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Management Plan for Midcontinent Lesser Snow Geese in the Mississippi Flyway

Prepared by the Mississippi Flyway Council Technical Section
Arctic Goose Committee

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Introduction and Purpose

Lesser snow geese (*Anser caerulescens caerulescens*) are important migratory birds whose management is a responsibility shared among federal, state, provincial, and territorial agencies, Indigenous Peoples, as well as non-governmental conservation organizations. The purpose of this plan is to promote and guide cooperative harvest management of lesser snow geese migrating through the states, provinces, and territories that comprise the Mississippi Flyway (Figure 1). The Mississippi Flyway Council (MFC) was organized in 1952 to promote and help coordinate management of migratory game birds, and this plan was written under its direction and authority.

Figure 1. Mississippi Flyway administrative boundaries in relation to three other major North American Flyways defined for cooperatively managing migratory birds.

Population Delineation

For the purposes of this management plan, midcontinent lesser snow geese include all those that winter in the Central and Mississippi Flyways (Figure 1). These geese primarily nest in northern Canada, east of 110°W longitude, from the Queen Maud Gulf

region of the central arctic, east to the western and southern coasts of Hudson Bay and James Bay, and on Southampton and Baffin Island (Figure 2).

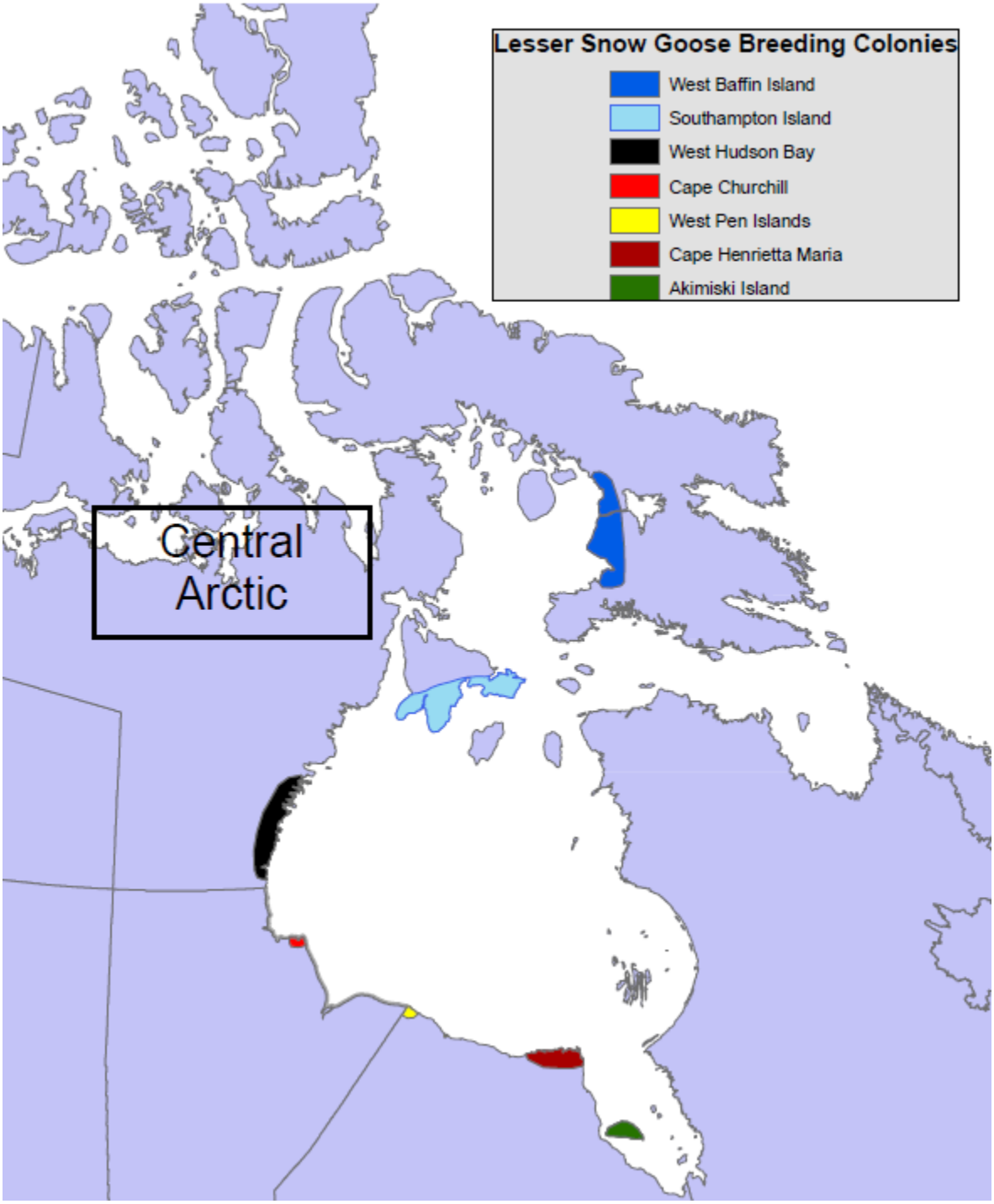

Figure 2. Locations of the main breeding colonies of midcontinent lesser snow geese.

