults)

on the Nowitna, Kaiyuh, and Dulbi rivers average 2.12, 1.66, 0.77, respectively. Average age-ratio for the study area currently is 1.14, 1996-2005.

Fall Age Ratio –Annual population surveys and banding programs allow for monitoring of abundance and annual survival, but state-wide measures of productivity remain elusive. Koyukuk/Nowitna NWR conducts float surveys to estimate productivity, but inferences from these results are limited to the local region and are not necessarily representative of the mid-continent population in Alaska. We sought to measure white-front production for the entire interior/NW Alaska region to determine whether current survival rates are sustainable, and to provide an important covariate for analysis of molt survey results that may be influenced by variation in breeding success.

To obtain an index to production we calculated age-ratios of fall migrating white-fronts near Delta Junction, Alaska. There, white-fronts from throughout the interior/NW Alaska region congregate in fields of waste grain in late August (unpubl. satellite transmitter data, Bird Banding Lab unpubl. data; Steve Dubois ADFG pers. comm.. 2005). There is no evidence to suggest that white-fronts that breed on the Arctic Coastal Plain use this area in fall. Goose arrival, departure, and duration of stay in the Delta Junction vicinity varies among years, but in general white-fronts are present from the latter half of August through the first week of September (Steve Dubois, ADFG pers. comm. 2005). Craig Ely (USGS) and Julian Fischer (FWS) gathered data on flock size, family group size, and age-ratios in the Barley Project area of Delta Junction from August 21- August 23, 2005 (Tables 7 - 9). The sport hunting season starts on September 1, after which time displacement of birds by hunters and disproportionate hunting mortality of juvenile geese was expected; thus field activities were timed after geese began to arrive (based on discussions with area biologists), but prior to September 1st. Unfortunately the field activities did not coincide with peak arrival of white-fronts in 2005, but some flocks were present. Field activities will be repeated in 2006, and will likely be timed during the last week of August.

Parts Collection Survey – Age ratio of harvested geese is calculated annually through a Parts Collection Survey. These estimates are not directly comparable with field age ratios calculated from fall staging flocks in Alaska because of differential harvest mortality among age classes of geese, and because the Parts Collection Survey samples harvested geese from throughout the breeding range, rather than Alaska breeding birds exclusively. Nonetheless, the Parts Collection Survey can provide an index to trends in range-wide productivity. In 2004 the ratio of juveniles to adults was 0.65 in the Central Flyway and 0.44 in the Mississippi Flyway. These estimates were both below the 1999-2004 average age ratio of 0.70 and 0.62 (Central and Mississippi Flyways, respectively). While age-ratios calculated from hunter collected geese are not expected to match age-ratios calculated on the breeding grounds, estimates are surprisingly parallel between the Central Flyway Parts Collection Survey and float surveys on the Koyukuk NWR, 1999-2004 (Fig. 13).

Breeding Biology

In 2005, the results of a 10-year study examining nesting biology and local movements of white-fronts in interior Alaska was reported in a final USFWS report

(Spindler and Hans 2005). The objectives of the study were to identify preferred nesting and brood-rearing habitats, determine breeding chronology and susceptibility of nests to flooding, describe movements of female white-fronts and their broods, and evaluate return rates, mortality and predation on the breeding grounds.
Results included:

- 33% of nests were in uplands not susceptible to flooding
- 55% of nests were in open low scrub, 35% in needleleaf forest and woodland habitats, and 10% in graminoid-herbaceous meadows
- On average, nests were 273 m from nearest waterbody, 4.6 km from nearest rivers
- On average, nest initiation was 11 May, hatching 13 June
- Departure from brood rearing areas occurred in early August
- Geese marked in lower Koyukuk made a pre-migratory movement to Kotzebue Sound prior to southeast migration, whereas those marked on the upper Koyukuk, Kanuti, and Innoko Rivers migrated southeast directly
- Fall departure from west-central AK was usually complete by late August

Harvest

Subsistence – There are no new subsistence harvest survey results available since the 2004 version of this report was written. Table 10 shows previously reported estimates.

Sport – Since 1999, the Harvest Information Program (HIP) has been used to generate state and flyway estimates of waterfowl harvest. During that period, harvest of mid-continent white-fronts has tracked fairly well with the fall population index (Fig. 14). Harvest estimates in the Central Flyway and in Canada are likely most relevant to boreal nesting white fronts in Alaska because band return data suggests that 64% of sport harvest of white-fronts from interior and northwest Alaska occurs in Texas and Canada (Ely pers. comm. 2004; Fig. 15). In 2004 white-front harvest in the Central Flyway was the lowest in the history of HIP (52,163) and harvest in Canada was 12% below average (Kruse 2005). Harvest in the Mississippi Flyway has been relatively consistent since 1999.

Band-return data from Texas has shown a recent shift in harvest from the Gulf Coast to the north central portion of the state (Ely and Schmutz 1999). This change indicates either a change in hunting pressure or shift in goose distribution. Analysis is ongoing and will delineate temporal changes in harvest and fine scale distribution of harvest (Ely pers. comm. 2004).

Distribution

Band return data – Band return data indicate that white-fronted geese from interior/northwest Alaska have a nonbreeding distribution unique from geese that breed in Canada. For example interior/northwest birds are more likely to winter in Mexico and use spring staging grounds in Nebraska, than geese from other breeding areas (Ely and Schmutz 1999). Further, geese from interior/northwest Alaska initiate fall and spring migration earlier than other segments of the mid-continent population. Distribution analyses using band return data are ongoing and will be updated by Craig Ely (USGS-Alaska Science Center).

Satellite transmitters – From 2001 to 2003 satellite transmitters were deployed in 51 mid-continent greater white-fronted geese in Alaska. There are no new results of this study available since the 2004 version of this report was written. Main findings reported to date include spatial and temporal separation between boreal (interior/NW) and tundra (North Slope) nesting white fronts in their migration pathways and wintering grounds. Results of this project will be presented in Deborah Webb's 2006 MS thesis and subsequent publications.

Leg-Banding Program

Staff from Migratory Bird Management, Innoko NWR, Koyukuk/Nowitna NWR, and Selawik NWR, continued annual goose banding efforts at various locations in 2005. A total of 2,475 white-fronted geese were banded at four sites on the Innoko NWR (1,150 bands), one site on the Seward Peninsula (206 bands), two sites on the Noatak Flats (198 bands), and five sites on the western North Slope (921 bands). Poor weather precluded capture of white-fronts on the Selawik Refuge. Details of the 2005 banding trip are reported by Marks (2005).

Banding effort on the North Slope has been variable in recent decades. A total of 5,145 white-fronted geese were banded on the North Slope in 1975-1979 (King and Hodges 1979, Lobpries 1980) and an additional 1,085 geese were banded in 1990-1994 (USFWS unpubl. data). Banding on the North Slope resumed in 2003 with the goal of 1,000 geese per year in order to provide sufficient data to compare survival rates of geese in tundra habitats with boreal habitats, and to detect and quantify interchange between tundra nesting and boreal nesting geese in Alaska. Starting in late 2006, there will be sufficient data available from the Bird Banding Lab to calculate a survival estimate for white-fronts from the North Slope using band-return data from 2003-2005.

Band recaptures suggest that there is some interchange of molting white-fronts north and south of the Brooks Range. In 2004, two white-fronts were recaptured on the western North Slope that had been originally banded at Innoko NWR in 2003. Similarly, one goose was recaptured at Innoko NWR in 2004 that was banded on the central North Slope in 2003. In 2005, 231 banded white-fronts were recaptured during banding drives. Of these, 5% were recaptured in a location far from their original banding location, but only 3 geese (1.2% of recaptures) were recaptured on the other side of the Brooks Range from where they were initially banded (2 between Innoko and North Slope, and 1 between Selawik and the North Slope). Other studies have found evidence that interior Alaska breeding white-fronted geese occasionally migrate to the North Slope to molt. For example, a white-fronted goose banded in Kanuti NWR in 1973 was recaptured two years later near Teshekpuk Lake (Martin 1998). Similarly several satellite transmitter tagged geese that were captured at Kanuti NWR in 2003 migrated to the North Slope to molt in 2004 (Webb unpubl. data). These findings suggest that there is at least a small degree of interchange across the Brooks Range. It is not clear whether geese shift breeding sites between these sites or if interior breeders migrate to the North Slope to molt in years of poor breeding success.

Survival

Leg-banding provides data necessary to calculate annual survival of mid-continent greater white-fronted geese in interior and northwest Alaska. Joel Schmutz (USGS, Alaska Science Center) used band recoveries from geese banded during 2000-2004 to generate survival estimates for white-fronts from interior/northwest Alaska. He found that during the 2000-2004 period, mean survival rate was approximately 0.62 (± 0.07 95%CI). This estimate was significantly lower than mean survival of white-fronts from Queen Maud Gulf, Canada during the same period (0.77; ± 0.05 95%CI). Indexed reporting rate (product of the probability a band will be recovered and probability a recovered band will be reported) differed significantly between Alaska and Queen Maud Gulf (0.10 ± 0.01 SE, 0.18 ± 0.02 SE, respectively). The lower rate in Alaska could be due to higher natural mortality and/or lower reporting rates by subsistence hunters compared with sport hunters. A lower indexed reporting rate decreases precision of the survival estimate, but accuracy remains the same.

