# CHAPTER 3

# AFFECTED ENVIRONMENT

## 3.1 LIGHT GEESE

### 3.1.1 Definition

The term light geese refers collectively to three taxa in North America: lesser snow geese (*Chen caerulescens caerulescens*), greater snow geese *(C. c. atlantica*), and Ross'sgeese (*C. rossii*). These taxa are referred to as "light" geese due to their light coloration; as opposed to "dark" geese such as Canada geese (*Branta canadensis*) and white-fronted geese (*Anser albifrons*). Interestingly, there are two color phases of lesser snow geese: the dark phase, typically referred to as "blue" geese, and white phase, typically referred to as "snow" geese or "white" geese. Blue phase lesser snow geese are the same species as white phase lesser snow geese and the two color phases may interbreed. Regardless of the color phase, blue and snow geese are referred to as light geese.

### 3.1.2 Geographic Distribution of Species

*Greater snow geese*. — Greater snow geese breed in the eastern Arctic of Canada and migrate southward through Quebec, New York, and New England to their wintering grounds in the mid-Atlantic U.S. (Fig. 3.1).

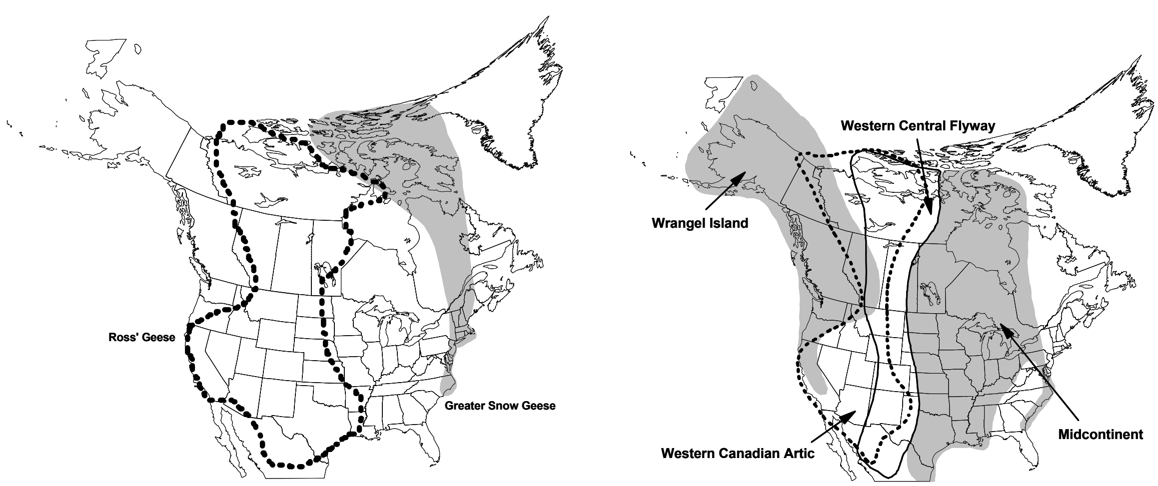


Fig. 3.1. Primary geographic distribution of greater snow (shaded area) and Ross's (dotted line) geese (left), and several populations of lesser snow geese (right).

*Ross's geese*. — Approximately 90-95% of Ross's geese breed in the Queen Maud Gulf region of the central Arctic (Kerbes 1994). Small numbers of Ross's geese also breed on Banks Island in the western Arctic, along western and southern Hudson Bay, and Southampton and Baffin Islands in the eastern Arctic. Prior to the 1960s, Ross's geese nested primarily in the central arctic region and most birds migrated to wintering areas in California. This species has dramatically expanded its range eastward in recent decades (Ryder and Alisauskas 1995; Fig. 3.1). Examination of the occurrence of Ross's geese in the harvest of the various Flyways (Fig. 3.2) illustrates the range expansion. Ross's geese did not occur in the Central Flyway harvest survey until 1974, and did not occur in the Mississippi Flyway harvest survey until 1982. The first occurrence of Ross's geese in the Atlantic Flyway was in 1996 (Sharp and Moser 1999). The largest proportion of Ross's geese winters in the Central Valley of California. Smaller numbers of Ross's geese winter in the southwest portion of the Central Flyway, and in Arkansas and Louisiana. Changes in the distribution of recoveries of banded birds further illustrate the range expansion from the 1950s to the 1990s (Table 3.1).

*Lesser snow geese*. — Lesser snow geese breed throughout much of the arctic region of North America. Additionally, a population that breeds on Wrangel Island, Russia, migrates through Alaska, western Canada, and several western States (Fig. 3.1). The wintering range of this species is broad, with birds nesting in the western Arctic tending to winter in the Pacific Flyway, and birds nesting in the central and eastern Arctic wintering in the Central and Mississippi Flyways (Table 3.1). Small numbers of lesser snow geese winter in the Atlantic Flyway.

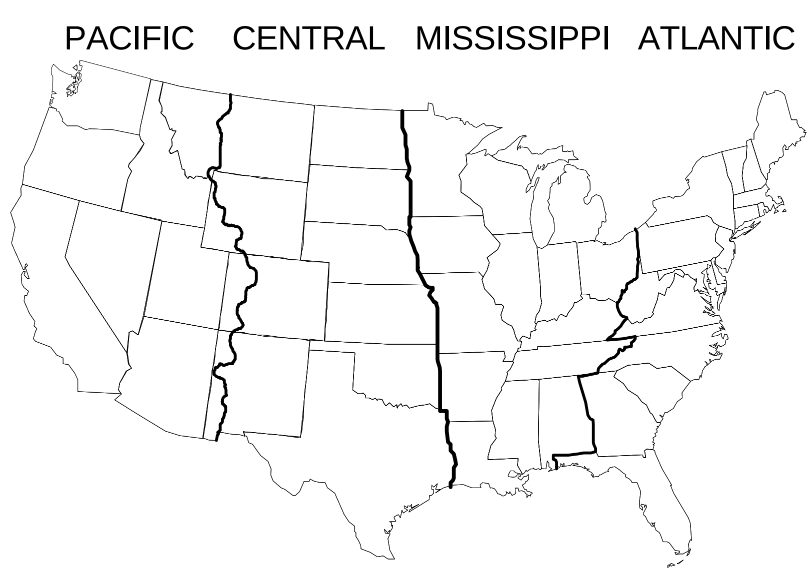


Fig. 3.2. Boundaries of administrative Flyways.

## 3.1.3 Population Delineation

Waterfowl management activities frequently are based on delineation of populations that are the target of management. In most instances, populations are delineated according to where they winter, whereas others are delineated based on location of their breeding grounds. For management purposes, populations can be comprised of one or more species of geese that generally breed and/or winter in similar areas. For example, lesser snow geese and Ross's geese in the central portion of North America are frequently found in the same breeding, migration, and wintering areas. Due to these similarities, the term "light goose population" is used to refer to various populations comprised of both lesser snow geese and Ross's geese, as described below. In descriptions of geographic areas, eastern Arctic refers to the area east of approximately longitude $95^{o}$ W; the central Arctic refers to the area between $95^{o}$ W and approximately $115^{o}$ W and the western Arctic refers to the area west of $115^{o}$ W. Administrative Flyway boundaries also are used to describe population ranges (Fig. 3.2).

*Greater snow geese*. — A single population of greater snow geese is recognized in North America. The population is relatively isolated from other light goose populations, except for potential mixing with small groups of lesser snow geese in the central portion of the Atlantic Flyway.

*Mid-Continent Population (MCP) of light geese*. — This term is used to describe light geese (lesser snow and Ross's geese) that migrate primarily through North Dakota, South Dakota, Nebraska, Kansas, Iowa, and Missouri, and winter in Arkansas, Louisiana, Mississippi, and eastern, central, and southern Texas. MCP birds nest in colonies along the southern and western shores of Hudson Bay and on Southampton and Baffin Islands in the eastern Arctic, and in the Queen Maud Gulf region of the central Arctic (Fig. 3.3). Field studies conducted in Texas during winter indicate that MCP light geese are comprised of approximately 94.3% lesser snow geese and only 5.7% Ross's geese (Texas Parks and Wildlife Department, unpublished data).

*Western Central Flyway Population (WCFP) of light geese*. — WCFP light geese winter in southern Colorado, northwestern Texas, New Mexico, and the Northern Highlands of Mexico (Hines et al. 1999). WCFP light geese nest primarily in the central and western Canadian Arctic, with nesting colonies on Banks Island (mostly lesser snow geese, with some Ross's geese) and Queen Maud Gulf (mostly Ross's geese, with some lesser snow geese). Observations of birds marked with neck collars indicate that 17% of lesser snow geese from the central Arctic (Kerbes et al. 1999), and 24% of lesser snow geese from the western Arctic (Armstrong et al. 1999), migrate to WCFP wintering areas. Neck collar data are not available

Table 3.1. Distribution of legband recoveries for lesser snow and Ross's geese banded in the western, central, and eastern Arctic by decade, 1950-98. Numbers in parentheses represent sample size for each species by decade. Recoveries are not weighted by population size, nor are they adjusted for differences in band-reporting rates among Flyways.

| | | Western Arctic[1] | | | | | Central Arctic[2] | | | | | Eastern Arctic and Subarctic[3] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Flyway | 1950s (0) | 1960s (0) | 1970s (0) | 1980s (0) | 1990-98 (0) | 1950s (2) | 1960s (279) | 1970s (274) | 1980s (45) | 1990-98 (479) | 1950s (0) | 1960s (7) | 1970s (30) | 1980s (9) | 1990-98 (160) |
| Ross's | Pacific | | | | | | 100 | 96 | 94 | 87 | 60 | | 29 | 3 | 0 | 8 |
| | Central | | | | | | 0 | 3 | 5 | 13 | 32 | | 43 | 90 | 100 | 63 |
| | Mississippi | | | | | | 0 | <1 | <1 | 0 | 8 | | 29 | 7 | 0 | 29 |
| | Atlantic | | | | | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| | | (41) | (648) | (448) | (190) | (334) | (0) | (25) | (42) | (34) | (409) | (3,293) | (8,685) | (16,328) | (9,810) | (3,603) |
| Lesser | Pacific | 95 | 95 | 96 | 84 | 87 | | 4 | 10 | 0 | 2 | <1 | <1 | <1 | <1 | <1 |
| | Central | 5 | 5 | 4 | 15 | 11 | | 88 | 80 | 82 | 61 | 78 | 70 | 70 | 74 | 63 |
| | Mississippi | 0 | 0 | 0 | 1 | 2 | | 8 | 10 | 18 | 37 | 22 | 30 | 30 | 25 | 37 |
| | Atlantic | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <1 | <1 |

[1] Area between 115° and 140° W longitude, above 65° latitude.

[2] Area between 95° and 115° W longitude, above 65° latitude.

[3] Area east of 95° W longitude.


Fig. 3.3. Major arctic and subarctic geographic features referenced to in text.

for Ross's geese. Overall, the WCFP is comprised of approximately 79% lesser snow geese and 21% Ross's geese (Thorpe 1999).

MCP and WCFP light geese confine most of their migration and wintering activities to the Mississippi and Central Flyways. For this reason, these 2 populations were collectively referred to as Mid-Continent Light Geese (MCLG) in our previous Environmental Assessment (U.S. Fish and Wildlife Service 1999). However, the term Mid-Continent Light Geese often was confused with the term Mid-Continent Population (MCP) of light geese. In order to eliminate such confusion, we have chosen to refer to the combination of MCP and WCFP birds as Central/ Mississippi Flyway (CMF) light geese.

*Western Population of Ross's geese (WPRG).* — We have chosen this designation for those Ross's geese that migrate to the Pacific Flyway; primarily to the Central Valley of California. The WPRG nest mainly in the Queen Maud Gulf region of the central Arctic, with some birds nesting on Banks Island in the western Arctic. The WPRG comprises the largest percentage of wintering Ross's geese in the U.S. However, the percent of central arctic Ross's geese marked with leg-bands that are recovered by hunters in the Pacific Flyway has declined from nearly 100% in the 1950s and 1960s, to 60% during 1990-98 (Table 3.1).

*Pacific Flyway Population of lesser snow geese (PFSG)*. — PFSG winter in the Pacific Flyway and nest primarily on Banks Island, and coastal river deltas on the mainland at Anderson River and Kendall Island in the western Arctic. Neck collar observations indicate that approximately 76% of lesser snow geese that nest in the western Arctic migrate to PFSG wintering areas (Hines et al. 1999). Very few lesser snow geese banded in the central and eastern Arctic are recovered in the Pacific Flyway (Table 3.1).

*Wrangel Island Population of lesser snow geese*. — This population nests on Wrangel Island off the north coast of Russia, and winters in southern British Columbia, the Puget Sound area of Washington, and in northern California.

## 3.1.4 Population Surveys

The status of light goose populations in North America is monitored using a combination of aerial and ground surveys conducted on breeding, migration, and wintering areas. Due to the difficulty of conducting surveys throughout the vast arctic region, light goose breeding colonies (primarily lesser snow geese and Ross's geese) are monitored on a 5-year rotating basis using low-level aerial photography (Kerbes 1994, Kerbes et al. 1999). Therefore, estimates of the number of breeding birds at each colony are not available every year. Surveys of breeding colonies provide estimates of the number of nesting birds, but not the number of non-breeding birds (primarily 1- and 2-year olds). Consequently, the total population size in spring is higher than breeding colony estimates. On the average, snow goose populations are considered to have 25-35% non-breeders in spring (Kerbes et al. 1999). Therefore, the total population size may be 1.25 to 1.35 times greater than breeding colony estimates indicate.

The population of greater snow geese is estimated each spring (1965-present) when the entire population is staging in the St. Lawrence River Valley during northward migration (Reed et al. 1998). Recently, monitoring of radio-marked birds has been used to determine the percentage of birds that have dispersed outside the surveyed areas. The photo survey estimate is then corrected for the percentage of birds outside the survey coverage. By taking advantage of the concentration of the entire population at one point in time, this survey is a reliable method for monitoring population size of this species.

Mid-winter waterfowl surveys are conducted each year throughout the entire lower 48 States in the U.S. These surveys began in some areas as early as the 1930s; however, consistent survey coverage and data summarization began in 1955. Biologists did not begin separate inventories of MCP and WCFP light geese until the winter of 1969/70. Therefore, during 1955-1969, the CMF light goose count could not be separated into MCP and WCFP components.

Because not all areas in each State are surveyed, the mid-winter survey does not provide a complete population estimate for light geese. Instead, the survey provides an index to the winter population of geese, which should not be confused with the size of the breeding population. Past photographic inventories of eastern arctic nesting colonies suggested that winter indices averaged about half of the actual spring population estimate (Kerbes 1975). Boyd et al. (1982) used a correction factor of 1.6 to apply to winter indices to estimate the approximate size of the spring breeding population.

Surveys of light geese wintering in Mexico are conducted every 3 years. Therefore, a complete winter inventory of WCFP light geese is obtained every 3 years. However, WCFP light geese that occur in the U.S. are surveyed every winter in Central Flyway States. By maintaining similar survey methods from year to year, the winter index is utilized to monitor the relative size of the various populations each year. Because U.S. winter index data are available every year for most light goose populations (versus every 5 years for arctic breeding colony data), the winter index is utilized to annually monitor populations and aid in making many management decisions.

### 3.1.5 Population Status - Historical Accounts

Estimates of the size of light goose populations prior to the advent of modern aerial surveys (i.e. pre-1955) do not exist. There were no coordinated, simultaneous air or ground surveys conducted over the majority of light goose breeding or wintering ranges prior to 1955. Bent (1962:164-188; reprint of original 1925 publication) presents several accounts of observations of greater snow geese, Ross’s geese, and lesser snow geese (distinguished as snow and blue geese) during winter, migration, and breeding periods. Some of these accounts allude to large numbers of birds concentrated over large areas; however, few report actual numbers of birds observed. Furthermore, observer variability cannot be adequately assessed from the accounts. The variability in observers’ frames of reference to flock size is illustrated by comments of M. Frazar and Harrison Lewis (Bent 1962:174). M. Frazar wrote a letter describing a “large flock” of greater snow geese he saw in 1908 that was comprised of “at least 75 birds.” Lewis wrote of C. Dionne’s reference to “considerable flocks” of snow geese comprised of “three or four thousand individuals.” In this situation, 2 observers are referring to seemingly large flocks of birds, but the actual number of birds may be as low as 75, or as high as 3,000 to 4,000 birds. This variability in descriptions illustrates the difficulty in trying to compare historical, anecdotal accounts of light goose abundance with population estimates derived from standardized aerial surveys.

McIlhenny (1932) reported observing a flock of blue-phase snow geese in March 1914 that was estimated to contain 1.25-1.5 million birds. The methodology used to obtain the estimate was not specified. Prior to the 1960s, snow geese wintered almost exclusively in salt marsh habitats on the Gulf Coast (Lynch

1975, Bateman et al. 1988). In fact, McIlhenny (1932) felt that at least 70% of all wintering blue-phase lesser snow geese inhabited the marsh habitats near where his observations were made. By early March, the snow geese on the Gulf Coast seemed to gather into only 2 or 3 flocks (McIlhenny 1932). Therefore, it is not surprising that large flocks of birds were encountered in the first part of the 20th century. Lynch (1975) wrote that the number of geese wintering on the Gulf Coast prior to the advent of rice culture is unknown and is a matter of conjecture.

Johnsgard (1974) felt that early 20th century goose population estimates were either wildly optimistic, or the number of snow geese in the mid-continent region declined greatly in subsequent decades. If early anecdotal accounts of flock sizes were accurate, it is unclear why coordinated winter surveys several decades later accounted for far fewer birds. The 1954/55 winter count of light geese (primarily lesser snow geese) in the Mississippi Flyway was only 368,000 birds. There are no reports of large die-offs of geese between the early part of the 20th century and the advent of winter surveys in the mid-1950s. Furthermore, market hunting had been prohibited in 1918 with passage of the Migratory Bird Treaty Act. Therefore, evidence of large-scale declines in goose populations after the early 20th century does not exist. Evidence of arctic nesting colonies of sufficient size to corroborate early 20th century reports of large goose populations on wintering grounds also is lacking (Abraham and Jefferies 1997).

We do not question the observational abilities of the few naturalists that wrote about flocks of light geese in the mid-continent region near the turn of the 20th century. Nor do we doubt that they often encountered flocks of light geese that were of considerable size. However, it was impossible to obtain accurate range-wide estimates of light goose population size during the pre-survey period. Therefore, we have every reason to believe that current numbers of light geese in the mid-continent region are unprecedented.

In the early 20th century, Ross's geese were considered to be the rarest goose species that visited the U.S. (Bent 1962). Although locations of the species' breeding colonies were unknown, the principal wintering grounds were limited to the interior valleys of California. No population estimates were made in the early 20th century, although Bent (1962) cites a report of a flock of "several thousand individuals" on the Missouri River in Montana in April 1885.

