III. AFFECTED ENVIRONMENT

A. BIOLOGICAL ENVIRONMENT

1. Canada Geese

Canada geese (*Branta canadensis*) are endemic to North America, where they occur in each of the United States except Hawaii, each Province of Canada, and many States of Mexico. Canada geese are readily recognized by their characteristic black neck and white cheek patch. Most authorities currently recognize 11 extant subspecies of Canada geese which differ primarily in body size and color (Johnsgard 1978, Bellrose 1980). Two subspecies, the giant Canada goose (*B. c. maxima*) and the western Canada goose (*B. c. moffitti*), and possible hybrids between these and other subspecies, are included in the definition of "resident" geese in this document (Palmer {1976} considered giant and western Canada geese as one subspecies *B. c. moffitti*). Giant and western Canada geese are the largest 2 of the 11 subspecies, ranging in weight from 8 to more than 15 pounds. These two subspecies nest in southern Canada and the conterminous United States, and winter relatively near their nesting areas, except in severe winters. The other nine subspecies of Canada geese (hereafter referred to as migrant geese) generally nest in more northerly locations and undertake semi-annual migrations each year. These migrations may encompass up to 3,000 miles, like that of the Richardson's Canada goose (*B. c. hutchinsii*) which nests as far north as Baffin Island, Nunavut, Canada, and winters as far south as the eastern States of Mexico. Migrant geese nest across the Arctic, subarctic, and boreal regions of Canada and Alaska and range in size from the 2-4 pound cackling Canada goose (*B. c. minima*) to the 7-10 pound dusky Canada goose (*B. c. occidentalis*).

a. Ecology and Behavior

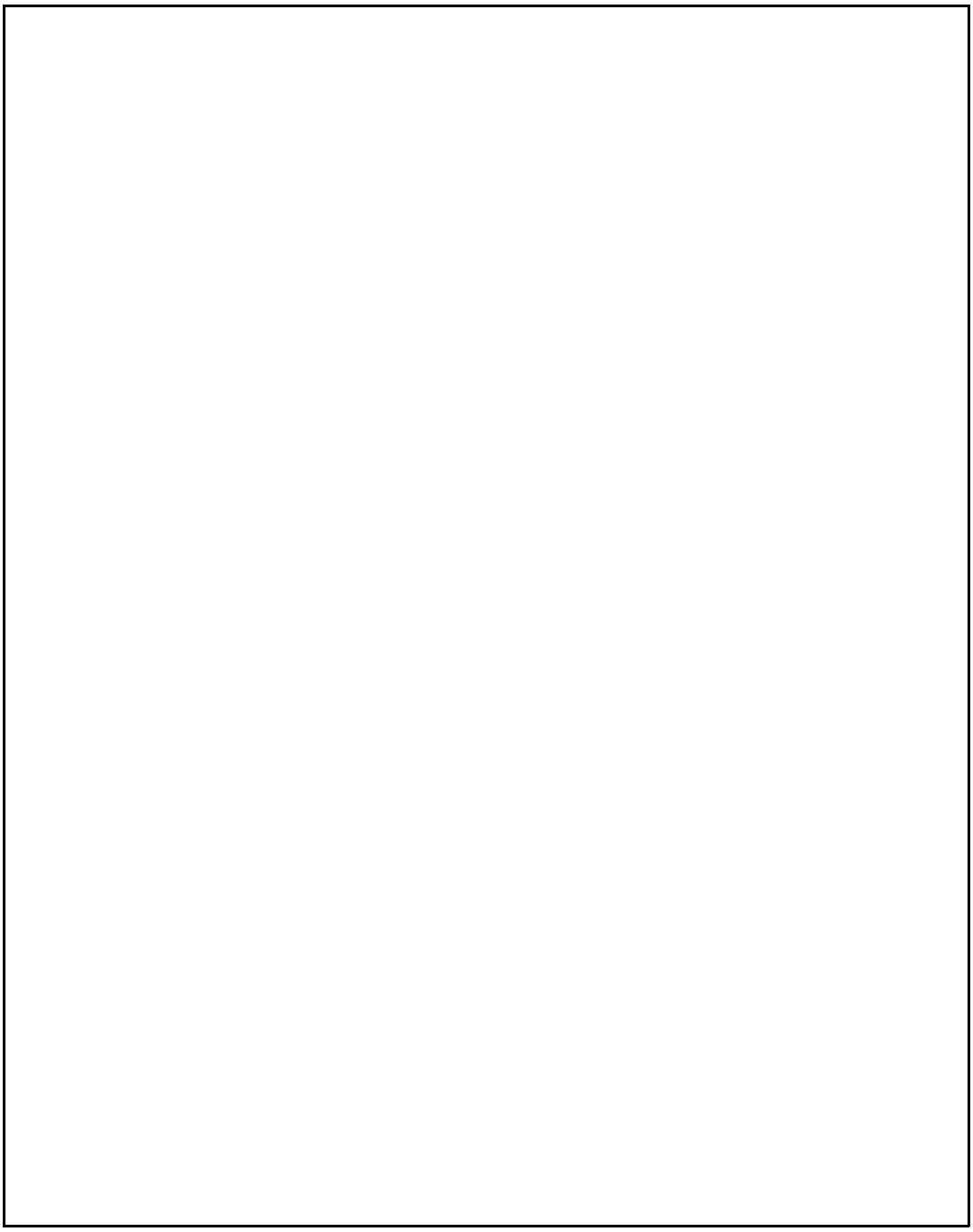
Although the general ecology and behavior of migrant and resident Canada geese are similar, several aspects of their life histories differ. These differences are due predominantly to variation in body size and migration behavior. The section below on the general characteristics of all Canada geese is followed by sections comparing and contrasting migrant and resident Canada geese.

(1) General Canada geese

(a) Appearance

Size and color are the major visible indicators of subspecies in Canada geese (see **Table III-1** from Bellrose 1980:141). However, there is enough overlap in one or more of these characters among some subspecies that classification to subspecies may be possible only by trained biologists. The sex and age of Canada geese in the hand can be determined by characteristics of the cloaca (the urogenital opening), the wing, and tail feathers. At a distance, however, the plumage of males and females and young and adults appear very similar. The sex of geese in the field can only be surmised by the larger size of the male (also with overlap), behavior, or secondary characteristics (Caithamer et al. 1993). Young Canada geese may be identified by their smaller and slimmer appearance, a less distinct division between the black neck and the breast coloration, and at very close range other plumage characters (Caithamer et al. 1993).

Table III-1. Vital statistics for various subspecies of Canada geese (from Bellrose 1980).



(b) Food Habits

Canada geese are herbivores, obtaining nutrition only from plants, including their leaves, roots, seeds,

and fruits. Before the advent of modern agriculture, geese relied primarily on natural wetland vegetation throughout their annual life cycle (Bent 1925, Hanson and Smith 1950). Geese now also make extensive use of grain (e.g., corn, soybeans, and milo) and leafy portions of agricultural crops (wheat, rye, and alfalfa), as well as moist-soil foods managed for wildlife (Eggeman et al. 1989). Vegetative diets generally provide higher fiber and lower protein content than the insectivorous or omnivorous diets of many birds. Canada geese are primarily grazers, especially during periods when accumulation of protein is especially important. These periods include preparation for spring migration and nesting, during rapid growth of goslings, and during the post-nesting replacement of feathers. During these periods geese may feed nearly constantly during daylight hours to obtain adequate protein. Geese prefer to feed on young and actively growing portions of plants which are highest in protein. The generally high fiber content of goose diets and the relatively inefficient digestive systems of geese result in high consumption rate and rapid turnover of foods. During periods of high energy use (i.e., winter or during migration), geese feed more intently on high energy foods, often waste grain remaining after agricultural harvest. Medium-sized geese (e.g., *B. c. interior*) may consume 0.4-0.5 pounds of corn a day under general wintering conditions (Vaught and Kirsch 1966, extrapolated from Frederick and Klaas 1982). When actively feeding, individuals of most goose species defecate up to once every 3-4 minutes (Owen 1980).

(c) Spring Migration

Canada geese are among the earliest spring waterfowl migrants. For most Canada geese, spring migration and nesting activities are timed so that the subsequent hatch of goslings occurs concurrently with the most vigorous growth of spring vegetation (Owen 1980). Migrating Canada geese move northward fairly gradually following the retreating snow cover and an isotherm of about 35° F (Bellrose 1980). For the last portion of migration, northern-nesting geese often overfly areas of snow in boreal forests to arrive on Arctic and subarctic nesting areas just as spring breaks. The most southerly wintering geese leave their wintering areas in January and geese wintering at middle-latitudes move northward in March or April (Bellrose 1980, Tacha et al. 1991).

(d) Pairing

Some geese form pair bonds during their first year of life but most defer pairing until subsequent years. Pair bonds are predominantly formed in the spring and are long-lasting in Canada geese. Generally, pair bonds are maintained until one of the pair dies, but at times, geese will form new pairs even when their old mates are still alive (MacInnes et al 1974). Pairs copulate over water during spring migration and on their nesting grounds.

(e) Nesting

Nesting-age geese arrive on the breeding areas already paired. Pairs begin to establish territories and search for nest sites as soon as snow cover melts and nest sites become exposed. Most Canada geese nest within 50 meters of a water body, most often on raised areas that afford good visibility from the nest site (Bellrose 1980). Common nest sites include islands, hummocks, pond banks, and muskrat houses, but a variety of sites are used including cliffs and trees. The resident subspecies readily use man-made nesting structures (e.g., elevated tubs and platforms). Canada geese are very philopatric to their previous nesting areas and often use the exact same nest site year after year (Brakhage 1965).

Canada goose females prepare their nest sites by scraping shallow depressions in the soil and lining them

with vegetation pulled from the immediate area. Clutches of one to eight large cream-colored eggs are laid approximately one per day until the clutch is complete. As egg-laying progresses the female plucks down from her breast to line the nest. Incubation is conducted exclusively by the female and does not start until the entire clutch is laid. The female will incubate from 24 to 30 days (depending on subspecies) taking only a few brief recesses each day. During the incubation period females spend from 91 to 99 percent of their time on the nest (Afton and Paulus 1992).

As an adaptation to initiating nests prior to the growing season, laying large clutches, and high incubation constancy, Canada geese accumulate the fat and protein required to conduct nesting activities in "nutrient reserves" within their body. These reserves are built prior to and during migration but supply the energy required to complete migration, produce eggs, and survive through the prenesting and incubation periods. Females are at their highest annual body weight just prior to arrival on their breeding grounds, nearly twice as heavy as during the winter months. The weights of all eggs in a clutch may represent as much as 22 percent of females' basal winter weight (Raveling and Lumsden 1977, Moser and Rusch 1998). By the end of incubation females may have lost up to 34 percent of their prelaying body weight (Raveling and Lumsden 1977, Gates et al. 1998, Moser and Rusch 1998), will be at their lowest annual weight, and may be near starvation. Harsh conditions during migration or prenesting periods may require further depletion of these reserves and force females to lay fewer eggs, to abandon nests prior to hatching, or even to forego nesting (Newton 1977, Krapu and Reinecke 1992). Weather conditions in some years may be so harsh that few females in northern areas have adequate reserves to successfully complete nesting activities (Moser and Rusch 1998), or time to allow goslings to fledge before the breeding grounds become inhospitable (Barry 1962).

The gander's contribution to the nesting effort is to provide protection for the female before nesting and during incubation recesses, and to assist the female in defense of the nest from predators. The cooperative defense of the nest is quite effective against most natural predators. Egg predation by gulls, crows, other avian predators and all but the larger mammalian predators is uncommon except when geese are away from their nests during recesses or due to human disturbance (MacInnes and Misra 1972). Larger mammals may be able to displace the pair and take eggs and/or adults (Bellrose 1980, Campbell 1991, Stephenson and Van Bellenberghe 1995). In some areas, substantial numbers of nests may be destroyed by flooding. Eggs also may fail to hatch due to abandonment by the female, infertility of all eggs, or death of the eggs' embryos. In some cases, females may continue to incubate a clutch of infertile eggs, or eggs containing dead embryos for indefinite periods. At southern latitudes, if all eggs in a nest are destroyed the goose may make another nesting attempt. At northern latitudes (except where coastal currents ameliorate conditions), renesting is rare and may be restricted by female energy reserves and/or lack of adequate time to fledge young before fall migration is required (Bellrose 1980). If one or some eggs remain intact the female will likely continue to incubate the nest. Overall nest success varies among locations and years, ranging from 10 to 95 percent, but is generally high on an annual basis, averaging 50 to 80 percent for most populations (Bellrose 1980, Sargeant and Raveling 1992, Bromley et al. 1998, Bruggink et al. 1998, Huskey et al. 1998a, Conover 1998, Rusch et al. 1998).

Not all geese nest each year. Canada geese exhibit delayed sexual maturity and most geese are not physiologically capable of breeding until they are at least 2 years old. Although many young geese form pair bonds and may even defend territories, many do not nest for the first time until the age of at least 2, 3, or 4 (Kossack 1950, Craighead and Stockstad 1964, Moser and Rusch 1989). Further, success in raising young also increases with age (Raveling 1981, Hardy and Tacha 1989). Some geese that have nested previously do not nest every year and the proportion of females that attempt to nest and their

nesting success may depend on the severity of spring conditions (MacInnes et al. 1974, MacInnes and Dunn 1988).

(f) Brood-rearing

Eggs within individual clutches hatch nearly synchronously and goslings spend less than 24 hours in the nest before being led to preferred brood-rearing areas by the goose and gander. Preferred areas provide protein-rich vegetation that goslings require to build body tissues and open water that provides escape from predators. Accompanied by both parents, the precocial goslings will spend nearly all their daylight hours feeding for the next 6-8 weeks. During this period goslings will build body tissues, replace their natal down with juvenal body feathers, and grow the wing feathers (i.e., primaries, secondaries, and tertials) necessary for flight. Females also feed extensively during this period to replace energy reserves used during the energy-demanding laying and incubation periods.

(g) Family structure

Family unity is strong in Canada geese. Adult geese with goslings aggressively protect their mates and offspring. Disputes with other geese often arise at feeding areas when flocks feed in close proximity. In disputes, larger families usually displace smaller families, which in turn displace barren pairs, which in turn displace single geese (Raveling 1970). These aggressive encounters often solicit the "triumph ceremony" among members of the pair or family, a behavior including rushing, gaping, neck-waving, and calling (Balham 1954). Goose families generally migrate south and spend much of the fall and winter together (Raveling 1968, 1969).

(h) Molt

Adult Canada geese replace all their feathers once per year. Body feathers are gradually molted throughout the year, but the flight feathers are molted simultaneously during summer. For geese that have produced young, the loss of flight feathers occurs 2-3 weeks after hatch and leaves them as flightless as their young. During this flightless period goose families are susceptible to predators so they become more secretive, call little, and remain close to bodies of water for safety. The adults regain flight capability in 4-6 weeks, about the same time their young reach flight stage (Bellrose 1980).

