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Population and spatial dynamics of resident Canada geese in southeastern Nebraska

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Abstract: In response to increasing populations, damage complaints, and a desire to understand population and spatial dynamics, we studied population size, survival rates, home ranges, movements, and site fidelity of female resident Canada geese *(Branta canadensis)* at 18 study sites within 23 km of Lincoln, Nebraska, during 1991–1994. Based on mean flock size ($\bar{x}$ = 93) and number of collared geese in flocks ($\bar{x}$ = 13), the estimated population of resident Canada geese was nearly 4,000. Estimated monthly survival for female Canada geese was 0.94, mean home range was 25 km^2, and mean maximum distance moved between use areas was 13 km. Collared female Canada geese exhibited strong site fidelity, with 16% of relocated individuals observed at only 1 location during a single year. Other collared geese were observed at a single site during 75% of all observations. Our findings suggest that management efforts to address complaints about nuisance Canada geese must be implemented on the local level to be successful.

Key words: *Branta canadensis,* home range, human–wildlife conflicts, resident Canada geese, site fidelity

Restoration of Canada geese *(Branta canadensis)* for consumptive (e. g., hunting) and nonconsumptive (e.g., bird-watching) uses is considered a success story of 20th century wildlife management (Schmidt 2004). Resident Canada geese are nonmigrating and typically spend the majority of the year in a single location. Populations of resident Canada geese have increased since restoration efforts began in the 1960s. In the prairies of Canada and the United States, goose populations have increased at an average of 6.2% per year since the mid-1970s (Schmidt 2004). Canada geese have increased in number and have become common inhabitants of urban areas due to abundant nesting habitat, plentiful food sources, and relatively few predators. The public generally enjoys the aesthetic values of resident Canada geese, but complaints may increase as damage and nuisance problems become more widespread and goose populations increase (Coluccy et al. 2001, Powell et al. 2004*a*).

Management agencies face a dilemma, however, when attempting to continue or improve recreational opportunities, but simultaneously address nuisance, damage, and safety issues caused by Canada geese. During 1992–1999, 1,710 nuisance complaints, as well as 1,701 complaints about agricultural depredation, concerned resident Canada geese in the Central Flyway of North America. In Oklahoma and North Dakota, monetary losses were estimated at $618,870, and nearly 90% of the losses were agricultural (Gabig 2000). Loss of revenue may also be significant for urban businesses, such as golf courses, that experience damage to property from resident geese (Powell et al. 2004*a*).

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Information is needed to develop strategies for managing resident Canada geese. In the early 1990s, the local population of Canada geese near Lincoln, Nebraska, appeared to be highly residential (Powell et al. 2004*b*), with potential to cause significant future damage and general nuisance complaints. We conducted a study during 1991–1994 to determine population size, survival rates, home ranges, movements, and site fidelity of resident Canada geese in southeastern Nebraska. We predicted movements of resident Canada geese would be localized and that year-round site fidelity and survival would be high.

Study area

The 3,019-km^2 study area in and around Lincoln, Nebraska, included 43 sites comprised of lakes, ponds, parks, and golf courses used by Canada geese. The city of Lincoln, Nebraska, covers 202 km^2 of the study area. Based on the presence of geese during initial observations, we captured, marked, and observed geese at 18 study sites in Lancaster and Seward counties in southeastern Nebraska (Figure 1). Ten sites were within the city limits of Lincoln and included 3 golf courses with lakes or ponds, 3 private areas with small ponds, 2 lakes managed by the city of Lincoln, 1 large private lake, and 1 large riparian area. We also captured, marked, and observed geese at 8 lakes that were managed by the Nebraska Game and Parks Commission (NGPC) and located ≤23 km from the city limits of Lincoln, Nebraska. Study sites averaged 1.05 km^2 (range 0.01–7.28 km^2), and all included a body of water and areas of mowed grass lawns.

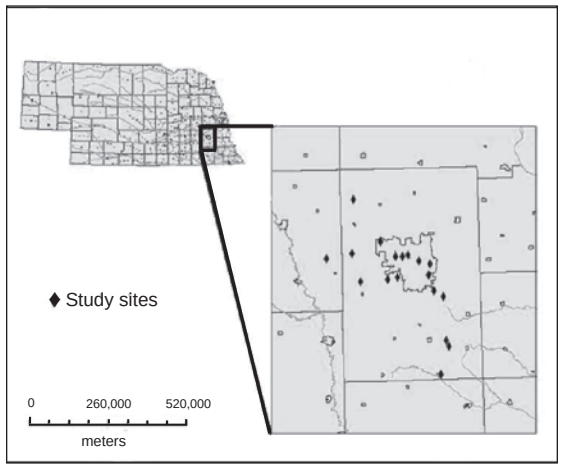

Figure 1. Resident Canada goose study area, 1991–1994. Inset features Lancaster County, Nebraska.

