Pacific Flyway Management Plan for the

Western Arctic Population of Lesser Snow Geese

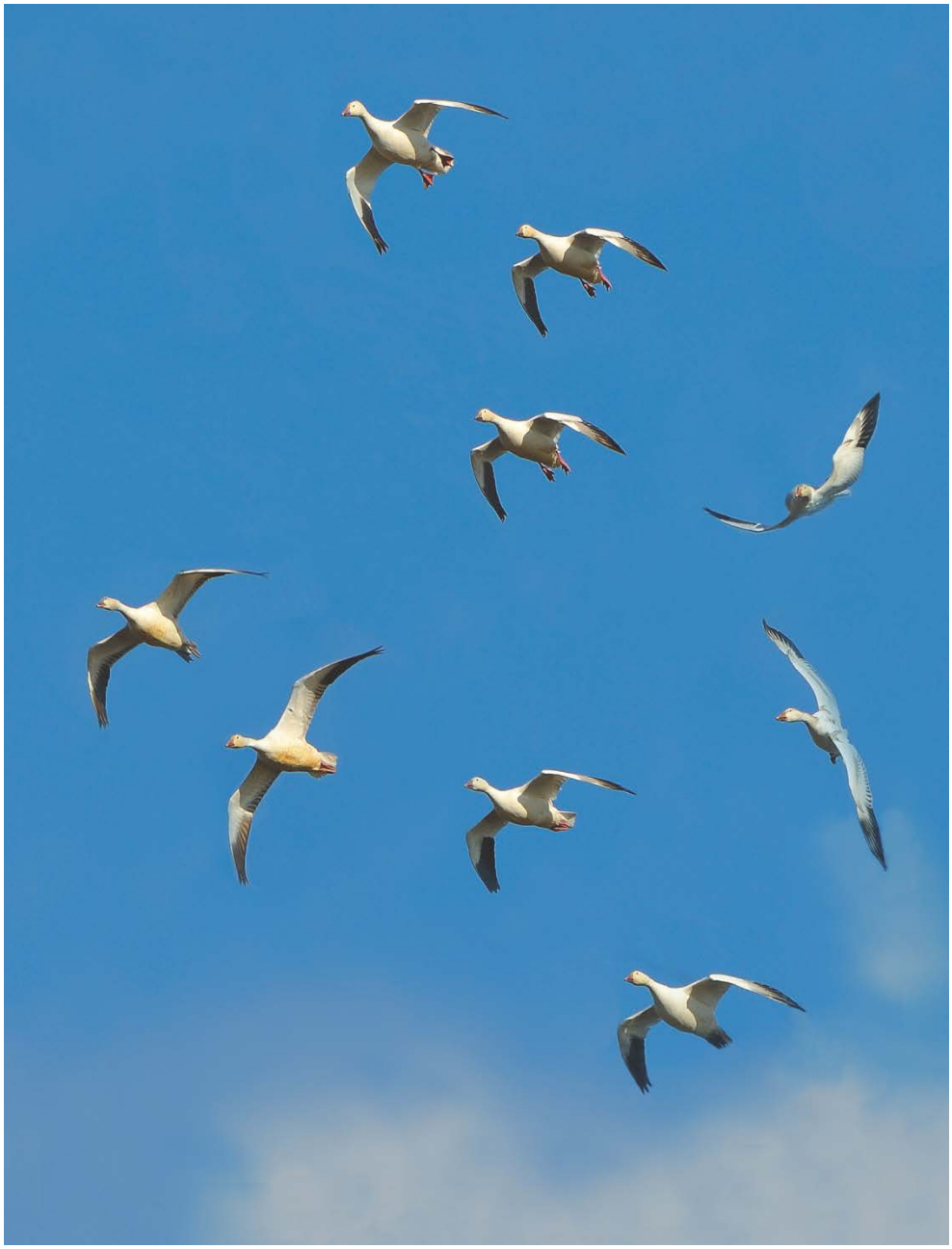

Photo courtesy Clair Kofoed.

This management plan is one of a series of cooperatively developed plans for managing the various species of migratory birds of the Pacific Flyway. Inquiries about this plan may be directed to member states of the Pacific Flyway Council or to the Pacific Flyway Representative, U.S. Fish and Wildlife Service, 911 N.E. 11th Ave., Portland, OR 97232.

Suggested Citation: Pacific Flyway Council. 2013. Pacific Flyway management plan for the Western Arctic Population of Lesser Snow Geese. Pacific Flyway Council [c/o USFWS, DMBM] Portland, OR]. Unpublished report. 37 pages.

PACIFIC FLYWAY MANAGEMENT PLAN

FOR THE

WESTERN ARCTIC POPULATION OF LESSER SNOW GEESE

Prepared for the:

Pacific Flyway Council
Direccion General de Conservacion Ecologica de Recursos Naturales
U.S. Fish and Wildlife Service
Canadian Wildlife Service

Prepared by:

Subcommittee on White Geese
Pacific Flyway Study Committee

JULY 2013

Approved by: _____ July 26, 2013
Chairman, Pacific Flyway Council — Date

July 1992
Revised July 2013

ACKNOWLEDGEMENTS

This plan was prepared by the Pacific Flyway Study Committee, Subcommittee on White Geese. During the process of revising this plan, those persons belonging to the Subcommittee and/or contributing significantly to its development include:

Dan Rosenberg, Alaska Department of Fish and Game
Mike Rabe, Arizona Department of Game and Fish
Shaun Oldenburger, California Department of Fish and Wildlife
Melanie Weaver, California Department of Fish and Wildlife
Jeff Knetter, Idaho Department of Fish and Game
Rick Northrup, Montana Fish Wildlife and Parks
Russell Woolstenhulme, Nevada Department of Wildlife
Brad Bales, Oregon Department of Fish and Wildlife
Blair Stringham, Utah Division of Wildlife Resources
Don Kraege, Washington Department of Fish and Wildlife
Joseph Sands, USFWS, Region 1, Portland
Dave Olson, USFWS, Region 6, Denver
Russ Oates, USFWS, Region 7, Anchorage
Chris Nicolai, USFWS, Region 8, Reno
Bob Trost, USFWS, DMBM, Portland
Steve Olson, USFWS, DMBM, Portland
James Hines, CWS, (Emeritus Associate) Arcola
Andre Breault, CWS, Delta
Kathy Meeres, CWS, Saskatoon
Myra Wiebe Robertson, CWS, Yellowknife
Sean Boyd, Environment Canada, Wildlife and Landscape Science Directorate, Delta
Vasiliy Baranyuk, Wrangel Island Nature Reserve (Retired), Mount Vernon

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

PACIFIC FLYWAY MANAGEMENT PLAN

FOR THE

WESTERN ARCTIC POPULATION LESSER SNOW GOOSE

INTRODUCTION

The Pacific Flyway Council (Council) is an administrative body that forges cooperation among public wildlife agencies to protect and conserve migratory birds in western North America. The Council has prepared numerous management plans for most populations of swans, geese, and sandhill cranes in the Pacific Flyway (www.pacificflyway.gov). These plans typically focus on populations, which are the primary unit of management, but may be specific to a species or subspecies. Management plans serve to:

- Identify common goals;
- Coordinate collection and analysis of biological data;
- Prioritize management actions and establish responsibility for them; and
- Emphasize research needed to improve management.

Flyway management plans are products of the Council, developed and adopted to help state and federal agencies cooperatively manage migratory game birds under common goals. Management strategies are recommendations, but do not commit agencies to specific actions or schedules. Fiscal, legislative, and priority constraints influence the level and timing of implementation. Pacific Flyway plans generally guide management and research for a five-year planning horizon.

This plan provides guidelines for management of that portion of the Western Arctic Population (WAP) of lesser snow geese (*Chen caerulescens caerulescens*) that occurs in the Pacific Flyway. The WAP breeds primarily on Banks Island, Northwest Territories (NWT) in the western Canadian Arctic, with smaller colonies westward to the central Alaska coast (Fig. 1, Table 1). The majority of the population winters in the Central Valley of California, with the remainder mostly wintering in the western part of the Central Flyway, an area that includes eastern New Mexico, northwestern Texas, eastern Colorado, and the Central Highlands of Mexico (Fig. 2, Table 1). Important migration staging areas include the Arctic Coastal Plain of northeast Alaska and the Yukon, the Mackenzie River Valley, southeastern Alberta, southwestern Saskatchewan, western Montana, southern Idaho and Oregon, western Utah, southeastern Colorado, and northeastern California (Table 1). The WAP mixes in migration and on the wintering grounds with the Wrangel Island Population (WIP) and the Midcontinent Population (MP) of lesser snow geese and Ross's geese (*Chen rossii*). These other populations are addressed in separate Pacific and Central Flyway plans, but integration among them is essential to manage these overlapping populations of white geese.

