THE URBAN OPEN SPACE MANAGER

A newsletter about wildlife and nature conservation in urban areas
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Survival and Movement of Translocated Raccoons

Numerous raccoons, squirrels, and other species are annually live-trapped as nuisance animals in urban-suburban areas and released in seemingly appropriate habitat some distance away, generally in a more rural environment. Little information is available on survival rates and movement patterns of these translocated animals. Researchers Maia Mosillo and Edward Heske, of the Illinois Natural History Survey, and John Thompson, of the Max McGraw Wildlife Foundation in Dundee, Illinois, recently added to our knowledge base in this subject area. These investigators studied survival and movement patterns of translocated nuisance raccoons trapped in suburban Chicago and moved to the 47.3-ha Lone Grove Forest Preserve in southern Kane County, Illinois.

During the fall of 1993 and 1994, 25 suburban raccoons were trapped, fitted with radiocollars, and translocated to the forest preserve where they were tracked with radiotelemetry equipment. In addition, twenty-six rural raccoons were live-trapped elsewhere in Kane County, fitted with radiocollars, and moved to the forest preserve, and 25 resident raccoons of the forest preserve were trapped, fitted with radiocollars, and released back to the preserve.

Seventy-five to 80% of translocated raccoons survived two or more months following release into the forest preserve. Such high survival corroborates a couple of other studies reflecting high survival of translocated raccoons. However, there also are some studies showing lower survival of translocated raccoons. A number of factors may influence survival rates, including quality of the habitat, food availability, and resident animal density. Mosillo, Heske, and Thompson speculate that mild autumn weather conditions and abundant food and cover provided by agricultural crops may have been influential in their study. Fourteen known raccoon deaths were recorded, with five animals killed by vehicles, four apparently killed by local homeowners, one trapped and killed for being a nuisance, and four dying of unknown causes. Mortality was similarly distributed among all three groups (urban and rural translocated animals and resident raccoons). Ten animals were lost during tracking periods and fates of these were not determined.

Although no differences were noted in survival rates between translocated and resident raccoons, movement patterns between these groups differed considerably. Most of the resident raccoons remained in the vicinity of the forest preserve, whereas translocated animals typically dispersed from the area within hours to a few days. These results are consistent with other published work showing greater movement of translocated animals. Many translocated animals denned near human residences or on residential property and such animals may again cause damage or create a nuisance problem for humans. At least four study raccoons were captured and killed by local human residents because of nuisance behavior. Also, there is some concern that highly mobile translocated animals may spread disease. Further, an increased raccoon density resulting from the addition of new animals may adversely affect other species. For example, raccoons are nest predators on songbirds, game birds, waterfowl, turtles, and other species. Competition for food and den sites also may increase with an influx of new animals in an area, and translocated animals may disrupt social organization of resident populations. Thus, although high survivability of translocated raccoons provides support to translocation being a humane method for dealing with nuisance raccoons, the high dispersal and other issues associated with translocation still pose some concern for the widespread application of translocation for solving local damage or nuisance problems.

Reference: Mosillo, M., E.J. Heske, and J.D. Thompson. 1999. Survival and movements of translocated raccoons in northcentral Illinois. *Journal of Wildlife Management* 63:278-286.

Raccoon Populations in an Urban Park

Raccoons have adapted well to urban areas. Research conducted to date shows that urban-suburban animals often are larger bodied, have higher reproductive rates

and densities, and exhibit smaller home ranges and less movement than rural raccoons. Raccoons are susceptible to rabies, a disease transmissible to humans and of considerable public health concern.

Researcher Seth Riley, formerly of the Center for Urban Ecology, National Park Service, now at the University of California, Davis, and two of his former National Park Service colleagues studied the population dynamics of urban raccoons in relation to rabies over an 8-year period beginning in 1982. Specifically, these investigators were interested in density and survival of raccoons in Rock Creek Park, a 710-ha national park in metropolitan Washington, D.C., and the impact of rabies on raccoon density and survival.

