2007

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Robin A. Holevinski
New York State Department of Environmental Conservation

Paul D. Curtis
Cornell University

Richard A. Malecki
Cornell University

Human–Wildlife Conflicts 1(2):257–264, Fall 2007

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ROBIN A. HOLEVINSKI, New York State Department of Environmental Conservation, 182 East Union Street, Suite 3, Alleghany, NY 14706-1328, USA

PAUL D. CURTIS, Cornell University, Department of Natural Resources, Fernow Hall, Ithaca, NY 14853, USA *pdc1@cornell.edu*

RICHARD A. MALECKI, USGS, New York Cooperative Fish and Wildlife Research Unit, Cornell University, Ithaca, NY 14853, USA

Abstract:
Growing populations of resident Canada geese (*Branta canadensis)* have caused increased nuisance problems in urban and suburban communities. Hazing, or persistent harassment, is often recommended as a nonlethal management strategy to alleviate these problems. Does hazing simply cause a local redistribution of birds, or can it solve nuisance problems by pushing geese to rural areas where hunting mortality could reduce the population? To answer this question, we marked 368 adult and 400 juvenile geese with leg bands in 1 urban and 1 suburban community in western New York State during June 2002 and 2003. This sample included 30 adult females with radio-transmitters and 151 adults with individually coded neck bands. From August 15 to September 25 and October 25 to November 15, we subjected these geese and their flock mates to post-molt hazing with border collies, lasers, pyrotechnics, remote-controlled boats, strobe lights, kayaks, a goose distress call device, or a combination of these techniques. Hazing was most successful using border collies in conjunction with remote-controlled boats (>90% of geese removed in 97% of 37 events), border collies alone (94% of 113 events), and nocturnal use of lasers (64% of 134 events). Radio-marked individuals demonstrated a strong affinity to hazing sites, averaging 16.9 hazing events per individual. Geese moved to areas where hazing was not permitted and were available for hazing only 51% of the time (n = 739). Geese moved 1.18 km (SD = 0.91) <2 hours after 153 hazing events, which was not far enough to place them in areas open to hunting. Although hunting was permitted >5 km from hazing treatment sites, only 13% (SE = 0.01) of adult geese and 7% (SE = 0.01) of juveniles were harvested in 2 years. Hazing alone is unlikely to reduce goose populations in urban and suburban communities by exposing them to hunting in adjacent rural areas.

Key words: border collies, *Branta canadensis*, Canada geese, hazing, human–wildlife conflicts, hunting mortality, lasers, nuisance control, pyrotechnics, remote-controlled boat

CANADA GEESE (*Branta canadensis*) that nest or reside primarily in the temperate latitudes of North America are generally referred to as resident geese. In recent years, resident Canada goose populations have increased dramatically, with estimates for the northeastern United States being approximately 1 million birds (Conover and Chasko 1985, U.S. Fish and Wildlife Service 2003). With this growth has come an increase in the number of conflicts with people and human-related activities, especially in urban and suburban landscapes (Nelson and Oetting 1981, Conover 1985, Conover and Chasko 1985).

Conflicts arise from the congregation of geese in parks, playgrounds, athletic fields, residential areas, corporate complexes, golf courses, college campuses, airports, and shopping malls. Often these areas consist of mowed lawns in close proximity to water (Conover and Chasko 1985, Conover and Kania 1991, Cooper and Keefe 1997). Reasons for conflict include accumulation of feathers on lawns, water quality degradation, increased noise from vocalizations by geese, attacks by aggressive geese (Forbes 1993), and aircraft hazards (Nelson and Oetting 1998). Geese cause damage to turf by grazing and trampling, while accumulation of fecal deposits leads to unsightly and unsanitary conditions and concerns of disease transmission (Smith et al. 1999). When goose populations reach nuisance levels, innovative and acceptable management strategies are needed to effectively reduce conflicts. This usually involves a combination of lethal and nonlethal techniques (Coluccy 2001).

