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MOVEMENTS OF TRANSLOCATED AND NONTRANSLOCATED CANADA GEESE IN GEORGIA ESTIMATED WITH THE USE OF BAND RECOVERIES

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ABSTRACT

Overabundant populations of resident Canada geese *(Branta canadensis*) are an increasing source of human-wildlife complaints throughout the species' range. Many resident geese exploit urban areas, and translocation is one method of reducing nuisance problems associated with resident Canada geese. Translocated geese have similar harvest rates but lower survival rates than nontranslocated geese. To examine relationships between distance moved and the age, sex, and status of geese, we evaluated distances from banding sites to recovery sites for resident geese banded in Georgia, USA, during 2001–2015. We assessed potential differences in movements between rural and urban, and nontranslocated and translocated geese, by examining the distribution of band recoveries spatially. Rural and urban geese traveled similar distances; however, distances traveled by translocated geese were significantly farther than nontranslocated geese, and adults traveled significantly farther than juveniles. Our findings suggest that distances moved by resident geese are most often localized, and harvested birds were mostly recovered in-state.

Keywords: Canada goose, *Branta canadensis*, Georgia, distribution, movements, translocated, urban

INTRODUCTION

Canada geese (*Branta canadensis*) are an important waterfowl species throughout North America and are valued for wildlife viewing and recreational opportunities (McCoy 2000; Conover et al. 2015). Geese are identified and managed as either migratory or resident, with resident geese being defined as those that nest or reside year-round in the contiguous United States (Rusch et al. 1996; Ankney 1996). Populations of resident geese have increased many-fold since the 1990s and now outnumber migratory geese in every flyway (Dolbeer et al. 2014).

Resident geese are a source of human-wildlife conflicts (Conover and Chasko 1985; Ankney 1996; Conover 2011). Overabundant geese potentially pose a risk to human health through increased disease transmission, aircraft collisions, contamination of water, and accumulation of feces (Atlantic Flyway Council 2011). Furthermore, high densities of geese can cause economic loss through damage to property (e.g. managed turf areas) and agricultural crops (Conover and Chasko 1985; Ankney 1996; Smith et al. 1999; Atlantic Flyway Council 2011).

Population growth of resident Canada geese can be partially attributed to the species' ability to exploit urban and suburban areas, where anthropogenic activities

provide habitat conditions that promote survival and reproduction (Smith et al. 1999). Wildlife managers have difficulty managing resident goose populations because hunter harvest is reduced or not possible in urban areas (Ankney 1996; Coluccy et al. 2001; Balkcom 2010). Furthermore, previous research has shown that many resident geese make only local movements (Castelli and Trost 1996; Powell et al. 2004; Conover 2011; Beston et al. 2015), further preventing hunters from harvesting them outside of urban areas and ultimately creating additional challenges for managers (James and Krementz 2005; Gleason et al. 2015; Guerena et al. 2016).

Although historically migrant to Georgia and other southeastern states during the winter, migratory Canada geese are now largely restricted to more northerly portions of the Atlantic Flyway due to changes in available habitat (Crider 1967; Addy and Heyland 1968; Sheaffer and Malecki 1987). Because migrant geese stopped coming to Georgia, the Georgia Department of Natural Resources (GADNR) started a restocking effort, and between 1975 and 1987, relocated 8,000 Canada geese from northern states in the Atlantic Flyway to Georgia. The resident goose population has increased and become well-established in both urban and rural habitats (Powell et al. 2001; Stephens et al. 2007; Balkcom 2010).

Survival rates of geese inhabiting urban environments in Georgia are higher than their rural counterparts (Balkcom 2010), a pattern also observed in other states (Beston et al. 2014). Resident Canada geese in urban environments face greatly reduced pressure from hunter harvest, but harvest rates and survival rates of rural geese indicate that hunting may be at or near the maximum sustainable level in Georgia (Balkcom 2010). Survival rates of resident geese are suspected to be influenced by movements, with farther movements likely resulting in reduced survival (Castelli and Trost 1996; Johnson and Castelli 1998; Conover 2011; Beston et al. 2015; Ronke and Krementz 2015).