Riley and his associates captured 386 different raccoons, with multiple recaptures for many animals. Raccoon density ranged from 67 to 333.3 animals/km^2 with a mean of 125 animals/km^2. This density is from two to more than 100 times densities reported for exurban habitats and consistent with other published estimates for urban-suburban populations. Raccoon density was high during low rabies prevalence after an epizootic of the disease in Rock Creek Park and low after a rabies resurgence. The disease cycled on a 3-1/2 year average schedule, which is consistent with other studies of rabies and distemper cycles in raccoon and fox populations.

Adult raccoon survival was high during a rabies epizootic, whereas juvenile raccoon survival was significantly lower during an epizootic than at other times. The authors attribute differential survival to the fact that all captured animals were immunized, which may have been more effective for adult animals. It is known from other work that young animals often are less able to mount an immune response after vaccination.

The high population densities reported here, as well as in other similar studies, are influenced by abundant food sources and den sites, and low human exploitation. Diseases such as rabies and canine distemper are likely to continue as major mortality factors in such populations.

Reference: Riley, S.P.D., J. Hadidian, and D.A. Manski. 1998. Population density, survival, and rabies in raccoons in an urban national park. *Canadian Journal of Zoology* 76: 1153-1164.

Songbird Survival in Town and in the Country

Researcher Peeter Horak, of the University of Tartu, Estonia, and Jean-Dominique Lebreton, a colleague from France, studied the survival rates of great tits (related to the chickadees of North America) in urban and rural habitats of southeastern Estonia. Two large and two small parks, totaling about 22 ha, were studied in the town of Tartu, where winter bird feeding was common on surrounding properties. The country study site was a rural area of Torvandi, about 5 km from Tartu. The study was conducted over seven breeding seasons, 1987-1993. These investigators found that the average annual survival rate for urban birds was about 40%, whereas the average rate for rural birds was about 32%. They speculate that the greater survival rate in town was due to milder temperature and winter bird feeding by humans.

This editor is aware of research conducted by Margaret Brittingham and Stan Temple in the United States that documents higher survival rates for black-capped chickadees with access to feeders. Brittingham and Temple conducted their study over three winter seasons in Wisconsin. They studied three populations of chickadees with access to feeders and two populations with no access to feeders. Overwinter survival of birds with access to feeders was 69%, whereas overwinter survival of birds without feeder access was 37%, a significant difference. Interestingly, these differences hold only for severe weather conditions. Little or no effect was noted on survival for mild or average winter months. Under these conditions, monthly survival rates for birds with or without access to feeders were greater than 90%. However, months with extended periods of cold temperature resulted in monthly survival rates of 67% for birds without access to feeders, whereas survival remained above 90% for birds with access to feeders.

Brittingham and Temple also provide evidence that winter feeding does not promote dependency on feeders. They compared a chickadee population that had past access to feeders on a regular basis with a population that had never been exposed to bird feeders during a winter when feeders were not available to either group. There was no difference in the average monthly survival rates for the two populations, indicating that the birds used to being fed in past years fared just as well on their own as birds never exposed to feeders.

References: Brittingham, M.C., and S.A. Temple. 1988. Impacts of supplemental feeding on survival rates of black-capped chickadees. *Ecology* 69:581-589.

Brittingham, M.C., and S.A. Temple. 1992. Does winter bird feeding promote dependency? *Journal of Field Ornithology*

63:190-194.
Horak, P., and J.-D. Lebreton. 1998. Survival of adult Great Tits *Parus major* in relation to sex and habitat; a comparison of urban and rural populations. *Ibis* 140:205-209.

Breeding Ecology of Urban Cooper's Hawks

Earlier research has shown high nesting densities of Cooper's hawks in Tucson, Arizona (reported in Volume 4, Number 2, 1999, of *The Urban Open Space Manager*). Follow-up work by the same researchers, Clint Boal and William Mannan of the University of Arizona, and highlighted here, focuses on comparative breeding ecology of the hawks in urban and exurban areas of southeastern Arizona. In the latter study, the investigators were interested in nesting phenology, productivity, mortality, and behavior of the hawks in metropolitan Tucson and the surrounding countryside.

