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Source: *The Journal of Wildlife Management*, Vol. 63, No. 1 (Jan., 1999), pp. 278-286
Published by: Wiley on behalf of the Wildlife Society
Stable URL: http://www.jstor.org/stable/3802510

SURVIVAL AND MOVEMENTS OF TRANSLOCATED RACCOONS IN NORTHCENTRAL ILLINOIS

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Abstract: Translocation of nuisance raccoons (*Procyon lotor*) is a common practice, but the fates of translocated animals after release are not known. We monitored postrelease survival rates and dispersal of radio-collared raccoons that were trapped as nuisance wildlife in suburban Chicago and translocated to a rural forest preserve (translocated urban), trapped in another wooded area and translocated to the forest preserve (translocated rural), and trapped and released in the forest preserve that served as the release site for the translocations (resident). Thirty-one raccoons were radiotracked in autumn 1993, and 45 were radiotracked in autumn 1994. We detected no differences in survival rates among the 3 treatment groups ($P > 0.05$). Resident raccoons tended to remain in the vicinity of the release site, whereas translocated raccoons left the release site within hours to days and dispersed into the surrounding area. Dispersing raccoons had high daily movement rates for the first 2 weeks postrelease but then seemed to establish new home ranges. Translocated raccoons frequently denned near human residences and in agricultural fields, whereas resident raccoons denned primarily in the forest preserve. Because translocated raccoons survived well, translocation could be an effective way to supplement depleted or reestablish extirpated populations of this species. However, translocating large numbers of raccoons for animal damage control could cause problems for other wildlife and human residents near release sites, and translocated animals could serve as vectors for wildlife diseases during zoonotic outbreaks.

JOURNAL OF WILDLIFE MANAGEMENT 63(1):278–286

Key words: animal damage control, Illinois, nuisance wildlife, *Procyon lotor*, raccoon, survival rates, translocation.

Many species of wildlife are thriving in human-dominated landscapes. In the midwestern United States, for example, some species of game and furbearing mammals such as white-tailed deer (*Odocoileus virginianus*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), and opossums (*Didelphis virginiana*) are probably near historical record high numbers (Hoffmeister 1989). As populations of humans also continue to increase, conflicts between humans and wildlife are inevitable. In 1994, for example, 45,331 mammals were handled by nuisance wildlife control permittees in Illinois (Bluett 1995). Raccoons accounted for 13,193 (29%) of these mammals, and were by far the most common pest species. Illinois law allows for nuisance raccoons to be euthanized, but many are relocated to woodlots or forest preserves in rural areas. A total of 18,879 mammals was reported as translocated and released in Illinois in 1994, including 5,832 raccoons (Bluett 1995). These numbers are typical of recent years, but they probably underestimate the true numbers of translocated animals because many residents of rural areas handle nuisance wildlife problems without reporting them to state agencies.

Translocating nuisance wildlife to rural habitats might seem a humane way to handle problem animals. However, survival rates of translocated animals after release are not known. Translocated deer, for example, generally have high mortality rates (O'Bryan and McCullough 1985, Jones and Witham 1990, Bryant and Ishmael 1991). Radiotelemetry studies of translocated raccoons have yielded mixed results. Frampton and Webb (1973) and Taylor and Pelton (1979) reported high survival rates among translocated raccoons, but Wright (1977) and Rosatte and MacInnes (1989) found more than half of the raccoons translocated in their studies died within a few months of release. Few studies have monitored the fates of raccoons translocated from urban to rural environments (Rosatte and MacInnes 1989), and no published studies have simultaneously monitored survival rates of resident raccoons at the release site.

Translocating wildlife could facilitate the spread of zoonotic diseases (Davidson and Nettles 1992). For example, the rapid spread of rabies in raccoons in the eastern United States

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has been linked to translocation of disease-carrying animals (Nettles et al. 1979, Smith et al. 1984, Jenkins and Winkler 1987). If translocated raccoons settle near human residences, they could add to nuisance wildlife problems in rural areas. Finally, translocated raccoons could compete with resident populations for food or other resources, disrupt existing social structure of resident populations, or increase rates of predation on songbird and waterfowl nests or other threatened wildlife.