Non-breeding geese and unsuccessfully nesting geese often congregate in local or distant places to undergo the molt. In most populations, non-productive Canada geese complete a "molt migration" to molting areas generally northward of the breeding areas, often by hundreds of miles (Hanson 1965:78-82, Abraham et al. 1999). Regardless of the location, these molting areas provide open water for safety, abundant food, and are often separate from areas occupied by successfully breeding geese which reduces competition with the more dominant family groups. Far-northern areas offer additional advantages of longer day lengths in which to feed, different predator communities, and little human disturbance.

(i) Fall Migration and Wintering

Instinct, tradition, and opportunity, as well as weather, food, and disturbance affect the migration patterns of Canada geese. Some geese move south from their nesting or molting areas in response to freezing temperatures, snowfall, and advantageous winds; others migrate before conditions become harsh. Before arriving at their final wintering destination geese often gather at staging grounds, places that provide

attractive but temporary conditions prior to further movement. Fall migration may start as early as late August from northern areas and southern-nesting geese may not move at all from their nesting areas. The latitude at which geese ultimately spend the winter depends largely on weather, food availability, and goose body size. Larger geese are better able to withstand cold temperatures and tend to winter farther north than smaller geese (Lefebvre and Raveling 1967).

Geese in fall and winter are extremely gregarious and are attracted to areas that provide adequate foraging opportunities, water, protection, and other Canada geese. Federal, State, and Provincial wildlife areas throughout migration corridors have been important staging and wintering areas for geese in the past. Some individuals or populations of Canada geese now winter farther north and are less reliant on refuges than they were historically. The current, more northerly distribution of Canada geese (see Flyway summaries) has been attributed to the influence of northern refuges, cumulative harvest that depressed survival rates of goose stocks that traditionally wintered in the south, the decoying effect of northern resident Canada geese, and global warming (Crider 1967, Raveling 1978, Rusch et al. 1985, Malecki and Trost 1986). Geese now winter as far north as Washington, South Dakota, Minnesota, and New York in mild winters.

During winter, geese generally make two foraging trips from their roosting sites each day, one shortly after sunrise and another in late afternoon, depending on temperature and daylight intensity. Geese will travel considerable distances during these feeding flights, if conditions warrant. Canada geese are large enough to withstand cold temperatures and harsh conditions for prolonged periods; however, geese have to emigrate if their food resources become covered with deep snow or open water is unavailable for more than a few days.

(j) Annual Survival

Canada geese are long lived birds with generally high annual survival rates. The oldest known wild Canada goose was banded as an adult and recaptured 28 years and 5 months later (Klimkiewicz 2000).

Many species prey on goslings (including gulls, jeagers, crows, ravens, raptors, foxes, wolves, bears, dogs, and cats) and exposure to the elements can cause mortality. Most gosling mortality occurs within the first 2-3 weeks after hatching and Canada goose gosling survival is generally high (Bellrose 1980, Sargeant and Raveling 1992, Ely 1998, Huskey et al.1998b, Lawrence et al. 1998a). Reported gosling survival rates for Canada geese are generally from 60 to 80 percent, but range from 4 to 95 percent (MacInnes et al. 1974, Krohn and Bizeau 1980, Baker et al. 1990).

Annual survival rates for Canada geese vary by subspecies and population but generally range from 65 to 85 percent for adults and from 30 to 70 percent for juveniles (Bellrose 1980, Hestbeck and Malecki 1989, Samuel et al. 1990, Raveling et al. 1992, Harris et al. 1998, Johnson and Castelli 1998, Lawrence et al. 1998b).

Few predators regularly take adult Canada geese and other forms of natural mortality are limited. Hunting is thought to be the predominant source of post-fledging mortality for most hunted populations of Canada geese (Chapman et al. 1969, Raveling and Lumsden 1977, Krohn and Bizeau 1980, Tacha et al. 1980). Estimates of legband recovery rates of hunted goose populations vary among regions but range from <1 to 9 percent for adults and < 1 to 12 percent for juveniles (Tacha et al. 1980, Harris et al. 1998, Johnson and Castelli 1998, Lawrence et al. 1998b).

(2) Comparison of Resident and Migrant Canada Geese

Although resident and migrant Canada geese share basic life histories, several differences between these groups confer advantages upon resident geese regarding reproductive success and annual survival. Migrant Canada geese have life history strategies that accommodate the reduced length of the growing season on the breeding grounds, the additional energetic rigors of migration, reduced food availability, and harsher climate on their northern breeding grounds. Many life history differences result in energy benefits to resident geese that allow them to allocate more energy to reproductive efforts or to reduce their exposure to hunting pressure, both of which contribute to the higher potential population growth rates for resident Canada geese.

(a) Food Habits

Food habit differences between resident and migrant Canada geese are due mainly to their disjunct breeding areas. Resident geese remain in areas associated with human activity and longer growing seasons all year. Their residency there ensures a consistently available source of food (actively growing crops, pasture, and lawn vegetation, as well as waste grains and natural wetland vegetation) right up to and after the nesting period. The human practice of mowing grasses (e.g., lawns, parks, cemeteries) stimulates the tender new grass growth preferred by geese. Resident geese may also forage in urban gardens and consume a variety of native and exotic plants, as well as human hand-outs (Conover and Kania 1991). In contrast, migrant geese begin moving north in time to arrive on their breeding grounds concurrent with the disappearance of snow cover and the availability of nest sites. Many northern-nesting geese migrate over vast boreal forests which provide only limited food resources and often are snow-covered. When they reach their breeding grounds, food availability is restricted primarily to the underground portions of plants, and goose caloric intake is limited. Even this limited food may be rendered unavailable by additional snowfall. Food availability remains low during most of the nesting period but lush grass and sedge forage becomes available some time prior to hatch. Thus migrant geese undergo longer periods of restricted food availability and consume a diet less subsidized by agricultural and horticultural practices than do resident geese.

(b) Spring Migration

For Canada geese, flight requires about 12 times as much energy as loafing/resting (LeFebvre and Raveling 1967, Raveling and Lumsden 1977). A flight of 660 miles (a moderate final migration distance) for a medium-sized goose can require the expenditure of approximately 2,015 Kcal of energy, equal to the energy in 210 grams of fat, or more than the dry weight of 2 eggs (Raveling and Lumsden 1977). Longer migrations would further deplete the nutrient reserves that are used by geese for subsequent reproduction. Migration also exposes geese to risks such as collision with man-made towers or aircraft, uncertain terrain, predation risk, and subsistence harvest (adults and subsequently their eggs) near some native communities in Canada and Alaska. Spring goose harvests by aboriginal peoples, while generally not of great magnitude (Dickson 1996, Wentworth 1998) is another source of mortality incurred by migrant geese to which resident geese are not subjected.

Migrant Canada geese arrive on the breeding grounds from mid-April on James Bay, late April for Hudson Bay, mid-May for the Yukon-Kuskokwim Delta in Alaska, to June for islands in the Arctic (Bellrose 1980). In contrast, resident geese arrive on their northern U.S. breeding areas in March and on Canadian breeding areas in early April. In southern nesting areas, resident birds may winter on or near

nesting areas and may begin nesting as early as February.

(c) Nesting, Molting, and Brood-Rearing

Migrant Canada geese have adapted to the shorter growing seasons on their nesting areas by shortening many of their summer activities, while resident geese have additional time (**Table III-2**). Relative to migrant geese, resident geese lay eggs at a slower rate, incubate eggs longer, have longer nesting (and renesting) periods, and have longer flightless periods for molting adults and maturing goslings.

Sexual maturity occurs in resident geese at an earlier age than most migrant geese (**Table III-2**). While most resident geese breed first at 2-3 years of age (Brakhage 1965, Cooper 1978), most individuals of migrant subspecies do not nest until the ages of 3-5 years (Hardy and Tacha 1989, Moser and Rusch 1989, Rusch et al. 1996).

Table III-2. Comparison of biological attributes of Canada geese of various migration behavior and size (modified from Rusch et al. 1996, additional data from Hanson 1965).

Attribute	Resident Geese	Medium-sized Migrants	Small Migrants
Population dynamics			
Age at first nesting	2-3 years	4-5 years	4 years
Clutch size	5-7	3-5	2-5
Nest Success	High	Variable	Variable
Renesting	Yes, frequent	Rare-infrequent	No
Annual Reproductive Success	High, constant	Medium, variable	Low, boom-bust years
Adult survival	>0.90	0.70-0.90	<0.70
Migration distance	Short	Medium	Long
Hunting exposure	50-100 days	120 days	160 days
Population trend	Long-term increase	Fluctuation	Fluctuation
Time constraints			
Nesting period	Feb - Jun	Apr - Jun	Jun - Jul
Incubation period	28-30 days	28 days	24 days
Egg-laying rate	1 egg/1.5 days	1 egg/day	1 egg/day
Gosling time to fledge	85 days	63 days	43-55 days
Adult molt time	35 days	32 days	26 days

Migrant Canada geese, because of their smaller body size, cannot store as much fat and protein internally as can resident geese (proportionally or absolutely) (Ankney and MacInnes 1978). Resident geese, therefore, have the potential to store the most nutrient reserves, migrate the shortest distances, have the greatest access to food prior to and during nesting, and have the longest growing season in which to reproduce. Accordingly, clutch size varies along the size gradient of geese, as do average indices of nest success and other reproductive parameters (**Table III-2**). Reproductive rates for resident geese are quite consistent from year to year, while northern-nesting migrants may experience nearly complete reproductive failures in some years due to delayed spring phenology or inclement weather (Rusch et al.

1996).

(d) Fall Migration and Wintering

Migrant Canada geese move much farther to wintering areas than do resident geese. In addition to the increased energy expenditure of longer migrations and other risks of migration, migrant geese are exposed to hunting pressure for a greater period. Traditionally, States and Provinces have set their goose hunting seasons to correspond with the peak abundance of migrant geese. Geese are subject to hunting pressure consecutively in each State/Province along their migratory path. Resident geese that undertake short or no migrations are exposed to hunting seasons in only one or a few States/Provinces. Hunting seasons in the Mississippi Flyway exposed interior and Richardson's geese there to 120 and 160 days of sport hunting, respectively, while the resident geese were exposed to only 50-100 days (Rusch et al. 1996). Rusch et al. (1996) reported a declining trend in general annual survival from resident Canada geese to small migrant Canada geese (**Table III-2**). In recent years, some States and Provinces have set hunting seasons to better coincide with peak abundance of resident geese (in addition to establishing special seasons for resident Canada geese). However, setting goose seasons to harvest only resident geese is temporally and spatially difficult under the existing Migratory Bird Treaty Act, and social and other constraints.

Resident geese also avoid hunting mortality through their extensive use of urban environments. Urban environments can provide all resident goose life cycle requirements, at least for short periods, and allow geese to remain in urban "refuges" and avoid peak harvest periods (i.e., weekends). Urban resident geese also likely benefit from the less dangerous predator communities within cities. Additionally, the larger size of resident Canada geese likely makes them even less susceptible to the predators they do encounter in both urban and rural areas. Urban geese however, are subjected to herbicides, pesticides, pollution, automobiles, illegal take, pets, and transmission of disease from domestic fowl.

(e) Population Growth

Canada geese are one of North America's greatest wildlife success stories. The total number of Canada geese counted during winter in North America has increased from 980,000 in 1960 to 3,734,500 in 2000 (Mid-winter Survey unpublished reports), and most biologists believe there are more Canada geese now than at any time in history (Rusch et al. 1995, Ankney 1996). The giant Canada goose, thought to be extinct from the 1930s until the 1960s, is now the most abundant of all subspecies and is considered overabundant in many regions. Of the 15 recognized Canada goose populations assessed in the North American Waterfowl Management Plan, all show increasing or stable population trends (Department of the Interior 1998). The following few populations which had declined substantially since 1900 are doing well:

- The Aleutian Canada goose suffered drastic declines during the early 1900s due primarily to introduction of arctic fox to their restricted insular breeding habitats and were listed as endangered in 1967. A Recovery plan was devised in 1974, the population has since rebounded, and the Aleutian Canada goose was delisted in 2001.

- Dusky Canada goose numbers declined drastically due to changes in their Alaskan nesting habitat resulting from earthquakes in 1964. Surveys suggest dusky goose populations are now approximately mid-way between population lows and population

highs estimated since 1969 (U.S. Fish and Wildlife Service 2000).

- Cackling Canada goose population levels declined rapidly to a low level in 1984, but have reached record highs (since surveys began in 1980) in the last several years.

- Atlantic Population Canada geese declined in the mid-90s due to an unrecognized imbalance in production and survival (see **section III.A.1.a.(3)(a)**) but have recovered in recent years.

- Southern James Bay Population Canada geese have remained at a relatively low but stable level for many years. Distribution of geese between insular and mainland areas and resultant estimation of population size may be influenced by light goose induced habitat degradations.

While most North American Canada goose populations are increasing or stable, resident populations, in general, are growing more rapidly than migrants (U.S. Fish and Wildlife Service 2000). The foregoing text provides substantial background on the reasons for the disparate growth of resident and migrant Canada goose populations. In general, resident geese exhibit more advantageous reproductive (i.e., younger breeding age, fewer or no years of population reproductive failures, larger clutch sizes, greater nest success rates, renesting propensity) and survival parameters than migrant geese. Given these advantages, the greater rate of population growth of resident geese in relation to migrant populations is expected. Urban populations of resident geese likely have even higher reproductive and survival rates that do rural resident geese (Smith et al. 1999). The growth of Canada goose populations within Flyways is documented in cooperative waterfowl monitoring programs (see Flyway summaries).

(3) Population Interactions

Although resident and migrant Canada geese are allopatric during portions of their respective nesting seasons, it is apparent that individuals of these groups concurrently occupy much of their wintering and staging areas and, through the molt migrations of resident birds, also concurrently occupy migrant Canada goose breeding areas for a portion of the summer. The concurrent presence of these groups in space and time and their interactions introduce complexities for Canada goose management, deleterious impacts upon geese and their habitats, and have potential socioeconomic and sociologic implications. These include problems in assessing population parameters of various populations, competition for food and space, disadvantageous changes in goose distribution and habitat use, potential for disease transmission, loss of genetic diversity, and sociological perceptions.

(a) Assessment of Population Parameters

Canada goose management focuses on maintaining population levels that maximize sociological benefits and minimize sociological conflicts consistent with ecosystem status. Managers attempt to maintain populations at these levels by balancing annual production of young with annual mortality, monitoring these parameters through a variety of surveys and other methods. Survey data are examined annually and changes in harvest strategies are enacted when appropriate. Prior to the growth of resident Canada goose populations, migrant geese were monitored predominantly on wintering areas, where geese were concentrated and costs of conducting local surveys were minimized. However, as resident goose populations grew and commingled with migrant geese on wintering grounds, differentiation of resident

and migrant populations became increasingly difficult. In response to difficulties in assessing populations on wintering areas, many agencies initiated surveys on the breeding grounds of migrant (and later resident) goose populations. As resident goose populations grew even larger it became apparent that groups of molting resident geese were present during later periods of migrant breeding ground surveys. The concurrent presence of resident geese within the breeding range of migrant geese also has the potential to compromise the reliability of these surveys (Abraham et al. 1999).