Lethal techniques for controlling goose populations, such as euthanization and hun-

ting, are often not accepted nor applicable in some locations. Euthanization can reduce a local goose population in a brief time, but moral and ethical issues arise, even when meat is processed and donated to food banks (Cooper and Keefe 1997). Hunting is a successful means of reducing Canada goose populations in rural areas (Conover and Chasko 1985), although in many urban and suburban locations it may not be effective due to safety concerns, public opposition, or local ordinances that prohibit the discharge of firearms (Smith et al. 1999).

Some communities and individual landowners in urban and suburban areas have taken steps to alleviate goose conflicts through nonlethal hazing programs, which are more socially accepted than lethal control techniques. Hazing, defined as the continuous harassment of birds until they leave a location, is frequently suggested as an option for urban and suburban goose control. Hazing techniques have been designed to scare geese using audio or visual stimuli. Trained border collies have been used effectively to chase geese out of problem areas (Castelli and Sleggs 2000). Pyrotechnics used as scare devices may be a temporary solution until geese become accustomed to the noise (Heinrich and Craven 1990). More recently, long-wavelength lasers directed toward geese were found to be a safe and effective method of removing birds from problem sites (Blackwell et al. 2002, Sherman and Barras 2004). A combination of hazing techniques may be necessary to move geese from multiple problem sites within urban and suburban communities, but where geese move in response to hazing is an important consideration.

One hypothesis having merit is that hazed geese will move from sites where they cause problems to areas where they may be exposed to hunting. However, this has not been adequately tested. The objectives of this study were to haze geese from problem sites with the intent of moving them completely out of a community, monitor their movements in direct response to hazing, and determine the efficacy of postmolt hazing to disperse geese and increase their exposure to hunting.

Study area

We selected 1 urban and 1 suburban community in western New York State, both with a history of goose-related complaints. The town of Brighton (Figure 1) is located in an urban area of Monroe County and directly borders the city of Rochester. The town encompasses 40 km^2, with an approximate population of 36,000 people and a housing density of 250/km^2. The town has developed a task force to discuss goose issues, and a border-collie service is used to haze geese at 1 public park and 2 privately-owned sites. Volunteers also participate in egg-oiling programs, coating eggs with vegetable oil to prevent gas exchange and reduce the annual production of young. The discharge of firearms is prohibited, and noise ordinances are in effect.

The town of Clarence (Figure 1) is a suburban community in Erie County and located 32 km northeast of downtown Buffalo. The town is approximately 85 km^2 with a population of 26,000 people at the time of our study and a housing density of 110/km^2. Over 52% of the total area is considered agricultural, but land is continually being converted to residential subdivisions with multiple drainage ponds, which attract geese. From 2001 to 2003, Clarence participated in an egg-oiling program and received a depredation permit to remove 20 nuisance Canada geese per year. Hunting is prohibited in parks and residential areas where geese are causing problems.

Methods

Capture and banding

In late June 2002 and 2003, we used drive-traps to capture 245 adult and 169 juvenile geese in at the urban site and 123 adults and 231 juveniles at the suburban site during their summer molt when the birds were flightless. Geese were aged, sexed, and fitted with standard aluminum U.S. Fish and Wildlife Service leg bands. All geese were handled in accordance with New York State Department of Environmental Conservation animal handling protocols.

In 2002, backpack-style radio transmitters, manufactured by Advanced Telemetry Systems (ATS, Isanti, Minnesota, Model A1560, 48 g; mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. government), were attached by elastic harness to 9 adult females in each community. Radio-marked geese were also fitted with a red plastic tarsal band with a unique white 3-letter code. Only adult females exhibiting a brood patch were radio-marked

