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RH: Mississippi Flyway Canada Geese - Leafloor et al.

CANADA GOOSE MANAGEMENT IN THE MISSISSIPPI FLYWAY

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Abstract: Canada goose (*Branta canadensis*) populations and associated management programs in the Mississippi Flyway (MF) have undergone tremendous changes in the past 50 years. Early management efforts were focused on 3 populations of interior Canada geese (*B. c. interior*) at a few geographically restricted refuges where large numbers of geese congregated in fall and winter. Annual harvests of Canada geese in the U.S. portion of the Flyway averaged about 145,000 birds in the 1960s, but peaked at almost 900,000 birds in 2000. Canadian harvests increased about 30%, while hunter numbers declined by 60% from 1975 to 2002. In 1969, the first mid-December goose survey indicated about 600,000 Canada geese in the Flyway; giant Canada geese (*B. c. maxima*) comprised less than 10% of the population, and small Canada geese (*B. c. hutchinsii*) from the Tall Grass Prairie Population (TGPP) were even more scarce. In 2002, Flyway-wide surveys suggested a pre-nesting population of about 2.4 million Canada geese, about half of which were giant Canada geese (the Mississippi Flyway Giant Population, or MFGP). While numbers of Canada geese have increased in the south, the proportion of migrant *B. c. interior* wintering in southern portions of the Flyway has declined. Increasing overlap between wintering interior and giant Canada goose populations led to a change in management focus in the late 1980s. Since then, most population monitoring efforts have occurred on the breeding grounds, where populations are most discrete geographically. Giant Canada geese now comprise the bulk of the harvest in many states, and recent harvest management strategies are aimed at further increasing harvest of giants while controlling harvest of subarctic- and arctic-nesting populations. PROCEEDINGS OF THE

INTERNATIONAL CANADA GOOSE SYMPOSIUM

Key words: banding, *Branta canadensis*, Canada goose, harvest, management,

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INTRODUCTION

Five populations of Canada geese are recognized for management purposes in the Mississippi Flyway. Three populations of interior Canada geese were originally described based on fall and winter distributions determined from band recovery data (Hanson and Smith 1950). The Eastern Prairie Population (EPP), Mississippi Valley Population (MVP), and Southern James Bay Population (SJB; formerly the Tennessee Valley Population or TVP) have traditionally been the focus for population management efforts in the Flyway. Geographically expanded banding efforts and radio telemetry studies on the breeding grounds have refined, and largely confirmed, the original descriptions of these populations (Vaught and Arthur 1965, Vaught and Kirsch 1966, Malecki et al. 1980, Craven and Rusch 1983, Tacha et al. 1988, Samuel et al. 1991, Trost et al. 1998). These studies have also documented the breeding ground origins of interior Canada geese associated with particular wintering areas, a prerequisite for management of breeding populations (Fig. 1, 2).

Giant Canada geese, once thought to be extinct, were found in small numbers throughout the MF in the early 1960s (Hanson 1965). Thereafter, restoration programs that had begun as early as the 1930s were expanded, and giant Canada geese are now the most widespread and abundant subspecies in the Flyway. The Tall Grass Prairie Population of small-bodied Canada geese nests in Nunavut along the west coast of

Hudson Bay, and on Southampton Island and western Baffin Island (Marquardt 1962, MacInnes 1966). About 60% of TGPP Canada geese originating from Baffin Island winter in the western MF, while about 85% of those from the west coast of Hudson Bay and from Southampton Island are affiliated with the Central Flyway (Fig. 3).

Canada geese are an important component of the waterfowl harvest in Canada and the northern states of the MF. Annual harvests in the U.S. portion of the Flyway averaged about 145,000 birds in the 1960s, grew to an average of 675,000 per year in the 1990s, and peaked at almost 900,000 birds in 2000 (Fig. 4). Combined annual harvests in Manitoba and Ontario (the two main provinces affiliated with the MF) increased from about 125,000 in the late 1970s to about 165,000 in the 1990s, despite a 60% decline in waterfowl hunter numbers in the two provinces (Fig.5). In 2001, Canada geese were the most commonly harvested waterfowl in Manitoba and Ohio, and ranked second to mallards (*Anas platyrhynchos*) in Ontario and 8 states (IA, IL, IN, KY, MI, MN, MO, and WI) in the MF (CWS and USFWS, unpublished data). In addition, the annual subsistence harvest of approximately 50,000 Canada geese is an integral component of the traditional economy of Cree people in northern Ontario (Berkes et al. 1994) and MF-associated Canada geese are also harvested by aboriginal people of Manitoba and Nunavut.

As distribution and abundance of Canada geese have changed, and harvests have increased, the need for more refined population information has also increased. Since its inception in 1952, the Mississippi Flyway Council (MFC) has guided development of a comprehensive international management program for Canada geese. Management efforts necessarily were focused on wintering areas at first, but have gradually evolved to

focus on monitoring populations on their breeding grounds. Today, the program consists of a coordinated system of population surveys, banding, harvest management, and research designed to understand and maintain the diversity and abundance of Canada geese throughout the Flyway. Herein, we describe the Canada goose management program in the Mississippi Flyway, its history and development, and some remaining challenges.

). In the 1950s and 1960s, most harvest control efforts tended to focus on a few major concentration areas, but outside quota zones seasons were more liberal, often 70 days long with 2 birds/day bag limits (Crissey 1968, Jahn 1968). Initiation of the U.S. National Harvest Survey in 1962 revealed unexpectedly high harvests of Canada geese, over a broader geographic area than expected (Reeves et al. 1968), leading to calls for more effective harvest restrictions outside concentration areas (Raveling 1978). Though modern strategies to control harvest most often involve timing of seasons, restrictions of season length, and reduced bag limits, quota zones are still used in some states (e.g., WI, IL, IN, TN, KY) to Think we should list those using them WI, IL, IN, TN, KY.

control harvests in local areas.

At the Flyway level, Canada geese wintering in southern regions declined while numbers in northern regions increased through the mid-1960s (Hankla and Rudolph 1967), leading to perceived inequity in harvest opportunity between northern and

southern jurisdictions (Reeves et al. 1968, Miller 1998). This situation spawned numerous efforts to re-distribute Canada geese by several methods. Hankla (1968) described unsuccessful efforts to transplant more than 20,000 Canada geese from mid-Flyway flocks to southern wintering areas between 1953 and 1965. Agricultural damage related to short-stopping geese was I might be wrong here, but wasn't it related to agricultural damage or did they think there just shouldn't be that many there?

considered a severe problem at Horicon Marsh, WI, where large numbers of Canada geese built up in the 1950s. Large-scale hazing programs were implemented at Horicon in 1966 (Reeves et al. 1968), and again during 1976-1980 in attempts to move geese farther south, but were unsuccessful in making permanent changes to wintering distributions of Canada geese. Rusch et al. (1985) also reported increased harvest rates of geese during the latter dispersal program. Some southern states also attempted to establish resident flocks by releasing captive-reared geese into protected environments, with varying degrees of success (e.g., Gore and Barstow 1969, MF Giant Canada Goose Management Plan 1996).