Controlling urban geese often involves agencies capturing and translocating nuisance geese out of those urban areas (Coluccy et al. 2001; Powell et al. 2004; Holevinski et al. 2006), a method that is viable and socially acceptable (Coluccy et al. 2001; Stephens et al. 2007). Translocation efforts are most successful in alleviating conflict when geese are translocated to areas where hunting can increase harvest rates (Holevinski et al. 2006; Powell et al. 2004; Balkcom 2011). Balkcom (2011) reported that translocated and nontranslocated geese in Georgia had similar harvest rates of about 8%, but survival rates were 62% for translocated and 76% for nontranslocated. We postulated that movements of translocated geese might be negatively impacting survival rates. As a first step to investigating relationships between movement and survival, we examined differences in movements between urban and rural geese and between translocated and nontranslocated geese. For this analysis, we used recovery distances obtained via banding data as a surrogate for movement. Our objectives were to assess recovery distances of geese banded in urban and rural areas, and assess recovery distances of geese banded and released on the capture site compared to translocated geese.

MATERIALS & METHODS

Study Area

Urban vs. Rural

To evaluate movements of urban and rural geese in Georgia, we used data from two banding locations that included a private farm in west-central Georgia within the city of Columbus, Muscogee County (the urban site), and Rum Creek Wildlife Management Area (WMA) in central Georgia, approximately 9 km east of the city of Forsyth, Monroe County (the rural site; Figure 1). No hunting was allowed at the private farm but hunting was common at Rum Creek WMA.

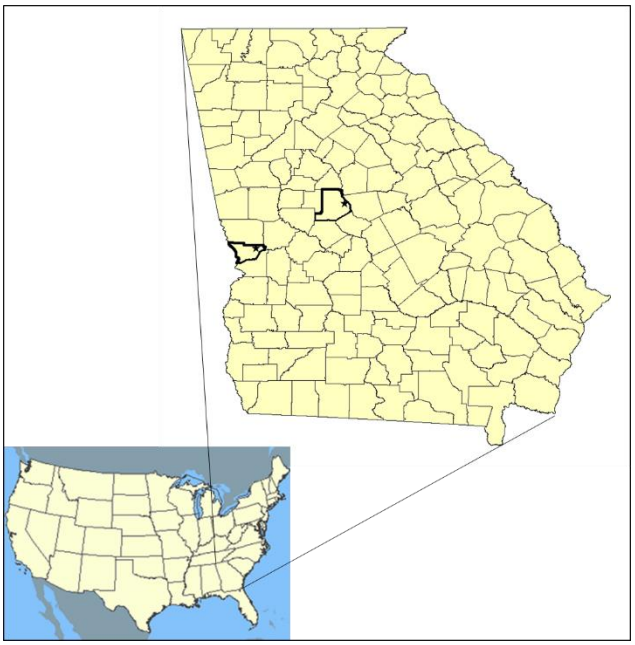

Figure 1. Location of the urban banding site (Muscogee County in western Georgia) and rural banding site (Monroe County in central Georgia) within Georgia, United States. Small USA map credit: U.S. Geological Survey. Georgia map credit ESRI and ArcMap, data source TomTom.

Translocated vs. Nontranslocated

To evaluate movements of translocated and nontranslocated geese, we used data from multiple capture and release sites. Nuisance resident geese were captured and translocated by United States Department of Agriculture (USDA) staff from golf courses, office complexes, private subdivisions, and other similar locations across Georgia. Translocated geese were moved >160 km from the capture site and released on private property in rural areas or on WMAs, and the release site was considered the banding location. Resident Canada geese also were banded by GADNR staff on WMAs and selected private properties; geese captured in these locations were released on-site.

Methods

From 2001 through 2015, resident Canada geese from across Georgia were captured and banded annually during the June–July molting period. Flightless geese were herded into corral traps (Cooch 1953) where age (adult or juvenile), sex (male or female), date, and location of banding were recorded. All geese were banded with a standard numbered U.S. Fish and Wildlife Service aluminum leg band (Dimmick and Pelton 1994). We classified geese captured at the private farm as urban and those captured at Rum Creek WMA as rural. We classified nuisance geese captured and

relocated as translocated, and geese captured and released on-site by the GADNR as nontranslocated.

We collected banding and recovery data from the Bird Banding Laboratory (United States Geological Survey, Patuxent, Maryland), and compiled band-recovery data for urban, rural, translocated, and nontranslocated geese captured and marked during 2001–2015. We evaluated recoveries from 2001 through June 2016. Banding recovery data included sex, age, distance traveled between banding and recovery location, and the spatial coordinates where birds were banded and recovered.

