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Abstract: Special hunting seasons were first implemented in 1992 to help reduce the growth rate of Pennsylvania's rapidly expanding resident Canada goose *(Branta canadensis)* population. Special seasons timed to occur before and after fall migration were successful in harvesting resident and not migrant Canada geese. Since 1992, September and late season hunting opportunities have been gradually expanded to include the entire state. The special season harvest of resident Canada geese has increased from about 13,000 birds in 1992 to over 68,000 in 1999. Special hunting seasons now account for over 80% of the entire Canada goose kill in Pennsylvania. Despite the harvest increase, the resident goose population in Pennsylvania has continued to grow from 95,000 to over 250,000 since special seasons were first implemented. Canada goose direct band recovery and harvest rates have increased since the inception of special seasons in Pennsylvania. However, there is little evidence that harvest rates of suburban geese have increased and appear to be below that necessary to stabilize population growth. This limits the effectiveness of special seasons to remove problem geese in suburban settings, where most nuisance and damage complaints originate. Regulated hunting is the most cost effective method of controlling resident geese, but in suburban areas where hunting is often restricted, additional methods are needed to resolve nuisance and damage complaints.

Key Words: Branta canadensis, Canada geese, hunting, Pennsylvania, special seasons

Canada geese *(Branta canadensis)* breeding south of 48° degrees North latitude have been defined for management purposes as resident Canada geese (Atlantic Flyway Council 1999). In the Atlantic Flyway (Flyway) breeding populations of resident Canada geese now occur from the Canadian Maritimes to Ontario, and south to Florida. These populations are thought to have been established through introductions (Hawkins 1970), releases of live decoys during the 1930's (Dill 1970), and translocation programs (Blandin andHeusmann 1974, Dunn 1992). Resident populations have increased dramatically in the past decade to over 1 million birds in the Flyway (H. Heusmann, Massachusetts Division of Wildlife, Westboro, unpublished report). The Atlantic flyway resident Canada goose management plan (1999) calls for a total spring resident population goal of 650,000 which includes a 100,000 population goal for Pennsylvania. Expanding populations have now increased to the point where they are a major source of damage and complaints. In Pennsylvania, Canada geese are primarily involved with damage to property, agriculture, and conflicts with public health and safety. In 1999, total

damage estimates from resident Canada geese were estimated at over 2 million dollars annually in Pennsylvania (J. Dunn, unpublished data).

Special resident Canada goose hunting seasons were designed to increase mortality rates on resident flocks at times and locations where the probability of harvesting migrant geese is low. Canada goose hunting seasons in Pennsylvania have undergone dramatic changes from 1992 to 1999 (Table 1). Beginning in 1992 Pennsylvania was granted a 10-day September season in 4 northwestern and 3 southeastern counties. The daily bag limit was 3 and 5 in the northwestern and southeastern counties, respectively. Additional counties were added from 1993-1995. In 1993 Pennsylvania held its first late Canada goose season (January 15 - February 15) in a limited area within 5 miles of the Susquehanna and Juniata rivers north of Harrisburg. The 1995-96 fall hunting season was suspended throughout the Flyway except for West Virginia and 4 counties in northwestern Pennsylvania to protect declining stocks of migratory Atlantic population geese. Because this suspension also reduced hunting opportunity on resident geese, an expansion of special seasons designed to harvest resident Canada geese occurred in the northern half of the Flyway. Currently 14 states and 2 provinces offer September seasons and late seasons occur in 10 states and one province in the Flyway. The United States Fish and Wildlife Service (USFWS) allowed all Flyway states to hold a September season in 1995. In 1996 the September season in Pennsylvania was expanded statewide from September 1 - 25 with a 3-bird daily bag limit. In 1997, September season bag limits were changed to allow for a 5-bird daily bag limit in southeastern counties while the reminder of the state remained at a 3-bird daily bag limit. In 1997, the late season was expanded

Table 1. Changes in Canada goose hunting seasons in Pennsylvania from 1992-1999. Statewide = 66 counties.