A minimum of 1,000 white-fronts in interior/northwest Alaska should be banded each year for 10 years to ensure a 90% chance of detecting a 5% change in survival rate (Schmutz 2001). After 5 years of banding 1,000 white-fronts per year, we have approximately a 75% chance of detecting a 10% change in survival. Modifications to the mid-continent white-front management plan will likely result in tightened restrictions to sport harvest. Reductions in sport harvest may translate to increased survival that could be detected through continued banding and analysis in Alaska. The Alaska crew has banded approximately 1,000 white-fronts each year on the North Slope since 2003. A preliminary survival estimate will be available for white-fronts in this region will be available in late 2006.

Body Condition

The USGS-Alaska Science Center, in cooperation with FWS and CWS, is investigating the body condition dynamics in primary molting habitats of Alaska. Biologists have shown that body mass varies by year, sex, and site within Innoko NWR (Fig. 16) but the relationship between condition and habitat quality is under investigation. Studies are underway to determine whether morphological variation and site selection of molting white-fronts is related to winter distribution and survival. Preliminary data suggests that both survival and body condition are higher in Queen Maud Gulf than in Innoko (Fig. 17). These investigations will continue over the next few years.

Management Plan Update

In April, 2005 a subcommittee comprised of biologists and managers from state, federal and provincial agencies completed a draft revision of the Mid-continent Greater White-fronted Goose Management Plan. The Mississippi, Central and Pacific Flyway Councils are expected to approve and sign the Management Plan in 2006. The impetus behind revising the plan was a substantial decline in the mid-continent population from over one million birds in 1998 to about 600,000 by 2002. A population decline was planned and expected after implementation of liberal harvest frameworks in 1998, but the magnitude of the change was not desirable. Changes to harvest guidelines in the revised management plan are expected to reverse the negative population trend in 2006.

Key changes to the management plan are listed below:

1. The population objective was increased from 600,000 to 650,000.
2. Three harvest frameworks were defined – restrictive, base, and liberal
    a. The threshold triggering restrictive regulations is 500,000 and will be activated if any single-year index is at or below that level (previously based on the 3-year running average)
    b. The population must be restored to 600,000 based on the 3-year running average before base regulations are resumed
    c. The threshold triggering liberal regulations was raised from 700,000 to 800,000
3. Prescribed restrictive regulation guidelines are now included for all jurisdictions
4. Management strategies, tasks, and appendices are updated

Avian Cholera

One possible explanation for low survival in greater white-fronted geese is disease. Band return data show that Alaska breeding mid-continent greater white-fronted geese migrate through Nebraska's Rainwater Basin (Ely and Schmutz 1999) where outbreaks of avian cholera are common (Samuel 2005). A three-year study was initiated in 2001 to:

1) quantify prevalence of greater white-fronted geese in interior/northwest Alaska with recent exposure to *Pasteurella multocida*, the bacterium responsible for causing avian cholera; and
2) detect occurrence of avian cholera carriers in the population based on pharyngeal swab cultures

Serum and oral swab samples were collected from captured geese in several sites in interior and northwest Alaska in July, 2001-2003 to assess whether white-fronted geese are exposed to avian cholera, determine the likelihood that these geese act as carriers of the disease agent, and compare results to other goose populations. The results of this work were recently published in the Journal of Wildlife Diseases (Samuel et al. 2005). The key finding of this work was that greater white-fronted geese in interior and northwest Alaska may be exposed to avian cholera during the winter or spring, but are unlikely to play a significant role as carriers of the bacterium causing avian cholera. Analysis of serum samples showed that approximately 4% of the sampled geese had antibody levels to *P. multocida* indicative of recent exposure to the bacteria. While antibodies in serum samples indicated exposure to *P. multocida*, the bacteria itself was not present in swab samples indicating that the geese are not likely carriers. It is noteworthy that sampling occurred in years when there were no major outbreaks in the spring staging areas; thus, the impact of a major outbreak to the Alaska breeding population is unknown.

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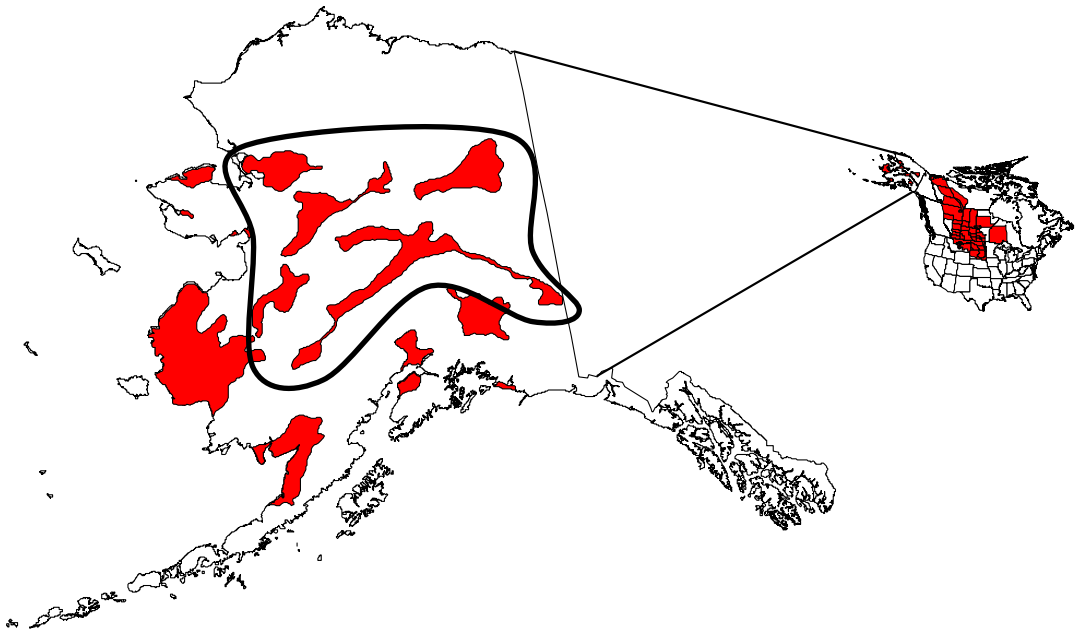
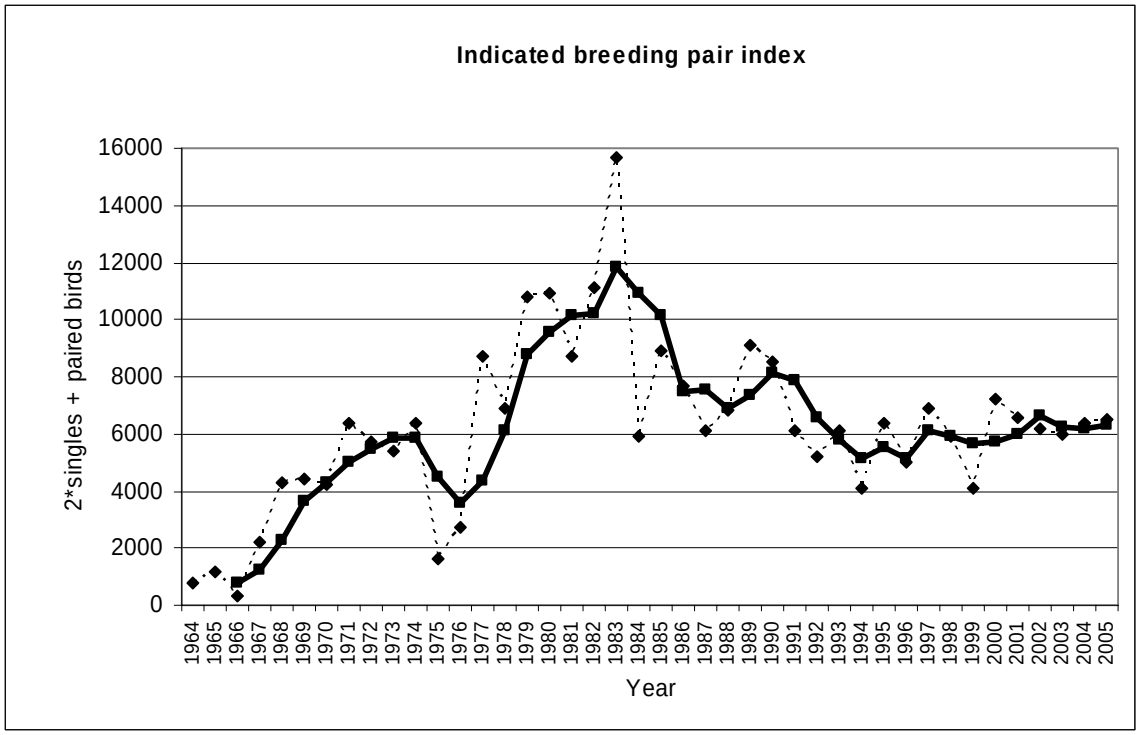


Figure 1. Location of five interior and northwest Alaska strata (encircled polygons) relative to all surveyed areas (red) in the Continental Breeding Pair Survey.