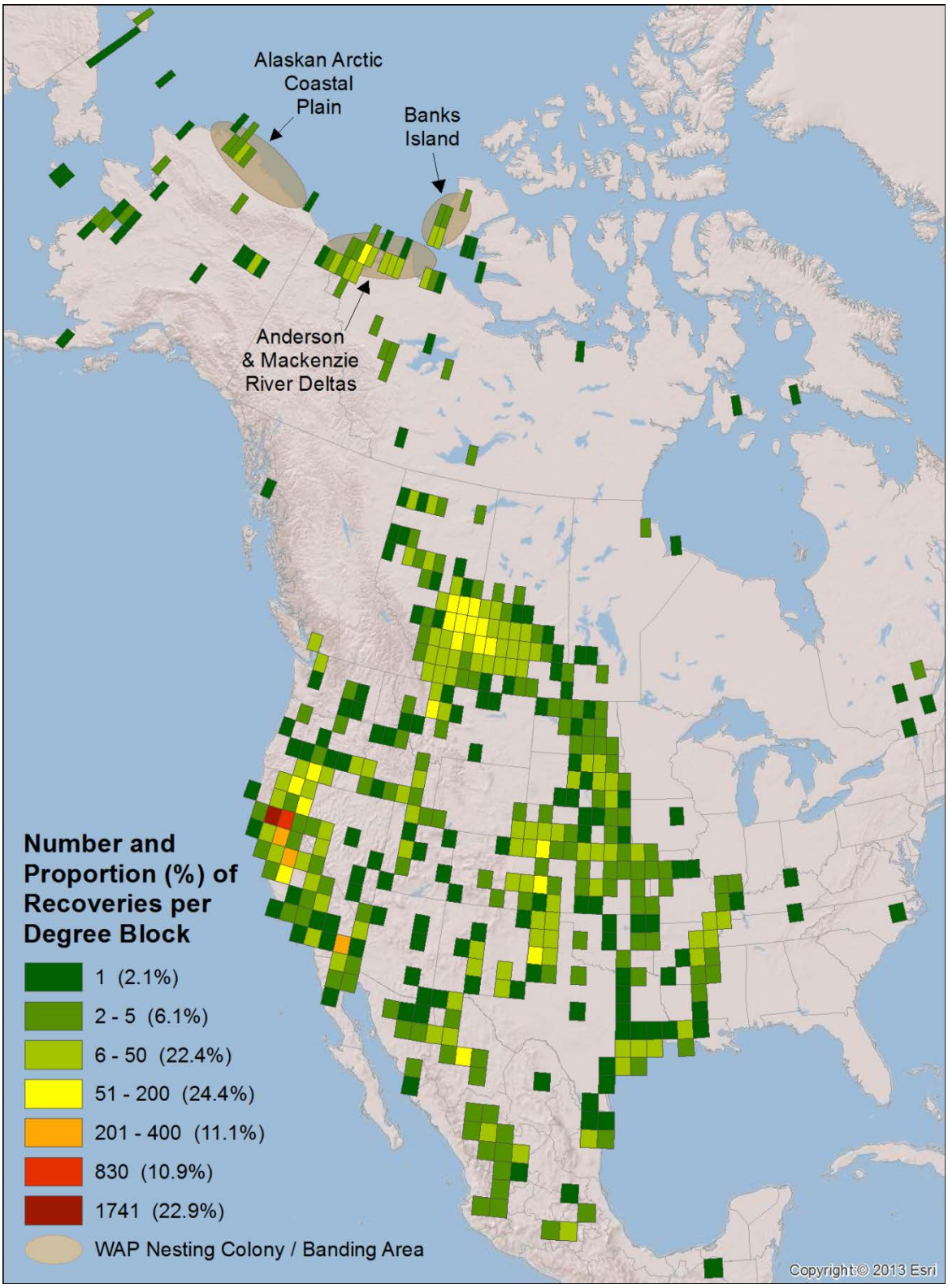

Figure 1. Distribution of Western Arctic Population lesser snow goose leg band recoveries, 1939–2012.

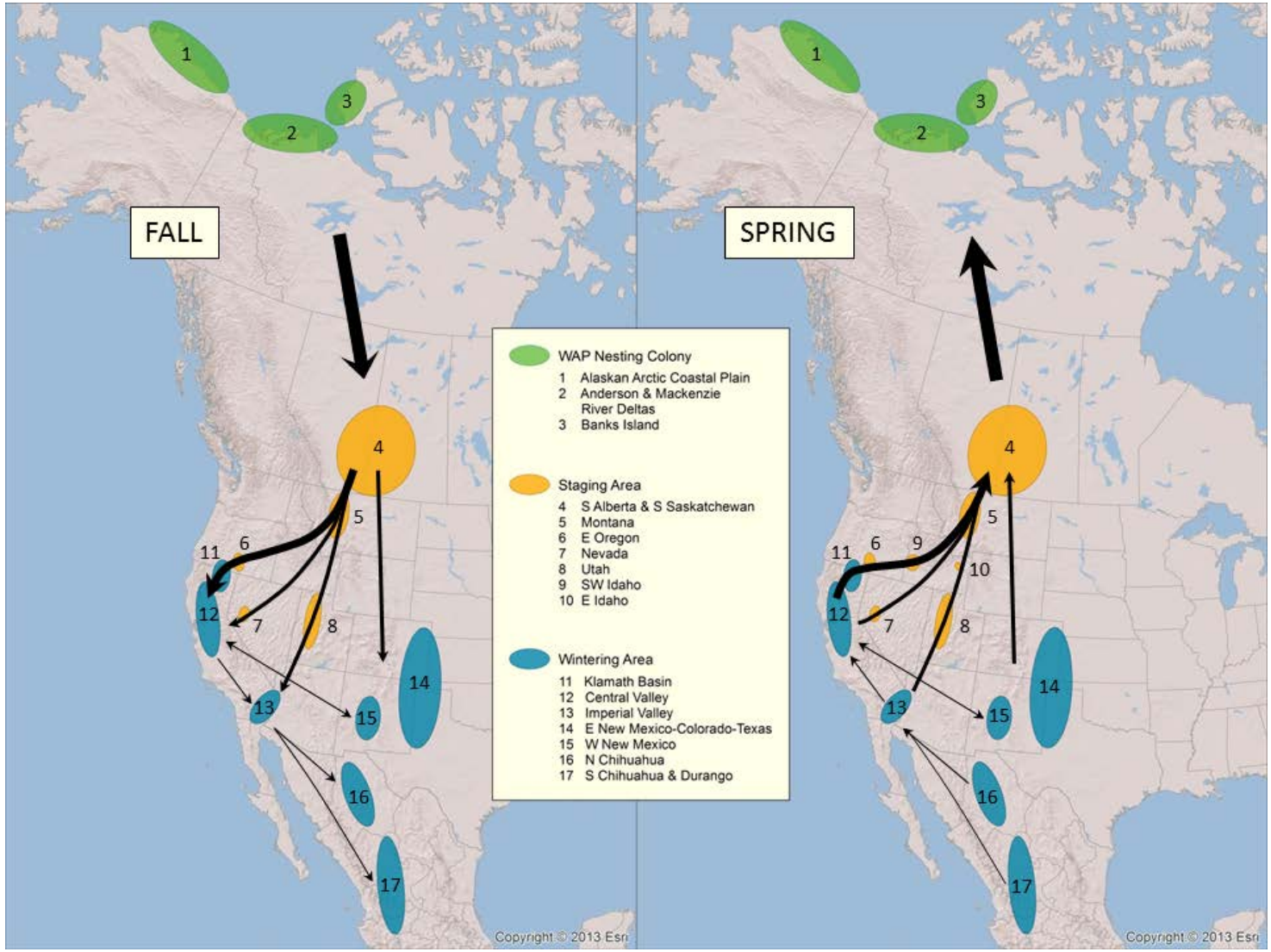

Figure 2. General migration pathways of Western Arctic Population lesser snow geese between breeding, staging, and wintering areas (adapted from Armstrong et al. 1999).

GOALS AND OBJECTIVES

The goal of this management plan is to maintain the WAP at a healthy level and optimize distribution of lesser snow geese in all parts of their range to benefit society. It is recognized that the distribution of WAP lesser snow geese between the Pacific and Central flyways continues to be dynamic. Complementary planning between all jurisdictions is needed to ensure that coordinated management of the WAP is based on shared objectives and the best available information.

Objectives

A. Reduce breeding population to 200,000 adult lesser snow geese on the three traditional breeding areas (Banks Island, Anderson River delta, and Kendall Island), based on a five-year or more frequent photographic inventory.

B. Ensure adequate year-round habitat is available to support the population, but minimize negative effects due to overgrazing by geese.

C. Ensure WAP lesser snow geese, or management actions on the population do not negatively impact other species or populations, in particular WIP lesser snow geese.

D. Provide for aesthetic, educational, scientific, and consumptive uses.

STATUS

Abundance and Trends

Since 1976, the status of the WAP has been measured with periodic photographic inventories of the three main colonies in the Northwest Territories of Canada, including Banks Island, Anderson River, and Kendall Island (Table 2). In 1987, those three colonies had 98,300, 3,600, and 700 nesting pairs of lesser snow geese, respectively and over 205,000 geese (Hines et al. 1999). The colonies increased to 486,100 geese by 1995 and to 579,700 geese by 2002. The 2009 photo inventory estimated 431,800 lesser snow geese. The population in these colonies has increased approximately 4% per year from 1976 to 2010, despite a reduction in geese between the 2002 and 2009 photo inventories (Wood et al. 2011). The nesting colonies in Alaska have risen from 95 nesting pairs in 1980 to over 6,000 in 2010 (Ritchie et al. 2011; Table 3). The Ikpikpuk colony alone has increased from 40 nesting pairs in 1980 to over 8,600 in 2011 (Burgess et al. 2012). Continued growth at these observed rates, which are similar to those observed in the central Arctic, would inevitably lead to broad scale habitat destruction on the breeding grounds (Hines et al. 2010).

Traditional midwinter surveys indicate an increasing trend of white geese wintering in the Pacific Flyway; an average of 360,490 during 1955–1959 and 763,965 during 2009–2013. In 1979, the operational survey for Pacific Flyway white geese was changed to an early December count which has averaged 611,800 geese (Table 4). These counts neither distinguish the proportions of white geese which originate from the WAP, the WIP, or the MP, nor do they distinguish between lesser snow and Ross's geese. However, periodic air and ground

composition surveys are conducted in California to estimate proportions of lesser snow and Ross's geese (Table 5). The proportions of these populations in the Pacific Flyway are known to have changed since initiation of population surveys, and primarily show a reduction in the proportion of Ross's geese due to the increase in the lesser snow goose population.

WAP lesser snow geese also winter in the western part of the Central Flyway, including the Central Highlands of Mexico, where they mix with MP lesser snow and Ross's geese (Drewien et al. 2003). Surveys of the white geese wintering in the western part of the Central Flyway suggest increasing populations of snow and Ross's geese. During the 1989–1990 winter survey of major migration and wintering areas in Colorado, New Mexico and Texas, there were an estimated 172,700 birds, of which 13% were Ross's geese (Benning 1991), while the 2011–2012 winter survey estimated 260,200 birds, of which 33% were Ross's geese (Thorpe 2012).

It is important to note that declines in the estimated number of lesser snow geese from photo surveys do not necessarily reflect declines in the population. Specifically, the number of nests may decrease due to poor nesting conditions (i.e. late springs); therefore, many non-breeding adults may remain uncounted. Likewise, we report information only from known nesting colonies in the western Arctic. With the relatively recent (1990–present) expansion of nesting colonies in Alaska and the fact that nesting locations are quite remote, it is possible unknown colonies exist that remain to be surveyed. Furthermore, fall age ratios and other data (i.e., an increasing disparity between Lincoln-Peterson estimates and winter counts, and between Lincoln-Peterson estimates and photo estimates) suggest that there may be a large and possibly increasing non-breeding component among MP lesser snow geese (Leafloor et al. 2012). It is possible this may be occurring in the WAP as well.

Nesting Areas

Most (88% of the total) WAP lesser snow geese nest in the Egg River colony on Banks Island, with smaller colonies on the Anderson River delta and at Kendall Island in the Mackenzie River delta (Table 2). The nesting population on Banks Island has increased from 165,000 birds in 1976 to approximately 500,000 birds in recent years. The number of nesting geese varies considerably among years and is lower in years when nesting is delayed by late snowmelt (Samelius et al. 2008). In those years when nesting is delayed, large numbers of nonbreeding geese were found in brood-rearing areas, which suggest timing of snowmelt has a greater effect on the proportion of geese attempting to breed each year than it has on the number of geese that arrive at Banks Island (Samelius et al. 2008). Nesting numbers and success at Anderson River have declined substantially since the 1970s and 1980s, likely due to vegetation loss from increased soil salinity and increased predation from grizzly bears (Obst et al. 2013). Nesting numbers and success at Kendall Island can vary greatly each year, depending on the level of spring flooding and predation by grizzly bears (Kerbes et al. 1999a).