Year	Hunting Season						
	September[1]			Late[2]			Fall[3]
	Counties	Days	Daily Bag	Counties	Days	Daily Bag	Counties
1992-93	7	10	3 west/5 east	12	30	5	Statewide
1993-94	10	10 west *IX* 5 east	3 west/5 east	12	30	5	Statewide
1994-95	26	10 west/15 east	3 west/5 east	12	30	5	Statewide
1995-96	Statewide	15	3	42	30	5	4
1996-97	Statewide	25	3 west/5 east	42	30	5	4
1997-98	Statewide	25	3 west/5 east	42	30	5	40
1998-99	Statewide	25	3 west/5 east	42	30	5	40
1999-00	Statewide	25	3 west/5 east	46	30	5	Statewide

'September seasons began 1 September and ran consecutive days.
[2]Late Season dates were 15 January to 15 February.
[3]Fall hunting season frameworks were 1 October to 20 January. Season Length varied from 15 days to 90 days. Bag limits varied from 1 to 2 per day.

statewide except for 4 northwestern counties and southeastern counties where AP geese winter. The late season was again modified in 1999 to include the 4 northwestern counties except for the migratory Southern James Bay Population (SJBP) harvest area surrounding Pymatuning Wildlife Management Area (WMA). In this paper we report on these special seasons and their impacts upon resident Canada goose populations in Pennsylvania.

Methods

Special season goose harvests

Federal harvest estimates for special Canada goose seasons were obtained from the USFWS for 5-day periods adjusted for memory bias and junior hunter activity (United States Fish and Wildlife Service, Laurel, Md.). State estimates were obtained from special season permits issued by the Pennsylvania Game Commission (PGC) along with a postage-paid harvest report card to report hunting effort and success. For each day, every hunter was required to record whether he or she went hunting, how many geese were retrieved, how many geese were killed but not retrieved (i.e. crippling loss), and the county in which the person hunted. A telephone survey was conducted to determine the hunting activity of those hunters who failed to return their report card. We called a simple random sample of nonrespondents and requested the same information requested on the report card. Based on the responses from the returned report cards and the sample of nonrespondents, the number of hunters and their harvest was estimated using methods described by Cochran (1977).

In 1996 and subsequent years, we did not issue permits for special Canada goose hunting seasons since this requirement was dropped by the USFWS as states entered into the Federal Harvest Information Program (H.I.P.). However, the PGC does obtain annual harvest estimates from all harvested wildlife species in Pennsylvania (D.R. Diefenbach, Pennsylvania Game Commission, unpublished report). This random survey of all general license buyers also provides estimates of Canada goose harvest and hunter activity by season (i.e. September, regular, late). The PGC Game Take Survey was used to provide state special season harvest and hunter estimates for 1996-1999.

Banding

From 1991 to 1999 we captured geese for marking purposes during the bird's annual prebasic molt in early summer. During the molt, geese are flightless for a period of several weeks and are relatively easy to capture. We used a combination of metal posts and welded wire to form a funnel shaped pen or the panel system described by Costanzo et al. (1995) to corral flightless geese. After setting up the catch pen, we would then drive the flock of geese into the pen. Following capture, each goose was assigned an age and sex using a combination of feather (age) and cloacal (age and sex) characteristics (Hanson 1962). All geese were marked using standard USFWS size 8 butt-end aluminum leg-bands. From 1991 to 1996 leg-bands were inscribed with an address for the band finder to report the band. From 1997 to 1999 all bands were inscribed with a toll-free telephone number along with an address for the finder to report the band. A large number of geese banded from 1991 to 1993 were also fitted with flexible neckbands that contained unique

alpha-numeric codes. Following band application, all geese were released at the trap site.

Population size and trends

Estimates of Canada goose breeding pairs and total population in Pennsylvania from 1989 to 2000 were obtained from the northeast states' waterfowl breeding population survey (survey) (Heusmann and Sauer 1997, Heusmann and Sauer 2000). The survey provides waterfowl population estimates from a stratified random design of 1 -km^2 plots selected among 6 physiographic strata in Pennsylvania using the Universal Transverse Mercator grid of 1:25,000 scale topographic maps. During early years (1989-1992) of the survey, between 173 and 338 plots were surveyed each year in Pennsylvania. Also, 50% of the plots each year were identical to the previous year while the other 50% were re-selected plots. Vehicle, foot, canoe, or combinations of these methods were used to search all wetland habitats within survey plots. Canada goose pairs were indicated if a lone male or 2 geese were observed, while 3 geese (pair plus lone male) were counted as 2 indicated pairs. Groups larger than 3 were counted as flocks and were included in the total population estimate. Since 1993, the same 345 randomly selected plots have been surveyed each year. Also, since 1993, three geese together were no longer counted as a pair plus a lone male; they were simply lumped into the total population estimate as a group of 3 geese.