Methods

We captured groups of Canada geese on the study sites during their flightless molt period of June and July of 1991–1993. We placed neck collars with unique alpha-numeric codes and U.S. Fish and Wildlife Service leg bands on 915 adult females with brood patches. In 1991, 1992, and 1993, we collared 461, 201, and 253 resident Canada geese, respectively. In 1991, we translocated 1 group of 205 geese, including 66 collared females, a distance of 500 km to western Nebraska to determine return rates, relieve nuisance complaints, and increase hunting opportunity.

We observed marked and unmarked geese from June–October 1991, February–November 1992, February–December 1993, and January–April 1994. We made observations at an average of 3 sites per observation day. Sites were visited weekly; observations were made at sunrise, sunset, and between of 1000 and 1600 hours. We used spotting scopes to read collar codes and count the total number of birds in the flock. Date and study site also were recorded. We extrapolated an estimate of the total population in the 202-km^2 area of Lincoln, Nebraska, from the average flock size on the 18 study sites. We used the mark-recapture module (Cormack-Jolly-Seber model) of program MARK (White and Burnham 1999) to estimate monthly survival and resighting probabilities (Seber 1982).

We used the Home Range Extension tool (Rodgers et al. 2005) in ArcGIS 9.1 to estimate home ranges. We estimated 100% minimum convex polygons because of the limited number of use areas (range: 1–7) within the home ranges of our sample geese. We selected 92 of the 849 collared, female Canada geese in our sample for home range estimation, and constructed home ranges for these geese because they provided at least 12 observations during a single year. Multiple observations on the same day at the same study site were considered a single observation. Observations were spread over multiple months of a single year. We did not make observations in all areas

where geese might have fed or roosted. Eleven translocated geese were used for home range estimation, but we included study sites only in eastern Nebraska to calculate home ranges for these geese. We calculated site fidelity from observations by dividing the number of times a goose was seen at a particular location by the total number of observations of that goose.

Results

Population dynamics

We made 7,280 observations of the 849 collared, female Canada geese during the 3-year study. We observed 144 collared geese only once, while three were observed ≥40 times ($\bar{x}$ = 7.9 observations/goose; Figure 2). The resighting probability estimate for female collared geese was 0.37 (SE = 0.006). Throughout the study period we collared 14% of the geese in flocks. The mean number of collared geese in each flock was 13 (SE = 0.6).

Mean flock size at study sites over the study period was 93 geese (SE = 4.3). We estimated that the total population of resident Canada geese was 3,999 throughout 1991–1994 (SE = 192.5), based on the average flock size for the 18 study sites multiplied by the number of favorable areas for goose inhabitation in the study area (n = 43). We estimated that the monthly survival rate of female Canada geese was 0.94 (SE = 0.003, 95% CI = 0.937–0.947), resulting in an annual survival rate ($\hat{S}_{annual} = \hat{S}_{mo}^{12}$) of 0.49.

Geese in a public area. Increasing goose populations may result in water contamination and other problems.

Spatial dynamics

Mean home range for collared female geese in our study was 25.3 km^2 (SE = 4.3; Figure 3). Twenty-two home ranges were <1.0 km^2, while only six were 100 km^2 (range = 0.02–227.40 km^2). Mean maximum distance moved between used areas was 13 km (SE = 1.2; Figure 4). Only 25% of the geese observed moved >20 km, and the longest observed maximum movement was 48 km. Canada geese had high fidelity to specific study areas. On average, we found individual Canada geese at the same study site during 75% of all observations. We observed that resident Canada geese used an average of 2.8 of the 18 potential sites (range = 1–7). Fifteen (16%) of the 92 female geese in our sample were observed at only 1 location over the course of a single year. We made 2,226 observations of the 92 collared geese. Seventy-two percent of the observations were made within the city limits. Resident Canada geese in our study area were found on areas that allowed hunting during 38% of observations. Of the 92 geese, 33 geese had home ranges that existed solely within the city limits of Lincoln, Nebraska.

