Management Plan for Midcontinent Greater White-fronted Geese

Photo by Mike Wintroath

Prepared for the:
Central Flyway Council
Mississippi Flyway Council
Pacific Flyway Council
Canadian Wildlife Service
United States Fish and Wildlife Service

July 2015

Background

This plan was prepared by members of the White-fronted Goose Subcommittee of the Central Flyway Waterfowl Technical Committee, the Arctic Goose Committee of the Mississippi Flyway Game Bird Technical Section, and the Alaska Department of Fish and Game, with assistance from representatives of the Canadian Wildlife Service and U.S. Fish and Wildlife Service (see Participants section).

Midcontinent greater white-fronted geese migrate through many jurisdictions in three nations, and are of great interest to many individuals and organizations. The Central, Mississippi, and Pacific Flyway Councils solicit the cooperation of all who are responsible for and interested in the management of the international resource these geese comprise. Inquiries or comments may be addressed to:

Central Flyway Representative
U.S. Fish and Wildlife Service
755 Parfet Street, Suite 235
Lakewood, CO 80215

Mississippi Flyway Representative
U.S. Fish and Wildlife Service
5600 American Blvd., West, Suite 950
Bloomington, MN 55437-1458

Pacific Flyway Representative
U.S. Fish and Wildlife Service
1211 SE Cardinal Court, Suite 100
Vancouver, WA 98683

Approved by:

Chair, Central Flyway Council — Date 7/23/15

Chair, Mississippi Flyway Council — Date 7/23/15

Tony Wadley
Chair, Pacific Flyway Council — Date 8/4/15

Participants

Among the numerous individuals participating in the development of this management plan and harvest regulations guidelines were:

White-fronted Goose Subcommittee, Central Flyway Waterfowl Technical Committee:
Kevin Kraai, Chair, Texas Parks and Wildlife Department
Mike Johnson, North Dakota Game and Fish Department
Rocco Murano, South Dakota Game, Fish, and Parks Department
Mark Vrtiska, Nebraska Game and Parks Commission
Tom Bidrowski, Kansas Department of Wildlife, Parks and Tourism
Joshua Richardson, Oklahoma Department of Wildlife Conservation
Blake Bartzen, Canadian Wildlife Service
Jim Dubovsky, U. S. Fish and Wildlife Service
Jason Caswell, Alberta Sustainable Resource Development
Kathy Conkin – Saskatchewan Ministry of Environment

Arctic Goose Committee, Mississippi Flyway Game Bird Technical Section:
Frank Baldwin, Co-chair, Manitoba Department of Natural Resources
Luke Naylor, Co-chair, Arkansas Game and Fish Commission
Roy Domazlicky, Illinois Department of Natural Resources
Jim Leafloor, Canadian Wildlife Service
Larry Reynolds, Louisiana Department of Wildlife and Fisheries
Andy Raedeke, Missouri Department of Conservation
Orrin Jones, Iowa Department of Natural Resources
Jim Kelley, U. S. Fish and Wildlife Service

Pacific Flyway Study Committee
Dan Rosenberg, Alaska Department of Fish and Game

Other participants:
Pam Garretson, U. S. Fish and Wildlife Service
Terry Liddick, U. S. Fish and Wildlife Service
Dave Olsen, U. S. Fish and Wildlife Service
Doug Osborne, University of Arkansas, Monticello
Fred Roetker, U. S. Fish and Wildlife Service
Rich Schultheis, Kansas Department of Wildlife, Parks and Tourism

Table of Contents

Population Definition

For the purposes of this management plan, the midcontinent population of greater white-fronted geese (*Anser albifrons frontalis*; white-fronted geese or MCWFG) will include all white-fronted geese nesting in Canada, and in interior and northern Alaska that winter in the Central and Mississippi Flyways (Fig. 1). Prior to 2000, eastern and western components of the midcontinent population of greater white-fronted geese were managed independently, but extensive banding on the breeding grounds during the 1980s and 1990s indicated relatively little longitudinal variation in recovery distributions (AGJV 2008). Recent analyses indicate segments of the MCWFG throughout the breeding range exhibit spatial and temporal segregation during portions of the non-breeding period (Ely et al. 2013). Nonetheless, the birds have been managed as a single population shared by the Central, Mississippi and Pacific Flyways since that time. Most MCWFG migrate through Alberta and Saskatchewan in the fall. Migration stopovers include areas in prairie Canada, the eastern Central Flyway, and the western Mississippi Flyway, with primary wintering areas in the Gulf Coast marshes and prairies, the Mississippi River Alluvial Valley, and in Mexico. Major recreational harvest areas include Louisiana, Texas and Arkansas, where over 50 percent of the harvest occurs, and Kansas, Saskatchewan and Alberta Band recoveries from birds banded at the Mackenzie Delta and Queen Maud Gulf Migratory Bird Sanctuary reflect this distribution (Fig. 2). Additionally, subsistence harvest occurs in Alaska and the Northwest Territories.

Management Objective

The management objective is to maintain a midcontinent greater white-fronted goose population that allows optimum harvest opportunities in the Central and Mississippi Flyways and supports traditional subsistence harvest with consideration for special management options for identifiable and manageable segments or subunits within the population.

Population Monitoring Strategy

Population indices vary but generally indicate stable or increasing populations over the past several decades. The various indices span different time periods and trends in the different surveys do not always occur during the same times or in the same fashion. The annual fall survey in Prairie Canada has shown no significant trend in the population since 1992, but has shown an increasing trend in the most recent years, which is similar to the other survey estimates (Fig. 3). Estimates of population size that are derived from harvest estimates and banding data (Lincoln 1930, Alisauskas et al. 2009) show an approximately four-fold increase from 1975-2011. These increases occurred largely from 1995-2000, peaking in 2007, and then showing declines in the adult population estimate until 2012; the most recent estimates (2010-2012 three-year average) suggest a population size of about 2.2 million adults (Fig. 4; R. Alisauskas, unpublished data). The midwinter survey has shown a general steady linear increase over time since the beginning of the survey, increasing approximately four-fold since 1969 (Fig. 5). Increases in population indices in the breeding grounds of northern Alaska have occurred from 1986-2012, but primarily since 2005, while populations in interior Alaska remained relatively stable over the past decade (Figs. 6 and 7; Marks and Fischer 2015).

Because of differences in indicated population trends between two primary MCWFG monitoring programs – summer banding and the annual fall survey – maintaining both long-standing monitoring programs is recommended, at least during the next five-year update cycle of this plan. Information from these two programs will be used in harvest-management decisions.

Monitoring will include continuation of the annual fall survey conducted in Prairie Canada. Surveys of MCWFG are difficult or impossible except when the birds are relatively concentrated during fall migration in southwestern Saskatchewan and southeastern Alberta. Later during fall, winter, and spring, the population is more dispersed and intermingled with other goose species. The fall survey will be coordinated by the Canadian Wildlife Service, with assistance from provincial wildlife agencies, the U.S. Fish and Wildlife Service and the Central and Mississippi Flyway Councils. The U.S. Fish and Wildlife Service will provide two aircraft and pilots, and the Central and Mississippi Flyway Councils will provide one observer each, including travel expenses. Observer commitments should be considered long-term (5 or more years). If a change in observers is necessary, each Council will be responsible for expenses incurred in training a new observer for their respective flyway. Training would involve sending an "observer trainee", in addition to the regular observer for a period of one to three years. Ideally, any change in observers would be known for 3 years ahead of time for training a replacement. Consideration should be given to having two trained observers, in addition to those flying, in the event of unforeseen circumstances. Explicit assumptions and biases of the fall survey and a brief explanation of suggested steps to quantify and determine the influence of those biases along with suggested measures to address them are contained in Appendix 1. Appendix 1 also includes a thorough description of survey history and methods.

Monitoring also will include banding a representative sample of these geese on their breeding grounds in northern Canada and Alaska each year. Band recovery data provide consistent information to assess survival and harvest rates, temporal and geographic distribution of the harvest, and population size. Harvest management based only on population indices (i.e., fall survey) may become unreliable due to changing bird distribution and may not reflect changes in manageable subunits. Banding data provide a means to assess the overall success of population management and can be applied at regional scales. Banded samples should be adequate to provide statistically valid results and have sufficient distribution across breeding areas if analyses (e.g., harvest, survival) are intended to represent the whole MCWFG population (see Calvert 2010). Recoveries of these banded birds will provide information on distribution of harvest and, more importantly, annual survival and harvest rates. Additionally, age-specific harvests will be estimated annually in both the United States and Canada using tail feathers collected via the annual waterfowl parts collection survey. Finally, age-specific harvest estimates, when combined with band recovery data, allow estimation of the number of adult birds in the population, and the trend information can be used for monitoring the status of the population as has been proposed for several other species of arctic-nesting geese (Alisauskas et al. 2009, 2011, 2012).

A review of arctic goose banding program (Calvert 2010) indicated high precision of adult survivorship estimates from 1996-2008, likely due at least in part to a long period of record (typically over 100 recoveries per year for over a decade). However, as in many banding programs, questions remain about what the best representative sample of banded birds should be, both geographically and by cohort. These questions will be important to answer during the next five-year update cycle; however, existing banding data are sufficiently robust for use in this management plan. Guidelines for calculating demographic parameter(s) from banding and harvest data are found in Appendix 2.

Midwinter Survey estimates will continue to provide annual information on the distribution of white-fronted geese on concentration areas during winter. Experimental transect surveys of some arctic nesting areas were conducted from 2005-2011 to provide additional information about the distribution and abundance of white-fronted geese on arctic nesting areas in Canada, but this survey is not likely to become operational in the near future. Finally, monitoring will also include conducting surveys in select areas of the breeding range, including documenting population status and trends of breeding white-fronted geese in interior and Arctic Alaska.

Harvest Management Strategy

Population indices vary but generally indicate stable or increasing populations over the past several decades, with declining harvest rates over time despite long-term increases in harvest in the CF and MF. Recent experience suggests changes in regulations have little impact on actual harvest; however, the waterfowl management community has limited experience with more liberal MCWFG harvest regulations, the most recent being a brief period of regulations under a liberal framework in the mid-1990s. This liberalization and prior liberalization in the Central Flyway West Tier in the early 1990s coincided with a decline in the interior Alaska population (Marks and Fischer 2015).