Population trend information from 1966 to 1999 was also obtained from the Breeding Bird Survey (BBS) (Sauer et al. 2000).

Statistical analyses

Banding and band recovery files were obtained from the United States Geological Survey, Bird Banding Laboratory in Laurel, Maryland. Banding and recovery data were summarized using Microsoft Access. Only direct recoveries of normal, wild banded geese that were subsequently shot were used for recovery rate and harvest rate analyses, however, we also included neck-banded geese from 1991-1993 because the majority of geese banded were also fitted with neck-bands. Annual direct recovery rates (/) were estimated by dividing the total number of geese shot in hunting season by the number of Canada geese banded during the prior June and July in Pennsylvania. For harvest rate estimates, we first needed to estimate band-reporting probabilities each year. To estimate cumulative annual band reporting probabilities, recoveries were first defined by whether the band report was solicited or unsolicited, whether it was reported by mail or using the toll-free telephone number, and whether the goose had a neck-band when shot. Estimated reporting rates (J. Dubovsky, Office of Migratory Bird Management, Personal Communication), (D. Rusch and J. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Flyway Technical Section 1999) were assigned for each reporting method used. These estimates are based upon the best information currently available concerning reporting rates. Annual band-reporting probabilities were then estimated as follows:

$$l_a=((u_n*\lambda_n)+(u_1*\lambda_1)+(s*\lambda_s)+(tf*\lambda_t))/N_{dr}$$

where l_a = annual band reporting probability, u_n = number of direct unsolicited address reported neck-banded recoveries, λ_n = estimated unsolicited reporting rate for neckbanded geese (0.65), u_1, = number of

direct unsolicited address reported leg-banded recoveries, \ = estimated unsolicited address reporting rate for leg-banded geese (0.50), s = number of direct solicited recoveries, λ_s = estimated reporting rate for solicited band recoveries (1.0), tf = number of direct unsolicited toll-free recoveries, λ_t= reporting rate for unsolicited toll-free recoveries (0.82), N_{dr} = number of direct recoveries (D. Rusch and J. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Fly way Technical Section 1999).

Annual harvest rate was estimated as follows: $h_a = f/l_a$ where h_a = annual harvest rate (D. Rusch and J. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Flyway Technical Section 1999).

Canada goose breeding pairs and total population estimates were obtained from survey reports (Heusmann 2000). We calculated Pearson correlation coefficients *(r)* and Bonferoni probability tests (Systat 1999) to determine trends in numbers of breeding pairs or the total number of geese counted during the survey in Pennsylvania over the period 1993-2000. We also calculated *r* and Bonferoni probability test to examine the relationship between the survey estimate of breeding pairs and the total Canada goose harvest estimates in Pennsylvania provided by the USFWS parts collection survey (United States Fish and Wildlife Service, Laurel, Maryland). Linear route regression was used to analyze trends in BBS data (Sauer et al. 2000).

Landscape variables associated with banding and recovery locations

We determined the habitat characteristics for each 10-minute block (block) of latitude and longitude of banding and recovery locations from Pennsylvania Gap Analysis land cover digital data. Land cover classes examined included the percentage composition of water, forest, perennial herbaceous, annual herbaceous, and unvegetated. These land cover classes were then grouped into rural and suburban categories based upon road density and percentage of unvegetated (developed) land. Banding and recovery blocks were classified by the composition of the majority of the blocks land cover type. The MEANS Procedure (SAS 1999) was used to obtain average habitats of banding and recovery blocks. To examine patterns in recovery location, each recovery was classified by whether it was recovered in the same block where it was banded (same) or in a different block than it was banded (different). The FREQ Procedure (SAS 1999) was used to calculate chi-square statistic to test if recoveries were equally likely to be recovered in the same block as banded or in a different block than banded.

Results

Special season harvests

Special season's harvest ranged from 12,700 during the 1992-93 season to 83,800 during the 1997-98 season (Table 2). Both Federal and State estimates tracked the general trend of increasing harvest over time. The proportion of the total annual harvest (all seasons combined) that occurred during September seasons increased from 23% in 1992 to 63% in 1999. The late season harvest since 1997 has comprised an average of 16% of the total goose harvest. Overall, special season harvests now comprise about 80% of the total annual goose harvest occurring in Pennsylvania (Figure 1). Pennsylvania now accounts for 27% of the total Canada goose

Table 2. Hunter survey estimates of Canada goose harvests in Pennsylvania during special hunting seasons and for all seasons combined (special and fall).