After Hanson (1965) recognized the existence of giant Canada geese in the MF, efforts to re-establish local nesting populations of Canada geese also increased in the northern states and Canada. This involved releasing birds from captive rearing programs, translocation of birds within and among states and provinces, and closure of Canada goose hunting in some areas (MF Giant Canada Goose Management Plan 1996). In hindsight, season closures to establish and grow local populations in northern portions of the Flyway might have contributed to the continuing shift in wintering distributions of Canada geese. Numbers of Canada geese counted in mid-winter surveys (conducted in early January), however, actually increased in most southern states of the MF (except

LA) between 1960 and 1989 (Orr et al. 1998; Table 1). After a rapid increase in numbers at Wheeler National Wildlife Refuge in northern AL from its establishment to the mid-1960s, there was a precipitous decline in numbers of Canada geese wintering there through 1989 (Orr et al. 1998), and statewide declines in mid-winter counts continued through 2002 (Fronczak and Gamble 2002). Nonetheless, statewide harvests of Canada geese in AL have increased over the past decade, as they have in all southern states in the Flyway (Fronczak and Gamble 2002). This was most likely a result of increasing numbers of giant Canada geese in southern states. Careful harvest management and maintenance of suitable habitats in these states will ensure that local giant Canada goose populations continue to increase and provide sustainable harvest opportunities. I think there should be some mention of the contribution of northern giants to the kill in southern states (the harvest derivation tables give some figures).

Jahn (1968) described the late 1960s as a transition period from general to intensive management of Canada geese, and reiterated the need for focused harvest management efforts to ensure that harvests did not exceed annual production for individual populations. Formal management plans were developed for EPP geese in 1978, for MVP geese in 1979, for SJBP geese in 1994 (although a draft plan was written by 1979, it was never formally adopted), and for giant Canada geese in 1996, but no plan has been developed for TGPP Canada geese in the Mississippi Flyway. Current management plans contain population objectives, describe harvest strategies and management needs, and outline research priorities for improving management programs. The documents are adaptive, in that objectives and strategies are updated as new information becomes available. Most are updated at 5-year intervals, though some recent

plans are being treated as “living documents” that are updated continuously, as necessary.

Population Monitoring

Winter surveys traditionally were used to monitor Canada geese in the Flyway, beginning in 1936 (Reeves et al. 1968). These surveys provided information about winter numbers and distribution in areas where the majority of harvest took place, and were focused on refuges and other areas where large numbers of Canada geese congregated. Canada geese were tallied during mid-winter duck surveys until 1969, when a mid-December survey, specifically for geese, was implemented. It was believed that geese were more concentrated on refuges during and soon after hunting seasons, making mid-December counts more complete than traditional mid-winter surveys (A. S. Hawkins and R. C. Hanson. 1970. Report on the December 1969 inventory of Canada geese in the Mississippi Flyway. USFWS unpublished report, 7 pp.).

Beginning in 1969, mid-December counts of Canada geese in each state were allocated among four populations (EPP, MVP, TVP, or MFGP) based on knowledge of band recovery distributions or the “best guess” of state waterfowl biologists. Some states were zoned geographically to account for geese in different populations, while in others, counts were evenly allocated among populations known to occur in a particular state. For example, in December 1969, Canada geese in OH and MI were evenly split between TVP (SJBP) and giants; IN counts were equally divided among MVP, TVP, and giants. In MN, all but 300 Canada geese at Lac Qui Parle were considered EPP, and the rest of the state count was considered giants. In KY, Canada geese in Ballard County were considered MVP, while those at Land-Between-The-Lakes Refuge were TVP (Hawkins and Hanson 1970). These allocation criteria changed over time, as new information

became available from survey and/or banding and neck banding programs.

In 1969, giant Canada geese (about 50,000 birds) were thought to comprise less than 10% of the total Flyway population, and TGPP birds evidently were so scarce that they were not considered in mid-December inventories. Because of the clumped distribution of Canada geese on refuges at the time, mid-December surveys likely accounted for a high proportion of the Canada geese in the Flyway, and because of relatively discrete distributions among the 3 interior populations, probably provided a reasonable index to population size for the EPP, MVP, and TVP. As numbers of giant Canada geese increased (Rusch et al. 1996a,b), and the distribution of interior geese began to change (e.g., Orr et al. 1998), there was increasing overlap Clarify at what level this overlap occurs; are saying local, state wide or Flyway wide?

among wintering giant and interior Canada geese. This made it impossible to reliably estimate the size of individual populations, and by the mid-1980s, the value of winter surveys for Canada goose population monitoring in the MF was in doubt (Mississippi Flyway Council Technical Section (MFCTS) minutes, February 11-15, 1985, Kansas City, MO).

A formal shift in survey emphasis to the breeding grounds occurred in the late 1980s and early 1990s (Babcock et al. 1990, Trost et al. 1990, Humburg et al. 1998), even though the first spring surveys for Canada geese were actually developed in the early 1970s to provide annual information on breeding effort and production (Malecki 1976; Malecki et al. 1980, 1981; Humburg et al. 1998, 2000). EPP breeding ground surveys were flown annually from 1972 onward, though mid-December counts remained the primary means of population assessment through 1991 (Humburg et al. 2000). Spring surveys were developed for MVP Canada geese in 1989 (Tacha et al. 1998, Schneider et

al. 1994, Leafloor and Abraham 2000), and for SJBP Canada geese in 1990 (Leafloor et al. 1996).

The first SJBP breeding ground surveys indicated fewer birds in the population than had been expected, suggesting that the SJBP had been overestimated by winter counts (Leafloor et al. 1996, Rusch et al 1996a, b). This was confirmed in 1993, when spring surveys for giant Canada geese revealed that the Flyway population was approximately 3-4 times higher than previously thought (Rusch et al. 1996a,b); some of these MFGP likely had been allocated to the SJBP during winter surveys. Giant Canada geese have been surveyed annually since 1993 in most MF states and tri-annually in Ontario. Methods vary between jurisdictions, but counts usually occur in March or April, when most northern migrants are not present in southern Canada and the United States.

Though the TGPP of small Canada geese was first described in the early 1960s (Marquardt 1962, MacInnes 1966), these Canada geese were not tallied separately during winter surveys in the MF until 1980. Until that time, TGPP Canada geese usually were considered a component of one of the 3 interior populations where they overlapped (Vaught and Kirsch 1966, Bellrose 1976). In 1980, the population was estimated at only 3,500 birds; 2,000 in LA, and 1,500 in MO (K. Gamble, 1981. December 1980 goose survey – Mississippi Flyway. USFWS unpublished report, 5 pp.). Between 1980 and 1997, Flyway estimates of the TGPP fluctuated, and ranged between 1,500 and 12,500 birds. Winter surveys of the TGPP were incomplete because not all states identified small Canada geese separately (K. Gamble, USFWS, unpublished data).