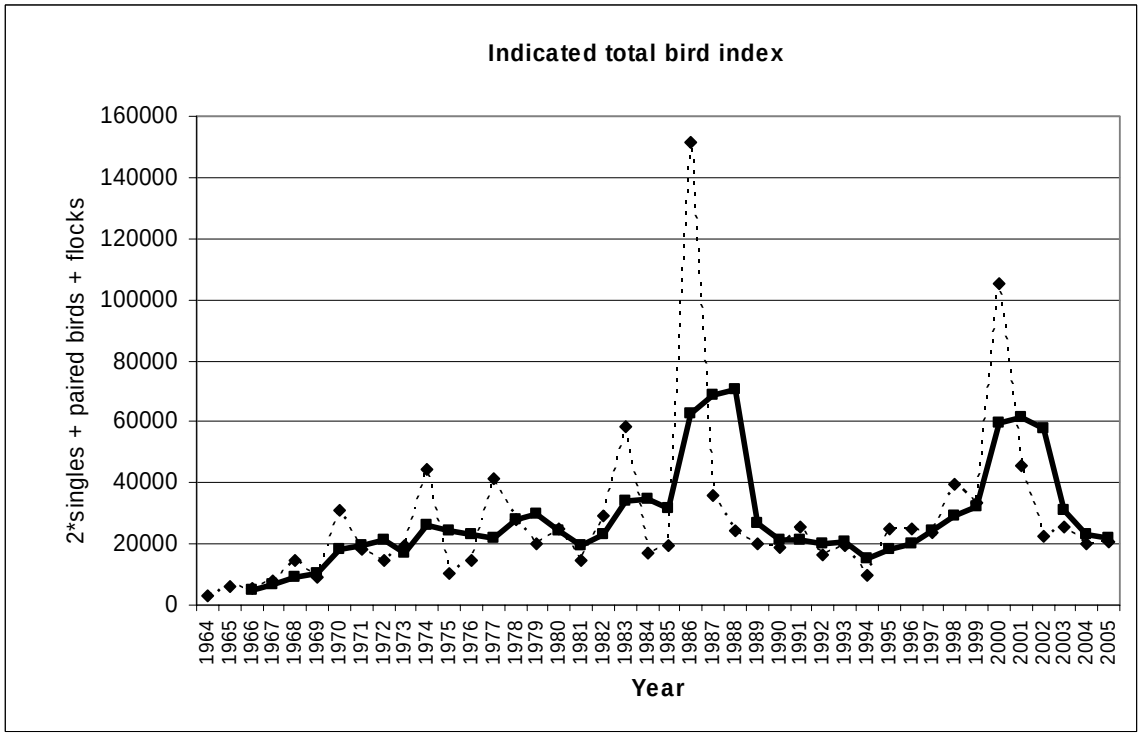


Figure 2. Breeding pair (upper) and total bird (lower) indices of mid-continent greater white-fronted geese estimated during spring breeding pair surveys in interior and northwest Alaska, 1964-2005. Point estimates connected with dashed lines, 3-year running averages connected with solid bold lines. Indices derived from strata 3-6, and 11 in the Continental Breeding Pair Survey (Conant and Groves 2005).

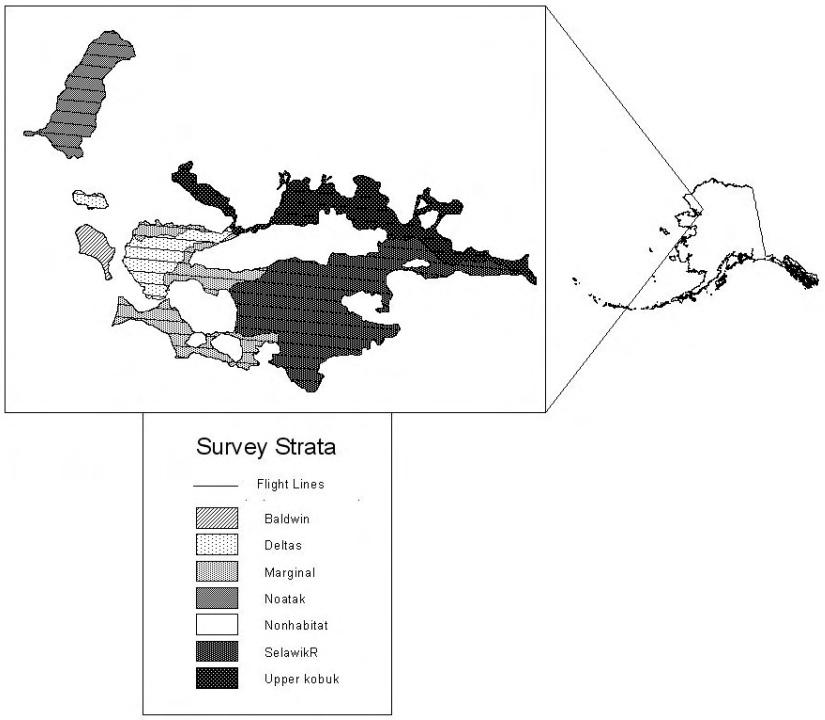


Figure 3. Location of experimental white-fronted goose breeding pair survey, northwest Alaska, May 25-28, 2005.

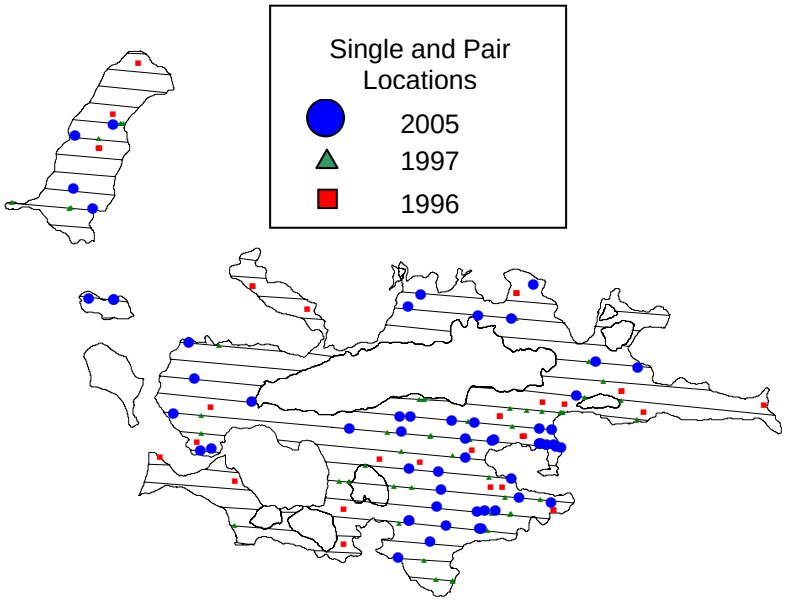
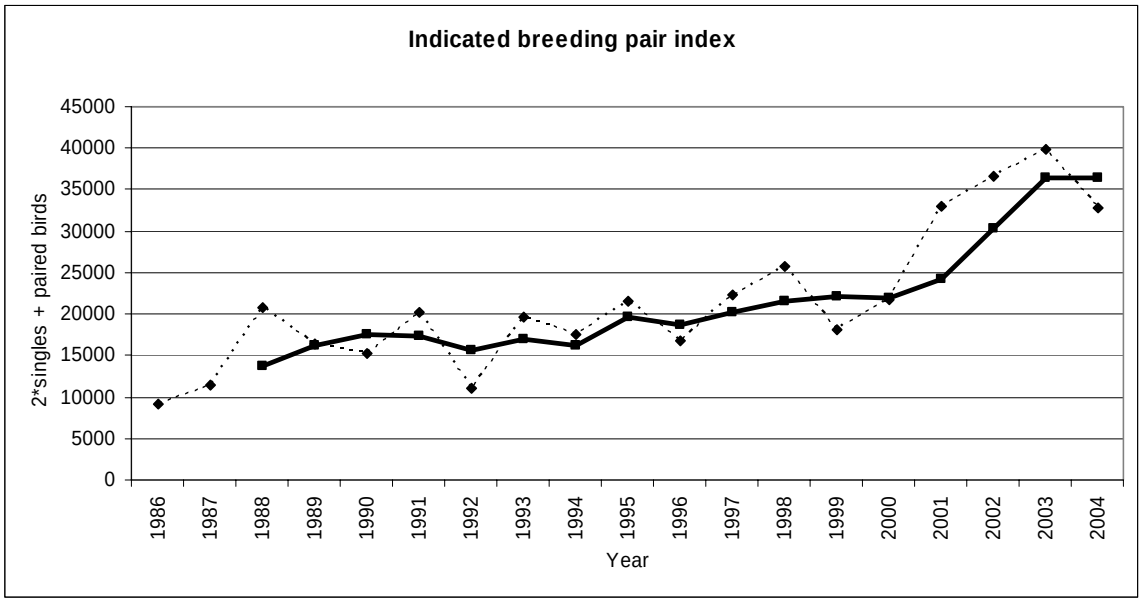


Figure 4. Locations of indicated white-front pairs (singles and pairs) during breeding pair surveys in 1996, 1997, and 2005 (Platte 1999, Fischer et al. 2005).