	Canada Goose Harvest Estimates							
	United States Fish & *i* Wildlife Service Harvest Estimate				Pennsylvania Game Commission Harvest Estimate			
Year	September	Late	Special Sum[1]	Total[2]	September	Late	Special	Total
1992-93	11,700	1,000	12,700	50,900	50,900	1,200	52,100	78,900
1993-94	11,900	1,800	13,700	52,200	52,200	500	52,700	84,300
1994-95	17,900	6,000	23,900	61,600	61,600	1,400	63,000	103,000
1995-96	40,900	1,700	42,600	56,800	56,800	1,700	58,500	64,400
1996-97	51,000	19,300	70,300	91,300	91,300	20,500	111,800	96,900
1997-98	64,500	19,300	83,800	104,500	104,500	19,900	124,400	115,500
1998-99	63,200	11,400	74,600	91,100	91,100	25,900	117,000	131,800
1999-00	59,500[a]	8,800	68,300	94,700[a]	94,700	21,100	115,800	118,700

[1] Special sum is sum of special September and late season harvest.
[2] Total is sum of special and regular fall seasons.
[a] preliminary harvest estimate.

harvest in the Atlantic Flyway and 29% of the total special season harvest occurring in the flyway (Serie and Raftovich 2000).

Landscape level variables

Classifications of banding and recovery blocks were determined by half or more of the blocks being either rural or suburban. There were no banding locations identified as suburban and 93% of all banding blocks were classified as rural. The average banding block contained over 93.5% rural habitats and only 6.5% suburban habitats, while the average recovery block contained 92.8% rural habitats and 7.2% suburban habitats. None of the habitat variables examined explained more than 9% of the variance in direct recovery rates. We were therefore unable to make any inferences regarding differences in direct recovery rates between suburban and rural landscapes. However, it was determined that significantly more geese (*n*= 1,424) were harvested in a block other than where they were banded, than were geese (*n* = 904) harvested in the same block they were banded (chi-square = 116.15, 1 df, **P**< 0.0001).

Banding and recoveries

Over the period 1991 to 1999, a total of 15,301 Canada geese were banded in 71 different locations in Pennsylvania (Figure 2). Banding locations were concentrated in the southeastern and northwestern portions of the Commonwealth, areas with historically higher numbers of geese. However, in recent years there has been more emphasis to band geese over a broader geographic area. Most (n=3) locations had between 20 and 350 geese banded, whereas 3 locations, Middle Creek WMA, Pymatuning WMA and Haldemans Island WMA accounted for 43% of the banding total during the 7 year period.

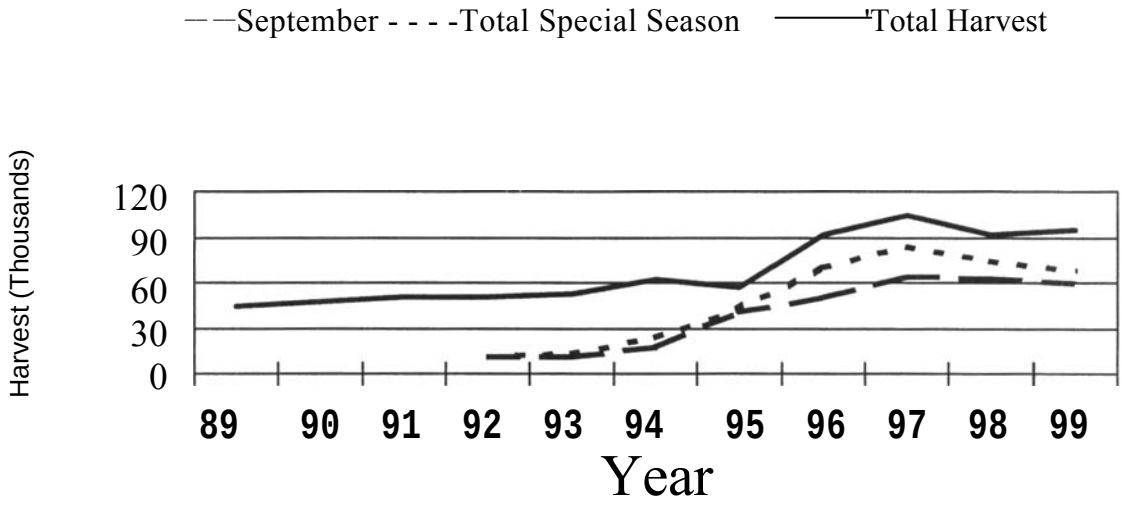

Figure 1. Canada goose harvest in Pennsylvania from 1989 to 1999 including special season (September and late) harvest as estimated by USFWS parts collection survey.

