

Evaluation of an Integrated Non-Lethal Canada Goose Management Program in New York (2004 - 2006)

Stacy E. Preusser

USDA APHIS Wildlife Services, Castleton, New York

Tom W. Seamans

USDA APHIS Wildlife Services, National Wildlife Research Center, Sandusky, Ohio

Allen L. Gosser and Richard B. Chipman

USDA APHIS Wildlife Services, Castleton, New York

ABSTRACT: New York State has an estimated population of 249,702 resident Canada geese. Human-goose conflicts are increasing, including unacceptable accumulation of goose feces in public parks, overgrazing of landscaped lawns, noise, and aggressive behavior of individual geese. An integrated Canada goose management program was conducted and evaluated at 8 sites in Orange County, New York from 2004 to 2006. The program, conducted from March through November each year, consisted of egg oiling (300-470 eggs oiled a year), hazing to reduce local goose populations using multiple techniques, public outreach/education, and program monitoring. The monitoring component included goose movement and population surveys using neck-collared geese and standardized fecal counts, at both managed and unmanaged sites. We monitored 3 unmanaged ("control") sites to provide a comparison. We conducted fecal surveys, as an indirect method for potentially estimating site-specific goose populations and associated reduction in damage. The number of droppings counted, when standardized to droppings per foot per day, decreased at treated sites (2004, 0.16; 2005, 0.12; 2006, 0.05) but did not differ at unmanaged sites, indicating a sustained population reduction on site during the project. In addition, the mean number of geese observed at treated sites decreased each year (2004, 77; 2005, 19; 2006, 11) while the mean number at unmanaged sites did not differ. The alternate location of the majority of dispersed geese is unknown, although monitoring of marked birds indicates that many birds moved only short distances (<2 km). The implementation of an integrated non-lethal goose damage management program over 3 years reduced the number of Canada geese at specific locations and minimized local conflicts. The widespread adoption of this type of program could reduce human-Canada goose conflicts across a larger landscape but will require extensive coordination of local projects, a public involvement process, and an intensive, long-term commitment of resources.

KEY WORDS: border collie, *Branta canadensis*, Canada geese, damage management, egg oiling, feces, hazing, New York, nuisance geese

Proc. 23rd Vertebr. Pest Conf. (R. M. Timm and M. B. Madon, Eds.)
Published at Univ. of Calif., Davis. 2008. Pp. 66-73.

INTRODUCTION

In the Atlantic Flyway, there are currently 1.1 million resident Canada geese (*Branta canadensis*) (USFWS 2007). Geese are considered resident geese if they nest or reside in the areas of Southern Quebec and the Maritime Provinces of Canada, southward through the states along the Atlantic coast (Nelson and Oetting 1998, Sheaffer and Malecki 1998, Johnson and Castelli 1998). Resident goose populations have experienced significant increases in recent years, with populations growing at a rate of 7.9% per year (Sauer et al. 2006). The population of resident geese has grown so rapidly that they now meet or exceed the number of geese in all 4 flyways (USFWS 2002). With these population increases have come an increased number of conflicts associated with resident geese, particularly in urban and suburban areas (Fairaizl 1992, Forbes 1993, Cooper and Keefe 1997, Lowney et al. 1997, Holevinski et al. 2007).

Resident geese have several biological advantages over migratory geese: they breed at a younger age, have larger clutch sizes, and have higher nest success rates and higher survival rates than migratory geese (Smith et al. 1999). Canada geese, primarily resident populations, have caused conflicts in at least 37 states at both feeding and loafing areas (Forbes 1993). These conflicts include overgrazing and excessive droppings on lawns, golf

courses, pastures, athletic fields, public parks and beaches, playgrounds, cemeteries, and residential areas. Urban geese create traffic hazards and are aggressive towards people during the breeding season. Urban and suburban areas have experienced an increase in goose conflicts, as geese target areas with water bodies adjacent to mowed lawns, which provide ideal habitat. Desired qualities include short grass, open space for flight clearance, and water, which provides a safe refuge from predators (Holevinski et al. 2007, Conover and Kania 1991, Converse 1985, Cooper and Keefe 1997). Costs related to replanting and reseeding overgrazed lawns and cleaning up goose droppings is estimated to exceed \$60 per goose (Allan et al. 1995).

Large flocks of geese can also be a potential source of disease for both humans and other waterfowl. Urban geese often come into contact with exotic, domestic, or hand-reared waterfowl, which can be a source of duck virus enteritis (USDI 2003). This virus is a highly contagious disease of waterfowl caused by the herpes virus and kills many infected birds (Baldassarre and Bolen 2006). Urban geese often mingle with waterfowl outside urban areas and may spread diseases into the migrating population. Urban geese can create human health and safety concerns. Public beaches have been closed due to excessive fecal coliform levels that been attributed to

geese (Woodruff et al. 2004). Goose feces have been found to contain *Salmonella*, *Listeria*, and *Campylobacter*, which can be carried into drinking water supplies (Graczyk et al. 1998, Clark 2004). Heavy concentrations of goose droppings can cause eutrophication of lakes and reservoirs, as well as excessive algae growth; this, in turn, lowers water quality for other aquatic life (Clark 2004).