Twelve (18%) of the 66

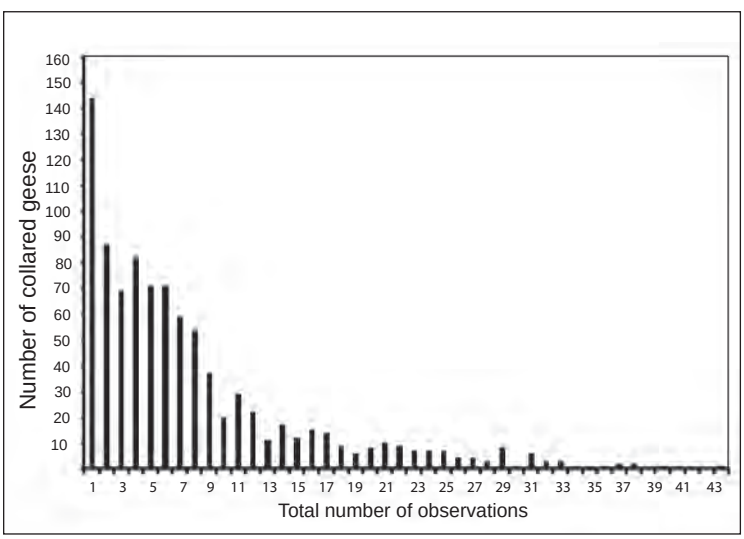

Figure 2. Frequency of unique observations (total sightings during 1991–1994) of collared female resident Canada geese in southeastern Nebraska.

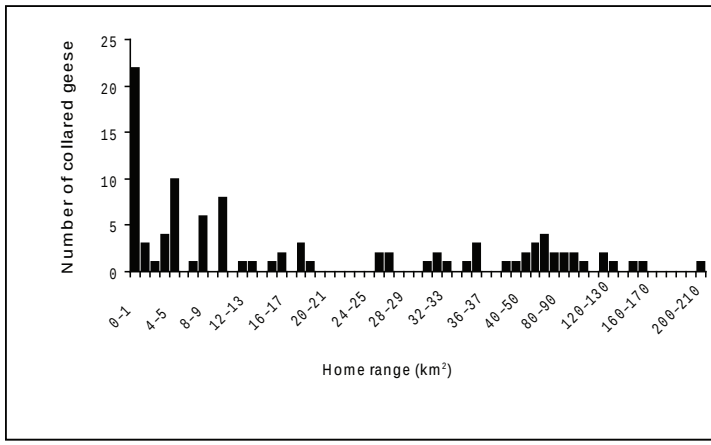

Figure 3. Mean home-range of collared, female resident Canada geese in southeastern Nebraska. Home ranges were estimated from resightings at study sites during 1991–1994.

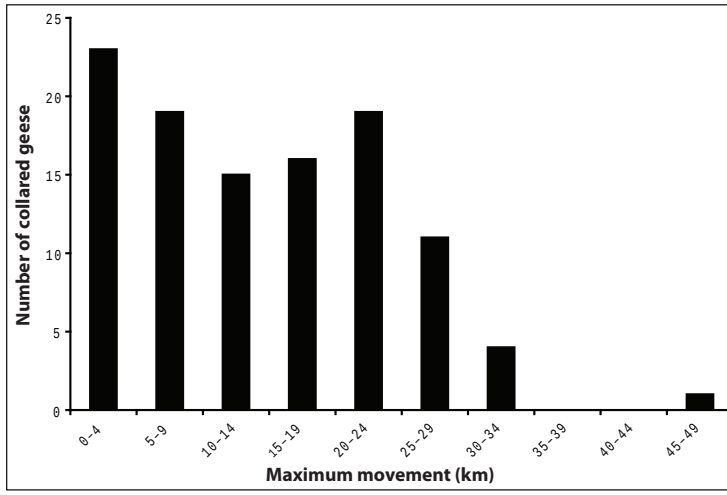

Figure 4. Length of maximum movements between observations of neck-collared, female, resident Canada geese, southeastern Nebraska, 1991-1994, excluding movements of translocated geese.

collared geese that were translocated to western Nebraska in July 1991 appeared again in the study area; the first returned by September 1991, and the last was observed in January 1994. Only 1 goose returned to the initial capture site; the remaining 11 were observed at 4 other study sites.