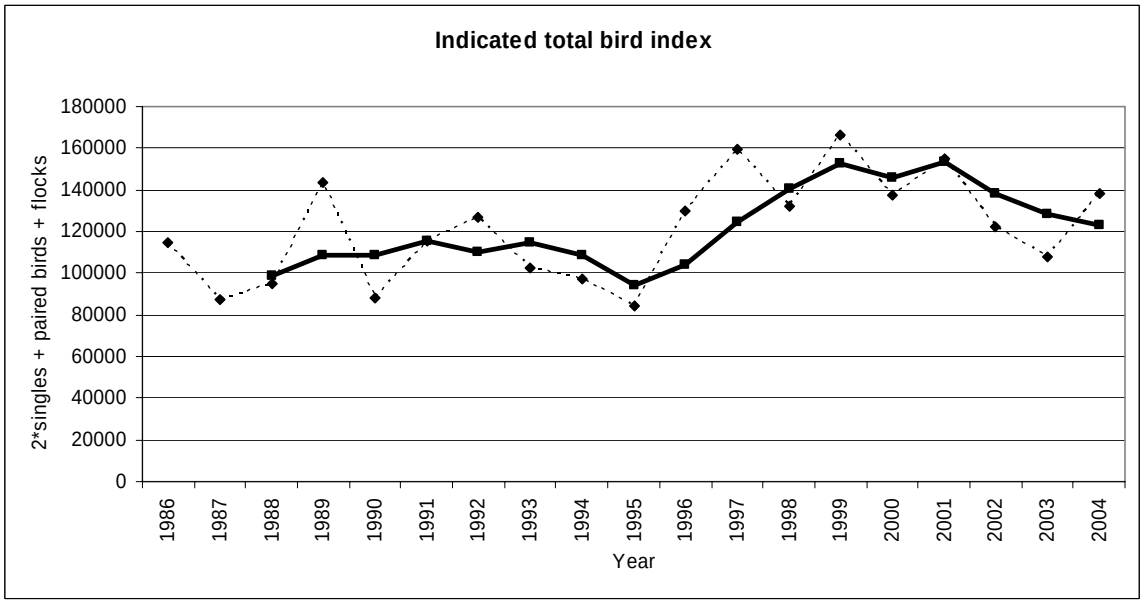
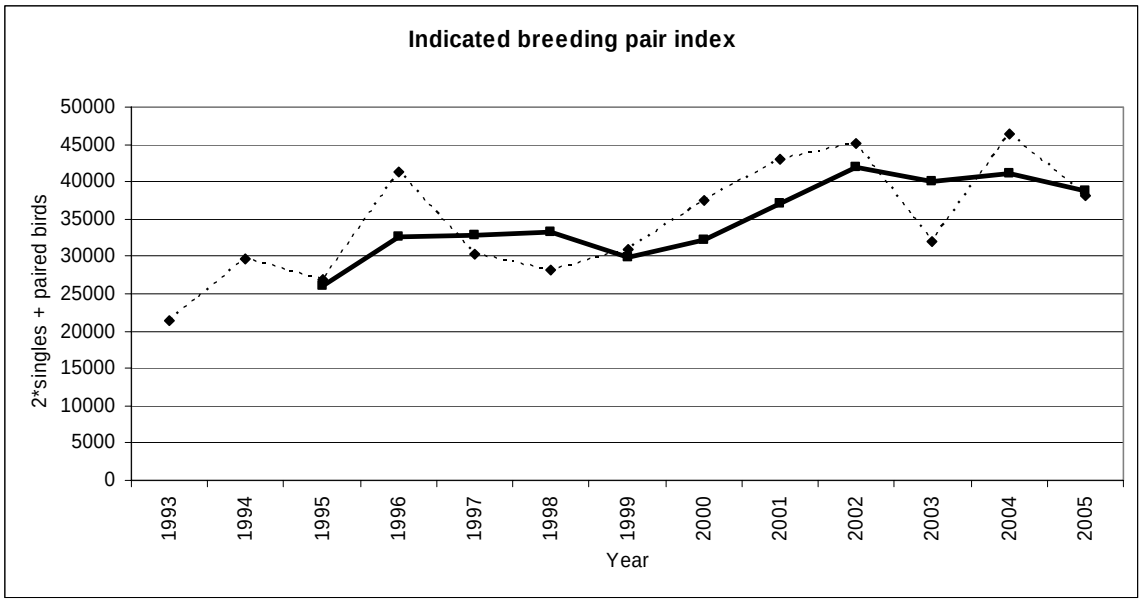


Figure 5. Indicated breeding pair (upper) and total bird (lower) indices of mid-continent greater white-fronted geese estimated during breeding pair surveys on the Arctic Coastal Plain, Alaska, 1986-2004. Point estimates connected with dashed line, 3-year running average connected with solid bold line (Mallek et al. 2005).



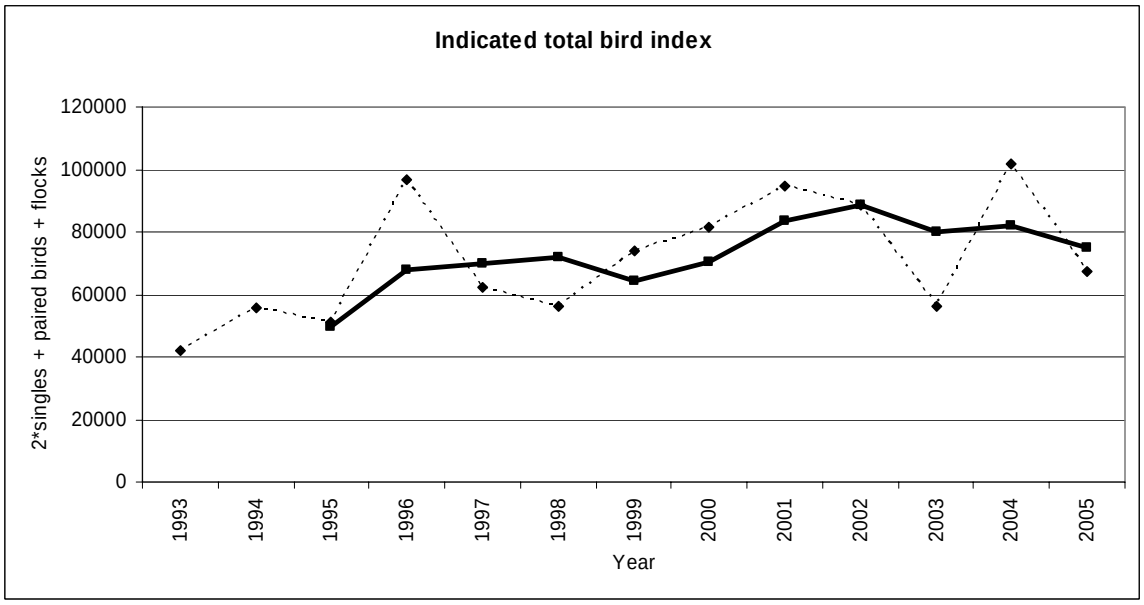


Figure 6. Indicated breeding pair (upper) and total bird (lower) indices of mid-continent greater white-fronted geese estimated during breeding pair surveys on the North Slope Eider Survey, 1993-2005. Point estimates connected with dashed line, 3-year running average connected with solid bold line (Larned et al. 2005).

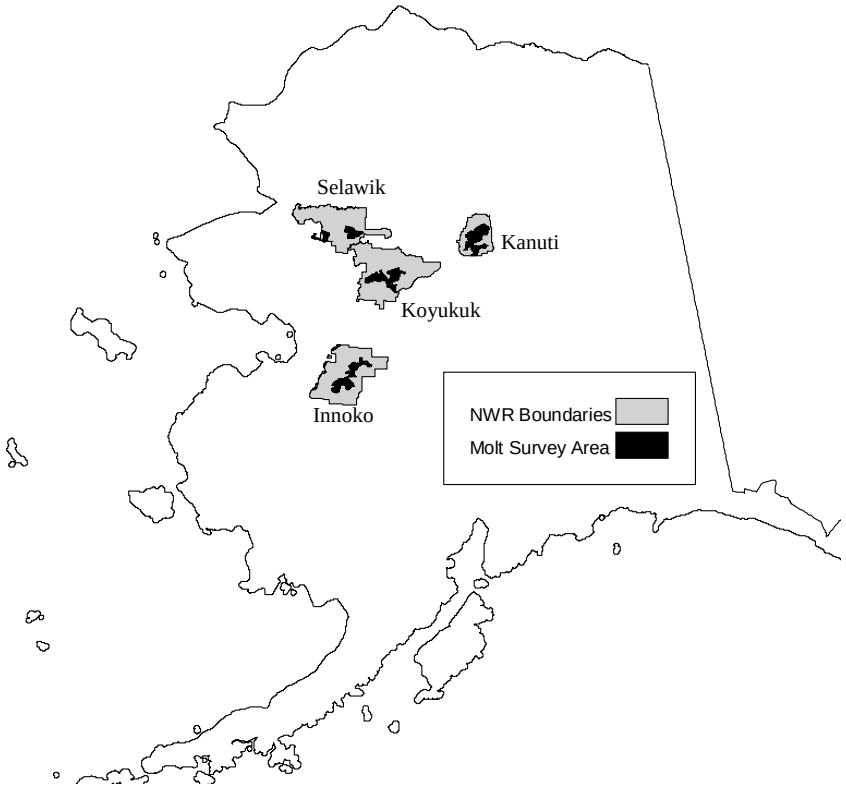


Figure 7. Coordinated molting goose survey area, interior/northwest Alaska, 2000-2005.