Expanded banding efforts on the TGPP breeding grounds began in 1987, and revealed that most small-bodied Canada geese from Baffin Island were recovered in the

MF, while most of those from Southampton Island and the west coast of Hudson Bay were recovered in the Central Flyway (Fig. 3). Experimental helicopter surveys have been conducted on western Baffin Island during banding operations in August since 1993, and suggest that the breeding population has been relatively stable at about 100,000 adult birds for the past decade (D. Caswell and S. Wendt, CWS, unpublished data). The August surveys allow annual assessment of gosling production, an important consideration in monitoring high arctic-nesting populations, which often exhibit “boom or bust” reproductive success.

Spring surveys initially were thought to provide unbiased estimates of population size because they occurred at a time when populations were geographically discrete (Trost et al. 1990). Northward molt migrations of non-breeding giant Canada geese posed a new challenge in assessing population changes in interior Canada geese. We could specify EPP, MVP and SJBP so there's no confusion.

(Abraham et al. 1999). The presence of molt migrant giant Canada geese on northern breeding grounds is most likely to inflate estimates of non-breeding geese, because most molt migrants occur in flocks, as opposed to single geese or pairs. This is reflected in high variability of estimates of non-breeding geese in spring counts (e.g., Leafloor et al. 1996, Humburg et al. 2000). For this reason, status of EPP (Humburg et al. 2000) and MVP Canada geese (MFCTS meeting minutes, Baton Rouge, LA, 25-28 July, 2002) is now mainly based on an assessment of breeding birds (i.e., birds counted as singles and pairs). In the southern James Bay region, most nests are initiated before mid-May each year (Raveling and Lumsden 1977, Leafloor et al. 2000), while most molt migrants arrive in late May or early June (Abraham et al. 1999). Thus, in most years it should be possible to survey SJBP Canada geese before most molt migrants arrive on

nesting areas. Large Canada geese are not encountered in large numbers on Baffin Island, so molt migrants likely do not affect estimates of TGPP Canada geese (D. Caswell, unpublished data). This seems to imply he only counts non-flying geese, which I don't remember doing. What does he do in a failed breeding year? Is he saying he can distinguish among the small and large Canada geese when they are all on the wing?).

Despite problems associated with the presence of giant Canada geese, population surveys on breeding areas have several advantages over winter counts. Breeding ground surveys cover the majority of known nesting areas (though boundaries are impossible to know with certainty), and most are designed with statistical sampling frameworks that allow variance estimation. In addition, surveys are stratified based on habitat differences and/or nest densities, and this results in lower variance of population estimates (e.g., Malecki et al. 1981, Tacha et al. 1998). Counts of single geese and pairs provide an indication of presumed nesting effort, while counts of flocked birds allow estimation of the size of the non-breeding component of populations when giant Canada geese are not present. Finally, most population estimates are available prior to summer Flyway meetings, enabling biologists to consider the most recent population estimates when developing harvest regulations.

Another important aspect of population monitoring involves banding programs. The first efforts to band Canada geese in North America began in 1915 at the Jack Miner Sanctuary in Kingsville, Ontario (Miner 1923). Band recoveries from the Miner sanctuary and from later banding at Horseshoe Lake, IL formed the basis for defining the 3 interior populations in the MF (Hanson and Smith 1950). As with surveys, most banding programs in the MF were re-directed from wintering areas to nesting areas when

overlapping populations caused problems in data interpretation (though some banding occurred on the breeding grounds as early as the 1950s). Because of the confounding influence of molt migrants in the north, considerable effort was expended in developing morphometric discrimination criteria for separating giant and interior Canada geese in the hand (Moser and Rolley 1990, Merendino et al. 1994, Leafloor and Rusch 1997).

Modern banding data have been used to estimate annual survival rates, to identify important harvest areas for more effective harvest management, and to estimate population-specific harvests of Canada geese (Rusch et al. 1996a).

Widespread use of neck bands for marking geese on the breeding grounds began in the mid-1980s, and yielded additional information compared to regular leg banding (e.g., Samuel et al. 1991). Observations of individually coded neck bands provided information about goose distribution outside of hunting seasons, and contributed to higher reporting rates for hunter-shot birds. Operational use of neck bands has not been sustained for all populations because of the difficulty of maintaining observer networks throughout the Flyway, and questions about the possible bias of survival estimates derived from neck banded birds (e.g., Castelli and Trost 1996; Alisauskas and Lindberg 2002). There have been additional concerns about mortality caused by icing of neck bands during severe weather episodes (e.g., Craven 1979, Zicus et al. 1983), and the resultant negative public perception of neck bands. Annual banding occurs for all sub-arctic and arctic populations in the Flyway, but banding efforts for giant Canada geese are determined by individual states. In general, states and provinces with large populations of giant Canada geese (e.g., MN, MI, OH, ON) tend to have large annual banding programs. Simultaneous banding of all Canada goose populations, combined

with annual population estimates, allows use of band recovery data to estimate the contribution of individual populations to the overall Canada goose harvest in the Flyway (see below).

Harvest Monitoring

The first national harvest surveys for waterfowl began in the United States in 1961 (1962 for geese), and in Canada in 1975 (Cooch et al. 1978). These surveys provided harvest estimates for Canada geese as a species, but there was no satisfactory means of identifying harvest composition of Canada geese by population. Attempts to estimate population-specific harvests of Canada geese in each state and province began in the early 1980s using weighted band recoveries (see Rusch et al. 1996a), similar to methods developed to estimate derivation of mallard harvests (Munro and Kimball 1982). In brief, the derivation of harvest is calculated by first using estimates of spring population size and annual production to estimate the fall flight of each population in the Flyway. These estimates are used to “weight” the bands applied to birds in each population (i.e., the number of geese in that population for each banded bird that is shot and reported). The number of band recoveries, multiplied by the respective weight for each population, provides a weighted harvest estimate. These estimates are then converted to percentages that reflect the population composition of the harvest within each state and province in the Flyway. The percentages are then multiplied by state and provincial harvest estimates (from national harvest surveys) to obtain population-specific harvest estimates in each jurisdiction (Rusch et al. 1996a). Band reporting rates are unknown for geese, so the current procedure uses reporting rates derived from reward band studies of mallards (T. J. Moser, USFWS, personal communication). Based on the

most recent estimates using this procedure for the period 1998-2000, the Mississippi Flyway harvest was composed of about 71% MFGP, 28% interiors, and 1% TGPP Canada geese.