In this study, we compared survival rates, dispersal from the release area, and causes of mortality among raccoons translocated from an urban to a rural area, translocated from a rural to a rural area, and, as a control, residents captured at the rural release site. We recorded habitats used as daily den sites by translocated and resident raccoons as an indicator of whether translocated raccoons were likely to add to wildlife nuisance problems for human residents of rural areas.

STUDY AREA

The study was conducted in southern Kane County and northern Kendall County, Illinois. The release site was the Lone Grove Forest Preserve (LGFP) in Kane County (80°33′45″E, 41°51′3″N). The 47.3-ha preserve included about 33.3 ha of mature upland forest in 2 blocks on either side of a paved road, 2 ha of old field undergoing succession, and 12 ha of open, mesic grassland bissected by a small creek.

The area surrounding LGFP was dominated by row-crop agriculture, primarily corn and soybeans. Agricultural fields were occasionally dissected by creeks or drainage ditches. A few isolated woodlots were scattered throughout the region. Most woodlots were small (<10 ha) and appeared as islands in the agricultural matrix. The only other trees in this landscape were associated with farmsteads, residential areas, and occasionally along creeks.

METHODS

We studied 3 treatment groups in each year: resident raccoons were livetrapped in LGFP, translocated rural raccoons were livetrapped in another wooded area (Max McGraw Wildlife Foundation, Dundee, Illinois, USA), and translocated urban raccoons were captured by licensed animal control agents in response to nuisance wildlife complaints (from Kane, DuPage, and Cook counties, Illinois, USA). In 1993, we captured and radiocollared resident raccoons from 30 August to 1 October, translocated rural raccoons from 2 to 29 September, and translocated urban raccoons from 6 to 29 September. In 1994, we captured and radiocollared resident raccoons from 28 July to 1 August, translocated rural raccoons from 3 to 11 August, and translocated urban raccoons from 14 August to 23 September. We followed raccoon movements from 1 September to 15 November 1993, and 28 July to 12 November 1994. We conducted our study in the fall of each year because fall is when the greatest numbers of nuisance raccoon complaints occur.

We captured raccoons in box traps, sedated them with Telazol, then weighed, measured, and ear-tagged them for individual identification. We fitted approximately equal numbers of adult males and females in each treatment group with radiocollars (Advanced Telemetry Systems, Isanti, Minnesota, USA). Radiocollars were equipped with a mortality switch and weighed 120–126 g. We held animals in their traps until they recovered from the anaesthetic, and we then released them at LGFP. We released all translocated animals at a parking area on the north side of LGFP because this was the standard practice of many nuisance animal control agents. We released resident raccoons either at their capture site or at the parking area if the capture site was less than about 500 m away, and we released raccoons within 24 hr of capture. The Laboratory Animal Care Advisory Committee of the University of Illinois, Urbana-Champaign approved all procedures for capture and handling of raccoons.

After release, we attempted to locate radiocollared raccoons daily until mid-November. We did not delay data collection for an acclimation period because some responses of interest (e.g., dispersal from the release site) typically occurred in the first few days after release. Azimuths were recorded via a vehicle-mounted, single-peak yagi antenna system. We recorded 4 azimuths/raccoon for each daily location from a set of fixed points corresponding to landscape features easily identifiable on maps and aerial photographs. Because our study area was generally covered with a grid system of county roads at 1.6-km (1-mile) intervals, we were able to confirm the locations by driving around the area until we had identified the particular landscape feature where the animal had denned. We then plotted daily locations of radiocollared raccoons on aerial photos. We determined linear distance from the release point, and we determined habitat classification for each location (woodlot, hedgerow, waterway, agricultural field, residential property). We used monthly checks from December through April in each year to monitor survival through the winter. Aerial searches (1 in 1993, 4 in 1994) were used to supplement ground searches.