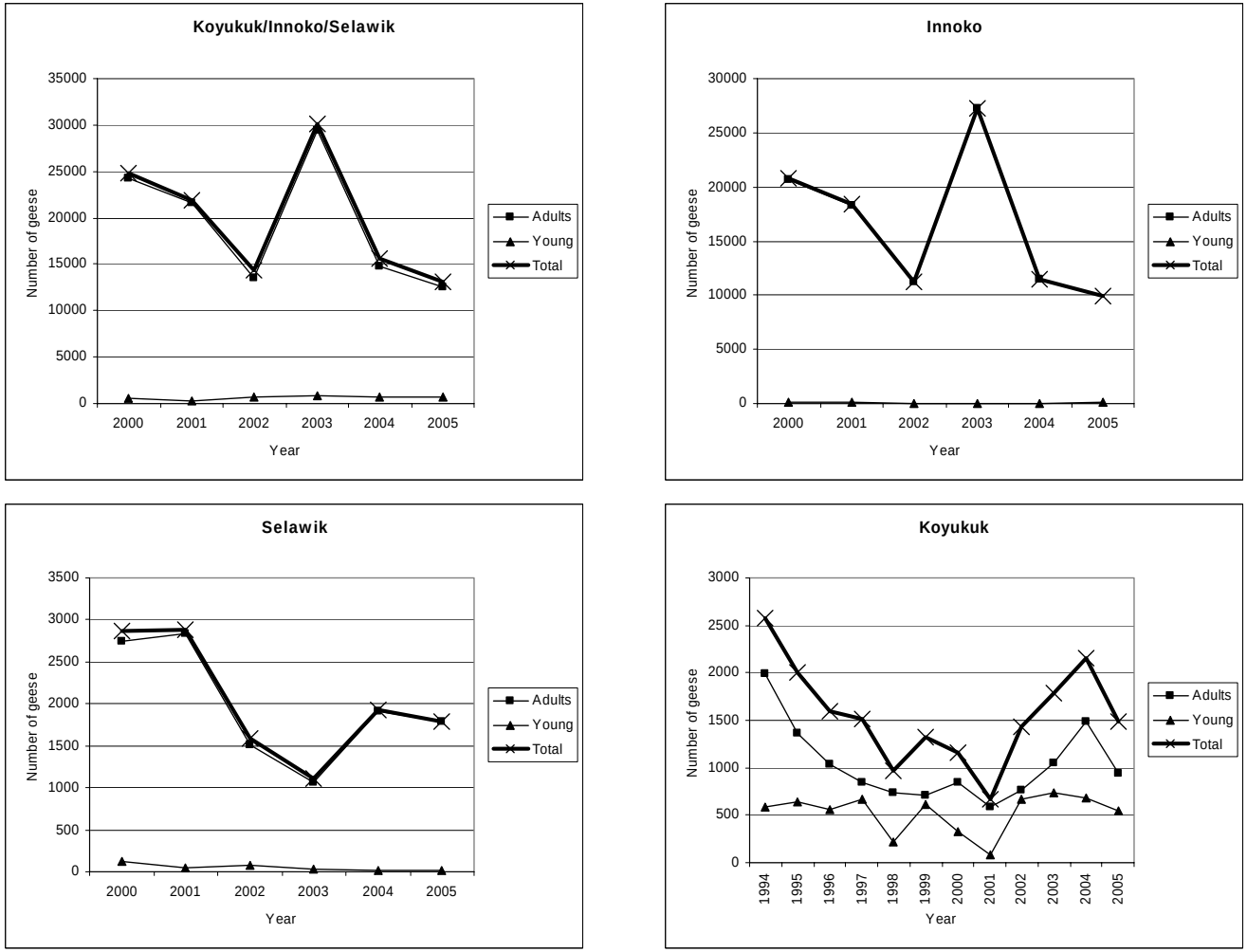


Figure 8. Abundance of mid-continent greater white-fronted geese at three index sites estimated during molting goose surveys in interior/northwest Alaska, 2000-2005. The upper left graph shows the three sites combined.

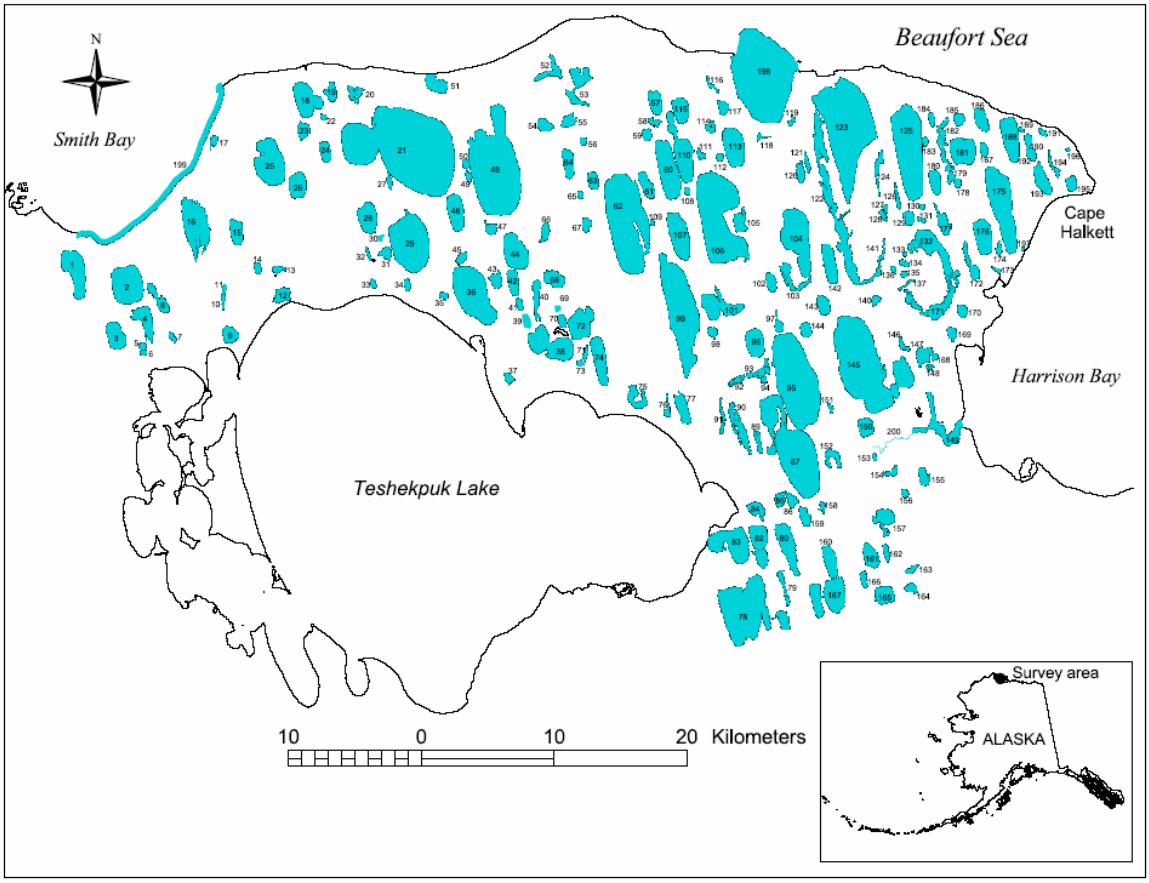


Figure 9. Lakes sampled in the Teshekpuk Lake area molting goose survey.

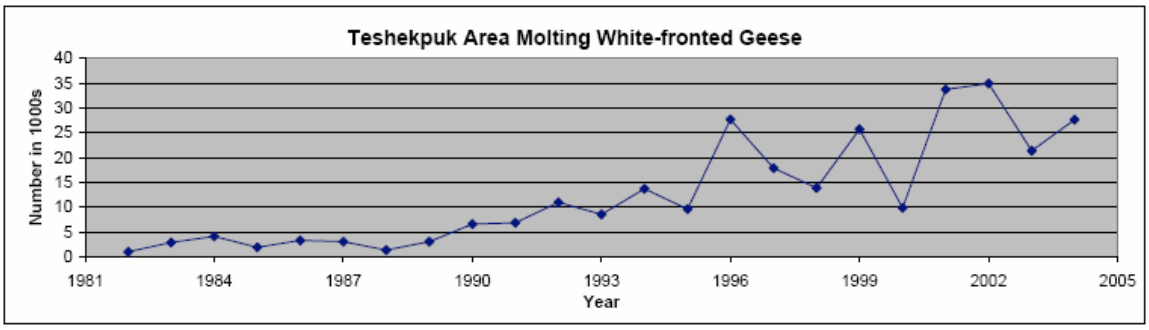


Figure 10. Numbers of adult greater white-fronted geese observed in the Teshekpuk Lake molting survey area, 1982-2004. Data from Mallek (2005).