Early explorers wrote of "many thousands of white and grey geese" near present-day Quebec City in 1535, and "many wild white geese" in the same region in 1663-64 (Abraham and Jefferies 1997). It is presumed that such birds were greater snow geese. Bent (1962) cites a 1906 report by C.E. Dionne of 5,000-6,000 geese on fall and spring migration areas in Quebec that represented "probably all the greater snow geese in a wild state." The limited information available suggests a gradual increase from about 2,000 birds in the early 1900s to approximately 20,000 birds by 1941 (Reed et al. 1998). Clearly, present-day population levels of greater snow geese are unprecedented in recorded history.

### 3.1.6 Population Status - Spring/Breeding Colony Survey Estimates

Estimation of the spring population of greater snow geese is straightforward, because most birds are encountered during the photo survey in the St. Lawrence Valley. However, determination of the number of breeding lesser snow and Ross's geese in various populations is problematic, because populations are named based on wintering ground affiliation. For example, MCP light geese are comprised of birds that breed in the eastern and central Arctic. WCFP light geese are comprised of birds that breed in the central and western Arctic. Because photo surveys of breeding colonies for a particular region are conducted every 5 years, simultaneous estimates from 2 different portions of a population's breeding range may be lacking. Therefore, we have chosen to present breeding population estimates for lesser snow and Ross's geese for the eastern, central, and western Arctic regions; rather than providing estimates for populations that are named based on wintering ground affiliation.

*Greater snow geese*. — The spring population estimate of greater snow geese increased from approximately 25,400 birds in 1965, to 813,900 birds in 2000 (Reed et al. 1998, Reed et al. 2000; Fig. 3.4). The population growth rate during 1965-2000 was 8.8 % per year. The Atlantic Flyway Council population objective, as well as the North American Waterfowl Management Plan (NAWMP) spring population goal for greater snow geese is 500,000 birds (U.S. Dept. of the Interior et al. 1998). Therefore, the greater snow goose population currently is 63% higher than the Atlantic Flyway Council and NAWMP goals. The Arctic Goose Habitat Working Group has recommended a management goal of stabilizing the greater snow goose population at between 800,000 to 1 million birds (Giroux et al. 1998). However, a reduction of the population below this level was recommended if natural habitats continue to deteriorate, or if measures taken to reduce crop depredation do not achieve desired results (Giroux et al. 1998). At the current rate of growth, the greater snow goose population will reach 1 million by 2002, and over 2 million by 2010.

*Light Geese in the eastern Arctic*. — The number of breeding lesser snow geese on surveyed colonies in 1973 was approximately 1,057,400 birds (Kerbes 1975; Fig. 3.5). During 1973-97, the number of breeding lesser snow geese increased at an annual rate of 4.7%, to the most recent estimate of 3,010,200 birds (Table 3.2). Including an additional 30% for non-breeding birds, the total number of lesser snow geese in the eastern Arctic was nearly 4 million birds in 1997. The number of Ross's geese in the eastern Arctic has increased from 2,000 birds in 1990, to 52,000 birds in 1998 (Table 3.2).

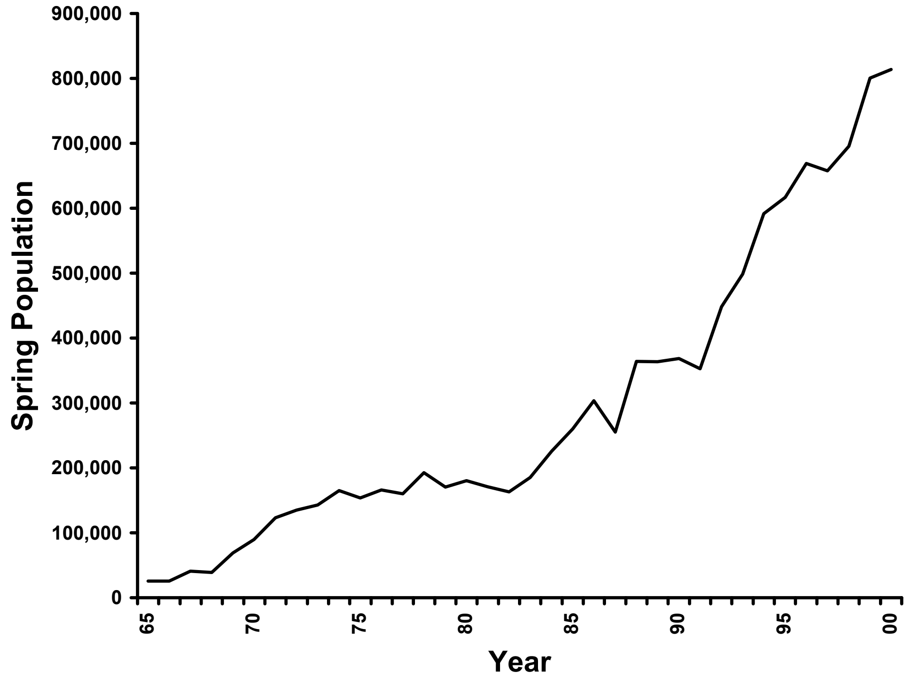


Fig. 3.4. Population growth of greater snow geese as measured by photo-inventories during spring migration in the St. Lawrence River valley, 1965-2000.

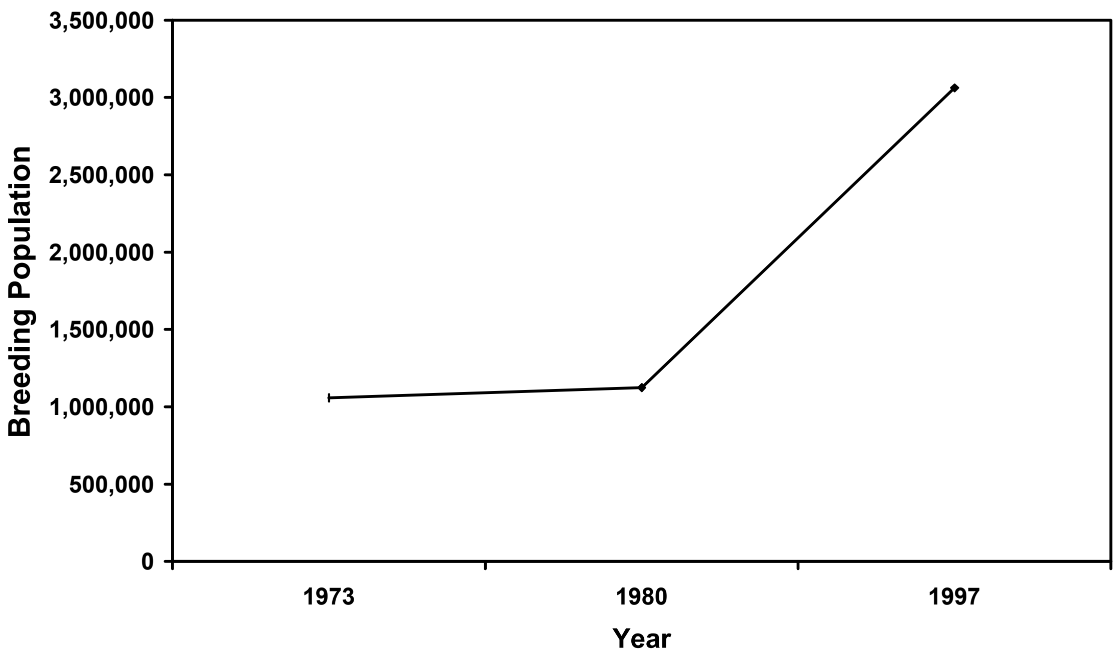


Fig. 3.5. Lesser snow goose population estimates from breeding colonies in the eastern Arctic, determined from photo inventories, 1973-97. Population estimates do not include Ross's geese or non-breeding birds.

Table 3.2. Breeding adult lesser snow and Ross's goose population estimates as determined from aerial photo inventories, 1966-99 (compiled by R. Kerbes, CWS). Inclusion of estimates of non-breeding adults would increase population estimates by 30%.

| | Lesser snow geese | | | | | | | | | Ross's geese | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Eastern Arctic | | | | | | | | |
| Year | Wrangel Island[1] | Western Arctic | Central Arctic | Baffin Island | Southampton Island | West Hudson Bay | La Perouse Bay | Cape Henrietta Maria | Total | Central Arctic | Eastern Arctic | Total |
| 1966 | | | 10,300 | | | | | | | 34,000 | | 34,000 |
| 1973 | 86,000 | | | 446,600 | 155,800 | 390,200 | 5,600 | 59,200 | 1,057,400 | | | |
| 1976 | 58,000 | 169,900 | 56,400 | | | | | | | 77,300 | | 77,300 |
| 1977 | 68,200 | | | | | 353,200 | | | | | | |
| 1978 | 65,400 | | | | | 331,800 | | | | | | |
| 1979 | 84,500 | | | 454,800 | 233,000 | | | 109,200 | | | | |
| 1980 | 90,700 | | | | | 309,200 | 17,000 | | 1,123,200 | | | 90,800 |
| 1981 | 89,000 | 207,500 | | | | | | | | | | |
| 1982 | 100,00 | | 105,700 | | | | | | | 90,800 | | |
| 1985 | 85,000 | | | | | 436,400 | 28,100 | | | | | |
| 1987 | 100,00 | 205,100 | | | | | | | | | | |
| 1988 | 80,000 | | 279,000 | | | | | | | 188,000 | | |
| 1990 | 60,000 | | | | | 201,900 | 46,400 | | | | 2,000 | 190,000 |
| 1995 | 65,000 | 486,100 | | | | | | | | | | |
| 1997 | | | | 1,766,500 | 715,900 | 153,500 | 66,000 | 280,200 | 3,010,200 | | | |
| 1998 | | | 816,100 | | | | | | | 567,100 | 52,000 | 619,100 |
| 1999 | | | | | | | | | | | | |
| 2000 | 95,000 | | | | | | | | | | | |

[1] Estimates for Wrangel Island represent total birds, including yearlings and non-breeding birds (Kerbes et al. 1999). Number of breeding birds varies widely depending on spring conditions.

*Light geese in the* c*entral Arctic*. — In 1966, the number of breeding light geese on surveyed colonies in the central Arctic was 44,300 birds (Kerbes 1994; Fig. 3.6). During the period 1966-98, the number of breeding light geese increased at an annual rate of 11.0%, to the current estimate of 1,383,200 birds (Table 3.1). Lesser snow and Ross's geese comprised 59% and 41%, respectively, of the total number of breeding geese in 1998 (Table 3.2). Including an additional 30% to account for non-breeding birds, the total number of light geese in the central Arctic was nearly 1.8 million birds in 1998.

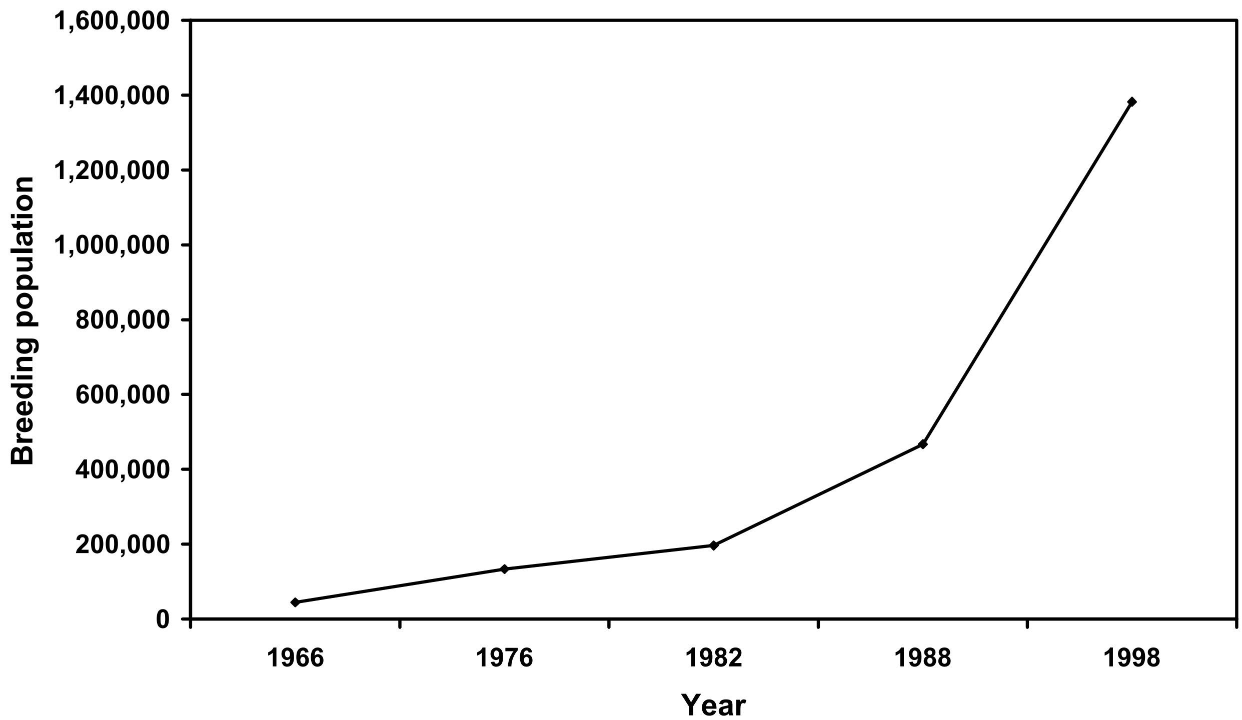


Fig. 3.6. Light (lesser snow and Ross's) goose population estimates from breeding colonies in the central Arctic, determined from photo inventories, 1966-98. Population estimates do not include non-breeding birds.

*Light geese in the western Arctic*. — The number of breeding lesser snow geese on surveyed colonies in 1976 was estimated to be 169,600 birds (Kerbes et al. 1999; Fig. 3.7). During the period 1976-95, the number of breeding lesser snow geese increased at an annual rate of 5.4%, to the current estimate of 486,100 birds (Table 3.2). Including an additional 30% for non-breeding birds, the total number of lesser snow geese in the western Arctic was approximately 632,000 birds in 1995. Ross's geese are not commonly found on breeding colonies in the western Arctic; however, small numbers are found on Banks Island.

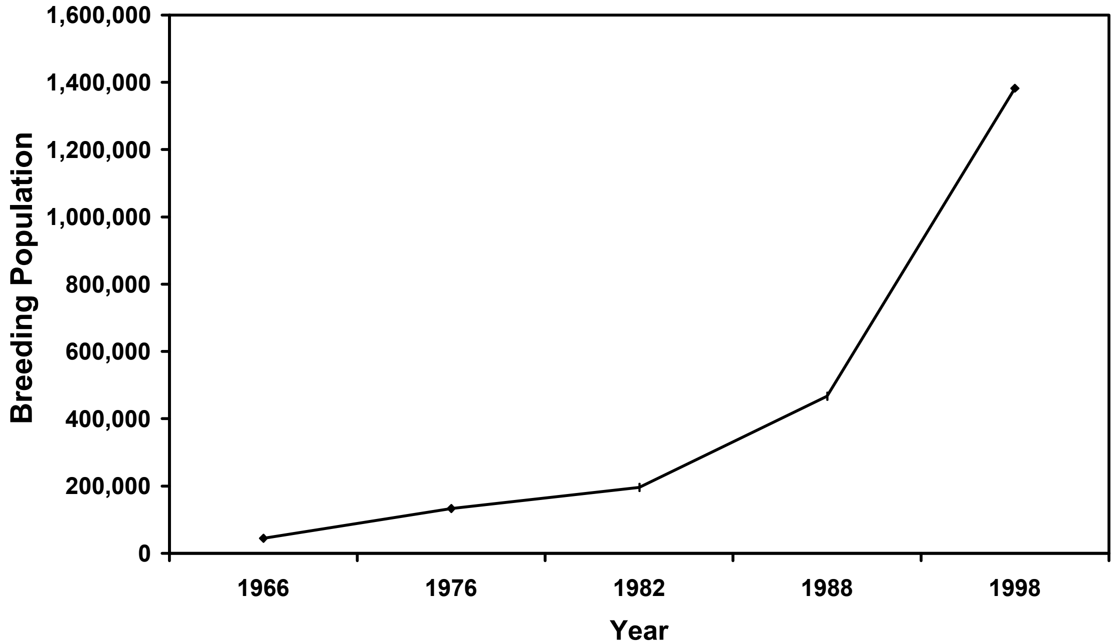


Fig. 3.7. Lesser snow goose population estimates from breeding colonies in the western Arctic, determined from photo inventories. Population estimates do not include non-breeding birds and likely contain few, if any, Ross's geese.

*Wrangel Island Population of lesser snow geese*. — The total population (breeders and non-breeders) of lesser snow geese on Wrangel Island declined from approximately 150,000 birds in 1970 to 56,000 birds in 1975, due to four consecutive years of poor reproductive success (Kerbes et al. 1999). The population increased during the 1980s to nearly 100,000 birds, but averaged only about 65,000 birds in the mid-1990s. The 2000 population estimate was approximately 95,000 birds (U.S. Fish and Wildlife Service 2000).

### 3.1.7 Population Status - Winter Survey Indices

*Greater snow geese*. — The winter index of greater snow geese has increased from approximately 46,000 birds in 1955, to approximately 465,000 birds in 2000 (Serie and Raftovich 2000; Fig. 3.8). The winter survey is a useful tool for providing information on the winter distribution of snow geese in the Atlantic Flyway. However, the winter survey counts a smaller proportion of the population than does the spring survey.