Assessment of the annual production of young geese is an important management function. In some populations, the production of young per adult is ascertained during goose capture and banding operations conducted during the brood-rearing period on the migrant goose breeding grounds. The presence of molt migrant resident geese (adults) in these captured samples degrades the quality of production information. During these summer banding operations, geese are banded with individually numbered legbands and, at times, also with coded neck collars. These banded geese subsequently provide information on migration, distribution, and population characteristics (natural mortality, hunting mortality) when they are recovered and reported by hunters or observers. It is therefore important that banded geese be representative of a particular group of geese (e.g., Mississippi Valley Population). Due to the increased prevalence of resident molt migrants on northern breeding areas, goose banders must identify and separate resident molt migrants from locally produced migrant geese if banding information is to be meaningful.

Managers also obtain estimates of Canada goose harvest from a mail Hunter Questionnaire Survey (HQS) and a Parts Collection Survey (PCS) of randomly selected hunters (Martin and Padding 2000). Randomly selected hunters are asked to report the numbers of geese they harvested, the county of harvest, and to send in tail feathers from each goose. The total number of geese harvested is calculated from the HQS survey and the species and age composition of the harvest is determined from the PCS. Traditionally, managers associated the harvest from specific geographic areas with various migrant or resident Canada goose populations. However, as resident populations and their harvest have increased, association of harvest data with various populations of migrant or resident geese has become increasingly complicated.

Biologists also gain information on the annual production of young by examining the ages of geese shot in the fall/winter using tail feathers collected in the PCS. However, resident Canada geese replace their juvenal tail feathers with adult-type feathers (thus appear to be adults in the PCS) earlier than do migrant geese. Therefore, a production ratio based on tail-feathers alone from a sample which includes substantial number of resident geese will incorrectly lower the production index obtained (Tacha et al. 1987).

Fortunately, agencies and biologists have devised ways to minimize the influence of resident geese on many of these surveys. For example, the recent addition of wing feathers in the PCS may help reduce the bias in Canada goose age ratios obtained from the PCS. However, many of the methods devised are often costly in terms of dollars and staff-time and some surveys are still partially influenced by high resident goose population levels.

(b) Competition for Food

Numbers of resident Canada geese rival or exceed the numbers of migrant geese in all 4 Flyways. These numbers are in stark contrast to 30 years ago when resident goose prevalence was only a fraction of the

migrant goose numbers. Although both resident and migrant geese have benefitted from increased agricultural activities, food resources on their shared wintering and staging grounds are not limitless. Recent improvement in the efficiency of harvest machinery is reducing the amount of waste grain available for wildlife consumption. With the exception of year-around urban dwelling geese, food preferences of resident and migrant geese during winter are very similar. Resident geese likely have an advantage in exploitation of wintering foods due to their increased familiarity and experience with local feeding areas, competitive edge of larger family sizes, and their larger body size. Fat and protein accumulation is an important component of Canada goose reproductive strategy and reductions in food availability due to competition could potentially impact the reproductive success of migrant geese.

Increasing numbers of molt migrant resident Canada geese also deplete food resources of migrant geese on the northern brood-rearing areas (Ankney 1996, Abraham et al. 1999). Food consumption and brood-rearing area degradation have been implicated in poor gosling growth, poor reproduction, low population growth rate, and declining adult body size of migrant Canada geese on Akimiski Island in James Bay (Ankney 1996, Leafloor et al. 1998, Abraham et al. 1999).

(c) Goose Distribution

The winter distribution of migrant Canada geese has been shifting northward for decades (Hankla and Rudolph 1967, Hestbeck 1998, Pacific Flyway Council 1998). Many reasons for historical and recent shifts have been postulated (Crider 1967, Hankla and Rudolph 1967, Hestbeck 1998) but a definitive reason(s) for this shift is difficult to ascertain. In many areas, a more northerly wintering terminus for migrant geese has been attributed at least in part to the decoying effect of resident goose flocks (Mississippi Flyway Council 1996, Central Flyway Council 1998, Atlantic Flyway Council 1999). Perhaps the greatest evidence of this decoying effect is the winter use of urban areas by migrant subspecies (Smith et al. 1999; H. L. Alexander, unpublished data; J. Gammonley, personal communication). This effect, when and where it occurs, can further disrupt traditional goose wintering distribution and normal migration patterns, and exacerbates urban goose nuisance problems.

(d) Disease

Urban parks are often inhabited by an assortment of exotic, domestic, or hand-reared waterfowl (e.g., muscovy, pekin, domestic mallard). The combination of these types of fowl and the waterfowl densities often found in parks are conducive to the transmission of disease and are associated especially with Duck Virus Enteritis (Friend and Franson 1999:151). Resident Canada geese also frequent these areas, and their interaction with wild waterfowl outside urban areas, or by decoying wild birds into these areas, is reason for concern. Some diseases of fowl, such as Duck Virus Enteritis can be transmitted to other bird by "carriers" that do not show signs of the disease.

(e) Genetics

The taxonomy of morphologically diverse Canada goose species has been debated for decades (Swarth 1913, Palmer 1976, Johnsgard 1978). Some biologists believe subspecies of Canada geese were originally more distinct than they are presently. They consider the advent of agriculture and establishment of refuges as factors that contributed to the loss of genetic integrity of subspecies and the formation of hybrids among subspecies (*B. c. canadensis x maxima*, Pottie and Heusmann 1979; *B. c. occidentalis x moffitti*, P. Miller and D. Kraege personal communication). If subspecies do interbreed commonly, the

frequency of this has been exacerbated by the increased numbers and broader distribution of resident geese.

(f) Sociologic Implications

In "A Sand County Almanac", Aldo Leopold (1949) celebrated the connection to wildness that Canada geese and their "music" instilled in humans. Although many people still thrill at overhead honking or the V-shaped wedge of migrating geese, there are many that associate these birds only with the nuisance and mess with which they are familiar at the park or golf course. Once considered a trophy bird for hunters and an awe-inspiring sighting for outdoor enthusiasts, Canada geese have been degraded in the eyes of some humans. The separation of the embodiment of wildness from Canada geese certainly has some cost to society, albeit hard to measure. However, a more tangible loss to society was reported by Ankney (1996), that some landowners have pursued wetland drainage on their lands to discourage the presence of resident Canada geese.

b. Population Status, Trends, and Distribution

(1) Atlantic Flyway

For management purposes, Atlantic Flyway "resident" Canada geese are defined as geese that were hatched or nest in any Atlantic Flyway State, or in Canada at or below 48° N latitude and east of 80° W longitude, excluding Newfoundland (Atlantic Flyway Council 1999).

Atlantic Flyway resident geese are different from Canada geese that nested in the Flyway historically. The original stock in pre-colonial times was primarily *Branta canadensis canadensis* (Delacour 1954), but they were extirpated long ago. The present-day population was introduced and established during the early 20th century, and is comprised of various subspecies or races of Canada geese, including *B. c. maxima*, *B. c. moffitti, B. c. interior*, *B. c. canadensis*, and possibly other subspecies, reflecting their diverse origins (Dill and Lee 1970, Pottie and Heusmann 1979, Benson et al. 1982).

The numbers of resident Canada geese have increased dramatically in recent years across North America (Ankney 1996, Nelson and Oetting 1998). The dramatic growth and importance of resident goose populations in the Flyway was not fully recognized until recently. In the 1980s, biologists became concerned that increasing numbers of resident geese might be masking a decline in number of migratory Atlantic Population (AP) Canada geese wintering in the flyway. Banding studies confirmed that resident geese were not AP geese that simply stopped migrating north to breed; they are distinct populations with very different management needs and opportunities.

(a) Origins

Giant Canada geese (*B. c. maxima*) did not nest in the Atlantic Flyway historically (Hanson 1965), so releases here were never considered part of a restoration program. Stocking and translocation of geese were done to establish new breeding populations and provide additional recreational opportunities (primarily hunting) in Atlantic Flyway States and Provinces.

Releases of Canada geese in the Atlantic Flyway were not well documented. As indicated, the first Atlantic Flyway resident geese were birds released by private individuals in the early 1900s. When use of

live decoys for hunting was prohibited in 1935, captive flocks of domesticated or semi-domesticated geese were numerous (estimated at more than 15,000 birds in Maryland and more than 8,000 in Massachusetts), and many were liberated in parks or allowed to wander at large (Dill and Lee 1970). The first State agency release programs began in New York (1919) and Pennsylvania (1936) using imported game farm stock, and in Maryland (1935) using migrant geese trapped during winter. From the 1950s through the 1980s, wildlife agencies in many Atlantic Flyway States were actively involved in relocation and stocking programs to establish resident populations, primarily in rural areas (**Table III-3**). These programs were highly successful and most were discontinued by 1990.

Table III-3. Stocking and translocations of resident Canada geese in the Atlantic Flyway.

State	Summary of known origins or translocations
CT	85 geese were transplanted from Brigantine National Wildlife Refuge (NJ) during 1963-68; <50 were moved in-State during the 1960s (P. Merola)
DE	No birds brought in from out-of-State; moved geese in-State during 1980-1997 (T. Whittendale)
FL	1,598 geese from NJ, SD and Canada were released during 1968-1978 to establish a resident flock (D. Eggeman)
GA	>8,000 geese from NY and other Atlantic Flyway States were released during 1975-1987 (G. Balcomb)
ME	2,341 geese transplanted from NY, NJ and CT during 1965-1975; 1,723 more from CT during 1981-1985; moved 50-75 geese/yr in-State in recent years (B. Allen)
MD	Earliest stockings were 41 geese at Blackwater National Wildlife Refuge (1935) and 8 geese moved to Patuxent in 1946; >2,000 geese moved in-State prior to 1991 (L. Hindman)
MA	Releases from decoy flocks in 1930s originally from MI and NC; no geese were imported by MA Fish and Wildlife; moved <500 in-State during 1960s-1970s (H Heusmann)
NJ	Releases at Great Swamp and Brigantine National Wildlife Refuges during 1950s (source unknown); more came from CT and NY during 1960s-1970s; some in-State transplants during 1960s-1970s (P. Castelli)
NH	Population in MA expanded into NH; additional geese were brought in from southern New England during late 1970s (E. Robinson)
NY	Private releases before 1900; in 1919 NY began releasing game farm geese upstate; approximately 1,000 game farm geese released during 1957-1964 in upstate NY; moved an estimated 25,000 geese from problem sites in southeastern NY to other States or rural areas in NY during 1960s-1990s (B. Swift)
NC	Several thousand geese obtained from ON, PA, NY, NJ, CT and DE during 1980s (D. Luszcz)
PA	Game Commission and others brought 30 pinioned geese in 1936 to Pymatuning; this flock provided stock for other areas of PA; during 1975-1992, >32,000 geese were translocated both within and outside of Pennsylvania (J. Dunn)
RI	First reported nesting in 1958; transplanted 167 geese from out-of-State during 1960-1967 (C. Allin)
SC	Obtained original stock from NY and other States during 1980s; numbers unknown
VT	First reported nesting in 1960, after release of 44 geese from DE in 1956; release of 723 at Mississquoi National Wildlife Refuge during 1951-1964 failed; no in-State movement of geese in VT (B. Crenshaw)
VA	Obtained geese from NY and other States during 1980s; in-State relocations from problem sites through 1990s
WV	Obtained 10 wild live-trapped geese from U.S. Fish and Wildlife Service in 1954 (Moser 1973); 5,442 were imported from NY, CT, NJ and MD during 1976-1983 in-State transplants began in 1967, 814 moved in-State during 1989-2000 (S. Wilson)

Resident goose populations became established in most Atlantic Flyway States as a direct result of these stocking programs (**Table III-4**). Following establishment of breeding populations, many States used in-State translocation to reduce goose flocks in urban-suburban conflict areas and to expand the distribution of nesting birds in rural areas. In-State translocations are still used in a few Atlantic Flyway States (e.g., Virginia) to help alleviate problems caused by resident geese (**Table III-3**).

Table III-4. Population estimates for resident Canada geese in the Atlantic Flyway prior to 1990[a].

Years	ME	VT	NH	MA	CT	RI	NY	PA	NJ	DE	MD	WV	VA	NC	SC	GA	FL
1900s	0	0	0	tr	tr	0	tr	0	0	0	0	0	0	0	0	0	0
1910s	0	0	0	tr	tr	0	tr	0	0	0	0	0	0	0	0	0	0
1920s	0	0	0	tr	tr	0	tr	na	na	0	0	0	0	0	0	0	0
1930s	0	0	0	na	tr	0	1,000	na	tr	na	tr+	0	tr	tr	0	0	0
1940s	0	0	na	500	na	0	na	na	tr	na	na	0	tr	na	0	0	0
1950s	0	0	na	na	na	tr	na	na	na	500	na	tr	na	na	0	0	0
1960s	0	na	na	6,00	600	tr	5,200	na	2,50	1,00	na	100	na	na	0	0	tr
1970s	na	300	na	na	na	500	na	na	na	na	na	na	na	na	na	na	na
1980s	500	300	300	8,00	6,00	775	24,00	44,00	9,00	700	5,50	4,30	12,60	2,50	300	8,00	800

[a] tr = trace (a few nesting pairs reported, <100 birds total); na = no estimate available. Sources: 1960s - Dill and Lee (1970); 1980s - Sheaffer and Malecki (1998) and R. Malecki, unpubl. data); other years - State biologists and unpublished reports.

(b) Breeding Distribution

Over the past 50 years, the Atlantic Flyway resident goose population has expanded from a few early releases to a breeding range that now includes every State and Province in the flyway (Hindman and Ferrigno 1990). Their range continues to expand at the North ans South ends of the flyway and within most States and Provinces. The resident population may someday merge with migrant geese nesting in the boreal forest zone of Quebec above 48° N latitude. Throughout this range, breeding habitats of Atlantic Flyway resident Canada geese vary widely from agricultural landscapes to forested wetlands to urban and suburban environments.

Highest densities (>2/km^2 in spring) of resident geese occur in Atlantic coastal regions, such as southern New England, southeastern New York, New Jersey, southeastern Pennsylvania, Delaware, Maryland, and eastern Virginia. This may reflect the long history of resident geese nesting in those areas. Densities as high as 5/km^2 occur in some localities. Moderate densities (1-2/km^2) occur in interior regions of the Atlantic Flyway, from southern Ontario to Georgia, and low densities (<0.5/km^2) occur in mountainous areas of northern New England, northern New York, and in southern Maritime provinces (H W. Heusmann, Massachusetts Division of Fisheries and Wildlife, unpublished data; J. D. Goldsberry, U.S. Fish and Wildlife Service, unpublished data).

(c) Migration and Winter Distribution

Most Atlantic Flyway resident geese are non-migratory or undertake short local movements between breeding and wintering areas. Geese nesting inland in northern States and Provinces tend to exhibit more regular "migration" behavior than those nesting in coastal regions or at mid or southern latitudes. Some

flocks in northern and interior parts of the flyway travel several hundred kilometers between breeding and wintering areas, but most travel <35 km or remain year-round in local areas (Johnson and Castelli 1998).

Winter distribution of Atlantic Flyway resident geese is similar to their breeding distribution, with wintering flocks found from southern Canada to northern Florida. In northern States, concentrations occur inland in agricultural areas near large unfrozen water bodies, such as the Finger Lakes and Hudson River Valley in New York, and water supply reservoirs. In southern New England and States to the south, where ice and snow cover are less common, wintering resident geese are more widely distributed throughout the Atlantic Coastal Plain.