Populations of geese near airports create hazards, and Canada geese are ranked as the third-most-hazardous species involving collisions with aircraft (Dolbeer et al. 2000). From 1990-2005, geese were involved in 1,279 strikes with civil aircraft and caused \$395 million in damage (Cleary et al. 2006). Eschenfelder (2000) stated that currently there are no civil aircraft engines in existence that are certified to tolerate an impact with a bird the size of an adult Canada goose and continue operating.

Management of Canada geese is best accomplished using a variety of tools and techniques. Killing geese is often viewed as unacceptable in many urban communities; therefore, some communities look to non-lethal techniques, which can be more socially acceptable to the public. However, some non-lethal techniques have little or no effect. These include the use of dead goose decoys (Seamans and Bernhardt 2004), plastic alligator heads, coyote effigies, scary-eye balloons, swans, and distress calls (Mott and Timbrook 1988, Aguilera et al. 1991). Some techniques do work to alleviate problems for several weeks or months, including chemical repellents (Cummings et al. 1992, 1995; Dolbeer et al. 1998), grid-wires, propane cannons, and mylar tape (Smith et al. 1999). Natural and artificial barriers can reduce access to certain areas by geese and limit geese numbers in defined areas during the molt (Gosser et al. 1997). Recently, an integrated hazing approach using pyrotechnics, dogs, and lasers has become a popular method of deterring geese from a site (Castelli and Sleggs 2000, Swift 2000, York et al. 2000, Holevinski et al. 2007). Hazing involves continuously harassing geese until they leave the site, using one or more scare tactics. Translocation (capture and transfer programs) was popular in the past, but very few states remain willing to accept more geese. Many states including New York now prohibit translocation, due to concerns associated with the spread of avian diseases. Avian contraceptives are being developed, but results have varied (Bynum et al. 2005, VerCauteren and Marks 2003). One long-term management approach to reduce goose populations and the associated damage is egg oiling. This technique is often endorsed as a non-lethal form of control, when in fact it is a form of lethal control. Other population management techniques to reduce local goose populations include capture-and-euthanize programs, most often conducted during the goose molting period, and implementation of hunting seasons that target resident geese. These lethal approaches, in conjunction with habitat modification, may lower local populations (Gosser et al. 1997, Cooper 1998).

There are an estimated 249,702 resident geese in New York state (USFWS 2007). From 1 Jan. 2004 to 31 Jan. 2006, there were 206 newspaper articles covering urban goose issues in 30 newspapers throughout NY. In

1996, there were 30 Canada goose depredation permits issued by the U.S. Fish and Wildlife Service in New York; by 2006 that number had increased to 337 (USFWS 2008).

We examined the efficacy of an integrated goose management program that included egg oiling and the use of border collies, remote-controlled boats, kayaks, and pyrotechnics to chase resident Canada geese from parks in Orange County, New York communities that did not want to conduct "roundups" (capture-and-euthanize programs) or were unable or unwilling to implement limited shooting programs. To monitor and document reduction in damage, we conducted a standard fecal count survey of goose droppings at managed and unmanaged sites to determine if the program was reducing the number of droppings and associated conflicts. Our goals were: 1) to test a resident Canada goose management program that could be recommended to communities to reduce goose population to a more acceptable level, and 2) to determine if the implementation of a standardized droppings count could provide a suitable index to on site goose populations and damage reduction.

Study Area

This study was conducted at 11 locations in Orange County, NY. Orange County is located in the lower Hudson Valley of New York on the west side of the Hudson River and is 80 km north of New York City. Orange County borders both Pennsylvania and New Jersey and measures 211,343 ha, with more than 35,000 ha of parkland. Eighteen percent of county land is in agriculture. The landscape is primarily suburban-residential, interspersed with areas devoted to agricultural production. The human population is estimated at 359,089, with people living primarily in several densely populated urban centers bordering large tracts of undeveloped lands. Orange County has a history of urban goose conflicts, and in 2005 the Orange County Parks and Recreation Department had begun making inquiries to various wildlife management agencies about establishing a county-wide program to manage geese at locations that were had documented goose complaints on both public and private properties.