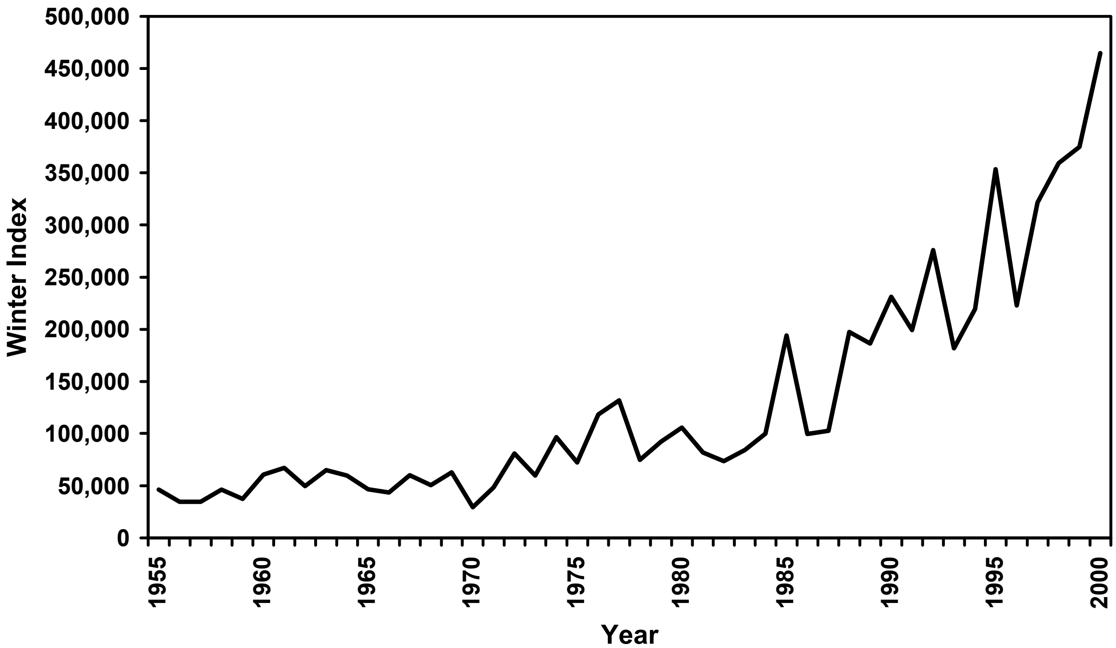


Fig. 3.8. Winter index of greater snow geese in the Atlantic Flyway, 1955-2000.

*Mid-continent Population (MCP) of light geese*. — The winter index of MCP light geese has increased from approximately 777,000 birds in 1970, to about 2.4 million birds in 2000 (Fig. 3.9; Sharp and Moser 2000). During 1970-2000, the MCP winter index increased 3.3% per year. The rate of increase has elevated to 4.2% per year in the past 10 years.

Field studies indicate that MCP light geese wintering in Texas are comprised of approximately 94% lesser snow geese and 6% Ross's geese (Texas Parks and Wildlife Department, unpublished data). Recent surveys conducted in Louisiana indicated that lesser snow geese comprised nearly 98%, and Ross's geese only 2% of light geese wintering in the state (Helm 2001). Using the average of species composition in Texas and Louisiana, the lesser snow and Ross's goose portions of MCP light geese in winter 2000 were approximately 2,291,000 and 99,200 birds, respectively. The NAWMP winter index goal for MCP lesser snow geese is 1 million, and the Central and Mississippi Flyway Councils have set an upper management threshold (winter index) of 1.5 million for MCP lesser snow geese. The lesser snow goose 2000 winter index is 129% higher than the NAWMP goal, and 53% higher than the management threshold adopted by the Flyway Councils. There is no NAWMP goal for Ross's geese in the MCP geographic range.

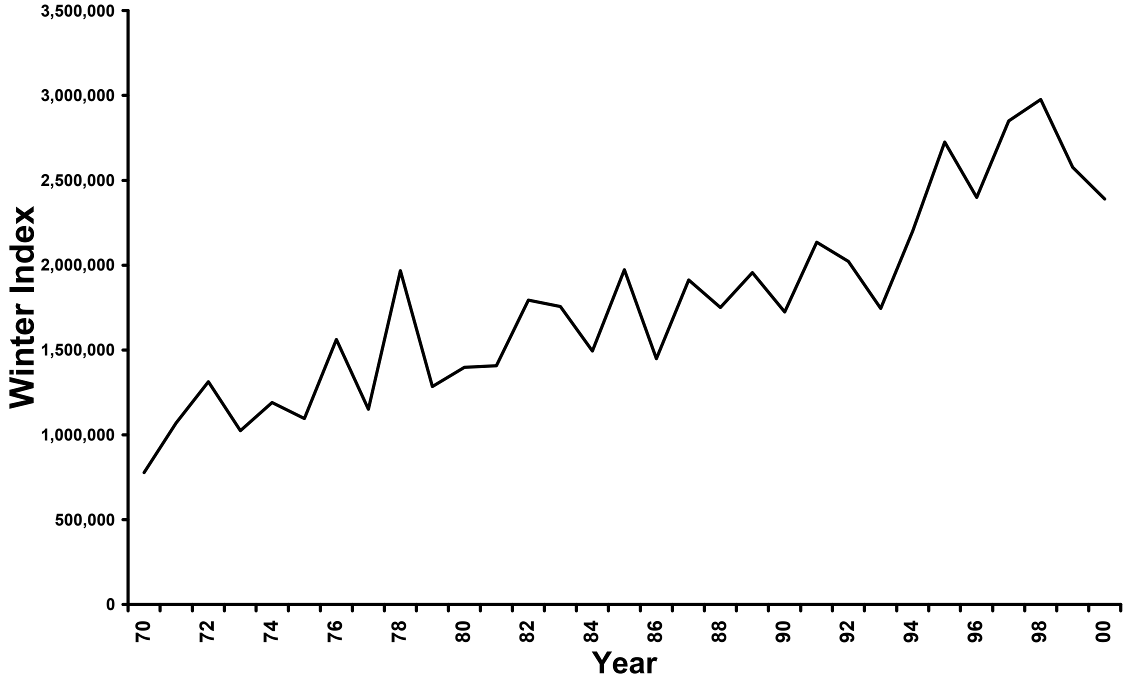


Fig. 3.9. Winter index of the Mid-Continent Population of light geese, 1970-2000.

*Western Central Flyway Population (WCFP) of light geese*. — The winter index of WCFP light geese has increased from approximately 42,000 birds in 1970, to approximately 256,000 birds in 2000 (Fig. 3.10; Sharp and Moser 2000). During 1970-2000, the WCFP winter index increased 6.2% per year.

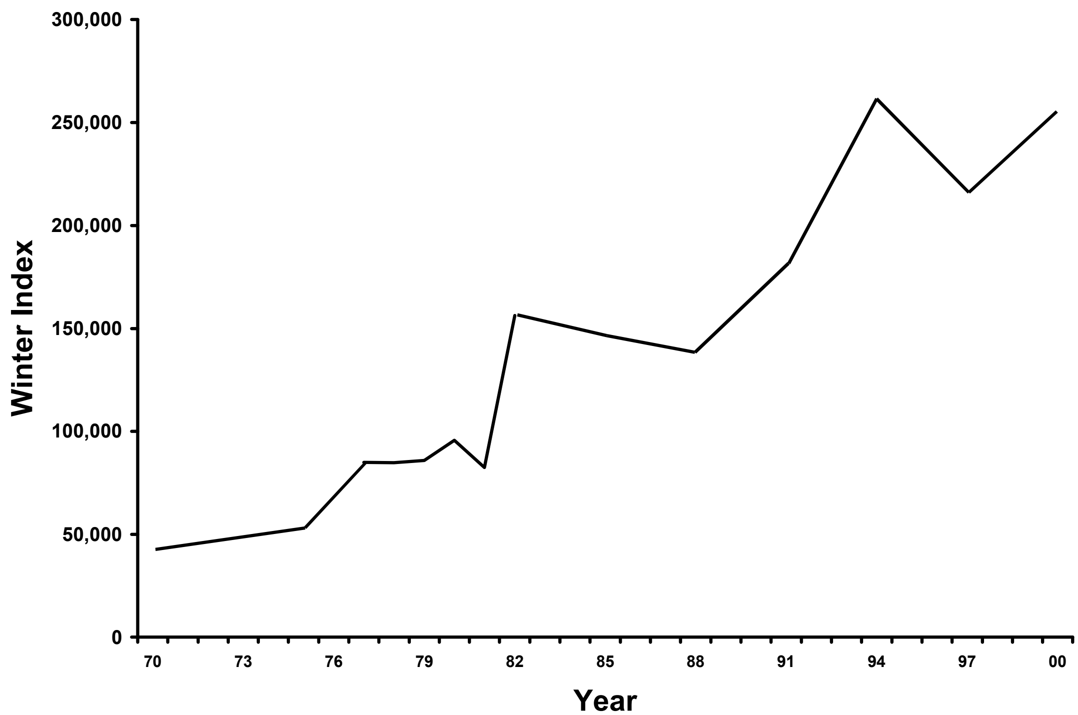


Fig. 3.10. Winter index of the Western Central Flyway Population of light geese, 1970-2000.

Lesser snow geese and Ross's geese comprise approximately 79% and 21%, respectively, of WCFP light geese (Thorpe 1999). Using these proportions, the Ross's goose component of WCFP light geese in winter 2000 was approximately 53,550 birds. The lesser snow goose portion of WCFP light geese during the same year was approximately 202,216 birds; which is 84% higher than the NAWMP winter index goal of 110,000 for WCFP lesser snow geese. Flyway Councils have not set management thresholds for WCFP lesser snow geese. There is no NAWMP goal for Ross's geese in the WCFP geographic range.

MCP and WCFP components of CMF light geese were not tallied separately until 1970. However, winter indices for CMF light geese (MCP and WCFP combined) are available beginning in 1955. The winter index of CMF light geese has increased from 693,421 birds in 1955 to 2.65 million birds in 2000 (Fig. 3.11). During 1955-2000, the CMF light goose winter index grew at an annual rate of 3.8%.

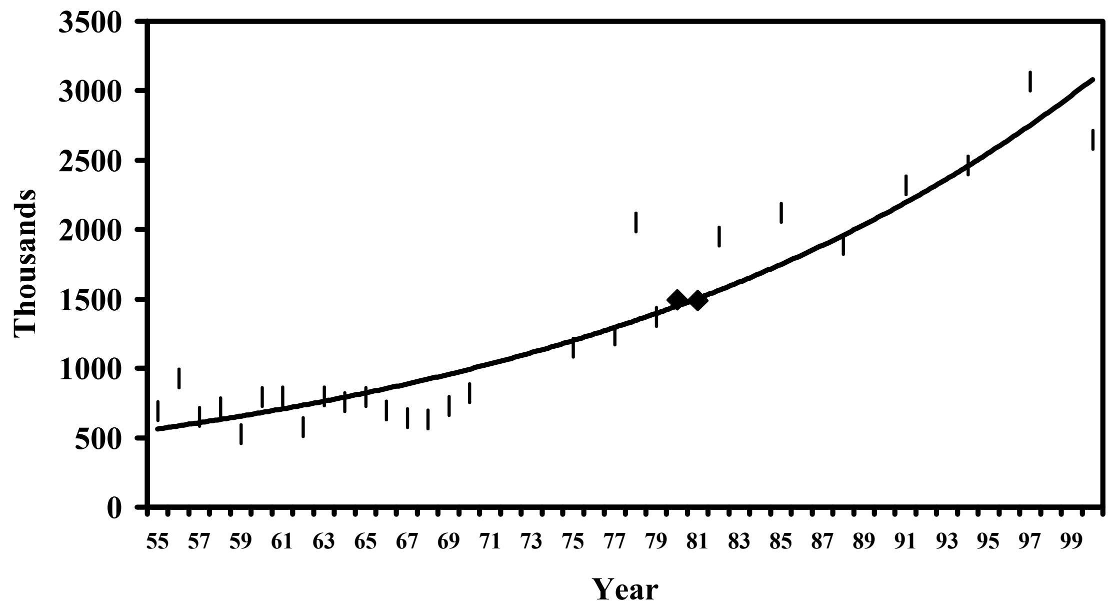


Fig. 3.11. Winter index of Central/Mississippi Flyway (CMF) light geese. Solid curve represents the exponential trend line that fits the observed data.

*Western Population of Ross's geese (WPRG).* — Annual winter indices are not available for the WPRG because it mixes with other light goose populations in the Pacific Flyway (Fig. 3.12). Special surveys conducted during the winters of 1988 and 1989 produced estimates of 214,700 and 168,400 Ross's geese in the Central Valley of California (Silveira 1989, 1990). A December, 2000, survey in California resulted in an estimate 256,000 Ross's geese (U.S. Fish and Wildlife Service, unpublished data).

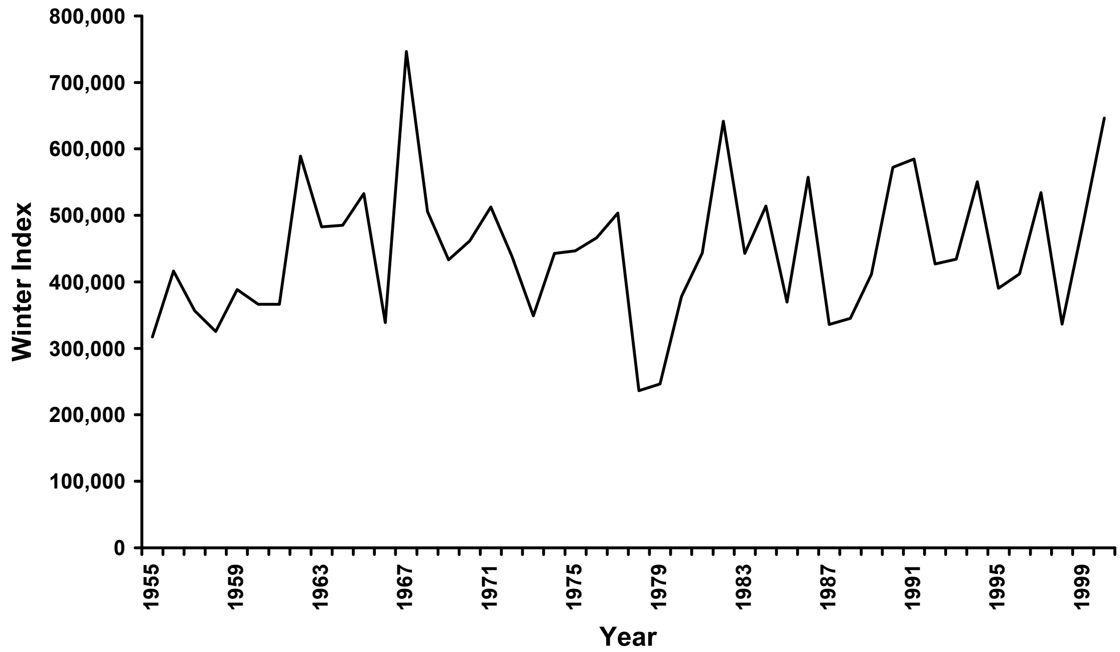


Fig. 3.12. Winter index of light geese in the Pacific Flyway, 1955-2000. Birds included in the index are derived from several breeding populations in the central and western Arctic, and Wrangel Island.

The NAWMP does not contain winter index goals for Ross's geese. Instead, a continental *breeding* population goal of 100,000 Ross's geese is utilized. The Pacific Flyway Council has adopted a winter index goal of 150,000 Ross's geese. The combined 2000 winter index total of 408,750 MCP, WCFP, and WPRG Ross's geese is 172% higher than the Pacific Flyway Council winter index goal, and 308% higher than the NAWMP breeding population goal.

*Pacific Flyway Population of lesser snow geese*. — No winter indices are available for PFSG because they mix with other light goose populations in the Pacific Flyway (Fig. 3.12). The distribution of band recoveries indicates that 87% of lesser snow geese banded in the western Arctic are recovered in the Pacific, whereas 2% or less of birds banded in the central and eastern Arctic are recovered in the Pacific Flyway (Table 3.1). Species composition surveys conducted in December, 2000, indicated a total of 409,000 lesser snow geese wintering in California (U.S. Fish and Wildlife Service, unpublished data).

*Wrangel Island Population of lesser snow geese*. — No winter indices are available for this population because it mixes with other light goose populations in the Pacific Flyway.

### 3.1.8 Population Status - Summary

The number of greater snow geese and CMF light geese increased dramatically during the past 30 years. Western arctic lesser snow geese have increased as well; however, their rate of increase has been slower than populations occurring to the east. The Wrangel Island lesser snow goose population has fluctuated widely, likely due to frequent failures in reproduction as a result of poor spring weather. Utilizing the most recent estimates for known colony sites, and accounting for 30% additional non-breeding birds, there currently are approximately 5.8 million lesser snow and Ross's geese in the eastern and central Arctic, 0.7 million lesser snow geese in the western Arctic and Wrangel Island. The spring population of greater snow geese in the St. Lawrence River Valley is approximately 0.8 million birds.

North American Waterfowl Management Plan population goals for greater snow geese, MCP and WCFP lesser snow geese, and Ross's geese (MCP and WCFP combined) have all been exceeded. The joint Central and Mississippi Flyway Council upper management thresholds for MCP lesser snow geese has been exceeded by 53%. The Atlantic Flyway Council population objective for greater snow geese has been exceeded by 63%. These light goose population levels are the highest in recorded survey history, and likely are unprecedented (Abraham and Jeffries 1997; Reed et al. 1998).

### 3.1.9 Migration and Wintering Ecology

*Greater snow geese*. — Upon leaving breeding colonies in late August, greater snow geese make an initial migration flight of over 1000 km to the central portion of the Ungava Peninsula. Geese stage on the Ungava for several days before they undertake a second long migration flight to the St. Lawrence River. Traditionally, birds staged during October almost exclusively on the St. Lawrence within a relatively small area of bulrush marshes before leaving on a non-stop flight to Delaware Bay (Reed et al. 1998). Beginning in the 1980s, some geese began dispersing from traditional staging areas early in October and moved southwesterly to Lake Saint-Pierre or northern Lake Champlain, where they feed in agricultural fields. Geese inhabit these new staging areas well into November and December. However, some birds are now over-flying the St. Lawrence altogether, and are flying directly to the U.S. in fall (Maisonneuve and Bedard 1992).

The winter range of greater snow geese extends along the Atlantic coast from New Jersey to South Carolina. Main concentration areas are in New Jersey, Delaware, Maryland, Virginia and North Carolina. As a result of population growth, there has been an increase in the number of birds wintering in Maryland and Delaware. Beginning in 1991, there also has been an increase in the number of birds wintering in New Jersey, Pennsylvania and New York. Concurrent decreases have occurred in the number of birds wintering in southern portions of the range (Reed et al. 1998).

Historically, greater snow geese flew non-stop in spring from Delaware Bay to traditional bulrush marshes on the St. Lawrence River. However, many birds now make intermediate stops on Lake Champlain, the Richelieu River, and Lac Saint-Pierre before moving to traditional marshes on the St. Lawrence. Many of these intermediate stopover areas have an agricultural base and are becoming important staging areas. In late May, some geese may stage for a short time in central and eastern portions of the Ungava Peninsula before migrating to breeding colonies (Reed et al. 1998).