In Canada goose management in the Mississippi Flyway, managers have taken incremental steps to simplify and liberalize regulations, measure impacts and adjust accordingly. This plan embraces this premise given current monitoring systems remain intact during a period of evaluation. Thus, a more risk-tolerant cooperative harvest management strategy was supported within a system of adaptive management. This strategy would include: (1) use of a minimum population threshold approach, as indicated by the fall survey; (2) harvest management decisions based on an annual assessment of harvest rates and trend data at spatial and temporal scales consistent with management objectives; (3) stable regulations whenever possible; and, (4) flexibility to use an aggregate dark goose bag limit in some provinces and states with low annual harvest.

From 2002 through 2011, annual harvest rates of midcontinent adult white-fronted geese averaged 4.4%, and appear to have declined markedly since the late 1970s, although they have been relatively stable since 1989 (Fig. 8). Adult harvest rates have exceeded 6% only four times since 1989 (in 1992, 1997, 1999, and 2004). Estimated harvests of white-fronted geese in states of the Mississippi Flyway appear to have increased over time and averaged about 98,000 birds per year from 2010-2014 (Fig. 9). Annual harvests averaged about 94,000 birds annually from 2010-2014 in the Central Flyway, and also showed a

long-term increase (Fig. 10). Combined U.S. harvests of MCWFG averaged approximately 67,000 birds per year in the 1970s, but increased to about 193,000 birds annually from 2010-2014 (Fig. 11). Harvests in Canada averaged about 71,000 birds per year from 2010-2014. Almost all of the Canadian harvest occurs in the provinces of Alberta and Saskatchewan, and although estimated harvests have been more erratic in recent years, there has been an increase in harvest in Canada (Fig. 12) despite substantial declines in sales of migratory game bird hunting permits. Total MCWFG harvest also has increased over time, averaging ~125,000 birds from 1975-1979, and 265,000 annually from 2010-2014 (Fig. 13).

The use of harvest rates in a revised harvest management strategy and regulatory frameworks will require an evaluation of harvest potential for midcontinent greater white-fronted geese that includes evaluations for identifiable subunits. The flyways will work cooperatively with the U.S. Fish and Wildlife Service and the Harvest Management Working Group to ensure this evaluation is completed in a timely manner.

In the interim, a harvest rate of 6% - calculated as the most recent three-year average harvest rate point estimate – will be used as a trigger in MCWFG harvest management. The 6% harvest rate objective was selected because harvest rates higher than this have been sustainable for the management of other goose populations in North America, including some in the Mississippi Flyway (e.g., see Table 3 in Zimmerman et al. 2009).

There is evidence that harvest rates were likely much higher in the past (1975-1979; Fig. 8). The number of white-fronted geese likely has increased over the past several decades under existing harvest rates, despite increasing harvest totals in all parts of their range during that time. Because harvest rates currently are well below the stated threshold of 6% in both flyways, it is unknown whether harvest at proposed levels will negatively impact the population or have disproportionate effects in specific management subunits. However, if the harvest rate for white-fronted geese should approach or exceed 6%, or the harvest potential analysis is not completed by September 2016, then harvest strategies and regulations in both the Central and Mississippi Flyways may need to be revisited and revised, and these discussions should include the Canadian Wildlife Service and the Provinces of Alberta and Saskatchewan.

The MCWFG harvest management strategy also will use a minimum threshold of 600,000 geese, calculated as the most recent three-year average of the fall survey population estimate. Since 1992, MCWFG population indices have ranged from 522,812 to 1,129,400 and have fallen below 600,000 only three times (in 2003, 2005 and 2009). The most recent three-year average population index (2012-2014, excluding 2013 because no survey was conducted) was 891,000.

Regulatory Frameworks

Population impact of liberalizations will be measured from a combination of the fall survey (most recent 3-yr running average) and banding data (most recent three-year average harvest rate point estimate), both of which would have to change to take regulatory action. Each flyway will consider season framework

dates independently and states must choose a single framework statewide each year.

Regulatory frameworks for midcontinent greater white-fronted geese are as follows:

- Canada: 107 days and 5 birds per day daily bag
  - Consider restrictions if the most recent fall survey 3-year average was below 600,000 and the 3-year average harvest rate point estimate was above 6%
- Alaska: 107 days and 4 birds per day daily bag
- West Tier Central Flyway (except Texas West Goose Zone): 107 days and 5 birds per day daily bag, in aggregate with dark geese
- Texas West Goose Zone: 95 days and 2 birds per day daily bag
- Low-harvest Mississippi Flyway states (most recent 5-year average harvest <500 white-fronted geese annually): up to 107 days and 5 birds per day daily bag, in aggregate with dark geese
- Balance of Central and Mississippi Flyway states
  - *Standard Package*: 88 days and 2 birds per day daily bag OR 74 days and 3 birds per day daily bag OR 107 days and 1 bird per day daily bag
    - Offered when the most recent three-year average fall survey estimate is above 600,000 AND the most recent three-year average harvest rate point estimate is below 6%
  - *Restrictive Package*: 88 days and 1 bird per day daily bag OR 74 days and 2 birds per day daily bag
    - Offered when the most recent three-year average fall survey estimate is below 600,000 AND the most recent three-year average harvest rate point estimate is above 6%.
  - *Closed Season*
    - Considered jointly by all partners in this plan when the most recent three-year average fall survey estimate is below 250,000

Maintenance of Plan

This plan will be reviewed at 5-year intervals (2020, 2025, etc.) by the Central, Mississippi, and Pacific Flyway Councils, their technical committees, and representatives from the Canadian Wildlife Service and U.S. Fish and Wildlife Service. Participation by Mexico in future plan revisions will also be encouraged. All available information will be considered and necessary modifications to this plan will be developed and presented to all 3 Flyway Councils for consideration and appropriate action. Appendices containing information on annual data collection programs will be updated annually and distributed through appropriate contacts before the July Flyway Council meetings. These updates will be provided by the Chair of the Central Flyway White-fronted Goose Subcommittee.

Literature Cited

ALISAUSKAS, R. T., K. L. DRAKE, AND J. D. NICHOLS. 2009. Filling a void: abundance estimation of North American populations of arctic geese using hunter recoveries. Pages 465-492 in Thomson, D. L., E. G. Cooch, and M. J. Conroy (editors). Modeling Demographic Processes in Marked Populations. Environmental and Ecological Statistics 3:465-492.

ALISAUSKAS, R. T., R. F. ROCKWELL, K. W. DUFOUR, E. G. COOCH, G. ZIMMERMAN, K. L. DRAKE, J. O. LEAFLOOR, T. J. MOSER, E. T. REED. 2011. Harvest, survival, and abundance of midcontinent lesser snow geese relative to population reduction efforts. Wildlife Monographs 179:1-42.

ALISAUSKAS, R. T., J. O. LEAFLOOR, AND D. K. KELLETT. 2012. Population status of midcontinent Lesser Snow Geese and Ross's Geese following special conservation measures. Pages 132-177 in Leafloor, J. O., T. J. Moser, and B. D. J. Batt (editors). Evaluation of special management measures for midcontinent lesser snow geese and Ross's geese. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C. and Canadian Wildlife Service, Ottawa, Ontario.

ARCTIC GOOSE JOINT VENTURE. 2008. *Arctic Goose Joint Venture Strategic Plan: 2008-2012*. Unpublished Report, c/o AGJV Coordination Office, CWS, Edmonton, Alberta. 112 pages.

CALVERT, A.M. 2010. REVIEW OF ARCTIC GOOSE BANDING PROGRAMS: CONTRIBUTION TO THE AVIAN MONITORING REVIEW. UNPUBLISHED REPORT TO ENVIRONMENT CANADA, OTTAWA ON, 58 PAGES.

Ely, C. R., D. J. Neiman, R. T. Alisauskas, J. A. Schmutz, and J. E. Hines. 2013. Geographic variation in migration chronology and winter distribution of midcontinent greater white-fronted geese. J. Wildl. Mang. 77:1182-1191.

LINCOLN, F. C. 1930. Calculating waterfowl abundance on the basis of banding returns. Circular 118, U.S. Department of Agriculture, Washington, D.C.

Marks, D.K. and J. B. Fischer. 2015. Midcontinent greater white-fronted geese in Alaska: Annual summary of monitoring and research 2014. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage. 42pp.

ZIMMERMAN, G. S., T. J. MOSER, W. L. KENDALL, P. F. DOHERTY, G. C. WHITE, AND D. F. CASWELL. 2009. Factors influencing reporting and harvest probabilities in North American geese. Journal of Wildlife Management 73:710-719.

Figure 1. Approximate breeding range of midcontinent greater white-fronted geese.