Early attempts to estimate Canada goose harvest composition were hampered by overlapping populations on wintering areas that made winter counts unreliable for individual populations, and winter banding made it impossible to know which populations were represented in banding samples. Though spring surveys and banding on the breeding grounds likely have improved the estimates, the derivation technique requires accurate estimates of spring population size and production, as well as representative banding, of all populations in the harvest. Despite several untested assumptions, and no universal standard against which to measure accuracy, harvest derivations based on band recoveries are widely used by Flyway biologists to assess general harvest trends for each population. Derivations also have been important for identifying gaps or weaknesses in the MF monitoring programs. For example, in states or provinces where numbers of giant Canada geese are underestimated (perhaps because no survey was done), or where banding of MFGP geese does not occur, the proportion of those populations in the harvest will likely be underestimated. Because the current harvest derivation technique requires a large amount of data and effort on an annual basis, there have been attempts to find alternative means of identifying populations in the harvest using morphometric criteria (Spitzkeit and Tacha 1987, Moser and Rolley 1990), genetic techniques (Scribner et al. 2003), and stable isotopes (Caccamise et al. 2000). In most cases, these alternatives have been as expensive and time-consuming to perform as the traditional method for determining harvest derivations. Morphometric criteria have

been used to estimate numbers of small- and large-bodied Canada geese based on measurement of tail fans collected from hunters. The proportion of small-bodied Canada geese in the harvest based on these criteria ranged from 2-6% from 1994 through 2001, compared to about 1% based on recent band recovery derivations. The latter estimate may be biased low because only geese nesting on Baffin Island are included in the estimate of TGPP Canada geese used in the derivation process, but geese nesting elsewhere in the arctic (e.g., Southampton Island) also contribute to the MF harvest.

Modern Harvest Management and Some Remaining Challenges

Traditional harvest management in the Mississippi Flyway focused on the 3 populations of *B. c. interior*, with relatively little consideration of the status of MFGP and TGPP Canada geese until the 1980s. Throughout the Flyway's history, harvest control has been a key component of population management efforts, and as a result of early management experience, harvest strategies tended to be conservative to reduce the potential for overharvest. Early harvest management efforts were largely focused on refuges and other areas where large numbers of geese and hunters were concentrated, but the geographic focus of harvest restrictions has changed as goose numbers have expanded beyond traditional concentration areas. Harvest restrictions occurred in EPP harvest areas during the 1970s and 1980s, in MVP areas throughout the 1980s (Miller 1998), and in SJPB areas in the 1990s (Leafloor et al. 1996), in response to perceived Do you have a specific case of "perceived" decline in mind?

declines in population size or annual production. Restrictive regulations aimed at controlling harvest of interiors likely enhanced growth of the MFGP.

Populations of *B. c. interior* and *B. c. maxima* in the MF are managed according to management plans, each of which includes a population objective and harvest

management strategy. Though no formal harvest strategy exists for all Canada geese (combined) in the Flyway, biologists recognize that different characteristics among arctic, sub-arctic, and temperate-nesting Canada geese necessitate different management strategies for each group. Herein we describe the harvest management strategies for these populations, and review the recent management history of each.

Limited geographic overlap among EPP, MVP, and SJBP geese (Fig. 2) allows independent harvest management for each population, although there are important differences among them. The SJBP was thought to number more than 200,000 birds as recently as 1990 based on winter counts, but spring population estimates from 1990 through 2001 averaged only 101,000 birds (Fronczak and Gamble 2002). Leafloor et al. (1996) suggested that winter surveys had overestimated the size of the SJBP because of inclusion of some giants in the counts, but also presented evidence that numbers of Canada geese on Akimiski Island declined by more than 60% between 1985 and 1993. Concern over lower-than-expected numbers of geese, and the sharp decline in numbers of Canada geese nesting on Akimiski Island, resulted in restrictive hunting regulations in SJBP harvest areas from 1993 through 2001. Restrictive regulations designed to protect SJBP Canada geese occurred primarily in high harvest areas determined from band recovery data, and included adjustment of season length and timing, and reduced bag limits in some areas. Despite these harvest restrictions, there was no consistent increase in numbers of SJBP Canada geese during that time (Fig. 7), especially on Akimiski Island, where low per capita food availability probably limited recruitment (Leafloor et al. 1996, Hill 1999, Patton 2001, Hill et al. 2003). Meanwhile, numbers of giant Canada geese continued to increase in SJBP harvest areas. As a result, SJBP managers agreed to

relax some harvest restrictions beginning in 2002 to determine if increased numbers of giants would effectively buffer the harvest of interiors, in the eastern MF, under more liberal harvest regulations. Even with such changes, harvest regulations remained fairly conservative for SJB Canada geese compared to other parts of the Flyway. The population objective for the SJB is 100,000 adults in spring, and a return to more restrictive regulations would be considered if the population declined to fewer than 85,000 birds (SJB Management Plan 2003).

The current harvest management strategy for MVP Canada geese was developed in the early 1990s, at a time when this population was at record high levels (Tacha and Thornburg 1998). The strategy required a forecast of the number of birds in the fall flight each year, and this was derived in part from the spring survey estimate of the number of nests (Schneider et al. 1994). The number of nests was then multiplied by average estimates of nest success (82%), number of goslings leaving successful nests (3.85), and gosling survival to fledging (0.41) derived from nesting studies at Winisk, Ontario (Bruggink et al. 1994) to estimate annual production of goslings. The production estimate combined with the spring population estimate represented the fall flight forecast (Leafloor and Abraham 2000). The spring population objective was 900,000 birds in the most recent management plan, and any birds in the fall flight in excess of this number could be allocated for harvest among the states where MVP geese occur (Tacha and Thornburg 1998; MVP Management Plan 1996). Most MVP Canada geese are harvested in WI, IL, the Upper Peninsula and the western Lower Peninsula of MI, in western Ontario, and in western TN and KY. While the strategy appeared reasonable when the population was high, there was no consideration given to the possibility of a fall flight

below 900,000 birds, a scenario that occurred 6 times between 1989 and 2002. In practice, because hunting had not been curtailed for MVP Canada geese in the early 1980s when the population was thought to be much smaller, conservative seasons were allowed in each case. This sentence is confusing. At what time period were conservative seasons allowed (early 1980s) or between 1989 and 2002? Sentence also seems to be contradictory - if they "had not been curtailed".

MVP harvest allocations ranged from 175,000 to 600,000 birds between 1989 and 2001.

The MVP strategy is the only one in the Flyway that allocates a specified number of birds to be harvested, a source of considerable controversy over the past decade. The population objective of 900,000 birds has been questioned, in part because fall flight forecasts varied between about 560,000 and 1.15 million birds between 1989 and 2002, and exceeded 900,000 birds only about half the time. Also, there was a realization that, in theory, harvesting the difference between the fall flight and the population objective could lead to excessive harvest because interior geese require several years to become sexually mature. This lesson became clear when using age-structured population models and estimates of survival and reproduction; the MVP Committee found that lower harvest rates were required to maintain population stability. The allocation of harvest among states has also been contentious, and has occasionally resulted in harvest restrictions beyond those in place for some smaller populations, despite fall flights approaching or exceeding 1 million birds in some years. Changes in banding effort in eastern portions of the MVP breeding range have resulted in changes in the distribution of band recoveries, e.g., in MISaying e.g. instead of particularly allows us to ignore the similar increases in ON, OH and IN (which simply haven't been quantified as well, but might be proportionately as important to

them.

, leading to suggestions that harvest allocation among states needed to be revisited (Fritzell and Luukkonen 2003). Evaluation of state and provincial efforts to control harvest requires that accurate estimates of MVP harvest be available. Current harvest estimates for each state and province, as derived from weighted band recoveries, may not be accurate to the degree necessary for such evaluation. Consequently, the relationship between harvest regulation packages and actual harvests of MVP geese remains uncertain.