*Mid-continent Population (MCP) of light geese*. — Prior to 1960, the lesser snow goose component of the MCP wintered exclusively on coastal marshes in Texas and Louisiana (Bateman et al. 1988). The migration from arctic breeding areas to the Gulf Coast often was completed nearly nonstop, with only occasional short stopovers (Lynch 1975). Therefore, light goose populations would not have been affected by wetland losses in interior portions of the continent in the first half of the 20th century. However, during the 1960s, noticeable changes in migration habits became evident. For example, Squaw Creek National Wildlife Refuge (NWR) in northwest Missouri rarely received any usage by snow geese during the 1940s. In the early 1970s, more than 200,000 snow geese regularly stopped at Squaw Creek NWR during fall migration (Bateman et al. 1988). Sand Lake NWR in South Dakota, and DeSoto Bend NWR in Iowa also held more than 200,000 snow geese during fall migration in the 1970s. Migration shifts continued, and MCP snow geese eventually began to stop in southern Canada and North Dakota during fall migration (Bateman et al. 1988). Currently, their wintering grounds extend across Texas, Louisiana, Arkansas, Oklahoma, Mississippi, and New Mexico and the central highlands of Mexico.

Prior to 1920, MCP lesser snow geese wintered primarily in a narrow band of brackish marsh along the Texas and Louisiana coasts (Bateman et al. 1988; Fig. 3.13). Birds seldom moved inland more than a few miles and did not consistently use bluestem prairies that lay directly north of marshes. Geese exhibited this distribution pattern until the 1920s in Texas, and the 1940s in Louisiana (Bateman et al. 1988). Due to the finite amount of suitable coastal marsh habitat available on the wintering grounds, winter food resources were presumed to be a limiting factor for winter survival (Lynch 1975).

As the extent of rice culture began to increase in Texas and Louisiana, rice fields became larger and were developed farther away from human activity centers. In addition, rice agriculture moved closer to the brackish marshes that geese inhabited. By the late 1940s, rice culture had expanded to and dominated the bluestem prairie areas of Texas and Louisiana, extending inland as far as 160 km at some points (Bateman et al. 1988). Geese began to utilize rice fields in Texas about 1920, but not until the 1940s in Louisiana. Texas rice fields were closer to natural marshes than those in Louisiana, which facilitated an earlier initiation date of use by geese. In the 1940s and 1950s, some landowners began pumping water into harvested rice fields and restricted hunting in and around water areas to hold birds for improved hunting. As a result, secure roosting areas were created (Bateman et al. 1988).

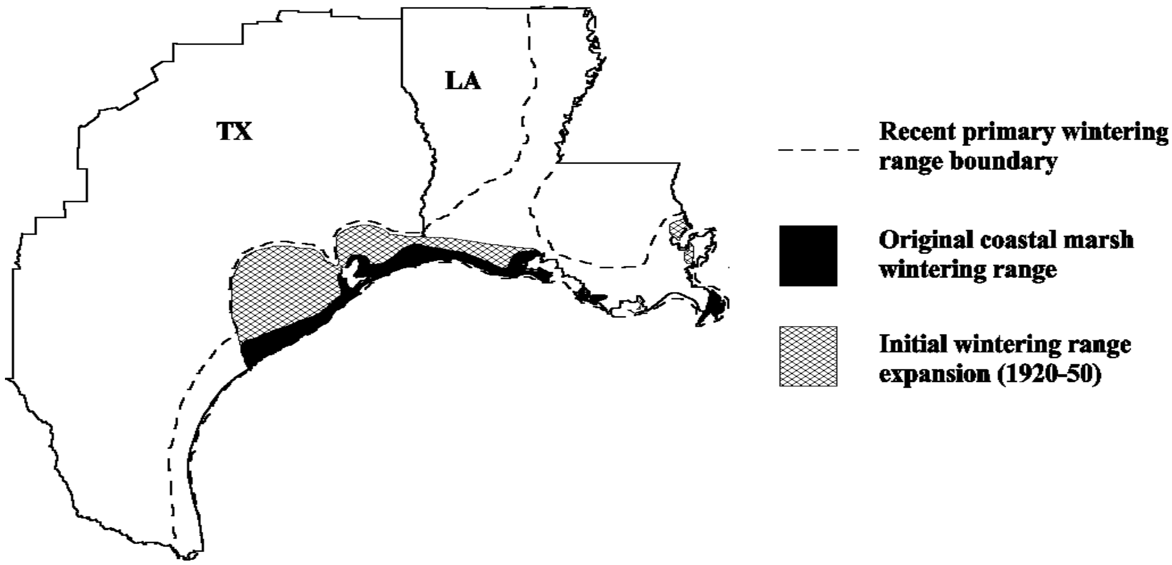


Fig. 3.13. Original coastal marsh wintering range (black shading), extent of initial range expansion (cross-hatch), and recent wintering range boundary (dashed line) of light geese in Texas and Louisiana (adapted from Bateman et al. 1988).

Continued inland expansion of agricultural areas fostered a similar expansion of light goose wintering range. Furthermore, the addition of over 400,000 ha of rice culture significantly increased the amount of food resources available to geese.

Historically, Ross's geese wintered in the interior valleys of California and eventually expanded into WCFP wintering range. In the early to mid-1980s, Ross's geese began to expand eastward and mix extensively with MCP lesser snow geese during winter. Evidence for this range expansion is illustrated by the increased occurrence of Ross's geese in harvests from eastern areas between 1974 and 1996. Inland range expansion of Ross's geese occurred in a fashion similar to that of lesser snow geese.

*Western Central Flyway Population (WCFP) of light geese*. — WCFP light geese typically migrate south along the western edge of the Central Flyway and winter primarily in northwestern Texas, Oklahoma, New Mexico, and the Central Highlands of Mexico. They have expanded their range and today overlap the MCP light goose range during spring migration. Their expansion inland, concurrent with agricultural expansion, was similar to that of MCP light geese.

Similar to the exploitation of agriculture in the wintering States, CMF light geese migrating through the mid- and northern-latitudes exploited cereal grain crops consisting of corn, wheat, barley, oats and rye and continue to do so today (Alisauskas et al. 1988). For example, an estimated 1 to 2 million light geese stage in the Rainwater Basin in Nebraska from mid-February to mid-March and primarily feed on post-harvest waste corn (USFWS 1998a). These waste crops provide light geese with additional nutrients during spring migration, thus enabling birds to arrive on the breeding grounds in prime condition to breed.

Increased food resources afforded by agriculture during spring migration resulted in higher reproductive potential and breeding success (Ankney and McInnes 1978, Abraham and Jefferies 1997). Consequently, more geese survived the winter and migration and were healthier as they returned to their breeding grounds in Canada.

*Pacific Flyway Population of lesser snow geese (PFSG)*. — Lesser snow geese following westerly migration corridors interrupt their fall migration more frequently to rest and feed than do birds to the east (Bellrose 1980). The Mackenzie Delta is the major staging area for lesser snow geese in the western Arctic before birds move on to resting and feeding areas in southeastern Alberta and southwestern Saskatchewan (Bellrose 1980, Armstrong et al. 1999). In Montana, the migration corridors diverge into three components; one directed toward the southwest to the Klamath Basin of northern California, one south-southwest to Nevada, and a third directly south to the Bear River marshes in Utah. Eighty percent of western arctic lesser snow geese marked with neckbands migrated to the Klamath Basin and Central Valley, whereas smaller numbers winter in the Imperial Valley of California (Armstrong et al. 1999).

Lesser snow geese wintering in California shifted their feeding habits several decades ago from natural marsh plants to agricultural foods (Bellrose 1980). Geese consume grains of barley, wheat, and rice, and they also graze on shoots of pasture grasses and cereal grains. Natural marsh plants such as alkali bulrush are still important foods for lesser snow geese in the Bear River marshes of Utah and the Klamath Basin in California (Bellrose 1980).

*Western Population of Ross's geese (WPRG).* — Upon leaving breeding areas in the Queen Maud Gulf, many Ross's geese migrate to the Peace-Athabasca River Delta in northern Alberta (Bellrose 1980). Birds then move through eastern Alberta and western Saskatchewan, with some stopping near Freezeout Lake, Montana until mid-October (Bellrose 1980, Ryder and Alisauskas 1995). Most birds migrate through the Klamath Basin in California and winter either in the Sacramento Valley or in the grasslands of the San Joaquin Valley (Bellrose 1980, Ryder and Alisauskas 1995). During winter, Ross's geese utilize agricultural habitat much of the time for feeding (Ryder and Alisauskas 1995). Barley is an important food for birds in the Klamath Basin, whereas rice is commonly used in the Sacramento Valley (Bellrose 1980).

*Wrangel Island Population of lesser snow geese*. — Most lesser snow geese from Wrangel Island migrate along several corridors off or along the coast of southeast Alaska and British Columbia (Bellrose 1980). A small number of birds migrate to wintering areas through prairie areas in Alberta and Saskatchewan (Armstrong et al. 1999). Observations of birds marked with neckbands indicate that Wrangel Island birds winter either in British Columbia, Washington, or in the Central Valley of California (Armstrong et al. 1999). Food habits of Wrangel Island birds are assumed to be similar to other lesser snow geese in such wintering areas.

## 3.1.10 Harvest Estimates

*Federal frameworks.* — Light goose harvest is influenced by several variables that comprise frameworks for hunting seasons in the U.S. Federal frameworks are comprised of earliest opening and latest closing dates for hunting seasons and maximum season length and daily bag and possession limits. State hunting regulations may be more restrictive than Federal frameworks, but cannot be more liberal. Waterfowl managers have attempted to increase the harvest of light geese by liberalizing all components of the Federal frameworks. Possession limits for light geese were increased in 1980 from 5 to 10 birds in the Mississippi Flyway and portions of the Central Flyway. Beginning in 1984, season closing dates began to be pushed closer to the March 10 closing date allowed by the Migratory Bird Treaty. The season length for light geese was 60 days in 1961, but by 1991 had been increased to 107 days in western portions of the Central Flyway and all portions of the Mississippi and Central Flyways by 1994. In 1998 the daily bag limit for light geese was increased from 10 to 20 birds, and possession limits were eliminated.

*Greater snow geese*. — Harvest estimates for greater snow geese in the U.S. and Canada are presented in Figure 3.14. The hunting season in the U.S. was re-opened in 1975. We initially calculated the harvest rate index for greater snow geese by dividing the estimated continental harvest by the population estimate of the previous spring (Fig. 3.15). To obtain a more accurate estimate of the harvest rate during 1999/2000, we determined the approximate fall population size using the method described by Reed et al. (1998). The size of the adult population in fall 1999 was determined by applying a spring-to-fall survival rate of 0.946 to the 1999 spring population estimate of 800,400 birds. The number of juveniles in the fall population was estimated by multiplying the adult population size in fall (757,178 birds) by the proportion of juveniles in the fall flight (0.028; Ferguson 1999), divided by the proportion of adults in the fall flight. We estimated a harvest rate of 16.7% by dividing the sum of the continental harvest during the 1999/00 regular season (75,821) and the spring conservation harvest in Quebec during 2000 (55,000 birds), by the total fall-flight estimate of 778,990 birds.

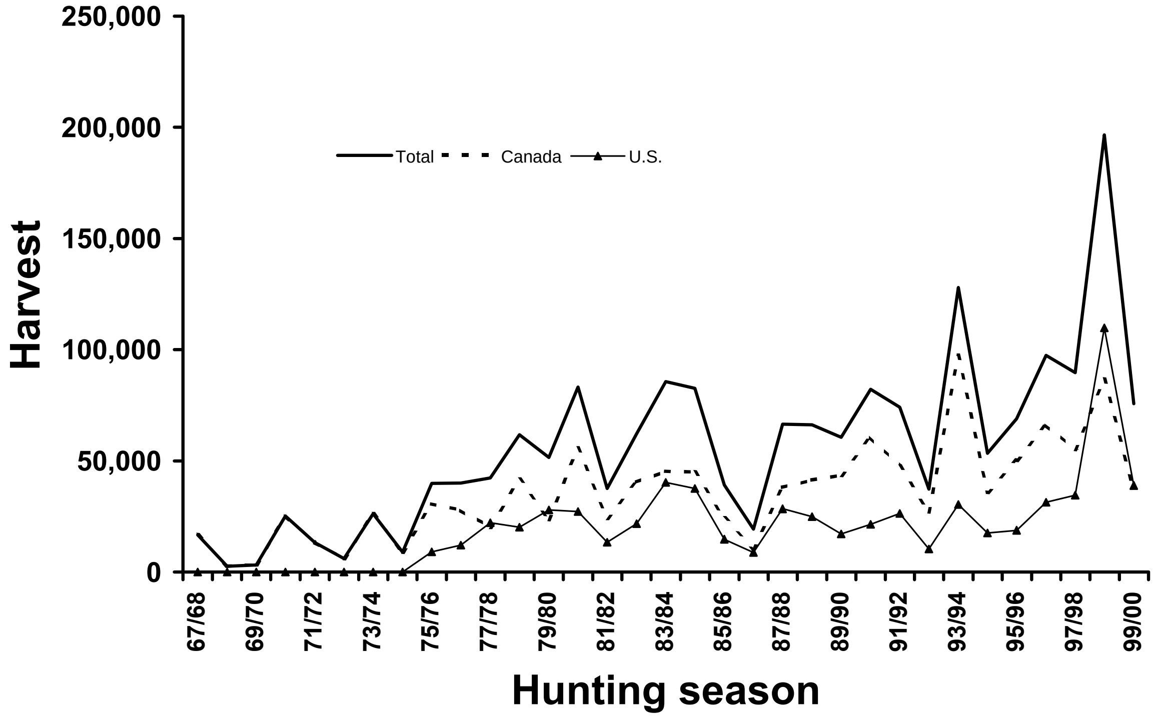


Fig. 3.14. Harvest of greater snow geese in Canada and the U.S., 1967-99.

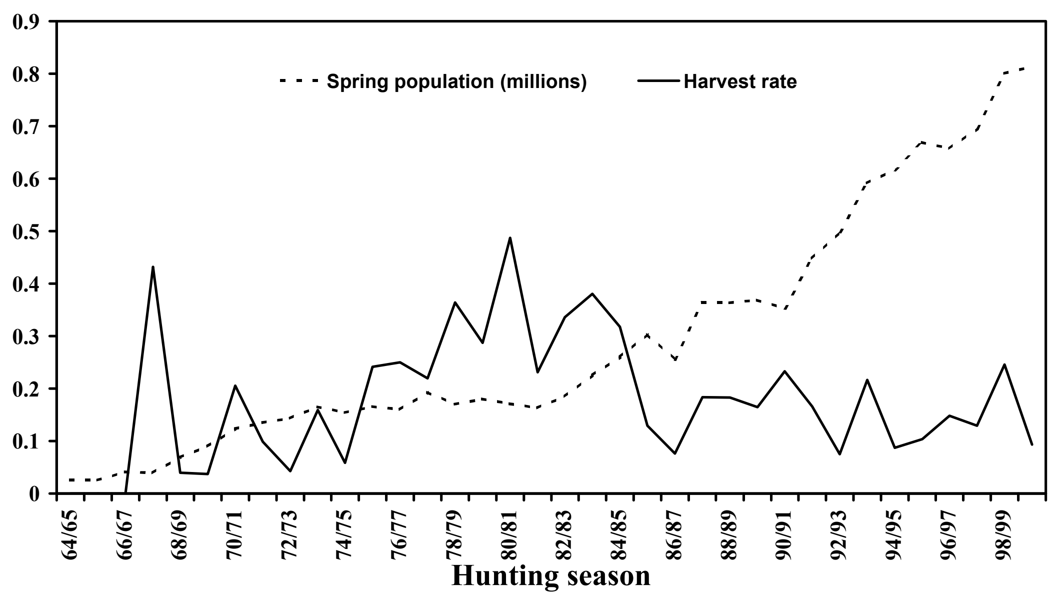


Fig. 3.15. Spring population estimates (millions, 1964-2000) and harvest rate indices (1967-99) of greater snow geese in the Atlantic Flyway.

*CMF light geese*. — Gradual liberalizations in regular-season frameworks have been ineffective at controlling the population growth of CMF light geese, as indicated by the harvest rate. Surveys to estimate light goose harvest were implemented in 1962. An index to the harvest rate was obtained by dividing the total estimated harvest in a given season by the population winter index for that season. The harvest rate index for CMF light geese gradually declined after the 1960s, to a low in the 1992/93 season (Fig. 3.16). This was partially due to a decrease in hunter numbers, but was primarily due to the high rate of growth of the light goose population during this period (Fig. 3.17).

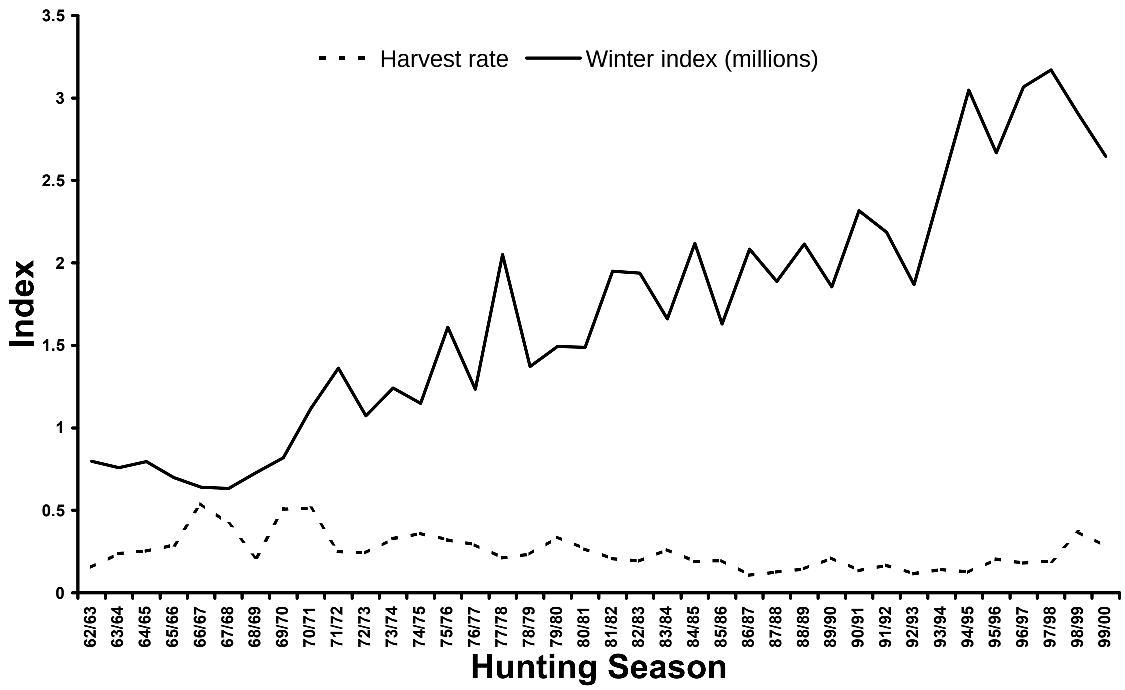


Fig. 3.16. Winter indices and harvest rates of Central/Mississippi Flyway light geese, 1962-2000.