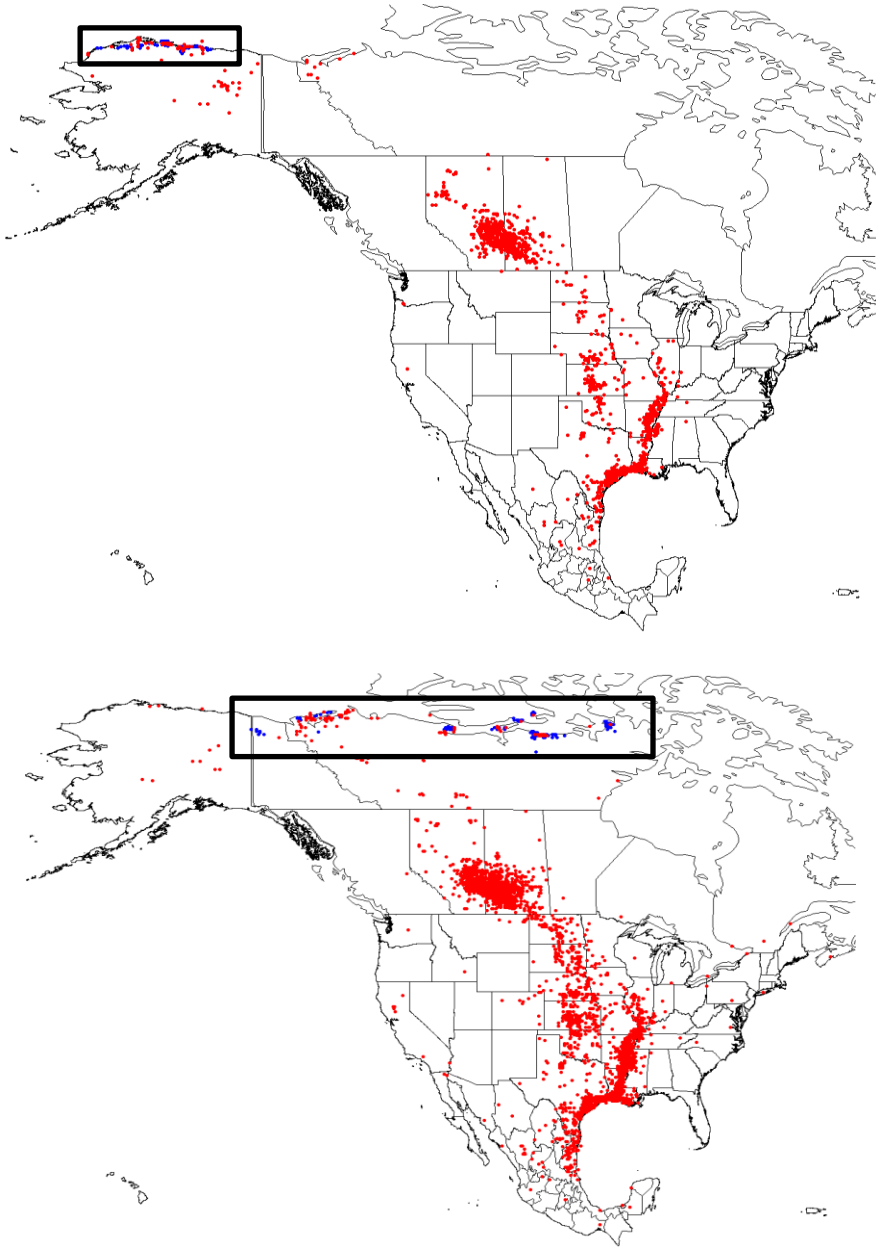


Figure 2. Banding and recovery locations of all midcontinent GWFG banded in arctic North America; Alaska Arctic Coastal Plain (top,rectangle, n=3,789 recoveries) and Canada arctic (bottom, n=11,992 recoveries) . Banding locations in blue, individual recovery locations, red. Data from Game Bird encounters database, USGS Bird Banding Laboratory, Patuxant, MD.

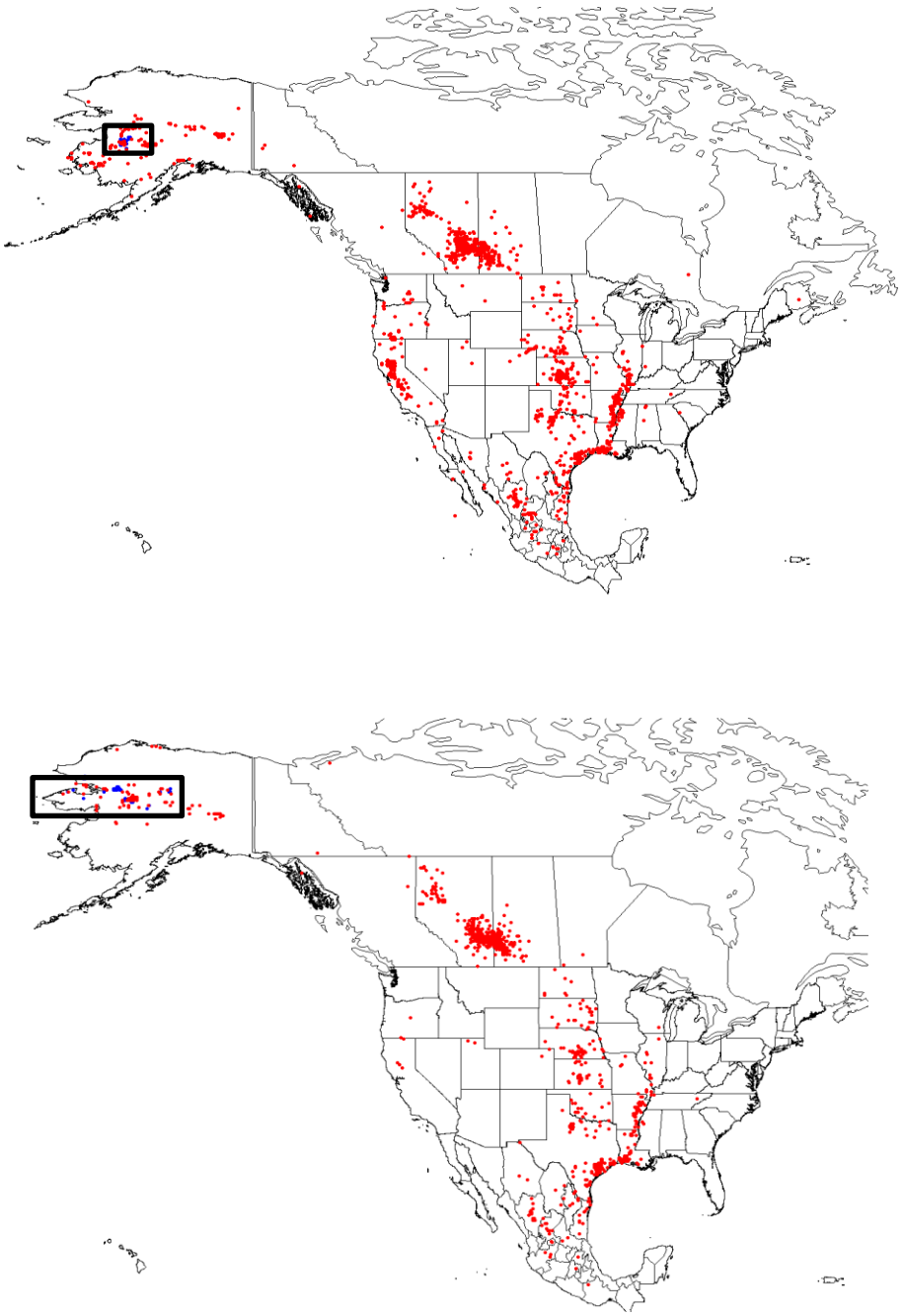


Figure 2 (continued). Banding and recovery locations of all midcontinent GWFG banded in interior Alaska; Innoko NWR (top, rectangle, n=2,484 recoveries) and other interior (Koyukuk-Nowitna,Kanuti and Selawik NWR, Seward Peninsula and Noatak River delta, bottom, n=2,166

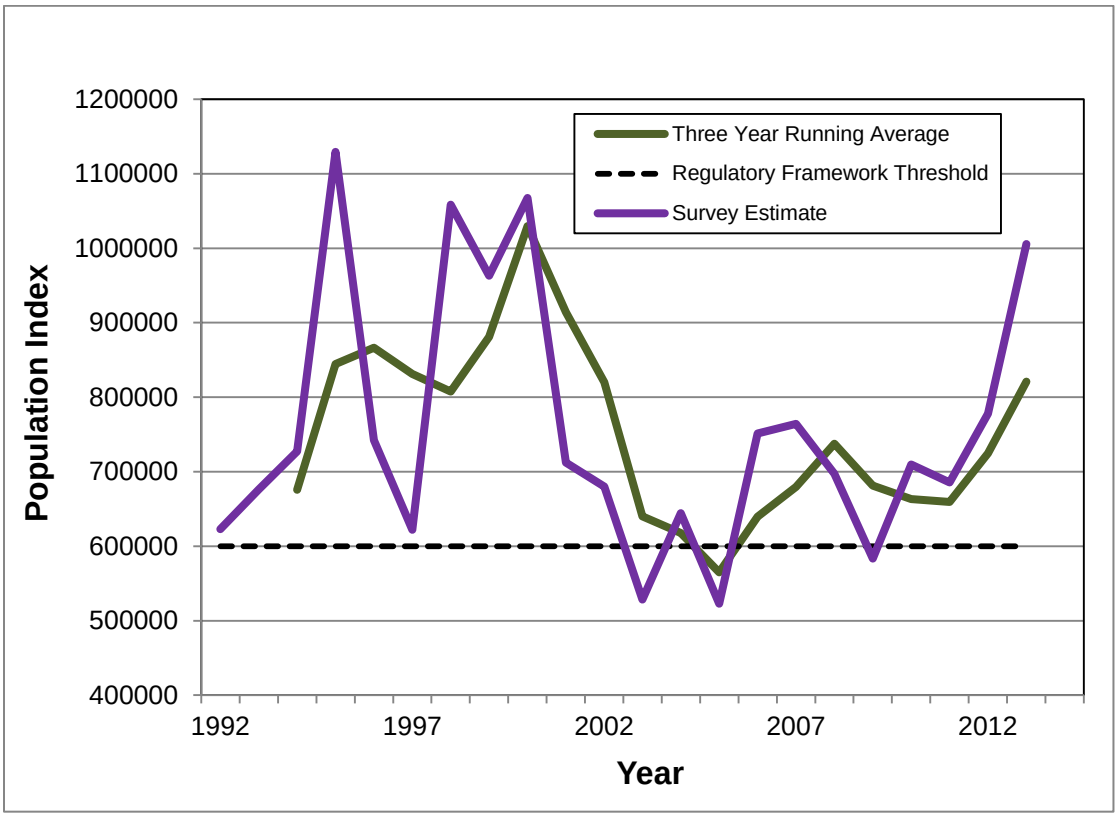


Figure 3. Population index for midcontinent greater white-fronted geese as determined by annual fall surveys in Prairie Canada.