WAP lesser snow geese occasionally bred on the Arctic Coastal Plain of Alaska through the 1970s; however, a small colony of 100–200 nesting pairs became established on Howe Island in the Sagavanirktok River delta near Prudhoe Bay. This colony has had a history of boom and bust years, and seldom exceeded 400 nests through the 1990s. Colony distribution has varied with ice conditions and predation by foxes and bears. By 2008, the Howe Island colony surpassed 1,000

nests (Blees et al. 2010). Lesser snow geese now nest in three other colonies on the Colville, Ikpikpuk, and Kukpowruk river deltas (Table 3). Since 1999, the Ikpikpuk colony has grown from 176 nests to over 4,000 nests in 2010 (Ritchie, et al. 2011). In 2010, nearly 7,000 pairs of lesser snow geese nested in four colonies along the Arctic Coastal Plain of northeast Alaska.

All main breeding colonies are located on flat, coastal areas, drained by braided deltas, and are within five miles of salt water, with the exception of those along the Egg and Kellet Rivers, about 16 miles inland on Banks Island (McEwen 1958).

Migration Routes and Chronology

Fall. – The Arctic Coastal Plain of northeast Alaska and the Yukon Territory, and the Mackenzie River delta in the NWT are important fall staging areas for as many as 600,000 WAP lesser snow geese (Garner and Reynolds 1986). In 1978, 325,800 lesser snow geese were estimated in the Arctic National Wildlife Refuge (Spindler 1978) and that number has since decreased. In 2004, the peak count (adjusted for observer error) was 189,600 and the long-term average is 106,100 lesser snow geese (Kendall 2006). Lesser snow geese utilize the Arctic Coastal Plain between late August and early September to build energy reserves needed for migration (Hupp et al. 2002) and, from there, they move south along the Mackenzie River to additional staging areas, first in the southern Northwest Territories (NWT), then to southeastern Alberta and southwestern Saskatchewan.

Non-breeding lesser snow geese leave Banks Island about mid-August on their southern migration. They first stage on the northwest edge of the Mackenzie River delta in early September, where they are joined by adults with young who stage throughout the Beaufort Sea Coastal Plain in western Canada and eastern Alaska (Barry 1967). The exact timing and path followed from the western Arctic to the Canadian prairies are unknown (Armstrong et al. 1999). On the main staging areas of southeastern Alberta and southwestern Saskatchewan, lesser snow geese peak in mid- to late October. Autumn staging areas used by WAP lesser snow geese in the Canadian prairies have gradually shifted eastward. In the 1950s and 1960s, 74% of the leg bands recovered in the Canadian prairies occurred in Alberta, and 26% occurred in Saskatchewan. By the late 1980s and early 1990s, only 36% of the recoveries occurred in Alberta, while the remainder (64%) occurred in Saskatchewan (Hines et al. 1999). Much of the fall migration is non-stop between Prairie Canada and wintering areas.

WAP lesser snow geese continue south from the Canadian prairies via several different routes (Fig. 2). One route passes through Freezout Lake, Montana, then southwest to Summer Lake, Oregon and the Klamath Basin on the Oregon-California border. These geese move on to winter in the Central Valley (especially the Sacramento Valley) of California. A small number of these geese continue on to the Imperial Valley of California. Others depart Montana and pass through the Bear River Marshes of Utah to the Imperial Valley of California (Armstrong et al.1999).

Another migration route used by WAP geese follows the Canadian prairies east of the Rocky Mountains to wintering grounds in southeastern Colorado, the Panhandle of Texas, the Rio Grande and Pecos River valleys of New Mexico, and the Central Highlands of Mexico (Fig. 2). A small

number of geese wintering in the western part of the Central Flyway arrive there via the Klamath Basin and the Central Valley (Armstrong et al. 1999).

Peak numbers are usually reached at Freezout Lake, Montana, during the first week in November, and most depart by the end of the month. White geese start to arrive in the Klamath Basin during mid-October, with large numbers arriving in late October or early November. Neck collar observations suggest that WIP lesser snow geese arrive in early to mid-October. Since the 1980s, an increasing proportion of lesser snow geese began bypassing the Klamath Basin, migrating directly to the Central Valley (Gilmer et al. 2004). Most of the geese that winter in the western Central Flyway arrive in early to mid-November. In the Central Highlands of Mexico (Chihuahua and Durango), lesser snow geese arrive in late-November and peak in mid-January (Armstrong et al. 1999).

Wintering Areas. – During the last ten years, the average midwinter and December surveys of white geese in the Pacific Flyway, excluding Mexico, were 723,100 and 843,300, respectively (Table 4). These include WAP and WIP lesser snow geese, as well as MP lesser snow geese and Ross's geese, the latter making up as much as 20–30% of the California wintering white goose population (Weaver 2011; Table 5). Other than the Skagit River/Fraser River (geese from the WIP), only small numbers of white geese winter anywhere else in the Pacific Flyway.

Historically, approximately 90% of the WAP wintered in the Central Valley of California, while the remainder mostly wintered in the western Central Flyway (Hines et al. 1999). However, band recoveries from the last 30 years show that the winter distribution of WAP lesser snow geese has shifted eastward and the population is increasingly mixing with MP lesser snow geese (Wood et al. 2011). In the 2000s, 81% of band recoveries occurred in the Pacific Flyway, while the rest were recovered in the western part of the Central Flyway (12%), the remainder of the Central Flyway (4%) and the Mississippi Flyway (3%) (Fig. 3; Table 6).

The midwinter survey estimate of lesser snow geese in the western part of the Central Flyway has increased since the early 1980s to about 260,200 in 2012 (Thorpe 2012; Table 7). Wood et al. (2011) suggest that WAP lesser snow geese are contributing to the observed increase in this wintering population.

Conventional leg banding conducted through the early 1980s indicated little or no interchange between wintering areas in the Pacific and Central flyways. However, neck collaring studies conducted during the late 1980s and early 1990s showed that some WAP lesser snow geese do move between the California and western part of the Central Flyway wintering areas, sometimes moving in both directions within the same winter (Kerbes 1988, 1989, 1990).

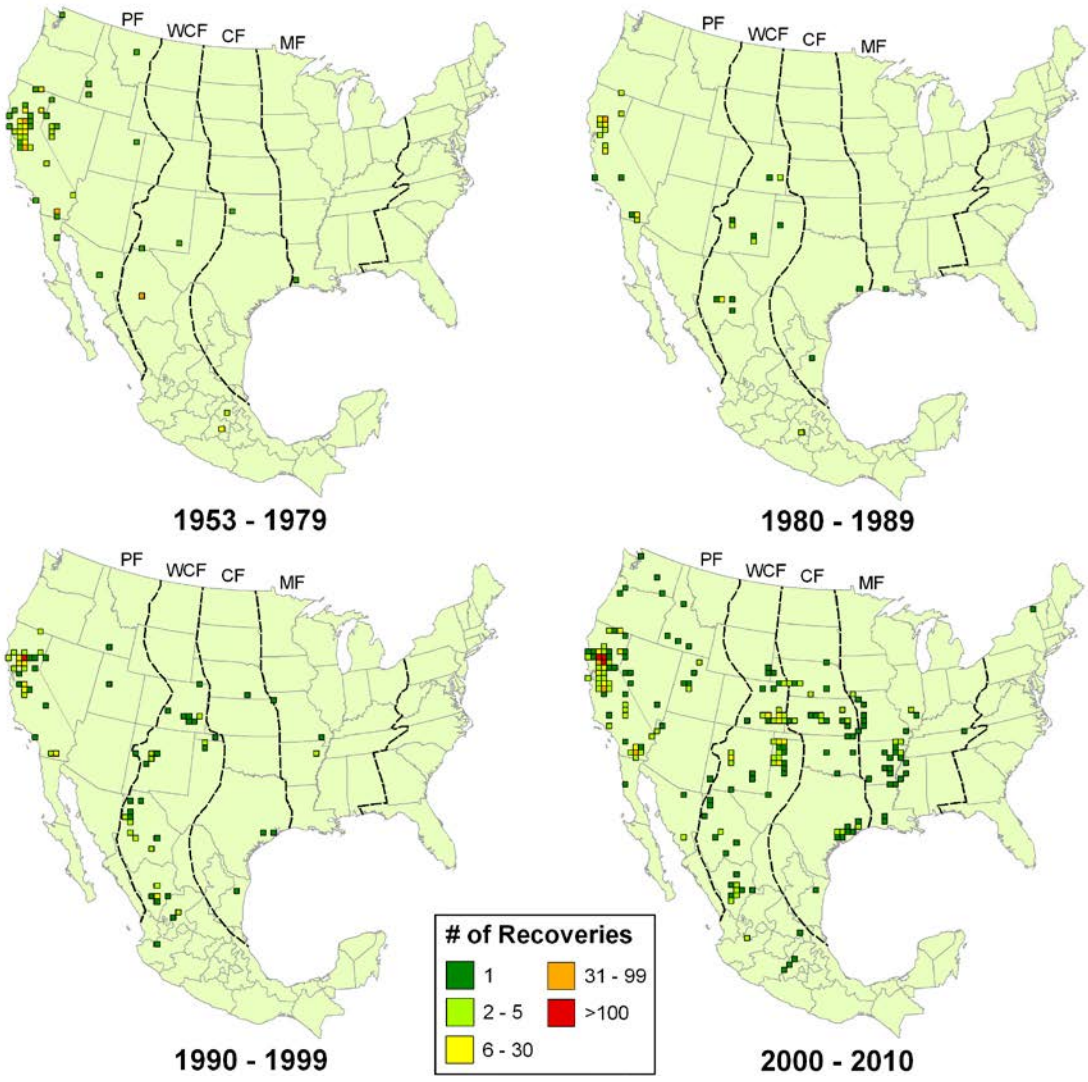

Figure 3. Distribution of leg band recoveries by recovery period for lesser snow geese marked in the Western Canadian Arctic from 1953–2007. Winter recoveries are displayed as a number per square area (2500 km2) to better represent areas with high densities. Pacific (PF), western part of the Central (WCF) and Mississippi (MF) flyways are represented by dashed lines (Wood et al. 2011).

Spring Migration Routes. – Armstrong et al. (1999) used neck collar observations to describe the spring migration of WAP lesser snow geese. Spring migration begins during February as geese leave the Central Valley of California for the Klamath Basin and southern Oregon (Fig. 2). By mid-March, they move northward through eastern Oregon and southern Idaho before moving to western Montana, southeastern Alberta, and southwestern Saskatchewan by early to mid-April on their return to the western Arctic. Since the early 2000s, significant numbers of lesser snow geese have been observed across southwestern Idaho. It is not well understood where these birds originate.

Most geese that winter in the western part of the Central Flyway make a more direct return to Alberta-Saskatchewan, but some geese follow a secondary route through the Central Valley and then on to Alberta-Saskatchewan.