We estimated survival functions via the Kaplan-Meier method (Kaplan and Meier 1958) for the period when daily locations were obtained for each treatment group. We estimated survival and its associated standard error with the Kaplan-Meier survivorship analysis program, Version 1.0 (Kulowiec 1988). We used log-rank tests (SPSS 1993) to compare differences among survival functions over time periods when we had complete data for all treatment groups (45 days in 1993, 50 days in 1994), but we present the survival functions for all data collected. We analyzed all data as days postrelease, because releases were staggered over 32 days in 1993 and 57 days in 1994. This staggering of release dates was because of the time required to capture equal numbers of adult male and female raccoons for each treatment group and waiting for suitable animals for the translocated urban sample to be captured in response to nuisance wildlife complaints. When the mortality switch was activated in a radiocollar, we located the dead raccoon (or the radiocollar if it had been removed) and attempted to determine the cause of mortality. We tested for differences in overwinter survival among treatment groups via chi-squared tests of independence.

To examine dispersal, we first compared the numbers of raccoons in each treatment group that remained near (<1 km from) the release site. The numbers in each treatment group still denning <1 km from the release site at 50 days postrelease were compared via chi-square tests of independence. Second, we compared mean linear distances from the release site for individuals that survived to the last 2 weeks of tracking in each treatment group in each year. Individuals that died or were lost before the last 2 weeks of tracking were not included in the statistical analysis. We used Kruskal-Wallis tests to examine differences among treatment groups because variances were not equal among groups. When mean linear distances differed ($P < 0.05$) among treatment groups, we used Mann-Whitney *U*-tests (SPSS 1993) to conduct pairwise comparisons between groups.

We classified daily den locations as occurring in 1 of 5 general habitat types: wooded areas, hedgerows, creeks or ditches, crop fields, or residential areas (farmsteads and other human habitations). Habitat use at this scale was easily determined in the field when we recorded azimuths, given the open landscape and grid-like system of rural roads. Because only some individuals, particularly resident raccoons, were located consistently, we quantified habitat use as frequency distributions for comparative purposes. A frequency distribution of den sites in each habitat was first calculated for each individual. Frequencies in each habitat type were then summed over all individuals in each treatment group for each year, and overall frequency distributions were recalculated from these summed values. Thus, each individual contributed equally to the final frequency distribution for each treatment group in each year.

RESULTS

We radiocollared and tracked 76 raccoons: 31 (15 M, 16 F) in 1993 and 45 (23 M, 22 F) in 1994. Sample size in each treatment group was equal within each year, with the exception that we radiocollared 11 raccoons in the translocated rural group in 1993 (instead of 10). We monitored radiocollared animals for 45–77 days in 1993 and 50–107 days in 1994.

Survival functions did not differ between males and females in either year (1993: $\chi^2_1 = 0.75$, $P = 0.39$; 1994: $\chi^2_1 = 1.38$, $P = 0.24$); therefore, we pooled sexes for further analysis. We analyzed each year separately because we tracked raccoons for >1 month longer in 1994 than in 1993.

Survival functions did not differ among the 3 treatment groups (1993: $\chi^2_2 = 0.18$, $P = 0.91$; 1994: $\chi^2_2 = 0.66$, $P = 0.72$; Fig. 1). We also did not detect differences in survival estimates among treatment groups in either year (mean estimate at 45 days postrelease for 1993: resident = 0.70 [95% CI = 0.27], translocated rural = 0.79 [95% CI = 0.27], translocated urban = 0.78 [95% CI = 0.31]; mean estimate at 50 days postrelease for 1994: resident = 0.93 [95% CI = 0.12], translocated rural = 0.85 [95% CI = 0.20], translocated urban = 0.87 [95% CI = 0.18]). Fourteen known deaths occurred during the daily radiotracking periods in 1993 and