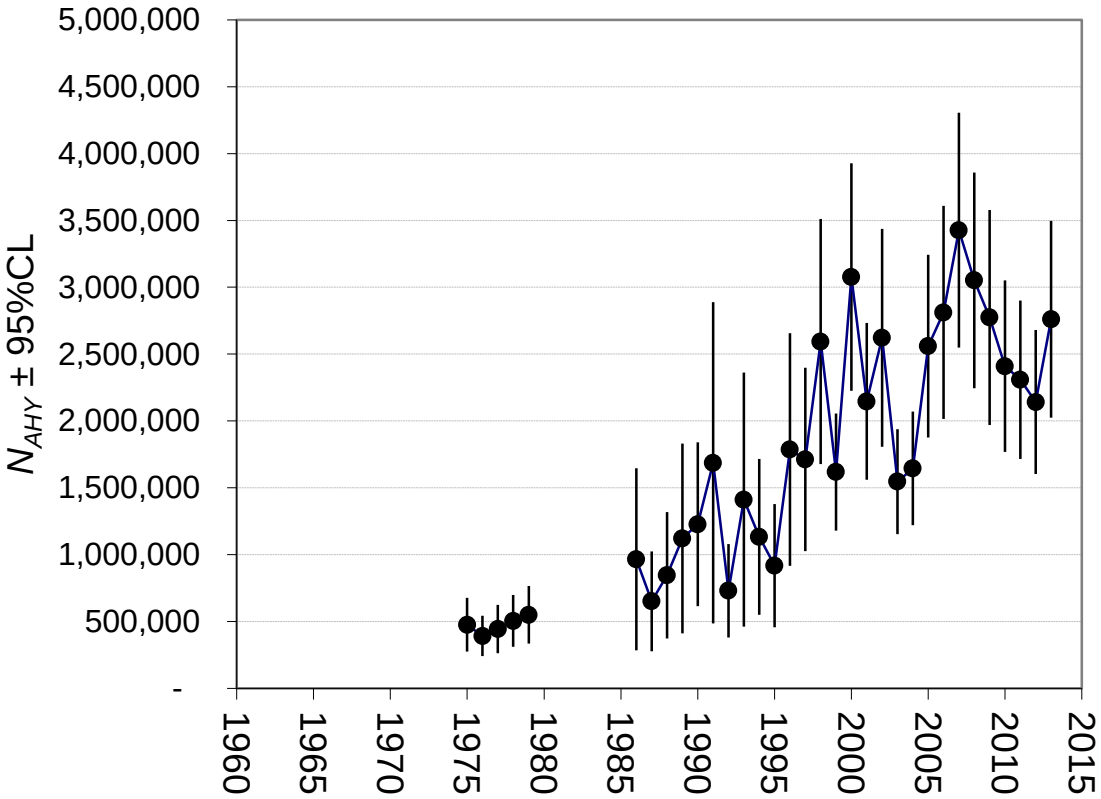


Figure 4. Population index for midcontinent greater white-fronted geese as determined by Lincoln's estimates (see Appendix 2).

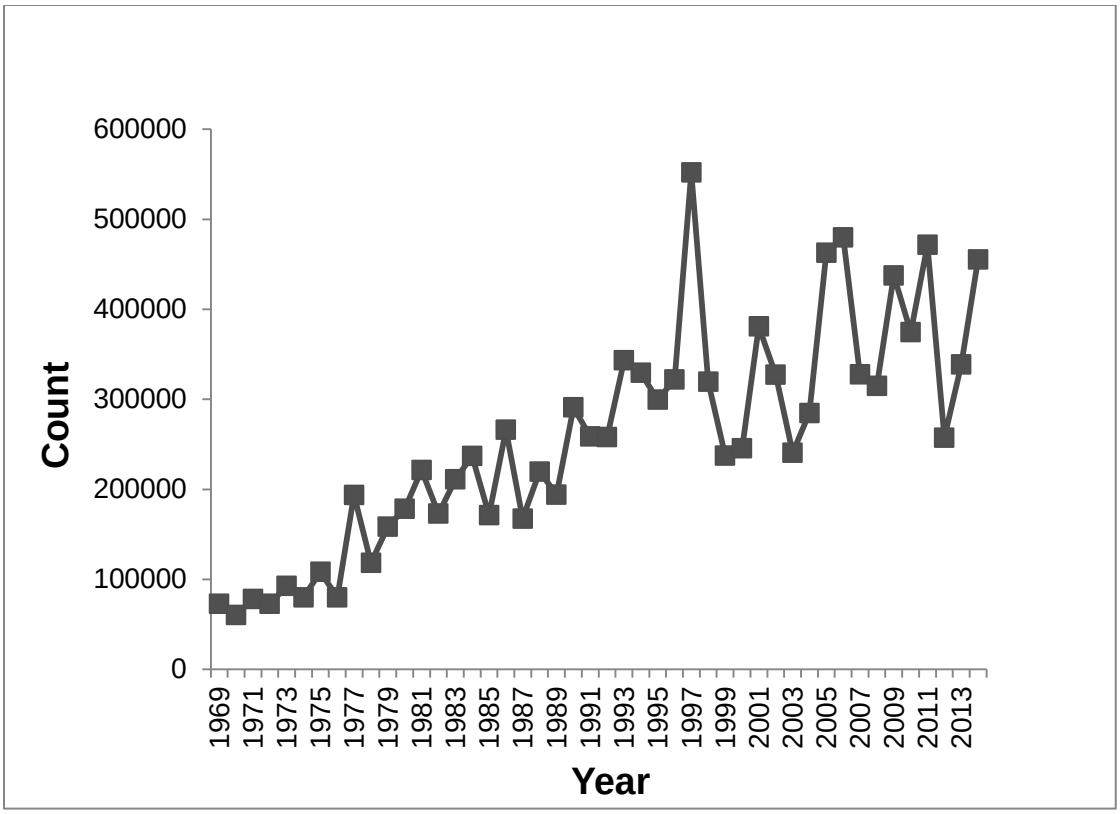
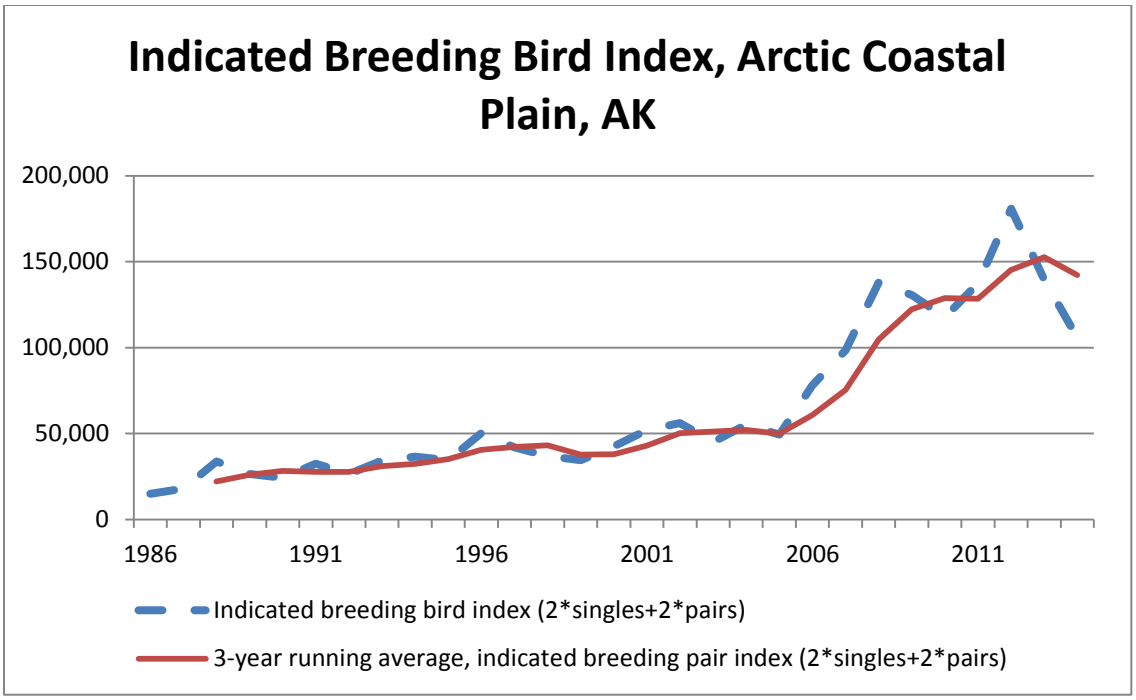


Figure 5. Midwinter counts of midcontinent greater white-fronted geese in the Central and Mississippi Flyways, 1969-2014.



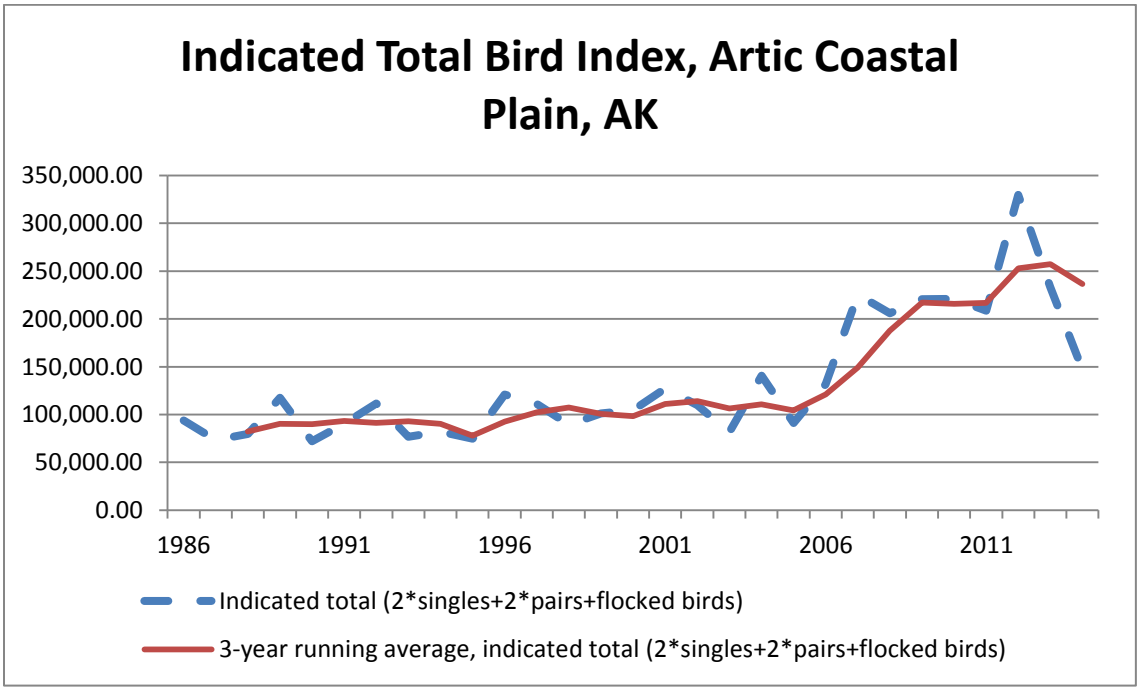
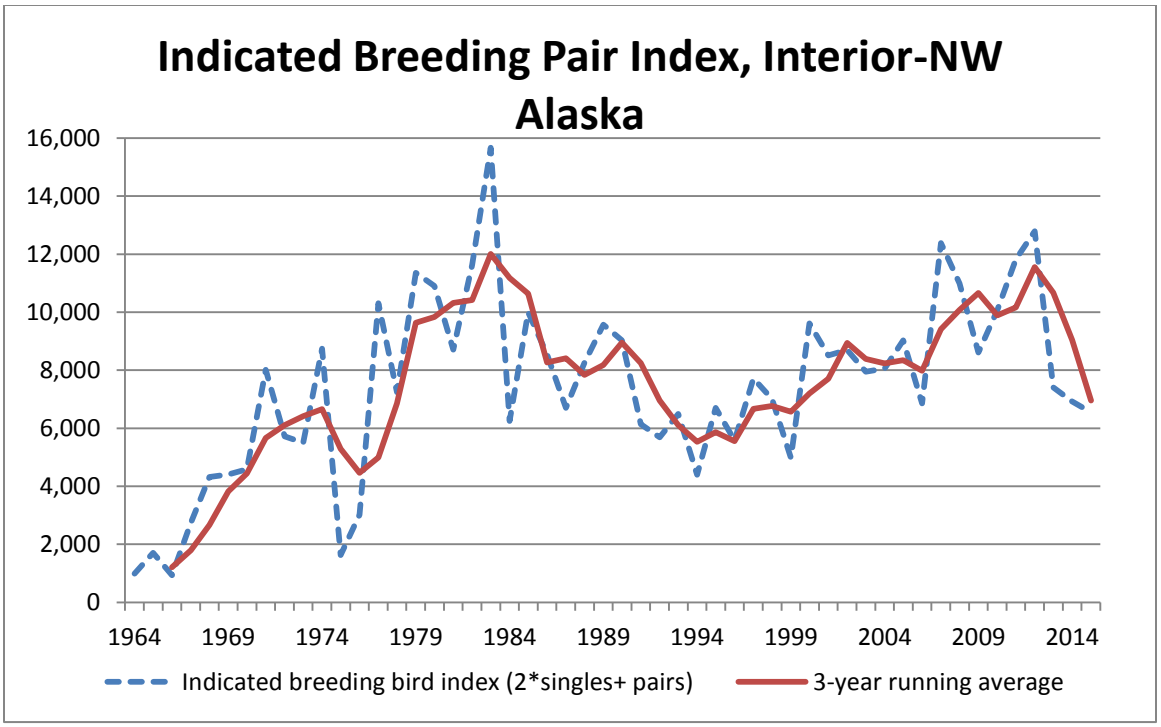