Population Status and Trends

During the 1980s, waterfowl managers became aware of sustained and rapid increases in the abundance of lesser snow geese, and recognized the potential adverse impacts on subarctic habitats of increasing numbers of snow geese (Central Flyway Council and Mississippi Flyway Council 1982). Abundance of lesser snow and Ross's geese has increased substantially in the Central and Mississippi Flyways since the 1970s, as indexed by the midwinter survey (Figure 3) and from photographic surveys at nesting colonies (Kerbes et al. 2006, Kerbes et al. 2014).

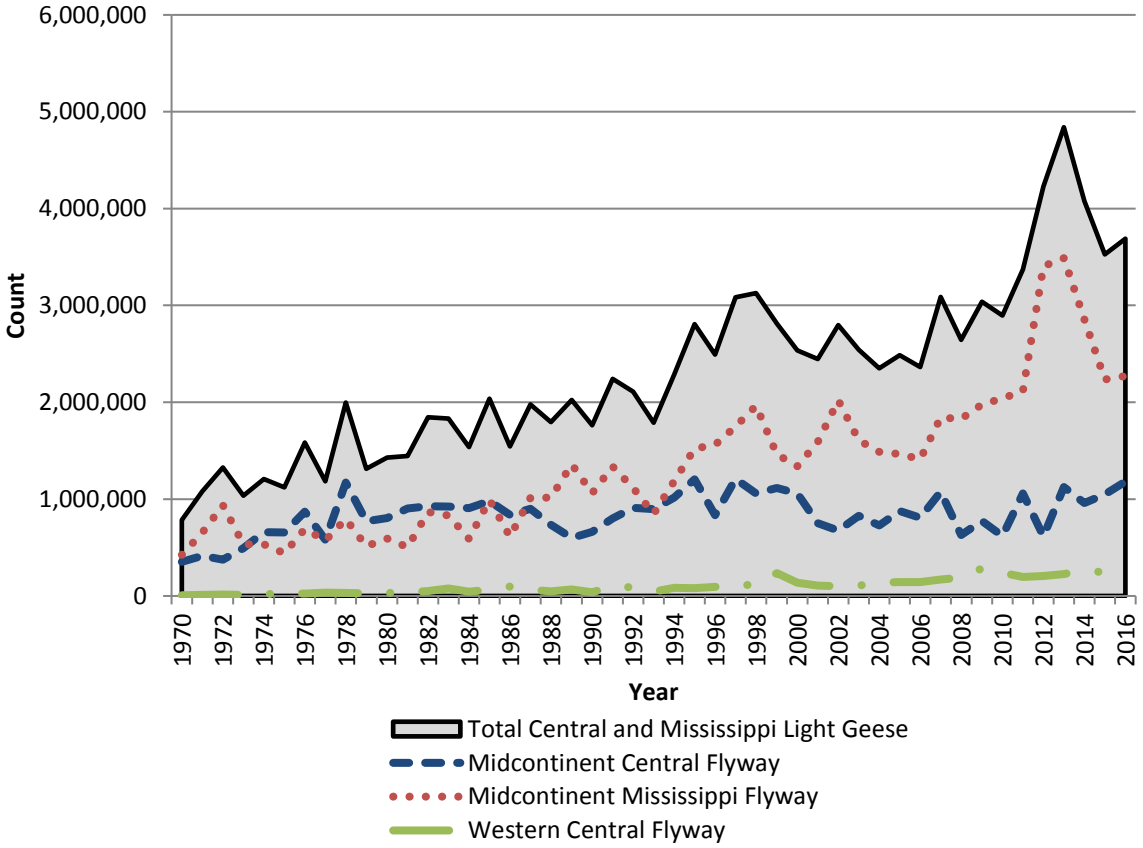

Figure 3. Midwinter counts of light geese (Ross's geese and lesser snow geese combined) in the Central and Mississippi Flyways, 1970-2016 (data from USFWS 2016).

Population expansion was mainly attributed to a combination of increased availability of agricultural foods and refuges throughout the flyway, which improved survival (Abraham and Jefferies 1997). Beginning in 1989, jurisdictions in the Mississippi Flyway began liberalizing hunting regulations in response to this growth. Bag and

possession limits were gradually increased, and by 1996, hunting seasons were extended to the latest date (March 10) allowed under the Migratory Bird Treaty. By 1997, further growth of the population, increasing concern about damage to agricultural crops, and concerns about potential widespread degradation of arctic and sub-arctic habitats (Kerbes et al. 1990, Jano et al. 1998) resulted in recommendations to reduce the population. The goals at the time were to reduce the population by 50% by 2005, reduce the population growth rate to between 0.85 to 0.95, and triple the harvest rate (Batt 1997). Reducing adult survival rates through increased harvest mortality was considered the most efficient mechanism to reduce the population size and slow the population growth rate (Rockwell et al. 1997), and making use of harvested birds was thought to be the most socially accepted approach to achieving management goals (Johnson 1997:102). Recognizing such increases in harvest would not be possible under current regulatory constraints, Canada and the United States introduced new regulations in 1999. These changes allowed hunting to occur after March 10 during special conservation seasons, expanded or removed daily bag or possession limits, extended hunting hours, and permitted the use of additional hunting methods (i.e., electronic calls in Canada and U.S., unplugged shotguns in the U.S., and baiting [Quebec only]).