Direct recovery rates for all seasons combined (September, fall, and late) varied from 11.0% during the 1995-96 hunting season to 17.3% during the 1998-99 hunting season (Table 3). Direct recovery rates during the September special season began at 0.4% in 1992 and rose to 11% during the 1998 and 1999 September seasons (Table 4). However, direct recovery rates are greatly affected by changes in band reporting rates, especially since the inception of the toll-free telephone number to report bands. For example, over 46% of all direct band recoveries reported since 1991 were via the toll-free telephone number even though it was operational only 4 of 9 years. Moreover, the toll-free number accounted for over 60% of all unsolicited band reports.

We have attempted to estimate band-reporting probabilities in order to adjust for method of band reporting over time in order to estimate band harvest rates since 1991. Reporting probability of all direct recoveries ranged from 64.4% during the 1995-96 hunting season to 84.2% during the 1997-98 hunting season and averaged 78.7% from 1991 to 1999 (Table 3). Reporting probability of September season direct recoveries ranged from 52.9% during the 1995-96 hunting season to 82.3% during the 1997-98 hunting season and averaged 76.6% from 1992 to 1999. (Table 4).

Harvest rates for all hunting seasons combined ranged from 14.4% in 1991, prior to initiation of September seasons, to 21.3% during the 1994-95 season, which was the last year Pennsylvania had extended fall hunting seasons statewide (Table 3). Combined all season harvest rates appear to be higher since special seasons have been expanded statewide. Harvest rates appear to have stabilized around 20% since 1997.

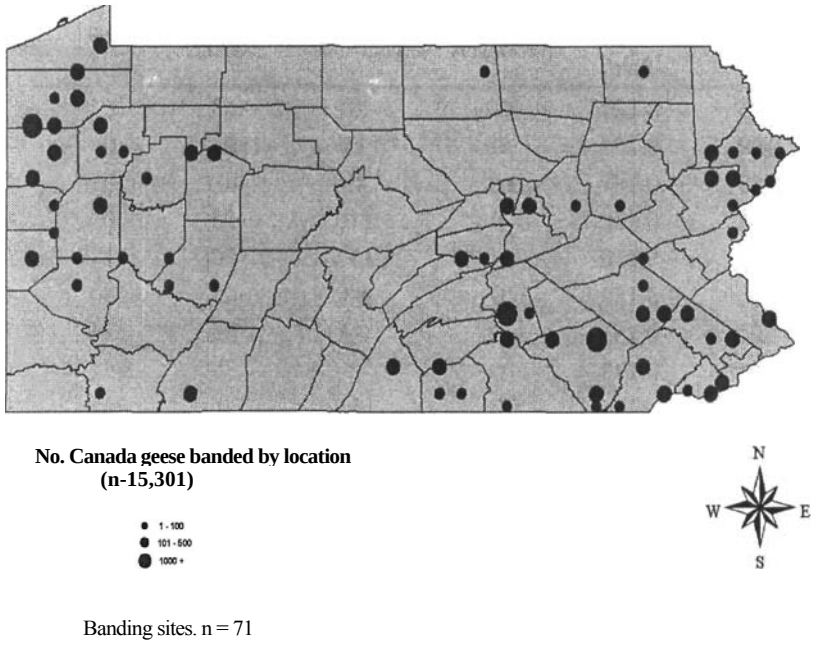

Figure 2. Number of Canada geese banded by location in Pennsylvania, 1991-1999, (n=71) banding sites and n = 15,301 total Canada geese banded).

Harvest rates during September seasons increased from less than 1% in 1992 to 13.5% in 1998 and 1999 (Table 4). September season harvest rates have accounted for most of the total annual harvest rate from 1995 to 1999.