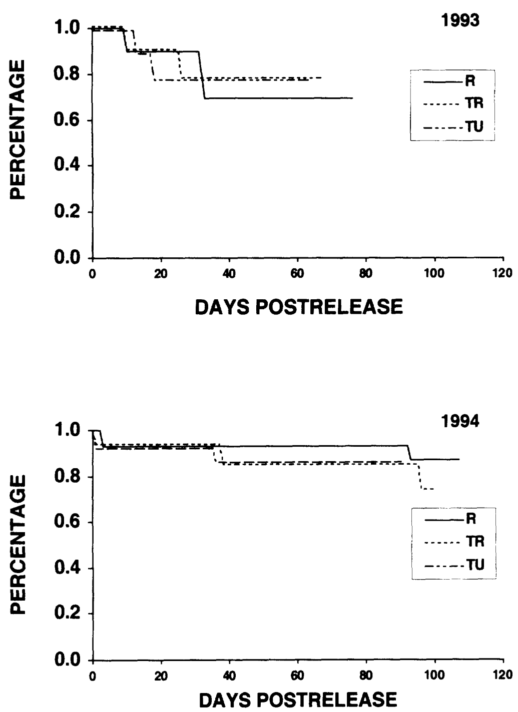

Fig. 1. Kaplan-Meier survival functions, estimated from days postrelease, for radiocollared raccoons trapped and released at the Lone Grove Forest Preserve, Kane County, Illinois (resident = R), trapped in another wooded area and translocated to the forest preserve (translocated rural = TR), and trapped as nuisance wildlife in suburban Chicago and translocated to the forest preserve (translocated urban = TU). Daily tracking was conducted from 30 August to 15 November in 1993 and from 28 July to 12 November in 1994. Curves are of different lengths because some groups were tracked for longer intervals than others.

1994: 5 raccoons were killed by vehicles, 4 were apparently killed by local homeowners (3 radiocollars were found discarded, 1 raccoon was found shot), 1 raccoon was trapped and killed as nuisance wildlife on private property, and 4 died of unknown causes (death occurred in tree cavities or in ground burrows, hence carcasses were not recovered for necropsy). Mortalities were distributed similarly among all 3 treatment groups (Table 1). In addition, 10 radiocollared animals were lost during the daily tracking periods, and their fates were unknown.

Of 19 radiocollared raccoons known alive at the end of the tracking period in 1993, 14 survived the winter, 3 died between November and April, and 2 disappeared (fates unknown). Of 33 radiocollared raccoons known alive at the end of the tracking period in 1994, 23 survived the winter, 5 died between November and April, and 5 disappeared (Table 1). Pooling data from both years, the numbers of raccoons that survived the winter, died during the winter, or were lost during the winter were not different among treatment groups ($\chi^2_4 = 3.86$, $P = 0.43$). Excluding lost animals from the analysis did not affect the results ($\chi^2_2 = 2.17$, $P = 0.34$).

Resident raccoons denned in or near LGFP during the radiotracking periods in both years, with the exception of 1 male in 1993 and 1 female in 1994 (the latter wandered widely but returned periodically until killed on the road about 1 month postrelease). In contrast, almost all translocated raccoons dispersed from the release site (Fig. 2). In 1993, only 2 of 21 translocated raccoons were still denning <1 km from the release site at the end of the tracking period, and most had left LGFP within 1–2 days postrelease. In 1994, only 4 of 30 translocated raccoons were still denning <1 km from the release site at the end of the tracking period. Pooling data from both years and excluding an-

Table 1. Fates of radiocollared raccoons trapped and released at the Lone Grove Forest Preserve, Kane County, Illinois (resident), trapped in another wooded area and translocated to the forest preserve (translocated rural), and trapped as nuisance wildlife in suburban Chicago and translocated to the forest preserve (translocated urban), 1993–94.

	1993			1994		
Treatment group	Survived	Died	Disappeared[a]	Survived	Died	Disappeared
Daily tracking period[b]						
Resident	7	3		13	2	
Translocated rural	7	2	2	8	3	4
Translocated urban	5	2	3	12	2	1
Overwinter[c]						
Resident	5	1	1	11	2	
Translocated rural	5	1	1	4	2	2
Translocated urban	4	1		8	1	3

[a] Individuals could no longer be located, no mortality signal detected.
[b] 1993: 30 August to 15 November; 1994: 28 July to 12 November.
[c] November to April.