Figure 6. Indicated breeding pair and total bird indices of mid-continent greater white-fronted geese estimated during spring breeding pair surveys in interior and northwest Alaska, 1986-2014. Annual point estimates connected with dashed lines, 3-year running averages connected with solid bold lines. Indices the Arctic Coastal Plain Breeding Pair Survey (Unpubl. Data, USFWS-R7 MBM).



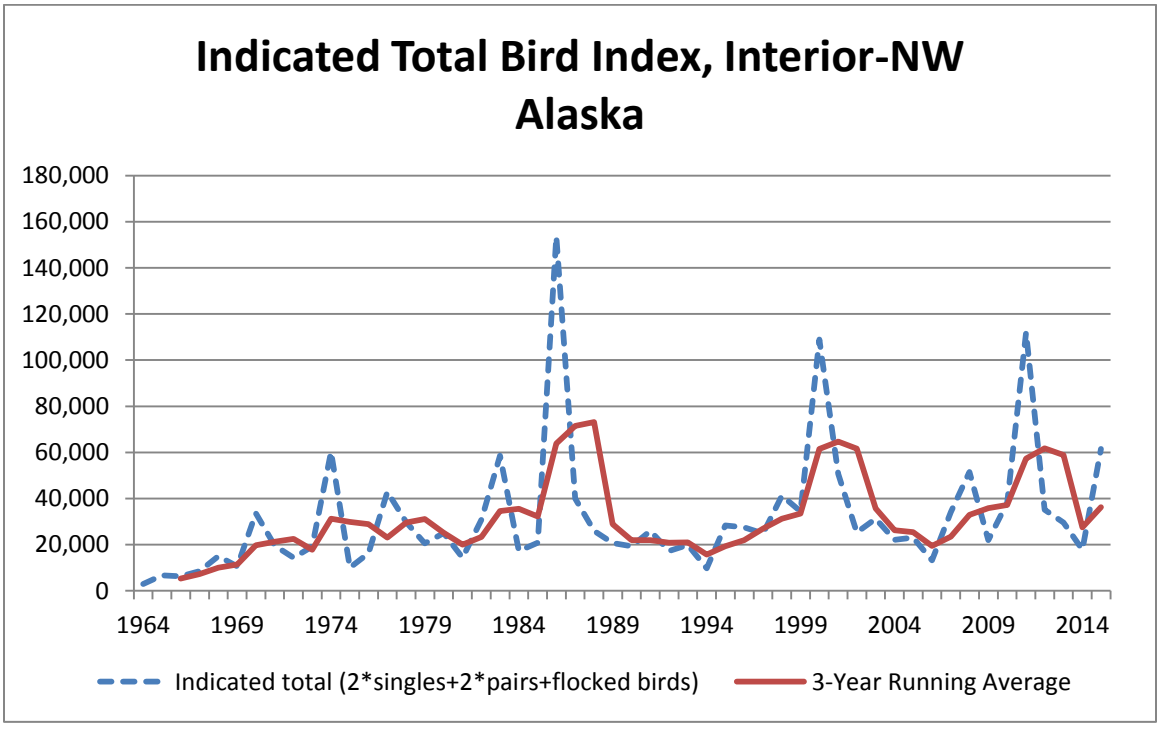


Figure 7. Indicated breeding pair and total bird indices of mid-continent greater white-fronted geese estimated during spring breeding pair surveys in interior and northwest Alaska, 1964-2015. Annual point estimates connected with dashed lines, 3-year running averages connected with solid bold lines. Indices derived from strata 3-6, 11 in the North American Waterfowl Breeding Population and Habitat Survey (Unpubl. Data, USFWS-R7 MBM).

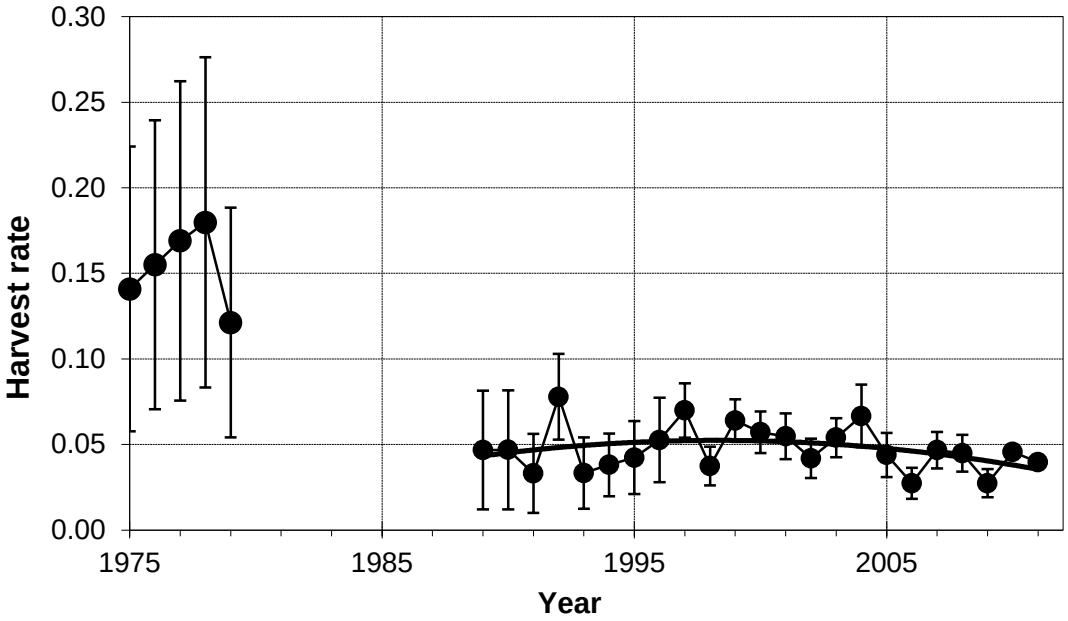


Figure 8. Estimates of harvest rate of adult midcontinent white-fronted geese banded on arctic nesting areas, 1975-2011.

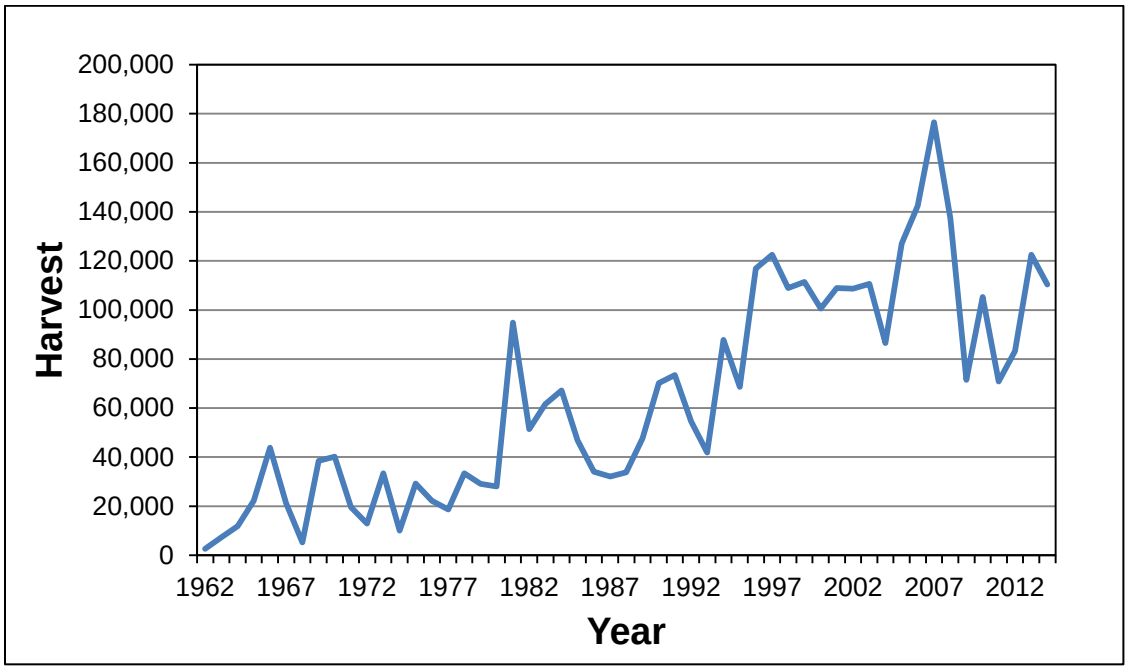


Figure 9. Annual harvest of midcontinent greater white-fronted geese in the Mississippi Flyway, 1962-2014.