During 1994-1996, 51 Cooper's hawk territories were identified in the metropolitan area and 26 were located in the countryside. Eggs hatched about 16 days earlier at urban nests, where clutch size (3.64 eggs) tended to be larger than in the countryside (3.20 eggs). Boal and Mannan report that urban birds were often found on territories together outside the breeding season, although it is thought the birds are solitary at this time. Maintenance of year-round pair bonds and territories may partly explain early nesting in the city. Perhaps also contributing to early nesting and larger clutch size is the abundant year-round availability of prey (mourning doves and Inca doves) in the city, leading to good physical condition of adult hawks. No difference was found in brood size for city (3.11 young) and country (2.81 young) nests. However, urban nestlings had high mortality caused primarily by trichomoniasis, an avian disease caused by a parasitic protozoan. Some 51% of nestlings at urban nests died before fledging compared with only 5% mortality during this stage in the countryside. Nest failures in the city (52.6%) were mostly during the nestling stage, whereas most failures in the countryside (20.5%) occurred during the courtship-egg laying stage. The disease link to nestling Cooper's hawks is probably by way of the dove food source. Some 16% of mourning doves and 52% of Inca doves in the city are infected with the protozoan and these birds account for 84% of the diet of urban hawks. Few doves are taken by hawks in the countryside.

There is some speculation that the disease may be associated with bird feeding. Both Inca and mourning doves are easily attracted to feeders. The birds are gregarious and large numbers concentrated at a feeding source may aid transmission of the disease. Perhaps advising residents to keep feeders clean, to use "dove-proof" feeders, and to avoid attracting large numbers of doves may reduce transmission of the disease. More research is needed in this regard.

Collisions with windows and vehicles were primary causes of mortality in the city for free-flying hawks, accounting for 69.8% of hawk deaths at this stage of their life cycle. Cooper's hawks often are attracted to backyard bird feeders because of a concentrated prey source there. Daniel Klem, Jr., of Muhlenberg College, Allentown, Pennsylvania, has devoted considerable effort to studying the problem of bird mortality associated with buildings and windows. He points out that clear or reflective glass presents the most serious problem, and birds are more vulnerable to large panes near ground level and at heights above 3 m. Use of nonreflective tinted glass is effective in preventing strikes. Also, netting or other outside glass covering that is opaque or translucent is effective; coverings can partially obscure the window but must be uniformly spaced over the surface. Placing feeders within 0.3 m of the unobscured glass surface will effectively prevent strikes. Hawk silhouettes and owl decoys are not effective in reducing bird strikes at windows.

References: Boal, C.W., and R.W. Mannan. 1999. Comparative breeding ecology of Cooper's hawks in urban and exurban areas of southeastern Arizona. *Journal of Wildlife Management* 63:77-84.
Klem, D., Jr. 1991. Glass and bird kills: an overview and suggested planning and design methods of preventing a fatal hazard. Pages 99-103 *in* L.W. Adams and D.L. Leedy, eds. *Wildlife Conservation in Metropolitan Environments*. Natl. Inst. for Urban Wildl., Columbia, Md.

Neighborhood Boundary Parks

Are urban parks that lie between racially different neighborhoods "green walls" that function as barriers to use and appreciation? Or, do they serve as "green magnets" with potential to improve interracial relations? These questions were posed by Paul Gobster in a recent paper published in *Landscape and Urban Planning*.

Gobster, with considerable experience in the Chicago metropolitan area, was responding to an earlier paper based on work done in Boston and published in this same journal that described how boundary parks could

become green walls. It may well be that such parks can function as either walls or magnets depending on a variety of factors. According to Gobster, "...if parks form boundaries that are perceived by nearby neighbors as green walls rather than green spaces, it behoves [sic] planners and managers to develop strategies and alternatives to counteract the vacuum effects of boundary phenomena."

Warren Park in Chicago is used as a case study to point out that boundary parks do not have to develop into green walls in diverse neighborhoods. Warren Park is a 33.2-ha park on the north side of the city devoted primarily to active use. Recent surveys showed that racial and ethnic use of the park was in general proportion to the racial make-up of nearby neighborhoods.