Overall harvest increased substantially during the 1990s, but has plateaued or declined in recent years, perhaps due to behavioral adjustments by geese to increased hunting pressure, or due to satiation of hunter demand (Johnson et al. 2012). However, in recent years, harvest during the Conservation Order (US) or spring Conservation Seasons (Canada) has accounted for an increasing proportion of the total harvest of juveniles and adults (Figure 4 and 5; Alisauskas unpubl. data, updated following Alisauskas et al. 2011). During the same period that overall harvest increased, the harvest rate (i.e., the proportion of the population that is harvested annually) declined, indicating that increased harvest did not keep pace with the increase in population size. Harvest rates of adults have shown a long-term decline and averaged only 2.8% during 2000–2016 (Figure 6).

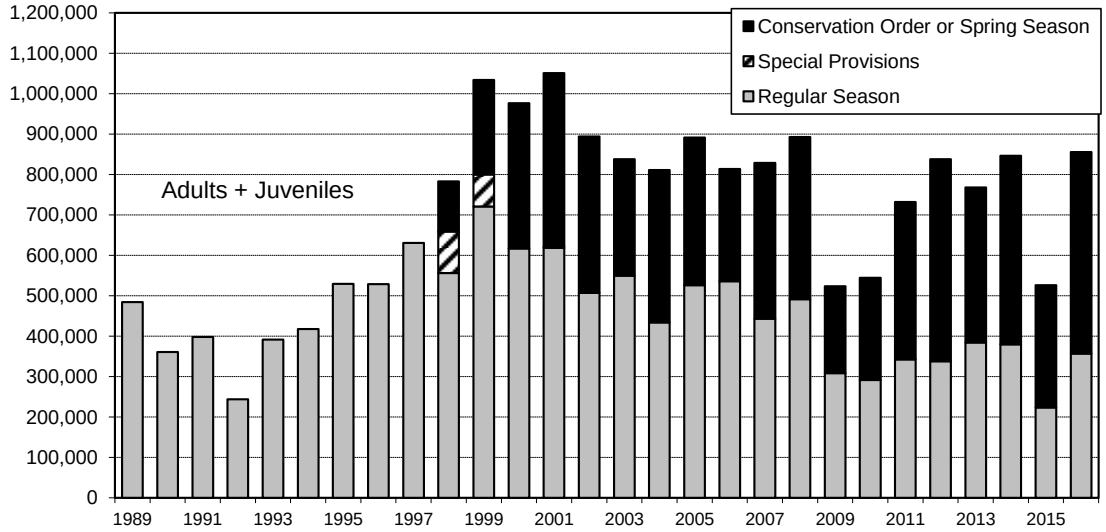

Figure 4. Annual harvest of midcontinent lesser snow geese (AHY and HY combined) during regular seasons, special provisions, and conservation order (US) or spring (Canada). Harvest outside of regular seasons were estimated from regular season harvest and ratio of band recoveries (Alisauskas et al. 2011).

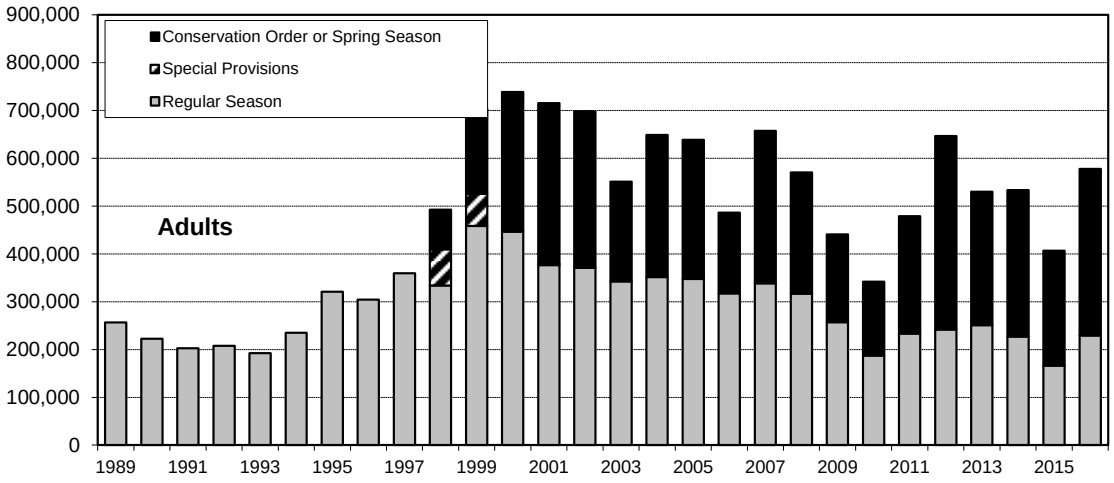

Figure 5. Annual harvest of midcontinent lesser snow geese (AHY only) during regular seasons, special provisions, and conservation order (US) or spring (Canada). Harvest outside of regular seasons were estimated from regular season harvest and ratio of band recoveries (Alisauskas et al. 2011).