Interstate movements

Of the 3,212 total (direct and indirect) recoveries of Canada geese killed in the September season, 779 (24.2%) were banded outside (foreign banded) of Pennsylvania. Foreign banded Canada geese were recovered from 23 states and 6 Canadian provinces from the Atlantic, Mississippi and Central Flyways. Seventy percent (70%) of all foreign banded geese were from states and provinces directly adjacent to Pennsylvania including New York (19.8%), Ontario (18.1%), Ohio (17.7%) and New Jersey (14.6%). Recoveries of Canada geese banded north of 47° N latitude and considered from migrant populations, ranged from 1.3% in 1993 to 6.4% in 1992. However, operational banding on AP breeding areas in northern Quebec did not begin until 1997 (J. Hughes and A. Reed, Canadian Wildlife Service 1997, unpublished report). Operational breeding ground bandings for S JBP Canada geese has been ongoing since the early 1970's (Leafloor et al. 1996). Over the period 1992-99, 4.1% of the banded geese harvested in Pennsylvania September seasons were identified as migrant geese from either the SJBP (n=24) or AP (n=5).

Table 3. Pennsylvania normal, wild-banded Canada goose direct recovery and harvest rates for all seasons combined (Special and fall) 1991-1999.

Year	Total Banded	Direct Recoveries	Direct Recovery Rate[a]	Unsolicited Neckbands[b]	Unsolicited Legbands[c]	Solicited Bands[d]	Toll-Free Bands[e]	Reporting Probability[f]	Harvest Rate[g]
1991-92	1,027	123	0.120	60	0	63	0	0.829	0.144
1992-93	1,358	169	0.124	56	15	98	0	0.829	0.150
1993-94	1,716	253	0.147	111	41	101	0	0.767	0.192
1994-95	1,226	171	0.139	0	116	55	0	0.654	0.213
1995-96	1,515	167	**0.110**	0	116	50	1	0.644	0.171
1996-97	2,255	358	0.159	0	83	95	180	0.791	0.201
1997-98	1,936	301	0.155	0	39	108	154	0.842	0.185
1998-99	1,996	345	0.173	0	2	2	341	0.819	0.211
1999-00	2,270	349	0.154	0	5	0	344	0.815	0.189
Total	15,299	2,236	0.146	227	417	572	1,020	0.787	0.186

[a]Total banded divided by n of direct recoveries = *f*.

[b] Estimated reporting rate for write-in unsolicited for neckbanded geese ($u_n = 0.65$) (D. Rusch and J. C. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Flyway Technical Section 1999).

[c] Estimated reporting rate for write-in unsolicited leg-banded geese (u, = 0.50) (J. Dubovsky, Office of Migratory Bird Management, personal communication)..

[d] Estimated reporting rate for solicited band recoveries (s = 1.0) (J. Dubovsky, Office of Migratory Bird Management, personal communication).

[e] Estimated reporting rate for unsolicited toll-free recoveries (tf = 0.82) (J. Dubovsky, Office of Migratory Bird Management, personal communication).

[f] Annual band-reporting probability = $l_a = ((u_n*\lambda_n) + (u_l*\lambda_l) + (s*\lambda_s) + (tf*\lambda_t))/N_{dr}$ (D. Rusch and J. C. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Flyway Technical Section 1999).

[g]Annual harvest rate $h_a = f/l_a$ (D. Rusch and J. C. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Flyway Technical Section 1999).

Table 4. Pennsylvania normal, wild banded Canada goose direct recovery and harvest rates for September seasons 1992-1999.

Year	Total Banded	Direct Recoveries	Direct Recovery Rate[a]	Unsolicited Neckbands[b]	Unsolicited Legbands[c]	Solicited Bands[d]	Toil-Free Bands[e]	Reporting Probability[f]	Harvest Rate[g]
1992-93	1,358	6	0.004	5	0	1	0	0.708	0.006
1993-94	1,716	57	0.033	39	13	5	0	0.649	0.051
1994-95	1,226	33	0.027	0	30	3	0	0.536	0.050
1995-96	1,515	88	0.058	0	81	6	1	0.529	0.110
1996-97	2,255	207	0.092	0	53	45	109	0.775	0.119
1997-98	1,936	191	0.099	0	28	55	108	0.823	0.120
1998-99	1,996	222	0.111	0	2	1	219	0.818	0.136
1999-00	2,270	250	0.110	0	5	0	245	0.813	0.135
Total	14,272	1,054	0.074	44	212	116	682	0.766	0.096

