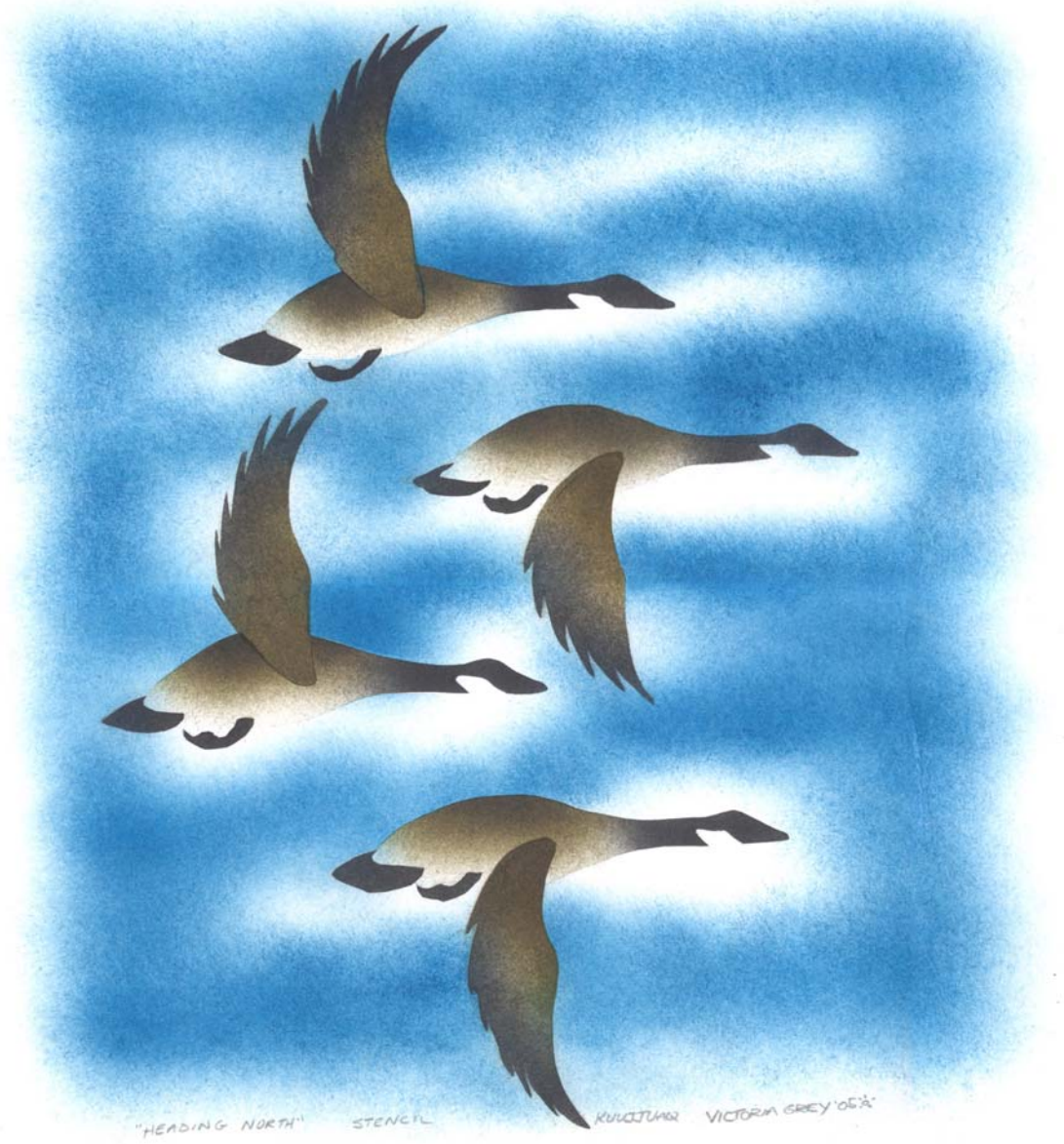
A MANAGEMENT PLAN FOR THE ATLANTIC POPULATION OF CANADA GEESE



Canada Goose Committee
Atlantic Flyway Migratory Game Bird Technical Section

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Prepared by the Canada Goose Committee
Atlantic Flyway Council Game Bird Technical Section

Cover – "Heading North" by Inuit Artist, Victoria Grey of Kuujjuaq, Nunavik

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EXECUTIVE SUMMARY

The Atlantic Population of Canada geese (hereafter AP) are managed under an Atlantic Flyway Canada Goose Management Plan developed in 1989. The 1989 plan established objectives and placed emphasis on status assessment using wintering ground surveys. Between 1986 and 1995, the number of wintering Canada geese in Atlantic Flyway states declined from 900,000 to 650,000, as measured by the Midwinter Waterfowl Survey. This decline occurred despite a rapid increase in numbers of temperate-nesting or Atlantic Flyway Resident Population (RP) Canada geese. Breeding surveys of key AP nesting areas in northern Québec documented a precipitous decline in AP breeding numbers from 118,000 nesting pairs recorded in 1988 to 90,000 in 1993, 40,000 in 1994, and 29,000 pairs in 1995. This dramatic change in numbers of AP geese, greater than 75 percent in less than a decade, prompted state, provincial, and federal wildlife agencies in 1995 to suspend the sport hunting season of AP geese in the United States and in the Canadian Provinces of Ontario and Québec. In July 1996, the Atlantic Flyway Council approved an Action Plan for AP Canada Geese to address immediate survey and research needs that would help guide management to rebuild AP goose numbers.

Since that plan was developed, a great deal of new knowledge of AP Canada geese has been gained to help establish management priorities, determine future research needs, and promote actions required to manage the AP from 2008 onwards. Good productivity in the late 1990s and again in 2001 and 2005, along with low harvest rates (e.g., <10%) of adult geese have resulted in continued population growth. From a low of 29,000 breeding pairs in 1995 the estimated number of breeding pairs on the Ungava Peninsula has increased to 196,000 in 2007. Management efforts have been directed towards ensuring that the population growth continues since the sport harvest was resumed in 1999.

The overall management goal is to maintain the Atlantic Population of Canada geese and their habitats at a level that provides optimum opportunities for people to use and enjoy geese on a sustainable basis. The population objective believed necessary to achieve this goal is to achieve and maintain an index of 225,000 breeding pairs of AP Canada geese in the Ungava region of northern Québec. The objective in this plan is significantly higher than that established in the 1996 Action Plan for AP Canada geese, which was focused on re-opening of a sport harvest season. The population objective requires continued population growth, assumes that the AP can be maintained at this higher level and reflects a desire to expand AP harvest opportunities using an adaptive management approach.

Harvest regulations may be liberalized under the current plan, subject to close monitoring of harvest rates and the spring breeding pair index. Regulations will be developed on a regional basis within the flyway to reflect differences in proportions of AP and RP geese in the harvest. An added benefit will be the additional harvest exerted upon RP Canada geese where the two populations overlap. The long-term decline of AP Canada geese in the southern Atlantic Flyway presents a unique harvest-management dilemma. Modifications in framework opening dates will be the primary means used to promote the long-term viability of this southern migrating group of geese.

Population models are being developed to predict and evaluate population response to management actions that affect harvest, survival, and growth rates. All parties recognize the need to support and maintain a long-term harvest strategy for AP Canada geese that ensures (a) the conservation of the population, (b) the conservation of habitat, (c) provides for equitable harvest opportunity among users, (d) provides for the subsistence harvest of geese by aboriginal peoples, and (e) prevents the population from causing significant harm to agricultural or ecological resources or becoming too large to control via sport harvest.

The spring breeding pair index will be used for monitoring status and for use in annual discussions of harvest regulations. The spring breeding pair index is expected to increase toward 225,000 pairs even as harvest regulations are modestly liberalized. If the 3-year mean spring pair index falls below 150,000, more restrictive regulations will be considered. The index accounts for roughly 90% of the total estimated number of breeding AP geese.

A review of accomplishments under the 1996 Action Plan for AP Canada geese is included. A list of research and information needs for AP management is appended.

Table of Contents

List of Tables

List of Figures

PREFACE

The purpose of this plan is to establish management objectives and priorities, determine research needs, and promote proper management of the Atlantic Population of Canada geese (hereafter AP) . The previous management plan (Atlantic Flyway Council July 1989) included all populations of Canada geese that winter in the Atlantic Flyway. The previous plan also delineated the AP to include all Canada geese that nested in northern Québec, Labrador and Newfoundland. In 1998, information from band recovery and radio telemetry data led to a new delineation and independent management of two migrant populations, the AP and the North Atlantic Population (NAP).

The 2008 plan sets a population goal, objectives, and strategies for the management of the AP in states and provinces of the Atlantic Flyway for the next five years (2008-2012). The involvement of the U.S. Fish and Wildlife Service (USFWS), the Canadian Wildlife Service (CWS), and aboriginal peoples of Ontario and Québec, in addition to state and provincial wildlife management agencies, is critical to the successful implementation of the plan. The focus of the management plan is to gather information needed to manage this population wisely with conservation as the first principle, to provide for subsistence harvest and sport hunting opportunities, to provide for aesthetic appreciation and viewing opportunities, and to address conflicts associated with AP or other Canada geese in the Atlantic Flyway. This plan will be revised as new information warrants, according to the direction of the Atlantic Flyway Council (AFC).

BACKGROUND

Introduction and History of the AP

The AP comprises the northernmost group of Canada geese of the subspecies *Branta canadensis interior*. Geese affiliated with the AP nest north of 48˚ latitude in northern Québec along Ungava Bay, the northeastern shore of Hudson Bay (where 80% of the breeding birds are found), and in the interior of the Ungava Peninsula. Densities of breeding pairs are highest (>4 pair/mi^2) along the western and eastern coasts of the Ungava Peninsula (Kaczynski and Chamberlain 1968, Malecki and Trost 1990). The AP was once considered the largest Canada goose population in North America. Winter indices approached one million birds by the mid-1980s and annual harvests often exceeded those of any duck species. The AP winters from southern Ontario eastward though the southernmost part of Quebec and southward to North Carolina with major concentrations occurring on the Delmarva Peninsula and in portions of New York, southeastern Pennsylvania, New Jersey, and Virginia.

The Midwinter Survey (MWS) was used as the primary measure of AP population size until the mid-1990s. The survey provided information on winter distribution and was considered a reliable measure of midwinter Canada goose numbers (Hestbeck and Malecki 1989). However, between 1986 and 1995, the MWS index for Canada geese in the Atlantic Flyway declined from 905,400 to 652,700 (Serie and Raftovich 2002). This decline occurred despite a rapid increase in spring estimates of Atlantic Flyway Resident Population (RP) Canada geese from 400,000 in 1989 to 780,000 in 1995 (Heusmann and Sauer 2000, U.S. Fish and Wildlife Service 2002b). By 1995, the number of RP Canada geese estimated during spring surveys in the U.S. portion of the flyway (excluding NC, SC, GA, and FL) exceeded the MWS index of all Canada geese (Caithamer and Dubovsky 1996). The dramatic increase in RP Canada geese (U.S. Fish and Wildlife Service 2002a) and mixing of RP and migrant subarctic nesting geese on wintering areas seriously reduced the value of the MWS as an index for monitoring individual goose populations.

The decline in MWS survey estimates of Canada geese was most pronounced in Maryland, the core wintering area of the AP. Simultaneously, problems were detected when low annual survival rates were observed in winter neck-banded geese in Maryland (Hindman et al. 1998). High harvest pressure and below average gosling production were the primary factors responsible for the AP decline (Hindman et al. 1996). In response to the decline in these vital parameters, hunting regulations were modified in 1988 and again in 1992 in AP harvest areas to reduce harvest rates and increase annual survival. These measures proved to be inadequate to halt population decline. Subsistence harvest of AP geese in the spring by the Cree and Inuit was an additional source of mortality and although no estimates of the magnitude of the subsistence harvest for this period were available, it likely represented a small fraction of the total harvest. The reliance on the MWS as a measure of AP status and the lack of a breeding ground assessment lead to the failure of managers to recognize the seriousness of the AP decline.

Based upon the results of an experimental spring breeding pair survey in 1988 (Malecki and Trost 1990), an annual spring breeding pair survey was initiated in 1993 to obtain a measure of AP population size without the confounding presence of large numbers of RP Canada geese. Breeding surveys of key AP nesting areas in northern Québec documented a precipitous decline in numbers from 118,000 nesting pairs recorded in 1988 to 91,000 in 1993, 40,000 in 1994, and 29,000 pairs in 1995 (Harvey and Bourget 1995). This dramatic decline in AP breeding pairs, (>75 percent in less than a decade), prompted the management agencies to close sport hunting seasons for AP geese in the U.S. portion of the Atlantic Flyway and in portions of Ontario and Québec in 1995. The season closure was an unprecedented action taken for any large North American Canada goose population.