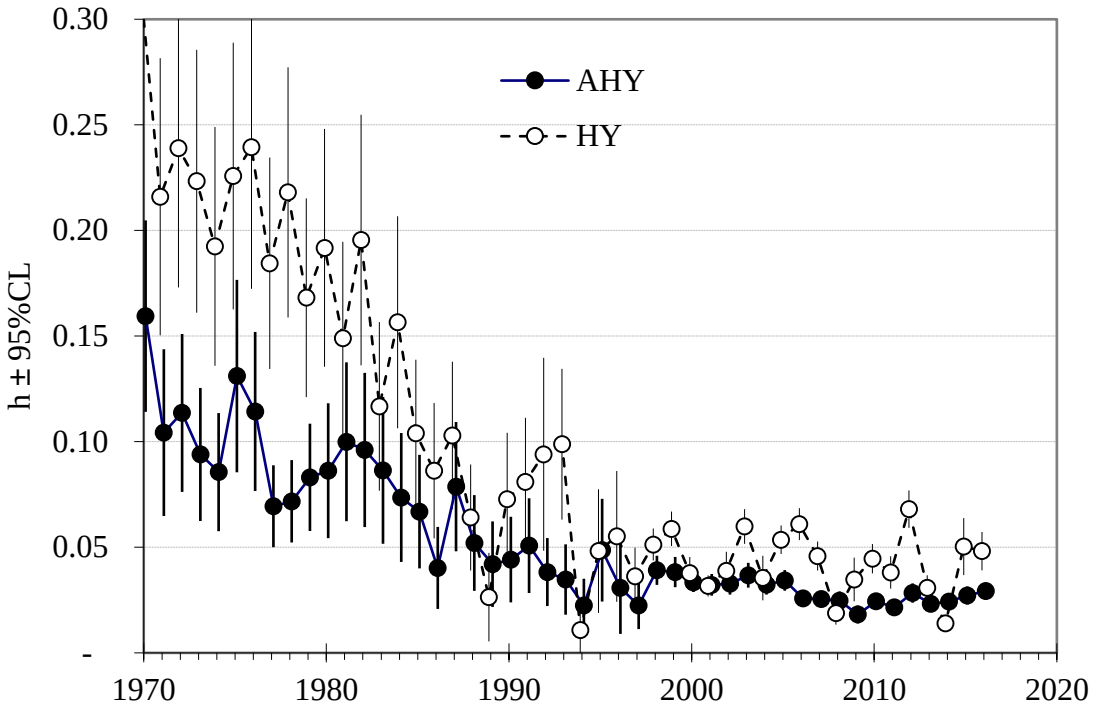

Figure 6. Harvest rates of adult (black dots) and juvenile (open dots) midcontinent lesser snow geese, 1970-2016 (R. T. Alisauskas, Environment and Climate Change Canada).

Although recent Lincoln estimates (Alisaukas et al. 2009) of adult midcontinent snow goose abundance were higher than, or as high as, any time period on record, the growth rate of the population decreased in recent years (Figure 7). The decreasing growth rate occurred simultaneously with static or increasing adult survival (Alisauskas et al. 2011, Dufour et al. 2012, Calvert et al. 2017), suggesting that recruitment rates must have declined over time. Consistent with that notion, age ratios in August based on Lincoln estimates of adults and juveniles showed a decline from about 0.55 in the early 1970s to about 0.35 in the early 2010s (Figure 8). Age ratios of snow geese harvested in the Central and Mississippi Flyways showed a similar decline over an even longer period (Figure 9). Reduced population growth and declining age ratios suggest that density-dependent population regulation may be occurring through a reduction in the recruitment rate (Ross et al. 2017).

Updated analysis of band recovery data from 1999 to 2015 suggested that adult survival for snow geese breeding north of 60° N latitude (representing ~90% of the midcontinent population) has continued to increase, and exceeded 0.90 in 9 of the 10 years

from 2004 to 2013 (Calvert et al. 2017). Thus, adult survival rate remains very high, despite the most liberal hunting regulations in more than a century.