Discussion

Population dynamics

About 4,000 resident Canada geese inhabited the community of Lincoln, Nebraska, during 1991 through 1994. During that time, the local population density appeared to be high and increasing. Powell et al. (2004*b*) found the annual population growth rate to be 0.995 (stable) for 1990–1995, although they suggested that their estimate of productivity might have been biased low. Thus, our study supports the prediction of Powell et al. (2004*b*) that the population of resident Canada geese will continue to increase as Lincoln expands. Larger populations can result in increased damage to landscapes including problems with droppings (Coluccy et al. 2004). Other goose-related problems, including agricultural depredation, airport hazards, fecal contamination of water, and damage to lawns, parks, beaches, and golf courses caused by grazing, trampling, feathers, and defecation have increased with growth of the goose population (Coluccy et al. 2004).

Mean monthly survival for female geese (0.94) was slightly lower than previously recorded for this area. Powell et al. (2004*b*) reported monthly survival of 0.972 in 1990–2000 for hunter-recovered, leg-banded Canada geese in Lancaster County, Nebraska, where Lincoln is located. They also found no difference in survival estimates among age or sex groups in Lancaster County, Nebraska. Collared geese were not included in their sample.

We cannot distinguish emigration from mortality in mark–resight models. Thus, high emigration from our study site would negatively bias survival rate estimates. The resighting probability that we estimated (0.37) suggests that emigration in our re-observed sample was not common. However, 16% of our collared birds were observed only once, and Powell et al. (2004*b*) found that birds banded on our study sites (including birds banded at the same time our females were collared) were recovered

by hunters outside our study area. Thus, our survival estimate is probably conservative.

We attempted to collar adult females with brood patches to avoid including molt migrants. It is possible, however, that we may have collared some female geese during molt migration (White and Combs 2003). These birds from other areas could express fidelity to the Lincoln area during the molt, which would add negative biases in our survival rate estimates. Nearly 51% of neck-collared geese expressed molt-site fidelity over a 3-year period in Tennessee (White and Combs 2004).

Canada goose seasons that allow hunting in September to reduce resident populations of Canada geese are now common in the Central Flyway of North America (Vrtiska et al. 2004). Hunting can be the primary source of mortality for resident geese. Howevr, the required reduction in adult survival necessary to stem goose population growth in urban areas may not be achieved through hunting when geese with small home ranges exist solely within city limits (Coluccy et al. 2004). Sheaffer et al. (2005) reported that annual survival declined 2–11% for resident geese in the Mississippi Flyway of North America after implementation of special early hunting seasons, but found that <10% of annual harvest mortality occurred during September. Conversely, in a more rural environment, Anderson (2006) reported that 45% of resident Canada geese in South Dakota were harvested; annual survival was estimated at 0.52. Sixty percent of all geese harvested throughout the year were harvested during September (Anderson 2006).

Spatial Dynamics

Canada geese in our study had relatively small home ranges ($\bar{x}$ = 25 km^2) that were approximately 12.5% the size of the city of Lincoln (202 km^2). Female geese were able to find necessary food and water in relatively small areas within Lincoln. Our home range estimates are conservative because of the relatively small number of observation sites (n = 18). It is possible that geese moved within the study area where they were not observed. Our home ranges infer the size of the area used for activities during the day when we observed geese. We did not make observations in all areas where geese might have fed or roosted.

The small home ranges of resident Canada geese allow management actions to be implemented on a number of different sites, thus, targeting problem geese. Mean maximum movement distances were relatively small ($\bar{x}$ = 13 km) in comparison to the size of the study area. Nearly half of the geese moved less than 10 km. Where applicable, we recommend that wildlife managers increase harvest of the resident population with sport hunting. Managers may need to use alternative techniques to reduce localized populations with small home ranges in urban areas.

We found strong site fidelity (75%) among the 92 reobserved, female resident geese in our sample. Our study resulted in a relatively high resighting probability (37%), suggesting that our movement information is representative. Most females used a limited number of sites ($\bar{x}$ = 2.8). Hestbeck et al. (1991) used mark-resight data and reported similar site fidelity (71%) for wintering Canada geese in the mid-Atlantic and Chesapeake areas of North America. Canada geese often congregate near large bodies of water, and understanding fidelity may help predict the likelihood of other geese colonizing a location (Nelson and Oetting 1982). Management actions should target areas where geese commonly congregate, as damage and nuisance impacts may be localized.

Site fidelity is important for several reasons. Canada geese tend to nest near the same location where they were hatched. Canada geese that are nesting often defend their nests aggressively, which causes conflicts, especially near houses and businesses (Conover and Chasko 1985). New neighborhoods are being developed that include additional parks and storm-water retention ponds. Also, new acreages are appearing within the study area, often with recreational ponds. These areas are likely to attract resident geese. Damage and nuisance problems caused by geese are often site-specific and should be dealt with on a case-by-case basis.

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