Following the hunting season closure in 1995, the estimated number of breeding pairs increased steadily from a low of 29,000 to 165,000 in 2002. Between 2002 and 2006 the index remained stable at 155,000-175,000 breeding pairs, but increased to 196,000 pairs in 2007 (Harvey and Rodrigue 2007). In 1999, sport hunting of AP geese resumed in Canada and the U.S. portion of the Atlantic Flyway with more liberalized regulations over time as summarized on Table 3. All AP harvest restrictions in Canada were lifted in 2003-04 where regulations are now considered liberal.

The harvest of Canada geese in Atlantic Flyway states (which include varying proportions of RP, NAP, and Southern James Bay Population Canada geese) during the regular seasons have increased from 113,000 in 1999 to 520,600 in 2005 (Table 4). Similarly, Canada goose harvests in AP harvest areas in Ontario and Québec have increased from 77,000 in 1999 to 164,800 in 2006 (Table 5). Direct band recovery rates for adult AP geese have increased steadily but have remained relatively low as regular sport hunting seasons have been reinstated and hunting regulations have gradually been relaxed. Estimated harvest rates for adult AP geese during 2002-2004 have ranged from 6.3% to 8.6% (Sheaffer 2005). Population model simulations project continued growth of the AP at harvest rates of breeding adults at or below about 15%.

For the purpose of setting hunting regulations since 1998, AP migration and wintering areas have been divided into 5 regions: Canada (Québec and eastern Ontario), New England (Connecticut, Rhode Island, Massachusetts, and Vermont), Mid-Atlantic (New York, New Jersey, and Pennsylvania), Chesapeake (Maryland, Delaware, and Virginia), and Southern (northeastern North Carolina) (Fig. 7). In 2002, portions of New York, Pennsylvania, Maryland, Virginia and North Carolina were delineated as RP harvest areas, where negligible harvest of AP geese occurs. These areas have very liberal harvest regulations, compared to remaining AP harvest areas in the flyway. Analysis of band recovery and harvest data may allow further refinement of AP harvest zones in the future.

Summaries of annual population data, both historical and current, are found in the Plan Appendices (Tables 1-8, Fig. 1-12). These will be updated and supplemented periodically, to ensure that the plan is considered a "living" document.

Review of 1996 Action Plan Accomplishments

In July 1996, the AFC approved an Action Plan for the Atlantic Population of Canada geese (Atlantic Flyway Council 1996) to address the immediate survey and research needs that would guide management to help rebuild AP goose numbers. The action plan established an interim population objective (index) of 150,000 breeding pairs in the Ungava Region of northern Québec and 25,000 in the Boreal Forest Region. The action plan also established a threshold for resuming sport harvest, stating that no harvest of AP geese would be considered until the breeding population index in the Ungava Region reached at least 60,000 pairs. Further, any sport harvest resumption would require evidence of a sustained recovery over several years. A resumption of sport hunting was also dependent upon the implementation of necessary monitoring and assessment programs to provide a reliable measure of population status. In addition, effective harvest controls would be enacted to ensure that high harvest rates would not jeopardize the AP recovery.

Following the season closure in 1995, CWS began consultation meetings with the Aboriginal peoples of Québec. In January 1996, a visit to all the Cree communities was organized and included the Grand Chief of the Québec Cree, as well as representatives of the Cree Trappers Association and Traditional Pursuits Department. The Inuit, represented by the Makivik Corporation and the Nunavik Hunting Fishing and Trapping Association, were consulted in Kuujjuaq, Nunavik, in February 1996. An overview of the AP population status along with the decision to close the sport-hunting season was presented. Although, the Cree and Inuit insisted that their harvest rights took precedence over those of sport hunters, both groups agreed to reduce their harvest and to participate and support any research activities.

Following the consultation process, cooperation with the Aboriginal people of Québec has been outstanding. In spring 1996, the Cree First Nation in cooperation with the CWS conducted a pilot harvest survey, which included recording harvest by all hunters in one village, and collecting goose bands and measuring structural size of geese in most communities. Since 1997, CWS has reported the results of the breeding ground monitoring programs to the Cree and Inuit on an annual basis. Representatives from both Aboriginal groups have since sent representatives to winter flyway meetings to participate in discussions regarding the management of AP geese. Since 2000, the Nunavik Hunting, Fishing, and Trapping Association and Makivik, Inc., have worked to determine harvest levels by their hunters at Kuujjuaq and plan to expand subsistence harvest surveys to other communities.

A comprehensive monitoring program for AP geese was instituted under the direction of the 1996 Action Plan. The aerial survey of breeding AP Canada geese in northern Québec initiated first on an annual basis in 1993 was continued using the methods developed by Malecki and Trost (1990) (Bordage and Plante 1993). The objective of the survey is to monitor the status of the AP by obtaining an index of the number of breeding pairs (Harvey and Rodrigue 2007). The survey is now conducted annually and timed to occur about the third week of incubation (typically mid to late June,). A visibility correction factor has not been derived. However, assuming that the correction factor would be similar to that derived by Malecki (1976), the survey index probably represents about 70% of the actual breeding population in the survey area.

The taiga and boreal forest regions of northern Québec (region 4 in Malecki and Trost 1990) were surveyed during the spring Canada goose pair survey in 1993 and 1996. Currently, this region or portions of the region are surveyed annually as part of the May Breeding Waterfowl and Habitat Survey (USFWS)

and the Eastern Waterfowl Breeding Ground Survey (CWS). The density of breeding pairs in the boreal forest is low (<0.1 pair/km^2; Bordage et al. 2003) and relatively constant compared to the Ungava Peninsula. Estimates from the taiga are not assessed on an annual basis.

The total number of Canada geese (breeding pairs plus nonbreeding geese) is also estimated on the spring surveys. However, large numbers of molt migrant geese are known to enter the survey area, particularly the Hudson Bay coastal region, at about the same time the spring survey is conducted. Differences in survey timing and the abundance of molt migrants can introduce substantial variability and bias in the total population estimates. Therefore, the estimated total number of geese is not considered a reliable measure of population status and, thus, is not used for management and setting hunting regulations.

A recommendation of the 1996 Action Plan was to initiate an annual monitoring program for determining productivity (recruitment) from the breeding grounds. Thus, in 1996, a pilot study of reproductive success was initiated in northern Québec with Inuit cooperation. In 1997, a full-scale breeding study of AP geese was initiated to measure reproductive success (Hughes 1998). The study focused on two key breeding areas on the Ungava Peninsula in northern Québec where the majority of the AP nest (Malecki and Trost 1990, Harvey and Rodrigue 2007); one along the northeastern coast of Hudson Bay and the other around Ungava Bay. A 34.5-km² primary study area was established on the Hudson Bay coast where an intensive ground-based study of nesting ecology and brood rearing was conducted from 1997 through 2003 (Hughes 1998, Cotter 2004). In addition, several small study sites with concentrations of nesting geese are visited using a helicopter; once in June to locate and mark a sample of nests and again in August to assess nest success. A similar approach of visiting small study sites was used in the Ungava Bay region. The spring breeding pair estimate from the Ungava Region combined with information from the recruitment assessment is the primary measure of AP status.

In the 1970s through the early 1990s, post-season banding on wintering areas was the primary tool used to estimate annual survival and harvest rates of AP geese. Mixing of AP geese with other goose populations made evaluation of population status difficult and clouded the effects of harvest regulations on specific populations. Breeding ground banding had been limited to large numbers of Canada geese banded on the Ungava Peninsula during the 1960s (10,171) (Heyland and Gerrard 1974) and a smaller number marked in the mid-1980s (5,662) (Hughes 2002). However, less than 200 of those banded in the 1980s were banded in the Hudson Bay coastal zone where more than 80% of the entire AP breeding population on the Ungava Peninsula occurs (Harvey and Rodrigue 2007). Thus, there had not been large numbers of geese banded in the principal breeding area for more than 30 years.

Under the direction of the AP Action Plan, an annual banding program for AP Canada geese was initiated in 1997 in the same coastal lowlands of the Ungava Peninsula where the annual recruitment assessment is conducted. Since 1997, banding of AP geese has occurred on both the Hudson Bay and Ungava Bay portions of the breeding range. The objective of the pre-season banding program was to mark an annual sample of AP geese from representative portions of the breeding range. Since 1997, more than 65,000 geese have been banded with annual banding samples averaging about 6,500 birds (juveniles and adults combined) (Cotter 2007). Although target samples have not been achieved in every year due to varying reproductive success, recent analyses of band recovery data indicated that adequate samples of AP geese were banded to provide reliable measures of AP harvest rates (Sheaffer 2002) and survival (Reed and Hughes 2004). These data have also provided measures of productivity, the timing and distribution of harvest, and population delineation.

In 2003, a band reporting rate study was initiated for several North American goose populations including the AP and RP (Smith 2002). Reward banding of AP geese during preseason banding in northern Québec was done in 2003, 2004, and 2005. An estimate of band reporting rates has provided a means of obtaining

reliable estimates of harvest rates under differing harvest regulation packages. A reliable band-reporting rate is critically important to the development of an Adaptive Harvest Management (AHM) approach to making harvest management decisions in the future.

In 1998, a mathematical population model was developed for AP geese to aid managers in harvest management decision-making. The model initially incorporated population parameters from other *B .c. interior* populations (Johnson et al.1996). As AP vital parameters became available from breeding ground surveys, these data were incorporated into the model. The basis for the model was to use existing or prior information to predict a growth rate under varying levels of harvest rate (e.g., 10%, 15%, and 20%) from which regulatory decisions could be made (Harvey 2002). The model was adopted as an important tool to predict a safe level of harvest for an introductory sport harvest following the 1995 hunting season closure.

In 2004, a new population modeling effort was initiated that incorporated Adaptive Harvest Management (AHM) principles into future harvest management of the AP. If feasible, the use of an AHM approach for making harvest regulation decisions will enable managers to develop a long-term harvest strategy to sustain sport harvest opportunities throughout the flyway while maintaining the long-term viability of the AP.

The 1996 Action Plan interim population goal of 150,000 breeding pairs in the Ungava Region of northern Québec and 15,000 in the Boreal Forest Region was achieved in 2002. Since hunting season closure in 1995, the estimated number of breeding pairs on the Ungava Peninsula has increased from a low of 29,000 to 196,000 in 2007 (Fig. 1). The estimated number of breeding pairs in Quebec's boreal forest has increased from a low of 8,000 in 1995 to 22,600 in 2006 (Fig. 4). Full implementation of the 1996 Action Plan has been achieved and has led to the successful recovery of the AP. The purpose of this new (2008) plan is to guide management of the AP for the next 5 years (2008-2012).

Management Plan 2008 - 2012

AP Management Goal and Objectives:

The goal of the Atlantic Flyway Council (and its partners) is to maintain the Atlantic Population of Canada geese and their habitats at a level that provides optimum opportunities for people to use and enjoy geese on a sustainable basis. Specific objectives under this goal are as follows:

1. Achieve and maintain an index of 225,000 breeding pairs of AP Canada geese in the Ungava Region of northern Québec as measured by the annual spring breeding pair survey.
2. Maintain the current winter distribution of AP Canada geese in the Atlantic Flyway.
3. Provide sustainable and equitable sport harvest opportunities for AP geese while maximizing associated harvest of RP geese.
4. Ensure adequate food, water and protection on nesting, migration and wintering areas consistent with population objectives, habitat status and landowner tolerances.

Strategies and tasks for achieving each of these objectives are discussed below.

Objective 1. Population Size

Achieve and maintain an index of 225,000 breeding pairs of AP Canada geese in the Ungava Region of northern Québec as measured by the annual spring breeding pair survey.

Rationale: Growth of the AP has averaged 11.7% since sport harvest resumed throughout the flyway in 2000. However, growth of the AP has slowed since 2002 as sport harvest has increased. Nevertheless, population model simulations under modest harvest rates suggest that the 225,000 pair index objective is attainable. As we approach the population objective, experience gained from past hunting seasons should be used to reassess the population objective as well as the hunting regulations and their expected harvest rate.

Strategy I. A. Monitor annual spring breeding population size, productivity, and survival.

Task 1. A. 1. Conduct an annual spring breeding ground survey of breeding pairs and continue to explore means of improving accuracy and precision of population estimates.

Rationale: The spring survey provides a systematic estimate of the number of breeding Canada goose pairs on the Ungava Peninsula and is the primary means for monitoring the status of the AP. It provides critical information to support recommendations for suitable harvest objectives and to analyze harvest management strategies over time. The survey also provides the basis for allocating banding quotas by region as well as an additional measure of annual productivity (i.e., the % of indicated pairs observed as single birds).

Task I. A. 2. Measure annual productivity on AP breeding grounds.