Concurrent with the advent of 107-day seasons in the early 1990s, total regular-season harvest of CMF light geese increased in a nearly linear fashion (Fig. 3.17). During 1992-1997, total regular-season CMF light goose harvest increased by approximately 79,800 birds each year. We expect this trend to continue in the near future, barring any major changes in hunter numbers.

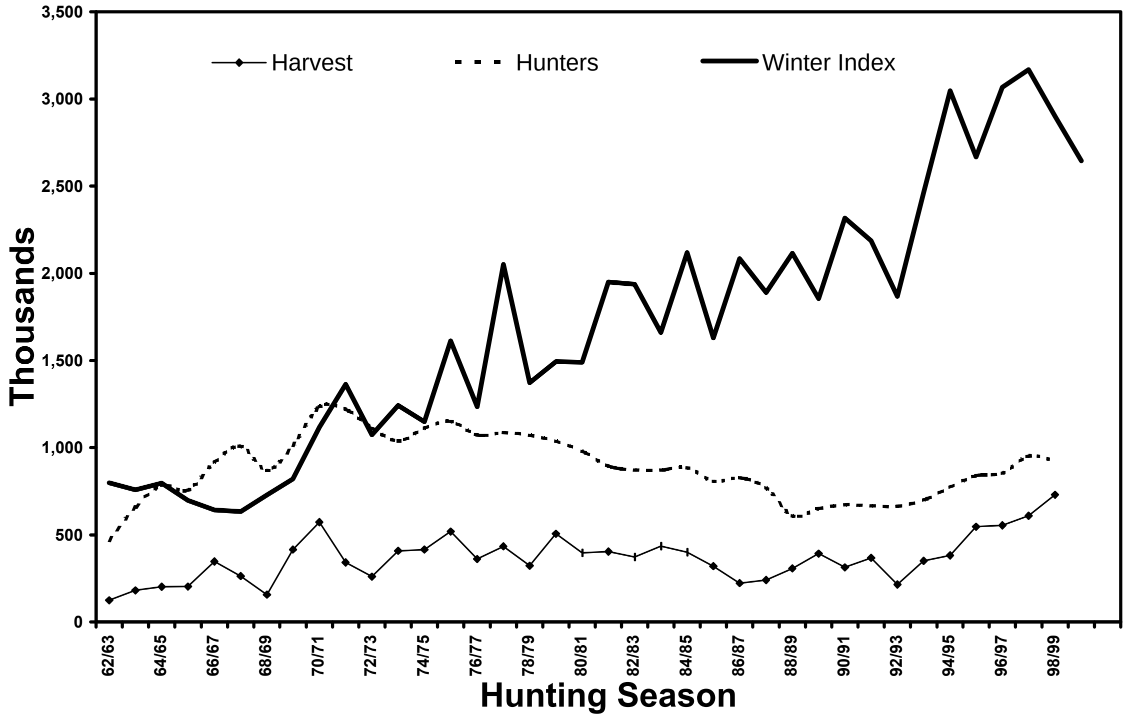


Fig. 3.17. Winter indices and harvests of Central/Mississippi Flyway light geese and active adult hunter numbers, 1962-2000.

In spring 1999, alternative harvest strategies were implemented in the Central and Mississippi Flyways in an attempt to reduce the number of CMF light geese (February 16, 1999, Federal Register; 64 FR 7507-7529). Strategies included authorization of the use of electronic calls and unplugged shotguns to hunt light geese during the regular season when all other waterfowl and crane seasons (excluding falconry) were closed. In addition, States were authorized to implement a conservation order that allowed take of CMF light geese at any time of year, authorized use of electronic calls and unplugged shotguns, removed bag limits, and extended shooting hours, provided that all waterfowl and crane hunting seasons (excluding falconry) were closed. To be eligible to implement a conservation order during the period in which hunting is allowed by the Treaty, September 1-March 10, States were required to close their regular seasons for waterfowl and cranes (excluding falconry). During winter and spring 1999, approximately 93,302 light geese were taken during the regular season in the time period when alternative methods of take were authorized in participating States (Table 3.3). In addition, approximately 341,732 light geese were taken during the conservation order.

The alternative light goose regulations were subsequently challenged in court in May 1999, and we eventually withdrew them in order to prevent further litigation. However, the regulations were later reinstated in November 1999, through enactment of the Arctic Tundra Habitat Emergency Conservation Act

Table 3.3. Estimated light goose (lesser snow and Ross's goose) harvests during regular season and conservation order periods in the Central and Mississippi Flyways (combined) during 1998/99 and 1999/00.

| | Regular season harvest[1] | | | | |
|---|---|---|---|---|---|
| Season | Without special regulations | With special regulations[2] | Total | Conservation order harvest [2, 3] | Total harvest |
| 1998/99 | 637,105 | 93,302 | 730,407 | 341,732 | 1,072,139 |
| 1999/00 | 715,356 | 29,195 | 744,551 | 602,171 | 1,346,722 |

[1] U.S. Federal Harvest Survey estimates.

[2] State Harvest Survey estimates.

[3] Special regulations during the regular season may include use of unplugged shotguns and electronic calls; Conservation order regulations may include regular season special regulations, shooting hours ending 1/2 hour after sunset, take of light geese beyond March 10, and unrestricted bag limit.

(P.L. 106-108). During winter and spring 2000, approximately 29,195 light geese were taken in the regular season during the time period when alternative methods of take were authorized in participating States (Table 3.3). The number of birds harvested in 2000 using special regulations during the regular season was lower than in 1999 because States implemented the conservation order earlier in the year, which reduced the length of the regular season. Furthermore, additional States participated in the conservation order in 2000, which also reduced the total number of days in the regular season for the Central and Mississippi Flyways.

The estimated harvest of light geese in Manitoba and Saskatchewan during the 1999/2000 regular season was 141,911 birds (Peterson 2000). Therefore, the harvest of CMF light geese during 1999/2000 was 1,488,633 birds. This level of harvest slightly exceeds the annual harvest of 1.41 million birds that is required to reduce the CMF light goose population by 50% by 2005 (Rockwell and Ankney 2000). Any harvest in excess of 1.41 million birds in a given year reduces the amount of time required to reach population reduction goals (Rockwell and Ankney 2000).

Each year, thousands of light geese are captured on arctic breeding grounds and marked with uniquely numbered leg bands. Hunter reports of leg-banded birds harvested in subsequent months allow documentation of migratory patterns. Banding locations of CMF light geese harvested during conservation orders indicate that such geese originated from arctic breeding areas where habitat damage is occurring (Fig. 3.18). The majority of light geese harvested during conservation orders originated from the west coast of Hudson and James Bays and the Queen Maud Gulf region.

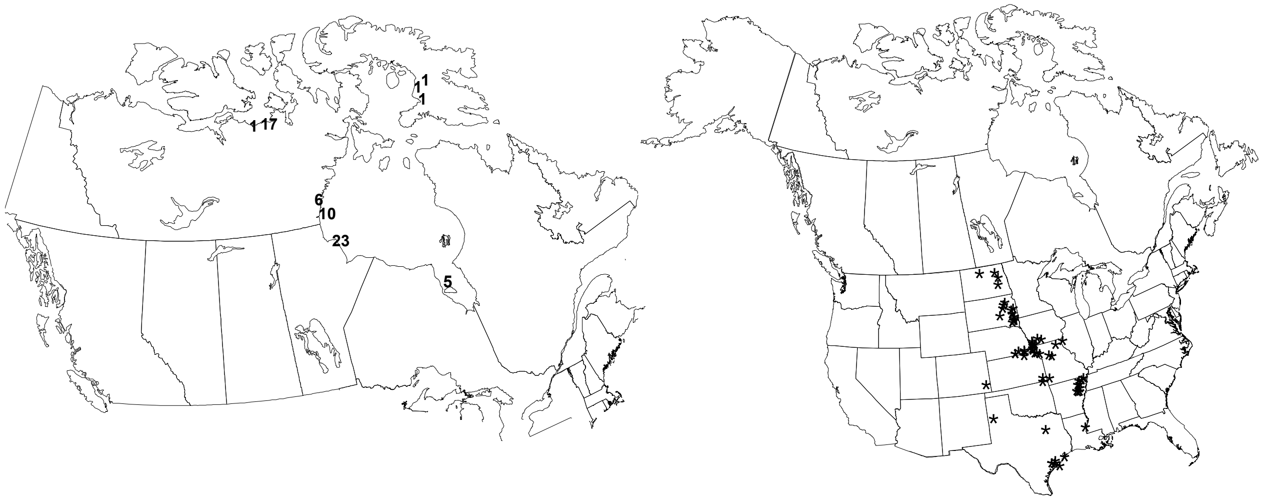


Fig. 3.18. Left: Banding locations of CMF light geese (summarized by degree blocks) harvested during conservation orders in the U.S. Right: Recovery locations of light geese harvested during conservation orders in the Central and Mississippi Flyways.

## *3.2 HABITAT*

### 3.2.1 Breeding habitat conditions and degradation

*Greater snow geese*. — Greater snow geese nest in the high Arctic, where salt marsh habitat is rare. Instead, geese utilize inland freshwater habitats that include permanent water bodies (ponds/lakes) and wet sedge meadows (Giroux et al. 1998). Approximately 15% of the breeding population nests on the south plain of Bylot Island, and events occurring there are likely typical of those happening elsewhere in the breeding range (Reed et al. 1998). Although the south plain covers an area of approximately 1,600 $km^2$ , only 11% of the land is covered by wetlands, the preferred feeding habitat of brood-rearing geese (Masse et al., in press).

Although levels of grazing by geese can be very high on Bylot Island, there are presently no indications that grazing is preventing vegetative re-growth or denuding vegetated areas. However, monitoring of long-term goose exclosures has shown that composition of the plant community is modified by geese, and that annual plant productivity is reduced in heavily-grazed areas. Long-term, intense grazing by geese leads to a low-level production equilibrium between geese and plants. When grazing is experimentally stopped (via exclosures), plant biomass increases rapidly within a few years (Giroux et al. 1998).

Short-term measurements of food availability on Bylot Island were used to estimate that greater snow geese consume 46% of total food available in wetland habitats (Masse et al. 2001). This suggests that the short-term ability of habitat to support geese has not been exceeded. However, given the rate of increase of greater snow goose numbers, it is highly probable that the intensity of grazing will increase and that the capacity of plants to recover will be exceeded (Masse et al. 2001).

*Eastern and central arctic light geese*. — Light geese have a profound effect on habitat through their feeding actions, and have developed several modes of feeding on plant material for meeting their energy needs (Goodman and Fisher 1962, Bolen and Rylander 1978). Where spring thawing has occurred, and above-ground plant growth has not begun, lesser and greater snow geese dig into and break open the turf (grubbing), consuming the highly nutritious belowground portions (e.g., roots and rhizomes) of plants. Grubbing continues into late spring. Lesser and greater snow geese also engage in shoot-pulling where birds pull the shoots of large sedges, consume the highly nutritious basal portion, and discard the remainder of the plant. A third feeding strategy utilized by all light goose species is grazing of above-ground plant material by clipping action of the bill. The extent to which Ross's geese utilize grubbing and shoot-pulling is not known. However, Ross's geese are known to feed on below-ground roots of sedges and grasses in early spring (Ryder and Alisauskas 1995, Didiuk et al. 2001). Due to their smaller bill size, Ross's geese are able to graze shorter stands of vegetation than can lesser and greater snow geese. In addition, Ross's geese cause considerable damage to vegetation by pulling up plants during nest-building activities (Didiuk et al. 2001).

Under certain levels of grazing intensity, some salt marsh plants show enhanced shoot growth following defoliation and are subject to multiple defoliations throughout the growing season (Abraham and Jefferies 1997). However, other plant species show only limited shoot growth or no growth following defoliation (Zellmer et al. 1993). At high levels of grazing intensity, plant communities are unable to rebound from constant feeding pressures. Once snow geese graze an area to the point where they can no longer obtain sufficient food, they will leave to exploit other areas. Normally, this would allow plant communities to rebound from grazing. However, Ross's geese can further impact damaged areas after snow geese leave because they can graze on shorter stands of plants, which may delay or prevent recovery (Didiuk et al. 2001). The potential for plant recovery is further reduced by the short growing season in arctic and sub-arctic habitats.

Accelerated habitat degradation results from a negative feedback loop between light geese and the plant communities they utilize (Abraham and Jefferies 1997; Fig. 3.19). Removal of above-ground plant cover reduces the thickness of the vegetative mat that insulates underlying sediments from the air. This causes an increase in the rate of evaporation from surface sediments and greater concentration of inorganic salts from marine clays. Grubbing by geese further exposes the soil substrate.

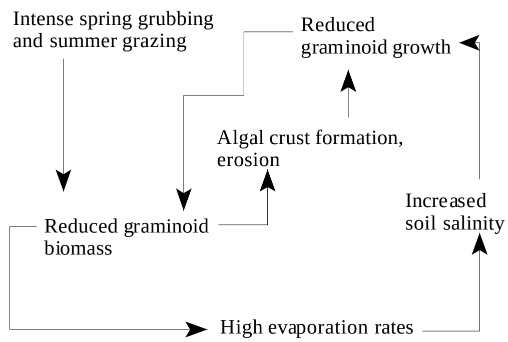


Fig. 3.19. Negative feedback loop between light geese and their habitat; which leads to habitat destruction (adapted from Abraham and Jefferies 1997).

Increased soil salinity reduces and eventually eliminates growth of the salt marsh plant community. Foraging activity of light geese maintains an open marsh situation and continued salinization of soils. Eventually, salt marsh stands are destroyed and desertification results. Bare mudflats may become colonized by salt-tolerant plant species, which are utilized as food by few, if any, wildlife species (Fig. 3.20). In other areas, mudflats become eroded and underlying glacial till and marine gravels are exposed (Fig. 3.21). Under such conditions there may be little or no chance of plant recovery within 25-50 years (Jano et al. 1990). Experimental sites where geese have been excluded by erection of fences following habitat destruction have experienced little or no re-vegetation after 15 years of protection (Abraham and Jefferies 1997). Placement of exclosure fences in intact stands of vegetation at La Perouse Bay in 1986 was used to demonstrate removal of vegetation by geese from surrounding sites by 1996 (Kotanen and Jefferies 1997). The primary plant foods of light geese in salt marsh habitat reproduce mainly by vegetative propagation and often do not produce seeds. Therefore, once plants are removed by geese, there is little chance of re-establishment.

Habitat degradation by light geese has been most extensively studied in specific areas where colonies have expanded exponentially and habitat degradation is severe. For example, comparison of satellite imagery for La Perouse Bay, Manitoba from 1973, 1984, and 1993 was used to document the decline in salt marsh vegetation as a result of the feeding activities of light geese (Jano et al. 1998; Fig. 3.22). Assuming a constant and linear rate of vegetation decline, the rate of decline at La Perouse Bay during 1984-93 was approximately 159 acres/year (Fig. 3.23; calculated from data in Jano et al. 1998).

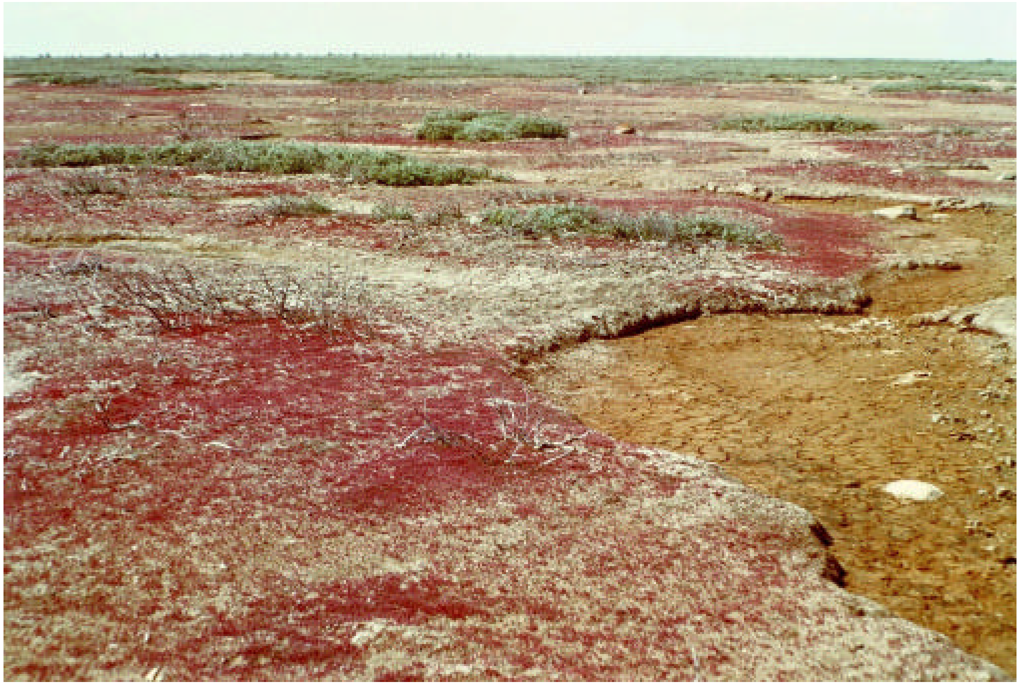

Fig. 3.20. Example of light goose habitat destruction at La Perouse Bay, Manitoba. Empty pond basin at right was caused by goose grubbing activity. Red plants surrounding dead willow trees are salt-tolerant species. Photo by J. Kelley, USFWS.

Fig. 3.21. Goose exclosure plot at La Perouse Bay, Manitoba. Green vegetation is enclosed by fencing that prevents geese from feeding in plot. Areas devoid of vegetation outside of plot were exposed to goose feeding and are characterized by mudflats and exposed gravel. Photo by J. Kelley, USFWS.