We identified 11 sites as high human-geese conflict areas, based on conversations with the Commissioner of Parks, town officials, and on records of public complaints. The high priority sites included 1) Mill Pond, located in Monroe, NY (a village park and a 3.2-ha pond with a bike path); 2) Twin Lakes, located just outside the town of Monroe (10.66 ha in size, used as a water-ski school); 3) Thomas Bull Memorial Park, just outside of Middletown (has an 18-hole golf course with approximately 28 ha of day-use area, including 2 ball fields and extensive lawns; it has a 2.4-ha fishing pond as well as 4 smaller ponds on the golf course, and it borders the Walkill River); 4) Silver Lake (a 13.7-ha lake, with a condominium complex on the south side and an assisted living center on the west side); 5) Alder Pond (a 18-ha floral supply distribution center, with a 0.2-ha pond); 6) Algonquin Park, located in the City of Newburgh (a 17-ha park with a 0.4-ha pond and a large picnic area); 7) Mary Harriman Park (a small urban park located in the

town of Woodbury, containing a 2.4-ha pond surrounded by 2 baseball fields and a roller hockey rink); 8) Union Hall, located at the Laborers International Union in Newburgh (has 40 ha of woods and large lawns, with 0.7-ha and 0.2-ha ponds); 9) Washington Lake (a 61-ha lake that is reservoir for the City of Newburgh; it has a picnic area and is considered a trophy bass management area for veterans and people with disabilities); 10) Northeast Business Center–Grainger Building (a large, 85-ha distribution center, located adjacent to Stewart International Airport, with 3 retention ponds of 0.4, 0.3, and 1.5 ha in size); and 11) Newburgh Auto Park (a car dealership located on Route 17K in Newburgh, with 69 ha of lawns as well as two 0.4-ha retention ponds).

METHODS

Egg Oiling

Egg oiling was conducted to stabilize goose populations on all managed study sites that had nesting geese. Oiling eggs also facilitates summer and fall hazing programs by reducing the number of goslings present, which otherwise promote a stronger site fidelity for breeding adults and result in a larger number of geese producing droppings. In 2004, 2005, and 2006, trained volunteers assisted with egg oiling programs. Volunteers and county and town park employees attended a 2-hour training session that provided them with a background on goose biology, how to properly oil nests, and how to safely interact with nesting geese. During 2004, 29 people were trained, and in 2005 18 people were trained. No additional training sessions were held in 2006. Nest searches began in late March and two person teams searched an area once per week for 3 weeks. Nests were flagged and the eggs were marked with a permanent black marker, coated with corn oil, and returned to the nest. After a 1-week period, nests were treated again to ensure that the entire clutch had been oiled and that the adults were continuing incubation. Nests were visited a third time to remove treated eggs and checked to ensure that no renesting had occurred. Egg oiling took place from 6 April to 25 April 2004, 15 April to 2 May 2005, and 4 April to 20 April 2006.

Capture and Banding

In late June and early July 2004 and 2005, we used drive traps to capture a total of 174 adult geese and 38 juvenile geese during the summer molt. All geese were sexed, aged, and fitted with standard aluminum U.S. Fish and Wildlife Service leg bands. Yellow alpha-numeric auxiliary neck bands were also placed on 88 adult geese. The location of collared geese was recorded, as well as associated flock size at study sites or other locations within the study area.

Nuisance Abatement

A border collie was obtained through a trainer who specialized in training dogs to herd geese. From 24 May to 10 November 2004, 25 May to 24 October 2005, and 16 May to 3 November 2006, Monday through Friday, trained border collies were used to scare geese out of Union Hall, Mill Pond, Algonquin Pond, Thomas Bull Park, and Mary Harriman Park. Harassment sessions

lasted until the geese had left the site, and they occurred at random times throughout the day. Sites were visited multiple times per day. Geese were harassed throughout the molt period to ensure that flighted geese were not loafing with molted geese, and geese searching for molting sites from points further south did not use these locations. The dog stalked geese on land until they flew away or entered the water. The dog was then sent into the water and further stalked geese until they flew away. In some cases, geese were herded off high-impact/high-conflict properties to areas considered to have low-impact/low-conflict potential. Washington Lake, Newburgh Auto Park, and Grainger were identified as experimental control sites, where no harassment or other management was conducted.

In conjunction with the trained border collie, we used 2 electric remote-controlled model boats (Aquacraft Hammer, and Traxxas Villian) powered by 7.2-volt 6-cell rechargeable batteries to harass the geese that flew into the water. The Aquacraft Hammer was dark blue in color 24 inches long, and had an average speed of 20 mph. The Traxxas Villian was white, 31 inches long, and had an average speed of about 25 mph. Both boats had a run time of approximately 15 minutes before batteries needed recharging. The range on the boats was about 250 yards from the remote-control unit.

In larger bodies of water, a 1-person kayak was used to assist the border collie. The kayak was used to chase geese, block swimming routes, or to pose as a threatening presence. Pyrotechnics were used in areas where it was difficult for the dog and remote-controlled boats to penetrate dense aquatic vegetation. Lasers were also used at dawn and dusk at 2 treatment sites to haze geese from roosting sites.

Program Monitoring

Standardized fecal counts were conducted at 5 treatment and 3 control sites. At each site, one 100 × 2-meter transect was set up and delineated with spray paint. Within each transect, goose droppings ≥1.3 cm were counted, and then the area was raked clean. Counts were conducted on Monday and Thursday of each week, from 27 May to 10 November 2004, 23 May to 10 October 2005, and 19 May to 2 November 2006. Total fecal counts were standardized to droppings per day per m, using the number of preceding days since the last count.