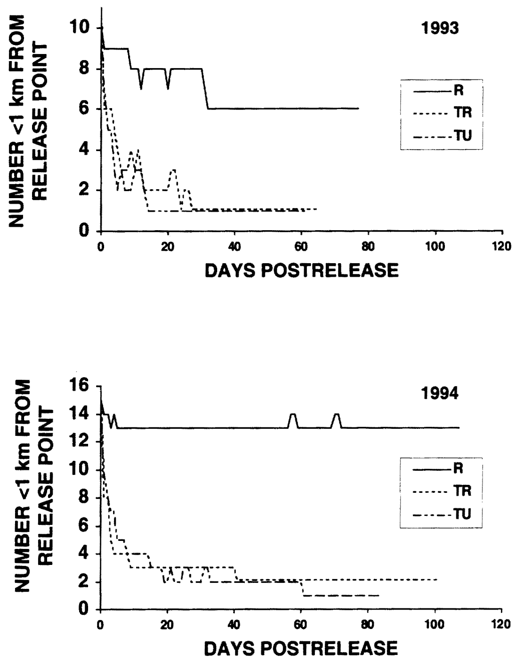

Fig. 2. Numbers of radiocollared raccoons trapped and released at the Lone Grove Forest Preserve, Kane County, Illinois (resident = R), trapped in another wooded area and translocated to the forest preserve (translocated rural = TR), and trapped as nuisance wildlife in suburban Chicago and translocated to the forest preserve (translocated urban = TU) that denned <1 km from the release site over time (days postrelease), 1993–94. Declines include losses due to both dispersal and mortality. Curves are of different lengths because some groups were tracked for longer intervals than others.

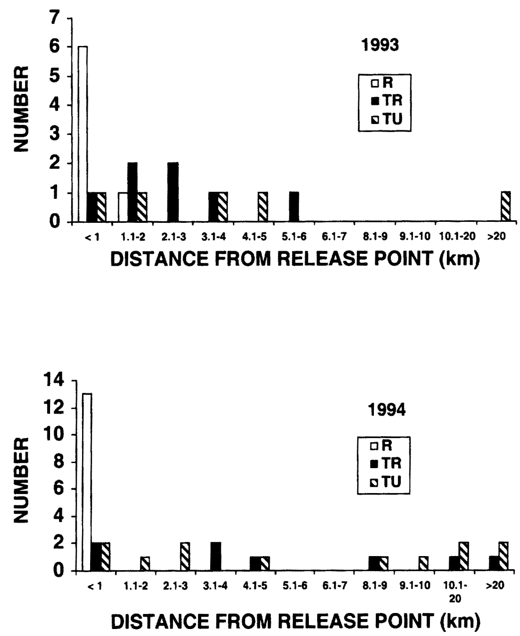

Fig. 3. Distances from the release site for radiocollared raccoons trapped and released at the Lone Grove Forest Preserve, Kane County, Illinois (resident = R), trapped in another wooded area and translocated to the forest preserve (translocated rural = TR), and trapped as nuisance wildlife in suburban Chicago and translocated to the forest preserve (translocated urban = TU) and known alive at the end of the period of daily radiotracking, 1993–94.

imals that died or were lost, 18 of 20 resident raccoons, 3 of 16 translocated rural raccoons, and 3 of 17 translocated urban raccoons were still denning <1 km from the release site at 50 days postrelease ($\chi^2_2 = 25.93$, $P < 0.001$). Differences in residency among the treatment groups were underestimated by this analysis because 4 of the raccoons in the resident sample that died before 50 days postrelease had consistently denned in the LGFP during the period they were monitored prior to their deaths.

Whereas most of the resident raccoons remained near the release site, many of the translocated rural and translocated urban raccoons dispersed considerable distances (Fig. 3). Three translocated raccoons were located 24, 25, and 60 km from the release site during aerial searches. The mean distance from the release site, excluding known mortalities, at the end of the period of daily tracking each year differed among treatment groups (1993: $\chi^2_2 = 7.78$, $P = 0.02$; 1994: $\chi^2_2 = 18.95$, $P < 0.001$). In both years, distances from the release site for resident raccoons (1993: 731 ± 424 m; 1994: 391 ± 125 m) were less than those for both translocated rural (1993: 3796 ± 2852 m; 1994: 9092 ± 8013 m) and translocated urban raccoons (1993: 7218 ± 8055 m; 1994: 7870 ± 6962 m; $Ps < 0.05$), whereas translocated groups did not differ in either year ($Ps > 0.05$).