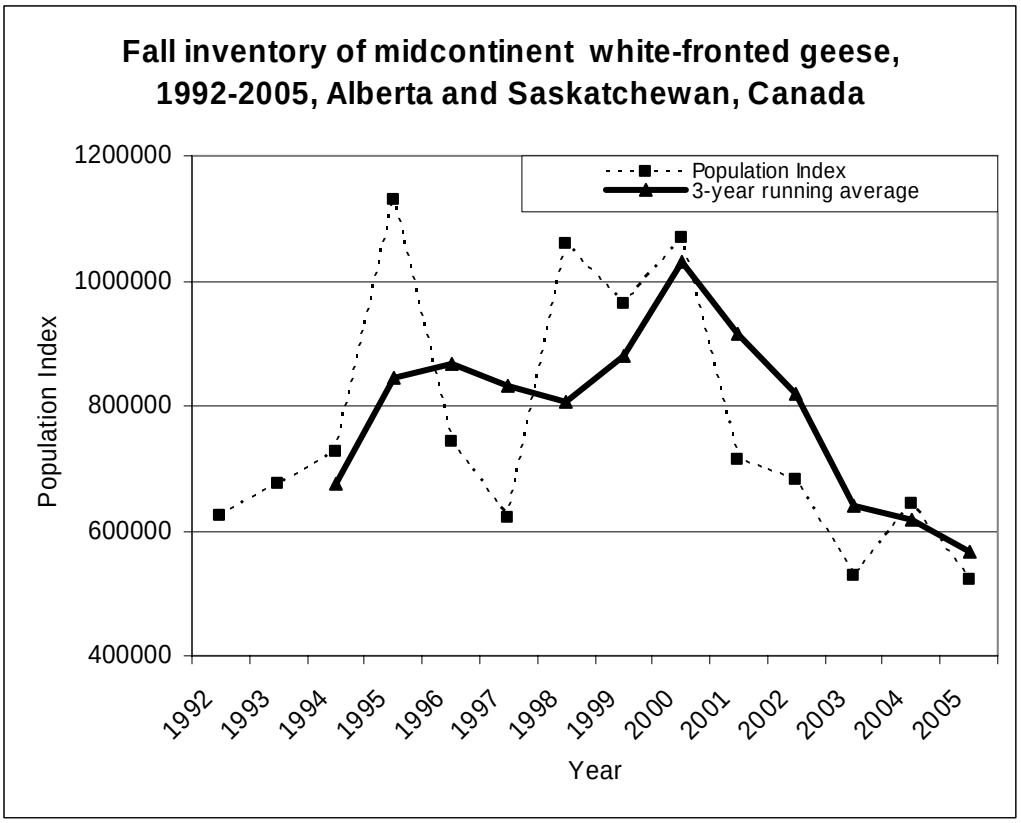


Figure 11. Mid-continent greater white-fronted goose population index based on fall inventory surveys in Alberta and Saskatchewan, 1992-2005 (Nieman et al. 2005).

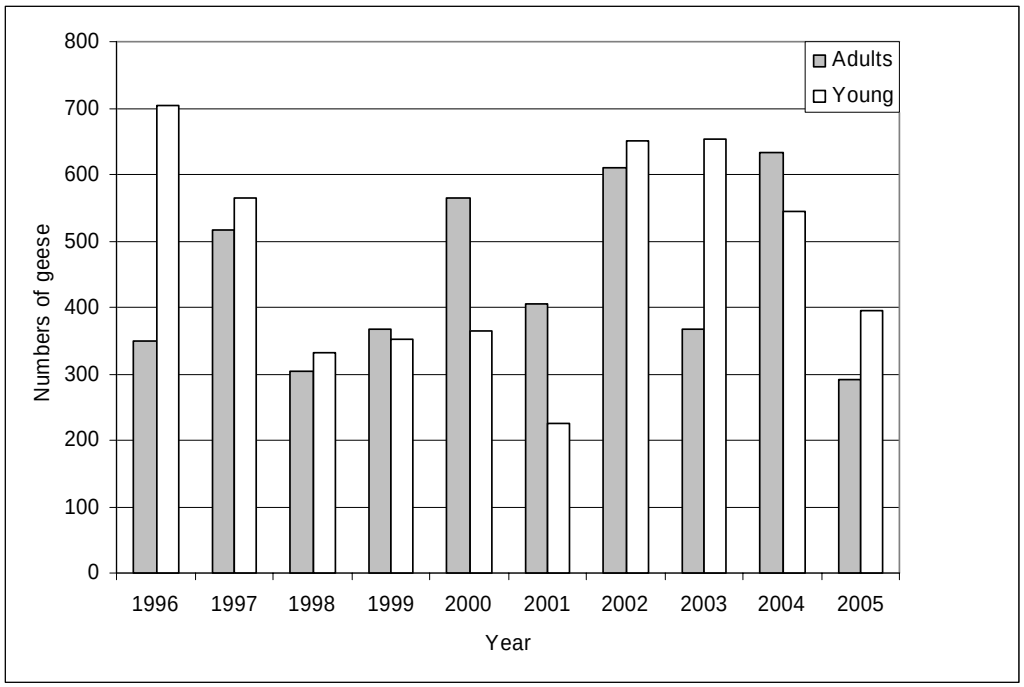


Figure. 12. Numbers of adult and gosling white-fronted geese observed during float surveys of 379 river miles, Dulbi (60), Kaiyuh (176), and Nowitna (143) rivers in interior Alaska, late June-early July, 1996-2005. (Data from J. Bryant, Koyukuk/Nowitna NWR)

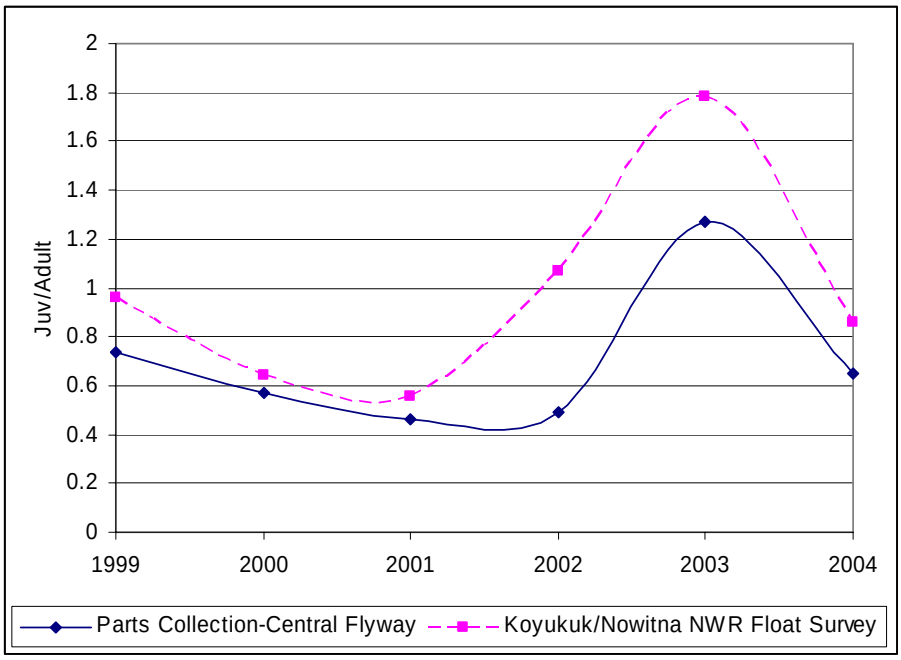


Figure 13. Comparison of age ratios (juveniles/adults) of mid-continent greater white-fronted geese calculated from Parts Collection Surveys during the regular harvest season in the Central Flyway (Kruse 2005) and July float surveys in the Koyukuk/Nowitna NWR, 1999-2004.

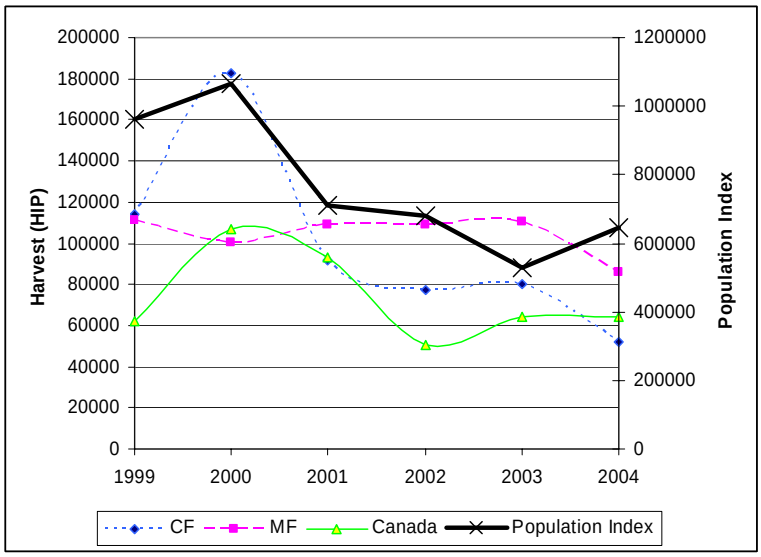


Figure 14. Estimated harvest of greater white-fronted geese in the Central Flyway, Mississippi Flyway, and Canada, 1999-2004 (HIP, Kruse 2005) relative to the fall population index (Neiman et al. 2005).