The number of droppings counted per day per m was compared between years within treatments using Kruskal-Wallis one-way analysis of variance, because data did not meet the assumption for normality (Zar 1984). Then number of geese observed was compared between years within treatments using Kruskal-Wallis one-way analysis of variance. Treated and control sites were not compared, because the sites could not be considered as independent sites because of documented interchange of geese among sites.

RESULTS

Nuisance Abatement

During 2004, we hazed geese on 73 days in Orange County, from 24 May to 10 November, and made 364 site visits ($\bar{x}$ = 1.2 visit/day), hazing an average 175 geese

/day. The border collie and remote-controlled boat combination was used in 70% of 189 events and removed all geese on site 72% of the time. The border collie alone was used in 11% of 189 events and removed all geese on site 70% of the time. We documented 12,800 goose flights (sum of geese in all flocks chased) out of parks. No geese were present at a treatment site on 22 visits.

During 2005, geese were hazed on 86 days, from 19 May to 29 October 2005, with an average of 109 geese hazed/day (-37% compared to 2004). The border collie/remote-controlled boat combination was used on 28% of 239 events and removed all geese 62 % of the time. The border collie alone was used on 53% of 239 events and removed all geese on site 68% of the time. Sites were visited 516 times, and we documented 9,432 goose flights out of parks. No geese were present at a treatment sites on 130 visits.

During 2006, geese were hazed on 106 days, from 11 May to 3 November, with an average of 78 geese hazed/day (-28% compared to 2005). We visited parks 786 times ($\bar{x} = 2.5$ visits/day). The collie and remote-controlled boat combination was used in 31% of 271 events and removed all geese on site 92% of the time. The border collie alone was used in 25% of 271 events and removed all geese on site 79% of the time. We documented 8,297 goose flights out of the parks. No geese were present at a treatment site on 475 visits.

Population Stabilization

Nest searches were conducted and eggs oiled for all 3 years of the project. Nest searches took anywhere from 2 to 8 hours to complete depending on the size of the location. During each visit, all eggs located were oiled, even if they had already been oiled on previous site visits. For each year, only the highest number of nests and eggs are reported. On 6 April, 15 April, and 26 April 2004, a total of 299 eggs from 65 nests were oiled during 3 visits to Orange County. Eggs were treated at control sites and adjacent wetlands only. Sites were monitored from May to June 2004, and 160 goslings were observed at treatment sites. During the following year, at the request of the county, all locations were searched for nests as well as adjacent wetlands. From 15 April to 2 May 2005, 404 eggs from 72 nests were oiled. Monitoring of all oiled sites found 35 goslings. A total of 473 eggs from 92 nests were oiled from 4 April to 20 April 2006. A total of 24 goslings were observed at oiled sites. Only the highest number of goslings observed at each site was recorded. There were no goslings observed on Mill Pond or Thomas Bull in 2006.

Harassment

The mean number of geese observed at managed sites was documented on days when fecal counts were conducted. The mean number of Canada geese observed at managed sites decreased ($T = 357.9$, $P < 0.01$) each year of the study. The mean number of geese at unmanaged sites remained stable ($T = 3.35$, $P = 0.18$) during the study period.

During 2004, we found that geese responded to being chased by the border collie by flying into the water. The dog was subsequently sent into the water to continue

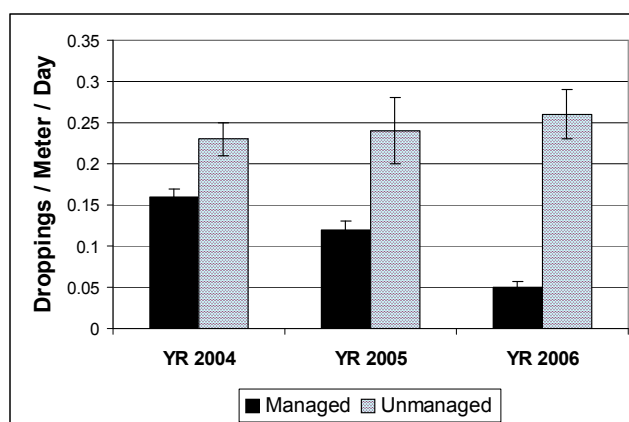


Figure 1. The mean number of Canada goose droppings counted along 100-meter transects at managed and unmanaged sites in Orange County, NY.

the chase. In some instances, it took up to 45 minutes for the geese to leave the water and the site. Using the remote-controlled boat without the dog resulted in geese leaving the water and running up on shore, but did not result in them flying away from the site. The combination of border collie and remote-controlled boat together was the most effective combination used. With this combination, all geese were removed from a site during 72% of 189 events in 2004. After the molt, the same combination removed all the geese in 95% of 111 events. Use of the border collie and remote-controlled boat reduced the goose population at the managed sites by 71% during the first month of use. The average amount of time required to clear a site of geese was 33 minutes.