Resident raccoons denned most frequently in wooded areas (i.e., LGFP; Fig. 4). Translocated raccoons frequently denned near human residences as well as in wooded areas, and they often denned in agricultural fields and along waterways.

DISCUSSION

In both years of our study, about 75–80% of the translocated raccoons survived until ≥2 months postrelease (Fig. 1), which did not differ from survival estimates for raccoons trapped at the release site. The survival of a translocated individual probably depends on a variety of factors including condition and health of the translocated animal, population density at the release site, area and quality of habitat at the release

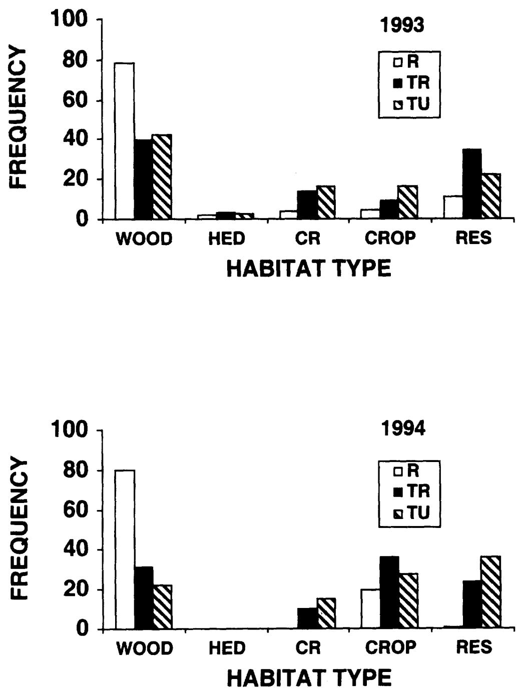

Fig. 4. Frequency distributions of habitats used for den sites during 1993–94 by radiocollared raccoons trapped and released at the Lone Grove Forest Preserve, Kane County, Illinois (resident = R), trapped in another wooded area and translocated to the forest preserve (translocated rural = TR), and trapped as nuisance wildlife in suburban Chicago and translocated to the forest preserve (translocated urban = TU), weighted so that each individual raccoon contributes equally. WOOD = woodlot or forest preserve; HED = hedgerow or treeline; CR = creek or drainage ditch; CROP = agricultural field; RES = farmstead, house, or other human construction.

site, and time of year. Frampton and Webb (1973) suggested translocations were most likely to succeed when population density at the release site was low. Raccoons were abundant in the area around LGFP; all 15 adult raccoons radiocollared in 1994 were captured in LGFP in only 5 nights (70 trapnights), and an attempt to identify resident raccoons in 1993 via a mark–recapture protocol resulted in 48 raccoons receiving ear tags in LGFP over a 45-day period in August–September. High survival rates of translocated raccoons in our study are probably attributable to benign weather conditions during autumn and abundant food and cover provided by agricultural crops.

The 10 "lost" raccoons in our study were treated as censored data in the calculation of survival function, and we assume they dispersed beyond the study area. Alternatively, their transmitters may have failed, but all 10 failures occurring in the translocated groups and none in the resident group is improbable. Only 3 raccoons were never relocated following release; 7 of the 10 "lost" raccoons were located for periods of 17–62 days postrelease, and all had dispersed from LGFP and moved extensively in the surrounding area prior to their last being located. Lost raccoons might have been resting in places such as culverts or barns where their signals were blocked. Finally, some of the lost raccoons could have been poached or killed as nuisance wildlife and their radiocollars disabled or discarded in places where signals would not be detected.