Gobster discusses both external and internal factors that may help explain success of Warren Park with regard to use by diverse groups. Four external factors can be identified. Firstly, Warren Park is located in an area that has had a long history of racial and ethnic diversity. Secondly, there is a strong constituency of neighborhood and community groups. These groups worked with governmental agencies to obtain funds to develop the park and subsequently fought to retain all lands when a portion of the park was proposed as a school site. Finally, a well-established advisory council of local residents and an effective community policing program help to unify the community with regard to the park.

Two internal factors--physical design and park management--are believed to be at least partially responsible for use by diverse groups. With regard to physical design, many high-use facilities are located along the perimeter of the park, visible and easily accessible from adjacent neighborhoods. Such a design for large urban parks may help to knit the park together with the surrounding neighborhoods. Also, a full range of facilities is provided throughout the park, which is attractive to diverse user groups. (Although not mentioned by Gobster, locating active use facilities on the perimeter of large parks can help to maintain conservation value of park interior lands if interior areas are dedicated as wildlife sanctuaries with minimum management activity.)

With regard to park management, a range of programs is provided for all ages and diverse racial and ethnic interests, along with good maintenance of facilities. Through such effort, parks can serve as active agents in counteracting "green wall" effects.

To improve relations among racial and ethnic groups, a recent Chicago Community Trust Task Force on Human Relations recommended that more opportunities be created for contact between diverse groups. According to Gobster, "In this light, urban 'boundary parks' offer an ideal setting for such contact to take place. The voluntary nature of leisure participation may remove some of the negative sentiment associated with structured programs for integration like school busing and scattered site public housing development, and leisure activities allow for contact and interaction to take place on a variety of levels. By creating a safe environment with attractive opportunities, it may be possible for boundary parks to play an active role as catalysts in improving interracial and ethnic relations." Gobster concludes, "By studying past problems and current successes, we may be able to make more boundary parks function as green magnets instead of green walls."

Reference: Gobster, P.H. 1998. Urban parks as green walls or green magnets? Interracial relations in neighborhood boundary parks. *Landscape and Urban Planning* 41:43-55.

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Bobcats in Residential Areas

Large mammalian predators are generally absent from the mammal community of urban areas. Wolves, cougars, and bears cannot easily be accommodated in such areas. However, coyotes are inhabiting the urban environment and some research has been reported in this newsletter (Vol. 3, No. 3, page 4 and Vol. 4, No. 2, page 2). This editor is unaware of previous studies of bobcats in the urban environment.

In a recent issue of *The Southwestern Naturalist*, Robert Harrison of the University of New Mexico discusses bobcat use of residential habitat in Central New Mexico. In 1997, he mailed a questionnaire survey to all residences and post office boxes (total of 11,447) in three residential study areas near Albuquerque, inquiring about bobcat sightings and human attitudes about bobcats. A letter accompanying the questionnaire described the size of bobcats and Harrison believes that bobcat confusion with cougars or domestic cats by respondents was minimal. Cougars are not common in the area and feral and free-ranging domestic cats also are lacking due to predation by coyotes.

All three study areas were partially bordered by national forest land. Housing density in two of the areas (considered semi-rural developments with undeveloped land between houses) was 24.5 and 25.4 houses/km^2. The third area (152.2 houses/km^2) had few vacant lots and was considered an urban residential setting.

Returned questionnaires totalled 2633, a 23% response rate. Bobcats were reported from all three residential areas and sightings were most frequently reported less than 25 m from houses. This could be due to more people spending more time near houses, thus, greater probability of a sighting rather than bobcat preference for such areas. On the other hand, bobcats could be targeting pets near houses, as well as birds and rabbits at backyard feeders. Bobcats were most frequently seen in winter and were clustered adjacent to large undeveloped areas. The author speculates that the natural prey base in the surrounding area may be lower at this time of year and the bobcats are attracted to small pets near houses.

About 18% of respondents expressed some fear of bobcats, primarily concern for their personal safety and the safety of children. Individuals who had seen bobcats were more likely to appreciate their presence, indicating that familiarity may change attitudes. According to Harrison, "There are no documented reports of healthy bobcats attacking humans of any age without provocation and the normal prey of bobcats are much smaller than humans...Whether bobcats are able to reside permanently within developed areas is strongly dependent on attitudes of homeowners...The majority of respondents liked the idea of bobcats living in their areas and would take beneficial or harmless actions if they encountered a bobcat at their homes."