Fecal Counts

The mean number of Canada goose droppings at managed sites decreased ($T = 56.6$, $P < 0.01$) each year while unmanaged site counts remained stable ($T = 0.23$, $P = 0.89$) (Figure 1).

Marked Geese

While no standardized route was driven to document collared geese, collared geese observations were made while driving and working throughout the study area on a daily basis. Only 2 geese were observed from those collared at Chadwick Lake ($n = 10$) during the 3-year study. Also, geese collared at Twin Lakes were seldom observed during the study. Band return data showed that many of these geese were likely molt migrants from Long Island and Pennsylvania. In 2004, collar observations were made from 28 June to 10 November; during that period, collared geese from Algonquin Park were observed on 298 occasions at managed sites where they were chased away 5-13 times each (mean = 9.25, $n = 21$). The same geese were observed 159 times at unmanaged sites.

During 2005, collar observations were made from 18 May to 28 October. An additional 30 geese were collared at Washington Lake on 8 July 2005. Collared geese were observed on 137 occasions at managed locations, and 231 times at unmanaged sites. Collared

geese from Algonquin Park were chased away 1-16 times each (mean = 5.2, $n = 24$). Six collars from Washington Lake appeared at Algonquin Park, a distance of 3.9 km, and were chased away once and not observed at Algonquin Park for the remainder of the year.

In 2006, collar observations were made from 11 May to 30 November. Collared geese were observed on 66 occasions at managed sites, and 250 times at unmanaged sites. Collared geese from Algonquin were chased away 1-10 times each (mean = 2.7, $n = 16$). Over the 3 years, there was a 78% reduction in the number of collared geese observed at managed sites, and a corresponding 57% increase in collared geese at unmanaged sites.

Collared geese were observed on the airfield of Stewart International Airport on 3 occasions and were associated with flocks of up to 20 geese. Collared geese were frequently observed at unmanaged locations around Newburgh. The furthest movement recorded by geese within the study area was 3.9 km and was made by geese moving from Washington Lake to Grainger. The furthest movement outside the study was of a goose banded in Newburgh and hunter harvested 632 km away near Quebec City, Canada, in 2005.

During the course of this study, 7.5% of the banded geese were hunter harvested, with band returns coming from New York (8), Pennsylvania (4), Maryland (2), and Delaware (1).

Program Costs

Funds for the 3 years of this study were provided through a Congressional directive. Material costs were \$7,500, which included the purchase of a trained border collie, 2 remote-controlled boats and batteries, a battery charger, kayak, life vests, and miscellaneous items. The salary for one person to harass geese from the 5 locations, visiting each site 3 times per day, 5 days per week for 8 months, was \$32,000.

DISCUSSION

Management of nuisance geese on private and public land has spawned a new industry that uses border collies as a management tool. The success of these companies suggests that few people and communities are willing to use lethal methods to control Canada goose populations. Unfortunately, the same property owners and communities are surprised at the amount of effort involved; typically, multiple visits are required per day several days a week, and our research showed that the same flock of geese may have to be chased away up to 21 times during the season. Some locations required up to 5 hours of harassment per visit, as the geese would fly from one extreme end of the park to the other. The goal is to get the geese to leave the site entirely, and in these situations, moving geese is physically demanding work, as a person constantly had to stay with them and keep them moving to encourage them to leave.

Several of the locations we worked with did not have the funds necessary to hire a staff member to chase geese, or they were concerned about purchasing and housing a dog and acquiring all the materials necessary to perform the work. Our research showed that the collared

geese would return to the parks in the spring after ice-off, and the whole process would start again. That is why a multi-year budget is needed to accomplish management objectives.

A key element to successfully hazing geese from specific locations can be attributed to the reduction of goslings from the site, because adult geese defend their goslings and rarely abandoning them when threatened. Nest searches and egg oiling, which reduced the number of goslings, was enhanced by the participation of the local communities. The addition of 8 town employees and 18 park staff as well as the observations of the volunteers who attended the egg oiling training sessions allowed for more efficient and complete coverage of the areas.

As an example of the difficulty involved in moving adult geese with goslings, we highlight work done in July 2006 at Thomas Bull Park. We located a group of geese consisting of 6 adults, 22 goslings, and 1 domestic goose. The group was initially harassed for 65 minutes using a kayak and remote-controlled boat. The harassment was repeated the following day for the same duration. By the third day, this group had left the site and was not observed again that year. Pressuring flocks of geese in this manner caused the goslings to emit distress calls, which further distressed the adults. We believe this caused the adults to relocate broods to safer brood-rearing locations. The combination of egg oiling with harassment is an example of a successful integrated program, where one technique (oiling) reduced the necessity for another (harassment).