Resident geese use a variety of habitats in winter, including agricultural fields, parks, golf courses and open lawns in urban/suburban areas. Resident geese often remain in urban areas during winter because those areas are typically not hunted, contain good roosting sites that remain ice-free well into winter, and have readily available foods, such as lawn grasses, supplemental feeding by local citizens, or waste grain on nearby croplands.

There is growing evidence that a molt migration occurs among Atlantic Flyway resident geese (Abraham et al. 1999; B. L. Swift, New York State Department of Environmental Conservation, unpublished data), but the extent to which this occurs, where the birds go, and when they return, is largely unknown.

(d) Population Trends

Numbers of resident geese in the Atlantic Flyway have increased dramatically since their establishment. Breeding waterfowl surveys in the northeastern U.S. (from New Hampshire to Virginia), aerial surveys in eastern Canada and Maine, and estimates provided by biologists in other States and Provinces indicate a total spring population of approximately 1.1 million resident Canada geese in the Flyway in 2000, including 1 million in the U.S. (**Table III-5**).

Table III-5. Estimated spring populations of resident Canada geese (1,000s of birds) in the Atlantic Flyway[a].

Year	ME	VT	NH	MA	CT	RI	NY	PA	NJ	DE	MD	VA	Total
1990	na	0.8	2.9	11.6	9.1	2.2	64.0	66.3	28.0	1.1	16.8	35.0	237.8
1991	na	2.5	2.5	13.0	15.1	1.4	58.6	65.0	43.4	0.5	35.1	68.7	305.8
1992	na	18.9	11.5	12.8	17.2	2.7	108.1	74.3	30.9	1.1	18.1	81.5	377.1
1993	na	0.0	7.6	16.3	16.5	1.9	167.7	196.5	37.7	4.1	33.2	128.6	610.1
1994	na	2.8	3.1	13.2	22.7	0.9	91.9	177.0	61.1	1.3	75.7	129.4	579.1
1995	na	1.4	13.5	16.1	23.2	2.5	78.4	208.1	67.4	4.7	62.7	207.6	685.6
1996	7.5	0.3	36.0	25.7	23.3	1.6	199.5	219.2	69.6	1.8	66.9	208.1	859.5
1997	9.6	18.2	16.6	16.8	31.1	3.4	119.5	194.6	85.3	4.8	69.9	332.5	902.3
1998	14.1	3.0	24.2	19.8	30.8	2.9	133.4	210.8	86.0	7.2	93.4	253.6	879.2
1999	48.0	3.7	23.1	18.3	23.7	3.4	158.8	262.0	82.3	5.5	58.9	198.2	885.9
2000	9.5	7.0	21.3	21.4	36.3	1.3	152.3	225.5	106.3	9.1	63.3	229.6	882.9

a Sources: ground plot surveys for NH to VA; aerial surveys for ME; na = no annual estimate available. State biologists estimated an additional 196k in 5 other States in 1999 (WV-28k, NC-97k, SC-22k, GA-44k, AND FL-<5k).

b Totals of State estimates differ from flyway totals calculated by physiographic strata.

The estimated number of resident Canada geese in the northeastern U.S. increased more than 3-fold between 1990 and 2000 (**Table III-5**). However, spring population estimates have leveled off since 1997 after special hunting seasons were established throughout the Flyway. Population trends in other States are not as well documented, but similar growth rates were indicated by Breeding Bird Survey (BBS) data, which increased between 1990 and 1996 for every physiographic region of the eastern U.S. (J. Sauer, U.S. Geological Survey, unpublished data).

Midwinter counts of Canada geese must be interpreted with caution because resident and migrant geese cannot be distinguished during these surveys. Neckband observation data indicate that resident Canada geese comprise the largest proportion of geese wintering in the mid-Atlantic and New England regions. The average total midwinter counts of Canada geese in those two regions increased approximately 29,000 birds during 1966-1970 to nearly 350,000 during 1996-1999 (Serie and Vecchio 1999), due largely to the growth of resident populations. Winter surveys in the southernmost Atlantic Flyway States (SC, GA, FL), where very few migrant geese winter, do not cover areas typically used by resident geese and may not accurately reflect population trends.

(e) Population Goals

Most State wildlife agencies in the Atlantic Flyway consider their resident goose populations to be at or above "social carrying capacity" (public tolerance level) with respect to damage and conflicts associated with the birds. Population goals, i.e., desired population size, were proposed by each State in 1999 (**Table III-6**). These goals were derived independently by State waterfowl biologists based on their respective management needs and capabilities and assessment of public desires (Atlantic Flyway Council 1999). Unlike traditional population goals for waterfowl, these population goals represent an optimal size, not a minimum number above which "more is better".

In some cases, goals were an approximation of population levels at an earlier time when problems were less frequent or less severe. In other cases, goals were calculated from what was judged to be a more desirable or acceptable density of birds. For States where resident geese have just recently become established, goals are near current population levels. In addition to wanting fewer geese, most States desire a more uniform distribution of geese to reduce severity of problems in many areas and help prevent new problems from occurring.

(2) Mississippi Flyway

For management purposes, the Mississippi Flyway giant (resident) Canada goose population is defined as Canada geese nesting in Mississippi Flyway States as well as Canada geese nesting south of latitude 50° N in Ontario and 54° N in Manitoba. This population may include geese belonging to the subspecies *B. c. maxima*, *B. c. moffitti*, and possibly other subspecies because the origins of the Canada geese used in some of the restoration projects in the Flyway are unknown (Mississippi Flyway Giant Canada Goose Management Plan, 1996).

Moser and Rolley (1990) found that Canada geese that nest in the area described above were similar in size and coloration to the giant Canada goose described by Hanson (1965). Giants historically nested throughout central North America (Cooke 1906, Hanson 1965). At the time of European settlement, the nesting range of giants probably extended from central Alberta, Saskatchewan, and Manitoba, south to central Kansas and Missouri, and east to the shores of Lake Erie, exclusive of the shield lake areas of

northeastern Minnesota, Wisconsin, Michigan and Ontario (**Figure III-1**; Hanson 1965).

Table III-6. Spring breeding population (BPOP) estimates (in thousands of geese) and population goals for resident Canada geese in Atlantic Flyway States (adapted from Atlantic Flyway Council 1999).

State	Land area (km^2)	Current BPOP[a]	BPOP per km^2	BPOP Goal	Goal per km^2	Goal per mi^2
CT	12,593	29	2.3	15	1.2	3.1
DE	5,135	6	1.1	1	0.2	0.5
FL	140,158	<5	0.0	<5	0.0	0.1
GA	150,259	44	0.3	30	0.2	0.5
ME	80,215	24	0.3	15?	0.2	0.5
MD	25,618	74	2.9	30	1.2	3.0
MA	20,267	18	0.9	≤ 20	1.0	2.6
NJ	19,477	85	4.3	41	2.1	5.5
NH	23,378	21	0.9	≈16	0.7	1.8
NY	124,730	137	1.1	85	0.7	1.8
NC	126,406	97	0.8	<30	0.2	0.6
PA	116,461	223	1.9	≈100	0.9	2.2
RI	2,717	3	1.2	3	1.1	2.9
SC	78,176	22	0.3	20	0.3	0.7
VT	24,002	8	0.3	5	0.2	0.5
VA	103,021	261	2.5	180	1.7	4.5
WV	62,433	28	0.4	24	0.4	1.0
Total	1,111,838	1,084	1.0	620	0.6	1.4

a Mean annual estimate for 1997-1999 or best estimate of wildlife agency staff.

Numbers of giant Canada geese were greatly reduced by unregulated harvest, egg gathering, and wetland destruction that accompanied 19th-century settlement of their breeding range. Cooke (1906) reported very small numbers of Canada geese nesting south of central Iowa. By the early 1930s, giants had disappeared from Minnesota, North Dakota, and northern Wisconsin (Hanson 1965). By 1950, many authorities believed the giant race of Canada geese to be extinct (Delacour 1954). However, in January of 1962, a wintering population of free-flying giant Canada geese was discovered at Rochester, Minnesota (Hanson 1965).

(a) Reintroduction Efforts

Efforts to re-establish giant Canada goose flocks in the Mississippi Flyway began as early as the 1920s in Michigan, and the 1930s in Wisconsin, Ontario and Minnesota (**Table III-7**). During the 1940s and

1950s, wildlife agencies in Wisconsin, Manitoba, Minnesota, Missouri, and Ohio also implemented giant restoration programs. In the 1960s State agencies in Iowa, Illinois, Indiana, Louisiana and Tennessee joined the restoration effort while the U.S. Fish and Wildlife Service initiated programs to establish nesting populations of giants on national wildlife refuges in Mississippi, Tennessee and Alabama. These projects were soon followed by State efforts to establish populations of giants in Kentucky, Arkansas, Alabama, and Mississippi in the 1970s and 1980s.

(b) Population Trends and Goals

Historically, populations of Canada geese in the Flyway were monitored on their wintering grounds through coordinated annual winter surveys (i.e., mid-December and Mid-winter; **Table III-8**), because each population exhibited a strong affinity for specific wintering sites. Winter surveys appeared to produce reliable estimates of the magnitude of most Canada goose populations in the Flyway through the 1970s; however, in the 1980s, increasing numbers of giants began to complicate winter estimates of other Canada goose populations.

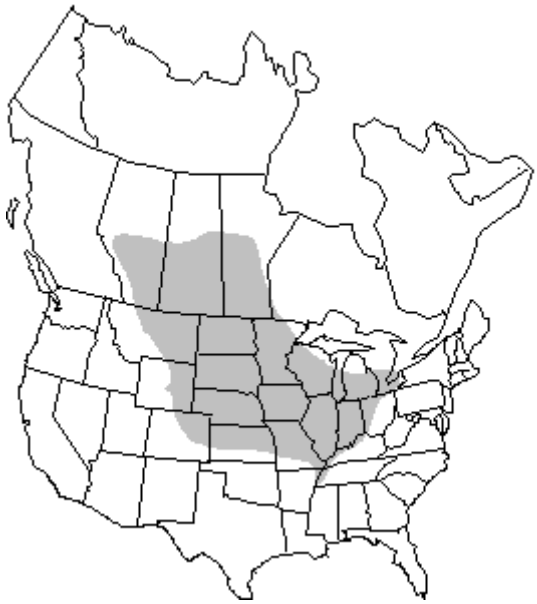


Figure III-1. Approximate breeding range (shaded area of the giant Canada goose prior to European settlement (Hanson 1965).

In the late 1980s, biologists became concerned that increasing numbers of giant Canada geese might be masking changes in populations of interior Canada geese. It was becoming increasingly difficult to sperate large concentrations of geese into appropriate populations (i.e., MVP, EPP, SJBP, and giants) during winter surveys, and biologists were becoming uncomfortable with relying on population estimates obtained from winter surveys.

Despite these concerns, winter surveys for Canada geese continued in the early 1990s, and numbers of Canada geese observed were reported by population. Annual population estimates obtained from winter counts must be interpreted cautiously because survey efforts have been inconsistent in recent years, varying from State to State as well as within States, and the methods used to allocate geese to the various populations have changed in some cases.

Prior to 1992, monitoring of breeding Canada goose numbers in the Mississippi Flyway States was limited. North American Breeding Bird Survey data indicate that Canada geese within the Mississippi Flyway region increased at a rate of 17 percent annually during 1966-98. However, this trend has decreased in recent years to approximately 9 percent during 1990-98, and to approximately 4 percent during 1994-98 (Sauer et al. 2000). Wisconsin's annual breeding waterfowl survey indicates that statewide Canada goose numbers increased from 6,900 to 102,600 during 1986-2000 (Bergquist et al. 2000). Spring Canada goose numbers in Minnesota have increased from approximately 50,000 to over 300,000 during 1988-2000 (Lawrence 2000).

To determine the feasibility of estimating breeding populations of giant Canada geese, experimental surveys were conducted in 1992 in Ohio and Michigan. By 1995, breeding surveys had been implemented in 25 States and 2 Provinces of the Mississippi and Atlantic Flyways. The Mississippi Flyway began formally

Table III-7. A synopsis of giant Canada goose restoration efforts in the Mississippi Flyway.[a]

State	Year	Release Sites	No. of Geese	Agency/Group Directing Project	Source of Geese
MI	1936	Seney NWR	332	USFWS	HM Wallace, Livingston Co., MI. B.c maxima from Owatonnia, MN (Hanson 1965)
MI	1928-64	30 Sites	2,500	MI DNR	HM Wallace, Livingston Co., MI
MI	1972-73	Various Sites	32,000	MI DNR	Translocated from within State
WI	1932	Barkenhausen Pres.	6	Jack Miner	HM Wallace, Livingston Co., MI
WI	1939	Necedah NWR	Unk.[b]	USFWS	B.c moffitti from UT
WI	1932-57	12 sites	Unk.	WI DNR	T. Yeager, Owatonna, MN, HM Wallace, MI, Rock Prarie, WI, and Barrington, IL
WI	1969-95	56 sites	3,500	WI DNR	Translocated from within State
MN	1930s	Agassiz NWR	Unk.	USFWS	B.c moffitti from OR,UT, & MT
MN	1949	Agassiz NWR	Unk.	USFWS	Seney NWR
MN	1950s	Rice Lake & Tamarack NWR's	Unk.	USFWS	Seney NWR
MN	1958-70	Thief Lake, Roseau River, Lac qui Parle & Talcot Lake WMA's	Unk.	MN DNR	Carlos Avery Game Farm
MN	1955-77	13 sites in the Twin Cities	Unk.	Private	Unknown
MN	1982-95	Various sites	34,000	MN DNR, Univ. MN	Translocated from within State
IN	1935	Jasper-Pulaski WA	Unk.	IN DFW	Offspring of captive giant C. geese
IN	1966-73	Jasper-Pulaski WA	650	IN DFW	Offspring of captive giant C. geese
IN	1970	Pigeon River, Atterbury and Glendale WA's	267	IN DFW	Jasper-Pulaski WA
IN	1979-82	82 Sites	200 pair	IN DFW	Translocated from within State
ON	1930s	Lake St. Clair, Holstein, Guelph Amherstburg	Unk.	Private	Offspring of decoy flocks
ON	1954	Pembroke Hatcher	Unk.	OMNR	Pea Island, NC
ON	1959-60	Morrisburg & St. Lawrence Seaway Pk	61	OMNR	Bombay Hook, DE & Mason Game Farm, MI

Table III-7, continued.