Urban vs. Rural

We used a 2-sample *t*-test to evaluate potential differences in distance traveled from banding to recovery sites for geese banded at rural and urban sites. Additionally, for urban and rural geese, we used an analysis of variance to examine potential differences in distance traveled relative to age, sex, location, and all potential interactions. We completed statistical analyses using Program R (R Core Team 2013) and excluded geese of unknown age or sex from analysis. To evaluate spatial distributions of band recoveries, we plotted locations of bandings and recoveries using ArcMap Version 10.4.1 (ERSI 2011) and visually assessed the distribution for general patterns. We also summarized locations where bands were recovered relative to county and state boundaries.

Translocated vs. Nontranslocated

We used a 2-sample *t*-test to evaluate potential differences in distance traveled from banding to recovery sites for translocated and nontranslocated geese. Additionally, for translocated and nontranslocated geese, we used an analysis of variance to examine potential differences in distance traveled relative to age, sex, translocation status, and all potential interactions. To evaluate spatial distributions of band recoveries, we plotted locations of bandings and recoveries using ArcMap Version 10.4.1 (ERSI 2011). We also summarized locations where bands were recovered relative to county and state boundaries.

RESULTS

Urban vs. Rural

From 2001 to 2015, 1,257 and 1,472 Canada geese were captured and banded at the urban and rural sites, respectively. Likewise, 535 recoveries were recorded for geese banded at the urban (n = 116) and rural banding site (n = 419; Table I). Distances between capture and recovery sites were similar for urban and rural geese (t_{524} = 1.417, P = 0.143). Geese in urban areas were recovered a mean distance of 25.01 km (SE = 7.52) from the banding site, whereas geese in rural areas were recovered a mean distance of 16.35 km (SE = 2.18) from the banding site. We observed no significant differences in distance traveled by age, sex, location, or interactions thereof (age: F = 1.075, df = 1 and 525, P = 0.300; sex: F = 1.265, df = 1 and 525, P = 0.261; location: F = 2.223, df = 1 and 525, P = 0.137; age:sex: F = 1.075, df = 1 and 525, P = 0.300; age:location: F = 0.298, df = 1 and 525, P = 0.585; sex:location: F = 1.039, df = 1 and 525, P = 0.309; and age:sex:location: F = 0.130, df = 1 and 525, P = 0.719). The maximum recovery distance for rural geese was 886.8 km by an adult female recovered in Ontario, whereas the maximum recovery distance for urban geese was 867.2 km by an adult female recovered in Connecticut.

Approximately 93% of urban geese and 99% of rural geese were recovered in Georgia. Recoveries of urban geese occurred in 12 counties, with 14% of birds recovered in the banding county of Muscogee. Out-of-state recoveries of urban geese only occurred in Alabama (n = 6) and Connecticut (n = 1). Only one goose banded at the rural site was recovered outside of Georgia, that recovery being in Ontario, Canada. We noted that 50% of rural geese were recovered in the county where they were captured; the remainder were recovered in 24 other counties, including Jones (13%, n = 58), Pike (5%, n = 24), and Bibb (5%, n = 23). No obvious spatial patterns were evident for urban or rural geese (Figure 2).

Table I. Number of recoveries by sex and age for urban, rural, translocated, and nontranslocated resident Canada geese in Georgia, USA, during 2001–2016

	Male	Female	Unknown Sex	Adult	Juvenile	Unknown Age	Total
Urban	65	49	2	104	12	0	116
Rural	206	213	0	343	76	0	419
Translocated	1,170	1,139	84	2,049	328	16	2,393
Nontranslocated	606	698	40	1,122	222	0	1,344