Rationale: The annual collection of data on nesting biology, recruitment, and gosling survival on the Ungava Peninsula has helped to ensure proper management of AP Canada geese since 1996. Prior to this program, the only recruitment assessment made prior to setting fall hunting regulations was an estimation of the timing of nest initiation using the timing of snowmelt via satellite imagery (Sheaffer and Malecki 1996). Annual recruitment varies widely among years, and intensive field studies during 1997-2005 provided a better understanding of factors affecting productivity. Recent analyses by Reed (2004) suggest that environmental parameters from weather stations on the Ungava Peninsula provide a reliable tool for predicting annual productivity. Consequently, a scaled back effort should now be sufficient for long-term management needs. Thus, beginning in 2006, the monitoring program was designed to provide key information needed to ensure proper timing of the spring breeding pair survey, timing of pre-season banding, and to monitor changes in demographic parameters of the population over time, which can be used to model population dynamics of AP geese. Data collected during the nesting season (i.e., timing of nest initiation and nest density) and during preseason banding (age ratios) will provide valuable indices of annual productivity prior to setting fall hunting regulations. Future changes in climate and nest densities may result in a decrease of the models ability to adequately predict annual production. Thus, regular updates of the models with weather covariates and immature/adult age ratios during banding drives should be done to ensure the models are performing adequately for management.

Task I. A. 3. Monitor survival and harvest rates and distribution of harvest.

Rationale: Changes in the size of Canada goose populations are directly related to annual survival and reproductive rates. Because Canada geese are relatively long-lived with delayed maturity, population size is sensitive to small changes in annual survival of adult geese. Estimates of survival and harvest rates from band recoveries indicate that harvest is the primary source of adult mortality for most populations of Canada geese. Annual monitoring of survival and harvest rates is essential for evaluation of the impact of harvest management strategies on population status. Information from geese marked during late summer on the breeding grounds is a critical tool for monitoring annual changes in survival and harvest rates.

Annual banding programs currently provide information that can be used with harvest and spring population surveys to estimate the distribution of harvest and the size and composition of regional, state, and provincial harvests. Canada geese banded north of 57° latitude are used for harvest distribution and derivation analysis for AP Canada geese (Sheaffer 2005). Operational leg-banding of geese should continue for all Canada goose populations affiliated with the Atlantic Flyway for periodic assessment (e.g., every 3 years) of harvest distributions and derivations. Failure to continue this program will constrain effective harvest management efforts for Atlantic Flyway Canada goose populations.

Task I. A. 4. Monitor subsistence harvest, disease and non-hunting mortality.

Rationale: The importance of disease and other forms of non-hunting mortality in the population dynamics of AP Canada geese is not known. Subsistence harvest and forms of non-hunting mortality (e.g., predation, disease, lead poisoning, accidents, etc.) account for about 13% $\pm$ 1.3% mortality among adult AP geese in the absence of sport hunting, and it is much higher for juveniles (Sheaffer 2004). Although there is currently no indication of any unusual or extraordinary disease effects in the AP, monitoring should be conducted and appropriate action taken if the situation warrants. It is imperative to any AP population model or harvest strategy to identify and understand the dynamics of any source of significant non-hunting mortality.

Strategy I.B. Monitor harvest and develop an optimal harvest strategy to ensure sustained subsistence and recreational uses.

Task I. B. 1. Develop and implement hunting regulations consistent with the spring breeding population objective of 225,000 breeding pairs.

Rationale: Harvest management for AP Canada geese has become increasingly complex over the last decade due to increasing numbers of RP geese that inhabit the AP fall and winter range. Dramatic differences in the dynamics of RP and sub-arctic nesting populations of Canada geese often warrant very different management strategies for individual populations that inhabit the AP fall and winter range. Data from the USFWS Harvest Information Program and Waterfowl Parts Survey, which is used to estimate size and age composition of the harvest, cannot differentiate among populations that share wintering areas. To account for different proportions of AP geese in the harvest, we have used a regional approach since 1988, and we delineated special RP harvest areas in 5 states in 2002. Implementation of these harvest areas and special early and late seasons that target RP geese requires an assessment (every 3 years) of harvest distribution and composition to ensure that the harvest of AP geese does not exceed management objectives. Identification of regions where harvest is primarily derived from AP geese is also warranted for development of harvest strategies that achieve the population goal. Continued refinement of harvest regions and RP harvest areas will help increase effectiveness of our harvest strategies.

The spring breeding pair index will be the primary measure of population status and determinant for any regulation changes. Review of regulations will be done annually, but longer-term trends (e.g., 3-year running averages) should be considered when regulations are recommended. Managers should try to avoid changing regulations frequently in an attempt to influence or take advantage of short-term changes in population levels.

For 2008 and beyond, harvest regulations in all AP harvest areas should be commensurate with the current interim AP harvest strategy and plan objectives, including the maintenance of a segment of AP geese wintering in the southern AF. Season length, bag limits and delineation of harvest regions will be the primary tools used to manage harvest of AP geese.

In the development of future regulation packages for AP geese, analysis of harvest, harvest rate, and growth rate expectations must be incorporated. Liberalization of hunting regulations will permit increased hunting opportunity, increased harvest of RP Canada geese, valuable experience with the effects of regulations on harvest rate, and evaluation of whether the AP can sustain increased harvest while allowing for continued population growth.

Specific AP regulation packages and decision criteria will be developed in an interim harvest strategy that is revised and updated on a regular basis. The interim harvest strategy will apply to all AP harvest areas defined by the AF Canada Goose Committee, the USFWS, and CWS. These currently include portions of Connecticut, Delaware, Massachusetts, Maryland, New Jersey, New York, North Carolina, Ontario, Pennsylvania, Québec Vermont, and Virginia.

Task I B 2. Develop and implement hunting regulations to maintain the current winter distribution of AP Canada geese in the Atlantic Flyway.

Rationale: There is general consensus that numbers of geese wintering in the southern Atlantic Flyway cannot be increased substantially by enacting modest reductions of current harvests. Additional restrictions in season length, season timing, and bag limits throughout the flyway (including Canada) are not practical as AP regulations have been relaxed in AP harvest areas commensurate with improved overall AP population status. Season opening date frameworks, however, will continue to be used, where practical, to allow for passage of early migrating AP geese that have the fidelity to winter in the southern portion of the AP range. Opening framework dates are considered to be an important tool to help maintain the current wintering distribution of the AP, especially in the southern range.

Task I. B. 3. Delineate AP harvest areas for each state and province.

Rationale: Up-to-date delineation of AP harvest areas is important for harvest management. The interim harvest strategy will define regions or harvest management regions or areas based on the relative proportion of AP and geese harvested, or the overall magnitude of AP harvest. Season length, bag limits and framework dates all may vary among regions, but will be consistent within each region to the extent possible. Harvest areas for AP geese were modified in 2005 as a result of RP harvest areas being delineated in five states (NY, PA, MD, VA and NC). The current areas encompass >90% of all AP band recoveries in the flyway from 1950-2004. Harvest areas for AP Canada geese should be reviewed periodically (e.g., every 3-5 years if necessary) from updated band recovery data.

Task I. B. 4. Monitor harvest rates and distribution in relation to hunting regulations.

Rationale: In modern goose management strategies, population-specific estimates of harvest are needed to monitor the effectiveness of regulation changes, and how these changes affect goose populations. In recent years, managers have used analysis of weighted band recoveries to calculate the derivation of the Canada goose harvest in each AF state and province (Sheaffer 2004). The method requires that the size of each population be reasonably estimated, that a representative sample of the population is banded, and band recoveries are produced during the entire hunting season. The weight per band recovery (i.e., how many birds each recovered band represents) is a proportion of the number of bands available divided by the estimated number of birds in the population. The number of bands available is estimated from the number of bands recovered divided by the harvest rate. Harvest rate is the direct band recovery rate divided by the estimated band-reporting rate for AP geese. The band reporting rate is 0.59 (0.13 SE) (2003-2005 pooled) (M. Koneff, unpubl. report, February 2007).

To determine the impact of hunting regulations, hunter harvest of AP should be accurately estimated through existing harvest surveys and analysis of band recovery data. Annual harvest estimates need to be refined to allow apportionment of the harvest among the different Canada goose populations (using an estimate of harvest rate), and to accurately assess age ratios of harvested geese. An estimate of band reporting rates has been obtained for RP Canada geese from goose reporting rates studies done in 2003-2005. Harvest rate objectives have been identified in the interim AP harvest strategy but experience with regulations may result in refinement of these objectives. Harvest and harvest rates must be monitored carefully as hunting regulations for the AP are modified to ensure attainment of the population objective.

Task I. B. 5. Develop and regularly update interim harvest strategy.

Rationale: An interim harvest strategy was developed in 2004 to guide the management of AP geese. There is a critical need to regularly assess the interim harvest strategy to ensure (a) the conservation of the population, (b) the conservation of habitat, (c) optimal recreational opportunities throughout the flyway, (d) sustained harvest of geese by Aboriginal peoples, (e) relief from excessive crop depredation and nuisance problems and (f) the population does not become so large that it cannot be controlled via sport harvest. This interim harvest strategy may be modified as managers gain reliable measures of harvest rates with contemporary harvest regulation packages as well as the varying harvest potential among different regions of the flyway. Further, population targets may be revised after Adaptive Harvest Management is incorporated into the management of AP geese.

Task I. B. 6. Monitor RP Canada goose breeding population size, distribution, and harvest in the AP range.

Rationale: Effective management of AP geese requires basic information on status, distribution and harvest of RP geese because the two overlap extensively during fall and winter in many areas of the Atlantic Flyway. Increases in the RP Canada goose population have greatly confounded goose population management (Hindman et al. 2004). The AF Breeding Waterfowl Plot Survey provides an annual assessment of breeding population size and distribution for RP geese (e.g., Virginia north to New Hampshire). A similar, ground-based plot survey in Ontario provides an annual estimate of the size of the Ontario portion of the RP.

All AF states as well as the provinces of Ontario and Québec have either special early, late, or regular RP goose seasons aimed at reducing both state and flyway numbers of RP Canada geese. Guidelines established by the USFWS for special seasons in the U.S. restrict the harvest of interior Canada geese to

no more than 10% and 20% of the total harvest during these special early and late seasons, respectively. Additional, regular RP seasons exist in portions of several AF states where there are relatively small numbers of AP geese. The cumulative harvest of AP Canada geese during all special RP seasons should be closely monitored and the impact of these harvests on AP goose survival and harvest rates should be evaluated periodically. An analysis of direct and indirect band recoveries for AP geese during existing September seasons revealed minimal impact on AP Canada geese (Nichols and Zimpher 2006).

Techniques (i.e., stable isotope, morphometric measurements, and genetic markers) continue to be refined to determine the derivation of harvest. Research of methods to discriminate between AP and RP Canada geese in the flyway harvest should continue to be a high priority.

Task I. B. 7. Develop and refine a set of adaptive harvest management models to describe the system dynamics for AP geese and derive optimal policies for setting hunting regulations

Rationale: Effective harvest management requires the ability to address multiple management objectives and to cope with various sources and degrees of uncertainty. Adaptive Harvest Management has proven to be a useful approach to meet these needs, but the application of the approach to geese presents challenges not present with ducks. In particular, a characteristic of age-structured goose populations is 'momentum', i.e., the tendency of a population to continue along a certain trajectory even after a change in management action. Other difficulties concern the inability to observe the population's age structure or to harvest selectively among age classes. This task thus involves the development of population models describing the dynamics of AP Canada geese as a function of harvest age structure and other uncontrolled environmental factors. These models will be parameterized using published information specific to AP Canada geese or to other Canada goose populations comprised principally of *B. c. interior*. Using stochastic dynamic programming, these models will be combined with appropriate management objectives and a range of applicable harvest rates to determine optimal state-specific harvest decisions. Sources of uncertainty to which optimal harvest strategies are sensitive will be identified. Model inputs and simulations will be used to develop, select and evaluate harvest strategies. Procedures will be developed for updating population models based upon a comparison of model predictions with the observed response(s) by the population (Runge et al. 2005).

Strategy I. C. Work cooperatively with the Cree and Inuit to ensure their participation in AP management and in monitoring Aboriginal harvests.

Task 1. C. 1. Coordinate the management of AP geese with Aboriginal Peoples.

Rationale: Coordination of AP management and sharing information with Aboriginal People on AP status, current research, management efforts, harvest levels, and reporting are very important to achieving the plan objectives. A strong commitment to cooperation among all users of the AP is necessary to ensure the successful implementation of this plan.

Task I. C. 1. Estimate the magnitude and spatial/temporal distribution of Aboriginal harvests of AP Canada geese.