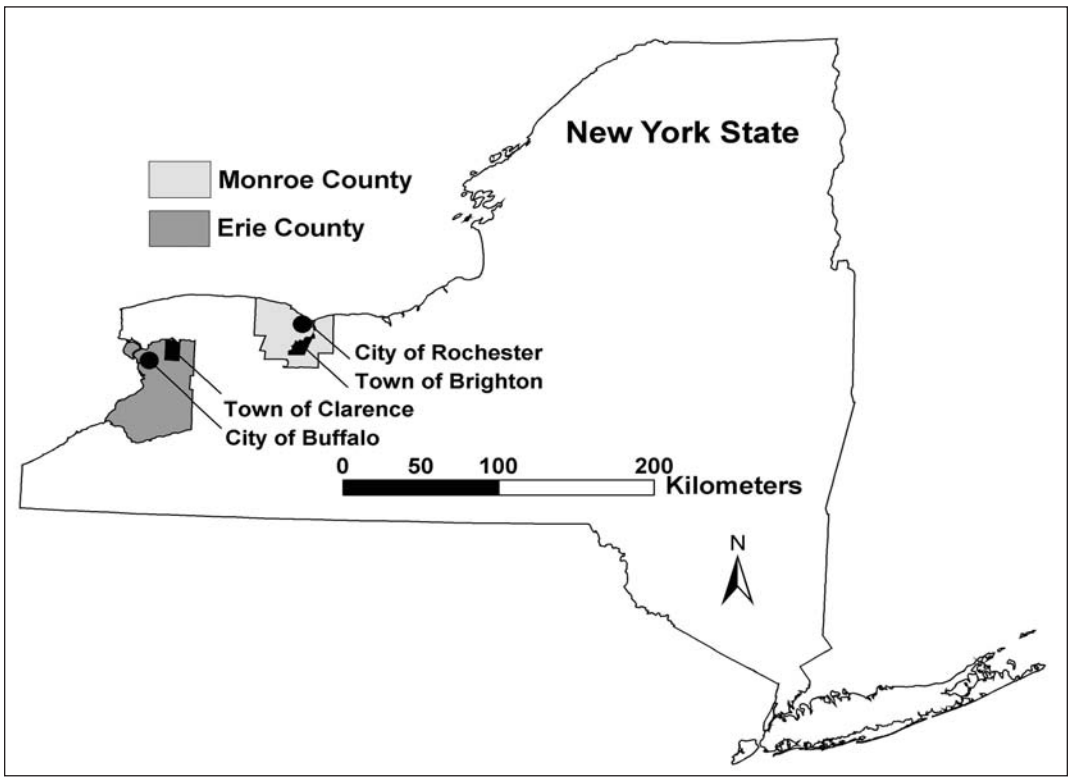

Figure 1. Study sites in western New York State where Canada goose hazing was done in an urban (town of Brighton, Monroe County, near city of Rochester) and suburban community (town of Clarence, Erie County, near city of Buffalo), 2002 and 2003.

to increase the likelihood of tracking geese in family groups through the hazing periods and to avoid marking a male-female pair that would provide similar movement data. In 2003, radio transmitters attached to plastic neckbands (ATS, Model A3880, 57 g) were placed on 7 adult females at Brighton and 5 females at Clarence. To supplement observational data of goose movements in 2003, a sample of adult geese (n = 118, Brighton; n = 33, Clarence) was fitted with plastic neckbands inscribed with unique alphanumeric codes.

Hazing

When geese regained flight after their summer molt, radio transmitters were used to locate problem flocks within each study site. Information recorded included date, time, location, number of geese present, transmitter frequency, and neck collar code. Movements of radio-marked and neck-collared geese were monitored during hazing periods, and locations were plotted using ArcView GIS v. 3.3 (Environmental Systems Research Institute, Inc., Redlands, Calif.).

Hazing included the use of border collies, pyrotechnics (Scare-Away Bird Bangers and Screamer Sirens with a 15-mm Single Shot Launcher, Reed-Joseph International Company, Greenville, Mo.), remote-controlled boats (AquaCraft Air Force™, Hobbico©, Champaign, Ill.), lasers (Avian Dissuader®, SEA Technology, Inc., Lebanon, Ky.), strobe lights, kayaks, a goose distress call device (GooseBuster®, Bird-X, Inc., Chicago, Ill.), or a combination of these. Individual hazing sites were similar within and among study areas, typically consisting of properties with mowed lawns in close proximity to open water. Hazing sites were evaluated to determine which hazing techniques could be used based on public perception, traffic considerations, town ordinances, and permission from townships and private landowners. Hazing occurred only where permission was granted, and only techniques approved for each site were used.