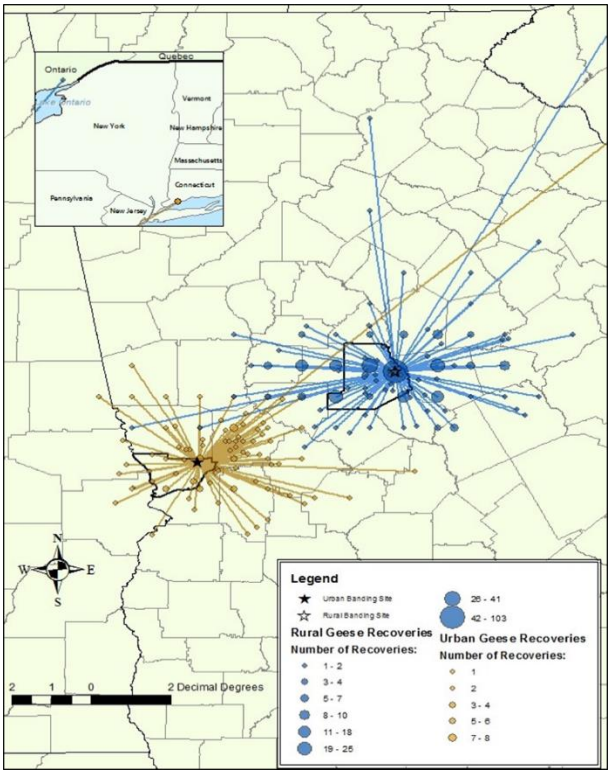

Figure 2. Recoveries of Canada geese banded in urban (Muscogee County, n = 116) and rural (Monroe County, n = 419) areas of Georgia, USA during 2001–2016. Map credit ESRI and ArcMap, data source TomTom.

Translocated vs. Nontranslocated

From 2001 to 2015, 5,119 geese were captured, banded, and released on-site in various locations across Georgia, and 12,164 geese were captured, banded, and translocated to a new release site. A total of 3,737 recoveries were recorded for translocated (n = 2,393) and nontranslocated geese (n = 1,344; Table I). Distances between capture and recovery sites differed between nontranslocated and translocated geese (t_{3735} = 7.237, P < 0.001). Translocated geese were recovered a mean distance of 37.93 km (SE = 1.76) from the banding site, whereas nontranslocated geese were recovered a mean distance of 19.87 km (SE = 1.38) from the banding site. Fifty-six percent of translocated geese were recovered <20 km from the banding site, whereas 72% of nontranslocated birds were recovered <20 km. The maximum recovery distance for translocated geese was 2,026.9 km by an adult male recovered in Quebec, and the maximum recovery distance for nontranslocated geese was 981.3 km by an adult male recovered in Vermont.

We found that distance traveled did vary among geese (F = 9.323, df = 7 and 3,592, P < 0.001). There were no interactions among the main effects of age, sex, and relocation category (all P > 0.05). There were no significant differences by sex (F = 0.020, df = 1 and 3,592, P = 0.88), but there were differences by age (F = 13.198, df = 1 and 3592, P < 0.001) and relocation category (F = 49.033, df = 1 and 3,592, P < 0.001). Adult geese were recovered a mean distance of 33.11 km (SE = 1.41) and juvenile geese were recovered a mean distance of 19.89 km (SE = 1.22) from their release site (Table II).

Approximately 93.4% of translocated and 93.1% of nontranslocated geese were recovered in Georgia. Of geese recovered out-of-state, nontranslocated geese were recovered in seven states, whereas translocated geese were recovered in 12 different states and Quebec (Table III). We did not observe any defined spatial patterns in the recoveries of translocated or nontranslocated geese (Figures 3 and 4).

Table II. Average recovery distances with associated standard error from banding site to recovery location for urban, rural, translocated, and nontranslocated Canada geese in Georgia, USA, during 2001–2016

	Average Distance Traveled (km)			
	Male	Female	Adult	Juvenile
Urban	17.74± 1.41	34.67 ± 17.14	26.43 ± 8.31	11.80 ± 1.88
Rural	15.00 ± 0.99	17.66 ± 4.18	17.14 ± 2.64	12.81 ± 1.68
Translocated	38.32 ± 2.65	37.29 ± 2.21	39.83 ± 1.95	24.18 ± 1.81
Nontranslocated	19.53 ± 1.97	20.18 ± 1.92	20.56 ± 1.58	15.68 ± 0.07

DISCUSSION

Some flocks of resident Canada geese, especially in northern states, exhibit short distance migrations and molt migrations, but most resident geese do not (Stephens et al. 2007; Atlantic Flyway Council 2011; Beston et al. 2015). Our data suggest that most resident Canada geese in Georgia predominately made short, local movements from their banding location to recovery sites. Our geese were recovered similar distances from

banding sites as resident geese elsewhere in the United States. In Arkansas, Ronke and Krementz (2015) found that resident geese that displayed only local movements (72% of the flock) were recovered an average distance of 9.6 km from banding sites. Groepper et al. (2008) reported an average recovery distance of 13 km in Nebraska, with 75% of resident geese recovered <20 km from banding locations. Similarly, >80% of radio

Table III. Number of recoveries by U.S. state and Canadian province of translocated and nontranslocated resident Canada geese banded in Georgia, USA, during 2001–2016.