Rationale: All Cree First Nations people in the Hudson and James Bay regions and all Inuit people in Nunavik in northern Québec live within the nesting and migration areas of the AP. Consequently, AP Canada geese have historically been taken for subsistence. Total Aboriginal harvest has been estimated only one time, at the end of 1970s (Boyd 1977). In Québec, that study was used to established a "guaranteed annual harvest level" of 83 000 Canada geese (including eggs), as part of the James Bay and

Northern Québec Agreement. The recent increase in temperate-nesting RP Canada geese undergoing a molt migration to the Hudson Bay coastal region and to the large hydroelectrical reservoirs of James Bay has attracted Aboriginal hunters. However, the number of RP Canada geese harvested is unknown. Small studies suggest that around 30% to 40% of the Aboriginal harvest may be composed of RP geese during the spring (Jean Rodrigue, Canadian Wildlife Service, pers. comm.). Subsistence harvest used in the AP model is judged to be about 7% of the total AP mortality, but probably varies based upon spring phenology. Subsistence harvest must be considered with changes to any AP harvest strategy to ensure the appropriate harvest levels for all users throughout the AP range. No comprehensive surveys of subsistence harvest in the James Bay region or Nunavik have been undertaken since the end of 1970s despite significant changes in the size of Aboriginal populations and the AP. Thus, a current estimate of the Aboriginal harvest by goose population is a high priority. In 2005, a survey of subsistence harvest by the Quebec Cree was initiated and was expanded to all Cree communities in 2006.

OBJECTIVE II. Winter Distribution.

Maintain the current winter distribution of AP Canada geese in the Atlantic Flyway.

Rationale: Historically, migrant Canada geese wintered in all southern Atlantic Flyway states. In Georgia and Florida, major declines occurred between 1953 and 1960. Today, no AP Canada geese are known to exist in these states. Midwinter survey estimates of Canada geese in South Carolina declined from 44,000 to 1,500 between 1964 and 2002. Today only a few remnant flocks winter in the state. Large numbers of Canada geese wintered in eastern North Carolina (Fig. 12) and Back Bay, Virginia. Migrant Canada geese wintering in these areas have declined greatly since the early 1960's. Hunting seasons for migrant Canada geese were closed in the area in 1989 (Back Bay, VA) and 1992 (eastern NC). Previous Atlantic Flyway goose management recognized this decline and plan objectives and strategies sought to increase numbers of Canada geese wintering in this area. However, numbers continued to decline and presently remain low. Approximately 5,000 migrant Canada geese currently winter in eastern North Carolina. Several factors are thought to influence the migration timing and wintering distribution/destination including differential survival of southern cohort geese, climate change (e.g., global warning), and long-term changes in farming practices throughout the flyway. Modifications in framework opening dates will be the primary means used to promote the long-term viability of this southern migrating group of geese.

Strategy II. A. Monitor AP population trend, distribution, and harvest in the southern AF.

Task I. A. I. Conduct aerial surveys of Canada geese in September, October, December, and early January in northeastern North Carolina.

Rationale: Monitoring changes in distribution and relative numbers of AP geese can only be accomplished through a combination of late summer, fall and winter aerial surveys. Increasing numbers of RP geese in the last 2 decades have made interpretation of fall and winter surveys difficult. The MWS provides the only long-term consistent dataset from which to make comparisons and should be continued. In addition, a September survey should be conducted in coastal North Carolina to account for the proportion of RP geese that winter in the same areas as AP geese. Further, surveys should be conducted during several time periods in the fall (late October - December) at key areas in coastal North Carolina to document gross long-term changes in migration timing and relative numbers of Canada geese throughout the fall/winter period.

Task I. A. 2. Monitor harvest of AP geese in the southern AF.

Rationale: In 2005, limited, experimental Canada goose hunting seasons were authorized in Back Bay, Virginia and northeast North Carolina. It is important that the proportions of harvested AP and RP geese be monitored from these seasons. Results of harvest monitoring would be one component necessary for season evaluation and to determine whether adjustments to harvest regulations are warranted. Because of the relatively small geographic hunt area and conservative season structure, review of leg band recovery data alone is not likely to provide a meaningful data set for evaluation. Additional methods such as genetic markers from harvested geese and morphometric measurements should be considered.

Strategy II. B. Consider research that will address reasons for the decline of AP geese in the southern AF.

Task II. B. 1. Monitor current temporal and spatial patterns of southern migrating AP geese.

Rationale: Factors contributing to the decline of AP geese in the southern AF can be attributed to lower survival from increased exposure to harvest in more northern states and provinces, and to distributional shifts caused by changes in agriculture, climate, and other factors often collectively referred to as "short-stopping." Although goose managers have no ability to affect climate change or landscape level agricultural practices, these possible reasons for distribution changes warrant additional investigation. Satellite telemetry should be used to determine the breeding origin of the southern AF cohort of the AP as well as their spatial and temporal migration patterns. Depending upon results, adjustment of season timing, season length, and bag limits maybe the only ways to affect AP goose distribution in the southern AF.

OBJECTIVE III: HABITAT MANAGEMENT.

Ensure adequate food, water and protection on nesting, migration and wintering areas consistent with population objectives, habitat status, and landowner tolerances.

Rationale: Habitat conditions throughout the nesting, migration, and wintering areas vary from year to year and can have a great influence on AP status. The quality and quantity of habitat on migration staging and wintering areas is changing for AP geese due to development and increased use of agricultural food resources by large populations of greater snow geese and RP Canada geese. Further, the availability of waste grain, important to winter survival, has been reduced from the increased efficiency of harvest machinery. Therefore, it is necessary to monitor and periodically evaluate the status and condition of nesting, migration, and wintering areas important to the AP.

Strategy III. A. Monitor habitat conditions, potential development projects, and other threats to ensure protection of critical nesting and brood-rearing habitats.

Task III. A. 1. Conduct habitat inventory to classify important nesting areas and identify areas of concern.

Rationale: The nesting area for the AP occurs in an approximately 730,800-km² area in northern Québec, including the Ungava Peninsula and the Boreal Forest. The northeastern coast of Hudson Bay hosts some of the highest nesting densities of subarctic Canada geese (Malecki and Trost 1990). Tidal flats and freshwater estuaries are the key brood rearing areas. Once thought to be relatively safe from development and major human impact, the breeding range of the AP is now facing

major changes. Managers should determine a baseline index of habitat quality and quantity for AP nesting and brood rearing habitats. Classification and inventory of habitats on the Ungava Peninsula by remote sensing techniques should be done to gain a better understanding of the preferred habitats of nesting AP geese. Potential hydroelectric development, mining, and mining exploration could all have an impact on the nesting and brood rearing grounds of the AP in the future. Potential impacts of climate change need to be considered as arctic ecosystem are likely to be impacted first and the habitat inventory would provide important baseline information to evaluate future changes. Proposed development and exploration projects within the AP nesting range should be monitored and potential impacts identified and evaluated at the planning and review stage. Collaboration with all interested parties, especially the Nunavik Hunting, Fishing, and Trapping Association and Makivik, Inc., should be sought through the Arctic Goose Joint Venture.

Task III. A. 2. Determine the abundance and impacts of molt migrant Canada geese and migrating greater snow geese on AP breeding ground habitats.

Rationale: Effective management of AP geese requires basic information on the distribution and abundance of migrating greater snow geese and other Canada goose populations that utilize the Hudson Bay coast as a molting area. Substantial numbers of greater snow geese utilize portions of the AP breeding range in the spring and fall during migration. Large numbers of molt migrant geese are known to enter the AP breeding range, particularly the Hudson Bay coastal region, at about the same time the spring breeding pair survey is conducted. The abundance of molt migrants can introduce substantial variability and bias in the total population estimates. Therefore, managers should determine the number of molt migrants in this area and assess any ecological impacts of these birds on AP brood-rearing habitats.

Strategy III. B. Monitor habitats at all significant AP migration and wintering areas and examine the efficacy of managing components to aid in achieving the population objective.

Rationale: Migration and wintering areas provide essential food, water, and sanctuary for Canada geese. The quantity and quality of wintering areas is important to AP survival and population growth. Accumulated and stored reserves obtained on fall migration areas enable continued migration and survival through inclement weather. Reserves accumulated during spring migration enable breeding geese to meet energy requirements associated with nesting and affect annual productivity. Important AP migration and wintering areas and migration chronology through these areas have been identified from band recovery data, mark-resight data, and satellite telemetry (Hestbeck et al. 1991, Malecki et al. 2001).

Task III. B. 1. Investigate ways to estimate the carrying capacity of breeding and wintering habitats for AP geese, and apply that information to a review of the 225,000 breeding pair objective.

Rationale: The winter distribution of geese during the hunting season is closely related to availability of food and sanctuary. An assessment of habitat quality and abundance should be conducted periodically for key staging, migration and wintering areas. This information should be evaluated to determine if these areas are adequate to sustain the AP or if, in northern areas they are contributing to geese wintering north of their historic winter range. This information should also be evaluated to determine if these resources could support the size of the population as expressed in the population objective. The relationship between population size and agricultural damage at staging and wintering areas should be closely monitored to ensure that the population is not increased above what can be tolerated by agricultural interests.

Even though AP geese wintering in the southern AF have been decreasing, it is important that state, provincial, and federal management areas maintain or increase habitat and food resources to ensure that adequate resources are available in those years when large numbers are found to migrate to and winter on southern management areas in response to severe winter weather in northern areas.

Task III. B. 2. Identify important wintering and staging areas of AP geese and provide this information to management agencies in U.S. and Canada that are responsible for permitting development projects.

Rationale: Migration and wintering areas provide food, water, and sanctuary necessary to sustain the AP from fall (September) until spring (early March). Most resource management agencies in the AF responsible for reviewing proposed development projects have not been provided information on key staging and wintering areas. Providing this information to these agencies will ensure that AP habitat needs are considered in the planning stages and may aid in directing development away from critically important habitats.

RESPONSIBILITIES FOR AND FUNDING OF RESEARCH, SURVEY, AND BANDING PROJECTS DEVELOPED AS A RESULT OF THIS PLAN SHOULD BE SHARED AMONG STATES AND PROVINCES BENEFITTING FROM THE AP, AND FROM THE CANADIAN WILDLIFE SERVICE AND U.S. FISH AND WIDLIFE SERVICE IN ACCORDANCE WITH THEIR RESPONSIBILITIES UNDER THE MIGRATORY BIRD TREATY.

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Appendix A: Tables

Table 1. Number of Canada goose breeding pairs estimated for the Ungava Region (regions 1, 2 and 3, Trost and Malecki 1990) of Québec, Canada, 1988-2007.

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Year	Total Area (km^2)	Surveyed Area (km^2)	N Transects	Pairs /km^2 (SE)	Total Pairs (SE)
1988	222700	575	16	0.53 (0.068)	118031 (15144)
1993	222700	838	35	0.41 (0.056)	91307 (12471)
1994	222700	1214	36	0.18 (0.020)	40086 (4454)
1995	222700	1211	36	0.13 (0.013)	29302 (2967)
1996	222700	1211	36	0.21 (0.023)	46058 (5052)
1997	222700	1239	36	0.28 (0.028)	63216 (6201)
1998	222700	1214	36	0.19 (0.023)	42166 (5009)
1999	222700	1208	35	0.35 (0.040)	77451 (8792)
2000	222700	1107	34	0.42 (0.044)	93230 (9850)
2001	222700	1029	31	0.66 (0.073)	146662 (16185)
2002	222700	1214	36	0.74 (0.068)	164840 (15169)
2003	222700	1208	36	0.71 (0.055)	156937 (12273)
2004	222700	1181	35	0.79 (0.068)	174793 (15049)
2005	222700	1214	36	0.73 (0.057)	162395 (12622)
2006	222700	838	28	0.72 (0.074)	160020 (16419)
2007	222700	1162	34	0.89 (0.075)	195709 (16621)

Table 2. Number of Canada goose breeding pairs and total breeding population estimated for the Boreal Forest Region of Québec Canada, 1990-2007.

Year	Estimated pairs per 100 km²	Standard Error of Pair Density	n	Area Sampled (km²)	Estimated Number of Pairs	Standard Error of Pair Estimate	CV%
1990	4.1702	0.9805	47	1,175	14,794	3,478	23.5%
1991	3.6596	1.2337	47	1,175	12,982	4,376	33.7%
1992	5.3617	1.7001	47	1,175	19,020	6,031	31.7%
1993	3.5000	1.2811	24	600	12,416	4,545	36.6%
1994	2.8333	1.4935	24	600	10,051	5,298	52.7%
1995	2.8571	1.0741	21	525	10,136	3,810	37.6%
1996	4.4615	1.0911	52	1,300	15,827	3,870	24.5%
1997	3.3846	0.9017	52	1,300	12,007	3,199	26.6%
1998	3.7692	0.7238	52	1,300	13,371	2,568	19.2%
1999	6.7692	1.3478	52	1,300	24,013	4,781	19.9%
2000	7.3846	1.7312	52	1,300	26,196	6,141	23.4%
2001	6.3846	1.4951	52	1,300	22,649	5,304	23.4%
2002	5.0769	0.9520	52	1,300	17,794	3,337	18.8%
2003	7.3077	1.3530	52	1,300	24,384	4,742	19.5%
2004	7.2308	1.4861	52	1,300	25,341	5,208	20.6%
2005	6.6154	1.3890	52	1,300	23,168	4,868	21.0%
2006	6.3846	1.0999	52	1,300	22,649	3,902	17.2%
2007	6.6154	1.3448	52	1,300	23,468	4,771	20.3%

Table 3. Canada goose hunting frameworks in the U.S. portion of the Atlantic Flyway occurring after September 30, 1945-2006.