Most WAP lesser snow geese that winter in southern California arrive in Utah during the last week of February, Nevada in the first week of March, eastern Oregon and Montana by mid-March, and the Canadian prairies during the first week of April (Armstrong et al. 1999). Some of the southern California geese take a route through the Central Valley and then on to Alberta-Saskatchewan (Armstrong et al. 1999).

Geese continue to travel north with the snowmelt, particularly along the Mackenzie River Valley, where they stage on islands in the river in mid-May (Latour et al. 2008). Beyond the zone of agriculture, the migration passes the snowmelt line to arrive on the nesting grounds by mid to late-May (Samelius et al. 2008). When the geese arrive on the nesting area, flocks break up into small groups and then into pairs as soon as snow-free ground is available (Barry 1967).

Production and Mortality

Barry (1967) concluded that most lesser snow geese nest for the first time in their third summer, but in particularly favorable seasons, some nest in their second summer. When snow conditions permit, nesting commences a few days after arrival on the breeding grounds. Most nest construction occurs within a ten-day period, regardless of the phenology of the season. Median nest initiation dates on Banks Island ranged from 26 May– June. Furthermore, nest initiation is highly synchronized within years, with 70–84% of geese initiating nests over a five-day period (Samelius et al. 2008). Generally, 12 days after the first nest has been completed, all laying has terminated (Cooch 1961). In a delayed season when snowmelt is late, the last bird to start laying has only about 83 days before freeze up. The average incubation period is 23.6 days and the first flight occurs about 43 days after hatching (Cooke et al. 1995, Lesage and Gauthier 1997).

Each pair occupies and defends a small area around the nest. Nests can be as close as six feet apart in the dense centers of colonies. Average clutch size ranges from 3.5–4.42, and is lower when nesting is delayed by snowmelt (Cooch 1961, Samelius et al. 2008). Number of eggs per clutch varies from two to 10, but rarely exceeds five (Cooch 1961).

Lesser snow geese are usually successful nesters, except during years of extremely severe weather. Samelius et al. (2008) found that nesting success on Banks Island ranged from 45–86%. Abandonment and nest depredation accounted for 87–100% of nest failures, while flooding and mortality of nesting females account for the remainder. As colony size increases over time,

predation pressure is generally reduced because predators become limited by factors other than food (Wittenberger and Hunt 1985, Raveling 1989). Samelius et al. (2008) speculate that the main factor affecting nesting success on Banks Island may switch from predation to spring chronology.

During 1995–1997 and 1999–2009, brood-rearing surveys of lesser snow geese on the Arctic Coastal Plain of northeast Alaska averaged 49% goslings, and ranged from 20–59% (Ritchie et al. 2011). In the western part of the Central Flyway, productivity surveys recorded an average of 20% young during the period 1984–2007 (Thorpe 2012, Table 7). The survival rate for adult WAP lesser snow geese from 2000–2007 was 0.85 (Hines et al. 2011).

Public Use

Harvest. – Currently, no method exists for estimating the proportions of harvest among the various lesser snow goose populations or breeding segments which winter in the Pacific and Central flyways. Total lesser snow goose harvest in the U.S. is measured by the federal Waterfowl Parts Collection and Mail Questionnaire Surveys, and the Harvest Information Program (HIP). About 64,100 lesser snow geese were harvested in the Pacific Flyway states in 2011, a 12% increase from the 1999–2010 average, and similar to the 2010 harvest of 65,000. The long-term average harvest (57,900) comprises 14% of the total goose harvest in the Pacific Flyway states (Table 8). Most of the flyway harvest (71%) occurs in California. Furthermore, 51% of all band recoveries occur in California (Fig. 1).

Lesser snow geese averaged 29% of the total goose harvest in California during the 2000s. The important lesser snow goose harvest counties within California for the same time period, expressed as a percentage of the state total, were: Colusa (28%), Glenn (20%), Butte (10%), Lassen (9%), and Merced (9%). The adjacent counties of Glenn and Colusa in California are the most important lesser snow goose harvest areas in the flyway. Goose harvest on state operated public hunting areas in California averaged 9–15% of the total goose harvest in the state during 1960–1989 (Fleskes et al. 1994). Lesser snow goose harvest on state operated public hunting areas in California average about 10% of the total lesser snow goose harvest in the state (M. Weaver, California Department of Fish and Wildlife, personal communication).

During the 2008–2009 regulations cycle, Council extended the white goose framework for Interior states to 10 March. Utah initiated seasons in two locations during spring 2009, Idaho followed with a season in southern Idaho in 2010, and Nevada held a season in spring 2013. Average annual harvest was estimated at 3,000 geese in Utah (B. Stringham, Utah Division of Wildlife Resources, personal communication; Table 9). In Idaho, average annual harvest was estimated at 2,200 geese (J. Knetter, Idaho Department of Fish and Game, personal communication; Table 9). The majority of band recoveries in Idaho originated from WAP geese banded in Alaska and Canada; however, there were a few recovered from the WIP.

Lesser snow goose harvest in western Canada appears to be increasing overall, but declining in Alberta. Average harvest in Alberta, British Columbia, and Saskatchewan has increased from 38,100 (1970–1979) to 102,700 (2002–2011). During the same time period in Saskatchewan, average harvest increased from 14,100 to 89,400, while Alberta harvest declined from 22,100 to 10,800 (Canadian Wildlife Service Waterfowl Committee 2012; Table 10).

Harvest rates for adult WAP lesser snow geese are low (~0.04) and are comparable to those for the overabundant MP (Alisauskas et al. 2011, Hines et al. 2011). This suggests very little impact of hunting on survival at current levels. Reduction or stabilization of the MP beginning in 1999 would have required adult survival rates to fall to 0.80 or lower (Rockwell et al. 1997). Even after 13 years of spring harvests and liberalized hunting regulations, annual adult survival ranges from 0.83–0.87 (Alisauskas et al. 2011).

Lesser snow geese nesting on Banks Island are of great importance to the Inuvialuit; geese make up an important part of local diets and are harvested by all six communities in the Inuvialuit Settlement Region, NWT (Joint Secretariat 2003). The harvest of WAP lesser snow geese by northern Aboriginal hunters in the NWT is about 6,000 per year (Hines et al. 2010). Average annual subsistence harvest in Alaska is about 1,100 birds (Naves 2010).

Nonconsumptive Use. – Lesser snow geese are impressive in areas of concentration and are of special interest to the general public. Annual snow goose festivals take place in California, Colorado, Utah, Washington and British Columbia. With increased interest in wildlife, nonconsumptive use continues to grow.

The importance of nonconsumptive use is apparent in the 2012 revision of the North American Waterfowl Management Plan (NAWMP): People Conserving Waterfowl and Wetlands. It specifically pursues formal integration of waterfowl population objectives, habitat conservation, and societal needs and desires. Furthermore, the NAWMP Committee and the National Flyway Council have formed a Human Dimensions Working Group to support the development of plan objectives for people and to ensure these actions are informed by science.

Conservation Status

In general, arctic-nesting geese have increased due to anthropogenic factors which include changes in agricultural practices, the establishment of wildlife refuges, declines in hunter numbers and hunting pressure, and climate change (Ankney 1996; Batt 1997, 1998; Moser 2001; Gauthier et al. 2005). Specifically, snow geese and Ross's geese have benefitted from these developments, and have increased to levels at which some populations of snow geese are considered overabundant in Canada and the United States, and Ross's geese are considered overabundant in the Unites States.

Lesser snow geese in the MP have increased to a level where they have caused major damage to arctic and sub-arctic ecosystems upon which they and other species depend (Leafloor et al 2012). A trophic cascade of habitat degradation has occurred whereby destructive foraging by geese has created soil salinity and moisture conditions that have led to desertification on both staging and nesting areas (Batt 1997).

As of 2001, extensive damage by foraging lesser snow geese, like that observed in the central Arctic, had not yet been observed on Banks Island; however, there is evidence that the lesser snow goose colony is negatively affecting breeding shorebird numbers within 10 km of the colony (Latour et al. 2010). Because the vast majority (95%) of the WAP of lesser snow geese nests on Banks Island, increased growth of the population is not desirable. The capacity of the lowlands that support large numbers of grazing animals (i.e., lesser snow geese and muskoxen) is unknown, and it

is extremely difficult to implement successful harvest-related management actions should the population become too large (Hines et al. 2010).

The WAP of lesser snow geese has rapidly increased on the Alaskan Arctic Coastal plain. As a result, Burgess et al. (2012) have speculated that increasing lesser snow goose numbers may have a negative impact on Pacific Brant due to competition for, or degradation of, salt marsh habitats used by both species during brood rearing.

Staging MP lesser snow and Ross's geese are known to have caused habitat degradation at coastal sites that serve as both breeding and staging sites in western and southern Hudson Bay and James Bay (Jefferies and Rockwell 2002). Limited data is available for staging sites in the western Arctic, but Obst et al. (2013) believe vegetation loss caused by salt-water flooding on the Anderson River delta may be exacerbated by the feeding activities of migrant lesser snow geese.

Increased impacts to managed wetlands have been observed in the Sacramento Valley, California, including removal of large expanses of bulrushes by foraging geese in winter months. Additional water is now being used on some areas to maintain bulrush in seasonal wetlands for goose forage and cover for other wetland species.

While WAP lesser snow geese have not been officially designated as overabundant, the long-term population growth, evidence of localized habitat loss on the breeding grounds, low rate of harvest, and high survival estimates suggest that management intervention is required to keep the population in check and prevent habitat destruction problems. Kerbes et al. (1999b) and Hines et al. (2010) recommend that the WAP be stabilized at its current level to prevent habitat loss, but still provide subsistence harvest by the Inuvialuit and hunting opportunities in the Canadian prairies, the western United States, and north-central Mexico.

The Canadian Wildlife Service has published a Notice of Intent to consider designation of the WAP of lesser snow geese as overabundant (Canadian Wildlife Service Waterfowl Committee 2012). This designation would provide tools to liberalize harvest under special conservation measures. It has become apparent from the experiences and lessons learned from management of MP lesser snow geese that a proactive approach to population management is advisable. It is easier to recover goose populations that reach low levels than to reduce them after they experience runaway growth (Leafloor et al. 2012).

Achieving a lower population through an increase in harvest alone in the Pacific Flyway may be unlikely given the gradual decline of hunters, particularly in California where the majority of harvest occurs. Active adult hunters averaged 127,600 in the 1970s compared to an average of 52,300 in the 2000s. In addition, there is concern over further liberalizing harvest regulations in California where WIP lesser snow geese mix with WAP lesser snow geese.

MANAGEMENT ISSUES

WAP lesser snow geese are currently above the North American Waterfowl Management Plan goal of 200,000. The nesting population has grown at a rate of 4% per year since 1976 and recent harvest rates are low. Both the rate of growth and harvest rates are comparable to overabundant MP lesser snow geese. While WAP lesser snow geese have not been officially designated as overabundant, the long-term population growth, evidence of localized habitat loss on the breeding grounds, low rate of harvest, and high survival estimates suggest that management intervention is required to keep the population in check and prevent habitat destruction problems.