	Number of Recoveries	
State or Province	Translocated geese	Nontranslocated geese
Georgia	2,236	1,251
South Carolina	78	49
Alabama	47	38
Florida	20	1
Tennessee	2	1
Indiana	0	1
Vermont	0	1
North Carolina	0	1
New York	1	0
Oklahoma	1	0
New Mexico	1	0
Nevada	1	0
Minnesota	1	0
Missouri	1	0
Mississippi	1	0
New Jersey	1	0
Province of Quebec	1	0

marked normal wild geese in New York were observed <10 km from their capture site, whereas 50% of translocated geese were recovered <20 km from the release site (Holevinski et al. 2006).

Balkcom (2010) reported that geese banded in rural and urban locations of Georgia during 2001–2006 were recovered similar distances from where they were originally banded, consistent with our results. Average recovery distances of rural and urban geese during 2001–2006 were comparable to our observed averages during 2001–2016, suggesting that populations are mostly localized throughout Georgia, and significant changes have not occurred in the past decade. Muscogee County is mainly urbanized and contains the city of Columbus, hence hunting opportunities are more limited compared to Monroe County, which is largely rural. As expected, few urban geese were harvested in

Muscogee County. We noted that a greater percentage of rural geese were recovered in Monroe County where hunting opportunities were more available.

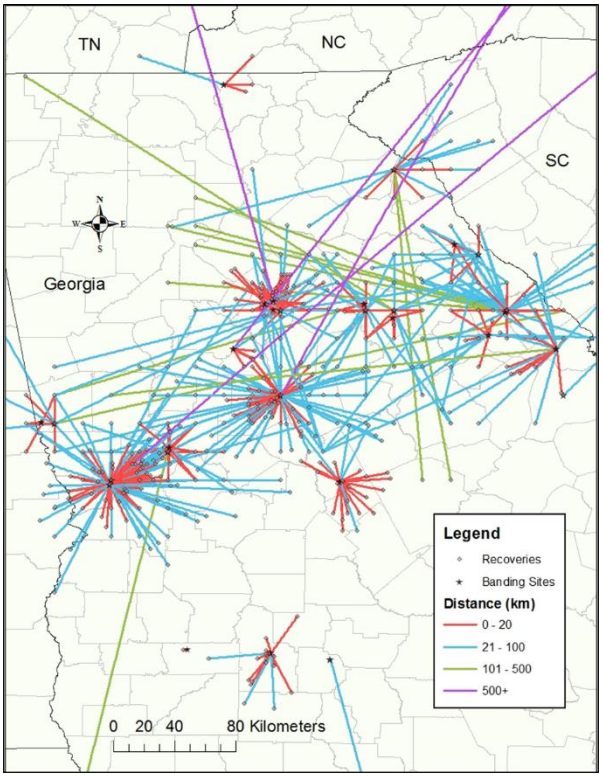

Figure 3. Recoveries of nontranslocated (n = 1,344) Canada geese banded in Georgia during 2001–2016. Distributions are separated by recovery distances (km). Map credit ESRI and ArcMap, data source TomTom.