[a]Total banded divided by n of direct recoveries = *f*.
[b] Estimated reporting rate for write-in unsolicited for neckbanded geese ($u_n = 0.65$) (D. Rusch and J. C. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Flyway Technical Section 1999).
[c] Estimated reporting rate for write-in unsolicited leg-banded geese (u, = 0.50) (J. Dubovsky, Office of Migratory Bird Management, personal communication)..
[d] Estimated reporting rate for solicited band recoveries (s = 1.0) (J. Dubovsky, Office of Migratory Bird Management, personal communication).
[e] Estimated reporting rate for unsolicited toll-free recoveries (tf = 0.82) (J. Dubovsky, Office of Migratory Bird Management, personal communication).
[f] Annual band-reporting probability = $l_a = ((u_n*\lambda_n) + (u_l*\lambda_l) + (s*\lambda_s) + (tf*\lambda_t))/N_{dr}$ (D. Rusch and J. C. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Flyway Technical Section 1999).
[g]Annual harvest rate $h_a = f/l_a$ (D. Rusch and J. C. Wood, University of Wisconsin-Madison, unpublished report, Mississippi Flyway Technical Section 1999).

Canada geese banded in Pennsylvania showed little propensity for moving out of state from the time of banding in June and July until the end of September. Only 2.4% (n=32) of all direct recoveries of Pennsylvania summer-banded geese occurred outside of Pennsylvania in September. However, prior to 1995 only 7 of the 17 states in the Flyway had instituted September hunting seasons.

Band recoveries in Pennsylvania'slate season have a higher percentage of foreign banded banded geese than September seasons. Recoveries from foreign banded geese comprised 34% of all recoveries and represented 11 states and 1 Canadian province. Unlike September hunting seasons, weather conditions during late season can affect movements of geese and hunter success. The winter of 1993-94 was characterized by heavy snows and extreme cold that forced many

geese south of Pennsylvania and thereby greatly reduced hunter participation and success (J. Dunn and D. Diefenbach 1994, Pennsylvania Game Commission, unpublished report). Short migrations of resident geese to escape freeze-up and deep snow are common in many areas of the northeast and can greatly affect harvest during late seasons (Heusmann et al. 1998, Johnson and Castelli 1998).

Population estimates

Survey estimates of Canada goose breeding pairs ranged from 11,200 in 1989 (the first year of the survey) to a high of 104,340 pairs in 1999 (Figure 3). Total population estimates have ranged from 28,770 in 1989 to 261,970 in 1999. However, because the survey is designed to provide population estimates for the entire northeast region with a Coefficient of Variation (CV) of approximately 20%, state estimate variation often proves more extreme. The CV of Canada goose estimates at the state level is approximately 30% each year. It is therefore, more useful to examine trends in numbers of pairs and total geese over years. There were increasing trends detected in both the number of pairs ($r = 0.850$, $P = 0.016$) from 1994 to 2000 and in total number of geese from 1993 to 2000 ($r = 0.882$, $P = 0.004$) counted on the survey. In addition, the BBS has detected increasing trends in Canada goose numbers over the periods 1966-1999 (23.6% per year, $P < 0.00$), and 1992 to 1998 (13.2% per year, $P = 0.04$). Clearly, Canada goose populations have continued to increase in Pennsylvania. From 1989 to 1999 the number of Canada geese harvested in Pennsylvania has increased as the estimated number of breeding pairs has increased ($r = 0.815$, $P = 0.002$) (Figure 4).

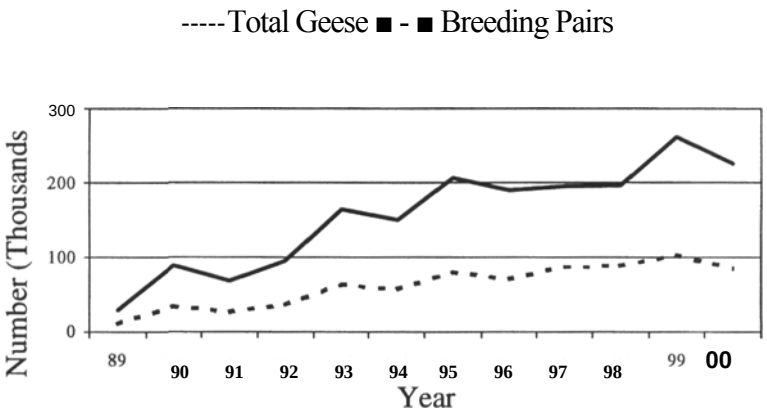

Figure 3. Pennsylvania Canada goose breeding pairs and total population estimates 1989-2000 estimated by the northeastern states' breeding waterfowl plot survey.