The states of IL and WI use mandatory reporting systems to determine statewide harvests almost daily throughout the season, and close their seasons when the quota is reached. The state of IL is divided into 3 quota zones (north, central, and southern zones) in an attempt to distribute hunting opportunities across the state; in WI, small areas around Horicon Marsh and Collins Marsh are assigned a pre-determined number of hunters instead of an actual quota, while the rest of the state constitutes a quota zone. The quota systems require hunters to report all harvested Canada geese within 24 to 48 hours using a toll-free telephone number, and to keep on their person a record of all Canada geese shot and the date of harvest for each. Enforcement personnel concurrently carry out field checks of hunter report cards to determine compliance rates for mandatory reporting. Birds that are recorded on hunter report cards, but not called in within the specified time period constitute a violation that lowers the overall compliance rate. Similarly, possession of harvested Canada geese that are not recorded on the hunters' cards constitutes a violation. Quota zone harvests are estimated continuously throughout the season, and are adjusted by compliance rates to account for harvested geese that are not reported. Canada goose hunting is curtailed in a zone when the quota is reached.

These intensive monitoring programs require considerable funding and manpower, but also maximize hunting opportunities for Canada goose hunters in these states. This can be an advantage when the date of arrival of migrant geese is unpredictable, and ensures strict adherence to quotas as long as compliance rates can be adequately monitored. Not sure I'm comfortable with a wholly positive assessment of quotas, as this seems to be. For example, it also promotes furtive behavior in hunters (and probably infractions), and because non-compliance results from regulations breakers, it actually allows them to influence the harvest opportunities of honest hunters on a state-wide basis.

. Other states use traditional methods, such as timing seasons to avoid peak migration periods, and season and bag limit restrictions, to regulate MVP harvests when allocated quotas are relatively low.

The relative variability of spring population estimates of the MVP, and of the non-breeding component in particular, has led to recent refinements to the harvest allocation procedure. At a meeting in KY in December of 2001, MVP managers agreed to base harvest allocations on the status of productive geese, similar to the methods used by EPP managers. It was recognized that a more stable set of hunting regulations was desirable, and that this would likely require a more conservative approach to managing harvest. In particular, it was important to view the annual quota not as a target to be achieved, but as a maximum harvest level that should not be exceeded in a given year. Beginning in 2002, harvest management decisions for MVP Canada geese were based on a population goal of 375,000 nesting geese, which is similar to the average number of nesting birds between 1989 and 2001. When the number of nesting geese is between 325,000 and 425,000, harvest regulations would be set to allow a maximum harvest of 300,000 birds. If the breeding population estimate is between 275,000 and 325,000 birds,

a maximum of 200,000 birds would be allocated for harvest (i.e., regulations designed to effect a 33% reduction in harvest would be enacted). Below 275,000, further unspecified restrictions would be implemented, and above 425,000, more liberal regulations (e.g., 25% increase) would be considered. The current harvest strategy also allows for consideration of environmental factors (e.g., late spring phenology, storms during the nesting period) that could reduce annual production, and thereby reduce the maximum allowable harvest. Overall, MVP managers have made a conscious choice to be more conservative in order to maintain more stable Canada goose hunting regulations from year to year.

A relatively long history of spring surveys and experience with varying population levels has benefited management of EPP Canada geese. Harvest management for this population is based on a population objective of 200,000 birds, about 145,000 of which should be represented by singles and pairs in the spring survey (i.e., birds assumed to be reproductive). This objective is based on average estimates of population size and breeding components from 1988-1997 (EPP Management Plan, 2000). The management plan specifies incremental levels of harvest restriction or liberalization, depending on the number of breeding birds in a given survey, and also considers current-year evaluations of productivity based on ground surveys conducted at Cape Churchill, Manitoba. EPP harvest management is driven by breeding birds, in part, because of concerns about molt migrant giant Canada geese that may inflate estimates of non-breeding geese (i.e., those that occur in flocks of ≥ 3 birds; Humburg et al. 2000). For example, if singles and pairs represent between 120,000 and 170,000 birds, regulations similar to those used in 1993-94 (i.e., baseline regulations) should be implemented in EPP harvest areas. Between

95,000 and 120,000 breeding pairs, a 25% harvest reduction from 1993-94 levels would be sought through harvest restrictions, and a 50% reduction in harvest would be sought if breeding birds fell below 95,000 breeding pairs. Above 170,000 pairs, harvest regulations could be relaxed to allow for up to a 25% increase in EPP harvest.

Regardless of estimates of the number of productive birds each year, the level of harvest can also be adjusted downward by one increment if ground studies indicate a production bust is likely. Criteria indicating a bust in production are specified in the plan, and include

consideration of average clutch size, spring weather (heating degree-days), and the composition of the breeding population (EPP Management Plan 2000). As with the SJBP, EPP harvest management areas have been identified based on band recovery distributions. You might simply want to say MN, IA and MO so readers unfamiliar with the Flyway will know.

. Overall, the EPP management plan is designed to provide average hunting opportunities under average conditions, and has resulted in a fairly stable population in recent years (Fig. 7).

The TGPP is the only Canada goose population in the Flyway that does not have a specific harvest management strategy. Baseline information, such as breeding population status, nesting habitat conditions, and production rates is not available prior to setting hunting seasons each year. Additionally, other than age ratios recorded at managed hunt sites, only a few Flyway states/provinces make an effort to identify and survey small Canada geese on migration and wintering sites.

The status of TGPP Canada geese has not been a determinant of hunting season regulations in most parts of the MF due to the low proportional harvest of these geese, and also due to the relatively stable population on Baffin Island over the past 10 years (Fig. 7). Instead, harvest management strategies in most areas have been aimed at ensuring that population objectives of EPP, MVP, SJBP and Giants are maintained.

Season timing in the Swan Lake Zone in Missouri has been adjusted to account for arrival and departure of small Canada geese (Sullivan et al. 1998), and there are substantial restrictions on season length and timing, and permit requirements to hunt Canada geese in parts of Louisiana. Current harvest management practices appear to be acceptable in regard to the TGPP as their status has not been impacted by the broad range of hunting seasons used in the Flyway in recent years. However, the TGPP may be given increased consideration in formulating future regulations as this flock might be the most likely group of Canada geese affected by the impacts of hunting seasons. This is related to life history characteristics such as the tendency for boom-bust production, relatively low productivity compared to other Canada goose populations, and their long distance and early migration. Many of the more recent hunting seasons for interior and giant Canada geese open earlier, during September and October, and it is during this time period that migrating TGPP may be most vulnerable. These expanded hunting opportunities have not been a problem to date, but to ensure that small Canada geese are not over-exploited in the future as the Flyway attempts to maximize harvest on other Canada goose populations, biologists need to be aware of the potential harvest of early migrating TGPP. No special considerations for TGPP are required at this time unless the population on Baffin Island declines significantly and/or harvest rates from small Canada geese banded on Baffin Island increase significantly.