Year(s)	Season Length	Bag Limit	Harvest Areas and notes
1945	60	2	all
1946	40	2	all
1947-48	30	1	all
1949-51	40	2	all
1952	55	3	all
1953-54	60	2	all
1955-60	70	2	all
1961-62	60	2	all
1963	70	2	all
1964	70	3	all
1965-67	70	2	all
1968	50	1	Back Bay VA, NC, SC, GA, FL
	70	2	all other areas
1969-73	50	1	Back Bay VA, NC, SC, GA, FL
	70	3	all other areas
1974-76	Closed	0	GA, FL
	50	1	NC, SC
	50	3	Back Bay VA
	70	3	all other areas
1977	same as 1976 except		
	90	3	east shore MD
	90	4	DE, southeast PA, east shore VA
	70	3	all other areas
1978	same as 1977 except		
	50	2	NC
	90	4	DE, southeast PA, east shore VA, south NJ
	70	3	all other areas
1979	same as 1978 except		
	50	1	west PA
1980	same as 1979 except		part of SC closed
1981-82	same as 1980 except		
	43	1	NC
	50	1	West PA, part of SC
	90	3	East shore MD, RI, CT, NY zones N, S, W
	90	4	DE, southeast PA, east shore VA, NJ
	70	3	all other areas
1983-84	same as 1981-82 except		
	50	2	West PA; Back Bay, VA
1985	same as 1983-84 except		
	Closed	0	SC
1986	same as 1985 except		
	70	3	East shore MD
	78	2-3	DE bag limit 2 birds in first split and 3 in second split
	50	3	West PA

	Winter Season*		Parts of CT
1987	same as 1986 except		
	Closed	0	NC west of Interstate 95
	17	1	NC east of Interstate 95
	50	1	West PA
	Winter Season		Parts of CT, MA
1988	same as 1987 except		
	11	1	NC east of Interstate 95
	50	2	West PA
	60	2	DE
	60	1-2	MD bag limit 1 bird during first split; 2 birds during second split
1989	Closed	0	FL, NC west of I-95
	8	1	GA (certain areas)
	11	1	NC (east of I-95), SC, Back Bay VA
	70	2	Northwest PA
	60	2	DE, MD, VA (except Back Bay)
	70	3	all other areas (including most of PA)
	90	1-3	NJ, NY, Southeast PA, RI, CT; Bag limit 1 <Oct 15; Bag limit 3 >Oct 15
	Winter Seasons		parts of: MA, CT
1990	same as 1989 except		
	50	2	Northwest PA (except Pymatuning)
	70	1	Pymatuning, PA
1991	same as 1990 except		
	70	2	Crawford Co, PA
	4	1	Parts of SC piedmont and mountains; season limit bag of 1 bird
1992	Closed	0	FL, NC, SC, Back Bay VA
	4	1	Parts of SC piedmont and mountains
	8	5	GA (certain areas)
	60	1-2	DE, MD, VA (except Back Bay): bag limit 1 for first 20 days; bag limit 2 thereafter
	70	1	Crawford Co, PA
	70	1-2	Northwest PA: Bag limit 1 during first 8 days; 2 birds >Oct 15
	70	1-3	All other areas: Bag limit 1 for first 8 days; 2 >Oct 15; 3 >Dec 31
	70	3	WV
	Winter Seasons		parts of: MA, CT, PA
1993	same as 1992 except		
	4	5	Parts of SC piedmont and mountains
	Winter Seasons		parts of: MA, CT, PA, NY
1994	same as 1993 except		
	35	1	Crawford Co, PA
	Winter Seasons		parts of: MA, CT, PA, NY, NJ
1995	12	5	Parts of SC piedmont and mountains
	15	5	GA (certain areas)
	35	1	Crawford Co, PA
	70	5	GA (certain areas)
	70	1-2	Northwest PA: Bag limit 1 during first 8 days after opening; bag limit 2 >Oct 15
	70	3	WV
	Closed	0	ME, NH, VT, MA, CT, RI, NY, NJ, PA, DE, MD, VA, NC
	Winter Seasons		parts of: MA, CT, PA, NY, NJ, MD
1996	same as 1995 except		

	70	5	SC (certain areas)
	Winter Seasons		parts of: MA, CT, PA, NY, NJ, MD, RI, VA
1997	same as 1996 except		
	35	1	Crawford County, PA
	40	2	SJBP areas of: MD, VA, PA
	46	2	NC (certain areas)
	70	2	SJBP areas: NY, PA
	70	5	FL, GA (certain areas), SC (certain areas)
1998	same as 1997 except		
	40	2	ME, NH, RI; NAP areas of: CT, NY, MA
1999	same as 1998 except		
	Closed	0	Back Bay, VA; Northeast NC
	6	1	DE; AP areas of MD, VA
	15	1	NJ, VT; AP areas of: CT, MA, NY, PA
2000	same as 1999		
2001	same as 2000 except		
	30	1	DE; AP areas of MD, VA
	30	2	NJ, VT; AP areas of: CT, MA, NY, PA
	35	1	Pymatuning
	45	2	ME, NH, RI; NAP areas of: CT, MA, NY
	50	2	NC (Certain areas)
2002	same as 2001 except		
	40	2	SJBP areas of: PA, VA
	45	1	DE; AP areas of MD, VA
	45	2	NJ, VT; AP areas of: CT, MA, NY, PA
	60	2	ME, NH, RI; NAP area MA; High NAP harvest areas of CT, NY
	70	2	SJBP areas of: NY, NC
	70	3	Low NAP harvest areas of CT, NY
	70	5	RP areas in parts of: NY, PA, MD, VA, NC
	Winter Seasons		parts of: MA, CT, PA, NY, NJ, RI, VA
2003	same as 2002		
2004	same as 2003 except		
	45	1-2	DE; AP areas of MD, VA; bag limit 1 for first 25 days, bag limit 2 for last 20 days
	45	3	NJ, VT; AP areas of: CT, MA, NY, PA
2005	same as 2004 except		
	45	2	DE; AP areas of MD, VA except for Back Bay
	15	1	Experimental season in Back Bay, VA and Northeast Hunt Unit, NC
2006	Same as 2005 except		
	30	1	Experimental season in Back Bay, VA and Northeast Hunt Unit, NC
2007	Same as 2006		

*Winter Season bag limit = 5

Table 4. Regular-season harvest of Canada geese in Atlantic Flyway states, 1990-2006.

Year	ME	VT	NH	MA	CT	RI	NY	PA	WV	NJ	DE	MD	VA	NC	SC	GA	FL	Flyway total
1990	2,800	8,800	1,200	24,200	16,300	3,100	68,400	47,400	900	22,400	8,100	78,800	8,600	1,900	1,000	1,500	0	295,400
1991	2,200	4,200	1,900	19,300	13,500	3,000	68,800	50,800	900	22,700	6,400	92,200	12,700	600	500	500	0	300,200
1992	2,800	2,600	2,500	8,900	11,100	500	51,700	39,000	2,200	14,400	5,900	71,900	10,400	0	0	1,400	0	225,300
1993	2,300	1,800	1,500	11,500	14,000	2,200	56,700	38,800	3,600	31,500	3,100	61,100	14,000	0	0	3,400	0	245,500
1994	2,400	1,900	1,800	14,500	12,900	4,500	45,200	43,300	4,700	20,700	3,600	66,200	11,700	0	0	4,500	0	237,900
1995	0	0	0	0	0	0	0	13,500	1,600	0	0	0	0	0	0	6,500	0	21,600
1996	0	0	0	0	0	0	0	19,500	2,600	0	0	0	0	0	0	8,700	0	30,800
1997	0	0	0	4,500	0	0	4,600	27,700	4,400	0	0	2,800	6,500	3,200	0	10,800	200	64,700
1998	3,700	0	3,000	6,800	3,200	1,500	6,300	16,400	3,400	0	0	4,400	4,700	8,500	6,300	9,000	0	77,200
1999	7,800	800	4,200	7,600	7,600	1,900	14,100	26,400	1,400	5,300	100	4,600	10,900	6,200	3,400	10,500	500	113,300
2000	4,800	300	4,500	7,700	7,100	1,100	19,000	21,200	1,700	4,000	0	7,700	16,800	9,000	72,000	6,400	0	183,300
2001	5,500	1,000	3,100	6,200	11,400	1,700	42,200	43,100	4,500	19,200	8,900	45,200	12,100	10,500	9,300	11,100	600	235,600
2002	9,100	3,100	4,800	8,300	14,800	2,300	58,100	92,800	3,200	15,000	15,200	98,600	30,100	20,500	25,900	26,300	3,700	431,800
2003	6,300	2,200	3,800	5,200	14,000	3,400	64,700	93,700	3,100	16,300	8,800	119,800	30,800	22,600	13,800	18,900	3,800	431,200
2004	4,500	3,200	2,700	7,100	14,300	3,500	73,500	80,300	5,100	12,800	10,700	123,400	23,900	17,000	13,900	14,600	300	410,700
2005	5,400	4,600	3,600	4,400	13,700	2,800	77,500	78,400	1,900	19,200	17,000	159,600	42,100	46,800	20,700	22,900	0	520,600
2006	7,700	4,400	4,300	6,200	7,400	4,500	61,500	76,200	1,400	19,400	11,700	140,000	21,000	19,700	20,300	12,200	2,800	420,700

Note: Estimates for 1990 to 2001 were derived from the U.S Fish and Wildlife Service Mail Questionnaire Survey. Estimates for 2002 to 2006 were derived from the Harvest Information Program.

Table 5. Regular-season harvest (includes some Resident Canada geese) of Canada geese in Atlantic Population harvest areas in Ontario and Québec, Canada, 1975-2006.

Year	ONT	PQ
1975	10200	10200
1976	14000	18800
1977	25400	45400
1978	28000	55600
1979	20100	48600
1980	36900	46300
1981	16200	15200
1982	22400	22400
1983	27000	32500
1984	1500	2400
1985	23500	26100
1986	29700	35100
1987	27200	50600
1988	14400	15000
1989	27100	45900
1990	36500	44200
1991	27100	44500
1992	29800	24000
1993	35400	38100
1994	35000	12100
1995	34500	1900
1996	38100	4800
1997	40700	7200
1998	45200	10500
1999	45200	31800
2000	53100	33000
2001	79400	61000
2002	74700	82400
2003	84600	104700
2004	83100	67700
2005	87400	97700
2006	89700	75100

Note: Harvest estimates were derived from the Canadian Hunter Mail Questionnaire Survey.

Table 6. Numbers of birds banded (*n*), the number of banded birds recovered (*x*), and the direct recovery rates (*f*) in the 2000-2004 harvest seasons, for Atlantic Population Canada geese.

	Atlantic Population Canada Geese							
	Young				Adult			
Year	*n*	*x*'	*f*'	SE(*f*')	*n*	*x*	*f*	SE(*f*)
2000	2,219	27	0.0122	0.0023	2,160	29	0.0134	0.0025
2001	5,650	244	0.0432	0.0027	2,705	76	0.0281	0.0032
2002	4,088	174	0.0426	0.0032	3,101	134	0.0432	0.0037
2003	6,420	190	0.0296	0.0021	2,044	63	0.0308	0.0038
2004	2,407	168	0.0698	0.0052	1,104	52	0.0471	0.0064

Table 7. Numbers of birds banded (*n*), the estimated number of banded birds harvested (H^b), and the estimated harvest rates (*h*) in the 2000-2004 harvest seasons, for Atlantic Population Canada geese.