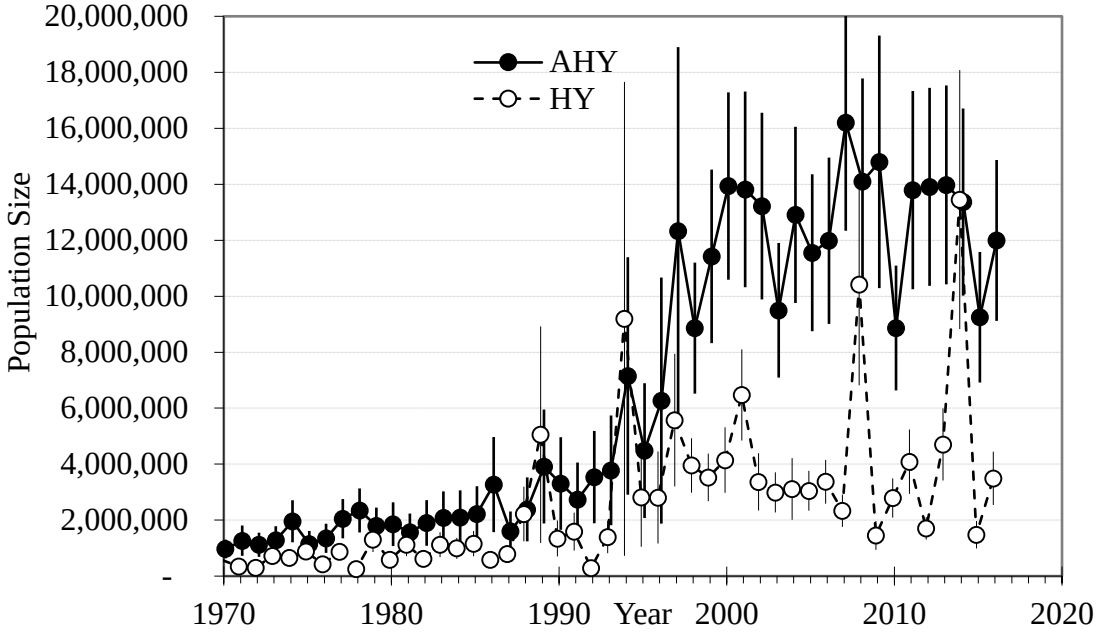

Figure 7. Lincoln estimates of population size (+/-95% CI) in August for adult (black dots) and juvenile (open dots) midcontinent lesser snow geese, 1970-2016 (R. T. Alisauskas, Environment and Climate Change Canada).

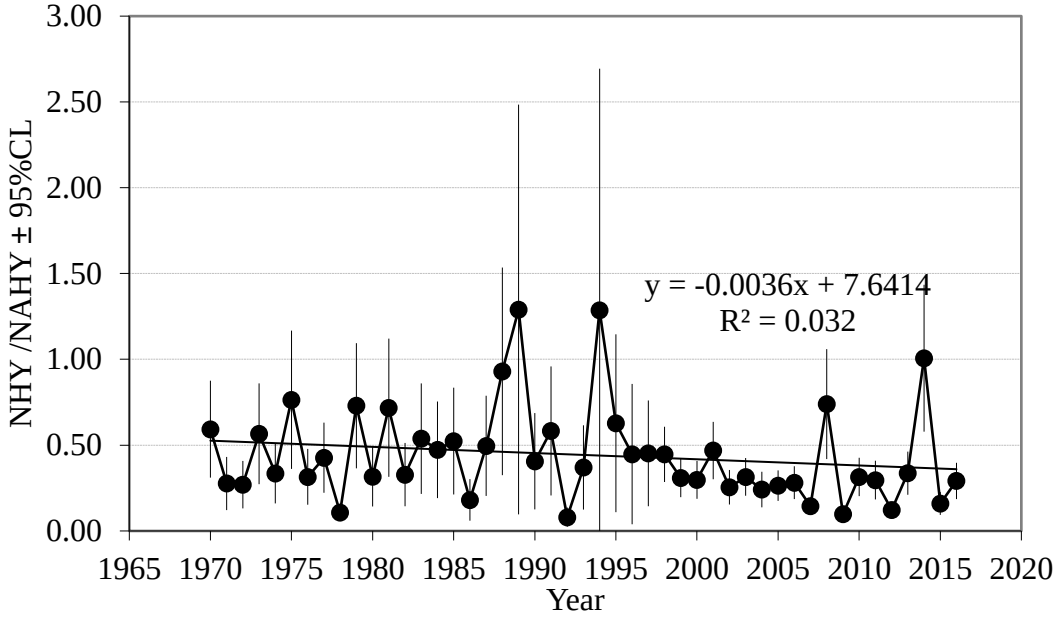

Figure 8. August age ratio of midcontinent lesser snow geese shown as the ratio of the number of goslings, $N_{HY,}$ to number of adults, N_{AHY} ,each estimated annually using Lincoln's method from 1970-2016 (R. T. Alisauskas, Environment and Climate Change Canada). Estimates are

not adjusted for breeding phenology resulting from annual variation in climate severity (Alisauskas 2002).