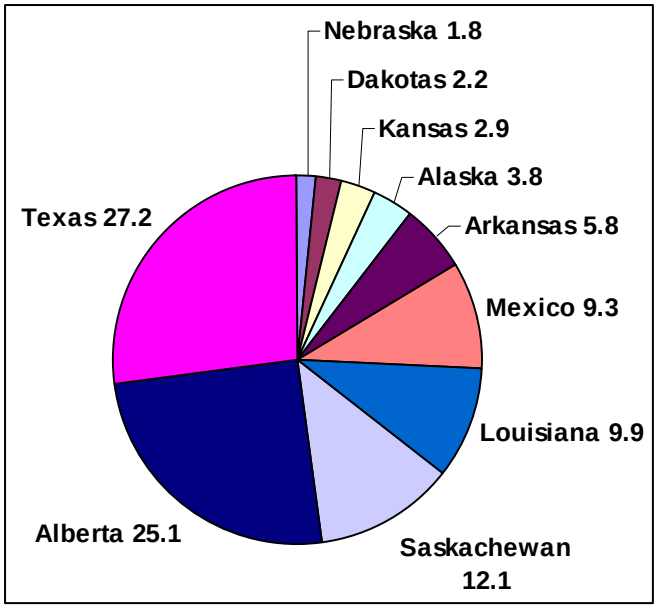


Figure 15. Distribution of sport harvest of mid-continent greater white-fronted geese that breed in interior and northwest Alaska, 1990-2002 (Ely pers. comm. 2004). Numbers indicate proportion of harvest by state or province. Results based on recoveries of leg-banded geese from interior and northwest Alaska.

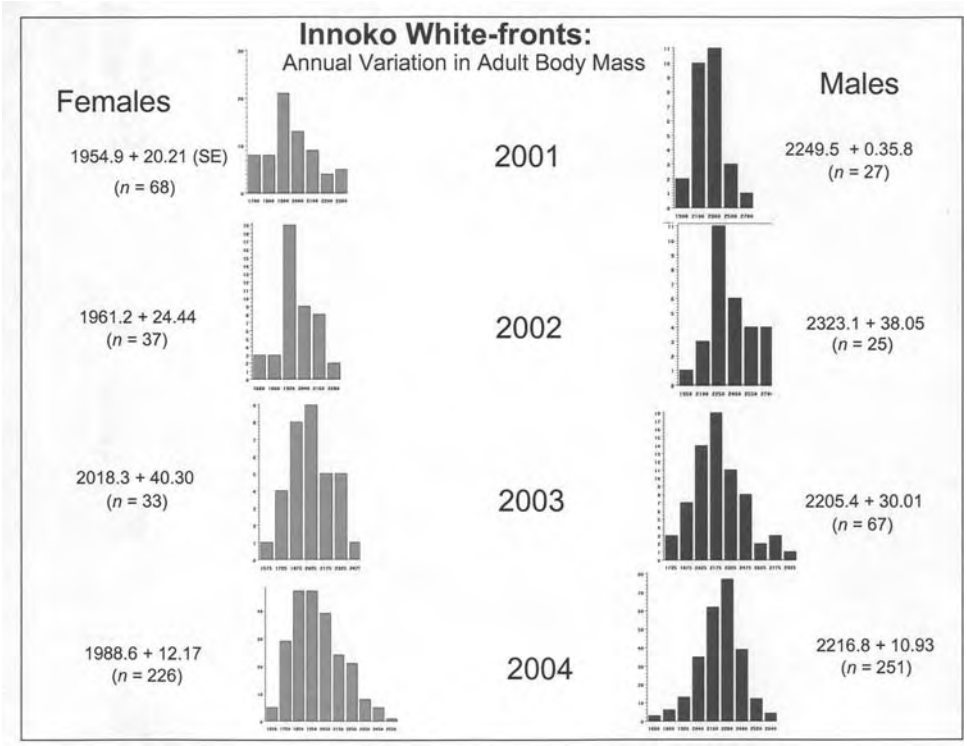


Figure 16. Inter-year and sex differences in adult body mass of mid-continent greater white-fronted geese at Innoko, Alaska. (Craig Ely, unpubl. data)

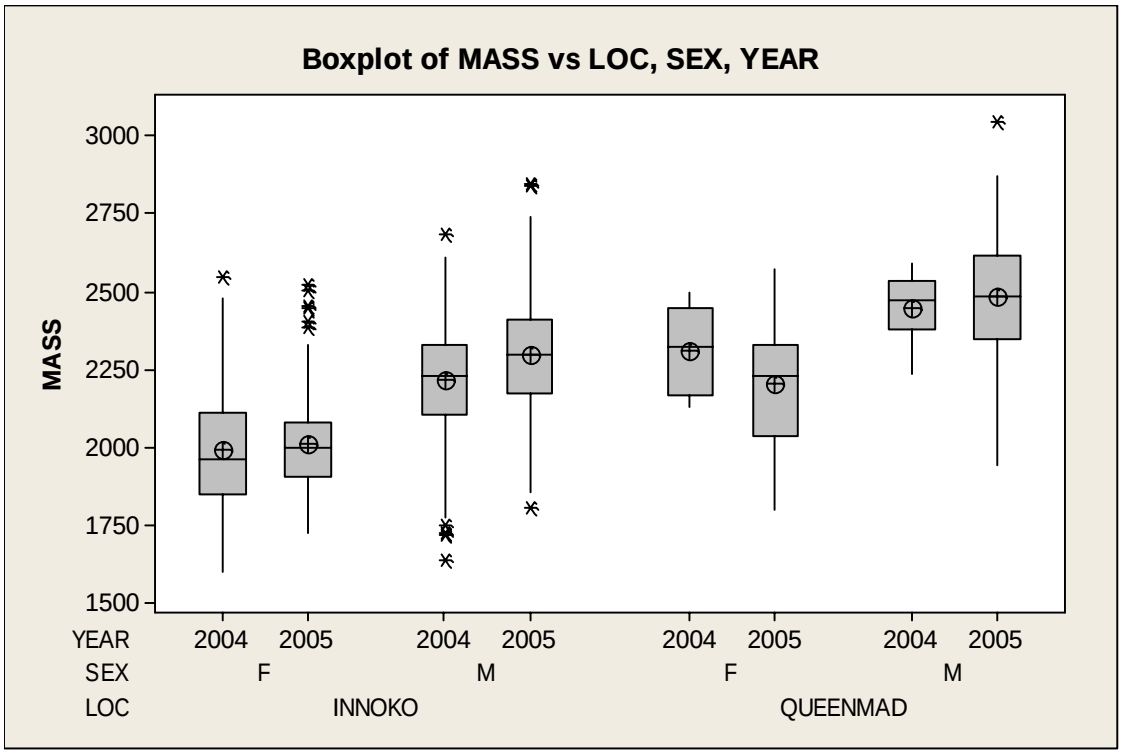


Figure 17. Inter-population variation in body mass of adult white-fronted geese from Innoko NWR, Alaska and Queen Maud Gulf, Nunavut Canada. (Craig Ely, unpubl. data).

Table 1. Estimates of indicated breeding pairs and indicated total greater white-fronted geese in northwest Alaska, May, 2005 (Fischer et al. 2005), and June 1996-1997 (Platte 1999). Indicated breeding pairs was calculated by two times the number of singles plus the number of paired birds; indicated total birds was calculated by indicated breeding pairs plus flocked birds.

			Indicated Breeding Pairs					Indicated Total Birds				
Stratum Name	Statum Size (km^2)	Year	Mean Density	SE	Population	SE	95%CI	Mean Density	SE	Population	SE	95%CI
Noatak	1896	1996	0.08	0.04	151	85	167	0.68	0.23	1280	442	866
		1997	0.15	0.09	292	167	327	1.11	0.32	2099	598	1172
		2005	0.08	0.03	150	59	115	0.39	0.14	729	261	511
Deltas	1413	1996	0.05	0.04	75	52	102	0.11	0.06	150	89	174
		1997	0.08	0.04	113	63	123	0.20	0.15	283	218	427
		2005	0.19	0.10	268	141	277	0.28	0.14	401	201	394
Marginal	2207	1996	0.05	0.03	117	67	131	0.49	0.28	1072	625	1225
		1997	0.03	0.02	71	44	86	0.03	0.02	71	44	86
		2005	0.03	0.02	75	51	100	0.32	0.20	695	442	866
Upper Kobuk	3255	1996	0.08	0.04	254	135	265	0.70	0.31	2264	1019	1997
		1997	0.05	0.04	174	122	239	0.58	0.23	1892	752	1474
		2005	0.10	0.04	317	118	231	0.27	0.11	882	355	696
Selawik	6076	1996	0.11	0.02	655	97	190	1.12	0.35	6785	2106	4128
		1997	0.25	0.04	1496	231	453	1.22	0.26	7411	1588	3112
		2005	0.22	0.06	1351	335	656	0.66	0.11	3977	694	1360
Total	14848	1996	0.08	0.01	1252	205	402	0.78	0.17	11552	2463	4827
		1997	0.14	0.02	2147	320	627	0.77	0.12	11756	1869	3663
		2005	0.15	0.03	2160	390	764	0.45	0.06	6685	954	1871

Table 2. Abundance of mid-continent greater white-fronted geese during molting surveys in interior/northwest Alaska, 1994-2005.