1. WAP lesser snow geese are currently above the North American Waterfowl Management Plan goal of 200,000.
    - The nesting population on Banks Island has grown at a rate of 4% per year since 1976 and recent harvest rates are low. Both are comparable to overabundant MP lesser snow geese.
    - Nesting colonies continue to rapidly expand on the Alaskan Arctic Coastal Plain.
    - Habitat effects on breeding, staging, and wintering grounds need to be assessed.
        - Continue efforts on Banks Island and implement efforts on Alaskan Arctic Coastal Plain.
    - Monitoring is required to track population numbers, distribution, harvest rates and survival.

2. Current harvest management strategies have not eliminated crop depredation on migration and wintering areas.
    - Evaluate economic and yield impacts on agricultural production.
    - Delineate problem areas and focus harvest in those areas.

3. Habitat condition of staging areas is currently unknown.
    - Assess habitat condition at important staging areas.

4. Management activity should consider and address the needs of WIP lesser snow geese.
    - Evaluate all harvest activities on WIP lesser snow geese through banding.
    - Evaluate timing of migration and compare to WAP lesser snow geese to determine areas where harvest can be focused primarily on WAP lesser snow geese.

RECOMMENDED MANAGEMENT STRATEGIES

Habitat

1. Confirm habitat loss or alteration on the breeding grounds due to overabundance. Determine if habitat loss or alteration is occurring on the staging, or wintering grounds.

    Lead Agencies: USFWS, CWS, NWT, Yukon, states, local governments
    Priority: 1
    Schedule: Ongoing

a. Initiate a long-term evaluation of the habitat health of the breeding grounds.

Lead Agencies: USFWS, CWS, NWT, Yukon, Alaska, local governments
Priority: 2
Schedule: Ongoing

b. Assess habitat conditions at important staging areas.

Lead Agencies: USFWS, CWS, NWT, Yukon, Alaska, local governments
Priority: 2
Schedule: Ongoing

c. Determine if there are any negative impacts to agricultural areas and wetlands on migration and wintering areas.

Lead Agencies: USFWS, CDFW, CVJV, IWJV, SJV
Priority: 2
Schedule: Ongoing

2. Determine how agricultural practices and incentives in the Central Valley, northeast California and southern Oregon have contributed to increasing white goose populations.

Lead Agencies: USFWS, CDFW, CVJV, IWJV
Priority: 2
Schedule: Ongoing

a. Track rice production and agricultural practices implemented in the Central Valley, northeast California and southern Oregon.

Lead Agencies: USFWS, CDFW, CVJV, IWJV
Priority: 3
Schedule: Ongoing

3. Determine if winter habitat changes in Mexico are affecting populations of lesser snow geese. Areas which should be monitored include Laguna de Bavicora, Laguna Salada, Ascension, Casas Grandes, Minsca Mexicanos, Gertrudis Delicias Santiaguillo, south Durango, Laguna de Guzman, and Laguna de Santa Maria.

Lead Agencies: Mexico, USFWS, CWS, DUMAC
Priority: 3
Schedule: Ongoing

Harvest

1. Establish, adjust, and enforce hunting regulations to meet the objectives of this plan, and determine whether or not hunters can/will increase their harvest of lesser snow geese and Ross's geese if given the opportunity (i.e., before the population escapes the ability of hunters to control them).

   Lead Agencies: USFWS, CWS, states, provinces, territories
   Priority: 1
   Schedule: Ongoing

   a. Seek an overabundant designation for WAP lesser snow geese and implementation of Conservation Order seasons in Canada and the United States, or implementation of direct control on the primary breeding colony on Banks Island if the 2013 photo inventory indicates population growth.

      Lead Agencies: USFWS, CWS, states, provinces, territories
      Priority: 1
      Schedule: Ongoing

   b. Liberalize hunting regulations to achieve an increased harvest rate of WAP geese. If cumulative impacts to WIP geese are too great, recently liberalized regulations should be adjusted prior to reducing white goose hunting opportunity during the traditional hunting season (occurring before the last Sunday in January).

      Lead Agencies: USFWS, CWS, states, provinces, territories
      Priority: 1
      Schedule: Ongoing

2. Continue to monitor harvest of lesser snow geese and develop means to assess WAP harvest to determine effectiveness of harvest strategies.

   Lead Agencies: USFWS, CWS, states, provinces, territories
   Priority: 1
   Schedule: Ongoing

   a. Establish a monitoring program to determine the potential impacts of increased harvest on survival and harvest rates, and the distribution of harvest.

      Lead Agencies: USGS, USFWS, CWS, states, provinces, territories
      Priority: 1
      Schedule: Ongoing

3. Evaluate all harvest activities on WIP lesser snow geese through banding.

   Lead Agencies: USFWS, CWS, states, provinces, territories
   Priority: 1
   Schedule: Ongoing

4. Delineate agricultural damage areas and focus harvest in those areas.

   Lead Agencies: USFWS, CWS, states, provinces, territories
   Priority: 2
   Schedule: Ongoing

5. Continue coordination with the Alaska Migratory Bird Co-Management Council (AMBCC) through cooperative management planning, delivery of the statewide subsistence harvest survey, development of annual hunting regulations, and implementation of other conservation measures.

   Lead Agency: AMBCC
   Participating: USFWS, ADFG, WDFW, ODFW, CDFW
   Priority: 1
   Schedule: Ongoing

6. Monitor subsistence harvest in Canada involving the subsistence users as data gatherers.

   Lead Agency: CWS, NWT, Yukon
   Priority: 3
   Schedule: Ongoing

Population Monitoring

1. Perform photo census of breeding colonies at a minimum frequency of every three years.

   Lead Agency: USFWS, CWS
   Priority: 1
   Schedule: 2013, 2016

2. Determine if there are nesting colony locations that are currently unknown.

   Lead Agency: USFWS, CWS, states, provinces, territories, communities
   Priority: 1
   Schedule: 2013, 2016

   a. Build spatial models to identify potentially suitable locations for nesting colonies, and conduct aerial surveys to determine if colonies are present.

Lead Agency: USFWS, CWS
Priority: 2
Schedule: Ongoing

3. Continue the special December winter survey initiated in 1979.

   Lead Agencies: USFWS, All states
   Priority: 1
   Schedule: Ongoing

4. Conduct aerial and ground surveys to estimate the proportion of Ross's geese on the wintering grounds every third year (2014, 2017).

   Lead Agencies: USFWS, CDFW
   Priority: 1
   Schedule: Ongoing

5. Implement a lesser snow goose banding program on Banks Island and continue banding efforts on the Alaskan Arctic Coastal Plain to obtain updated harvest and survival rates.

   Lead Agencies: CWS, North Slope Borough, USFWS
   Priority: 1
   Schedule: Ongoing

6. Monitor all breeding areas in Alaska at a minimum frequency of every three years to assess the impacts on Pacific brant.

   Lead Agency: North Slope Borough, USFWS
   Priority: 1
   Schedule: 2012, 2015

7. Implement lesser snow goose banding programs on the wintering grounds to obtain harvest migration information about the recently implemented spring seasons in Idaho, Nevada, and Utah.

   Lead Agencies: USFWS, states
   Priority: 2
   Schedule: Ongoing

Research

1. Implement research and monitoring efforts on WAP lesser snow goose breeding areas on the Alaskan Arctic Coastal Plain to determine breeding biology parameters and potential productivity of established colony sites, ecology and nutrient requirements of geese, competition with ungulates, and requirements for molting areas.

Lead Agencies: USFWS, ADFG, North Slope Borough
Priority: 1
Schedule: Undetermined

2. Continue research and monitoring efforts on Banks Island, a key WAP lesser snow goose breeding area, to determine breeding biology parameters and potential productivity of established colony sites, ecology and nutrient requirements of geese, competition with ungulates, and requirements for molting areas.

   Lead Agencies: CWS, NWT
   Priority: 3
   Schedule: Undetermined

3. Determine the extent of habitat degradation that may be occurring on important staging areas in the Arctic, similar to what has been or is being done on midcontinent staging and nesting areas.

   Lead Agency: USFWS, CWS, states, provinces, territories
   Priority: 1
   Schedule: Ongoing

   a. Conduct periodic ground studies and evaluate changes in habitat over time based on classified satellite imagery.

      Lead Agency: USFWS, CWS, states, provinces, territories
      Priority: 2
      Schedule: Ongoing

4. Identify important feeding habitats for WAP geese on the Beaufort Sea Coastal Plain. These determinations should be made to evaluate how those habitats are distributed, the annual movement of geese among these areas, and project how future resource development scenarios may impact habitat availability across the Coastal Plain.

   Lead Agency: USFWS, CWS
   Priority: 2
   Schedule: Ongoing

5. Model goose energetics with available rice and land use changes.

   Lead Agencies: USFWS, states, provinces, territories
   Priority: 2
   Schedule: Ongoing

6. Identify and determine the importance of fall and spring staging areas between the breeding grounds and agricultural areas of Alberta and Saskatchewan. Assess availability of food and water, and levels of use by geese.
   Lead Agencies: CWS, NWT, Yukon, provinces
   Priority: 2
   Schedule: Undetermined

7. Evaluate current population survey methods and investigate new approaches to efficiently obtain more accurate information.

   Lead Agencies: CWS, CDFW, USFWS, states, provinces, territories
   Priority: 2
   Schedule: Ongoing

PLAN IMPLEMENTATION AND ANNUAL REVIEW

The lesser snow/Ross's goose Subcommittee shall investigate both lesser snow and Ross's geese. The subcommittee shall meet twice annually or as needed to review progress toward achieving the goal and objectives of this plan and to recommend actions and revisions. The Subcommittee shall report, through the Pacific Flyway Study Committee, accomplishments and shortcomings of management efforts to Council, state and federal agencies having relevant management responsibilities, and organizations interested in the management of geese.

The Subcommittee shall, through the Pacific Flyway Study Committee and Council, be responsible for integrating the provisions of this plan with plans and programs for management of lesser snow geese in the Central Flyway and maintain an active, cooperative dialogue with the Central Flyway Technical Committee. In addition, the subcommittee will ensure that lesser snow goose management and research guidelines, and population and habitat objectives are linked with and related to the Arctic Goose Joint Venture and habitat Joint Ventures in the Pacific Flyway (CVJV, IWJV, PCJV, SJV; North American Waterfowl Management Plan). It shall be the responsibility of the subcommittee members to assure that the objectives and procedures of this plan are integrated and coordinated with those plans and activities of the various wildlife and land management agencies and local planning systems within their agency's venue.