Figure 4. Pennsylvania Canada goose breeding pairs and harvest from 1989-1999.

Discussion

Harvest and population size

The use of special seasons has been largely responsible for the increase in resident goose harvest in Pennsylvania. September and late seasons were first offered in limited counties during the initial years of implementation (Table 1). The suspension of fall hunting season for AP Canada geese increased the desire by hunters for special seasons to replace lost days of hunting and by the public as damage and nuisance complaints increased. The expansion of September seasons have been responsible for shifting the harvest earlier from the more traditional fall and early winter periods. Lindberg and Malecki (1994) have reported that resident geese in Pennsylvania were more vulnerable to hunting as the season progressed than were migrants, although Leafloor et al. (1996) disputed these findings. Resident goose harvest rates during September seasons have increased since special seasons were expanded in 1995. Overall, annual harvest rates appear higher since the initiation of September seasons. September seasons proved especially important in maintaining moderate harvest rates on resident geese during the closure of fall Canada goose season across Pennsylvania from 1995 to 1998.

Current harvest rates of around 20% are below what is needed to stabilize population growth. Heusmann (1999) found that harvesting 25% of the resident population during special seasons did not result in a decline in the population in Massachusetts. Hindman et al. (1998) suggested harvest rates approaching 30% may have been sufficient to cause a decline in survival rates for migrant Atlantic Population Canada geese in Maryland. At the fly way level, the growth of resident breeding populations as measured by the breeding plot survey (H. Heusmann, Massachusetts Division of Wildlife, Westboro, unpublished report) appears to have slowed in recent years since special seasons were established throughout the Atlantic Flyway in 1997.

Hunting is the only major source of mortality on adult Canada geese (Chapman et al. 1969, Raveling and Lumsden 1977) and is a well established and cost-effective method for reducing survival, especially in problem areas. Most harvest of resident geese during special seasons occurred within Pennsylvania. This suggests harvest regulations could be designed to target Pennsylvania geese causing local damage and nuisance problems.

Management implications

The Atlantic Fly way Council (1999) and many state wildlife agencies consider special seasons an important management tool for dealing with the problems associated with overabundant resident Canada geese. During special seasons hunting opportunity can occur on many non-traditional sites such as golf courses, parks, and corporate lawns. In recent years many state and local parks now provide for September hunting during at least part of the hunting season. (J. Barr, Pennsylvania Department of Conservation and Natural Resources, personal communication). However, the majority of the harvest is still occurring on traditional hunting sites in agricultural fields, water reservoirs, and on state hunting areas in Pennsylvania. Although the harvesting of geese can reduce populations to some extent at the affected site, it does not appear be reducing the size of the population in suburban and urban environments. Based upon past bandings, we were not able to adequately analyze harvest rate patterns in suburban and rural habitats. Further research examining differences in recovery and harvest rates between suburban and rural areas may help to answer this question. Hunting in suburban and urban settings is frequently not feasible due to state and local regulations against discharging firearms or hunting within safety zones. Direct population control methods such as egg shaking, nest destruction, and roundups can be somewhat effective, but are expensive and offensive to some members of the public (Conover and Chasko 1985) and have been challenged in courts of law (B. Swift, New York Department of Environmental Conservation, personal communication).

We believe current hunting regulations and frameworks allow insufficient flexibility for controlling numbers of resident Canada geese at regional, state, and local levels. Harvest is currently limited to September 1 - February 15. However, much of Pennsylvania and the Flyway have harvest restrictions during this period due to the presence of migratory geese. Hunting for resident geese outside of these periods should be pursued to deal with problem geese. There may also be opportunities for expanding resident seasons in areas and times where harvest of migrant geese can be minimized. It is our opinion that sport hunting does serve as an important tool in controlling resident goose numbers, particularly in traditionally hunted areas (e.g. agricultural lands) but provides limited control in suburban and urban environments where hunter access and safety considerations must be considered. Despite an increasing harvest of resident geese in Pennsylvania, we have been unable to stop population growth in those areas that have the most problems. Ultimately, population control of geese in suburban and urban environments will need to be addressed through a combination of techniques and methods that include hunting.

The U.S. Fish and Wildlife Service is presently preparing an Environmental Impact Statement to consider a range of options for managing overabundant resident Canada geese (Federal Register, August 19, 1999:45269-45274). New and innovative strategies will be

needed to address the range of problems associated with overabundant resident Canada geese.

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