During 2002 and 2003, hazing was conducted at 5 sites in the town of Brighton (urban) and 4 sites in the town of Clarence (suburban) from

August 15 to September 25, a period 2 weeks prior to and through the special September Canada goose hunting season, and October 25 to November 15, the first 22 days of the regular waterfowl hunting season. Hazing occurred both day and night, alternating between study sites (towns). A hazing event was defined as the time a technique or combination of techniques was used to disperse geese from an area. If geese moved off of the property and were subsequently hazed at another location, a separate hazing event was recorded. When hazing occurred, the date, time, location, number of geese present, hazing technique(s) used, duration of hazing session, and number of geese remaining after hazing were recorded. At night, geese were counted in areas where there was sufficient light, or spotlights were used to illuminate an area to estimate the number of geese present. Events involving border collies occurred between 0700 and 2000 hours. Lasers were used only between 2000 and 0700 hours due to the need for low-light conditions.

The effectiveness of each hazing technique was calculated as a percentage by dividing the number of geese remaining after hazing by the number of geese present before hazing. A hazing event was considered successful only when >90% of geese were removed from the property. Ninety percent was chosen because the purpose of hazing was to remove as many geese as possible from problem sites, while realizing that some geese would not leave an area when hazed. If geese did not leave an area within 30 minutes, the hazing event was determined unsuccessful, and the hazing session ended. Hazing events were pooled across study sites to determine overall success of each technique.

Mean distances traveled by radio-marked geese from hazing sites to subsequent locations <2 hours after hazing were calculated from locations plotted in ArcView GIS. Affinity of geese to hazing sites was determined by the average number of times radio-marked and neck-collared geese were hazed throughout the September to November hazing periods. Availability of geese for hazing was determined as the percentage of total observations of radio-marked geese recorded at hazing sites. Geese were unavailable for hazing when located at sites where landowner permission was not granted to haze geese or where landowners prohibited the use of hazing techniques during a specified time of day.

Mortality

In 2002 and 2003, leg-band recoveries of adult and juvenile birds shot or found dead during the September Canada goose hunting season and the regular waterfowl hunting season were obtained from the U.S. Geological Survey Bird Banding Laboratory (Laurel, Md.). Only direct band recoveries, (i.e., recoveries during the first hunting season after banding) were used to evaluate vulnerability of geese to harvest.

Results

Hazing

Geese were hazed on 378 separate occasions (Figure 2). Techniques most frequently used were lasers (n = 134), border collies (n = 113), laser/pyrotechnic combinations (n = 54), border collie and remote-controlled boat combinations (n = 37), and pyrotechnics (n = 27) alone. Border collie and remote-controlled boat combinations removed >90% of geese in 97% of events, while border collies alone were successful in 94% of events. Laser and pyrotechnic combinations removed >90% of geese in only 64% of events; lasers were successful in 64% of events, and pyrotechnics in 59% of events.

The mean amount of time to successfully remove geese from a site varied with the technique used. Geese left the sites after a mean of 4.2 (SE = 0.6, range 1–30) minutes with lasers, 5.1 (SE = 1.8, range 1–25) minutes with pyrotechnics, 6.3 (SE = 1.2, range 1–26) minutes with laser and pyrotechnic combinations, 6.4 (SE = 0.8, range 1–30) minutes with border collies, and 17.5 (SE = 2.5, range 1–30) minutes with border-collie and remote-controlled boat combinations.