Holevinski et al. (2007) found that a remote-controlled boat and border collie combination removed greater than 90% of geese. Results would likely have been similar in this study had we not chosen to harass geese through the molt in 2004 and 2006. This was done because pressuring molted geese caused several of them to relocate to lower-impact areas within or near treatment sites. Castelli and Sleggs (2000) found that border collies successfully reduced geese at a corporate complex in New Jersey. At a nuisance/suburban site located in Rockland County, New York, Swift and Felegy (2000) experienced a >50% reduction of geese while conducting a similar study. During 2005 and 2006, the remote-controlled boat and border collie combination was used on 28% of all events. We believe this decreased in number of intervention was attributed to geese associating the dog with the remote-controlled boat and not attempting to land in water (53% of 239 events).

The collared goose data showed that geese did not move far from areas in which they were being hazed. For example, 16 geese collared at Algonquin in 2004 were hazed from the park 48 times in 2006. This shows a high site fidelity to an area from which they had been harassed for the past 3 years. Twelve of the 59 geese banded at Algonquin were observed at an unmanaged location 1.2 km away on 161 occasions in 2004. This is similar to findings by Holevinski et al. (2007) of hazed radio-marked geese moving an average of 1.18 km, at an urban site in Brighton, NY. Collared geese hazed in a Rockland County, NY study were observed <2 km from the hazing site (B. L. Swift, NYDEC, unpubl. data). While the number of geese utilizing the managed locations de-

creased, there was a corresponding increase in geese at unmanaged areas within 3 km of the managed locations. Hazing geese does not remove the problem flocks from the general area, but instead simply moves the targeted population to a nearby area, usually <2 km from the treatment sites. In some instances, those are low-impact areas, but often they are not.

Although geese were observed at all managed sites, fecal counts showed a gradual decrease in number of droppings over time, indicating that geese were spending less time loafing and foraging at those sites. The primary complaint of most communities experiencing goose damage is the accumulation of droppings. Using a combination of border collies and remote-controlled boats, we were able to significantly reduce the fecal load at management sites.

More than half of the geese collared in 2004 were still observed in 2006. This shows a high site fidelity to historic nesting and molting areas. Collared geese were readily observed throughout all management periods. A total of 57% of all collar observations occurred at the Newburgh Autopark, a site that was not managed and that was considered a low-impact site because it consisted of a large field and pond that was only used during car shows and sales events. This suggests that geese were learning to avoid the treatment sites during the day. Based on the decrease in the number of droppings documented during fecal counts, this avoidance likely continued throughout times when we were not on site harassing the geese.

Management Implications

It is unlikely that any park, town, community, or golf course will completely eliminate geese, even seasonally. However, adhering to and budgeting for a multi-year management plan will markedly reduce the conflicts created by Canada geese over time. The findings of this study were similar to previous research examining the use of border collies, remote-controlled boats, and lasers as tools to disperse geese from a location (Holevinski et al. 2007). This study documented the effectiveness and advantages associated with implementation of an integrated Canada goose management program using remote-controlled boats, dogs, kayaks and pyrotechnics in reducing the problem of site-specific goose overabundance and droppings. The disadvantages of this type of program are that it may be too costly or not cost-effective for some communities, and many times it moves the geese only short distances. The relocated geese may cause similar conflicts on nearby properties or can cause human health and safety issues at airports or freshwater reservoirs. Harassment programs of any type are not recommended in areas within 3 miles of an airport, due to the safety concerns of repeatedly forcing geese into the air in the vicinity of airplane approach routes (Baxter and Robinson 2007). Holevinski et al. (2007) found that hazing alone is unlikely to reduce nuisance goose populations in a community. Programs conducting egg oiling and hazing techniques are becoming more common as the nuisance goose problem increases. However, in order to stabilize the resident Canada goose populations in the 4 flyways at the current population level, 787,000 nests would have to be

removed (or treated to prevent hatching) annually for the next 10 years (Federal Register 2006).

Private landowners and communities should consider managing their nuisance geese through population reduction and organized hunting programs where practical. Reducing the adult goose population could bring overall goose numbers to more manageable levels and states in the Atlantic Flyway are shifting hunting seasons to specifically target resident goose populations. In urban and suburban areas, harassment programs or round-ups may be the only management options available, with harassment programs the least cost effective management option because of the duration of time and labor required to keep the geese away for any period of time. Communities should also recognize that by allowing nuisance populations to grow, migratory populations of geese are negatively impacted at breeding locations in northern Canada, as a result of competition for food resources. Nuisance geese that have a failed nesting often undertake molt migrations into Canada. The influx of those molt migrant geese results in lower gosling survival and lower body weights in migratory geese (Ankney 1996). Our study showed that fecal counts could be used as an index to measure success of a harassment program, and that harassing geese with remote-controlled boats and border collies was an effective method to reduce populations of nuisance geese on individual sites.

ACKNOWLEDGEMENTS

We are grateful to the Orange County Department Parks and Recreation and the Village of Monroe for their assistance in identifying study sites, Mary Ann Fallon and Barbara Leverett for border collie advise and training, and the New York State Department of Environmental Conservation for their assistance in collaring geese.