State	Year	Release Sites	No. of Geese	Agency/Group Directing Project	Source of Geese
ON	1968-80s	Southern ON, Thunder Bay & Sault Ste. Marie	Unk.	OMNR & ON Waterfowl Res. Foundation	Primarily Toronto & Codrington Game Farm
MB	1945	Delta Marsh	Unk.	MB DNR	Offsring of domesticated giant Canada geese
MB	1940s	Rennie	Unk.	Alf Hole	Offsring of giant Canada geese captured in area
MB	1951	Marshy Point	Unk.	MB DNR	Island Pk, Delta Marsh & Dog Lake, MB
MB	1965	Oak Lake	Unk.	MB DNR	Regina, SK
MO	1949	A.A. Busch Memorial WA	Unk.	MO DOC	Private aviculturalist
MO	1952	Trimble Lake WA	Unk.	MO DOC	Private aviculturalist
MO	1949-91	44 Sites	4650	MO DOC	Trimble Lake & Busch Memorial WA
OH	1956	Mercer, Mosquito Creek & Killdeer Plains WA	20 each	OH DOW	Offspring of domesticated giant Canada geese
OH	1967	Ottawa NWR	100	OH DOW	Mosquito Creek WA
OH	1979	Muskingum Co.	1500	OH DOW	Toronto, ON
OH	1980s	W.A.'s Statewide	Unk.	OH DOW	Translocated from within State
IA	1965	Ingham Lake WA	Unk.	IA DNR	Offspring of domesticated giant Canada geese
IA	1971-72	Ruthven, Spirit Lake & Rice Lake	Unk.	IA DNR	Offspring of Ingham Lake flock
IA	1977-79	Rathbun, Lake Icaria & Bays Branch WA's	Unk.	IA DNR	Offspring of previously established flocks
IA	1983-93	33 Sites	5964	IA DNR	Translocated from within State
IL	1967-72	Fulton, Knox & Henry Co.	464	IL DOC	Des Plaines Game Farm, Wilimington, IL
IL	1970s	Mined areas in S. IL	Unk.	IL DOC	DesPlaines Game Farm, Wilmington, IL
IL	1970s	Kankakee & Grundy Counties	Unk.	IL DOC	DesPlaines Game Farm, Wilmington, IL
IL	1980-91	46 counties	8000	IL DOC	Offspring of previously established flocks
TN	1951	Old Hickory Resvr	12	Wick Comer	North Caroline game farm
TN	1964-67	Cross Creeks NWR	26	USFWS	15- Swan Lake NWR, 11 - MN

Table III-7, continued.

State	Year	Release Sites	No. of Geese	Agency/Group Directing Project	Source of Geese
TN	1968	Old Hickory Resvr	60	TWRA	Missouri game farm brood stock
TN	1971	Buffalo Springs Game Farm	23	TWRA	Old Hickory, MI & OH brood stock
TN	1972-77	Various reservoirs	1073	TWRA, TVA	Buffalo Springs Game Farm
TN	1974-80S	Various ponds & reservoirs	Unk.	TWRA, TVA	TVA & COE reservoirs
MS	1966	Noxubee NWR	76	USFWS	Sand Lake NWR, SD
MS	1966-68	Yazoo NWR	70	USFWS	20- Sand Lake NWR, SD 20- MN, 30- OH
MS	1960s	Sardis Waterfowl Refuge	Unk.	MS DWFP	Ohio and Louisiana
MS	1985-95	Various sites	20,000	MS DWFP	From GA, IL, OH, PA, NC, MN, TN, ON
LA	1966-69	Rockefeller Refuge 9	60	LA DFW	Translocated from MN & SK
LA	1973-88	16 private sites	607	LA DFW	Translocated from Rockefeller Refuge
AL	1967-69	Eufaula NWR	75	USFWS	New Jersey and Minnesota
AL	1980	Central Alabama	53	AL DCNR	Land-Between-the-Lakes, KY & TN
AL	1981	Jackson Co. & Central AL	313	AL DCNR	MI
AL	1987-90	Northern & Central AL	1740	AL DCNR	TN, IL, MI and PA
AL	1991-95	Southern & Central AL	1600	AL DCNR	Translocated from within State
KY	1970s	Frankfort, Lexington and Louisville areas	Unk.	KDFWR	Unknown
KY	1977	Daniel Boone National Forest	Unk.	USFS	Unknown
KY	1979	Land-Between-the-Lakes	Unk.	TN Valley Authority	MI and Others
KY	1980s	10 Locations	Unk.	KDFWR	MI, IL, TN
AR	1970	Holla Bend NWR	18	USFWS	Unknown
AR	1973	Wapanocca NWR	30	USFWS	Unknown
AR	1981-83	Arkansas River	Unk.	ARGF, USFWS,	Ontario, Mississippi, and Illinois

Table III-7, continued.

State	Year	Release Sites	No. of Geese	Agency/Group Directing Project	Source of Geese
AR	1983-90	Arkansas River Valley	4200	ARGF, USFWS, COE	TN, KT, ND, IL, MN, AL, ON, OH

[a] Mississippi Flyway Council Technical Section Giant Canada Goose Committee.
[b] Unk. = Unknown number released.

monitoring spring populations of giant Canada geese Flyway-wide in 1993 (**Table III-9**). From 1993 to 2000, the estimated number of Mississippi Flyway giant Canada geese has nearly doubled (from 700,000 to 1.3 million). During that time, estimated giant populations in seven States have more than doubled, while only two States (Illinois and Louisiana) have experienced population decreases (**Table III-9**).

Spring population objectives for Mississippi Flyway States were first established in 1996 and revised in 2001. Current objectives are shown in **Table III-10**. Since that time, the majority of States have exceeded their goals by at least 50 percent (five States are still below goal). The 2000 spring population estimates were 35 percent above the spring population objectives.

Of the 3 subspecies of Canada geese in the Flyway, giant Canada geese have both the highest reproductive rate and highest adult survival rate. Unlike arctic nesting geese, whose annual production is greatly influenced by weather conditions, giants inhabit temperate environments with relatively stable breeding habitat conditions, are tolerant of human disturbance, and are willing to nest in close proximity to other goose pairs (densities as high as 100 nests per acre have been found on islands; Klopman 1958, Ewaschuk and Boag 1972, Zenner et al. 1996). These factors, combined with the ability of this subspecies to utilize a wide range of habitats, has resulted in consistently high annual production across most of the breeding range (Mississippi Flyway Giant Canada Goose Management Plan, 1996).

More recently, summer-banded giant Canada geese from 26 States and 6 Provinces have been recaptured in late May or early June on James Bay. The majority of these were banded as flightless goslings in the eastern Mississippi Flyway - primarily Ohio and Michigan (Abraham et al. 1999). These molting giants may be compromising spring breeding grounds surveys for interior Canada geese, as well as impacting the availability and quality of nesting and brood rearing habitat for interior Canada geese.

(3) Central Flyway

The Central Flyway is comprised of ten States (Montana, Wyomong, Colorado, New Mexico, Texas, Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota), two Canadian Provinces (Saskatchewan & Alberta), the Northwest Territories, and Nunavut. The Central Flyway, in cooperation with the U.S. Fish and Wildlife Service and the Canadian Wildlife Service (CWS), manages five populations of Canada geese (*Branta canadensis*). The Short Grass Prairie and Tall Grass Prairie populations breed in the Arctic and are comprised of small races of Canada geese (e.g. *B. c. parvipes* and *hutchinsii*). The Western Prairie (WP) population breeds north of the Trans-Canada Highway in Manitoba and Sasketchewan and is composed mainly of large (*B. c. interior*) Canada geese. The other two populations of Canada geese are the Hi-Line (HL), and the Great Plains (GP), which for the purposes of this summary will be collectively

Table III-8. Winter survey estimates of giant Canada geese in the Mississippi Flyway.[a]

Year	AL	AR	IL	IN	IA	KY	LA	MI	MN	MS	MO	OH	TN	WI	Total
1971	0	100	0	4,500	1,000	0	600	5,900	14,600	7,600	3,600	14,700	800	2,400	52,600
1972	0	200	800	3,000	500	0	600	10,100	20,500	3,500	3,000	9,700	800	1,500	51,900
1973	0	0	1,600	1,900	1,400	0	600	8,900	22,400	7,600	2,800	8,200	1,300	900	55,400
1974	0	0	800	3,600	200	0	600	3,500	26,000	3,600	3,600	9,800	2,000	1,800	51,700
1975	200	0	500	600	2,100	0	600	6,100	23,400	6,800	3,900	10,600	2,600	1,200	54,800
1976	200	0	1,600	1,300	500	0	600	3,800	20,800	4,800	5,000	8,200	5,700	1,700	46,800
1977	400	0	900	1,900	1,200	0	2,500	4,200	22,900	5,100	4,400	9,800	4,100	1,200	58,600
1978	200	0	3,300	2,500	500	0	2,500	4,400	24,400	10,500	3,200	13,100	5,100	1,200	70,900
1979	400	0	800	2,400	3,700	0	3,500	9,500	30,900	7,800	1,500	12,900	5,400	1,900	80,700
1980	300	0	200	3,700	5,800	100	3,500	11,900	38,000	6,600	2,000	16,900	5,700	2,100	96,800
1981	400	0	7,300	4,100	9,400	200	3,500	10,100	27,700	6,600	5,000	15,200	6,900	2,100	98,500
1982	800	800	7,700	7,300	11,900	300	1,000	17,400	59,500	8,000	2,600	16,200	5,800	4,300	143,600
1983	600	700	3,400	10,500	3,700	1,300	2,000	13,800	21,800	7,600	3,100	17,900	6,900	1,100	94,400
1984	800	100	7,600	12,200	11,300	300	100	16,100	38,500	7,700	2,500	25,100	7,000	10,600	139,900
1985	1,200	400	27,800	15,100	3,000	500	1,000	21,000	30,700	13,600	2,300	32,300	10,600	6,900	166,400
1986	900	1,000	31,900	5,800	26,000	500	1,000	29,100	34,300	11,100	3,200	35,900	9,500	2,400	192,600
1987	1,200	2,200	28,300	9,700	23,600	800	1,000	30,400	36,300	5,800	2,800	35,300	8,900	22,300	208,600
1988	1,600	2,000	32,600	8,200	17,300	3,100	1,000	25,200	42,800	6,100	2,800	45,600	10,500	36,800	235,600
1989	600	2,900	43,689	5,689	32,739	1,300	1,000	33,796	55,560	16,500	1,300	32,911	10,600	33,377	271,961
1990	1,138	1,450	64,726	5,781	38,940	4,226	1,000	39,118	64,788	16,064	1,534	49,164	6,040	32,205	326,174
1991	1,797	2,200	10,944	7,102	24,652	1,348	1,000	38,561	31,814	15,255	1,460	53,143	6,430	30,168	225,874
1992	1,553	2,303	14,328	9,118	36,952	1,629	900	48,701	50,364	13,345	1,700	59,871	7,975	20,783	269,522
1993	1,776	2,310	34,608	5,158	55,887	1,190	1,000	64,441	47,594	20,810	2,627	55,840	4,647	75,042	372,930
1994	1,377	1,920	56,000	18,774	36,792	2,738	0	53,256	43,551	24,750	1,616	64,086	5,915	57,874	368,649
1995	1,435	2,007	51,067	11,536	47,315	1,694	0	49,160	45,338	22,415	1,600	71,565	6,779	NA	311,911
1996	1,322	1,010	41,540	4,870	69,817	1,496	NA	57,717	23,841	10,580	1,525	53,655	5,226	NA	272,599
1997	1,471	2,172	52,500	6,910	66,634	2,487	0	60,231	50,149	12,781	1,136	81,549	5,070	49,307	392,397
1998	4,558	2,709	54,995	6,948	71,447	5,232	0	93,979	122,614	20,414	671	42,065	8,505	143,016	577,153
AVE:															
71-79	156	33	1,144	2,411	1,233	0	1,344	6,267	22,878	6,367	3,444	10,778	3,089	1,533	56,563
80-89	840	1,010	19,049	8,229	14,474	840	1,510	20,880	38,516	8,960	2,760	27,331	8,240	12,198	164,836
90-99	1,825	2,009	42,301	8,466	49,826	2,449	488	56,129	53,339	17,379	1,541	58,993	6,287	58,342	128,560
96-00	2,450	1,964	49,678	6,243	69,299	3,072	0	70,642	65,535	14,592	1,111	59,090	6,267	96,162	248,430

[a] The 1971-97 estimates are based on mid-December goose surveys (Ken Gamble, USFWS). The 1998 estimate = January mid-winter survey Canada goose estimate x percentage of giants harvested in the State (John Wood, WI Coop. Wildlife Research Unit).

Table III-9. Mississippi Flyway giant Canada goose spring population estimates, 1993-2000.[a]

Year	AL	AR	IL	IN	IA	KY	LA	MI	MN	MS	MO	OH	TN	WI	Total
1993	16,000	3,000	106,200	67,500	38,000	18,000	3,000	152,340	138,000	9,000	30,300	58,000	38,000	60,700	738,040
1994	17,000	3,000	114,200	69,600	28,025	20,675	3,000	196,515	201,600	9,000	35,050	71,000	40,200	54,600	863,465
1995	18,000	3,300	107,000	101,800	32,100	15,000	3,300	174,131	207,200	9,000	32,200	69,300	44,300	29,350	845,981
1996	4,390	4,390	154,236	86,582	40,655	29,071	4,390	185,538	190,200	11,970	38,868	74,527	59,120	71,946	955,883
1997	4,030	4,785	72,720	92,940	42,300	19,670	4,030	212,612	169,000	10,980	41,020	72,000	54,120	77,210	877,417
1998	9,000	10,000	105,650	78,857	44,860	22,445	1,500	305,219	214,600	20,000	44,826	77,942	65,868	72,536	1,073,303
1999	12,000	20,000	111,800	88,966	44,400	46,395	2,000	269,268	210,200	20,000	56,750	84,208	53,077	78,956	1,098,020
2000	12,000	25,000	102,900	121,340	54,519	38,508	2,000	324,710	294,900	20,000	77,128	90,256	69,778	102,644	1,335,683

[a] Mississippi Flyway Council Technical Section Giant Canada Goose Committee.

Table III-10. Population objectives and spring 2000 population estimates of giant Canada geese in Mississippi Flyway States.

	AL	AR	IL	IN	IA	KY	LA	MI	MN	MS	MO	OH	TN	WI	Total
Population Objective	20,000	4,000	110,000	80,000	100,000	60,000	4,000	200,000	178,000	20,000	40,000	60,000	45,000	68,000	989,000
Population Estimate	12,000	25,000	102,900	121,340	54,519	38,508	2,000	324,710	294,900	20,000	77,128	90,256	69,778	102,644	1,335,683
% Difference	-40%	525%	-6%	52%	-45%	-36%	-50%	62%	66%	0%	93%	50%	55%	51%	35%

[a] Mississippi Flyway Council Technical Section Giant Canada Goose Committee.

referred to as resident Canada geese. These populations are comprised of the large races of geese (*B. c. moffitti, interior*, and *maxima*). As discussed in section **I.B. Scope**, the Western Prairie and Great Plains populations are often combined for Flyway management purposes. In addition, some western States in the Flyway deal with management issues related to expanding Rocky Mountain Population (RMP), which are largely residents associated with the Pacific Flyway. These populations of geese are distinguished from one another by their geographic distribution in the summer and winter as well as their racial makeup. Hi-Line birds predominantly occupy the western portions of the Flyway while WP and GP birds are residents of the east tier of States and Saskatchewan, with a portion of the breeding range extending into Manitoba.