Hazing events (n = 4) using a goose distress call device never moved geese from a location. Three events using strobe lights also were ineffective; geese swam within 5 m of the light without being disturbed. Similarly, in 4 events, geese chased with kayaks would not leave the water. Two attempts at using kayaks and pyrotechnics in combination did not remove any geese during daylight hours. We discontinued use of these techniques and excluded them from further analysis. Average flock size during hazing periods was 47 (SE = 3.7) from August to September and 146 (SE = 10.8) from October to

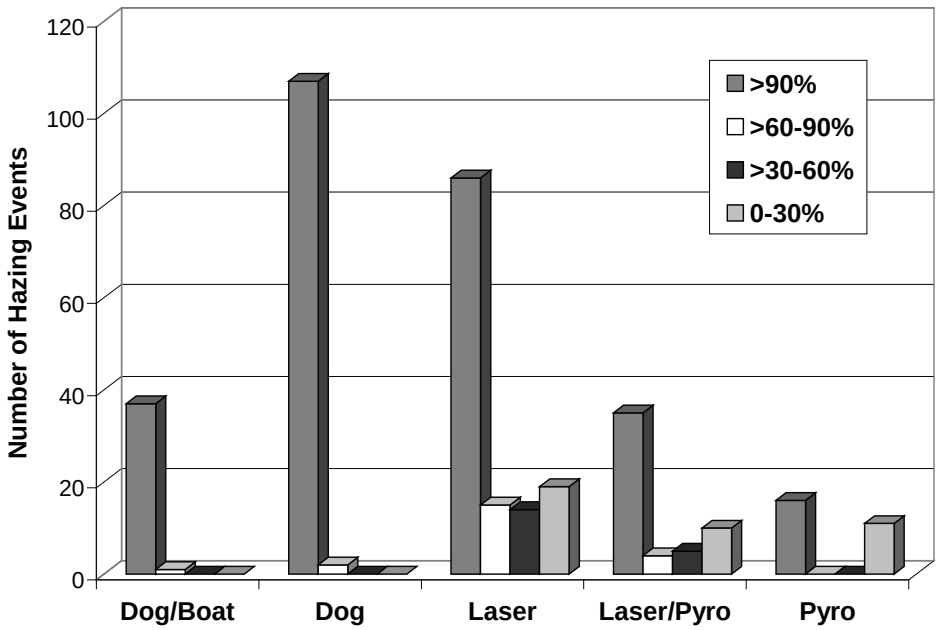

Figure 2. Percentage of resident Canada geese removed during each hazing event with border collie and remote-controlled boat combinations (Dog/Boat), border collies (Dog), lasers (Laser), laser and pyrotechnic combinations (Laser/Pyro), and pyrotechnics (Pyro) in Brighton and Clarence, New York, 2002 and 2003.

November. This was consistent between years, with the seasonal increase likely attributed to fall movements of local and migrant birds.

The average distance moved by radio-marked geese from a hazing site to a subsequent location <2 hours after hazing was 1.18 km (SD = 0.91, n = 153). Directly following a hazing event, geese moved a mean distance of 1.08 km (SD = 0.87, n = 61) with lasers, 0.80 km (SD = 0.34, n = 16) with border collies, 0.72 km (SD = 0.65, n = 41) with laser and pyrotechnic combinations, 0.61 km (SD = 0.31, n =24) with border collie and remote controlled boat combinations, and 0.53 km (SD = 0.42, n = 11) with pyrotechnics. Immediately after being hazed, geese moved to similar conflict sites within the community 80% of the time, and moved to alternate wetlands within the community where they were less likely to cause conflicts 19% of the time. Geese were tracked directly to a location where hunting could occur after only 1% of hazing events.

Radio-marked geese were located 739 times in this study, but were only hazed 378 times (51%). The remaining 49% of goose locations were in areas where hazing was not per-mitted. Only 23 of 30 radio-marked individuals were exposed to hazing techniques during the study. Seven birds were never located in hazing areas or died before hazing began. Observations of neck-collared geese were not used to determine availability for hazing because many hazing events occurred at night when neckbands could not be seen.

During the hazing periods, 122 of 151 (80%) neck-banded geese were observed near hazing sites. The remaining 29 (20%) neck-collared geese were never seen. Only 64 of 1,600 observations (4%) of these neck-banded geese occurred in areas open to hunting, 5–30 km from hazing sites.