While most early harvest management efforts for Canada geese in the MF focused on regulating harvest of sub-arctic nesting populations, there was increased effort directed at controlling increasing numbers of giant Canada geese during the last two decades. This has greatly complicated harvest management in the Flyway, because

MFGP geese overlap geographically with northern nesting populations of geese almost everywhere they occur during migration and winter. However, there are some time periods when giant Canada geese are largely separated from northern migrant populations that allow for more liberal harvest strategies. For example, early September seasons are widely used in attempts to control giant Canada geese before arrival of migrant geese, and some northern jurisdictions are currently experimenting with late seasons, designed to increase harvest of MFGP Canada geese after migrant geese move southward.

Attempts to increase harvest of giant Canada geese while minimizing harvest of interior Canada geese began in MI in 1977; an extended season with more liberal bag limits was designed to increase harvest of local MFGP birds in southern MI, after most migrant geese had departed southward (USFWS 2002). Special early seasons (usually between 1-15 September) with liberal bag limits began in several states in 1987, and use of these early seasons has expanded greatly since then (USFWS 2002).

In addition to special early September seasons, some northern states have requested permission to begin regular seasons (traditionally required to begin on the Saturday closest to 1 October in most years by federal frameworks in the United States) as early as 16 September. Many northern-nesting Canada geese remain in Canada until October, and these early regular seasons are aimed at providing more opportunity to harvest giant Canada geese while minimizing harvest of interiors. Early regular seasons must conform to federal bag limit frameworks of no more than 2 birds daily, however, so some states prefer the option of a special season with larger bag limits that extends past 15 September. Such extended special seasons require a 3-year experimental period to show that the harvest is comprised of $\geq 90\%$ giant Canada geese (see below).

Special seasons designed to increase harvest of giant Canada geese while controlling harvests of interior Canada geese have required data collection to show that impacts on non-target populations are minimal. Evaluation efforts have involved morphometric analyses (Spitzkeit and Tacha 1987, Moser and Rolley 1990), genetic evaluations (Scribner et al. 2003), neck band observations, and analysis of banding data to determine harvest composition during special seasons. USFWS criteria require that special season harvests include no more than 10% non-target geese. If these criteria are met in 3 consecutive years, special seasons can become operational, which eliminates the need for annual evaluations. In 2002, almost one-third of all Canada geese harvested in the U.S. portion of the Flyway were taken during these special seasons (Fig. 8), the vast majority of which were giant Canada geese. Despite this increase in harvest, and the importance of giant Canada geese in regular season harvests, the population still appears to be increasing in many states (Fig. 7). Increasing numbers of giant Canada geese in urban areas have resulted in increasing numbers of human-wildlife conflicts. Attempts are underway in the United States to address these concerns by giving states more authority and flexibility. Proposals include allowing states to control giant Canada goose populations using both direct and indirect control measures, including the possibility of taking Canada geese in August, outside the normal frameworks for migratory bird hunting (USFWS 2002).

Canada goose harvest management in the MF is currently based on information from annual surveys and banding on the breeding grounds for all populations. While the information is not perfect, refinements are being made to improve our understanding of Canada goose population dynamics in the Flyway. Overall, most Canada goose

populations are at all-time high numbers, and no MF population is currently in danger of being extirpated. Canada goose hunting opportunities are more widely available in most jurisdictions today than at any time in the last century. Human-goose conflicts, particularly in urban areas, will likely continue to increase, and managers will require more flexibility to address these localized concerns. Once considered a bird that symbolized wilderness, MF managers are now faced with the challenge of avoiding devaluation of Canada geese by some members of the public. State, federal, and provincial government agencies of the Mississippi Flyway Council and Technical Section have played the primary role in Canada goose hunt management, research, banding, and population monitoring over the past 50 years. This leadership role will continue, but will require continued support for research and monitoring programs to ensure the long term sustainability of all Canada goose populations in the Flyway Is it worth a sentence or two on the challenge of keeping Canada goose a valued/respected resource in the face of real and perceived nuisance problems/public health concerns, etc.? This bears directly on the preceding challenge, if money is siphoned out of the system to deal with these issues.

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Literature Cited

- Abraham, K. F., J. O. Leafloor, and D. H. Rusch. 1999. Molt migrant Canada geese in northern Ontario and western James Bay. *Journal of Wildlife Management* 63:649-655.
- Alisauskas, R. T., and M. S. Lindberg. 2002. Effects of neckbands on survival and fidelity of white-fronted and Canada geese captured as non-breeding adults. *Journal of Applied Statistics* 29:521-537.
- Babcock, K. M., D. D. Humburg, and D. A. Graber. 1990. Goose management: the

- Mississippi Flyway perspective. Transactions of the North American Wildlife and Natural Resources Conference 55:312-320.
- Bednarik, K. E. 1984. Canada goose history. Pages 486-489 in A. S. Hawkins, R. C. Hanson, H. K. Nelson, and H. M. Reeves, editors. Flyways: Pioneering waterfowl management in North America. U. S. Department of the Interior, Washington, D.C.
- Bellrose, F. C. 1976. Ducks, geese and swans of North America. Second edition. Stackpole Books, Harrisburg, Pa. 543pp.
- Berkes, F., P. J. George, R. J. Preston, A. Hughes, J. Turner, and B. D. Cummins. 1994. Wildlife harvesting and sustainable regional native economy in the Hudson and James Bay Lowland, Ontario. Arctic 47:350-360.
- Bruggink, J. G., T. C. Tacha, J. C. Davies, and K. F. Abraham. 1994. Nesting and brood-rearing ecology of Mississippi Valley Population Canada geese. Wildlife Monographs No. 126. 39pp.
- Caccamise, M. D. F., L. M. Reed, P. M. Castelli, W. Wainright, and T. C. Nichols. 2000. Distinguishing migratory and resident Canada geese using stable isotope analysis. Journal of Wildlife Management 64:1084-1091.
- Castelli, P. M., and R. E. Trost. 1996. Neck bands reduce survival of Canada geese in New Jersey. Journal of Wildlife Management 60:891-898.
- Cooch, F. G., S. Wendt, G. E. J. Smith, and G. Butler. 1978. The Canada migratory game bird hunting permit and associated surveys. Pages 8-39 in H. Boyd and G. H. Finney, editors. Migratory game bird hunters and hunting in Canada. Canadian Wildlife Service Technical Report Series 43.