The Flyway has adopted management plans for each of these populations Each of these has a similar Goal: Maximum recreational opportunity consistent with the welfare of the population, international treaties, habitat constraints and the interests of all Central Flyway provinces and States." The plans contain population objectives, and estimates of population size are obtained annually, most often by winter counts. In addition, in March 2000 the Central Flyway Council adopted the management plan, Large Canada Geese in the Central Flyway: Management of Depredation, Nuisance, and Human Health and Safety Issues. The Goal of the Central Flyway is to manage resident Canada geese to achieve maximum benefits from these birds while minimizing conflicts between geese and humans. All populations of Canada geese in the Central Flyway are above objective levels.

Most States and Alberta and Saskatchewan conducted programs to increase the number and expand the range of breeding Canada geese within their jurisdictions, including the release of captive-reared goslings, the release of adults, and the implementation of special hunting regulations. Some restoration programs trace their origin to the early 1950s and others to the 1970s. Programs in northern areas were being terminated while those in more southern areas were just beginning. More than 120,000 geese were handled for restoration purposes during 1960-99 in the Flyway. The 1997-99 average winter count of total Canada geese in the Central Flyway was 1.5 million birds, up from about 206,000 in the 1960s. Of the 1.5 million, about 620,000 were from the three populations of large Canada geese. This is about 60 percent above objective.

(a) History and Current Status

Even before Hanson (1965) announced the rediscovery of giant Canada geese, members of the Central Flyway had begun restoration projects. Captive breeding flocks were housed at four National Wildlife Refuges in North Dakota and South Dakota between 1938 and 1941 (Lee et al. 1984) and the first breeding flocks were established in Nebraska in 1936 (Gabig 1986). These early efforts experienced mixed success in terms of re-establishing flocks of Canada geese, but much success in learning about the techniques for successful reintroduction. Over the next 40 years, captive flocks of breeding adults were established in most States, Alberta, and Saskatchewan. Goslings from these flocks were allowed either to free fly from their hatching location or, more frequently, transported to a new location with suitable breeding habitat. The habit of the bird, particularly females, to return to the area where they fledged after reaching sexual maturity allowed nucleus breeding flocks to become established.

By 1960, attempts to establish breeding flocks were ongoing in several States, including Colorado, Kansas and Wyoming. During 1960-62, 259 wild geese were trapped at Bowdoin NWR in Montana and transplanted to Saskatchewan. The pace quickened in the 1970s, when over 18,000 geese were released in the Flyway, including over 12,000 in the U.S. (**Table III-11**). In the two decades that followed, over 85,000 birds were handled for restoration programs (**Table III-11**). Kansas and Oklahoma started major programs in this period while Wyoming and Alberta terminated theirs.

Table III-11. Number of Canada geese released either as goslings from captive flocks or as the result of trap and transport programs in the Central Flyway.

Period	AB	SK	MT	ND	SD	WY	NE	KS	CO	OK	NM	Total States	Total
1967-98	0		0	0	12,278	0	0	0	0	0	0	12,278	12,278
1960-69	156	1,737	371	0	0	121	0	0	1,800	0	0	2,292	4,185
1970-79	2,299	4,118	0	5,546	0	1,021	3,803	0	2,000	0	176	12,549	18,966
1980-89	1,265	7,075	0	4,457	0	1,049	4,224	10,701	730	13,057	432	34,650	42,990
1990-99	0	9,702	0	3,563	0	0	4,447	17,836	2,220	5,556	0	33,622	43,324
Total	3,720	22,632	371	13,566	12,278	2,191	12,474	28,537	6,750	18,613	0	95,391	121,743

There was a change in the focus of activity over these three decades. In the 1970s, 87 percent of the releases in the U.S. were goslings and 75 percent of these were from captive flocks held by States. During the 1980s, 54 percent of the releases were goslings but during the 1990s this decreased to 43 percent. In addition, only 23 percent of the goslings were from captive flocks during 1980-1999. The reason for this shift in the source of birds is that they became available both from other locations within a State and from other States and/or Provinces. In the decade 1990-99, more than 21,000 geese were trapped and translocated within a jurisdiction and another 18,500 were moved from one jurisdiction to another. The availability of Canada geese was directly related to population size (supply) and problems being caused by geese (i.e., the desire to reduce the number of geese in some places). Many adults were available. Essentially all geese translocated in the 1990s were available because they were causing problems. As of 2000, all States and Provinces had terminated their programs although Saskatchewan, Oklahoma, Kansas, Nebraska, South Dakota and North Dakota were still moving birds from places where they were causing problems to less populated locations.

(b) Population Size and Distribution

Breeding Bird Surveys: Population indices used are from several sources. Many are from the annual May Breeding Duck Survey (May Survey) (Wilkins and Cooch 1999) conducted across a broad range of northern North America. While some Canada goose data were recorded on this survey, which was designed to estimate duck population size, as early as 1955, data available from 1970 to 1999 were used in this report for HL, RM and WP populations and that portion of the GP population that occurs in Canada (Nieman et al. 2000). The May Survey data also were used to estimate goose populations in North Dakota, South Dakota and Montana. For States where the May Survey is not conducted or data sets were not available, population information was obtained from the State wildlife agencies where the May Survey is not conducted or data sets were not available. These latter estimates were based on State-directed surveys and, in some cases, the best professional judgment of waterfowl biologists. Projections for 2010 were made using linear and exponential regression equations unless States did their own projections.

All populations of Canada geese in the Central Flyway are increasing, including the RMP, which is largely associated with the Pacific Flyway. The spring index for total large Canada geese for the three populations in the Central Flyway in 1999 was over 900,000 birds, 95 percent higher than in 1990 and 687 percent larger than in 1980 (Table 2). There is evidence that the explosive growth in population of the 1970s and 80s has slowed (**Table III-12**). The sum of the point projections for 2010 indicates a 28 percent growth from the 1999 estimate to about 2.4 million birds (**Table III-12**).

Table III-12. Indices of the number of Canada geese in the spring in the Central Flyway, potential population size in 2010 and population objectives.

	1970	1980	1990	1999	2010[1]	Objective[2]
Great Plains Population						
Canada	1,900	4,900	20,800	43,000	359,700	
North Dakota	0	3,700	26,600	104,500	516,600	60,000-100,000
South Dakota	900	3,400	46,200	111,800	100,000	50,000[3]
Nebraska	4,000	8,000	12,000	32,000	36,800	30,000-50,000
Kansas	200	200	8,000	30,000	37,500	37,500
Oklahoma	30	30	11,100	43,900	75,000	20,000-40,000
Texas		500	600	750	900	750
Total	7,030	20,730	125,300	365,950	1,126,500	
% Change		195%	504%	192%	208%	
Western Prairie Population						
Canada	22,000	35,700	145,500	247,500	618,500	
% Change		62%	308%	70%	150%	
Hi-Line Population						
Canada	17,800	21,800	111,500	212,100	456,300	
Montana	40,500	27,500	69,500	62,200	141,600	80,000
Wyoming	500	2,400	5,900	9,800	14,000	13,300
Colorado	3,600	7,900	10,000	14,500	18,000	12,500
New Mexico	50	75	200	1,700	3,300	5,300
Total	62,450	59,675	197,100	300,300	633,200	
% Change		-4%	230%	52%	111%	
Sub-Total - Central Flyway Large Canada Geese						
	91,480	116,105	467,900	913,750	2,378,200	
% Change		27%	303%	95%	160%	
Rocky Mountain Population						
Canada	20,700	15,300	41,500	125,700	168,900	
Montana	8,400	8,900	28,000	41,400	64,700	45,000
Wyoming	2,600	2,900	3,300	4,700	3,000	8,300
Total	31,700	27,100	72,800	171,800	236,600	
% Change		-15%	169%	136%	38%	

1. Most estimates are based on a regression fitted exponential equation [$Y = e^{(b * year)}$]. By its nature, this equation accounts for historical growth and there is no certainty that such growth can be sustained.

2. The population objectives in this table are based on the best knowledge and information available. In addition, they represent State or provincial-wide objectives. As such, jurisdictions may modify population objectives and/or address the size of sub-populations as needed.

3. This estimate was provided by SD Game, Fish and Parks and represents a management objective they intend to attain.

Table III-13. Trends of the number of Canada geese in the Central Flyway as reported by the Breeding Bird Survey.[1]

	1966-1998						1980-98		
Region	**Trend**	**P**	**N**	**95% Conf. Int.**		**R.A.**	**Trend**	**P**	**N**
Alberta	9.8	***	57	1.9	17.8	7.78	7.2		58
Colorado	8.8	**	17	0.5	17.2	2.63	12.5	****	18
Kansas	39.6		9	*****	218.1	0.68	34.5		8
Montana	25.7	****	27	8.4	43.1	4.35	30.6	***	26
Nebraska	15.2	**	7	2.5	27.9	2.25	9.1		6
New Mexico	-7.6	**	5	-9.9	-5.3	0.40	-9.1	***	5
North Dakota	50.6	****	31	16.0	85.2	5.62	36.6	***	31
Oklahoma	17.5	***	6	10.8	24.3	0.34	17.5	**	7
Saskatchewan	8.1		32	-4.5	20.7	10.04	12.8	***	31
South Dakota	27.1	*	11	-7.6	61.8	0.71	15.3		11
Wyoming	-4.8		25	-18.8	9.2	8.67	-3.5		25

1 No Canada geese were reported in Texas, Trend is estimated percent change per year, R.A: Relative abundance - birds seen per route, *P<0.2 that the trend is zero: ** P<0.1: *** P<0.05: **** P<0.01

The Breeding Bird Survey (Peterjohn 1994) supports the conclusion that Canada goose populations are growing in most parts of the Central Flyway (**Table III-13**). Significant (P<0.1) positive annual trends range from 12 percent to 36 percent for the period 1980-98. Only the New Mexico data show a significant (P<0.05) negative trend.

Winter Surveys: Winter surveys have been conducted for Canada geese in the Central Flyway since the 1930s. Since the winter of 1981-82, estimates of individual populations have been made. Procedures for assigning geese to a population are contained in the Management Plans for each population (Central Flyway Council references) and include leg band recoveries and neck collar observations. Winter surveys are used to establish population objectives that in turn identify points at which hunting regulations may be changed.

All populations of Canada geese in the Flyway are above objective levels (**Table III-14**) and the total Canada geese counted in winter is continuing to increase. The three populations of large resident geese (with the WP and GP populations counted as one in the winter) are growing at a similar rate (P>0.9, equal slopes). The three-year running averages have been increasing since estimates were first computed for each population. Projections of population size indicate that the total number of Canada geese in the flyway will be 1.96 million by 2010, 31 percent larger than in 1999. This estimate is comparable to the 28 percent growth rate computed from breeding population data.

Table III-14. Population objectives, current status, and projected indices for 2010 for Canada goose populations in the Central Flyway based on winter surveys.

Population	Objective	Average 1998-2000 Index	Amount (Percent) Above Objective	Projected Population Index - 2010
Tall Grass Prairie	250,000	333,986	83,986 (34%)	329,000
Short Grass Prairie	150,000	255,767	105,767 (71%)	852,000
Western Prairie & Great Plains	300,000	581,531	281,531 (94%)	644,000
Hi-Line	80,000	216,040	136,040 (170%)	247,000

(4) Pacific Flyway

The only resident subspecies of Canada geese in the Pacific Flyway is the western Canada goose *(Branta canadensis moffitti)* which occurs throughout the States of Washington, Oregon, California, Idaho, Nevada, Arizona, Utah, Colorado, Montana, and Wyoming. Western Canada geese also occur in the Pacific Flyway portions of British Columbia and Alberta. Since 1983, the Pacific Flyway Study Committee has recognized and managed two populations of western Canada geese: the Pacific Population (PP) and the Rocky Mountain Population (RMP) (Krohn and Bizeau 1980). A large portion of the PP is relatively nonmigratory, with many segments wintering on or in close proximity to breeding areas, although more northern segments make annual migrations. In contrast, the RMP is primarily migratory with geese undertaking spring and fall migrations between breeding and wintering areas.

(a) Breeding Distribution

Pacific Population (PP) western Canada geese breed in central and southern British Columbia, southwest Alberta, northern and southwest Idaho, western Montana, northwest Nevada, northern California, and throughout Washington and Oregon (Krohn 1977). PP western Canada geese have been very successful in expanding their breeding range and are commonly found throughout most suitable habitats. Whether through transplant programs or natural pioneering, PP western Canada geese have expanded their historic distribution significantly over the past two decades. This expansion has been facilitated by the popularity of PP western Canada geese with wildlife managers and the public. Numerous management actions, such as placement of artificial nesting structures and trap-and-translocation programs, have been implemented to increase distribution and numbers of western Canada geese. Numerous agricultural practices and residential/recreational developments have also significantly increased habitats sought by Canada geese. While several indices exist, no overall population estimate (historic or current) is available for PP western Canada geese throughout its range.

Rocky Mountain Population (RMP) western Canada geese nest from central Nevada to western Colorado, and from at least as far north as central Alberta, and south to east-central Arizona and northwest New Mexico. The population affinity of geese nesting in southern California is unknown. Major nesting regions for the RMP are southern Alberta, southeast Idaho, Montana and northern Utah (see **Table III-17** for complete list of breeding reference areas). Krohn and Bizeau (1980) estimated the RMP population at 14,000 geese in the early 1970s. The current estimate of the breeding population is 130,000 geese (10-

year average) throughout the RMP range. Similar wildlife management practices conducted for PP western Canada geese to increase distribution and numbers also occurred for RMP birds. However, for both the PP and RMP populations, efforts to enhance populations have decreased concurrently with improved population status and increased depredation problems.

While numerous translocations have occurred throughout the western States for both PP and RMP western Canada goose populations, no complete records for all efforts are available. Translocations were conducted to assist in expanding the range of birds for the purpose of sport harvest and to assist with depredation and nuisance issues, primarily occurring on agricultural lands and urban settings. Private individuals also conducted release of captive reared birds into new areas. These efforts and natural pioneering of birds over several decades have resulted in western Canada geese occupying nearly all suitable habitats in western States.

(b) Migration and Winter Distribution

Although the majority of PP western Canada geese are generally nonmigratory, segments of the population do make annual migrations between breeding and wintering areas. Molt migrations of nonbreeding PP western Canada geese in U.S. States occur annually to the Northwest Territories, north of the Saskatchewan-Manitoba border (Ball et al. 1981), to areas in Alberta and Saskatchewan, and to large bodies of permanent water near breeding grounds in southern portions of the range (Ball et al. 1981; Rienecker 198x).

The population status and range of PP western Canada geese is not well defined in British Columbia and Alberta. Limited band recovery data from large Canada geese banded during the summer in northwestern Alberta indicate that the recoveries from this area occur in central and southern British Columbia, Washington, Oregon, and northern California during winter months (Bartonek 1991).

The RMP population winters from central and southern California to central Arizona and as far north as southern Alberta. Historically, the most northern wintering area for significant numbers of RMP western Canada geese was American Falls Reservoir in southeastern Idaho, however, growing segments of the population are wintering farther north and throughout the range of the RMP. Major segments wintered in central and southern California and western Arizona. Since 1971, the number of RMP Canada geese wintering in this region has grown from three birds to 23,475 (2000 winter survey). In the early 1990s, a significant number of birds that had traditionally wintered in southern California, northeast Arizona, and southern Nevada, appear to have shifted into western New Mexico. Prior to the late 1980s, relatively few RMP geese wintered in New Mexico.