The Subcommittee shall be comprised of a representative from each federal, provincial and state agency having management responsibility for this goose population. Chairmanship shall be appointed biannually and rotated among member agencies. The subcommittee will exercise its prerogative to invite participation (ex officio) at meetings by any individuals, group, agency or representative whose expertise, counsel or managerial capacity is required for the coordination and implementation of management programs. The chairmanship will rotate as follows:

Montana	2011-2013
USFWS R1	2013-2015
Utah	2015-2017
Idaho	2017-2019
TBD	2019-2021
USFWS R8	2021-2023

LITERATURE CITED

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

Ankney, C. D. 1996. An embarrassment of riches: too many geese. Journal of Wildlife Management 60:217-223.

Armstrong, W.T., K.M. Meeres, R.H. Kerbes, W.S. Boyd, J.G. Silveira, J.P. Taylor, and B. Tunrner. 1999. Routes and timing of migration of Lesser Snow Geese from the Western Canadian Arctic and Wrangel Island, Russia, 1987–1992. Pages 75-88 *in* Kerbes, R.H., K.M. Meeres, and J.E. Hines, editors. Distribution, survival, and numbers of lesser snow geese of the Western Canadian Arctic and Wrangel Island, Russia. Canadian Wildlife Service Occasional Paper 98. Ottawa, Ontario, Canada.

Barry, T.W. 1967. Geese of the Anderson River Delta, NWT. Ph.D. Thesis, University of Alberta, Edmonton, Canada. 212 pages.

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., USA and Canadian Wildlife Service, Ottawa, Ontario. 120 pages.

Batt, B. D. J., editor. 1998. The greater snow goose: 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., USA and Canadian Wildlife Service, Ottawa, Ontario. 88 pages.

Benning, D. S. 1991. Western Central Flyway white goose productivity survey - 1991. Pages 11-15 *in* Productivity surveys of geese, swans and brant wintering in North America, 1991. Administrative Report. U.S. Department of Interior, Fish and Wildlife Service, Office of Migratory Bird Management, Laurel, Maryland, USA.

Blees, M., R. Rodrigues, and M. Bourdon. 2010. Howe Island snow goose and brant nest monitoring, Sagavanirktok River Delta, Alaska, 2010. Unpublished Report. LGL Alaska Research Associates, Inc., Anchorage, Alaska, USA.

Burgess, R.M., T. Obritschkewitsch, R.J. Ritchie, J.E. Shook R, A.K. Prichard, and L.B. Attanas. 2012. Surveys for nesting and brood-rearing brant and lesser snow geese, Barrow to Fish Creek Delta, Alaska, 2011. Unpublished Annual Report. Alaska Biological Research, Inc.- Environmental Research and Services, Fairbanks, Alaska, USA.

Canadian Wildlife Service Waterfowl Committee. 2012. Population status of migratory game birds in Canada: November 2012. CWS Migratory Birds Regulatory Report Number 37.

Cooch, F.G. 1961. Ecological aspects of the blue-snow goose complex. Auk 78:72-89.

Cooke, F., R. F. Rockwell, and D. B. Lank. 1995. The snow Ggeese of La Pérouse Bay: natural selection in the wild. Oxford University Press, Oxford, UK.

Drewien, R.C., A.L. Terrazas, J. P. Taylor, J.M.O. Barraza, and R.E. Shea. 2003. Status of lesser snow geese wintering in the Interior Highlands of Mexico. Wildlife Society Bulletin 31: 417-432.

Fleskes, J.P., J.M. Hicks, D.S. Glimer, and D.R. Yparraguire. 1994. Changing patterns of goose harvest on California public hunting areas. California Fish and Game 80: 133-149.

Garner, G. W., and P. E. Reynolds. 1986. Final report - baseline study of the fish, wildlife, and their habitats. Arctic National Wildlife Refuge Coastal Plain Resource Assessment. (Several volumes). U.S. Department of Interior, Fish and Wildlife Service, Anchorage, Alaska, USA.

Gauthier, G., J.-F. Giroux, A. Reed, A. Béchet, and L. Bélanger. 2005. Interactions between land use, habitat use and population increase in greater snow geese: what are the consequences for natural wetlands? Global Change Biology 11:856-868.

Gilmer, D.S., Yee, J.L., Mauser, D.M., and J.L. Hainline. 2004. Waterfowl migration on Klamath Basin National Wildlife Refuges 1953–2001. U.S. Geological Survey, Biological Resources Discipline Biological Science Report USGS/BRD/BSR—2003-0004. 66 pages.

Hines, J.E., V.V. Baranyuk, B. Turner, W.S. Boyd, J.G. Silveira, J.P. Taylor, S.J. Barry, K.M. Meeres, R.H. Kerbes, and W.T. Armstrong. 1999. Autumn and winter distributions of lesser snow geese from the Western Canadian Arctic and Wrangel Island, Russia, 1953–1992. Pages 39-74 i*n:* Kerbes, R.H., K.M. Meeres, and J.E. Hines, editors. Distribution, survival, and numbers of lesser snow geese of the Western Canadian Arctic and Wrangel Island, Russia. Canadian Wildlife Service Occasional Paper 98. Ottawa, Ontario, Canada.

Hines J.E., P.B. Latour, and C.S. Machtans. 2010. The effects on lowland habitat, breeding shorebirds and songbirds in the Banks Island Migratory Bird Sanctuary Number 1 by the growing colony of lesser snow geese (*Chen caerulescens caerulescens*). Canadian Wildlife Service Occasional Paper 118. Ottawa, Ontario, Canada.

Hines, J.E., P.F. Woodward, M.O.W. Robertson, and C.J. Wood. (2011, January). Survival, band recovery, and harvest estimated for Western Arctic Lesser Snow Geese, 2000–2007. Poster session presented at the 12th North American Arctic Goose Conference, Portland, Oregon, USA.

Hupp, J. W., D. G. Robertson and A. W. Brackney. 2002. Snow Geese. Pages 71-74 *in* Douglas, D. C., P. E. Reynolds, and E. B. Rhode, editors. Arctic Refuge coastal plain

terrestrial wildlife research summaries. U. S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001.

Jefferies, R.L. and R.F. Rockwell. 2002. Foraging geese, vegetation loss and soil degradation in an Arctic salt marsh. Applied Vegetation Science 5:7-16.

Joint Secretariat. 2003. Inuvialuit harvest study, data and methods report 1988–1997. Inuvik, Northwest Territories, Canada. 209 pages.

Kendall, S. 2006. Distributions and abundance of post-breeding snow geese on the coastal plains of Arctic National Wildlife Refuge, Alaska, 2003–2004. Unpublished Report, Arctic National Wildlife Refuge, U. S. Fish and Wildlife Service, Fairbanks, Alaska, USA. 21 pages.

Kerbes, R.H. 1983. Lesser snow goose colonies in the western Canadian Arctic. Journal of Wildlife Management 47:523-526.

Kerbes, R.H. 1986. Lesser snow geese, Anser c. caerulescens, nesting in the western Canadian Arctic in 1981. Canadian Field-Naturalist 100:21-217.

Kerbes, R.H. 1988. Progress Report, International snow goose neckbanding project. Unpublished Report, Canadian Wildlife Service, Saskatoon, Saskatchewan, Canada. 14 pages.

Kerbes, R.H. 1989. International snow goose neckbanding project, progress report, 1988–89. Unpublished Report, Canadian Wildlife Service, Saskatoon, Saskatchewan, Canada. 18pages.

Kerbes, R.H. 1990. International Snow and Ross' Goose Project, Progress Report, 1989–90. Unpublished Report, Canadian Wildlife Service, Saskatoon, Saskatchewan, Canada. 15 pages.

Kerbes, R.H., V.V. Baranyuk, and J.E. Hines. 1999. Estimated size of the Western Canadian Arctic and Wrangel Island Lesser Snow Goose populations on their breeding and wintering grounds. Pages 25-38 i*n* Kerbes, R.H., K.M. Meeres, and J.E. Hines, editors. Distribution, survival, and numbers of Lesser Snow Geese of the Western Canadian Arctic and Wrangel Island, Russia. Canadian Wildlife Service Occasional Paper 98. Ottawa, Ontario, Canada.

Kerbes, R.H., K.M. Meeres, and J.E. Hines. 1999b. Distribution, survival, and numbers of Lesser Snow Geese of the Western Canadian Arctic and Wrangel Island, Russia. Canadian Wildlife Service Occasional Paper 98. Ottawa, Ontario, Canada.

Latour, P.B., J. Leger, J.E. Hines, M.L. Mallory, D.L. Mulders, H.G. Gilchrist, P.A. Smith, and D.L. Dickson. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut. 3rd edition. Canadian Wildlife Service Occasional Paper 114. Ottawa, Ontario, Canada.

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., USA and Canadian Wildlife Service, Ottawa, Ontario.

Lesage, L. and G. Gauthier. 1997. Growth and organ development in greater snow goose goslings. Auk 114:229-241.

McEwen, E.H. 1958. Observations on the lesser snow geese nesting grounds, Egg River, Banks Island. Canadian Field-Naturalist 72:122-127.

Moser, T.J., editor. 2001. The status of Ross's geese. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C., USA and Canadian Wildlife Service, Ottawa, Ontario.

Naves, L.C. 2011. Alaska migratory bird subsistence harvest estimates, 2009. Alaska Migratory Co-Management Council. Alaska Department of Fish and Game, Division of Subsistence. Technical Paper No. 364. Anchorage, Alaska, USA.

Obst, J., J.E. Hines, J.-F. Dufour, P.F. Woodard, and R.F. Bromley. 2013. Habitat conditions, grizzly bear predation of nests, and spring use of the Anderson River Delta by lesser snow geese and brant, 2005–06. Technical Report Series No. 523, Canadian Wildlife Service Yellowknife, Northwest Territories, Canada.

Raveling, D.G. 1989. Nest-predation rates in relation to colony size of Black Brant. Journal of Wildlife Management 53: 87-90.

Ritchie, R, R. Burgess, J. Shook, T. Obritschkewitsch, B. Person, and R. Suydam. (2011, January). Monitoring snow geese on the Arctic Coastal Plain, Alaska: Piecing together a history of snow goose colonies (1991–2010). Poster session presented at the 12th North American Arctic Goose Conference, Portland, Oregon, USA.

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., USA and Canadian Wildlife Service, Ottawa, Ontario.

Samelius, G., R.T. Alisauskas, and J.E. Hines. 2008. Productivity of lesser snow geese on Banks Island in 1995 to 1998. Canadian Wildlife Service Occasional Paper 115. Ottawa, Ontario, Canada.

Spindler, M. A. 1978. Fall staging of lesser snow geese on the north slope of the Arctic National Wildlife Range. Unpublished Report, Arctic National Wildlife Range, U. S. Fish and Wildlife Service, Fairbanks, Alaska, USA. 11 pages.

Thorpe, P. 2012. Western Central Flyway white goose productivity survey - 2011–2012. Unpublished Report. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Lakewood, Colorado, USA. 15 pages.

Weaver, M. 2011. Status of Ross' and lesser snow geese wintering in California - 2011. Unpublished Report, California Department of Fish and Wildlife, Sacramento, California, USA. 8 pages.