Year	Koyukuk		Innoko		Selawik		Kanuti		Noatak		Seward Peninsula	
	Adults	Young	Adults	Young	Adults	Young	Adults	Young	Adults	Young	Adults	Young
1994	1988	588	--	--	--	--	--	--	--	--	--	--
1995	1358	645	--	--	--	--	--	--	--	--	--	--
1996	1037	555	--	--	--	--	--	--	--	--	--	--
1997	848	671	--	--	--	--	--	--	--	--	--	--
1998	743	219	--	--	--	--	--	--	--	--	--	--
1999	705	618	--	--	--	--	--	--	--	--	--	--
2000	840	325	20684	121	2741	129	--	--	--	--	--	--
2001	593	78	18246	137	2844	45	332	142	--	--	--	--
2002	764	663	11273	19	1518	73	117	50	--	--	--	--
2003	1053	739	27243	17	1071	36	313	65	934	16	680	43
2004	1480	680	11420	42	1907	23	--	--	650	15	486	6
2005	944	545	9761	76	1786	10	--	--	--	--	--	--
Mean	1029	527	16438	69	1978	53	254	86	792	16	583	25

Table 3. Abundance of mid-continent greater white-fronted geese during molting surveys at three index sites in interior/northwest Alaska, 2000-2005.

Year	Koyukuk			Innoko			Selawik			Total		
	Adults	Young	Total	Adults	Young	Total	Adults	Young	Total	Adults	Young	Total
2000	840	325	1165	20684	121	20805	2741	129	2870	24265	575	24840
2001	593	78	671	18246	137	18383	2844	45	2889	21683	260	21943
2002	764	663	1427	11273	19	11292	1518	73	1591	13555	755	14310
2003	1053	739	1792	27243	17	27260	1071	36	1107	29367	792	30159
2004	1480	680	2160	11420	42	11462	1907	23	1930	14807	745	15552
2005	944	545	1489	9761	76	9873	1786	10	1796	12491	631	13158
Mean	946	505	1451	16438	69	16513	1978	53	2031	20735	625	21361

Table 4. Abundance of Canada geese during molting surveys in interior/northwest Alaska, 1994-2005.

Year	Koyukuk		Innoko		Selawik		Kanuti		Noatak		Seward Peninsula	
	Adults	Young	Adults	Young	Adults	Young	Adults	Young	Adults	Young	Adults	Young
1994	24	36	--	--	--	--	--	--	--	--	--	--
1995	60	6	--	--	--	--	--	--	--	--	--	--
1996	107	166	--	--	--	--	--	--	--	--	--	--
1997	54	97	--	--	--	--	--	--	--	--	--	--
1998	38	31	--	--	--	--	--	--	--	--	--	--
1999	68	128	--	--	--	--	--	--	--	--	--	--
2000	97	91	653	28	5143	82	--	--	--	--	--	--
2001	24	2	4777	40	4077	138	67	54	--	--	--	--
2002	25	28	3903	114	2576	224	87	122	--	--	--	--
2003	41	61	8216	132	1411	138	51	122	469	0	651	21
2004	44	39	4625	35	2803	252	--	--	346	28	753	23
2005	64	84	3153	162	988	217	--	--	--	--	--	--
Mean	54	64	4221	85	2833	175	68	99	408	14	702	22

Table 5. Abundance of Canada geese during molting surveys at three index sites in interior/northwest Alaska, 2000-2005.

Year	Koyukuk			Innoko			Selawik			Total		
	Adults	Young	Total	Adults	Young	Total	Adults	Young	Total	Adults	Young	Total
2000	97	91	188	653	28	681	5143	82	5225	5893	201	6094
2001	24	2	26	4777	40	4817	4077	138	4215	8878	180	9058
2002	25	28	53	3903	114	4017	2576	224	2800	6504	366	6870
2003	41	61	102	8216	132	8348	1411	138	1549	9668	331	9999
2004	44	39	83	4625	35	4660	2803	252	3055	7472	326	7798
2005	64	84	147	3153	162	3315	988	217	1205	4205	463	4667
Mean	49	51	100	4221	85	4306	2833	175	3008	7103	311	7414

Table 6. Greater white-fronted geese observed during float surveys of 379 river miles on the Dulbi (60), Kaiyuh (176), and Nowitna (143) rivers in interior Alaska, late June-early July, 1996-2005.

	Dulbi River			Kaiyuh River			Nowitna River			Total--379 River Miles		
Year	Adults	Young	Prop. Young	Adults	Young	Prop. Young	Adults	Young	Prop. Young	Adults	Young	Prop. Young
1996	198	244	0.55	46	170	0.79	106	290	0.73	350	704	0.67
1997	352	253	0.42	120	125	0.51	45	187	0.81	517	565	0.52
1998	130	87	0.40	16	38	0.70	159	207	0.57	305	332	0.52
1999	190	200	0.51	138	103	0.43	39	50	0.56	367	353	0.49
2000	409	149	0.27	62	48	0.44	94	168	0.64	565	365	0.39
2001	270	80	0.23	36	20	0.36	100	126	0.56	406	226	0.36
2002	382	248	0.39	53	131	0.71	175	272	0.61	610	651	0.52
2003	164	137	0.46	91	256	0.74	112	261	0.70	367	654	0.64
2004	413	312	0.43	142	32	0.18	77	200	0.72	632	544	0.46
2005	223	253	0.53	32	64	0.67	35	78	0.69	290	395	0.58

Table 7. Age composition, proportion juveniles, and age ratio of greater white-fronted geese observed in the Barley Project, Delta Junction, Alaska, August 21-23, 2005.

Date	Time	Location	Adults	Juveniles	Flock Count	Observer	Prop Juv.	Age Ratio (Juv/Adult)
8/21	20:30	AK Farmers Coop	30	11	230	Ely	0.27	0.37
8/21	20:30	AK Farmers Coop	145	48	230	Ely	0.25	0.33
8/22	6:37	AK Farmers Coop	43	22	206	Fischer	0.34	0.51
8/22	7:30	AK Farmers Coop	117	69	206	Fischer	0.37	0.59
8/22	20:30	AK Farmers Coop	34	10	na	Fischer	0.23	0.29
8/22	20:35	AK Farmers Coop	14	6	na	Fischer	0.30	0.43
8/23	6:40	AK Farmers Coop	31	18	280	Fischer	0.37	0.58
8/23	6:50	AK Farmers Coop	84	24	280	Fischer	0.22	0.29
8/23	7:15	AK Farmers Coop	77	29	280	Fischer	0.27	0.38
						Mean	**0.29**	**0.42**

Table 8. Greater white-fronted goose flocks observed in flight in the Barley Project, Delta Junction, Alaska, August 21-25, 2005.

Date	Time	Location	Flock Size	Flight Direction
8/21/2005	16:30	Spruce and Barley	6	S
8/21/2005	17:30	Tract D	100	S
8/21/2005	19:15	Tract I	8	W
8/21/2005	19:30	Tract F	2	W
8/22/2005	17:30	Tract J	7	circling
8/22/2005	18:00	Tract 1-A	150	E
8/22/2005	19:00	Tract 3	6	S
8/22/2005	19:05	Tract 3	12	N
8/22/2005	19:05	Tract 3	30	N
8/22/2005	21:00	Ak Hywy and Agric Way	8	N

Table 9. Greater white-fronted goose family sizes observed in the Barley Project, Delta Junction, Alaska, August 21-23, 2005.

Date	Time	Location	Family Size (#young)
8/21/2005	19:15	Tract O	7
8/21/2005	20:30	Alaska Farmers Coop	3
8/21/2005	20:30	Alaska Farmers Coop	3
8/21/2005	20:30	Alaska Farmers Coop	5
8/22/2005	19:00	Tract 3	4
8/23/2005	6:40	Alaska Farmers Coop	3
		Mean	**4**

Table 10. Regional subsistence harvest estimates for mid-continent greater white-fronted geese in Alaska (Alaska Migratory Bird Co-Management Council Website 2004; USFWS Koyukuk/Nowitna unpubl. data).

Region	Year(s)	Mean Annual Harvest
Northwest Arctic	1997-1998	2,871
Koyukuk/Nowitna	1998-2002	440
Kanuti	1999-2000	74
Innoko	2000	396
Upper Tanana River	2000	27
Yukon Flats	2000	1,420
North Slope	1992-1993	364
Total		5,592