(c) Population Trends

In recent years Pacific Flyway management agencies have focused more on establishing breeding population surveys to track the status of PP western Canada geese. However, a variety of survey methodologies are used to track the status of geese in individual States. The following indices in **Table III-15** illustrate general population trends for PP western Canada geese in some western States. Winter surveys are not precise for western Canada geese because of mixing of different subspecies of Canada geese on wintering grounds.

Table III-15. Pacific Population of western Canada goose breeding pair index.[1]

	Unit I			Unit II		Unit III		Unit IV			GRAND	Oregon
YEAR	CA	NV	TOTAL	S. ID	TOTAL	MT	TOTAL	N. ID	WA	TOTAL	TOTAL	Br. Pop.
1970	1,589	390	1,979						1,925	1,925	3,904	
1971	1,481	497	1,978			160	160		1,955	1,955	4,093	
1972	1,949	603	2,552						2,214	2,214	4,766	
1973	1,757	513	2,270						2,339	2,339	4,609	
1974	1,165	577	1,742			389	389		2,179	2,179	4,310	
1975	1,247	387	1,634			381	381		2,500	2,500	4,515	
1976	930	422	1,352			414	414		2,518	2,518	4,284	
1977	1,135	402	1,537	*806*	***806***	568	568		2,589	2,589	5,500	
1978	1,357	453	1,810	*943*	***943***	455	455		2,508	2,508	5,716	
1979	1,262	267	1,529	985	985	550	550	94	2,148	2,242	5,306	
1980	1,710	415	2,125	1,489	1,489	564	564	107	2,098	2,205	6,383	
1981	1,780	547	2,327	1,337	1,337	521	521	120	2,732	2,852	7,037	
1982	1,148	679	1,827	373	373	485	485	161	2,490	2,651	5,336	
1983	1,101	659	1,760	997	997	624	624	113	2,964	3,077	6,458	
1984	1,002	782	1,784	1,180	1,180	687	687	142	2,790	2,932	6,583	
1985	910	900	1,810	1,036	1,036	621	621	151	3,037	3,188	6,655	
1986	1,453	851	2,304	1,310	1,310	719	719	138	3,318	3,768	8,101	
1987	960	981	1,941	1,380	1,380	723	723	145	3,717	4,341	8,385	
1988	870	945	1,815	1,498	1,498	814	814	237	4,004	4,525	8,652	
1989	848	854	1,702	1,527	1,527	851	851	286	3,930	4,570	8,650	
1990	1,127	845	1,972	1,901	1,901	892	892	317	3,989	4,659	9,424	
1991	918	687	1,605	2,127	2,127	869	869	325	4,365	5,061	9,662	
1992	735	528	1,263	1,712	1,712	992	992	294	4,317	4,848	8,815	
1993	748	473	1,221	1,946	1,946	919	919	332	4,649	5,278	9,364	
1994	834	538	1,372	2,006	2,006	950	950	380	4,338	5,036	9,364	57,907
1995	473	626	1,099	1,688	1,688	959	959	374	4,334	4,708	8,454	44,464
1996	1,532	518	2,159	1,380	1,380	939	939	402	4,279	4,681	9,159	53,294
1997	634	669	1,303	1,686	1,686	1,056	1,056	366	3,930	4,296	8,341	56,881
1998	1,059	703	1,762	1,671	1,671	1,173	1,173	359	3,766	4,125	8,731	55,486
1999	831	870	1,701	1,722	1,722			290	3,776	4,066	7,489	
AVG.	1,166	607	1,778	1,396	1,396	684	684	236	3,148	3,416	6,851	53,137

Note:
1. Shaded area indicates no survey and that number is calculated, either average or trend.

The midwinter waterfowl survey currently provides the best long-term index for the overall RMP population. The RMP winter index increased from an average of 30,000 geese during the early 1970s, to an average of over 115,000 during the 1990s (**Table III-16**). Numbers of wintering geese increased in most reference areas, with central Wyoming and western Nevada and New Mexico showing the greatest increases. Indices from southern California and Nevada appear to be declining. States are placing more emphasis on completing breeding population estimates (**Table III-17**). Assessment of resident population status from winter counts are somewhat confounded by the mixing of other Canada goose subspecies in wintering flocks.

Table III-16. Mid-winter waterfowl survey indices of the Rocky Mountain Population of Canada geese by reference area.

Year	Mont.	Idaho	Wyoming			Colo.	Utah			Nevada				Arizona				California			NW		3-Yr-Avg
	Cent.	SE	Cent.	West.	Total	West.	North.	South.	Total	NE	South.	NW	Total	West.	East	North	Total	Cent.	South.	Total	New Mex.	Total	Index
1967	499	6,388		50	**50**	71	13	987	**1,000**	112	959	5,537	**6,608**	1,531	2,071		**3,602**	3,795	27,610	**31,405**	0	**49,623**	
1968	469	2,149	75	173	**248**	92	1,008	243	**1,251**	2	1,200	2,108	**3,310**	1,587	2,783		**4,370**	5,928	14,290	**20,218**	0	**32,107**	
1969	268	3,508	197	454	**651**	1,207	2,444	443	**2,887**	62	438	5,313	**5,813**	1,973	1,079		**3,052**	5,377	15,095	**20,472**	N.S.	**37,858**	**39,863**
1970	232	5,348	85	89	**174**	1,014	1,161	445	**1,606**	33	839	4,303	**5,175**	1,957	1,178		**3,135**	2,916	6,160	**9,076**	N.S.	**25,760**	**31,908**
1971	84	3,218	72	75	**147**	1,179	1,722	673	**2,395**	5	550	3,021	**3,576**	2,080	1,422		**3,502**	4,160	7,115	**11,275**	3	**25,379**	**29,666**
1972	70	11,615	197	225	**422**	1,205	2,209	517	**2,726**	2	659	3,422	**4,083**	2,505	1,736		**4,241**	3,590	8,694	**12,284**	45	**36,691**	**29,277**
1973	335	5,063	15	377	**392**	1,673	887	208	**1,095**	3	1,005	2,695	**3,703**	2,046	2,699		**4,745**	4,145	15,995	**20,140**	28	**37,174**	**33,081**
1974	330	10,005	90	276	**366**	1,558	2,894	904	**3,798**	70	1,320	3,661	**5,051**	3,242	2,115		**5,357**	4,095	12,255	**16,350**	158	**42,973**	**38,946**
1975	159	12,738	30	547	**577**	2,174	1,730	324	**2,054**	35	1,500	3,195	**4,730**	764	1,770		**2,534**	7,440	14,324	**21,764**	179	**46,909**	**42,352**
1976	0	19,675	32	215	**247**	1,503	1,321	722	**2,043**	540	1,225	4,090	**5,855**	1,995	1,550		**3,545**	5,735	12,965	**18,700**	177	**51,745**	**47,209**
1977	75	18,723	125	662	**787**	1,391	5,092	1,585	**6,677**	225	1,210	5,282	**6,717**	1,900	1,611		**3,511**	5,965	10,450	**16,415**	525	**54,821**	**51,158**
1978	60	26,269	300	409	**709**	2,405	6,863	2,220	**9,083**	1,090	1,400	5,540	**8,030**	2,685	1,654		**4,339**	2,620	5,480	**8,100**	411	**59,406**	**55,324**
1979	1	31,885	164	585	**749**	2,979	2,222	1,530	**3,752**	200	1,715	3,535	**5,450**	3,217	1,745		**4,962**	3,595	7,515	**11,110**	3,694	**64,582**	**59,603**
1980	740	27,976	176	638	**814**	2,362	2,205	3,417	**5,622**	1,000	1,940	8,135	**11,075**	12,050	1,942		**13,992**	1,115	11,510	**12,625**	661	**75,867**	**66,618**
1981	1,922	52,204	187	692	**879**	3,892	5,904	722	**6,626**	2,715	1,280	7,148	**11,143**	7,700	1,470		**9,170**	3,300	3,365	**6,665**	700	**93,201**	**77,883**
1982	66	21,564	1,681	689	**2,370**	4,476	2,314	2,494	**4,808**	1,466	1,352	6,743	**9,561**	8,625	2,210		**10,835**	4,420	5,250	**9,670**	1,370	**64,720**	**77,929**
1983	3,300	15,256	900	464	**1,364**	4,803	2,405	2,624	**5,029**	1,205	1,825	7,244	**10,274**	11,450	1,923		**13,373**	6,740	8,840	**15,580**	2,406	**71,385**	**76,435**
1984	25	7,765	470	558	**1,028**	2,912	2,480	2,362	**4,842**	2,115	2,380	12,420	**16,915**	14,850	1,981		**16,831**	1,225	4,010	**5,235**	7,054	**62,607**	**66,237**
1985	355	28,812	1,926	548	**2,474**	4,678	1,090	3,092	**4,182**	1,420	2,790	11,010	**15,220**	15,950	1,669		**17,619**	5,725	10,855	**16,580**	2,451	**92,371**	**75,454**
1986	0	6,130	295	602	**897**	6,667	1,671	3,701	**5,372**	1,952	1,706	13,283	**16,941**	21,200	1,842		**23,042**	1,499	7,811	**9,310**	3,388	**71,747**	**75,575**
1987	1,029	16,946	758	482	**1,240**	4,658	2,915	3,748	**6,663**	2,925	1,205	11,265	**15,395**	16,930	1,286		**18,216**	2,496	4,848	**7,344**	3,857	**75,348**	**79,822**
1988	819	19,229	732	486	**1,218**	5,996	2,263	2,488	**4,751**	1,236	1,280	8,263	**10,779**	22,600	1,330		**23,930**	1,645	3,050	**4,695**	4,325	**75,742**	**74,279**
1989	1,218	10,138	2,538	476	**3,014**	8,864	2,092	1,346	**3,438**	1,068	1,102	9,895	**12,065**	20,850	1,744		**22,594**	5,891	6,635	**12,526**	18,486	**92,343**	**81,144**
1990	3,864	22,474	1,977	673	**2,650**	15,877	3,480	3,295	**6,775**	2,925	1,405	13,952	**18,282**	25,600	1,374		**26,974**	3,323	2,215	**5,538**	32,646	**135,080**	**101,055**
1991	2,773	14,522	1,352	393	**1,745**	3,533	1,339	1,622	**2,961**	806	1,972	13,589	**16,367**	30,100	1,797		**31,897**	6,837	6,067	**12,904**	11,673	**98,375**	**108,599**
1992	14,704	46,689	2,668	293	**2,961**	8,111	3,837	3,216	**7,053**	914	1,358	12,044	**14,316**	17,650	1,083		**18,733**	1,398	1,742	**3,140**	18,352	**134,059**	**122,505**
1993	5,235	9,210	2,862	137	**2,999**	6,782	2,983	4,257	**7,240**	806	1,340	7,600	**9,746**	22,596	1,296		**23,892**	6,528	3,025	**9,553**	17,224	**91,881**	**108,105**
1994	5,559	11,199	2,279	394	**2,674**	10,046	5,491	3,232	**8,723**	401	446	11,524	**12,371**	21,300	1,307		**22,607**	3,617	484	**4,101**	13,645	**90,925**	**105,622**
1995	14,242	19,298	4,022	394	**4,416**	8,353	4,382	2,484	**6,866**	42	700	14,566	**15,308**	19,527	1,551		**21,078**	1,587	684	**2,271**	28,343	**120,175**	**100,994**
1996	3,096	47,070	3,353	328	**3,681**	8,297	17,121	1,871	**18,992**	2,250	580	12,195	**15,025**	14,043	1,283		**15,326**	3,972	1,537	**5,509**	12,714	**129,710**	**113,603**
1997	2,990	24,116	3,510	344	**3,854**	7,687	16,284	1,948	**18,232**	1,987	570	15,130	**17,687**	17,000	1,598		**18,598**	4,669	669	**5,338**	15,320	**113,822**	**121,236**
1998	24,122	22,878	4,758	225	**4,983**	7,721	11,683	2,395	**14,078**	1,350	625	14,267	**16,242**	12,816	1,348		**14,164**	218	1,018	**1,236**	11,234	**116,658**	**120,063**
1999	7,188	33,784	5,298	262	**5,560**	4,774	10,050	1,356	**11,406**	2,365	512	25,795	**28,672**	18,259	2,331	450	**21,040**	1,599	393	**1,992**	18,333	**132,749**	**121,076**
2000	26,112	14,859	8,726	547	**9,273**	8,397	7,441	1,631	**9,072**	890	840	14,805	**16,535**	*6,281*	1,833	315	**8,429**	4,352	1,715	**6,067**	23,475	**122,219**	**123,875**
Avg.	**3,586**	**18,491**	1,571	405	**1,930**	**4,628**	4,088	1,885	**5,973**	1,006	1,213	8,899	**11,118**	11,319	1,694	383	**13,036**	3,868	7,167	**11,035**	**7,902**	**77,236**	**76,766**

Table III-17. Breeding population index and objective by reference area for the Rocky Mountain Population of Canada geese.

Reference Area	Breeding Population Index	Objective Breeding Population Index
1. Southern Alberta [a]	81,700	**60,000**
2. Central Montana	27,600	**30,000**
3. Southeastern Idaho	5,040[b]	**5,550**
4. Western Wyoming	9,720[b]	**12,000**
5. Central Wyoming	6,520[b]	**6,050**
6. Western Colorado	380[b]	**460**
7. Northern Utah	1,520[b]	**1,550**
8. Southern Utah	240[b]	**250**
9. Northeastern Nevada	620[b]	**700**
11. Southern Nevada	200[b]	**240**
15. Eastern Arizona	40	**100**
16. Northwestern New Mexico	200	**200**
Totals	133,780	**117,100**
Restrictive level when 3 yr. average falls below --		**87,825**
Liberalization level when 3 yr. average is above --		**146,375**

Notes: The breeding population index is based upon the 10-year mean for the period between 1990 and 1999
a. Alberta numbers are provisional and will be adjusted as new data becomes available.
b. The breeding pair index is derived by doubling the State reported breeding pair index.

2. Natural Resources

Natural resource damage in the form of increased erosion, shoreline destabilization, destruction of newly seeded wetland restoration and mitigation sites, and damage to natural vegetation in natural marshes and impoundments that resulted from concentrated resident Canada goose feeding was noted by a number of States during public scoping. In a few examples, Pennsylvania indicated that water quality degradation by resident Canada geese occurred in about 30 percent of all State parks. Missouri implicated large Canada goose concentrations in localized areas and their associated fecal deposits in algal blooms and subsequent oxygen depletion in lakes that sometimes resulted in fish kills.

a. Water Quality and Wetlands

The most commonly listed concern reported by State agencies during scoping was degradation of water quality by either fecal contamination or erosion of sediments from areas denuded by goose grazing or trampling.