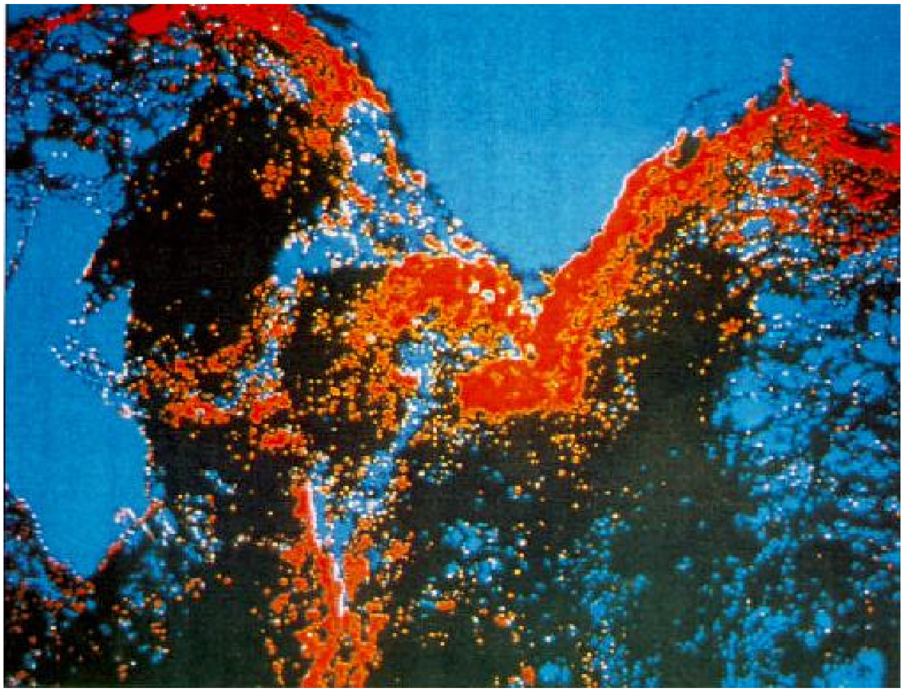

Fig. 3.22. Satellite imagery of the cumulative damage at La Perouse Bay caused by light geese during 1973-93. Water appears as blue, intact vegetation dark green, and damaged areas where there is bare soil or incomplete plant cover appears red. In 1973 these areas had complete vegetative cover (after Jano et. al. 1998). Width of photo covers approximately 16 kilometers.

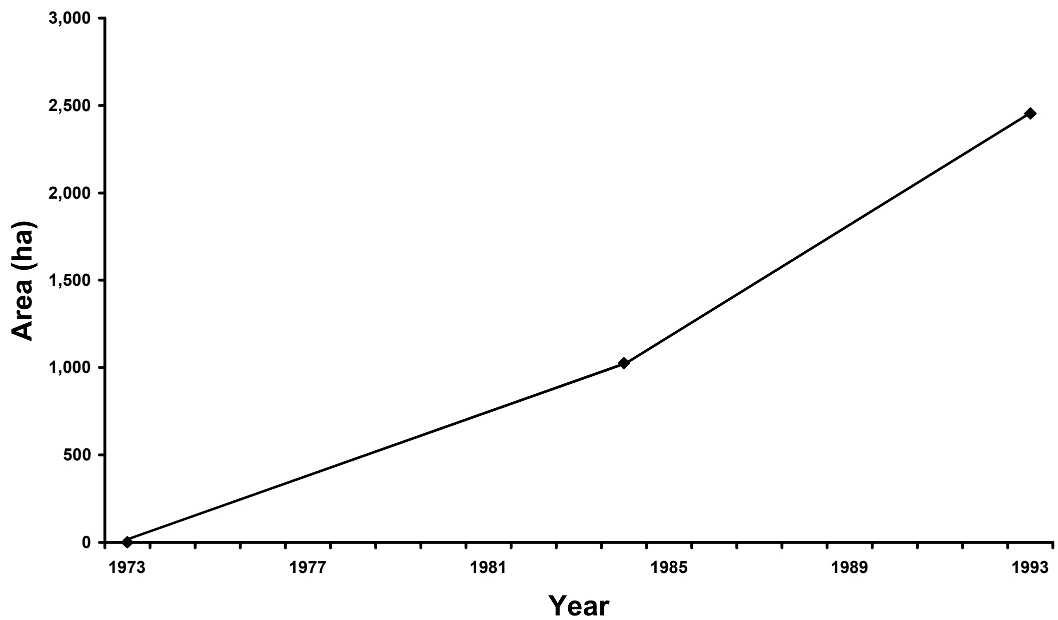


Fig. 3.23. Additional area (hectares) of salt marsh vegetation decline at La Perouse Bay after 1973 when monitoring began. Actual loss of vegetation was determined by comparison of satellite imagery from 1973, 1984, and 1993 (data from Jano et al. 1998).

Vegetation surveys conducted during 1993-95 indicate that destruction of vegetation and loss of habitat are widespread along the western and southern coasts of Hudson Bay and James Bay (Kerbes et al. 1990; Abraham and Jefferies 1997). The Hudson Bay Lowlands salt marsh ecosystem, for example, lies within a 1,200 mile strip of coastline along west Hudson and James Bays. This area contains approximately 135,000 acres of coastal salt marsh habitat; of which 35% is considered to be destroyed, 30% is damaged, and 35% is overgrazed (Abraham and Jefferies 1997). Habitats currently categorized as damaged or overgrazed are being further impacted and eventually will be destroyed if goose populations continue to expand.

The Hudson Bay Lowlands have undergone isostatic uplift following retreat of the last glacial episode. Upon being released from the weight of glaciers, the coastline has undergone a rate of uplift of between 0.5 to 1.2 meters per century (Hik et al. 1992). The gradual uplift causes modification to the soil environment and leads to a shift in communities of plants that tolerate drier conditions. In the absence of goose grazing this shift can occur within 5 years. However, the shift to a different plant community can be retarded by the grazing activity of geese, until the effects of isostatic uplift eventually predominate (Hik et al. 1992). It has been suggested that isostatic uplift, not the feeding actions of geese, is responsible for habitat damage at breeding colony sites (Thomas and Mackay 1999). This theory is disproved by the exclosure experiments cited above. If isostatic uplift was responsible for vegetation damage, then vegetation in fenced areas also should have been affected. Although isostatic uplift creates new salt marsh habitat as new land is exposed, the rate of increase of new habitat is too slow to keep up with the rate of habitat destruction caused by the increasing light goose population. As geese destroy salt marsh habitat and move inland they exploit other habitats that degrade much more quickly (R. Rockwell, personal communication).

Satellite imagery has been used to demonstrate habitat damage at other sites in the Arctic. For example, light goose population growth at Karrak Lake (approximately 750 miles northwest of La Perouse Bay) in the Queen Maud Gulf Migratory Bird Sanctuary has negatively affected habitat (Alisauskas 1998, Didiuk et al. 2001). Population growth rates of Ross's geese and lesser snow geese in Queen Maud Gulf during 1965-88 were 7.7% and 15.4%, respectively (Kerbes 1994). By 1989, 52% of plant communities within the areas occupied by nesting light geese at Karrak Lake were converted to exposed peat, and 7% had further eroded to bare mineral soils (Alisauskas 1998). Loss of vegetation at colony sites may eventually lead to desertification (Alisauskas 1998). Furthermore, destruction of food plants caused by increasing numbers of Ross's and lesser snow geese could have negative effects on other species inhabiting the area (Kerbes 1994).

The breeding range of light geese is vast, and a comprehensive inventory of habitat status at all major colony sites is unavailable at this time. However, all colonies have been visited during the past 5-10 years, and many have a history of visits during the past 40 years. Field observations indicate that various levels of habitat degradation have been caused by light geese in areas beyond those discussed above. Due to the high cost of obtaining satellite imagery and conducting detailed vegetation surveys in the Arctic, information from many areas is qualitative. Nevertheless, such observations point to the wide geographic range in which vegetation damage has been observed. The following descriptions of conditions at several major breeding or staging areas for light geese were reported by Abraham and Jefferies (1998).

Akimiski Island, NWT. Vegetation damage to the intertidal region along much of the north shore of the island is extensive. Mudflats have replaced many stands of vegetation and only patches of vegetation remain. Vegetation in the upper intertidal zone also is being grazed and grubbed. Brackish and freshwater vegetation immediately inland from the upper limit of spring tides is grazed heavily in summer and shoot pulling is common in spring. Bare peaty areas occur as a result of goose foraging activities, and stands of dead willows occur locally in areas grubbed by geese.

West coast of James Bay, Ontario. Localized damage to vegetation as a result of grubbing is found in salt marshes. Grubbing is more evident north of the Attawapiskat River than south of it. Intensive spring foraging by staging snow and Canada geese has been documented for areas north of Ekwan Point up to the Lakitusaki River. The absence of large breeding colonies of snow geese has resulted in only localized damage to vegetation.

Cape Henrietta Maria, Ontario. This region contains an extensive area of intertidal salt marsh that has been severely grubbed and heavily grazed. Inland from the intertidal zone are extensive moss carpets that have developed as a result of goose feeding. These conditions exist on the James Bay coast as far south as Hook Point. Between Cape Henrietta Maria and the Sutton River to the west, large grubbed areas, degraded salt marsh stands, and moss carpets dominate the coastal zone. Salt marsh habitat immediately west of the Sutton River is in relatively good condition, although signs of increased grubbing of these marshes exist. Intensive habitat damage has been noted only near the core of the goose colony located in this area. However, moderate to heavy goose grazing of freshwater sedge meadows has been observed up to 8-10 km from the coast.

Hudson Bay coast of Ontario. The stretch of coastline from Sutton River to the Ontario-Manitoba border contains small fringe salt marshes that have been grubbed and heavily grazed by Canada geese and lesser snow geese. Small colonies with high snow goose nest densities occur in the vicinity of more extensive salt marshes east of the Winisk River, Shell Brook, and at the Pen Islands. The vegetation stand at the Pen Islands (20 km x 5 km) is in good condition. However, at the other locations some damage to vegetation is evident.

Hudson Bay coast of Manitoba. Although the coastline of Manitoba between the Black Duck River in the east and Rupert Creek at the southern end of the Cape Churchill Peninsula is a major spring staging area for geese; no large breeding colonies of snow geese are found there. Fringe salt marshes in the area between the border with Ontario and Cape Tatnum have been heavily grazed and grubbed by geese. Migrating birds pull plant shoots in sedge meadows inland from the coast. Some moss carpets have developed and many bare areas are present on the surface.

Knife and Seal Rivers, Manitoba. The estuaries of these rivers have staging, breeding, and post-hatching populations of lesser snow and Canada geese. There are a number of marshes that are badly grubbed and damaged. Moss carpets have developed where geese have removed sedge shoots.

Tha-Anne River to the Maguse River (west coast of Hudson Bay). The coastal intertidal salt marsh in this area has been replaced by mudflats throughout the entire coastal strip, except at Wolf Creek. Sedge plant communities have either been heavily grazed or replaced by peat barrens for distances up to 10 km inland from the coast. In some areas the peat has been eroded to expose gravel.

Southampton Island. Visits to breeding colonies indicate that there is widespread shoot-pulling of sedges, heavy goose grazing of shoots, and bare peat areas and moss carpets are present. At Boas River, formerly extensive salt marshes have been badly grubbed and reduced to remnant patches.

Southwestern Baffin Island. This region contains several large colonies of lesser snow geese that breed in coastal marsh areas and move inland along river valleys to feed on freshwater vegetation. Widespread destruction of coastal vegetation due to grubbing, and the development of moss carpets in river valleys of the uplands, is evident.

Banks Island. Vegetation studies have not been conducted on the island; however, recent photographs of the area indicate vegetation changes as a result of goose grazing.

### 3.2.2 Migration and wintering habitat conditions and degradation

*Greater snow geese*. — The St. Lawrence River Valley is an important spring and fall staging area for greater snow geese. Traditionally, geese have utilized approximately 3,000 ha of bulrush marshes on the river. However, increased goose populations in the 1970s fostered the spread of geese into cordgrass salt marshes during spring. Although no vegetation studies have been conducted in cordgrass salt marshes, it is believed that geese are not negatively impacting this habitat to a large extent (Giroux et al. 1998). Most vegetation studies have been conducted in bulrush marshes, where geese feed on both aboveground and belowground portions of plants.

Most vegetation studies in bulrush marshes were conducted in the mid-1980s, when the snow goose population was less than half of current levels. At that time, it was estimated that geese consumed 23-32% of below-ground plant biomass during fall and spring combined (Giroux and Bedard 1987, Reed 1989). Employment of goose exclosures was used to demonstrate a 62% difference in plant production between grazed and un-grazed study plots. Bulrush stem density in some marshes declined by 40% during 1971-96 (Giroux and Bedard 1987). Repeated measures of below-ground plant biomass suggested that geese had maintained the marsh system in a low-level steady state during the 1980s. However, decreased number of use-days by geese, declining productivity of bulrush habitats at some sites, changes in plant species composition, and erosion of marshes indicate that the carrying capacity of bulrush marshes may have been reached and that marshes can no longer accommodate the increasing number of snow geese (Giroux et al. 1998).

Until the 1960s, migrating greater snow geese staged in their traditional bulrush marshes of the upper St. Lawrence River estuary. However, birds gradually began field-feeding behavior during spring in the late 1960s and early 1970s, when the population level approached 100,000 (Filion et al. 1998). Geese showed a strong preference for new hayfields with young grass growth and waste grain from the previous year. Between 1980 and 1985, hay crop loss due to goose grazing increased from 0.47 to 0.78 metric tons/ha. Studies conducted in 1995 indicated an average hay yield loss of 24% for the first cut, and a 7-10 day delay in plant maturity as a result of goose grazing (Filion et al. 1998). Goose grazing also has been implicated for increasing the abundance of weeds and decreasing hay vigor, which increases production costs. This damage has prompted implementation of a compensation fund to cover 80% of farmers' losses (Table 3.4). Bedard and Lapointe (1991) predicted that rapid goose population growth would soon lead to unacceptable crop damage. In some areas, compensation has not been sufficient for farmers who experience losses and the Quebec Farmers Union has asked for control of the snow goose population (Filion et al. 1998). With recent shifts of geese toward the upper St. Lawrence estuary and their later departure from these regions, damage to forage production could increase and additional crops, such as winter cereals, could be affected (Filion et al. 1998).

Table 3.4. Compensation paid to farmers in Quebec as a result of crop damages due to grazing by greater snow geese (Filion et al. 1998).

| Year | Number of farmers making claims | Total hectares affected | Estimated losses (Canadian dollars) | Total payments made (Canadian) |
|---|---|---|---|---|
| 1992 | 251 | 8,176 | 466,589 | 373,271 |
| 1993 | 136 | 3,526 | 211,514 | 169,211 |
| 1994 | 309 | 10,348 | 534,891 | 399,970 |
| 1995 | 369 | 16,081 | 904,043 | 560,000 |
| 1996 | 293 | 11,940 | 844,213 | 560,000 |
| 1997 | 283 | 11,411 | 485,312 | 485,312 |

Prior to the 1960s, the impact of greater snow geese on coastal marshes of the U.S. mid-Atlantic coast appeared to be relatively small. Goose impacts on marshes became more apparent as the population grew during the 1970s and 1980s. From New Jersey to North Carolina, areas of denuded marsh, or “eat-outs,” were created by foraging geese (Giroux et al. 1998). Cordgrass (*Spartina* spp.) marshes that have been heavily grazed by snow geese have significantly less above-ground and below-ground plant biomass than undisturbed marshes (Widjeskog 1977, Smith and Odum 1981, Young 1985). Marshes that have experienced eat-outs may be able to recover relatively quickly if sufficient below-ground biomass remains to resume vegetative growth (Smith and Odum 1981). However, areas that are grazed by geese year after year may be maintained as mudflats (Young 1985). A coastal marsh eat-out at Forsythe NWR in New Jersey has been maintained by annual goose grazing. Wind and wave action in the resulting open water area is causing erosion and may be preventing plant re-establishment (Giroux et al. 1998).

Snow goose grazing has impacted natural marshes at several sites throughout the mid-Atlantic coast. For example, 500-600 acres of marsh at Bombay Hook NWR in Delaware have been lost or reduced to bare mud since the early 1980s (Young 1985). Approximately 1,700 acres of salt marsh in the vicinity of Forsythe NWR in New Jersey were severely impacted by snow geese during the 1970s, and the impacted area appears to have increaseg gradually over time (Widjeskog 1978, Giroux et al. 1998). During the 1970s and 1980s, approximately 1,000-3,000 acres of cordgrass marsh along the Delaware Bay shore of New Jersey were impacted by snow geese (Giroux et al. 1998). Localized eat-outs have also been documented in Maryland and Virginia (Giroux et al. 1998). Goose impacts to coastal marshes appear to have been reduced in areas where birds have adapted to feeding in agricultural habitats. However, the nutritional subsidy that agricultural foods provides to birds likely has contributed to the increase in the goose population. Increased damage to coastal marshes during the last 5-10 years has occurred in areas where agricultural foods are less available or where large increases in goose numbers have rapidly occurred (Giroux et al. 1998).

The use of agricultural lands by greater snow geese in the mid-Atlantic region is a relatively recent development. During the 1960s, small groups of snow geese were first observed in agricultural fields in Virginia and North Carolina. Agricultural depredations by geese in the mid-Atlantic were first reported during the winter of 1971-72. Virginia and North Carolina experienced large numbers of crop damage complaints in the 1970s, but the number of reports has declined substantially. A 1998 poll of agency personnel in 6 mid-Atlantic states indicated that, on average, an annual total of less than 35 crop damage complaints (Giroux et al. 1998). However, goose damage was reported to be on the increase in Pennsylvania, Maryland, and Delaware, and stable in New Jersey, Virginia, North Carolina, and New York (Giroux et al. 1998). Crop damage assessment surveys were conducted in Delaware during 1998 and 1999 (Delaware Div. of Fish and Wildlife 2000). In 1998, a total of $500,000 in crop damage affecting 12,000 acres was documented; primarily in wheat, barley, and rye crops. In 1999, the number of acres affected had declined to 3,800, with damage amounts of $180,300. Although similar numbers of snow geese were present in both years, modification of hunting season opening dates for snow geese is believed to be responsible for the decline in crop damage.

With local exceptions, depredation problems resulting from feeding snow geese does not appear to be a serious widespread problem in the mid-Atlantic region. However, U.S. farmers are not traditionally compensated for wildlife damage and thus have little incentive to report damage to agencies. As snow goose populations continue to grow it is expected that agricultural depredations and complaints will increase.

*CMF light geese*. — As of yet, increasing light goose populations in the mid-continent region have not caused widespread crop depredation problems. A search of the crop damage reporting system of the U.S. Department of Agriculture indicated losses of $28,000 in Louisiana during January 1994 through November 2000 (U.S. Dept. Agriculture, unpublished data). Losses totaling $39,000 were reported in Texas from October 1993 to September 2000. Although many farmers may incur crop damage they often do not report such losses (M. Hoy, U.S. Dept. Agriculture., personal communication). Although light geese create eat-outs in natural marsh systems on the Gulf Coast, there are no indications that such occurrences are serious enough to warrant management action.

## *3.3 OTHER BIRD SPECIES*

### 3.3.1 Waterfowl

There are 43 species of ducks and geese (*Anatidae*) that occur throughout the United States and Canada (Bellrose 1976). There are 36 species of ducks (consisting of dabblers, divers, sea ducks, and mergansers) and seven species of geese (Bellrose 1976). Waterfowl production is closely associated with habitat. During the 1960s, large portions of forested and other wetland waterfowl habitat were converted to agricultural production, which resulted in the loss of that habitat for many waterfowl species. Habitats in the Mississippi Alluvial Valley, prairie-pothole regions of the Midwest, and important Gulf Coast wintering areas were converted to production of soybeans, rice, cereal grains, and other crops. However, Federal, State, and private conservation organizations established refuges, sanctuaries, and waterfowl production areas specifically to enhance production and protection of waterfowl and their habitats. Most North American goose populations remain numerically sound (USFWS 2000).