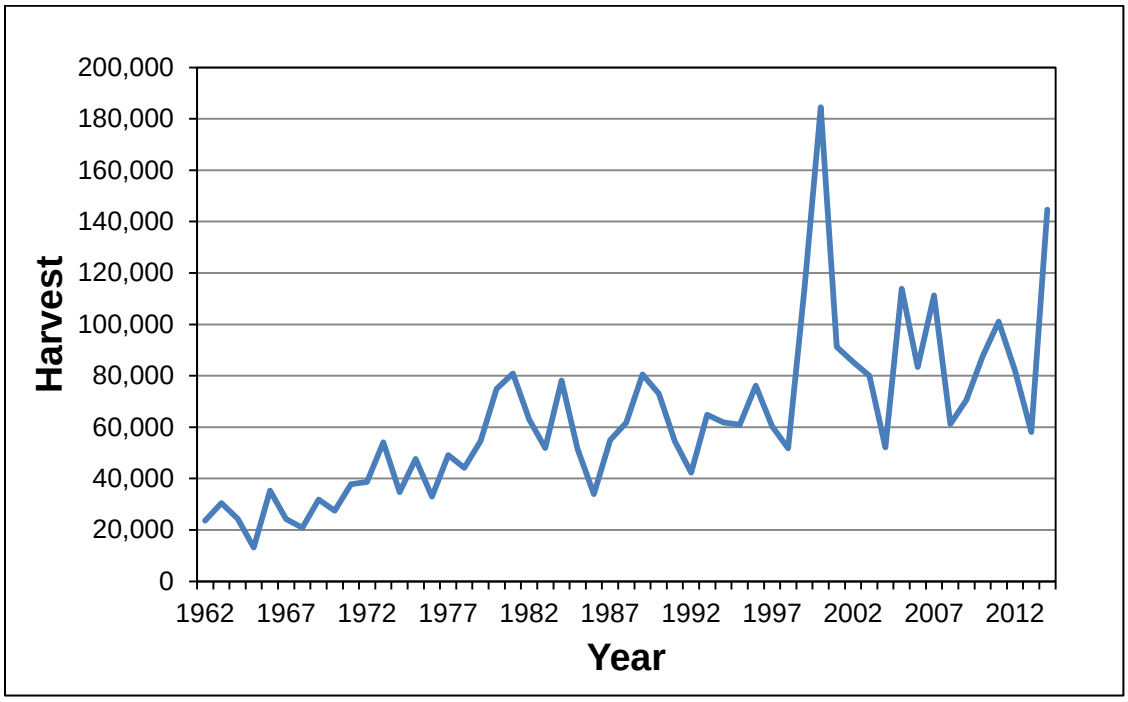


Figure 10. Annual harvest of midcontinent greater white-fronted geese in the Central Flyway, 1962-2014.

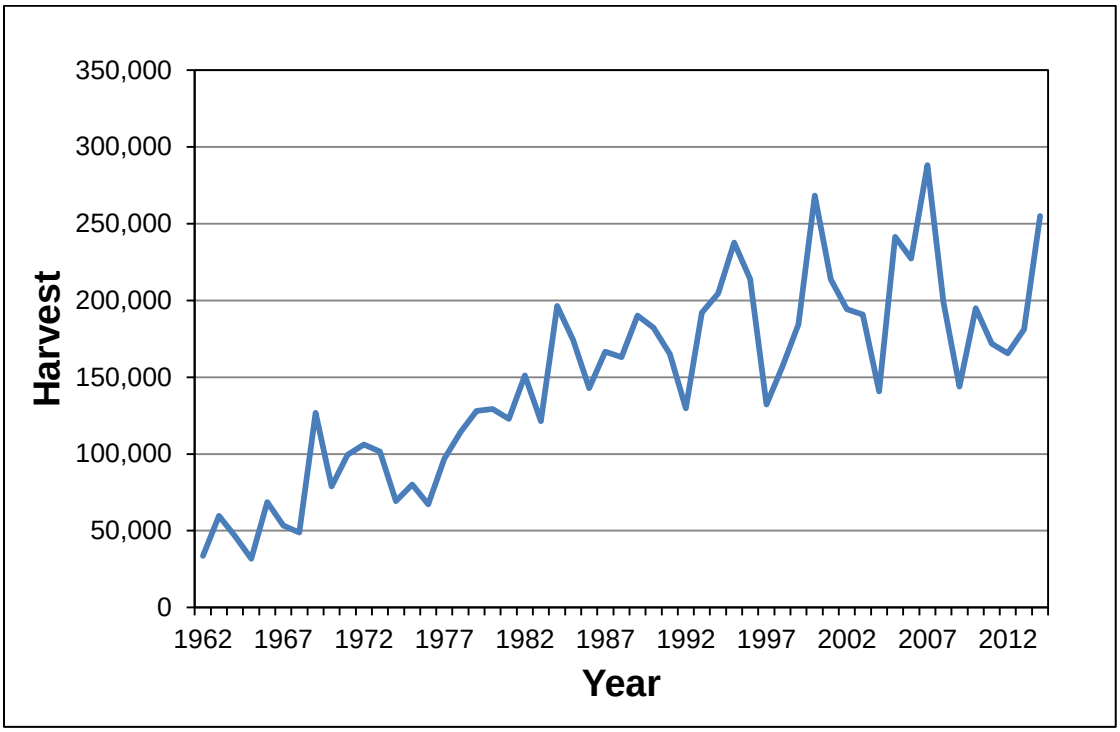


Figure 11. Annual harvests of midcontinent greater white-fronted geese in states of the Central and Mississippi Flyways, 1962-2014.

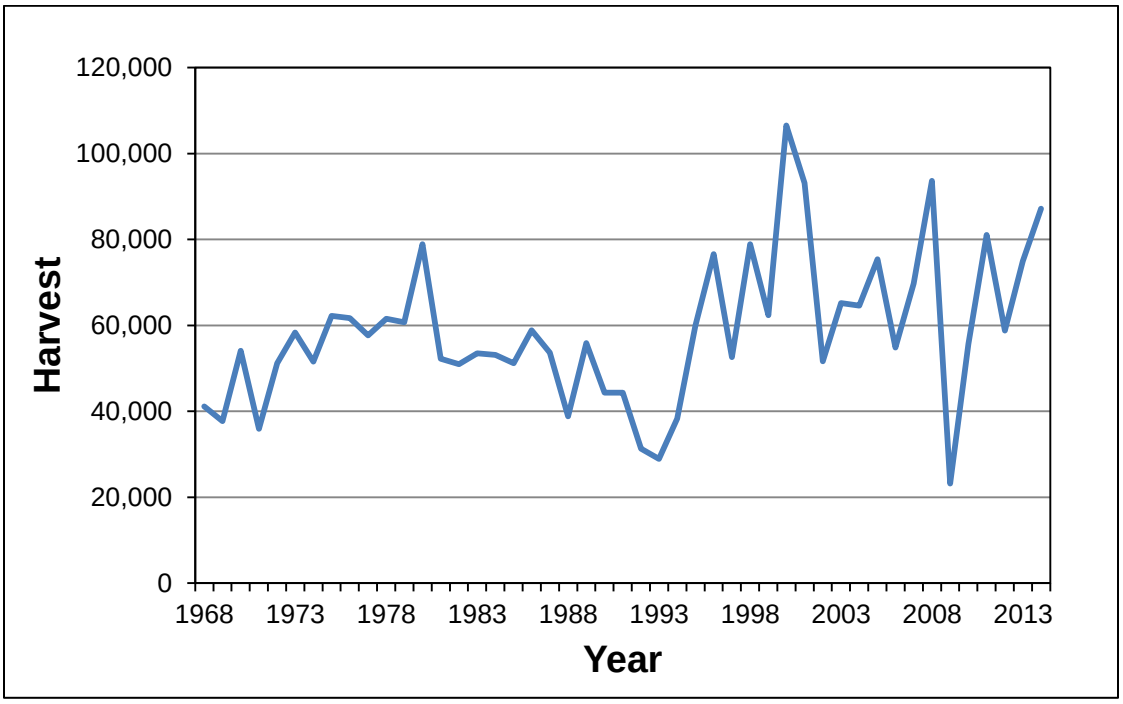


Figure 12. Annual harvests of midcontinent white-fronted geese in Alberta and Saskatchewan, Canada, 1975-2014.

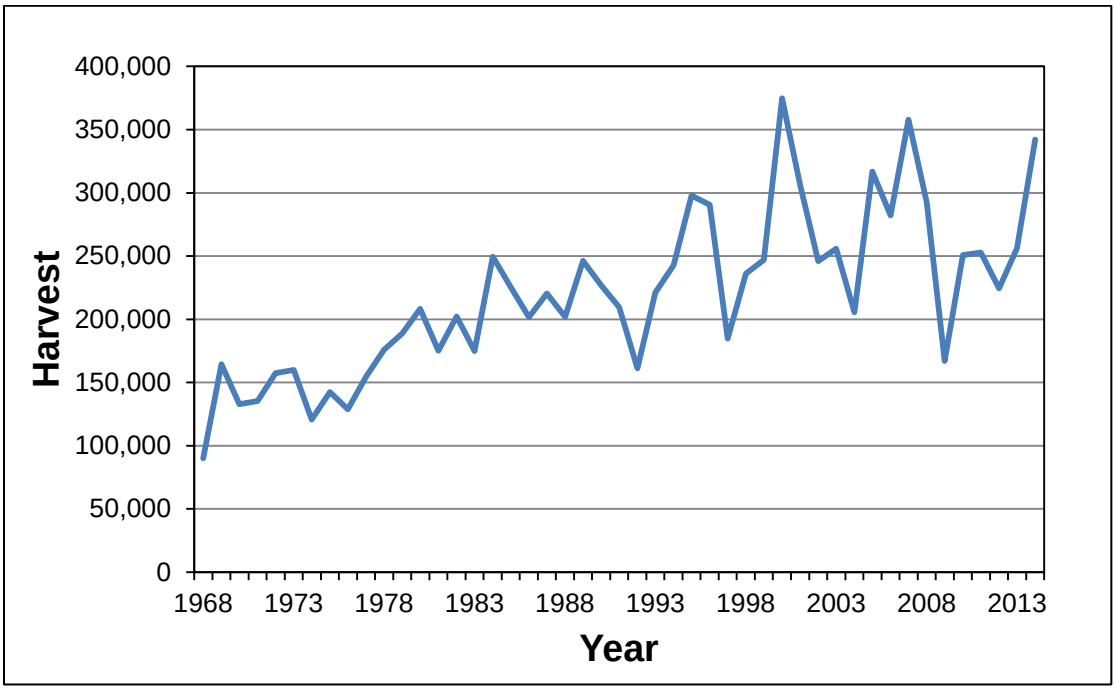


Figure 13. Total annual harvest of midcontinent greater white-fronted geese, 1968-2014.