Excessive numbers of resident Canada geese have affected water quality around beaches and in wetlands by nonpoint source pollution. There are four forms of nonpoint source pollution: sedimentation, nutrients, toxic substances, and pathogens. Excessive numbers of Canada geese can remove shoreline vegetation resulting in erosion of the shoreline and soil sediments being carried by rainwater into lakes, ponds, and reservoirs. Excessive numbers of Canada geese have been reported to be sources of nutrients and pathogens in water. Sewage treatment plants in Virginia are required to test effluent water quality before release from finishing ponds into the environment. Sewage treatment plants find that coliform bacteria counts increase dramatically when large numbers of Canada geese are present and decline dramatically when the geese are removed (A. Pratt, Upper Occoquan Sewage Authority, unpub. data as cited in USDA 1999b). Coliform bacteria causes acidic pH levels in the water and lowers dissolved oxygen which kills aquatic organisms (Cagle 1998). Also, fecal contamination increases nitrogen levels in the pond resulting in algal blooms. Oxygen levels are depleted when the algae dies resulting in the death of aquatic invertebrates and vertebrates (USDA 1999b).

Nutrient loading has been found to increase in wetlands in proportion to increases in the numbers of roosting geese (Mitchell et al. 1999, Manny et al. 1994). In studying the relationship between bird density and phosphorus (P) and nitrogen (N) levels in Bosque del Apache National Wildlife Refuge in New Mexico, Mitchell et al. (1999) found an increase in the concentration of both P and N correlated with an increase in bird density. Scherer et al. (undated) stated that waterfowl metabolize food very rapidly and most of the phosphorus contributed by bird feces probably originates from sources within a lake being studied. In addition, assimilation and defecation converted the phosphorus into a more soluble form, and therefore was considered a form of internal loading. Waterfowl have contributed substantial amounts of P and N into lakes through feces creating excessive aquatic macrophyte growth and algae blooms (Scherer et al. undated) and accelerated eutrophication through nutrient loading (Harris et al. 1981). In Pennsylvania, the Pennsylvania Department of Conservation and Natural Resources cited excessive numbers of resident geese and the their deposition of fecal matter as a factor in nutrient loading leading to eutrophication and aquatic weed growth at State park lakes (Pennsylvania Department of Conservation and Natural Resources 2000).

Canada geese may be attracted to waste water treatment plants because of the water and available grasses. Canada geese can threaten the health of the environment by damaging manmade structures holding waste water (USDA 1999b). Severe grazing of levees results in the removal and loss of turf which hold soil on the levees. Heavy rains on bare soil levees results in erosion which would not have occurred if the levee had remained vegetated. In Virginia, the Green County Waste Water Treatment Plant was instructed by the Virginia Department of Environmental Quality to take corrective action in July 1998 because excessive grazing by 200 Canada geese had left the levees vulnerable to washout during heavy rain (A. Koontz, Rapidan Service Authority, personal communication as cited in USDA 1999b).

b. Vegetation and Soils

Geese that denude vegetation indirectly cause soil erosion when subsequent rains wash away soils from bare areas. Erosion can compromise revegetation efforts when topsoil is lost. When vegetation that protects waterways is removed, sedimentation impacts the quality of the waterbody. Geese may damage landscaping, yards, beaches, shorelines, parks, golf courses, landscaping, athletic fields, ponds, lakes, gardens, playgrounds, school grounds, and cemeteries (USDA 2000, USDA 19999a, USDA 1999b).

The costs of reestablishing over-grazed lawns and cleaning goose droppings from sidewalks have been estimated at more than $60 per bird (Allan et at. 1995). The State of Minnesota noted during public scoping that an increasing number of their staff is spending time and resources responding to resident Canada goose issues. This is done at the expense of traditional natural resource management activities

such as habitat restoration and protection. In Pennsylvania, the Pennsylvania Department of Conservation and Natural Resources indicated that turf areas damaged by grazing geese caused shoreline erosion which increased the need for re-planting, dredging, and shoreline stabilization (Pennsylvania Department of Conservation and Natural Resources 2000).

c. Wildlife Habitat

Information concerning resident Canada geese impacts on other wildlife habitat is minimal. Haramis and Kearns (2000) found that resident Canada geese were having a profound effect on the survival and productivity of wild rice in the tidal Patuxent River (Maryland) marshes, a historically important sora rail wintering area. Damage to rice began as soon as it germinated in early spring and continued until the plants were too high to be reached by geese. Germinating rice plants were completely uprooted by geese, while more advanced plants were grazed repeatedly. Haramis and Kearns (2000) found that grazing of the growing tip of the plant set the rice back significantly while repeated grazing virtually eliminated all plants accessible to geese.

At Blackwater National Wildlife Refuge, in Dorchester County, Maryland, resident Canada geese are causing significant damage to agricultural crops planted to provide critical forage for wintering and migrating waterfowl (Blackwater National Wildlife Refuge 2000). For example, in 1999, geese destroyed almost half of the refuge's annual corn crop and 126 acres of Ladino clover. Additionally, resident geese are significantly affecting natural vegetation in moist-soil impoundments.

3. Waterfowl Health

In large concentrations, resident Canada geese, feral geese, and hybrids create a reservoir for disease and pose a health threat to migrating waterfowl. Tens of thousands of migratory waterfowl have been killed in single die-offs, with as many as 1,000 birds succumbing in 1 day (Friend and Franson 1987). For this reason, the American Association of Wildlife Veterinarians (AAWV) put forth the following resolution:

> "...wild and semi-domestic ducks, geese and swans are susceptible to and carriers of disease and parasites of free-ranging wild ducks, geese, and other birds;..."
>
> "...the AAWV encourages local authorities and State and federal agencies to cooperate to limit the population of waterfowl on urban water areas to prevent disease outbreaks in semi-domestic as well as free-ranging ducks, geese and swans and discourages the practice of relocating nuisance or excess urban ducks, geese and swans to other parks or wildlife areas as a means of local population control".

The State of Maryland reported its concerns with the potential wildlife disease threat posed by concentrations of resident Canada geese (from public scoping). Local concentrations of resident Canada geese may congregate around impoundments that are drawn down. The drawn-down pools can be contaminated by fecal material and, especially when temperatures are high, these stagnant pools are a potential source of avian diseases. A 1998 survey conducted by the USGS National Wildlife Health Research Center found 16 percent of 37 resident Canada geese sampled at Blackwater National Wildlife Refuge (NWR) tested positive for duck virus enteritis (DVE). Maryland points out that these birds serve as a reservoir for this highly contagious disease and pose a serious threat to other birds utilizing this refuge (from public scoping).

Both Minnesota and Maryland point to the impact of these geese on natural wild rice beds (public scoping). Maryland, Pennsylvania, and Tennessee also noted that resident goose populations are feeding

to a significant degree on crops and habitat maintained as food sources and cover for migrant geese and other waterfowl (public scoping).

4. Other Wildlife, Including Federally Protected Species

A common concern among members of the public and wildlife professionals, including Service and Wildlife Services personnel, is the impact of damage management assistance methods and activities on non-target species, particularly threatened and endangered species. Section 7 of the Endangered Species Act (ESA), as amended (16 U.S.C. 1531-1543; 87 Stat. 884), provides that,

> "The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this Act" (and) shall "ensure that any action authorized, funded or carried out ... is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of (critical) habitat ..."

Consequently, we are engaged in informal Section 7 consultation under the ESA for this management assessment. No determination has yet been made whether formal consultation will be necessary.

Due to the large geographical context of resident Canada goose management, a variety of special status species may occur in areas frequented by resident Canada geese. However, while the geographic distribution of many of these special status species may overlap with those of migratory Canada geese, there is generally less habitat overlap between these species and resident Canada geese given their occurrence in more urban and suburban areas, in addition to rural areas. In general, these urban and suburban areas are usually less utilized by sensitive species. Also the behavior, flight pattern, size, or other characteristics distinguish these species from any special status species. A regional listing of endangered, threatened, proposed, and candidate species that share the brood geographic range and some habitats of resident Canada goose populations is presented in **Appendix 11**.

Management activities associated with resident Canada goose population control have been reviewed in a variety of contexts. First, Wildlife Services has conducted three statewide Section 7 Consultations, in Wisconsin (U. S. Fish and Wildlife Service 1999), Washington (U.S. Fish and Wildlife Service 2000b) and Virginia (U.S. Fish and Wildlife Service 1999b) on the management of resident Canada geese. Each of these consultations resulted in informal consultation and letters of concurrence from the Service that the proposed projects and management actions would have no effect on listed species. Within the State of Wisconsin, the letter from the Service also indicated that the management actions have the potential to affect certain species within certain counties. The letter described that if Wildlife Services would like to conduct management efforts on resident Canada geese within these counties, then further consultation would be required.

Secondly, the Service has consulted through Section 7 of the ESA on annual migratory bird hunting regulations. Although 50 species may be affected by hunting activities, they are not adversely affected (U.S. Fish and Wildlife Service 2001). The Biological Opinion issued exemplifies methods to minimize disturbance of hunting activities on whooping cranes.

Endangered whooping cranes (*Grus americana*) occur in wintering areas that resident Canada geese occasionally use; primarily in the Central and Pacific Flyways (**Figure III-2**). Peak of the spring migration of cranes through important stopover areas along the Platte River and other portions of Nebraska occurs during April (**Figure III-3**). Most cranes begin their spring migration in April and early May (Lewis et al. 1994). No whooping cranes have been recorded as being shot incidental to recent efforts intended to increase harvest of resident Canada geese in the Central Flyway.

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. Finally, review of affects on threatened and endangered species is currently being conducted on management activities associated with light goose population control (U.S. Department of the Interior 2001). Activities such as increased hunting opportunities, liberal daily bag limits, use of electronic calls and unplugged shotguns, and allowing shooting hours to continue until one-half hour after sunset are being evaluated in relation to affects on species of special status. These activities are also being evaluated to control resident Canada goose populations.

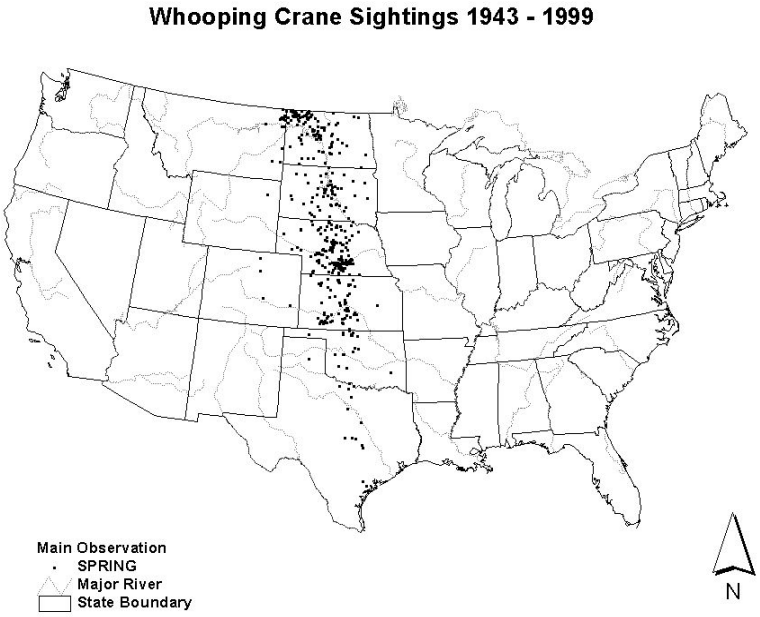


Figure III-2. Location of whooping crane sightings in the Central Flyway, 1943-99 (U.S. Fish and Wildlife Service, unpublished data).

The Service has also consulted on the Special Canada Goose Permit program (U.S. Fish and Wildlife Service 1998). The Service concluded that the proposed action was "not likely to adversely affect" the Aleutian Canada goose and resulted in informal consultation.

Finally, review of affects on threatened and endangered species is currently being conducted on management activities associated with light goose population control (U. S. Department of the Interior 2001). Activities such as increased hunting opportunities, liberal daily bag limits, use of electronic calls and unplugged shotguns, and allowing shooting hours to continue until one-half hour after sunset are being evaluated in relation to affects on species of special status. These activities are also being evaluated to control resident Canada goose populations.

Some people are concerned that non-lethal and lethal damage management methods directed at resident Canada geese will impact other subspecies of Canada geese. By definition (see section **I.B. Scope**),

resident Canada geese are those subspecies of Canada geese that nest and/or reside within the conterminous United States in the months of June, July, and August. Use of this definition for other permitted actions (see section **III.B.1.c. Migratory Bird Permit Program**) has significantly minimized any possible management action interactions with other Canada goose populations. Further, there are no special status species of Canada geese. Aleutian Canada geese, formerly threatened, were delisted in 2001 (Federal Register 2001) and there is little, if any, habitat overlap with resident Canada geese.

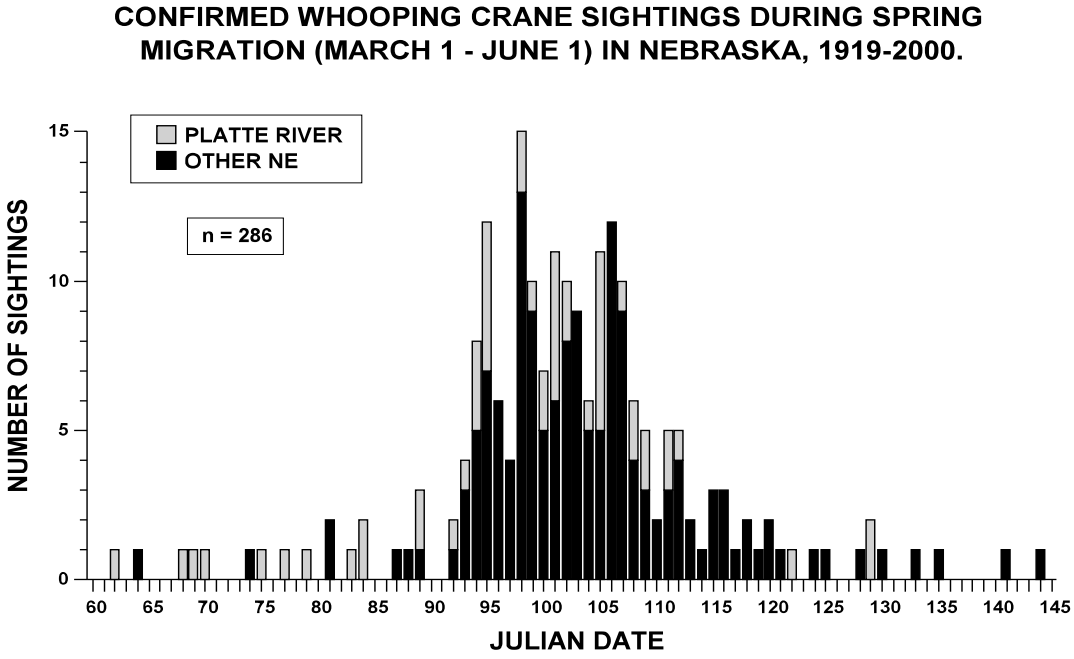


Figure III-3. Temporal distribution of whooping crane sightings in Nebraska, 1919-2000 (U.S. Fish and Wildlife Service, unpublished data).

As described in section **II.A. Description of Goose Management Techniques**, it is possible to manage certain suburban and urban habitats to make the area less attractive to resident geese (e.g., draining a pond, wetland or lake, altering varieties of grass). In these situations, the effects on migrant geese would be similar to the effects on resident geese, in that the birds would merely forage and/or loaf in other nearby locations more attractive to the birds.

All activities associated with resident Canada goose population control will be conducted in compliance with specific Service authorization through the ESA.