LITERATURE CITED

- AGUILERA, E., R. L. KNIGHT, and J. L. CUMMINGS. 1991. An evaluation of two hazing methods for urban Canada geese. *Wildl. Soc. Bull.* 19:32-35.
- ALLAN, J. R., J. S. KIRBY, and C. J. FEARE. 1995. The Biology of Canada geese *Branta canadensis* in relation to the management of feral populations. *Wildl. Biol.* 1(3):129-143.
- ANKNEY, C. D. 1996. An embarrassment of riches: Too many geese. *J. Wildl. Manage.* 60:217-223.
- BALDASSARRE, G. A., and E. G. BOLEN. 2006. *Waterfowl Ecology and Management*, Second Edition. Kreiger Publ. Co., Malabar, FL. 518 pp.
- BAXTER, A. T., and A. P. ROBINSON. 2007. Monitoring and influencing feral Canada goose (*Branta canadensis*) behaviour to reduce birdstrike risks to aircraft. *Int. J. Pest Manage.* 53(4):341-346.
- BYNUM, K. S., C. A. YODER, J. D. EISEMANN, J. J. JOHNSTON, and L. A. MILLER. 2005. Development of a nicarbazin as a reproductive inhibitor for resident Canada geese. *Proc. Wildl. Damage Manage. Conf.* 11:179-189.
- CASTELLI, P. M., and S. E. SLEGGS. 2000. Efficacy of border collies to control nuisance Canada geese. *Wildl. Soc. Bull.* 28(2):385-392.
- CLARK, L. 2004. A review of pathogens of agricultural and human health interest found in Canada Geese. Unpubl. report, USDA APHIS WS, National Wildlife Research Center, Fort Collins, CO.