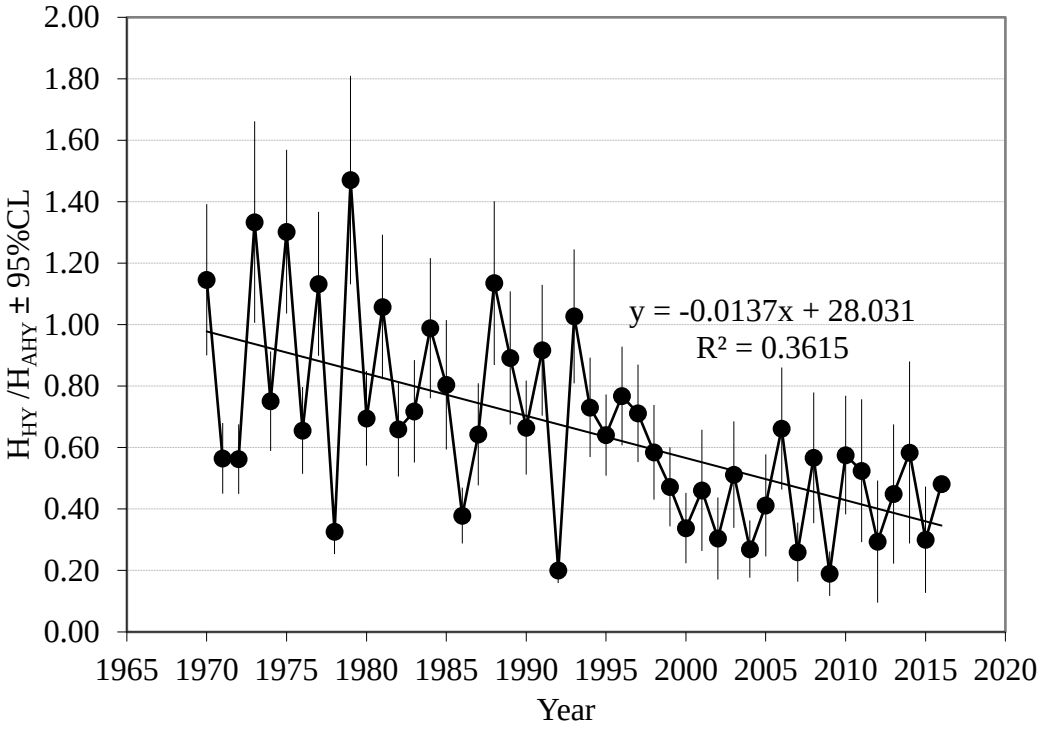

Figure 9. Age ratios (immature:adult) of midcontinent lesser snow geese harvested in the Central and Mississippi Flyway, 1963-2016 (R. Raftovich, USFWS).

Management Objective

Lesser snow geese were historically monitored using counts from the Midwinter Waterfowl Survey (MWS), which has been conducted in states of the Mississippi and Central Flyways since 1955 (USFWS; Figure 3). Batt (1997) acknowledged that the MWS underestimated true population size (see Boyd et al. 1982), and suggested the population size at that time was probably between 4.5 and 6 million, rather than approx.. 3 million counted on the MWS. Other useful indicators of population status have included aerial photographic surveys, which have been conducted periodically since the mid-1960s at known nesting colonies (Kerbes et al. 2014), and trends in nest density or colony size at established study areas in northern Canada (e.g., Karrak Lake, Nunavut and Cape Churchill, Manitoba). While all of these metrics show similar long-term increases in population size, the management goal established in 1997 and formalized in the Final Environmental Impact Statement (USFWS 2007) was based on the MWS, which was considered the best index of

population size at the time. However, there have been longstanding concerns about the ability of the MWS to provide much more than a coarse index of population size due to: 1) unknown precision of estimates; 2) uncertainty with respect to species composition (i.e., admixture with Ross's geese); and, 3) overall lack of standardization and replication, (especially considering expanding wintering distributions). In recent years, Lincoln estimates of population size have emerged as a preferred metric for monitoring other goose populations in the Mississippi Flyway (e.g. midcontinent Cackling and Greater White-fronted geese). The long-term availability of components used in calculations (i.e. estimates of age-specific harvest rate and age-specific harvest) have particular utility in evaluating long-term trends in population growth and historical ranges in population size.
At the time the population management goal was established by the Final Environmental Impact Statement (USFWS 2007), the average Lincoln estimate for the midcontinent lesser snow goose population (1996-1998 mean; Figure 5) was 9.97 million adult geese. Therefore, the management goal (i.e., reduce the adult population by 50%) at the time this population was declared over-abundant translated to a population size of about 5 million adults, and is the rationale for using this number as the lower threshold population objective in this plan.

Although additional harvest opportunities have not had the desired effect on this population (Leafloor et al. 2012), and the large-scale ecological consequences of continued population growth are incompletely understood, the management community has recommended that managers continue to explore options to maximize harvest, and the use of lesser snow geese by hunters (AGJV 2015). Given incomplete knowledge regarding the proportion of available habitat negatively impacted and carrying capacity of arctic habitats, we are unable to prescribe a more biologically meaningful population objective than the initial management target. Instead, the management objective of this plan is simply to reduce the size of the midcontinent populations of lesser snow geese by maximizing harvest during regular seasons and through continued special harvest measures. The intent is to increase adult harvest rates, which is considered the most accepted means of slowing or reducing the population growth rate. To achieve population reductions, it will be necessary to increase adult harvest rates to at about 10-12%, assuming that all harvest is additive to natural mortality (Dufour et al. 2012), and that recruitment levels do not change drastically.

Harvest levels in this range would be necessary to reduce adult survival below 80%, the level predicted to result in negative population growth (Rockwell et al. 1997).