The Southern James Bay Population of Canada geese (*B. c. interior*) (SJBP) breeds on Akimiski Island and on the west coast of James Bay. Much of the population winters in the Mississippi Flyway, with a smaller portion also wintering in the Atlantic Flyway. The spring population of SJBP Canada geese on Akimiski Island declined 67% between 1985 and 1995 (Leafloor et al. 1996). The number of reports of goslings banded in early summer and subsequently retrieved in fall was low, even though gosling production and survival to the banding period had improved. Leafloor et al. (1996) suspected that non-hunting mortality had increased during brood-rearing and early fall migration, possibly due to the effects of chronic malnutrition caused by habitat degradation by feeding, nesting, molting, and staging geese. Large numbers of light geese utilize the north shore of Akimiski Island, and evidence suggests they result in negative impacts on Canada goose gosling survival by nesting light geese.

Numerous white-fronted geese and various other populations of Canada geese migrate, stage, and winter in the same areas as do CMF light geese. Large flocks of CMF light geese may be crowding other species during migration and wintering, forcing them to seek habitat elsewhere. The risk of transmitting avian cholera to these other goose species may also increase (see Section 3.4).

Annual surveys of duck breeding populations across predominant nesting areas began in 1955. Today, the survey area encompasses over 2 million square miles of breeding habitat and spans across Alaska, Canada, north-central United States, and eastward to Labrador (U.S. Fish and Wildlife Service 2000). Migration and wintering ranges of most species of ducks overlap those of light goose populations. The status of waterfowl habitats and populations during 2000 is summarized as follows: In the traditional survey area (strata 1-18, 20-50, and 75-77), total duck abundance was 41.8 ± 0.7 million birds. This was similar to last year's record high estimate of 43.4 ± 0.7 million birds, and 27% above the long-term (i.e., 1955-99) average. Mallard (*Anas platyrhynchos*) abundance was 9.5 ± 0.3 million, which is 12% below the 1999 estimate of 10.8 ± 0.3 million and 27% above the long-term average. Blue-winged (*A. discors*) and green-winged teal (*A. crecca*) numbers were both at record high levels this spring. Blue-winged teal abundance was 7.4 ± 0.4 million, which was similar to last year's estimate of 7.1 ± 0.4 million and 69% above the long-term average. Green-winged teal abundance was 3.2 ± 0.2 million, 80% above the long-term average and 21% higher than last year. Gadwall (*A. strepera*; 3.2 ± 0.2 million, +100%), northern shovelers (*A. clypeata*; 3.5 ± 0.2 million, +73%), and redheads (*Aythya americana*; 0.9 ± 0.1 million, +50%) were all above their long-term averages, while northern pintails (Anas acuta; 2.9± 0.2 million, -33%) and scaup (*Aythya marila* and *A. affinis* combined; 4.0 ± 0.2 million, -25%) remained below their long-term averages. American wigeon (*Anas americana*) and canvasback (*Aythya valisineria*) estimates were similar to those of last year and to long-term averages. May conditions in the traditional survey area were generally drier than last year. The estimate of May ponds in Prairie Canada and the U.S. combined was 3.9 ± 0.1 million, down 41% from 1999 and 20% below the long-term average. The eastern survey area comprises strata 51-56 and 62-69. The 2000 total duck population estimate for the eastern survey area was 3.2 ± 0.3 million birds. This was essentially identical to the 1999 total duck estimate of 3.2 ± 0.2 million birds. Numbers of individual species were similar to 1999, with the exception of scoters (*Melanitta* spp.; 182 ± 59 thousand, +288%) and green-winged teal (202 ± 29 thousand, -52%).

### 3.3.2 Other bird species

Habitat degradation caused by light geese has the potential to affect the ability of other bird species to utilize the same area. Desertification of salt marsh habitat will reduce or eliminate feeding grounds for birds migrating through impacted areas on their way northward. In addition, nesting habitat of bird species that normally breed in and near light goose colonies will be reduced or eliminated. Some local populations may not be high enough to withstand long-term setbacks resulting from habitat loss.

Local populations of more than 30 other avian species in the La Pérouse Bay area have declined, presumably due to habitat degradation from large numbers of foraging light geese (Table 3.5; Rockwell et al. 1997b). Declines in these populations represent an overall decline in use of the region by other wildlife

Table 3.5. Locally declining populations of other avian species in the La Pérouse Bay area. **Bold** indicates a significant decline (Rockwell et al. 1997b).

| | | |
|---|---|---|
| Tundra swan | Sandhill crane | Semipalmated sandpiper |
| Mallard | Ruddy turnstone | Red-necked phalarope |
| Black duck | Golden and black-bellied plover | **Parasitic jaeger** |
| **American wigeon** | Semipalmated plover | Bonaparte’s gull |
| Northern Pintail | **Dowitcher** | Arctic tern |
| **Northern shoveler** | **Hudsonian godwit** | Short-eared owl |
| Green-winged teal | **Whimbrel** | Horned lark |
| **Oldsquaw** | **Stilt sandpiper** | Raven |
| **Red-breasted merganser** | Dunlin | Yellow warbler |
| Savannah sparrow | Tree sparrow | White-crowned sparrow |
| Lapland longspur | Snow bunting | Redpoll |
| Northern harrier | Least sandpiper | |

species, resulting in a decrease in regional biological diversity. Significantly declining local populations of species listed by Rockwell et al. (1997) include northern shoveler, American wigeon, red-breasted merganser, stilt sandpiper, parasitic jaeger, oldsquaw, Hudsonian godwit, short-billed dowitcher, and others.

Documentation of specific losses in bird nests have been determined by repeated visits to study plots. For example, local nesting populations of semi-palmated sandpipers and red-necked phalaropes at La Perouse Bay, Manitoba, were sampled on study areas during 1983-87, 1993, and 1998-99 (Gratto-Trevor 1994; Rockwell 1999). In 1983, more than 120 semi-palmated sandpiper and 46 red-necked phalarope nests were documented (Gratto-Trevor 1994). When the study area was sampled in 1999, only 4 sandpiper and 1 phalarope nests were found (Rockwell 1999; Fig. 3.24).

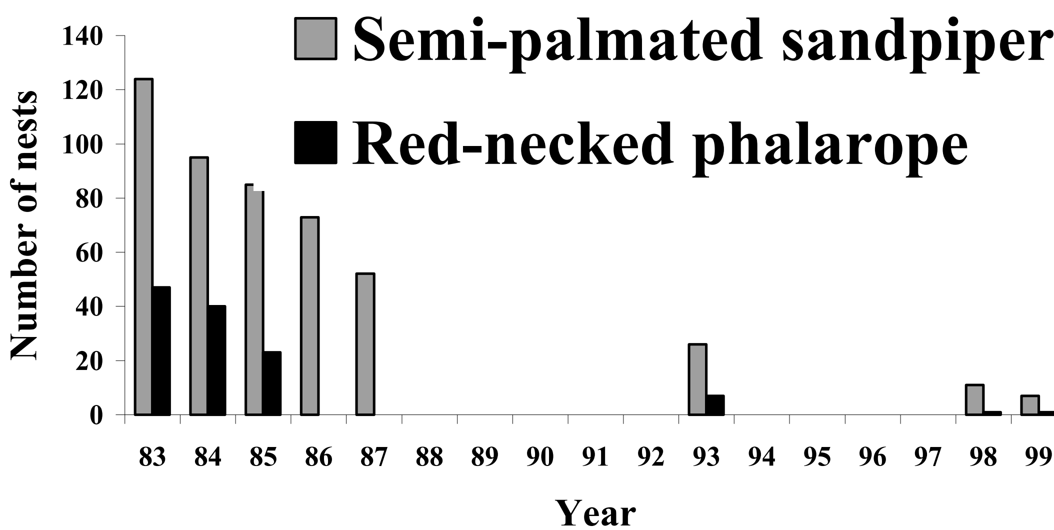


Fig. 3.24. Documented decline of semi-palmated sandpiper and red-necked phalarope nests on permanent study plots at La Perouse Bay, Manitoba, 1983-99 (Gratto-Trevor 1994; Rockwell 1999).

Results from these studies indicate declines in local populations of species in areas damaged by light geese. These results are not presented to suggest continental declines in populations of a particular species. However, if light goose populations continue to grow at current rates, and geese continue to exploit and destroy habitats in new areas, it is possible that regional and continental declines in populations of other bird species may occur.

### 3.3.3 Special Status Species

Due to the large geographical context of light goose management, a variety of special status species may occur in areas frequented by light geese. There are many endangered, threatened, proposed, and candidate species that occur in areas inhabited by light geese during migration and wintering periods. Although the geographic distribution of many of these species overlaps with those of light geese, the behavior, flight pattern, size, or other characteristics distinguish these species from any species of light geese. A regional listing of endangered and threatened species occurring in various light goose areas is presented in Appendix 5.

Endangered whooping cranes (*Grus americana*) occur in light goose migration and wintering areas; primarily in the Central and Pacific Flyways. Spring migration pathways of whooping cranes overlap those of light geese in the Central Flyway (Fig. 3.25). However, peak of the spring migration of cranes through important stopover areas along the Platte River and other portions of Nebraska occurs during April (Fig. 3.26). Most cranes begin their spring migration in April and early May (Lewis et al. 1994), after most light geese have already left their wintering grounds. No whooping cranes have been recorded as being shot incidental to recent efforts intended to increase spring harvest of light geese in the Central Flyway.

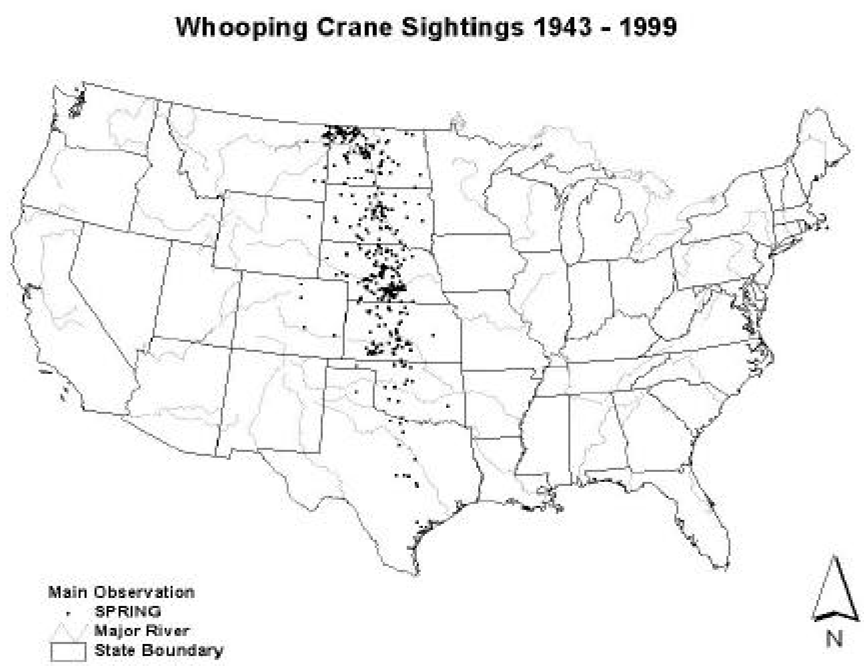


Fig. 3.25. Location of whooping crane sightings in the Central Flyway, 1943-99 (USFWS, unpublished data).

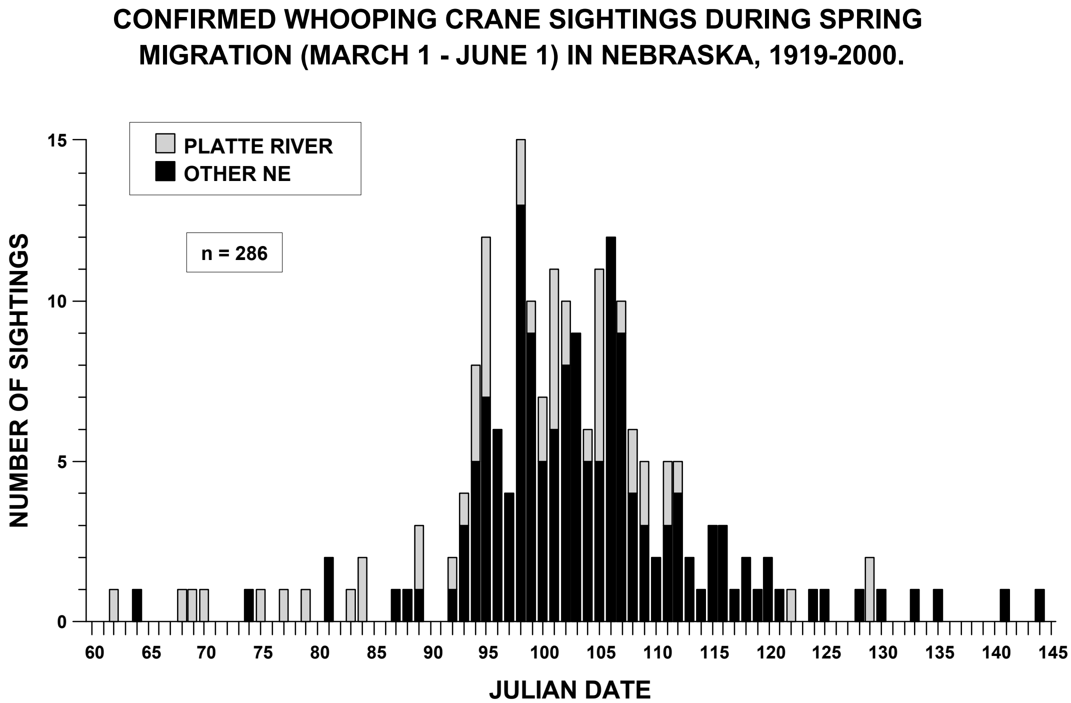


Fig. 3.26. Temporal distribution of whooping crane sightings in Nebraska, 1919-2000 (USFWS, unpublished data).

Protection of whooping cranes is ensured through implementation of the Contingency Plan for Federal-State Cooperative Protection of Whooping Cranes (Federal-State Contingency Plan Committee 2000). The contingency plan provides a mechanism for designating appropriate response options and reporting requirements whenever whooping cranes are confirmed as sick, injured, or dead, or when they are healthy but in a situation where they face hazards, such as shooting/hunting activities or contaminants and disease. Furthermore, plan objectives include reducing the likelihood of illegal shooting of whooping cranes by non-sportsmen or vandals, and increasing the opportunity to recover and rehabilitate wild whooping cranes found injured or sick.

## 3.4 AVIAN CHOLERA

Avian cholera is a highly contagious and deadly disease caused by the bacterium *Pasteurella multocida*, and is one of the most important diseases of North American waterfowl (Friend 1999). Two reservoirs have been suggested as the source of avian cholera in waterfowl populations: carrier birds and sites of disease outbreaks (Samuel et al. 1997). However, most studies do not support the hypothesis that soil and water conditions on cholera outbreak sites act as a reservoir for the disease (Backstrand and Botzler 1986; Samuel et al. 1997).

Although much remains to be learned about the mechanism of transmission, there is increasing evidence that lesser snow and Ross's geese act as reservoirs for the bacterium that causes cholera (Friend 1999, Samuel et al. 1997, Samuel et al. 1999a). There are four major U.S. focal points for avian cholera in waterfowl: the Central Valley of California; the Tule Lake and Klamath Basins of northern California and southern Oregon; the Texas Panhandle; and Nebraska's Rainwater Basin (Friend 1999). The movement of cholera from these areas follows the well-defined pathways of waterfowl migration (Fig. 3.27), and is associated with movements of lesser snow and Ross's geese (Brand 1984; Samuel et al. 1999a).

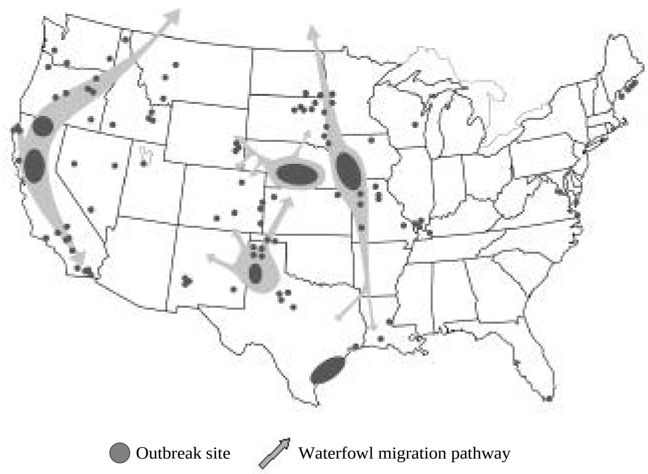


Fig. 3.27. Location of recurring avian cholera outbreaks and associated waterfowl migration pathways (Friend 1999).

Over 100 species of waterbirds and raptors are susceptible to avian cholera (Botzler 1991). Waterfowl species that are usually associated with cholera die-offs involving light geese include pintail, mallard, white-fronted geese, and Canada geese (Brand 1984, Samuel unpublished data). The threat of avian cholera to endangered and threatened bird species is continually increasing because of increasing numbers of cholera outbreaks and the expanding geographic distribution of the disease (Friend 1999). Potentially-affected species include whooping cranes and bald eagles (*Haliaeetus leucocephalus*). Various populations of sandhill cranes migrate, stage, and winter with CMF light geese and potentially could be affected by cholera outbreaks.

The potential for massive outbreaks of avian cholera in light geese and other waterfowl is illustrated by several documented die-offs. On Banks Island, avian cholera caused the death of at least 30,000 and 20,000 lesser snow geese in 1995 and 1996, respectively (Samuel et al. 1999a). Over 72,000 and 100,000 waterbirds died of cholera in the Rainwater Basin of Nebraska during 1980 and 1998, respectively (Brand 1984; Samuel, unpubl. report). Annual outbreaks of cholera involving the death of thousands of birds during individual events occur in Texas, Nebraska, and California (Fig. 3.28). Frequent outbreaks involving the deaths of small to moderate numbers of birds occur in Oregon, New Mexico, Colorado, South Dakota, Iowa, and Missouri; and occasional outbreaks occur in numerous other midwestern and western States (Friend 1999). Banding of vaccinated and control birds on breeding grounds indicate that survival of lesser snow geese that winter in the Central Valley of California is reduced 10-15% by avian cholera; and the disease accounts for about half of annual mortality (Samuel et al. 1999b). Evaluation of banding data from mid-continent white-fronted geese, and field observations of other waterfowl populations, suggest decreased survival rates due to avian cholera during some years (Friend 1999).