	Atlantic Population Canada Geese							
	Young				Adult			
Year	*n*	H^b!	*h*'	SE(*h*')	*n*	H^b	*h*	SE(*h*)
2000	2,219	53	0.0239	0.0032	2,160	52	0.0241	0.0033
2001	5,650	482	0.0853	0.0037	2,705	151	0.0558	0.0044
2002	4,088	345	0.0844	0.0043	3,101	262	0.0845	0.0050
2003	6,420	378	0.0589	0.0029	3,542	222	0.0627	0.0041
2004	2,407	331	0.1375	0.0070	2,129	182	0.0855	0.0061

Table 8. Number of Canada geese banded on the Ungava Peninsula, Québec, Canada, 1997-2007, Cotter 2007.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Hudson Bay												
Young banded	793	2461	3314	1334	4103	2547	3736	1662	2022	3296	1216	26,484
Adults banded	355	1360	2018	1285	1845	2011	2092	1226	1209	1675	1043	16,119
Subtotal	1148	3821	5332	2619	5948	4560	5828	2888	3231	4971	2259	42,605
% young	69	64	62	51	69	56	64	58	63	66	54	62
Ungava Bay												
Young banded	1081	1332	1200	896	1568	1541	2713	766	1888	1377	928	15,290
Adults banded	917	675	1039	1032	943	1103	1451	928	1006	1234	1055	11,383
Subtotal	1998	2007	2239	1928	2511	2644	4164	1694	2894	2611	1983	26,673
% young	54	66	54	46	62	58	65	45	65	53	47	57
TOTAL Young	1874	3793	4514	2230	5671	4088	6449	2428	3910	4673	2144	41,774
TOTAL Adults	1272	2035	3057	2317	2788	3114	3543	2154	2215	2909	2098	27,502
Total banded	3146	5828	7571	4547	8459	7204	9992	4582	6125	7582	4242	69,278

Appendix B: Figures

Fig.1. Study area and location of transects for the Atlantic Population Canada goose breeding pair survey in northern Québec, Canada, 1993-2007.

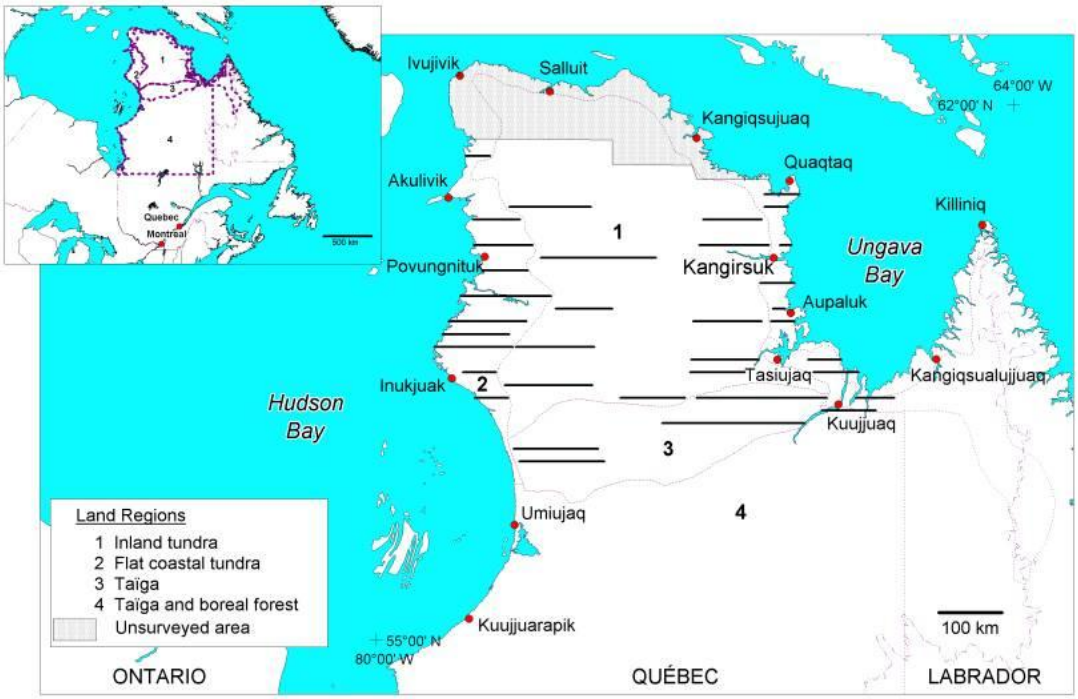


Fig. 2. Estimated number (± 1 SE) of Atlantic Population Canada goose breeding pairs on the Ungava Peninsula, Québec, Canada, 1988 and 1993-2007.

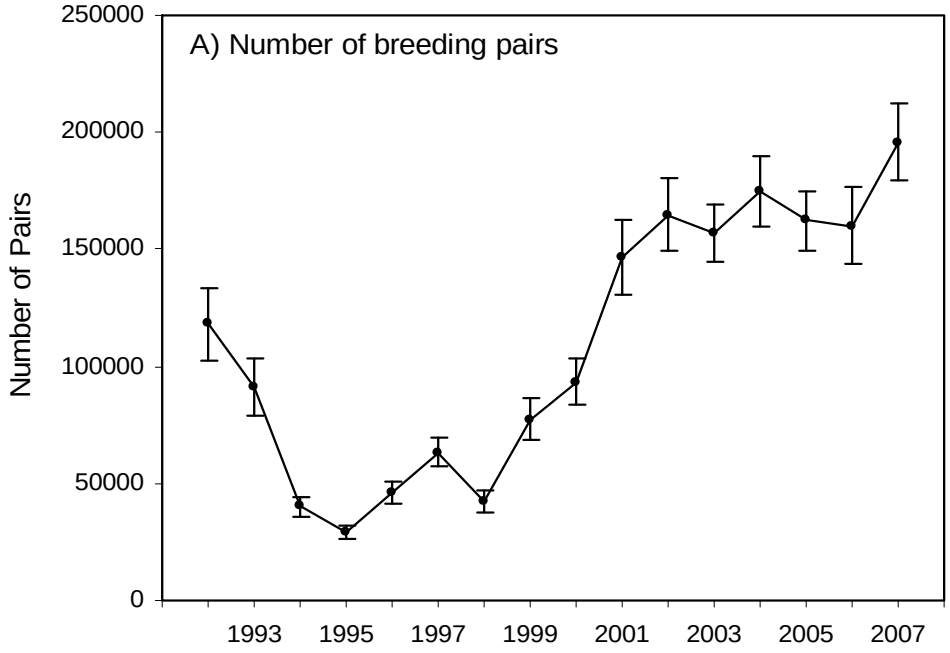


Fig 3. Estimated number (± 1 SE) of total Canada geese on the Ungava Peninsula, Québec, Canada, 1988 and 1993-2007.

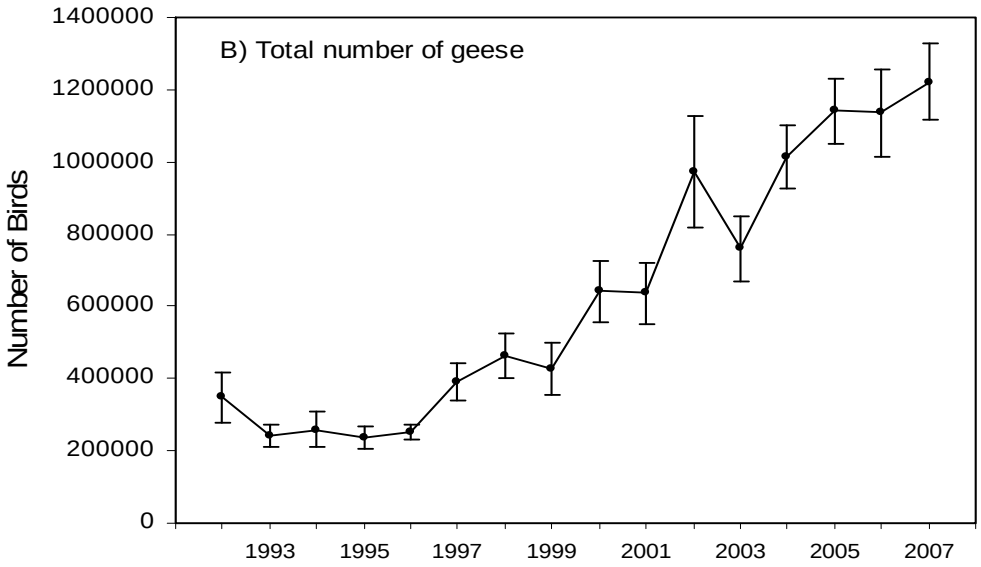


Fig. 4. Estimated number of breeding pairs of Atlantic Population Canada geese from the Boreal Forest Region of Québec, Canada, 1990-2007.

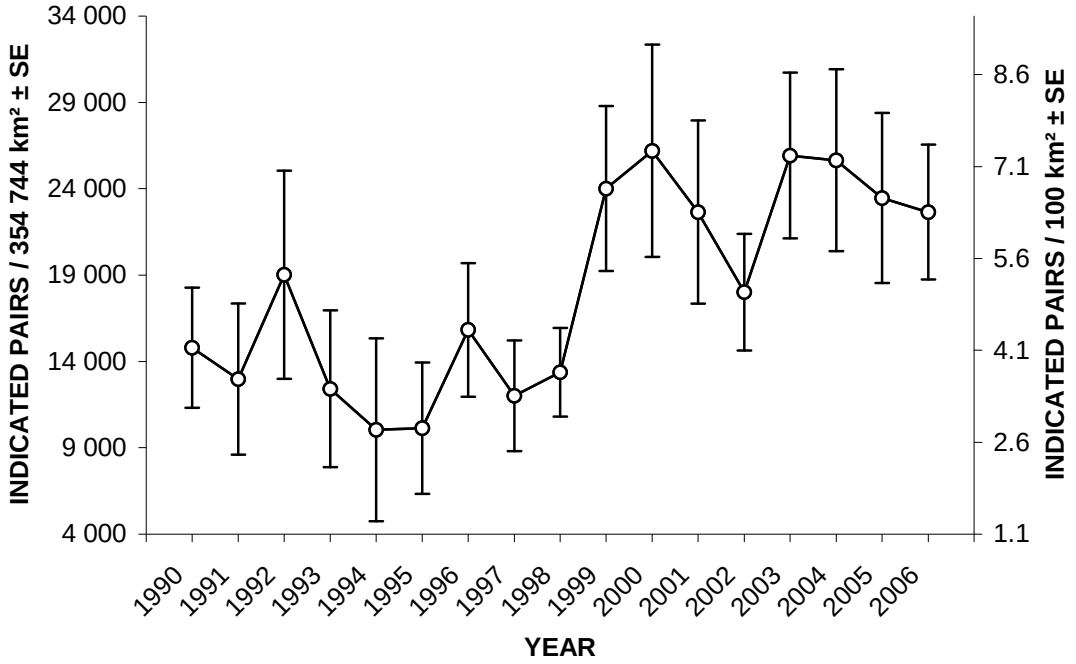


Fig. 5. Mean clutch size of Atlantic Population Canada geese at satellite study areas along the coast of Hudson Bay (n = 7 sites) and Ungava Bay (n = 2-6 sites), Québec, Canada, 1997-2005.

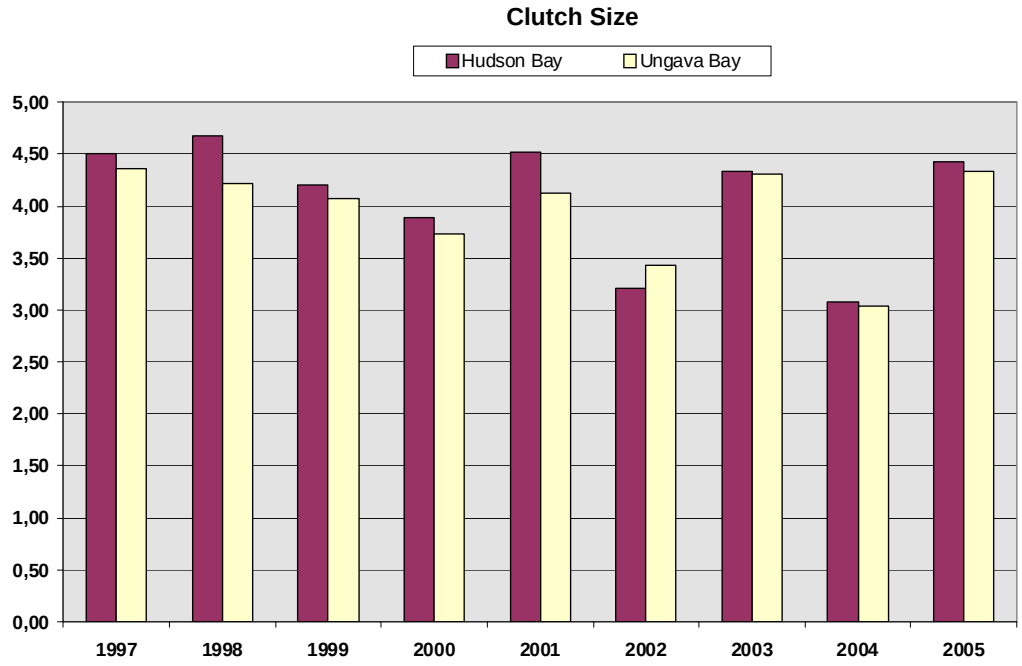


Fig 6. Number of nests for Atlantic Population Canada geese at seven satellite study areas along the northeastern coast of Hudson Bay, Québec, Canada, 1997-2005.