Appendix 1. Midcontinent greater white-fronted goose fall survey SOP

Abbreviated methods of the Fall Inventory of Mid-continent Greater White-fronted Geese

The general survey area, and the locations of specific wetlands within Alberta and Saskatchewan, which supported or had the potential to support fall staging white-fronted geese were identified in 1992 prior to the first year of the survey (Nieman and Gollop 1993). With changes in distribution of wetlands and white-fronted geese, the survey area and number of wetlands has generally increased over time. All areas and wetlands were delineated on 1:250,000 scale Universal Transverse Mercator topographic maps and given unique identifiers to aid in navigation and to make the survey repeatable on an annual basis.

Up to two weeks prior to the aerial survey, ground personnel conduct reconnaissance in the survey area to get an indication of habitat conditions and distribution of geese. Ground personnel survey not only areas known to have geese but also areas not traditionally included in the survey in the event that distribution of geese has changed. Prior to the aerial survey, ground personnel brief the aerial survey crews on the current conditions and apprise them of areas where additional surveying may be required because of atypical distribution of geese.

Based on peak abundance of white-fronted geese, it is recommended that the aerial survey take place sometime from September 24 to October 4, but survey dates have ranged from September 21 to October 7 for the survey start and completion, respectively. The survey begins in eastern Saskatchewan and proceeds westward into eastern Alberta (Figure 1). Since 2001, a single day of survey has been conducted in the Peace River region of northwestern Alberta. Six days of surveying are required to complete the survey, but the survey usually requires more time because of inclement weather.

Two aircraft, each with a pilot-biologist and observer, are used during the survey. For consistency and familiarity of the region, it is important to maintain the same pilot and observer personnel as much as possible. If a personnel change is anticipated in advance, it is ideal if there can be 2-3 years when replacement personnel travel with the aerial crew to become familiar with the survey and techniques used. Each crew is assigned specific areas to survey and given the maps with all the survey areas marked. The marked areas are surveyed each year with crews travelling along similar routes between years, but additional areas are surveyed in years with unusual habitat conditions or distribution of geese. All white-fronted geese detected during the survey are recorded, and in the case where they are not on an identified survey wetland or area, they are assigned to the nearest one. The actual survey takes place from 10:00-14:00 daily to ensure that the maximum number of geese have returned from feeding in nearby fields. On cool, cloudy days, geese do not consistently return to water for a break from feeding, and, thus, surveys do not take place on those types of days.

In some years, more than half of the white-fronted geese surveyed on the fall count occur on a portion of South Saskatchewan River between the Alberta – Saskatchewan border and Lake Diefenbaker, Saskatchewan. Consequently, a ground crew is deployed to count white-fronted geese on that portion of the survey. Ground crews position at particular locations where geese funnel through from feeding in the fields in early morning to return to the River. The ground personnel communicate with each other during the survey to ensure geese are not being missed or double-counted. To facilitate the counts, geese are counted as they fly towards the River in smaller groups, and they are not counted in the larger groups once they are on the river, as they are more difficult to count then. Typically, the ground surveys are conducted twice. The purpose of the first survey is to ensure that crews are in good positions to count incoming geese. If necessary, crews make adjustments to their positions during the first survey with the impetus being that those adjustments will not be necessary on the second day; thereby, allowing the crews to focus on counting in the second survey. The second survey occurs on the morning prior to aerial survey of that portion of the river, which occurs mid-day. In wetter years, ground crews are not deployed for a ground count because the geese do not concentrate on the River because of the availability of water elsewhere.

Once the survey is completed, the counts are tallied to produce an annual fall count number. In the years when a ground count is conducted, the ground count substitutes the aerial count for that portion of the survey. For management purposes, the most recent three years are averaged together to produce three-year average.

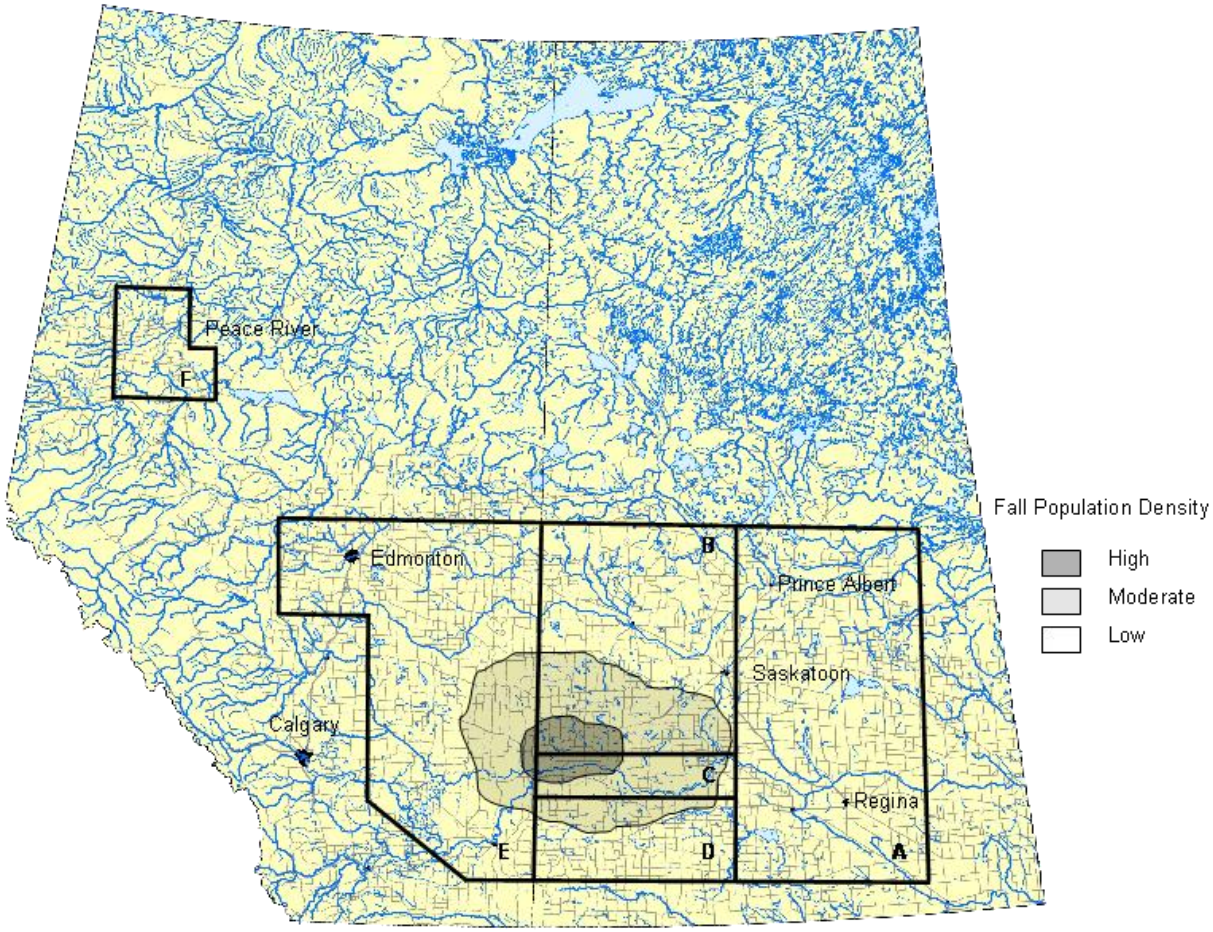


Figure 1. Greater white-fronted goose survey regions (A-F) comprising important late-September staging areas.

Appendix 2. Guidelines for calculating demographic parameters

Calculating Lincoln Estimates of Population Size for Midcontinent White-fronted Geese

J. O. Leafloor
Canadian Wildlife Service
July 20, 2015

Alisauskas et al. (2009) suggested that Lincoln's (1930) approach could be used to estimate population size of several species of arctic-nesting geese for which band recovery data and age-specific harvest estimates were available. This method can be used to estimate population size of adult birds in August (i.e., at the time of banding), and a summary of the general methodology based on Lincoln (1930) and Alisauskas et al. (2009) is provided below.

Population size is calculated indirectly using the following relationship: N=H/*h*. Harvest rate (*h*) is the proportion of the population (N) that is harvested by hunters (H = harvest), or

$$(1)\quad h = H/N.$$

Harvest rate can be calculated using band recovery data as:

$$(2)\quad h = DRR/r,$$

where DRR is direct recovery rate, and *r* is band reporting rate. For example, if 2% of a population of adult geese is shot and reported in the first hunting season after banding (DRR = 0.02), and only half of the bands are reported (*r* = 0.5), then the actual harvest rate of adults is 0.04 (*h* = DRR/*r* = 0.02/0.5 = 0.04). In this example, 4% of the adult population was shot by hunters in the first hunting season following banding. If we also estimated the number of adults harvested (H), then we would know that this harvest must equal 4% of the population size at the time of banding. To continue with this theoretical example, if the harvest of adult geese was 10,000 birds, then we would know that 10,000 adults represented 4% of the population (because harvest rate, *h*, is the proportion of the population harvested by hunters, or H/N). Substituting what we know into equation (1), *h* = H/N, or 0.04 = 10,000/N. If we rearrange this equation to find N, we get N = H/*h* = 10,000/0.04 = 250,000. In this example, population size at the time of banding was 250,000 adults.

So, in order to calculate population size, we require the following: (1) estimate of DRR from banding data; (2) estimate of reporting rate (*r*) from reward band studies; and, (3) an estimate of age-specific harvest (H). Lincoln estimates require an assumption of population closure, so harvest estimates should be derived from the same geographic area as are band recovery and reporting rate data (Alisauskas et al. 2009). Ultimately, we are

estimating the size of the population that contributes birds to the harvest in that geographic area.