Mortality

Although areas open to goose hunting existed <10 km from each study site, only 13.6% (SE = 0.01) of adult geese (n = 338), 7.5% (SE = 0.01) of juveniles (n = 400), and 8.0% (SE = 0.07) of radio-marked adults (n = 23) banded at hazing sites were harvested during open hunting seasons in this 2-year study. Of 46 geese harvested, 41 were recovered <50 km from the hazing sites, and 5 were recovered out-of-state.

Discussion

Many nonlethal hazing techniques have had limited success (Conover and Chasko 1985, Smith et al. 1999) because the techniques shift geese

from 1 location to another (Forbes 1993). They also can be costly and ineffective in providing long-term control (Hindman and Ferrigno 1990), often needing repeated treatments (Conover 1985, Cummings et al. 1991). Use of some techniques is limited due to public perceptions or town ordinances (Forbes 1993). A variety of techniques are available, but land use, public acceptance, and permission of landowners may limit their application (Allan et al. 1995). Despite these limitations, hazing continues to be a popular and accepted method of goose control in urban and suburban environments.

Border collies alone and border collies used in conjunction with remote-controlled boats were our most successful hazing techniques during daylight hours. Because border-collie handlers worked under contract for this study, use of dogs was limited to only 3 hazing sites within the urban study area. However, border collies would likely have removed geese from similar hazing sites in the suburban community. Despite their success in removing geese from problem sites, dogs chased geese 113 times at 3 hazing sites within a 3-month period. Therefore, geese were only temporarily removed from hazing sites and returned multiple times when dogs were not present. These findings were similar to border collie studies in Rockland County, New York, in 1997 and 1998 that showed that geese always left a hazing site when chased by dogs, but always returned (B. L. Swift, New York State Department of Environmental Conservation, unpublished data).

Lasers and laser and pyrotechnic combinations effectively removed geese from individual roost sites when we were in close proximity to the birds, and the laser beam could be directed at or near them. The limited effectiveness in 35% of events was attributed to obstructions in water bodies, such as islands, peninsulas, and patches of vegetation, which prevented the beam from reaching geese on their roost sites.

When pyrotechnics were used during the day, geese flew only far enough to avoid the stimulus. Because geese would not leave a hazing site in these instances, only 59% of hazing events involving pyrotechnics were considered effective (>90% removal of geese). Other studies indicate pyrotechnics only provide short-term relief, because geese habituate to the noise (Mott and Timbrook 1988, Heinrich and Craven 1990, Aguilera et al. 1991). During this study, town employees and individual landowners were observed using pyrotechnics at several sites, so geese may have habituated to them before this study began. Pyrotechnic use was limited to only a few sites in this study due to public perceptions, safety concerns, and noise ordinances, especially in residential and highly developed areas.

Most urban and suburban communities have numerous mowed lawns and man-made or natural water bodies that are preferred by geese (Conover and Kania 1991). Geese were mostly observed on lawns or ponds, but they also were found in less traditional areas, such as rooftops and parking lots. Their access to these nearby areas, where hazing was not allowed, greatly limited our ability to harass them continuously. Therefore, hazing had an impact on the localized movements of geese, but did little to move geese permanently out of study areas.

The distance that geese move in response to hazing often depends on flock size, frequency and predictability of the stimulus, and site conditions (Madsen and Fox 1995). Similar to our findings, Sherman and Barras (2004) reported that geese hazed with lasers moved <2 km from urban sites in Ohio. Even with intensive hazing (24 hours/day), post-molting geese at the Elmendorf Air Force Base in Anchorage, Alaska, moved only 3.53 ± 0.2 km (York et al. 2000). Some of our geese moved up to 3.6 km after a hazing event, but this distance was often not far enough to place them in areas accessible to hunting, or they used locations where hazing and hunting were prohibited.