Reference: Harrison, R.L. 1998. Bobcats in residential areas: distribution and homeowner attitudes. *The Southwestern Naturalist* 43:469-475.

Suburban Coyotes in Arizona

In 1991 and 1992, Dixie Bounds and Bill Shaw of the University of Arizona studied the movements of nine adult coyotes in suburban and rural areas adjacent to Saguaro National Park, west of Tucson, Arizona. Based on the minimum convex polygon method of calculation, no significant difference was noted in the home range size of suburban (median 9.7 km^2) and rural (median 15.8 km^2) animals. Home ranges were smallest during gestation and largest during pup rearing. Five of the six suburban animals (initially all captured and radio collared in the park) were subsequently located off the park more than 60% of the time. Sixty-nine percent of park locations for these animals were at night. Bounds and Shaw report that homeowners near the park fed wildlife during the day, thus, coyotes may have been responding to this food source. They conclude, "Our study showed that coyotes move easily and frequently between SNP [Saguaro National Park] and surrounding residential areas during all hours of the day and night."

Reference: Bounds, D.L., and W.W. Shaw. 1997. Movements of suburban and rural coyotes at Saguaro National Park, Arizona. *The Southwestern Naturalist* 42:94-99.

Coyotes in Banff

Coyotes are adaptable animals and increasingly are being noted in urban areas. Michael Gibeau of the University of Calgary, Alberta, Canada recently reported results of coyote-habitat studies in the vicinity of Banff, a highly commercialized town within Banff National Park, about 110 km west of Calgary. He was interested in determining whether or not coyotes prefer urban habitats and, if so, whether such preference leads to aggressive encounters of the animals with humans.

Gibeau radio-collared 11 adult animals and tracked them from July 1991 through September 1992. Coyote use was recorded of 12 habitat types, including urban areas, campgrounds, and a golf course. The author concluded that, "Generally, coyotes in the vicinity of Banff used habitats available to them irrespective of human activity. The only exception to this may be avoidance of intensively used urban areas during daylight hours in the summer. With the cover of darkness, coyotes still used urban areas only in direct proportion to availability. If coyotes were either attracted or repelled by human activity, one would expect to see large seasonal differences in use of campgrounds and the golf course depending upon the presence or absence of humans. The fact that the golf course, campgrounds and urban area were generally used in direct proportion to what was available within a coyote's home range reinforces the idea that coyotes are neither attracted nor repelled by humans and associated activities." (See also Vol. 4, No. 2 of *The Urban Open Space Manager* for a similar study.)

Reference: Gibeau, M.L. 1998. Use of urban habitats by coyotes in the vicinity of Banff Alberta. *Urban Ecosystems* 2:129-139.

Javelina in Prescott, Arizona

In Arizona, conflicts between javelina and humans are increasing, largely due to residential expansion into javelina habitat and the attractiveness of residential areas in providing food, water, and shelter for the animals. (Some people specifically feed them.) Javelina can cause damage to gardens and landscaping through their foraging activity. Also, some residents have safety concerns because javelina may kill or injure dogs, and cornered or startled animals may attack humans.

Cindy Ticer of the Arizona Game and Fish Department and three of her colleagues recently studied habitat use and activity patterns of javelina in Prescott. They captured and radio-collared eight animals and monitored them over the course of 1 year, April 1992 through March 1993, in four residential areas of the city.

These researchers found that home ranges of their urban-dwelling study animals were similar to home ranges of nonurban javelina. Some overlapping of home ranges was noted in Prescott. Such overlapping mostly occurred at night and included homes where animals were routinely fed. However, there was little interaction between animals of different herds because specific herds tended to feed at different times. Core use area was defined as the central 50% of home range and no overlapping was noted in use of herd core areas.

Javelina selected areas of open woodland overstory with shrubland understory. Shrubs provided primary escape cover for urban-dwelling animals. Undeveloped natural areas were primarily selected for use during the day and nearby developed areas were used at night, largely for foraging. Thus, animals typically were most active at night and tended to bed during the day. Streambeds provided travel corridors into and out of residential areas.