Rosatte and MacInnes (1989) reported that about 50% of 24 radiocollared raccoons transported from urban Toronto, Ontario, Canada, to a rural release site in the autumn died within 3 months of translocation. Wright (1977) also reported >57% mortality within 74 days of translocation for 28 radiocollared raccoons transported from Florida to Kentucky in the spring. In contrast, Taylor and Pelton (1979) found that 64% of 14 radiocollared raccoons translocated from bottomland forest to an upland forest preserve in the spring in Tennessee survived and established new home ranges, and Frampton and Webb (1973) detected only 20% mortalities for 10 radiocollared raccoons translocated from Coastal Plain to Upper Piedmont habitat in the spring in South Carolina, although the latter study had many technical difficulties. Thus, our survival estimates were higher than those of most other studies, but differences among habitats and timing of releases make comparisons difficult. Furthermore, none of the previous studies compared survival of translocated raccoons to that of a resident, control group.

Because we did not recapture radiocollared raccoons, we did not know the physical condition of animals at the beginning of winter. Overwinter survival rates were similar, however, among the 3 treatment groups. Severe winter weather did not begin until about 3 months after translocations were conducted, and translocated raccoons still being monitored at the end of the autumn radiotracking period had typically established new home ranges and den sites by that time.

In contrast to survival rates, dispersal patterns differed considerably between resident and translocated raccoons. Most of the resident sample remained in the vicinity of LGFP; with few exceptions, the linear distance between successive den sites averaged <400 m. Both translocated rural and translocated urban raccoons typically dispersed from the release site within hours to a few days. Dispersal could be a consequence of competition for den sites or other resources with resident animals at the release site, or due to disorientation and attempted homing by the released animals. The probability that a translocated raccoon would remain at the release site and the total distance dispersed from the release site by the end of the tracking period did not differ between raccoons translocated from urban to rural or from rural to rural environments.

The 24 translocated urban raccoons tracked by Rosatte and MacInnes (1989) similarly dispersed from their rural release sites but generally settled within 10–20 km of the release site. Other studies have reported some long-range movements by translocated raccoons: Wright (1977) reported mean dispersal distances of 27.5 km for 28 radiocollared and 25.7 km for 13 recovered (of 1,750 ear-tagged) raccoons moved from Florida to Kentucky, and Tabatabai and Kennedy (1989) reported a mean dispersal distance of 32.4 km for 25 recovered (of 450 ear-tagged) raccoons moved from urban to rural areas in Tennessee. The latter 2 studies detected maximum dispersal distances of 107 km and 295 km, respectively, from release sites for recovered, ear-tagged animals.

Because most of the translocated raccoons did not stay at the release site and sometimes dispersed considerable distances, translocated animals could add to nuisance wildlife problems for rural human residents or increase the spread of disease during zoonotic outbreaks. Raccoons exhibit high incidences of exposure to various wildlife diseases (e.g., Krebs et al. 1995, Centers for Disease Control 1997), and the risk of translocating diseases or parasites along with nuisance animals is an important consideration (Cunningham 1996). Hence, because some translocated animals disperse for long distances after translocation, the rate of spread of zoonotic disease could be accelerated considerably. Indeed, many translocated raccoons denned near human residences or on residential property, including backyards, barns, houses, and even a gas station. At least 4 translocated raccoons were captured or killed by local human residents because of nuisance behavior (1 during the tracking period, 3 during the winter of 1994).

Further research on the effects of translocating raccoons is warranted because of the potential consequences for other wildlife species. Raccoons are important nest predators on songbirds (Whelan et al. 1994, Donovan et al. 1997), game birds (Miller and Leopold 1992), waterfowl (Urban 1970, Duebbert and Kantrud 1974, Greenwood 1981, Jobin and Picman 1997), and other wildlife (e.g., turtles; Christens and Bider 1987, Congdon et al. 1987). Translocated raccoons also may compound the intense predation pressure already experienced by some wildlife in fragmented habitats. In some areas, existing management practices such as waterfowl management (Urban 1970, Fritzell 1978, Sargeant et al. 1993) near a release site could be jeopardized by an infusion of translocated raccoons. Finally, increased competition for food and den sites, or disruption of social organization, could negatively affect resident raccoons.