- Craven, S. R. 1979. Some problems with Canada goose neck bands. Wildlife Society Bulletin 7:268-273.
- Craven, S. R., and D. H. Rusch. 1983. Winter distribution and affinities of Canada geese marked on Hudson and James bays. Journal of Wildlife Management 47:307-319.
- Crissey, W. F. 1968. Informational needs for Canada goose management programs. Pages 141-147 in R. L. Hine and C. Schoenfeld, editors. Canada goose management: Current continental problems and programs. Dembar Education Research Services, Madison, Wisconsin, USA.
- Elder, W. H. 1946. Implications of a goose concentration. Transactions of the North American Wildlife Conference 11:441-446.
- Fronczak, D., and K. Gamble. 2002. Waterfowl harvest and population survey data. U.S. Fish and Wildlife Service, Columbia, Missouri, USA.
- Fritzell, P. A., and D. R. Luukkonen. 2003. Recovery rates and distributions of Mississippi Valley Population Canada geese in response to regional changes in banding effort. Pages ____-____ in Moser, T. J., K. C. Vercauteren, R. D. Lien, K. F. Abraham, D. E. Andersen, J. G. Bruggink, J. M. Coluccy, D. A. Graber, J. O. Leafloor, D. R. Luukkonen, and R. E. Trost, editors. Proceedings of the 2003 International Canada Goose Symposium, Madison, Wisconsin.
- Gates, R. J., D. F. Caithamer, W. E. Moritz, and T. C. Tacha. 2001. Bioenergetics and nutrition of Mississippi Valley Population Canada geese during winter and migration. Wildlife Monographs No. 146.
- Gore, J. F., and C. J. Barstow. 1969. Status of a free flying, resident flock of Canada

- geese (*Branta canadensis*) in Tennessee. Proceedings of the Southeastern Association of Game and Fish Commissioners 23:101-104.
- Hankla, D. J. 1968. Summary of Canada goose transplant program on nine National Wildlife Refuges in the Southeast, 1953-1965. Pages 105-111 in R. L. Hine and C. Schoenfeld, editors. Canada goose management: Current continental problems and programs. Dembar Education Research Services, Madison, Wisconsin, USA.
- Hankla, D. J., and R. R. Rudolph. 1967. Changes in the migration and wintering habits of Canada geese in the lower portion of the Atlantic and Mississippi Flyways with special reference to National Wildlife Refuges. Proceedings of the Southeastern Association of Game and Fish Commissioners 21:133-144.
- Hanson, H. C. 1965. The giant Canada goose. Southern Illinois University Press, Carbondale, Illinois, USA.
- Hanson, H. C., and R. H. Smith. 1950. Canada geese of the Mississippi Flyway with special reference to an Illinois flock. Illinois Natural History Survey Bulletin 25:67-210.
- Hill, M. R. J. 1999. Factors influencing pre- and post-fledging growth and survival of Canada goose goslings on Akimiski Island, Nunavut. Dissertation, University of Western Ontario, London, Ontario, Canada.
- Hill, M. R. J., R. T. Alisauskas, C. D. Ankney, and J. O. Leafloor. 2003. Influence of body size and condition on harvest and survival of juvenile Canada geese. Journal of Wildlife Management 67:530-541.
- Humburg, D. D., F. D. Caswell, D. H. Rusch, and M. M. Gillespie. 1998. Breeding ground surveys for the Eastern Prairie Population of Canada geese. Pages 9-19 in

- D.H. Rusch, M.D. Samuel, D.D. Humburg, and B.D. Sullivan, editors. Biology and management of Canada geese. Proceedings of the International Canada Goose Symposium, Milwaukee, Wisconsin, USA.
- Humburg, D. D., F. D. Caswell, D. H. Rusch, M. Gillespie, and P. Telander. 2000. Status and trends of the Eastern Prairie Population of Canada geese. Pages 123-135 in K. M. Dickson, editor. Towards conservation of the diversity of Canada geese (*Branta canadensis*). Canadian Wildlife Service Occasional Paper 103.
- Jahn, L. R. 1968. Summary: Requirements and opportunities for managing Canada geese. Pages 168-173 in R. L. Hine and C. Schoenfeld, editors. Canada goose management: Current continental problems and programs. Dembar Education Research Services, Madison, Wisconsin, USA.
- Leafloor, J. O., K. F. Abraham, D. H. Rusch, R. K. Ross, and M. R. J. Hill. 1996. Status of the Southern James Bay Population of Canada Geese. Pages 103-108 in J. T. Ratti, editor. Proceedings of the 7th International Waterfowl Symposium, Memphis, Tennessee, USA.
- Leafloor, J. O., and K. F. Abraham. 2000. Procedures for monitoring the Mississippi Valley Population of Canada geese and suggestions for improvement. Pages 117-122 in K. M. Dickson, editor. Towards conservation of the diversity of Canada geese (*Branta canadensis*). Canadian Wildlife Service Occasional Paper 103.
- Leafloor, J. O., M. R. J. Hill, D. H. Rusch, K. F. Abraham, and R. K. Ross. 2000. Nesting ecology and gosling survival of Canada Geese on Akimiski Island, Nunavut, Canada. Pages 109-116 in K. M. Dickson, editor. Towards conservation of the diversity of Canada geese (*Branta canadensis*). Canadian

- Wildlife Service Occasional Paper 103.
- Leafloor, J. O., and D. H. Rusch. 1997. Clinal size variation in Canada geese affects morphometric discrimination techniques. *Journal of Wildlife Management* 61:183-190.
- MacInnes, C. D. 1966. Population behavior of eastern arctic Canada geese. *Journal of Wildlife Management* 30:536-553.
- Malecki, R. A. 1976. The breeding biology of the Eastern Prairie Population of Canada geese. Dissertation, University of Missouri, Columbia, Missouri, USA.
- Malecki, R. A., F. D. Caswell, K. M. Babcock, R. A. Bishop, and R. K. Brace. 1980. Major nesting range of the Eastern Prairie Population of Canada geese. *Journal of Wildlife Management* 44:229-232.
- Malecki, R. A., F. D. Caswell, R. A. Bishop, K. M. Babcock, and M. M. Gillespie. 1981. A breeding ground survey of EPP Canada geese in northern Manitoba. *Journal of Wildlife Management* 45:46-53.
- Marquardt, R. E. 1962. Ecology of the migrating and wintering flocks of the small white-cheeked geese within the south central United States. Dissertation, Oklahoma State University, Stillwater, Oklahoma, USA.
- Merendino, M. T., C. D. Ankney, D. G. Dennis, and J. O. Leafloor. 1994. Morphometric discrimination of giant and Akimiski Island Canada geese. *Wildlife Society Bulletin* 22:14-19.
- Miller, S. W. 1998. The biopolitics of Mississippi Valley Population Canada goose management: the Wisconsin perspective. Pages 467-474 *in* D.H. Rusch, M.D. Samuel, D.D. Humburg, and B.D. Sullivan, editors. *Biology and management of*