Harvest Management Strategy

When the 3-year running average of adult harvest rate remains at or below 11%, and populations remain above the minimum threshold population size of 5 million adults (based on a 3-year running average of Lincoln estimates) maximum harvest opportunity should be offered during regular seasons, and through continued use of special harvest measures (i.e., Conservation Order in US and spring Conservations Seasons in Canada). This population level corresponds to 50% of the average Lincoln estimate of population size between 1996-1998 (9.97 million adults). If adult harvest rates exceeds threshold levels (i.e. 11%) or the population declines to 5 million adults, analyses shall be conducted to determine the hunting regulations required to achieve survival rates consistent with the long-term harvest and population objectives. To adjust recovery rates to harvest rates, we will use the best available estimates of band reporting rates for geese. Since there is reportedly little variation in reporting rates by species in the same geographic area (Nichols et al. 1995; Zimmerman et al. 2009), we suggest using reporting rate estimates of midcontinent mallards where rates for snow geese are not available (Alisauskas et al. 2009, 2011).

Population Monitoring

The midcontinent population of lesser snow geese will be monitored using harvest rates and Lincoln estimates of population size, which will require banding a representative sample of these geese on their breeding grounds in northern Canada each year and deriving age-specific harvest estimates from federal hunter surveys. Long-term banding programs provide not only information about survival and harvest rates, but also indices of annual production, harvest distribution, migration chronology, and population size. Banding data are the primary tools used for evaluating the effect of regulatory changes in several Mississippi Flyway Management Plans (e.g., Canada Goose, White-fronted Goose, Cackling Goose). Some geographic variation in survival and harvest rates has been found

among colonies of lesser snow geese, and it is therefore important to continue banding at representative sites across the breeding range (Alisauskas et al. 2011, Dufour et al. 2012). Annual pre-season banding of midcontinent lesser snow geese (2012-2016; Table 1) in the sub-arctic (Akimiski Island and Northern Manitoba) is carried out by the Hudson Bay Project, which is partially funded through the Mississippi Flyway. Banding in the Arctic (Southampton Island, Baffin Island, and Central Arctic-Queen Maud Gulf) is delivered under the Arctic Goose Banding Program (Leafloor 2012), which also bands other species of arctic nesting geese in these areas (e.g., White-fronted geese, Cackling geese, Atlantic Brant, Ross's geese). The AGBP is administered and delivered by the Canadian Wildlife Service, but is cooperatively funded by all flyways and both federal governments.

Table 1. Mean pre-season bandings (normal, wild) of midcontinent lesser snow geese in northern Canada, 2012-2016 (see Figure 2 for locations).

Banding Location	**Mean HY banded per year, 2012-2016**	**Mean AHY banded per year, 2012-2016**	**Mean LSGO banded per year, 2012-2016**	**Mean proportion of TOTAL AHY banded per year, 2012-2016**
Akimiski Island	530	581	1111	0.06
Baffin Island	478	1533	2011	0.16
Queen Maud Gulf	579	2196	2775	0.23
Northern Manitoba	2389	3104	5493	0.32
Southampton Island	0	2279	2279	0.24
TOTAL	**3976**	**9693**	**13669**	

Estimation of age-specific harvest will occur annually using tail feathers collected via the annual waterfowl Parts Collection Survey in the U.S. and the Species Composition Survey in Canada. Age-specific harvest estimates, when combined with band recovery data, allow estimation of the number of adult birds in the population (Alisauskas et al. 2012), and the trend information provided by these estimates will allow evaluation of progress towards

achieving the management objective. Finally, 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, we recommended that harvest estimates from both the United States and Canada continue to be adjusted by these correction factors.

In addition to information from banding and harvest programs, periodic surveys on nesting and wintering areas and data from long-term research programs in Nunavut, Northern Manitoba and Ontario will continue to provide information about changes in recruitment, abundance and distribution of midcontinent lesser snow geese.

Information Needs

The growth and expansion of this population continues to cause concern because of potential adverse impacts on habitat and on sympatric species, especially in arctic and subarctic habitats. Although the initial concern about lesser snow geese exceeding habitat capacity along West Hudson Bay was related to freshwater habitats, much of the initial research on habitat changes caused by overabundant geese came from intertidal marsh habitats along the James Bay and Hudson Bay coasts (see Jefferies et al. 2003).While these habitats are heavily used by snow geese and other migratory birds, especially during migration, they make up only a small proportion of the habitats used by snow geese overall. Freshwater wetland habitats are much more expansive and their ability to recover over time is poorly understood, and so the ecological impact of foraging by large numbers of geese remains uncertain. In 2017, the Mississippi Flyway recommended that the Arctic Goose Joint Venture prioritize evaluation of carrying capacity and impacts of overabundance on other species, but urged future work also include efforts to address uncertainty in data used to calculate estimates of abundance (e.g., updated band reporting estimates given recent changes in band inscriptions (web address only). In addition, the Arctic Goose Joint Venture Strategic Plan (AGJV 2016) recently summarized information needs for lesser snow geese, and identified the following high priority needs: .