MANAGEMENT IMPLICATIONS

Our study shows that survival rates of translocated raccoons can be as high as those of resident animals. This finding supports the view of some that translocation is a humane method for handling nuisance wildlife problems (Diehl 1988). However, large numbers of raccoons translocated into an area could increase competition for resources with resident raccoons, predation pressure on other wildlife, and nuisance wildlife problems for human residents near release sites. Records from licensed animal controllers in Kane County show that ≥84 raccoons were released in LGFP in 1993 prior to our study, and 823 more were released at other sites within the county. Raccoons are abundant in most of the Midwest, and there are few, if any, places to release a translocated raccoon where there is not already a substantial population of other raccoons or people. Further, most nature preserves around urban or suburban areas are relatively small and are unlikely to accommodate the thousands of animals handled by animal control professionals each year. Even when a translocated raccoon survives, however, our study indicates it rarely stays at the release site. When the risk of facilitating the spread of disease during zoonotic outbreaks also is considered, translocation of nuisance wildlife becomes a less attractive option.

Alternatives to translocation for solving nuisance wildlife problems also have drawbacks. The simplest alternative is euthanasia, but it is the most controversial. The use of reproductive inhibitors (Howard 1967) or surgical sterilization (Bojrab et al. 1983) is costly and labor intensive. Physically excluding nuisance wildlife from private property would be the most humane solution but may be difficult and ineffective. Thus, the negative effects of translocating large numbers of animals on wildlife and human residents of rural areas near release sites must be weighed against the negative public opinion and ethical considerations concerning euthanasia or sterilization when determining policy for the disposition of nuisance wildlife.

ACKNOWLEDGMENTS

Support for this project was provided by the Furbearer Fund of the Illinois Department of Natural Resources, the Max McGraw Wildlife Foundation, the Illinois Natural History Survey, and the Kane County Forest Preserve District. J. D. Brawn assisted with statistical analyses. F. T. Burbrink, S. L. Nelson, and R. J. Stockman provided able field assistance, and B. Reiter of Critter Control provided the raccoons removed from urban areas in response to nuisance wildlife complaints. The Kane County Forest Preserve District kindly gave permission to conduct the study in the LGFP. J. D. Brawn, G. C. Sanderson, S. D. Gehrt, C. R. Paine, S. K. Robinson, and T. R. Van Deelen provided helpful comments on earlier versions of the manuscript.

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Received 9 September 1997.
Accepted 26 June 1998.
Associate Editor: Diefenbach.

EVALUATING NUTRITIONAL CONDITION OF GRIZZLY BEARS VIA SELECT BLOOD PARAMETERS

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Abstract: The use of blood parameters to estimate nutritional condition of bears has yet to be validated with actual body compositions. We used bioelectrical impedance analysis (BIA) to accurately estimate the body composition of a free-ranging population of grizzly bears (*Ursus arctos*) from the central Arctic of the Northwest Territories (NWT), Canada. We then correlated their blood hematology and metabolite parameters, previously identified by other studies on black bears (*U. americanus*) and grizzly bears to be useful indicators of nutritional condition, to the percentage of total body fat determined by BIA. None of the examined blood parameters had a significant relation with total body fat levels that were free from the effects of activity, stress, or dietary changes. Thus, interpretations of a grizzly bear's nutritional condition via the blood parameters we examined would be spurious.

JOURNAL OF WILDLIFE MANAGEMENT 63(1):286–291

Key words: BIA, bioelectrical impedance analysis, blood chemistry, body composition, body condition, central Arctic, grizzly bear, nutritional condition, *Ursus arctos*.

Hematological and serum chemistry parameters have been shown to vary in bears with hibernation, activity, reproductive status, food supply, and stress due to capture or injury (Halloran and Pearson 1972, Nelson et al. 1983, Hellgren et al. 1993). Blood parameters also have been used in conjunction with morphological data and body mass to indirectly determine nutritional condition in free-ranging bear populations (Schroeder 1987, Franzmann and Schwartz 1988, Hellgren et al. 1989, DelGiudice et al. 1991, Hellgren et al. 1993). Thus far, no indirect determination of nutritional con-

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