- Canada geese. Proceedings of the International Canada Goose Symposium, Milwaukee, Wisconsin, USA.
- Miner, J. 1923. Jack Miner and the birds. Reilly and Lee Co., Chicago, Illinois, USA.
- Moser, T. J., and R. E. Rolley. 1990. Discrimination of giant and interior Canada geese of the Mississippi Flyway. *Wildlife Society Bulletin* 18:381-388.
- Munro, R. E. and C. F. Kimball. 1982. Population ecology of the mallard. VII. Distribution and derivation of the harvest. U.S. Fish and Wildlife Service Resource Publication 147.
- Orr, D. H., E. F. Bowers, and O. Florschutz, Jr. 1998. Canada geese population trends, distributions, and management strategies in the southeastern United States. Pages 239-248 in D.H. Rusch, M.D. Samuel, D.D. Humburg, and B.D. Sullivan, editors. *Biology and management of Canada geese. Proceedings of the International Canada Goose Symposium, Milwaukee, Wisconsin, USA.*
- Patton, K. A. 2001. Late summer survival of Canada goslings on Akimiski Island, Nunavut. Thesis, University of Western Ontario, London, Ontario, Canada.
- Raveling, D. G. 1978. Dynamics of distribution of Canada geese in winter. *Transactions of the North American Wildlife and Natural Resources Conference* 43:206-225.
- Raveling, D. G., and H. G. Lumsden. 1977. Nesting ecology of Canada geese in the Hudson Bay Lowlands of Ontario: Evolution and population regulation. Ontario Ministry of Natural Resources, Fish and Wildlife Research Report No. 98.
- Reeves, H. M., H. H. Dill, and A. S. Hawkins. 1968. A case study in Canada goose management: the Mississippi Valley Population. Pages 150-165 in R. L. Hine and C. Schoenfeld, editors. *Canada goose management: Current continental*

- problems and programs. Dembar Education Research Services, Madison, Wisconsin, USA.
- Rusch, D. H., S. R. Craven, R. E. Trost, J. R. Cary, R. L. Drieslein, J. W. Ellis, and J. Wetzel. 1985. Evaluation of efforts to re-distribute Canada geese. Transactions of the North American Wildlife and Natural Resources Conference 50:506-524.
- Rusch, D. H., F. D. Caswell, M. M. Gillespie, and J. O. Leafloor. 1996a. Research contributions to management of Canada geese in the Mississippi Flyway. Transactions of the North American Wildlife and Natural Resources Conference 61:437-449.
- Rusch, D. H., J. C. Wood, and G. G. Zenner. 1996b. The dilemma of giant Canada goose management. Pages 72-78 in J. T. Ratti, editor. Proceedings of the 7th International Waterfowl Symposium, Memphis, Tennessee, USA.
- Samuel, M. D., D. H. Rusch, K. F. Abraham, M. M. Gillespie, J. P. Prevett, and G. W. Swenson. 1991. Fall and winter distribution of Canada geese in the Mississippi Flyway. Journal of Wildlife Management 55:449-456.
- Schneider, J. P., T. C. Tacha, and J. O. Leafloor. 1994. Potential predictors of numbers of Canada goose nests from aerial surveys. Wildlife Society Bulletin 22:431-436.
- Scribner, K. T., J. A. Warrilow, J. O. Leafloor, H. H. Prince, R. L. Inman, D. R. Luukkonen, and C. S. Flagel. 2003. Genetic methods for determining racial composition of Canada goose harvests. Journal of Wildlife Management 67:123-136.
- Spitzkeit, J. W., and T. C. Tacha. 1987. Subspecific composition of Canada geese wintering in southern Illinois. Transactions of the Illinois Academy of Science

79:171-173.

Sullivan, B. D., D. D. Humburg, L. D. Burger, L. M. Mechlin, and D. A. Graber. 1998.

Components of the Canada goose flock at Swan Lake National Wildlife Refuge, Missouri. Pages 455-461 *in* D.H. Rusch, M.D. Samuel, D.D. Humburg, and B.D. Sullivan, editors. Biology and management of Canada geese. Proceedings of the International Canada Goose, Milwaukee, Wisconsin, USA.

Tacha, T.C., J.C. Davies, D. D. Thornburg, and K.F. Abraham. 1998. Estimating

breeding pairs and spring numbers of Mississippi Valley Population Canada geese. Pages 113-116 *in* D.H. Rusch, M.D. Samuel, D.D. Humburg, and B.D. Sullivan, editors. Biology and management of Canada geese. Proceedings of the International Canada Goose, Milwaukee, Wisconsin, USA.

Tacha, T.C., and D.D. Thornburg. 1998. Harvest and population management strategies

for Mississippi Valley Population Canada geese. Pages 463-466 *in* D.H. Rusch, M.D. Samuel, D.D. Humburg, and B.D. Sullivan, editors. Biology and management of Canada geese. Proceedings of the International Canada Goose Symposium, Milwaukee, Wisconsin, USA.

Tacha, T.C., A. Woolf, and W. D. Klimstra. 1988. Breeding distribution and

subpopulations of the Mississippi Valley Population of Canada geese. *Journal of Wildlife Management* 52:689-693.

Trost, R. E., K. E. Gamble, and D. J. Nieman. 1990. Goose surveys in North America:

current procedures and suggested improvements. *Transactions of the North American Wildlife and Natural Resources Conference* 55:338-349.

Trost, R. E., K. F. Abraham, J. C. Davies, K. E. Bednarik, and H. G. Lumsden. 1998.

- The distribution of leg-band recoveries from Canada geese banded in the southern James Bay region of Canada. Pages 249-254 *in* D.H. Rusch, M.D. Samuel, D.D. Humburg, and B.D. Sullivan, editors. Biology and management of Canada geese. Proceedings of the International Canada Goose Symposium, Milwaukee, Wisconsin, USA.
- United States Fish and Wildlife Service. 2002. Draft environmental impact statement. Resident Canada goose management, February 2002.
- Vaught, R. W. 1968. Problems and economics of Canada goose management in the Mississippi Flyway. Pages 25-29 *in* R. L. Hine and C. Schoenfeld, editors. Canada goose management: Current continental problems and programs. Dembar Education Research Services, Madison, Wisconsin, USA.
- Vaught, R. W., and G. C. Arthur. 1965. Migration routes and mortality rates of Canada geese banded in the Hudson Bay lowlands. *Journal of Wildlife Management* 29:244-252.
- Vaught, R. W., and L. M. Kirsch. 1966. Canada geese of the Eastern Prairie Population, with special reference to the Swan Lake flock. Missouri Department of Conservation Technical Bulletin No. 3.
- Zicus, M. C., D. F. Schultz, and J. A. Cooper. 1983. Canada goose mortality from neckband icing. *Wildlife Society Bulletin* 11:286-290.

Figure Legends

Figure 1. Approximate breeding ranges of 5 populations of Canada geese in the Mississippi Flyway.

Figure 2. Migration and wintering ranges for the majority of Southern James Bay Population (SJB), Mississippi Valley Population (MVP), and Eastern Prairie Population (EPP) Canada geese in the Mississippi Flyway.

Figure 3. Band recovery distributions for Tall Grass Prairie Population (TGPP) Canada geese banded at west Hudson Bay and Southampton Island (left map), and on Baffin Island, Nunavut (right map) from 1987-2001.

Figure 4. Annual harvests of Canada geese in the U.S. portion of the Mississippi Flyway, 1962-2001.

Figure 5. Migratory game bird hunting permit sales and annual harvests of Canada geese in Manitoba and Ontario, Canada, 1975-2001.

Figure 6. Location of important Canada goose refuges in the Mississippi Flyway.

Figure 7. Recent spring population estimates for 5 populations of Canada geese in the Mississippi Flyway.

Figure 8. Numbers of Canada geese harvested during special seasons in the U.S. portion of the Mississippi Flyway, 1981-2001.