Wittenberger, J.F. and G.L. Hunt. 1985. The adaptive significance of coloniality in birds. Avian Biology 8: 1-78.

Wood, C.J, J.E. Hines, and M.O.W. Robertson. (2011, January). Winter distribution of Western Arctic snow geese. Poster session presented at the 12th North American Arctic Goose Conference, Portland, Oregon, USA.

Table 1. Description of habitats used by Western Arctic Population lesser snow geese of the Pacific Flyway.

AREA	USE	NUMBER	SEASON	REMARKS	THREATS/SAFEGUARDS
ALASKA					
Sagavanirktok River delta	Breeding	2,000	Spring-summer	Major brood-rearing and banding site.	Adjacent to Prudhoe and Endicott oilfields.
Ikpikpuk River delta	Breeding	8,000	Spring-summer	Colony boom in 2000.	In NPR-A lease area.
Arctic NWR coastal plain	Migration	100-325,000	Late summer	Portions used for molting and staging.	Federal refuge oil and gas prospect.
CANADA					
Banks Island	Breeding	>400,000	Spring-summer	Based on aerial photo surveys approximately every five years. The population has grown from <200,000 nesting birds in 1970s and 1980s to a peak of >570,000 nesting birds in 2002. The current nesting population is >400,000 birds, based on the 2009 aerial photo survey.	
Anderson River delta	Breeding	1,400	Spring-summer	In the 1970s and 1980s, 4,000-8,000 lesser snow geese nested at the Anderson River colony. From 1995–2009, an average of 1,400 geese nested annually at Anderson River. The lower nesting numbers is thought to be from increased grizzly bear predation and vegetation changes.	Vegetation changes.

Table 1 Continued

Kendall Island	Breeding	1.800	Spring-summer	In the 1970s and 1980s, the Kendall Island colony. From 1995–2009, an average of 1,800 geese have nested annually at Kendall Island. The nesting population typically varies a lot from year to year.	Near proposed Mackenzie Gas Project and potential offshore oil and gas development.
Mackenzie River delta	Migration	25-320,000	Fall	In years when the Yukon and Alaskan North Slope is snow-covered, large numbers of snow geese will stage for extended periods in the delta.	
Mackenzie River Islands	Migration		Spring	The Mackenzie River is a major spring migration corridor and it is probable that the entire WAP migrates down the Mackenzie Valley. Islands on the Mackenzie River are important spring stopover areas for Snow Geese. Duration of stay is generally short, but depends on weather and snow conditions further north.	
Anderson River delta	Migration	20,000-40,000	Spring		
Yukon North Slope	Migration	100-600,000	Late summer		
Hay Lake, Grande Prairie	Migration		Fall, spring		
SE Alberta, SW Saskatchewan	Migration		Fall, spring		
MONTANA					
Freezout Lake	Migration	10-50,000 100-300,000	Fall Spring	Migration splits to OR, ID, UT, NV, CA.	
IDAHO					
Southwest Idaho	Migration	~50,000+	Spring		
Eastern Idaho	Migration	~30,000+	Spring		

Table 1 Continued

UTAH					
Great Salt Lake Marshes	Migration	<2,500	Fall		
Delta, UT and Bear River Marshes	Migration	~30,000	Spring	Mixed white geese.	
NEVADA					
Carson Sink	Migration and wintering	1,000-20,000	Fall, winter, spring		
OREGON					
Summer Lake (WA)	Migration	10,000	Fall, spring	Mixed white geese.	State wildlife area.
CALIFORNIA					
Klamath Basin	Migration	300,000+	Fall, spring	Mixed white geese.	Mostly on federal refuges.
Central Valley	Wintering	1,000,000	Winter	Mixed white geese.	State and federal areas, managed private lands (duck clubs) stable. Rice acreage subject to market fluctuations. Fowl cholera and botulism.
Imperial Valley	Wintering	30,000	Winter	Some WIP geese.	One state wildlife area and one federal refuge.
NEW MEXICO					
Bosque del Apache National Wildlife Refuge	Migration/wintering	57,000	Fall, winter	Population increasing since the 1950s.	Federal refuge.
Bitter Lake National Wildlife Refuge	Migration/wintering	75,000	Fall, winter	Population increasing since the 1950s.	Federal refuge.
COLORADO					
Northeast Colorado	Migration/wintering	11,000	Fall, winter	Increasing substantially in last decade.	
Southeast Colorado	Migration	42,000	Fall, winter	Population increasing since the 1950s.	Wintering since 1984–85.
MEXICO					
Central Highlands	Wintering	62,000	Winter		

Table 2. Photographic inventories of lesser snow goose colonies in the Western Canadian Arctic, 1976-2009.

Colony	No. Nesting Pairs	Total Nesting Area(km^2)	% analyzed on photos	Density Birds[a] per ha	% Non-breeding	Sample size	Total Geese
Banks Is.							
June 1976[b]	82,511	605.3	16	1.4	6%	42,007	175,555
June 1981[c]	99,063	169.2	33	5.9	8%	93,591	215,354
June 1987[d]	98,253	109.4	16	18.0			196,506
June 1995[d]		112.1	18	42.8			479,362
June 2002[e]		304.5					570,517
June 2007[e]							302,133
June 2009[e]		203.5	15	21.0			427,019
Anderson River							
June 1976[b]	1,913	15.5	100	1.2	21%	4,843	4,843
June 1981[c]	4,180	16.9	100	2.5	10%	9,238	9,238
June 1987[d]	3,593	15.9	100	4.6			7,186
June 1995[d]		15.2	100	2.4			3,607
June 2002[e]							2,288
June 2007[e]							4,036
June 2009[e]		21.0	82	0.1			222
Kendall Island							
June 1976[b]	416	6.2	100	0.7	41%	1,577	1,577
June 1981[c]	521	2.6	100	2.0	10%	1,153	1,153
June 1987[d]	690	3.2	100	4.4			1,380
June 1995[d]		6.4	100	4.8			3,050
June 2002[e]							6,948
June 2007[e]							4,606
June 2009[e]		7.7	100	0.4			287
Total (weighted)							
June 1976[b]	84,840	627.0		1.4	7%		181,975
June 1981[c]	103,764	188.7		5.5	8%		225,745
June 1987[d]	102,536	128.5		16.0			205,072
June 1995[d]		133.7		36.4			486,019
June 2002[e]							579,753
June 2007[e]							310,775
June 2009[e]		232.2					427,528

[a] Density from 1976 and 1981 presented as breeding pairs/ha.
[b] Kerbes, R.H. 1983.
[c] Kerbes, R.H. 1986.
[d] Kerbes et al. 1999a.
[e] Unpublished data, Canadian Wildlife Service.

Table 3. Inventories of lesser snow goose colonies on the Arctic Coastal Plain of northeast Alaska, 1980–2010.

Colony[a]	No. Nesting Pairs
Ikpikpuk	
1980	40
1990	40
2000	300
2010	4,000
Kukpowruk	
1980	0
1990	60
2000	40
2010	310
Colville Delta	
1980	5
1990	5
2000	90
2010	800
Howe Island	
1980	50
1990	400
2000	190
2010	1,000

[a] Ritchie et al . 2011.

Table 4. Estimated white geese in the Pacific Flyway from midwinter counts, 1955–2013, and special November - December white goose surveys,1979–2012.

Midwinter Survey				November-December Survey	
1955	317,284	1979	247,001		
1956	416,185	1980	378,252	1979	528,100
1957	356,601	1981	448,094	1980	204,200
1958	324,145	1982	660,549	1981	759,900
1959	388,143	1983	445,064	1982	354,100
1960	367,332	1984	525,945	1983	547,600
1961	463,523	1985	371,046	1984	466,300
1962	568,938	1986	557,223	1985	549,800
1963	482,916	1987	335,586	1986	521,700
1964	484,806	1988	345,101	1987	525,300
1965	533,493	1989	411,411	1988	441,000
1966	338,774	1990	572,118	1989	463,900
1967	746,610	1991	564,480	1990	708,500
1968	505,825	1992	428,648	1991	690,100
1969	432,809	1993	434,304	1992	639,300
1970	461,676	1994	550,269	1993	569,200
1971	513,221	1995	390,243	1994	478,200
1972	436,716	1996	411,665	1995	501,400
1973	343,445	1997	534,457	1996	366,300
1974	443,138	1998	336,290	1997	416,400
1975	446,540	1999	487,854	1998	354,300
1976	487,078	2000	646,014	1999	579,000
1977	507,347	2001	546,429	2000	656,800
1978	236,681	2002	399,169	2001	448,200
		2003	474,330	2002	596,800
		2004[a]	451,677	2003	587,800
		2005	795,928	2004	750,300
		2006	553,993	2005	710,700
		2007	734,415	2006	799,700
		2008	875,215	2007	1,073,455
		2009	852,666	2008	958,000
		2010	713,997	2009	900,969
		2011	628,433	2010	800,156
		2012	848,375	2011	1,027,887
		2013	776,353	2012	824,432
Long-term Mean			497,217		611,759

[a] January 2004 midwinter survey was incomplete in several states.

Table 5. Composition of lesser snow and Ross's geese from winter air and ground surveys in California, 1977–2011.

Month	Year	White Geese	Snow Geese	Ross's Geese	% Snow Geese
January	1977	507,347	400,937	106,410	65.9[a]
February	1989	560,650	545,928	214,722	58.1[a]
January	1990	572,118	403,691	168,427	56.4[a]
December	1992	598,100	575,914	221,286	63.1
December	2000	652,270	601,733	250,537	61.6
December	2005	630,686	410,881	219,805	65.2
December	2008	900,403	618,155	282,248	68.7
December	2011	1,027,887	818,614	209,273	79.6

[a] Percent Ross's geese calculated only from proportion among white geese in the Central Valley.

Table 6. Band recoveries of lesser snow geese marked in the Western Canadian Arctic 1953–2007, by flyway and state during winter recovery periods (December-February, Wood et al. 2011).