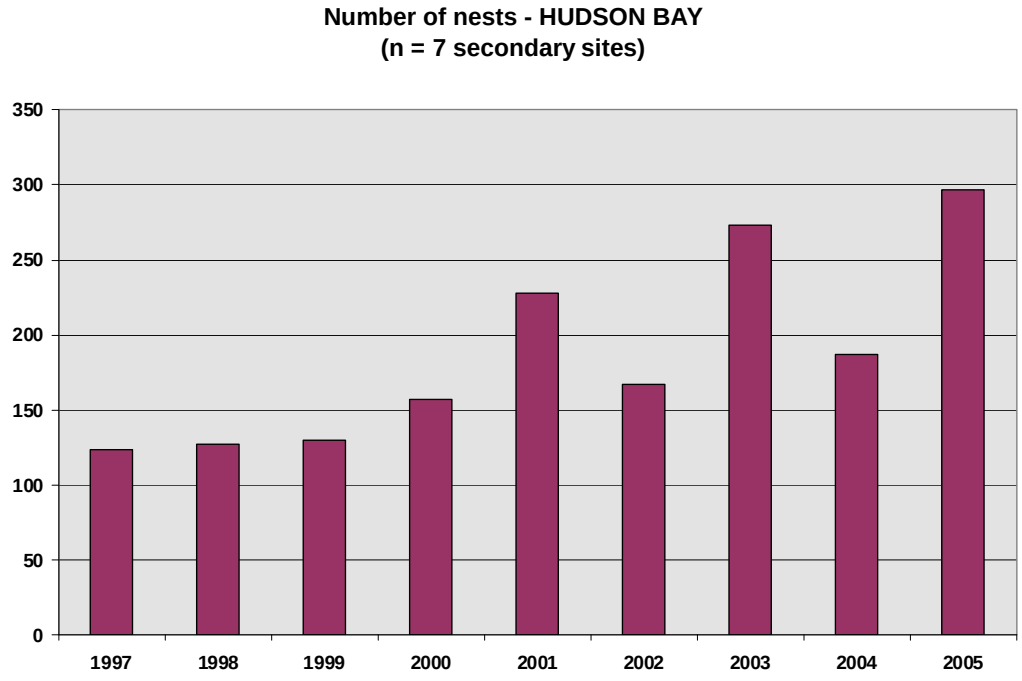


Fig. 7. Canada goose harvest zones in the Atlantic Flyway, 2007.

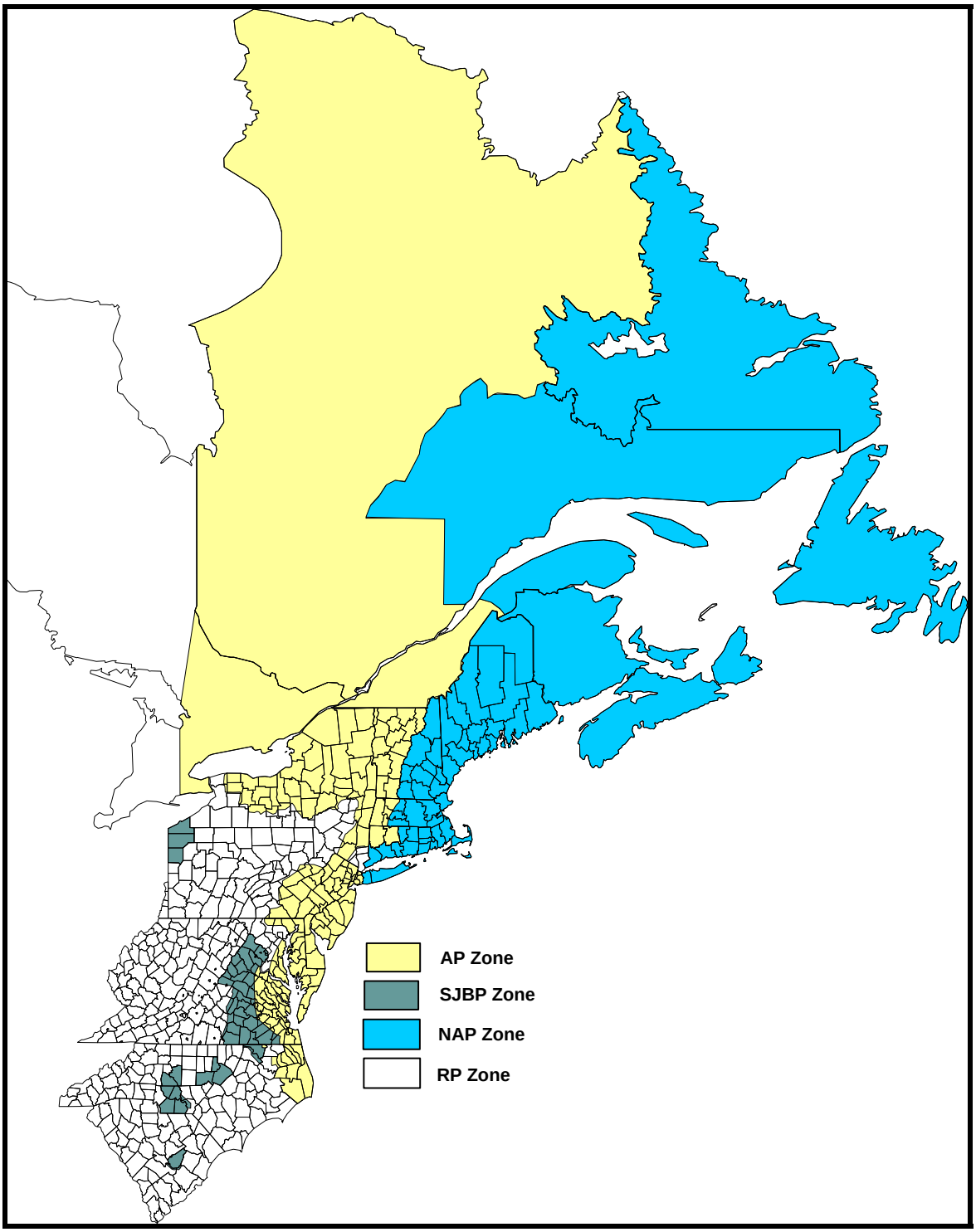


Fig. 8. Recoveries of Atlantic Population Canada geese banded in northern Québec and shot or found dead during 1950-2001 in the eastern United States.

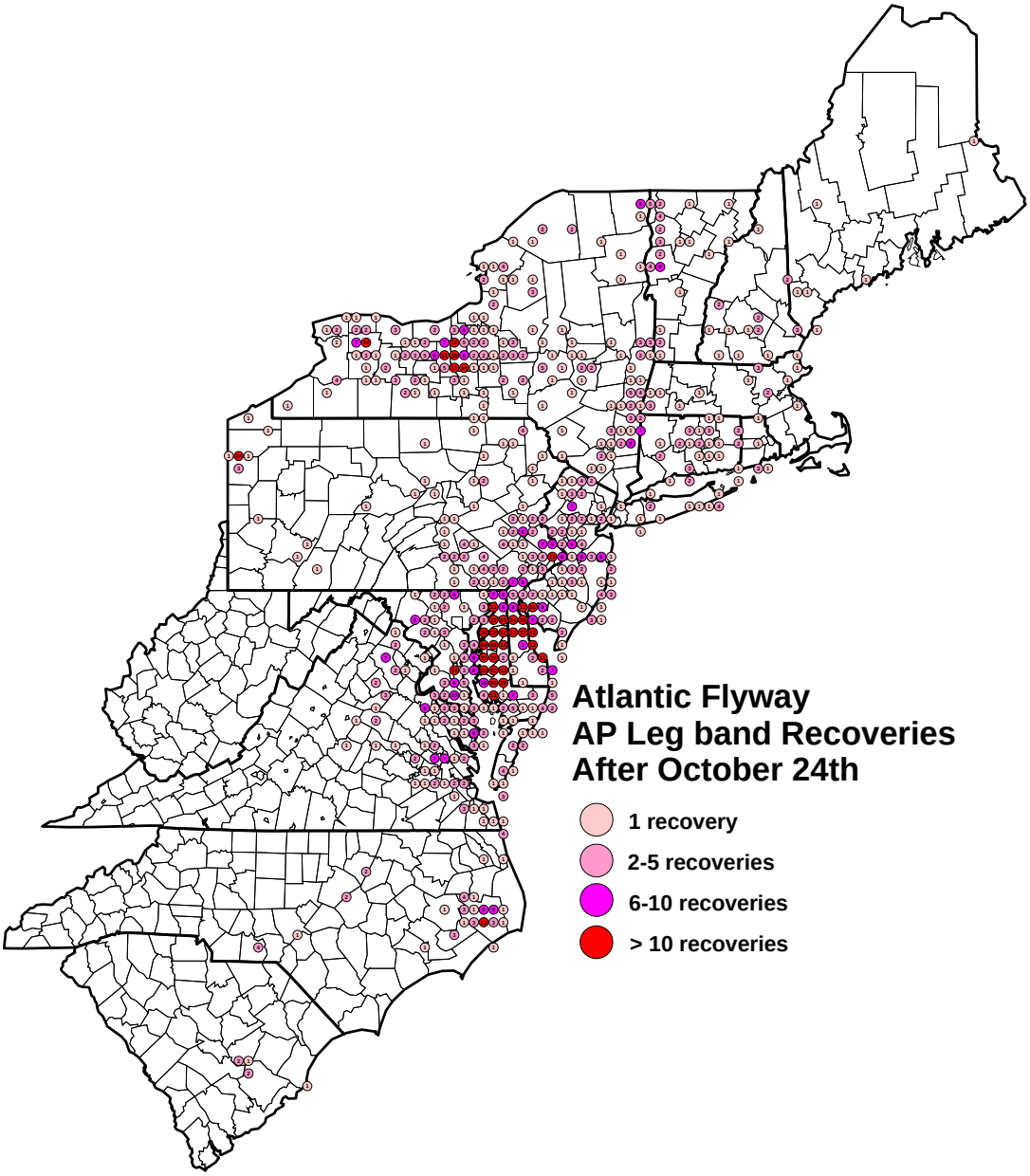


Fig. 9. Recoveries of Atlantic Population Canada geese banded in northern Québec and shot or found dead in Ontario and Québec, Canada 1950-2004.

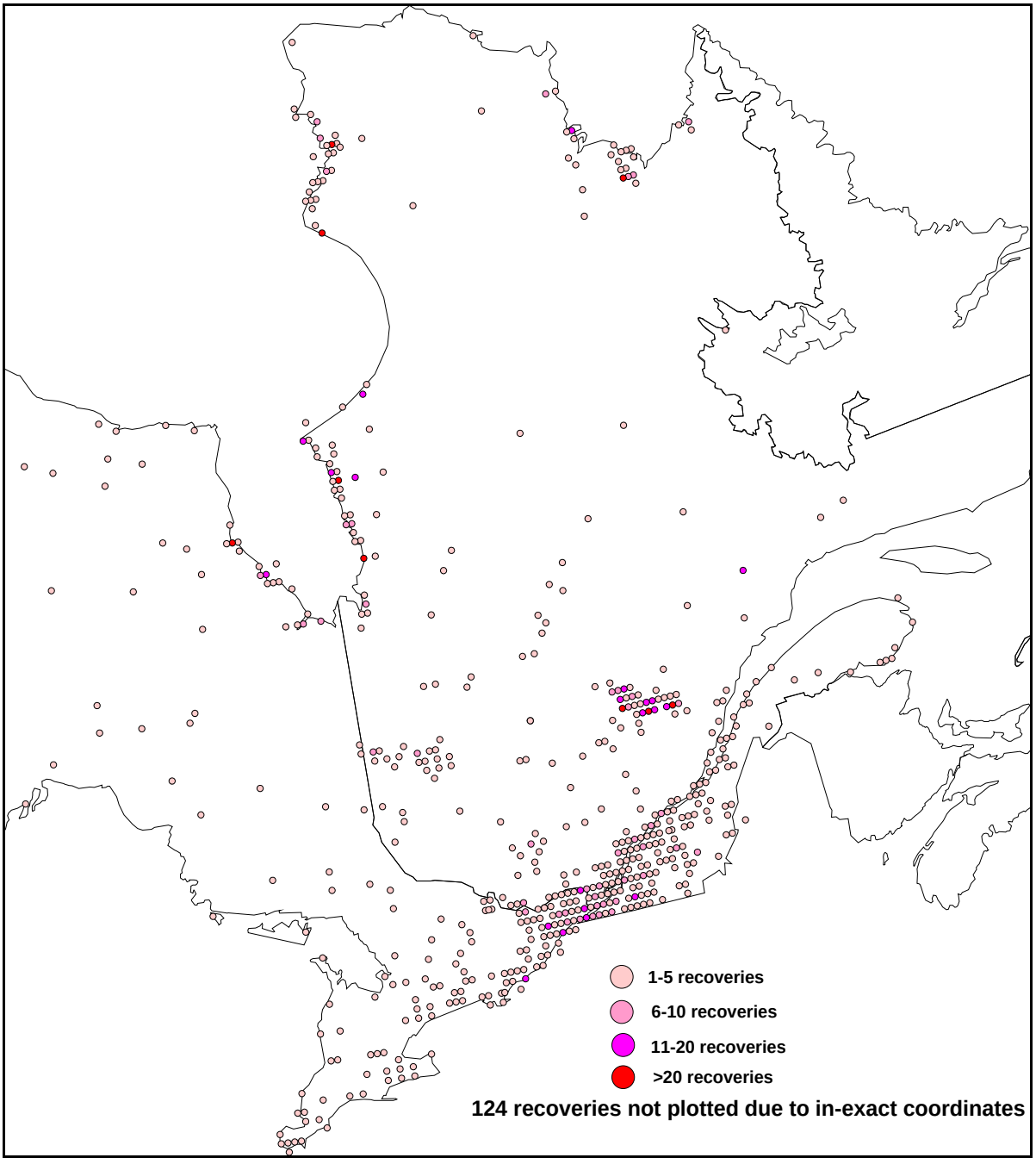


Fig. 10. Harvest distribution of adult Atlantic Population Canada geese in Atlantic Flyway, 2000-2004.