- CLEARY, E. C., R. A. DOLBEER, and S. E. WRIGHT. 2006. Wildlife strikes to civil aircraft in the United States 1990-2005. Serial Report No. 12, Federal Aviation Administration, U.S. Department of Transportation, Washington, D.C.
- CONVERSE, K. A. 1985. A study of resident nuisance Canada geese in Connecticut and New York. Ph.D. dissert., University of Massachusetts, Amherst, MA. 84 pp.
- CONOVER, M. R., and G. S. KANIA. 1991. Characteristics of feeding sites used by urban-suburban flocks of Canada Geese in Connecticut. *Wildl. Soc. Bull.* 19:36-38.
- COOPER, J. A. 1998. The potential for managing urban geese by modifying habitat. *Proc. Vertebr. Pest Conf.* 18:18-25.
- COOPER, J. A., and T. KEEFE. 1997. Urban Canada Goose management: Policies and procedures. *Trans. No. Am. Wildl. Nat. Res. Conf.* 62:412-430.
- CUMMINGS, J. L., D. L. OTIS, and J. E. DAVIS, JR. 1992. Dimethyl and methyl anthranilate and methiocarb deter feeding in captive Canada geese and mallards. *J. Wildl. Manage.* 56(2):349-355.
- CUMMINGS, J. L., P. A. POCHOP, J. E. DAVIS, JR., and H. W. KRUPA. 1995. Evaluation of ReJeX-iT AG-36 as a Canada goose grazing repellent. *J. Wildl. Manage.* 59:47-50.
- DOLBEER, R. A., T. W. SEAMANS, B. F. BLACKWELL, and J. L. BELANT. 1998. Anthraquinone formulation (Flight Control™) shows promise as avian feeding repellent. *J. Wildl. Manage.* 62:1558-1564.
- DOLBEER, R. A., S. E. WRIGHT, and E. C. CLEARY. 2000. Ranking the hazard level of wildlife species to aviation. *Wildl. Soc. Bull.* 28(2):116-123.
- ESCHENFELDER, P. 2000. Jet engine certification standards. Amsterdam, The Netherlands, 17-20 April 2000. *Proc. Int. Bird Strike Committee* 25:535-540.
- FEDERAL REGISTER. 2006. Migratory bird hunting and permits: Regulations for managing resident Canada goose populations. Rules and Regulations, Department of the Interior. August 10, 2006. 71(154):45964-45993.
- FAIRAZL, S. D. 1992. An integrated approach to the management of urban Canada geese depredations. *Proc. Vertebr. Pest Conf.* 15:105-109.
- FORBES, J. E. 1993. Survey of nuisance urban geese in the United States. *Proc. Gt. Plains Wildl. Damage Control Workshop* 11:92-101.
- GOSSER, A. L., M. R. CONOVER, and T. A. MESSMER. 1997. Managing problems caused by urban Canada geese. Berryman Institute Publication 13, Utah State University, Logan, UT. 8 pp.
- GRACZYK, T. K., R. FAYER, J. M. TROUT, E. J. LEWIS, C. A. FARLEY, I. SULAIMAN, and A. A. LAL. 1998. *Giardia* sp. cysts and infectious *Cryptosporidium parvum* oocysts in the feces of migratory Canada Geese. *Appl. Environ. Microbiol.* 64(7):2736-2738.
- HOLEVINSKI, R. A., P. D. CURTIS, and R. A. MALECKI. 2007. Hazing of Canada geese is unlikely to reduce nuisance populations in urban and suburban communities. *Human-Wildl. Conflicts* 1(2):257-264.
- JOHNSON, F. A., and P. M. CASTELLI. 1998. Demographics of "resident" Canada geese in the Atlantic Flyway. Pp.127-133 in: D. H. Rusch, M. D. Samuel, D. D. Humburg, and B. D. Sullivan (Eds.), *Biology and Management of Canada Geese*. Proceedings of the International Canada Goose Symposium, Milwaukee, WI.
- LOWNEY, M., P. EGGBORN, G. COSTANZO, and D. PATTERSON. 1997. Development of an integrated Canada goose management program in Virginia. *Proc. East. Wildl. Damage Manage. Conf.* 8:173-188.
- MOTT, D. F., and S. K. TIMBROOK. 1988. Alleviating nuisance Canada goose problems with acoustical stimuli. *Proc. Vertebr. Pest Conf.* 13:301-304.
- NELSON, H. K., and R. B. OETTING. 1998. Giant Canada goose flocks in the United States. Pp. 483-495 in: D. H. Rusch, M. D. Samuel, D. D. Humburg, and B. D. Sullivan (Eds.), *Biology and Management of Canada Geese*. *Proc. Int. Canada Goose Symposium*, Milwaukee, WI.
- SAUER, J. R., J. E. HINES, and J. FALLON. 2006. The North American Breeding Bird Survey, Results and Analysis 1966 - 2005. Version 2006.2, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, MD.
- SEAMANS, T. W., and G. E. BERNHARDT. 2004. Response of Canada geese to a dead goose effigy. *Proc. Vertebr. Pest Conf.* 21:104-106.
- SHEAFFER, S. E., and R. A. MALECKI. 1998. Status of Atlantic Flyway resident nesting Canada geese. Pp. 29-34 in: D. H. Rusch, M. D. Samuel, D. D. Humburg, and B. D. (Eds.), *Biology and Management of Canada Geese*. *Proc. Int. Canada Goose Symposium*, Milwaukee, WI.
- SMITH, A. E., S. R. CRAVEN, AND P. D. CURTIS. 1999. Managing Canada geese in urban environments: A technical guide. Jack Berryman Institute Publication 16. Cornell Cooperative Extension, Ithaca, NY. 42 pp.
- SWIFT, B. L. 2000. Suburban goose management: Insights from New York State. *Proc. Wildl. Damage Manage. Conf.* 9:307-321.
- SWIFT, B. L., and M. FELEGY. 2000. Response of resident geese to chasing by border collies. Unpubl. report., New York State Department of Environmental Conservation, Bureau of Wildlife, Wildlife Research Center, Delmar, NY. 6 pp.
- USDI (U.S. DEPARTMENT OF THE INTERIOR). 2003. 2003 Final Environmental Impact Statement: Resident Canada goose management. U.S. Fish and Wildlife Service, Washington, D.C. 250 pp. + appendices.
- USFWS (U.S. FISH AND WILDLIFE SERVICE). 2002. Waterfowl population status, 2002. U.S. Department of the Interior, Washington, D.C. 51 pp.
- USFWS (U.S. FISH AND WILDLIFE SERVICE). 2007. Waterfowl population status, 2007. U.S. Department of the Interior, Washington, D.C.
- USFWS (U.S. FISH AND WILDLIFE SERVICE). 2008. Waterfowl population status, 2008. U.S. Department of the Interior, Washington, D.C.
- VERCAUTEREN, K. C., and D. R. MARKS. 2003. Movements of urban Canada geese: Implications for nicarbazin treatment programs. Pp. 151-156 in: T. J. Moser, R. D. Lien, K. C. VerCauteren, K. F. Abraham, D. E. Andersen, J. G. Bruggink, J. M. Colucey, D. A. Graber, J. O. Leafloor, D. R. Luukkonen, and R. R. Trost (Eds.), *Proceedings, Int. Canada Goose Symposium*. March 19-21, 2003, Madison, WI.
- WOODRUFF, R. A., J. SHELTER, K. MCALLISTER, D. M. HARRIS, M. A. LINNELL, and K. I. PRICE. 2004. Resolving urban Canada goose problems in Puget Sound, Washington: A coalition-based approach. *Proc. Vertebr. Pest Conf.* 21:107-112.

YORK, D. L., J. L. CUMMINGS, and K. L. WEDEMEYER. 2000.
Movements and distribution of radio-collared Canada geese
in Anchorage, Alaska. Northwest. Nat. 81:11-17.
ZAR, J. H. 1984. Biostatistical Analysis, 2nd Ed. Prentice-Hall,
Englewood Cliffs, NJ. 718 pp.