Location		1953–69			1970–79			1980–89			1990–99			2000–2010		
Flyway	**State**	**#**	**State (%)**	**Flyway (%)**	**#**	**State (%)**	**Flyway (%)**	**#**	**State (%)**	**Flyway (%)**	**#**	**State (%)**	**Flyway (%)**	**#**	**State (%)**	**Flyway (%)**
Pacific	*Arizona*	1	0.2	**92.4**	-	-	**94.3**	-	-	**81.1**	-	-	**77.6**	6	0.5	**81.0**
	California	389	89.6		312	93.1		107	81.1		228	76.3		966	78.3	
	Idaho	1	0.2		1	0.3		-	-		1	0.3		4	0.3	
	Nevada	6	1.4		3	0.9		-	-		1	0.3		5	0.4	
	Oregon	-	-		-	-		-	-		1	0.3		4	0.3	
	Utah	1	0.2		-	-		-	-		1	0.3		7	0.6	
	Washington	1	0.2		-	-		-	-		-	-		3	0.2	
	Mexico - West	2	0.5		-	-		-	-		-	-		4	0.3	
Western	*Colorado*	-	-	**7.6**	-	-	**5.1**	3	2.3	**16.7**	8	2.7	**18.7**	49	4.0	**12.0**
Central	*Montana*	1	0.2		-	-		-	-		-	-		-	-	
	New Mexico	-	-		2	0.6		6	4.5		8	2.7		15	1.2	
	Texas - NW	-	-		-	-		1	0.8		3	1.0		48	3.9	
	Wyoming													2	0.2	
	Mexico - Highlands	32	7.4		15	4.5		12	9.1		37	12.4		34	2.8	
Central	*Kansas*	-	-	**0.0**	-	-	**0.3**	-	-	**1.5**	-	-	**1.7**	19	1.5	**4.1**
(East Tier	*Nebraska*	-	-		-	-		-	-		1	0.3		11	0.9	
States)	*Oklahoma*	-	-		1	0.3		-	-		1	0.3		4	0.3	
	South Dakota	-	-		-	-		-	-		-	-		1	0.1	
	Texas - SE	-	-		-	-		1	0.8		2	0.7		15	1.2	
	Mexico - East	-	-		-	-		1	0.8		1	0.3		1	0.1	
Mississippi	*Arkansas*	-	-	**0.0**	-	-	**0.3**	-	-	**0.8**	4	1.3	**2.0**	14	1.1	**2.8**
	Illinois	-	-		-	-		-	-		-	-		3	0.2	
	Kentucky	-	-		-	-		-	-		-	-		1	0.1	
	Louisiana	-	-		1	0.3		1	0.8		-	-		4	0.3	
	Mississippi	-	-		-	-		-	-		-	-		3	0.2	
	Missouri	-	-		-	-		-	-		2	0.7		9	0.7	
	Tennessee	-	-		-	-		-	-		-	-		1	0.1	
Total		**434**	100.0	**100.0**	**335**	100.0	**100.0**	**132**	100.0	**100.0**	**299**	100.0	**100.0**	**1233**	100.0	**100.0**

Table 7. Historical wintering population and productivity data, Western Central Flyway white goose population, U.S. and Mexico combined, 1979–2011.

Year	Population Estimate	Sample Size	% Composition			% Juveniles		Juv./Family	
			Snow[2]	Ross's[2]	Blue[2]	Snow	Ross's	Snow	Sample Size
1979[3]	94,283	6,776	86.7	13.3	2.2	20.6	21.6	--	--
1980[3]	98,996	8,833	85.6	14.4	3.5	35.2	30.7	--	--
1981[3]	75,073	5,705	84.4	15.6	2.6	25.1	22.1	--	--
1982	141,702	2,515	--	--	--	12.7	--	--	--
1983	36,493	8,988	71.1	28.9	1.8	39.9	19.2	--	--
1984[3]	63,043	15,224	93.6	6.4	1.8	25.6	22.1	--	--
1985	176,713	25,217	91.9	8.1	1.4	30.1	22.9	--	--
1986	121,395	23,721	85.3	14.7	0.9	3.7	12.2	2.03	378
1987	120,655	28,060	86.5	13.5	1.1	19.4	8.1	2.13	2,185
1988[3]	134,352	31,222	86.2	13.8	1.1	27.3	16.3	2.3	1,603
1989	172,813	34,336	89.1	10.9	1.7	21	27.2	2.12	1,214
1990	166,900	28,321	84.8	15.8	1.3	21.5	12.3	1.94	1,297
1991[3]	91,739	20,004	84.8	15.2	1.8	11.7	11.4	1.83	812
1992	139,162	21,629	80.1	19.9	1	15.6	8	1.93	850
1993	196,700	35,538	76.4	23.7	1.7	34.2	20.3	2.41	1,414
1994	161,290	26,531	74.4	25.6	1.3	18.9	13.8	1.99	916
1995	193,915	33,648	75.5	24.5	2.4	22.3	18.2	2.09	1,302
1996	183,290	37,005	82	18	1.7	29	20.9	2.42	2,019
1997	218,658	41,183	70.2	29.8	2.4	15.8	14	1.82	1,364
1998	240,410	43,771	75.4	24.6	1.9	31.8	24.9	2.11	2,202
1999	309,861	44,072	78.9	21.1	3.1	27.3	27.4	2.15	2,161
2000	221,736	40,270	75.9	24.1	2.3	12.6	12.8	1.78	1,066
2001	211,640	37,783	76	24	1.9	9.8	18.7	1.76	816
2002	236,775	47,868	69	31	1.8	7.8	14.9	1.6	841
2003	192,132	33,537	73.2	26.8	2	20.6	21.1	1.9	1,140
2004	228,065	32,089	63.2	36.8	3.7	14.9	10.5	1.9	991
2005	173,708	35,959	63.4	36.6	3.1	28.1	11.8	2.3	982
2006	282,680	40,304	76.4	23.6	3	24	20.2	2.3	1,094
2007	225,015	41,988	66.7	33.3	3.2	11.4	9.7	1.7	808
2008[3]	204,110	41,408	70.4	29.6	4.3	15.7	12.6	1.6	518
2009[3]	179,996	37,746	68.7	31.3	3.8	9.2	6.8	1.6	376
2010[3]	156,160	38,473	70.4	29.6	3.6	24.7	14	1.8	397
2011[3]	260,190	44,288	66.8	33.2	4.2	24.7	19.6	1.8	328
Avg 1984–2007[4]	198,739	34,841	76.8	23.2	2.0	20.0	16.7	2.0	1,252
% change from 2010	40.0	13.1	-5.4	10.8	14.3	0.0	28.6	0.0	-21.0

[1] Population estimates from ground and aerial estimates during production surveys; Chihuahua, Mexico added to coverage in 1984.
[2] Generated using adult component only.
[3] Incomplete survey coverage.
[4] Average does not include years prior to the addition of the Mexico productivity survey that began in 1984. Averages only include years of complete survey coverage.

Table 8. Estimated lesser snow/blue goose harvests in Pacific Flyway states, the Central, Mississippi, and Atlantic flyways, and the U.S. total from (a) the federal Mail Questionnaire Survey and (b) the Harvest Information Program, 1999–2011.

Year	AZ	CA	CO	ID	MT	NV	NM	OR	UT	WA	WY	PF Tot.	AK	CF Tot.	MF Tot.	AF Tot.	U.S. Tot.
1999	243	41,145	0	717	1,770	182	0	4,462	180	2,686	60	51,445	167	471,697	317,268	54,710	895,289
2000	323	26,344	0	0	2,101	105	0	7,899	118	1,463	0	38,352	87	385,950	236,451	72,256	733,097
2001	0	33,860	0	404	637	337	0	6,283	90	3,574	0	45,185	0	346,335	304,793	77,158	773,470
2002	221	25,180	0	218	933	107	0	7,810	0	6,730	0	41,199	329	287,793	188,949	39,375	557,645
2003	300	33,037	0	451	582	315	0	5,186	95	2,641	0	42,607	0	247,983	286,279	36,105	612,973
2004	1,200	35,355	0	124	1,188	183	0	945	80	1,535	0	40,611	0	216,202	192,256	31,548	480,617
2005	204	46,934	0	140	2,478	386	0	2,877	0	10,713	0	63,733	46	304,041	248,951	36,103	652,874
2006	492	43,551	0	122	2,089	79	0	11,160	651	13,334	0	71,479	0	255,994	213,274	33,256	574,003
2007	288	52,038	0	0	3,648	243	0	9,021	0	22,501	0	87,738	0	275,310	148,944	50,742	562,735
2008	300	70,946	0	0	1,385	90	0	3,231	403	10,920	0	87,274	0	240,597	168,482	58,752	555,105
2009	408	30,693	0	1,247	988	1,693	0	4,218	292	14,102	0	53,640	0	156,071	109,213	109,213	341,540
2010	859	54,548	0	1,221	1,382	1,652	0	2,220	866	2,285	0	65,034	0	153,759	82,935	18,293	320,021
2011	0	43,718	0	600	3,080	700	0	4,088	366	11,563	0	64,115	0	169,145	122,573	37,592	393,423
Averages:																	
1999–2000	283	33,745	0	359	1,936	144	0	6,181	149	2,075	30	44,899	127	428,824	276,860	63,483	814,193
2001–2005	385	34,873	0	267	1,164	266	0	4,620	53	5,039	0	46,667	75	280,471	244,246	44,058	615,516
2006–2011	391	49,249	0	532	2,095	743	0	5,656	430	12,451	0	71,547	0	208,479	140,904	51,308	457,805
All Years	372	41,335	0	403	1,712	467	0	5,338	242	8,004	5	57,878	48	270,067	201,567	50,393	573,292
% Change from:																	
1999–2010	-	6.3%	-	55.0%	92.7%	56.4%	-	24.9%	58.3%	50.0%	-	11.8%	-	-39.3%	-41.1%	-26.9%	-33.1%
2010	-	19.9%	-	50.9%	122.9%	57.6%	-	84.1%	57.7%	406.0%	-	-1.4%	-	10.0%	47.8%	105.5%	22.9%
% Flyway Harvest:																	
1999–2000	0.6%	75.2%	0.0%	0.8%	4.3%	0.3%	0.0%	13.8%	0.3%	4.6%	0.1%	5.5%	0.0%	52.7%	34.0%	7.8%	
2001–2005	0.8%	74.7%	0.0%	0.6%	2.5%	0.6%	0.0%	9.9%	0.1%	10.8%	0.0%	7.6%	0.0%	45.6%	39.7%	7.2%	
2006–2011	0.5%	68.8%	0.0%	0.7%	2.9%	1.0%	0.0%	7.9%	0.6%	17.4%	0.0%	15.6%	0.0%	45.5%	30.8%	11.2%	

Table 9. Estimated light goose harvest during early spring hunts in Idaho and Utah from state surveys, 2009–2012.

Year	Idaho	Utah
2009		4,500
2010	1,900	3,700
2011	1,300	2,400
2012	3,300	1,300
Average	2,200	3,000

Table 10. Estimated lesser snow/blue goose harvests in Pacific Flyway provinces from Canadian Wildlife Service Waterfowl Committee (2012), 1999–2011.

Year	British Columbia	Alberta	Saskatchewan
1999	1,990	15,416	116,313
2000	2,559	12,881	68,377
2001	2,354	13,367	100,525
2002	7,284	9,612	85,933
2003	1,312	10,539	108,457
2004	1,188	3,654	76,709
2005	2,443	6,490	81,946
2006	3,170	11,430	116,278
2007	4,626	14,976	66,934
2008	2,406	9,570	112,986
2009	1,316	11,613	80,753
2010	852	15,319	77,568
2011	0	14,970	85,848
Averages			
1970–1979	1,960	22,079	14,104
1980–1989	2,259	9,151	25,754
1990–1999	1,751	8,954	43,920
2000–2009	2,866	10,413	89,890
All Years	2,154	12,700	32,387