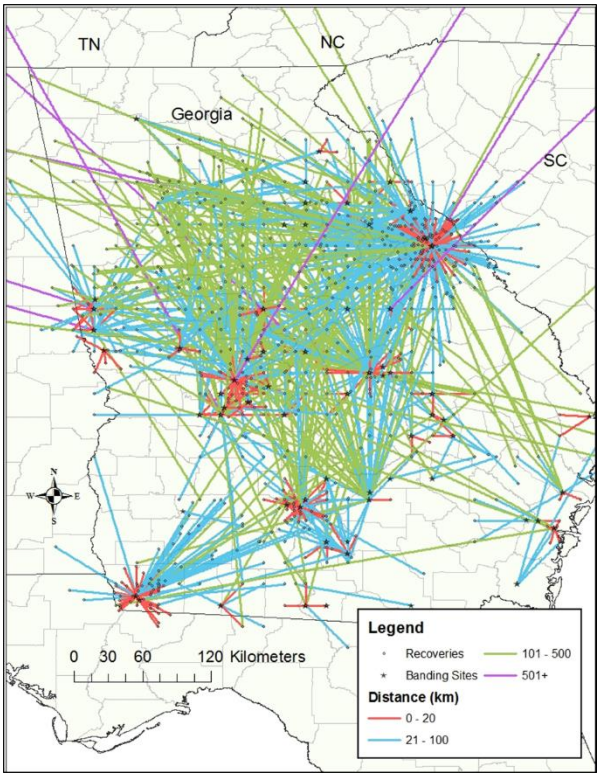

Figure 4. Recoveries of translocated (n = 2,393) Canada geese banded in Georgia during 2001–2016. Distributions are separated by recovery distances (km). Map credit ESRI and ArcMap, data source TomTom.

Most resident geese in the Atlantic Flyway (58–99%) are recovered in the state in which they were banded, with the number of in-state recoveries increasing from northern to southern states (Beston et al. 2015). Multiple previous studies have reported that >75% of resident geese are recovered in the state where they were banded (Tacha et al. 1980; Ronke and Krementz 2015; Iverson et al. 2014). The greater percentage of in-state recoveries in Georgia compared to many other states may be attributable to the southern location and relatively large area of the state. Likewise, winters are typically mild in Georgia, whereas geese in more northern states often make short-distance movements during severe winters when bodies of water freeze (Beston et al. 2015). Resident geese in Georgia appear to make mostly short distance movements, although little is known about seasonal and daily movements of these geese.

We attributed differences in the number of out-of-state recoveries primarily to the proximity of the urban banding location to the Alabama border. Balkcom (2010) reported similar high fidelity rates for urban (0.730) and rural (0.713) geese, regardless of

differences in hunting pressure between sites. This similarity in fidelity rates suggests that rural and urban geese have a comparable propensity to return and nest in the same locations, which could contribute to the relatively short distances between where birds were banded and recovered.

Urban habitats in Quebec were among the most preferred by resident Canada geese, and areas accessible to hunting were among the least preferred (Beaumont et al. 2013). Geese are thought to prefer urban areas because of increased forage, reduced predators, and protection from hunters (Luukonen et al. 2008; Beaumont et al. 2013). Because survival rates are higher for urban geese in Georgia (Balkcom 2010), we expected the urban geese to stay within those protected urban areas and not move around very much, which could expose them to hunting pressure. However, recovery distances were similar for urban and rural geese. In a recent study in Ohio (Shirkey et al. 2018), rural and urban geese had similar harvest rates (13–15% annually) and similar survival rates (ranging from 58 to 68% depending on winter weather) indicating that urban and rural geese may exhibit similar behaviors.

Distances from banding to recovery sites were farther for translocated geese than nontranslocated geese. In general, adult geese moved farther than juvenile geese, but this was especially true for translocated geese. Canada geese exhibit high nest site fidelity, and translocated adults are more likely to exhibit this fidelity than juveniles (Smith et al. 1999; Groepper et al. 2008; Beston et al. 2014), likely because juveniles have not previously nested (Smith et al. 1999). Flockhart and Clarke (2017) in a study of translocated geese in Saskatchewan found that immature geese had a greater probability of showing fidelity to the translocation site; whereas, adult geese had a greater probability of showing fidelity to the original trapping site. They suggested that translocation efforts should be directed towards immature geese.

Short distance movements of many resident geese may result in geographically defined subpopulations with limited interchange among them (James and Krementz 2005; Conover 2011). Some populations are susceptible to overharvest and some (e.g., urban populations) are often under-harvested, complicating management goals and approaches (Balkcom 2010; Conover et al. 2015). Moreover, resident Canada geese do not experience high energetic costs associated with migration, and their reduced mobility results in greater survival rates (Smith et al. 1999; Atlantic Flyway Council 2011; Beaumont et al. 2013; Beston et al. 2015). Managing resident goose populations, especially in urban areas, will require a long-term, integrated management plan implemented on a local scale.

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