- Improved knowledge of habitat use in subarctic and arctic staging areas.
- Improved knowledge of habitat quality and availability at arctic staging areas and breeding colonies.
- Recovery rates of freshwater habitats altered by geese in arctic and subarctic staging and nesting areas.
- Impact of habitat changes caused by snow geese on other populations of geese, other migratory birds, and a variety of other species-including plants.
- Evaluation of tail fan criteria used to separate Ross's geese and lesser snow geese in the Parts Collection Survey (PCS) in the United States and the Species Composition Survey (SCS) in Canada
- Improved harvest surveys to capture spring harvest

In addition, we recommend a commitment to undertake new research on alternative measures of population control in the event that such action becomes the consensus of the scientific community. Long-term research programs at Hudson and James Bay, and Karrak Lake continue to contribute information to address some of these priority questions, and the continued support of the Mississippi Flyway will be important in furthering these efforts.

Literature Cited

Abraham, K. F., and R. L. Jefferies. 1997. High populations, causes, impacts and implications. Pages 7-72 in Batt, B. D. J. (editor). Arctic Ecosystems in Peril: Report of the Arctic Goose Habitat Working Group. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C., and Canadian Wildlife Service, Ottawa, Canada. 126 pp.

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. 2016. Arctic Goose Joint Venture Strategic Plan: Updated February, 2016. Unpublished Report [c/o AGJV Coordination Office, CWS, Edmonton, Alberta]. 112 pp.

Batt, B. D. J., editor. 1997. Arctic ecosystems in peril: report of the Arctic Goose Habitat Working Group. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C. and Canadian Wildlife Service, Ottawa, Ontario.

Calvert, A. M., R. T. Alisauskas, and G. C. White. 2017. Annual survival and seasonal hunting mortality of midcontinent snow geese. Journal of Wildlife Management 81:1009-1020.

Central Flyway Council and Mississippi Flyway Council. 1982. Management guidelines for Mid-Continent Snow Geese. 17pp.

Dufour, K. W., R. T. Alisauskas, R. F. Rockwell, and E. T. Reed. 2012. Temporal variation in survival and productivity of midcontinent lesser snow geese and survival of Ross's geese and its relation to population reduction efforts. Pages 95-131 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.

Jano, A. P., R. L. Jefferies, and R. F. Rockwell. 1998. The detection of change by multi-temporal analysis of LANDSAT data: the effects of goose foraging. Journal of Ecology 86:93-100.

Johnson, M. A. 1997. Management strategies to address the midcontinent lesser snow goose overpopulation problem. Pages 101-111 in Batt, B. D. J. (editor). Arctic ecosystems in peril: report of the Arctic Goose Habitat Working Group. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C. and Canadian Wildlife Service, Ottawa, ON. 120pp.

Jefferies, R. L., A. P. Jano, and K. F. Abraham. 2006. A biotic agent promotes large-scale catastrophic change in coastal marshes of Hudson Bay. Journal of Ecology 94:234-242.

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.

Kerbes, R. H., P. M. Kotanen and R. L. Jefferies. 1990. Destruction of wetland habitats by lesser snow geese: a keystone species on the west coast of Hudson Bay. Journal of Applied Ecology 27:242-258.

Kerbes, R. H., K. M. Meeres, R. T. Alisauskas, F. D. Caswell, K. F. Abraham, and R. K. Ross. 2006. Surveys of nesting midcontinent lesser snow geese and Ross's geese in eastern and central arctic Canada, 1997-98. Technical Report Series No. 447, Canadian Wildlife Service, Prairie and Northern Region, Saskatoon, Saskatchewan.

Kerbes, R. H., K. M. Meeres, and R. T. Alisauskas. 2014. Surveys of nesting Lesser Snow Geese and Ross's Geese in arctic Canada, 2002 – 2009. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C. and Canadian Wildlife Service, Ottawa, Ontario.

Leafloor, J. O. 2012. Arctic Goose Banding Program. Funding Proposal to the Atlantic, Mississippi, and Central Flyways, and Arctic Goose Joint Venture, 2014-2018. 22 pages.

Leafloor, J. O., T. J. Moser, and B. D. J. Batt (editors). 2012. 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.

Nichols, J.D., R. J. Blohm, R. E. Reynolds, 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 59:697-708.

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

Rockwell, R. F., E. G. Cooch, and S. Brault. 1997. Dynamics of the midcontinent population of lesser snow geese - projected impacts of reductions in survival and fertility on population growth rates. Pages 73-100 in Batt, B. D. J. (editor). Arctic ecosystems in peril: report of the Arctic Goose Habitat Working Group. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C. and Canadian Wildlife Service, Ottawa, Ontario.

Ross, M. V., D.C. Douglas, R.T. Alisauskas, and D. K. Kellett. 2017. Decadal declines in avian herbivore reproduction: density-dependent nutrition and phenological mismatch in the Arctic. Ecology 98: 1869-1883.

U.S. Fish and Wildlife Service. 2007. Final Environmental Impact Statement: Light goose management. U.S. Dept. of Interior, Washington, DC. 243pp.

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.