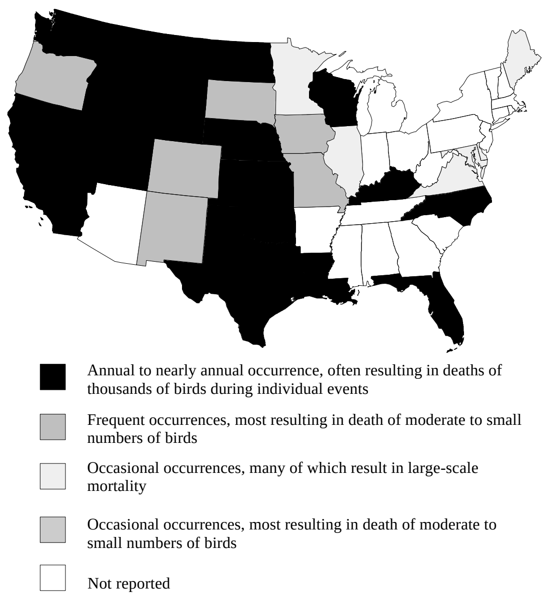


Fig. 3.28. Frequency of occurrence of avian cholera outbreaks in the U.S. (adapted from Friend 1999).

We believe that the increasing number and expanding geographic distribution of cholera outbreaks represent a serious threat to waterfowl and other bird populations that are susceptible to the disease. This threat is heightened due to the rapidly-increasing population of CMF light geese that are known carriers of the disease. Transmission of avian cholera is enhanced by the gregarious nature of most waterfowl species and by high densities of birds that result from habitat limitations, especially in winter and spring (Friend 1999). The likelihood of cholera outbreaks may be reduced when waterfowl occur in lower densities (Samuel et al. 1999b). Therefore, we believe that a reduction of light goose populations will reduce the risk of avian cholera outbreaks and associated impacts to other species in the future.

## 3.5 SOCIOECONOMIC CONSIDERATIONS

### 3.5.1 Economic impact of light goose hunting in the U.S.

Approximately 3.1 million people hunt migratory birds in the U.S. each year, and spend nearly $1.3 billion on trip- and equipment-related expenses (U.S. Department of the Interior 1997). Accounting for other indirect (influence of direct expenditures on secondary industries) and induced (wages and salaries for direct and indirect industries) impacts, migratory bird hunting results in a total economic impact of $3.6 billion each year in the U.S. (Teisl and Southwick 1995). Waterfowl (duck and goose) hunting represents 44% ($1.6 billion) of this total economic impact (Teisl and Southwick 1995). Estimates of the proportion of the total economic impact due to goose hunting are not available. However, goose hunting accounts for approximately 38% of the 22.2 million hunter days spent duck and goose hunting each year (U.S. Department of the Interior 1997:61). By assuming that days spent duck or goose hunting have equal cost, we estimate that the total annual economic impact of goose hunting in the U.S. is approximately $608 million.

Prior to implementation of special light goose regulations in the 1998/99 season, light geese represented approximately 24% of the total annual goose harvest in the U.S. (Martin and Padding 1999). Assuming that expenditures for goose hunting do not vary by species, light goose hunting creates an annual total economic impact of approximately $146 million. We used the percent distribution of harvest among Flyways to estimate the total economic impact of light goose hunting in each Flyway (Table 3.6).

Table 3.6. Light goose harvest in the U.S during 1997/98, and the proportion of the $146 million total economic impact generated by light goose hunting distributed among Flyways.

| | Flyway | | | | |
|---|---|---|---|---|---|
| | Atlantic | Mississippi | Central | Pacific | U.S. |
| Total light goose harvest | 35,200 | 247,100 | 361,200 | 43,700 | 687,200 |
| Percent of U.S. light goose harvest | 5.1 | 35.9 | 52.6 | 6.4 | 100.0 |
| Total economic impact resulting from light goose hunting ($ million) | $ 7.5 | $52.5 | $76.7 | $9.3 | $146.0 |

### 3.5.2 Economic impact of non-consumptive uses of light geese

Approximately 19.1 million people participate in non-consumptive uses (e.g. observe, photograph, etc.) of waterfowl in the U.S. each year, and spend $3.3 billion on trip- and equipment-related expenses (U.S. Department of the Interior 1997, Teisl and Southwick 1995). The total annual economic impact of non-consumptive uses of waterfowl in the U.S. is approximately $9.8 billion (Teisl and Southwick 1995). Information on the percentage of non-consumptive usage that can be attributed to duck or goose species is not available. Therefore, the economic impact of non-consumptive uses of light geese is not known.

### 3.5.3 Subsistence uses of light geese

Greater snow geese are harvested by subsistence hunters in northern Quebec, the eastern Canadian Arctic, and Greenland. The bulk of the harvest of geese and eggs likely is by hunters from villages at Pond Inlet, Arctic Bay, Clyde River, Resolute Bay, Grise Fiord, and possibly Spence Bay (Reed et al. 1998). Geese likely are also harvested during migration through more southerly areas. The most recent estimate of annual subsistence harvest of greater snow geese from the above areas is approximately 1,185 birds and 1,414 eggs (Reed et al. 1998).

Although lesser snow geese are harvested over a broad area in the Arctic, most subsistence harvest occurs near Cree communities of the Hudson Bay Lowland in southern Hudson Bay (Abraham and Jefferies 1997). In the Ontario portion of that region, the human population is concentrated in Moosonee and the 8 native communities of Moose Factory, Mocreebec, New Post, Fort Albany, Kashechewan, Attawapiskat, Peawanuck, and Fort Severn. Whereas harvest of lesser snow geese dominates in fall, the spring harvest typically is comprised of Canada geese. In 1990, it was estimated that the spring waterfowl hunt consisted of 14,000 person-days of harvest effort and the fall hunt consisted of 10,000 person-days (Abraham and Jefferies 1997). The communities of Moose Factory and Kashechewan accounted for over half of the hunting effort. In 1994, estimated subsistence harvest of snow geese in the Hudson Bay Lowland area of Ontario was 56,536 birds (Abraham and Jefferies 1997). The total annual subsistence harvest of snow geese in 1994 was greater than in the 1950s (35,000-40,000), likely due to an increase in the aboriginal population in the region. The mean annual harvest of snow geese per subsistence hunter on the Hudson Bay coast is approximately 37 birds (Abraham and Jefferies 1997). However, the annual harvest per hunter has remained similar during the past several decades, despite changes in goose population size (Abraham and Jefferies 1997). The fact that subsistence harvest has not risen proportionately with the increase in the size of the goose population suggests that attempts to manage light goose populations by increasing subsistence harvest would be ineffective (Johnson 1997).

## 3.6 National Wildlife Refuge System

The Service's National Wildlife Refuge System (System) is comprised of 721 refuges and waterfowl production areas on more than 93 million acres in the U.S. (USFWS 1999a). As stated in the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57), which amended the National Wildlife Refuge System Administration Act of 1966, the mission of the System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans". While some refuges may be opened for migratory bird hunting without area limitation, the National Wildlife Refuge System Administration Act of 1966 stipulates that only 40% of certain refuges may be opened to migratory bird hunting. The Fish and Wildlife Improvement Act of 1978 (Public Law 95-616) amended the 1966 Act to permit the opening of greater than 40% of certain refuges to hunting when it is determined to be beneficial to the species hunted. Following Executive Order 12996 issued on March 25, 1996, Congress enacted the National Wildlife Refuge System Improvement Act of 1997, amending the National Wildlife Refuge System Administration Act of 1966 to establish that compatible wildlife-dependent recreational uses involving hunting, fishing, wildlife observation and photography, and environmental education and interpretation are the priority public uses of the Refuge System. In order to establish a refuge hunt program, a determination must be made that the program is compatible with the major purposes for which the refuge was established (USFWS 1986b). Establishment of a hunt program includes preparation of the plan itself, an Environmental Assessment, a Finding of No Significant Impact, Section 7 consultation in accordance with the Endangered Species Act, and Proposed and Final Rules in the Federal Register (USFWS 1986b). Each year, we make new proposals for amendments to refuge-specific hunting regulations available for public review and comment in the Federal Register.

Croplands (including cropland pasture) account for approximately 200,000 acres of land in the System; compared to approximately 495 million acres of non-Federal cropland in the U.S. in 1997 (USDA 1999). Thus, refuge cropland comprises an insignificant amount (0.04%) of cropland when compared to the amount of croplands on private land. In any one year, only 40-60% of refuge cropland may actually be planted. Primary refuge crops include wheat, corn, soybeans and alfalfa. A certain percentage of crops may be harvested and removed by cooperative farmers, but the remainder is left standing or manipulated to provide supplementary food for migrating and resident wildlife (USFWS 1993).

*Greater snow geese*

Certain refuges often host large concentrations of greater snow geese during migration and winter periods. Snow geese are routinely observed at 8 refuges in USFWS Region 5, with peak visitation ranging from 500 to188,000 birds (Table 3.7). Peak populations occur on refuges during October through December,

Table 3.7. Peak population estimates for greater snow geese on National Wildlife Refuges in Region 5, 1994-99.

| Federal refuge and location | Peak population | Month/year of peak |
|---|---|---|
| Missisquoi NWR – VT | 500 | April 1999 |
| Montezuma NWR – NY | 15,000 | April 1999 |
| Forsythe NWR – NJ | 22,000 | November 1994 |
| Bombay Hook NWR – DE | 198,000 | October 1997 |
| Prime Hook NWR – DE | 157,000 | December 1997 |
| Blackwater NWR – MD | 6,500[1] | December 1998 |
| Chincoteague NWR – VA | 43,000 | December 1996 |
| Back Bay NWR - VA | 8,700 | January 1996 |

[1] Represents use by lesser snow geese

and in some months and years, more than 80% of snow geese in the Atlantic Flyway use Service refuges (USFWS, unpublished data).

Peak populations of greater snow geese on Bombay Hook NWR in Delaware have increased from 1,500 birds in 1968 to over 198,000 birds in 1997 (USFWS 1999). Birds traditionally concentrate their feeding activity in a small portion of the refuge and create “eat-outs” of salt marsh habitat. A portion of the refuge was open to public hunting during the 1983-84 hunting season in an attempt to alleviate damage to the salt marsh. Hunter interest and participation in the hunt program was high in the first 2 weeks of the season, but quickly declined as fall progressed. Snow goose harvest has varied from 150 to 1,450 birds/year, with high harvest years being associated with a large percentage of young birds in the population (USFWS 1999). With the advent of the hunting program, geese changed their behavior patterns and began using adjacent Federal, State, and private lands. Even during periods of high hunter activity, snow geese continue to roost on Bombay Hook NWR in the evening. Thus, damage to salt marsh habitat has not declined. Despite high populations of snow geese on the refuge, implementation of a hunting program has had less than expected results in increasing harvest and reducing habitat damage. With the exception of Blackwater and Back Bay NWRs, Region 5 refuges that snow geese use have some portion of the refuge open to hunting (Table 3.8).

Table 3.8. Refuges in Region 5 that receive snow goose use, and the proportion of each refuge open to hunting (USFWS, unpublished data).

| Refuge | Total refuge acres | Hunting allowed? | Acres hunted | % of refuge hunted |
|---|---|---|---|---|
| Missisquoi NWR - VT | 6,517 | Yes | 1,626 | 25 |
| Montezuma NWR - NY | 7,730 | Yes | 1,100 | 14 |
| Forsythe NWR – NJ | 44,302 | Yes | 11,489 | 26 |
| Bombay Hook NWR - DE | 15,978 | Yes | 5,416 | 33 |
| Prime Hook NWR – DE | 8,839 | Yes | 1,100 | 12 |
| Blackwater NWR – VA | 24,053 | No | 0 | 0 |
| Chincoteague NWR – VA | 14,100 | Yes | 1,750 | 12 |
| Back Bay NWR - VA | 8,000 | No | 0 | 0 |

*CMF light geese*

Certain refuges in the southern portions of the Central and Mississippi Flyways are also important to light geese. The number of use/days by birds in a particular year often exceeds 1 million birds, but usage is dependent on seasonal weather conditions (Table 3.9). In the States of Arkansas, Louisiana, Mississippi, and Texas, goose usage of Federal refuges represents only 10-13% of the estimated number of wintering light geese in those States (USFWS, unpublished data). A similar situation likely exists for migration States farther north. Therefore, it appears that privately owned lands are much more important to wintering light geese than are Federal refuges.

High populations of light geese on refuges may result in depletion of food resources intended for other waterfowl and crane species. In addition, the incidence of cholera and avian tuberculosis may increase in association with high populations of light geese on refuges (Taylor and Kirby 1990). Experimental light goose dispersal programs were attempted at Bosque del Apache NWR in New Mexico during 1986 (Taylor and Kirby 1990). A combination of crop manipulation, hazing, and to a lesser extent hunting, were able to move about 8,000 geese off the refuge in advance of normal dispersal movement. However, the program had the unintended effect of moving a large percentage of sandhill cranes and 2 whooping cranes off the refuge. Geese were unwilling to fly more than was necessary to escape disturbance, and often moved from one field to an adjacent field. Low hunter participation limited the effectiveness of the hunt program. Furthermore, hazing programs quickly reached a limit of effectiveness as geese became habituated to disturbance activities. Refuge staff concluded that making large-scale changes in goose distribution are impossible without dramatic and landscape-level changes in the environment (Taylor and Kirby 1990).

Table 3.9. Average number of annual use/days by light geese on selected refuges in the southern portion of the Central and Mississippi Flyways (USFWS, unpublished data).

| Refuge | State | Number of use/days |
|---|---|---|
| Lacassine NWR | LA | 607,000 |
| Cameron Prairie NWR | LA | 715,000 |
| Delta NWR | LA | 3,000,000 |
| Sabine NWR | LA | 1,929,400 |
| Upper Ouachita NWR | LA | 1,200,000 |
| Cache River NWR | AR | 1,429,453 |
| Bald Knob NWR | AR | 2,250,000 |
| Yazoo NWR | MS | 1,175,400 |
| Anahuac NWR | TX | 3,500,000 |
| McFaddin NWR | TX | 4,000,000 |
| Brazoria NWR | TX | 1,500,000 |
| San Bernard NWR | TX | 1,600,000 |
| Big Boggy NWR | TX | 2,000,000 |
| Aransas NWR | TX | 2,500,000 |
| Sequoyah NWR | OK | 770,000 |

Several refuges recently have made changes to their waterfowl hunting programs and/or cropland management in an effort to increase the harvest of light geese and reduce food availability (Table 3.10). Hunt program changes usually involved increasing the number of days open to hunting during the regular season, participation in the conservation order, and/or opening waterfowl sanctuary areas. Changes to cropland management were not common on most refuges because most programs were geared to management of ducks and shorebirds rather than geese. Reduction of cropland was accomplished on some refuges by reforestation efforts unrelated to light goose management actions.

Table 3.10. Examples of changes in management on various National Wildlife Refuges (NWR) and impacts on light goose harvest (USFWS, unpublished data).

| Refuge (State) | Management change | Impact on light geese |
|---|---|---|
| Yazoo NWR (MS) | Participated in conservation order | Additional harvest of 500 geese |
| Cache River NWR (AR) | Participated in conservation order<br>Open waterfowl sanctuary to hunting<br>Reforestation of agricultural land | Additional harvest of 100 geese by 5 hunters |
| Bald Knob NWR (AR) | Participated in conservation order<br>Open waterfowl sanctuary to hunting<br>Reforestation of agricultural land | Additional harvest of 250 geese |
| Lacassine NWR (LA) | No change due to negative impacts on non-target species | None |
| Cameron Prairie NWR (LA) | No cropland program (i.e., no change) | None |
| Brazoria NWR (TX) | Increase hunted acreage | Additional harvest of 1,350 geese |
| Anahuac NWR (TX) | Increase number of week days open to hunting<br><br>No changes to farming program due to negative impacts on non-target species | Additional harvest of 40 geese<br>Additional 250 hunter-days |
| McFaddin NWR (TX) | Increase number of week days and acreage open to hunting | Additional harvest of 250 geese<br>Additional 500 hunter-days |
| DeSoto NWR (IA) | Implemented controlled access hunt | For 1999 and 2000, 60-183 geese harvested by 83-122 hunters; movement of geese off refuge increased harvest on adjacent public hunting area by 500 geese |

Prior to implementation of changes in refuge management, there was a common perception that such changes would result in massive increases in light goose harvest. However, success of such changes was limited, and resulted in additional harvest of only 40 to 1,350 birds per refuge. Many refuges reported a lack of interest by local hunters, and that goose harvest was incidental to duck hunting. Hunters reported that geese quickly adjusted their daily movement patterns in response to hunter activity, thus decreasing success rates. Refuges often served only as roosting sites, and thus were not utilized for acquiring food. Several refuges indicated that changes to habitat management could not be made due to the likelihood of severe negative impacts to non-target waterfowl and shorebird species. Such impacts greatly outweighed any potential impacts on light goose food availability.

Beginning in 1997, we cooperated with State wildlife agencies to develop regional light goose action plans in the Central and Mississippi Flyways. Action plans identified important light goose wintering and migration areas, current habitat and hunting programs, and future potential for altering such programs to reduce food and sanctuary available to light geese. Prior to development of action plans, it was perceived that Federal refuges offered the potential for large-scale changes in total acreage open to light goose hunting. However, it became apparent that many Federal refuge areas had already been opened to hunting through normal administrative procedures for altering hunting programs. In some instances, hunting programs could not be expanded due to incompatibility with other refuge uses as outlined in the National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57; October 9, 1997).

Light geese in the Pacific Flyway

Several refuges in the Pacific Flyway winter large concentrations of light geese (Table 3.11). Separate tallies for lesser snow and Ross's geese were not available.

Table 3.11. Average number of annual use-days by light geese on selected refuges in the Pacific Flyway (USFWS, unpublished data).

| Refuge | State | Number of use/days |
|---|---|---|
| Sonny Bono Salton Sea NWR | CA | 1,800,000 |
| Sacramento NWR | CA | 5,646,850[1] |
| Delevan NWR | CA | 4,649,265[1] |
| Colusa NWR | CA | 2,895,735[1] |
| Sutter NWR | CA | 2,083,980[1] |
| Butte Sink NWR | CA | 283,760[1] |

[1] Represents average for 1996-2000

## 3.7 Historical and Cultural Resources

The geographic extent of light goose breeding, migration and wintering areas is continental in scope and encompasses a variety of historical sites and cultural resources. The management alternatives analyzed in this document do not involve construction of new building, excavations, or other activities that normally disturb historical sites or cultural resources.