We are uncertain whether movements geese made away from the study sites into areas open to hunting were a direct result of hazing. Because the study sites were close to agricultural fields (<10 km from all treatment sites), it is conceivable that some geese were making flights to feed on waste grain when they were harvested (Koerner et al. 1974, Craven and Hunt 1984). In larger metropolitan areas, where Canada goose conflict sites are farther from agricultural fields, foraging flights and resulting exposure to hunting may not occur.

The success of a Canada goose hazing program depends on the perspectives and roles of people in a community. Landowners who want geese removed from their property may consider a hazing program successful if geese simply move

onto a neighboring property. Local officials who receive complaints on a town- or city-wide basis, however, would label a program unsuccessful if geese simply move to similar locations within the community and continue to cause problems. However, if geese begin using sites that do not cause conflicts with people, hazing could be considered successful. Hazing geese to alternative sites throughout a community may have short-term benefits, but does not control increasing numbers of geese. Some type of direct removal (e.g., hunting, summer round-ups) is required for population management of resident goose flocks.

Management implications

This study confirmed previous research that hazing can disperse resident Canada geese from individual sites, especially with the use of border collies during daytime hours (Castelli and Sleggs 2000) and lasers at night (Blackwell et al. 2002, Sherman and Barras 2004). However, this dispersal is only short-term. Geese do not move far from hazing locations, and without continual harassment they will likely return.

Most auxiliary-marked geese and associated flocks in this study did not move far enough from hazing sites to be exposed to hunting. Therefore, hazing did not directly contribute to the reduction of Canada goose populations within communities. Instead, hazed geese often moved to nearby areas within study sites, potentially causing problems at new locations within the community. When implementing a hazing program on their property, landowners and property managers should consider potential impacts of Canada geese to surrounding areas.

Dispersing geese from several problem areas within a community would require frequent harassment of birds at each site and coordinated hazing efforts to prevent geese from using alternative locations. Hazing geese at every potential site would be virtually impossible due to the number of areas geese could use and property access limitations. Based on the time and effort needed to haze geese at multiple sites in this study, and the ability of geese to use a wide variety of habitats, hazing alone would not reduce goose populations at the community level.

Acknowledgments

We thank the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Geological Survey for financial and logistical support. We gratefully acknowledge NYSDEC wildlife biologists B. Swift, J. Eckler, D. Carroll, M. Kandel, T. Jurczak, and D. Odell; and fish and wildlife technicians S. Knowlton, D. Appleby, J. Curtiss, D. Dougherty, and B. Parton. Special thanks to all NYSDEC employees and volunteers who assisted with goose trapping. Border collie handling by G. Kornbau and R. Fess was an integral part of this research. Field work conducted by C. Sousa, T. Borchetta, and P. Mattison was greatly appreciated, as were volunteer efforts from the Brighton Goose Task Force and the Clarence Conservation Council. Logistical support and technical advice was graciously provided by the Pennsylvania and New York USDA/APHIS staff, and the Pennsylvania Game Commission, particularly J. Dunn and I. Gregg.

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ROBIN A. HOLEVINSKI (left in photo) is a senior wildlife biologist with the New York State Department of Environmental Conservation. She received a B.S. degree in biology and psychology from Eckerd College (1996), and an M.S. degree in wildlife science from Cornell University (2005). Her research focuses on wildlife management in urban and suburban landscapes, and nonnative species management.

PAUL D. CURTIS (right in photo) received a B.S. degree from West Virginia University (1978), an M.S. degree from Colorado State University (1981), and a Ph.D. degree from North Carolina State University (1990). He currently is an associate professor and extension wildlife specialist at Cornell University, and he has coordinated the wildlife damage management program there during the past 17 years. His research interests include wildlife damage management in urban and agricultural landscapes, wildlife fertility control, and resolving community-based wildlife issues.

RICHARD A. MALECKI (not pictured) is the assistant leader of the U.S. Geological Survey, New York Cooperative Fish and Wildlife Research Unit located on the Cornell University campus in Ithaca, New York. His primary research is in waterfowl biology, ecology, and management. He holds degrees in wildlife science from Cornell University (B.S.) and the University of Missouri (M.S. and Ph.D.).