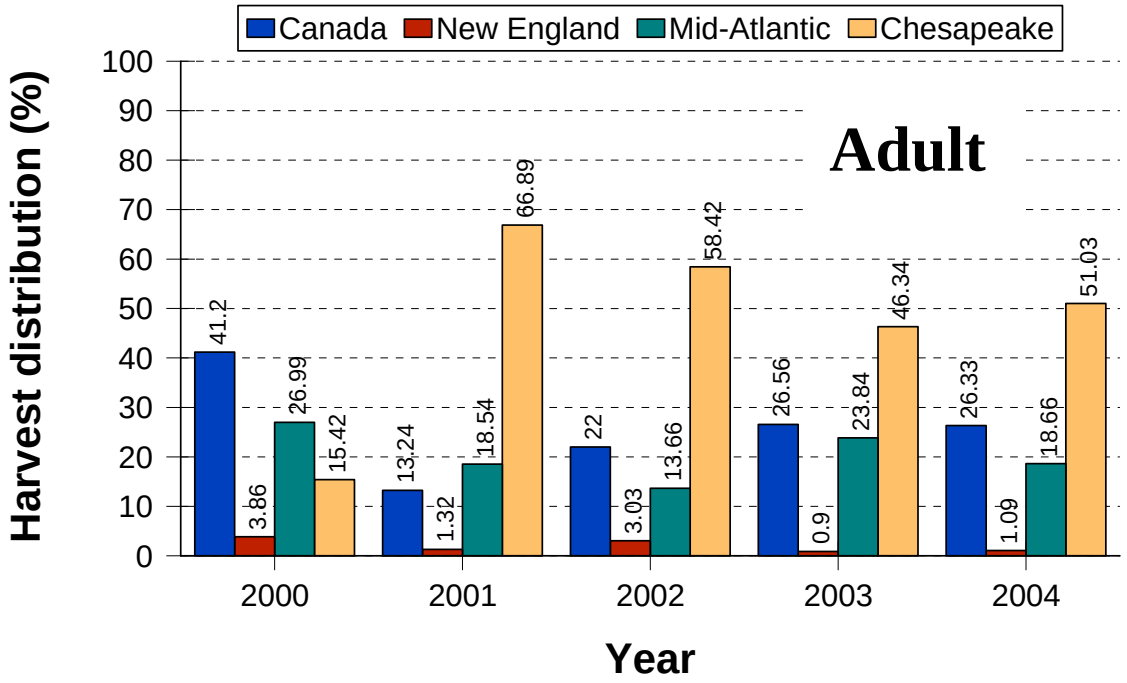


Fig. 11. Harvest distribution of juvenile Atlantic Population Canada geese in the Atlantic Flyway, 2000-2004.

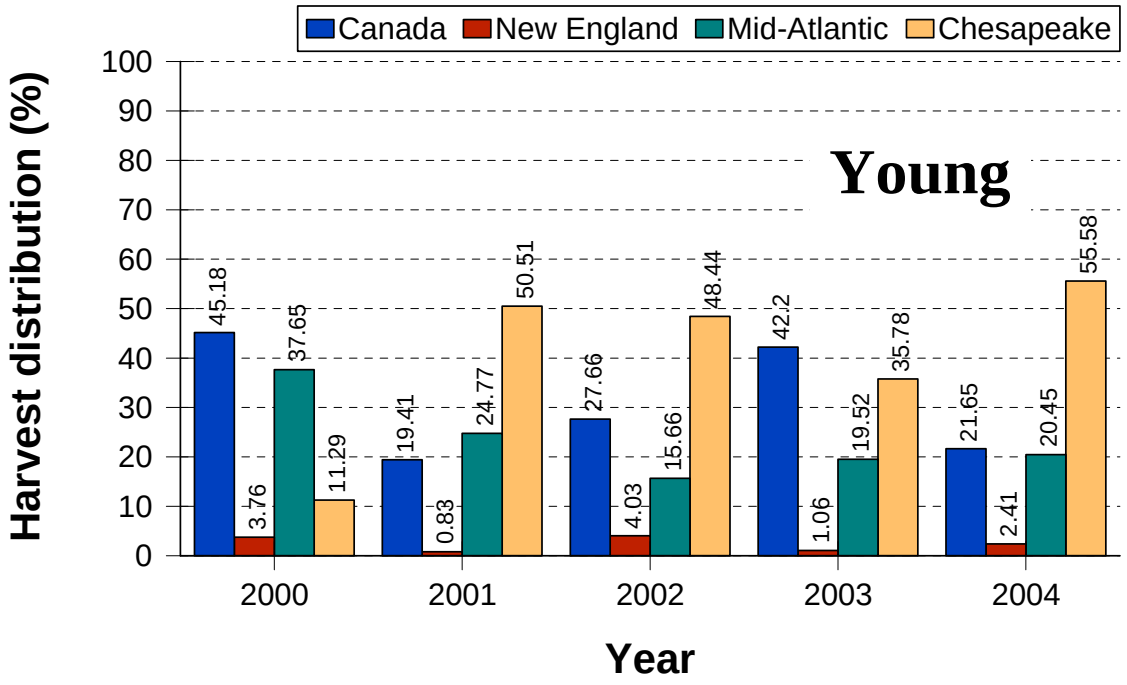
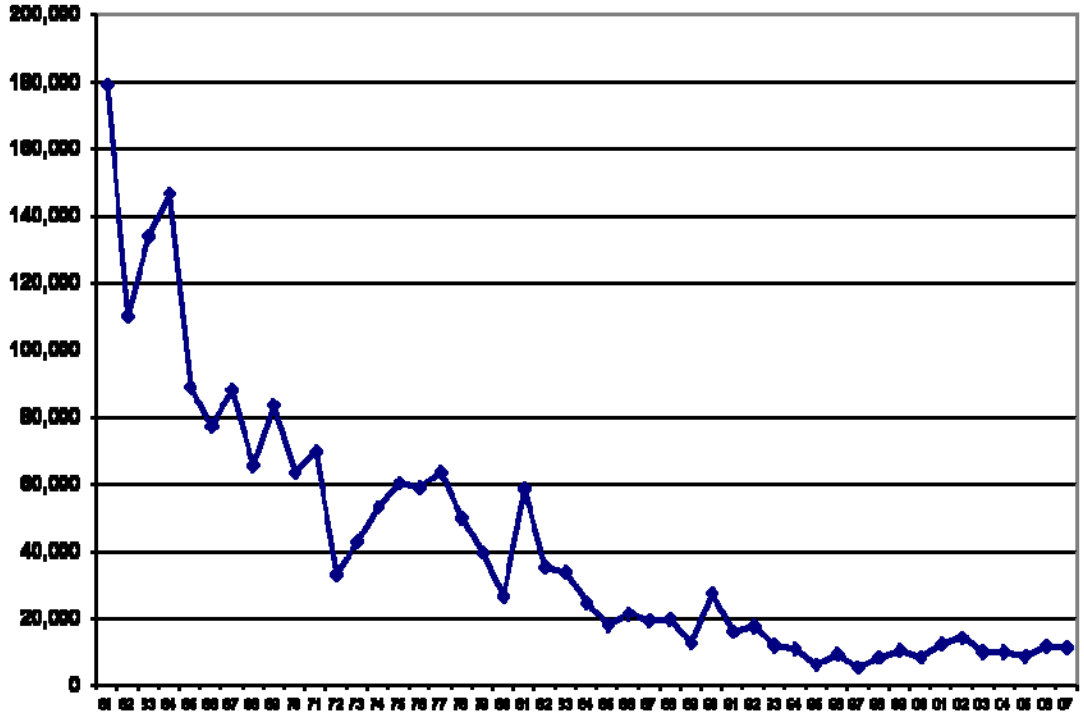


Fig. 12. Numbers of Canada geese observed during the mid-winter survey in North Carolina's Northeast Hunt Unit, 1961-2007.



APPENDIX C: Calculation of the AP Population Goal.

The following includes the calculations and assumption used to derive the population goal of 250,000 breeding pairs comprised of 225,000 breeding pairs as measured on the spring breeding pair survey on the Ungava Peninsula and 25,000 pairs as measured on the spring breeding pair survey in the boreal forest of Quebec:

- The goal of 250,000 breeding pairs represents a crude estimate of what size breeding population (as measured by the spring breeding pair survey on the Ungava Peninsula and the boreal forest of Quebec) it would take to produce a fall flight that can support a liberal hunting season with a total sport harvest of about 300,000 AP birds.
- Currently, our liberal packages target an adult harvest rate of about 15% (and a total harvest rate of about 20%). Assuming a total harvest rate of 20%, a fall flight of about 1.5 million AP geese would be needed to harvest 300,000 birds.
- Young geese make up about 25% of the fall flight on average (using vulnerability-corrected age ratios from the Maryland goose harvest during the 1980s). Thus, an average fall flight of 1.5 million would contain about 375,000 young and 1,125,000 adults.
- Adult geese observed on the surveys include nonbreeders (observed in groups), singles (usually the male of a pair that is nesting), and pairs (includes pairs that are nesting as well as geese observed as pairs that are not nesting). We applied a visibility correction factor of 1.4 (Malecki et al. 1981) for indicated pairs (pairs and singles). Thus a survey estimate of 250,000 pairs would translate to a total population of 350,000 pairs (250,000 x 1.4) or 700,000 adult paired geese.
- Estimating the number of nonbreeding geese (observed in groups) is complicated by the large number of molt migrant Resident Canada geese, especially along the Hudson Bay coast. The Ungava Bay coast is thought to be relatively free of molt migrants. During 2001-2005, we observed an average of 1.55 (range = 0.92 – 1.85) nonbreeding geese for every observed indicated pair along the Ungava Bay coast. We assumed that all geese in groups are observed. We applied this ratio to estimate the number of nonbreeding adult geese we might expect survey-wide. Thus, a survey estimate of 250,000 breeding pairs would yield 387,500 nonbreeding geese (250,000 x 1.55).
- Collectively, (375,000 young + 700,000 adult paired geese + 387,500 adult grouped geese) these calculations produce a fall flight of 1,462,500, close to the 1,500,000 needed to support a harvest of 300,000.

APPENDIX D: Research and Information Needs Beyond 2008.

The following is a list of research and information needs related to the strategies and tasks of the AP Canada Goose Management Plan, 2008-2012. Development of any of these projects by management agencies and cooperating partners is encouraged where suitable funding opportunities exist in addition to currently supported operational AP monitoring programs.

1. Investigate the need to determine a visibility correction factor for the AP goose spring breeding population survey.
2. Examine the current preseason banding effort to determine if the banding is representative of the population and if it is adequate to meet management objectives and harvest assessment.
3. Monitor brood-rearing habitats along the northeastern coast of Hudson Bay.
4. Identify where pre-breeding nutrient reserves are acquired by AP geese, and determine the capacity of these habitats to meet these needs.
5. Evaluate condition indices of AP geese relative to breeding, migration, and wintering habitats.
6. Identify key spring and fall migration areas and evaluate their role in providing resources and sanctuary to AP geese.
7. Continue to evaluate the use of genetic and stable isotope techniques to assess harvest derivation, and composition of migration and wintering populations.
8. Continue to determine the timing and the abundance of molt migrant, temperate-nesting and other subarctic-nesting Canada goose populations and the influence of molt migrants on AP brood-rearing habitats.
9. Comprehensively examine the effects of special early, regular, and late seasons for RP Canada geese on the survival and harvest rates of AP geese.
10. Determine breeding locations as well as spatial and temporal migration patterns for southern cohort AP geese.