Reward band studies have shown that reporting rates can vary geographically but do not tend to vary much by species in the same geographic areas (e.g., Nichols et al. 1995; Zimmerman et al. 2009), so reporting rate estimates of midcontinent mallards, for example, can be used as a proxy for midcontinent goose band reporting rates in years for which no goose reward band studies were done (e.g., Alisauskas et al. 2009, 2011). Once we obtain estimates of DRR from banding data, and *r* from reward band studies, we can estimate harvest rate using equation 2 above.

To estimate adult population size of midcontinent white-fronted geese at the time of banding, we used only harvest estimates (H) of adult birds, and direct band recoveries from birds banded as adults that were recovered in the same geographic areas for which harvest estimates were used. Specifically, we used only band recoveries and harvest estimates from SK and AB, and states of the Central and Mississippi Flyways. This constitutes the vast majority of the continental harvest and band recoveries for this population of geese.

Annual estimates of white-fronted goose harvests were available from Alberta and Saskatchewan, Canada from 1971 to present, and for the Central and Mississippi Flyways since 1962. In Canada, harvests of white-fronted geese were estimated by zone, as were age ratios from tail fans submitted by hunters for the Species Composition Survey (Cooch et al. 1978, Johnson et al. 2012). Numbers of adult and juvenile tail fans for white-fronted geese were used to determine age ratios of harvested geese. To calculate harvest estimates for adult white-fronted geese, the total harvest in each province was multiplied by the proportion of adults in that province based on age ratios from the Species Composition Survey. Provincial totals were then summed to get total harvest (H) of adult white-fronted geese in prairie Canada.

Similarly, age-specific harvest estimates for cackling geese in the Central and Mississippi Flyways were obtained by summing the estimates by state (USFWS, unpubl. data). Harvest estimates of adult white-fronted geese in the Central and Mississippi Flyway were then added to the number of adults harvested in prairie Canada to obtain the total harvest (H) of adult white-fronted geese. These values were used in the final calculation of Lincoln estimates of population size.

To calculate Lincoln estimates of population size, we first obtained data for all adult white-fronted geese banded on the breeding grounds during the months of July and August from 1975 to present. We calculated the direct recovery rate as the number of direct recoveries that occurred in prairie Canada and the Central and Mississippi Flyway each year, divided by the number of adults banded each year. To calculate annual harvest rates (*h*), we divided direct recovery rates of adult white-fronted geese by year-specific reporting rates for geese in the Central and Mississippi Flyway (these were modelled estimates based on all previously published estimates of reporting rates for geese in North America; Alisauskas et al., in prep.). Lincoln estimates of population size were

calculated as N=H/*h*, where H was the total annual harvest of adult white-fronted geese in AB, SK, and states of the Central and Mississippi Flyways, and *h* was the harvest rate for that year. However, Padding and Royle (2012) suggested that goose harvest estimates in the United States were biased high, and recommended using a multiplicative adjustment factor of 0.67 to correct estimates based on the harvest questionnaire survey for years prior to 1999, and to use an adjustment of 0.61 for HIP-based estimates of harvest from 1999 onward. To be conservative, harvest estimates from both the United States and Canada were adjusted by these factors before the final Lincoln estimates were calculated.

Here is an example of the calculation of Lincoln estimates using real data for midcontinent white-fronted geese: In 2013, 4214 adult white-fronted geese were banded, of which 124 were shot and reported from the prairie provinces and midcontinent states of the Mississippi and Central Flyways during the first hunting season after banding, for a direct recovery rate (DRR) of 124/4214 = 0.02943. Using the latest available reporting rates for midcontinent geese, the reporting rate (*r*) was 0.752808 (Alisauskas et al., unpublished data). Harvest rate (*h*) was therefore DRR/*r* = 0.02943/0.752808=0.03909. Harvest (H) of adult white-fronted geese in the midcontinent harvest area was 178,234 adults. After multiplying this estimate by 0.61 to account for potential bias in harvest estimates (Padding and Royle 2012), the harvest estimate declined to 108,723 adult white-fronted geese. Population size was then calculated as H/*h* = 108,723/0.03909 =~2.78 million adult white-fronted geese in August, 2013 (estimates in the text differ slightly from those in the spreadsheet due to rounding).

Looking at trends in population size for all years where sufficient data were available, it appears that midcontinent white-fronted geese have increased markedly since the 1970s based on Lincoln estimates. The population estimates averaged about 474,000 birds from 1975-1979, and about 2.5 million adults from 2009-2013 (Figure 1).

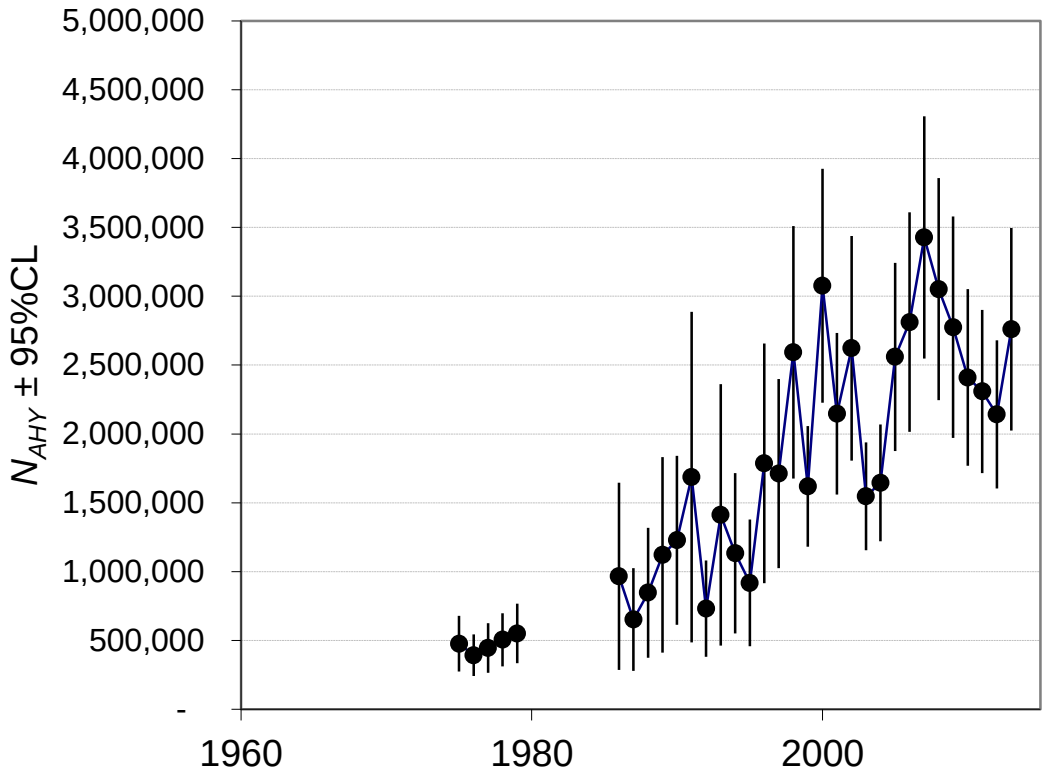


Figure 1. Lincoln estimates of population size in August for adult midcontinent white-fronted geese, 1975-2013 (R. Alisauskas, Science and Technology Branch, Environment Canada, Saskatoon, unpublished data).

Literature Cited

Alisauskas, R. T., K. L. Drake, and J. D. Nichols. 2009. Filling a void: abundance estimation of North American populations of arctic geese using hunter recoveries. Pages 465-492 *in* D. L. Thomson, E. G. Cooch, and M. J. Conroy, editors. Modeling demographic processes in marked populations. Environmental and Ecological Statistics 3:463-489.

Alisauskas, R. T., R. F. Rockwell, K. W. Dufour, E. G. Cooch, G. Zimmerman, K. L. Drake, J. O. Leafloor, T. J. Moser, E. T. Reed. 2011. Harvest, survival, and abundance of midcontinent lesser snow geese relative to population reduction efforts. Wildlife Monographs 179:1-42.

Boomer, G.S., G. S. Zimmerman, N. L. Zimpfer, P. R. Garrettson, M. D. Koneff, T. A. Sanders, K. D. Magruder, and J. A. Royle. 2013. Band reporting probabilities for mallards recovered in the United States and Canada. Journal of Wildlife Management 77: 1059-1066.

Cooch, F. G., S. Wendt, G. E. J. Smith, and G. Butler. 1978. The Canada Migratory Game Bird Hunting Permit and associated surveys. Pages 8-39 in Boyd, H., and G. H. Finney (eds.). Migratory game bird hunters and hunting in Canada. Canadian Wildlife Service Report Series No. 43.

Henny, C. J., and K. P. Burnham. 1976. A reward band study of mallards to estimate band reporting rates. Journal of Wildlife Management 40:1–14.

Johnson, M. A., P. I. Padding, M. H. Gendron, E. T. Reed, and D. A. Graber. 2012. Assessment of harvest from conservation actions for reducing midcontinent light geese and recommendations for future monitoring. Pages 46-94 in Leafloor, J. O., T. J. Moser, and B. D. J. Batt (eds.). Evaluation of special management measures for midcontinent lesser snow geese and Ross's geese. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C. and Canadian Wildlife Service, Ottawa, Ontario.

Lincoln, F. C. 1930. Calculating waterfowl abundance on the basis of banding returns. Circular 118, U.S. Department of Agriculture, Washington, D.C., USA.

Nichols, J. D., R. J. Blohm, R. E. Reynolds, R. E. Trost, J. E. Hines, and J. P. Bladen. 1991. Geographic variation in band reporting rates for mallards based on reward banding. Journal of Wildlife Management 55:119-126.

Nichols, J. D., R. E. Reynolds, R. J. Blohm, R. E. Trost, J. E. Hines, and J. P. Bladen. 1995. Geographic variation in band reporting rates for mallards based on reward banding. Journal of Wildlife Management 55:597-708.

Padding, P. A., and J. A. Royle. 2012. Assessment of bias in US waterfowl harvest estimates. Wildlife Research 39:336-342.

Royle, J. A., and P. R. Garrettson. 2005. The effect of reward band value on mid-continent mallard band reporting rates. Journal of Wildlife Management 69:800–804.

Zimmerman, G. S., T. J. Moser, W. L. Kendall, P. F. Doherty, G. C. White, and D. F. Caswell. 2009. Factors influencing reporting and harvest probabilities in North American geese. Journal of Wildlife Management 73:710-719.