Ticer and her associates concluded that "Effective javelina management in urban areas will require a concerted effort by all homeowners and agencies. To prevent or reduce javelina use, homeowners will need to coordinate with neighbors to remove attractants. Fencing may be required in some areas to eliminate problems...Woven-wire and brick or wood walls, if >1 m in height, should curtail javelina entry into an area. Hot-wire strands are also highly effective in preventing intrusions...Agencies may need to enact regulations that preclude feeding of any wildlife in unfenced yards."

Reference: Ticer, C.L., R.A. Ockenfels, J.C. deVos, Jr., and T.E. Morrell. 1998. Habitat use and activity patterns of urban-dwelling javelina. *Urban Ecosystems* 2:141-151.

Importance of Local Habitat to Urban Birds

Do urban bird communities on different continents show similar characteristics? This question was of interest to Philippe Clergeau and three of his colleagues who studied the structure and composition of bird communities in Quebec, Canada, and Rennes, France--both old, European-style cities. Quebec is embedded in a forest landscape and Rennes in an

agricultural landscape. These investigators surveyed breeding birds and wintering birds along an urbanization gradient from downtown to urban fringe in both cities during 1995 and 1996. Study plots were ordered along the gradient according to proportions of vegetated open space and built up area (buildings and roads). In Quebec, vegetated open space ranged from 17% (downtown) to 86% (on the outskirts of the city). In Rennes, comparable figures were 1% and 77%.

Bird diversity declined with increased urbanization in both cities and both seasons. However, during the breeding season there was a significant correlation between percent vegetated cover and bird diversity in both cities. These observations are in line with previous studies of urban bird-habitat associations.

Bird abundance increased with urbanization (also comparable with previous studies of other researchers). As a group, house sparrows, European starlings, and rock doves (pigeons) dominated the more urban areas of both cities during both seasons. Insect feeders were the most sensitive group and were much less abundant in the more urbanized areas. One exception to this observation was the presence of common swifts in downtown Rennes and chimney swifts in downtown Quebec. These species perform similar roles (i.e., fill similar niches) in the two cities, thus are considered "ecological equivalents." The American robin (in Quebec) and European blackbird (in Rennes) also fill similar niches in the two cities.

Clergeau and his colleagues argue that most urban birds are not common in the surrounding landscape and therefore landscape context is less important in structuring urban bird communities than local habitat features. Good vegetative cover and sufficient food resources lead to good bird diversity and abundance, including insectivores, frugivores, and seed eaters as well as the more common omnivores. According to these authors, "A better understanding of these newly created and evolving ecosystems [urban ecosystems] should help us understand natural ecosystems, contribute to a better management of increasing bird-people conflicts, and assist us in improving the quality of urban life."

Reference: Clergeau, P., J.-P. L. Savard, G. Mennechez, and G. Falardeau. 1998. Bird abundance and diversity along an urban-rural gradient: a comparative study between two cities on different continents. *The Condor* 100:413-425.

Nesting Habitat for Red-tailed Hawks

Little research has been conducted on nesting activity of urban red-tailed hawks. William Stout of Oconomowoc, Wisconsin and two of his colleagues recently reported results of studies they conducted on nesting habitat and reproductive success of the species in urban, suburban, and rural locations in Southeast Wisconsin. Their study area included metropolitan Milwaukee and work was done 1987-1994.

Productivity (young produced per nest) did not differ for urban-, suburban-, and rural-nesting birds, but nesting density was lowest at urban sites, intermediate in suburbia, and highest at rural sites. Reproductive success and productivity were similar to those measures reported by other investigators from previous studies in the state.

Nests were more often located in woodlots or on edges of woodlots than in hedgerows, exposed line trees, or human-made structures. The birds used similar types of nest sites in urban, suburban, and rural locations.

At the landscape scale (defined as the area within a 1.5-km radius, or 706.9 ha, of the nest tree) presence of "natural habitat" was an important nesting habitat component. Natural habitat included woodlots, tree and shrub savannahs, shrublands, herbaceous cover, and water.

These authors concluded that, "For the purposes of urban planning and development, we believe that managing for important habitat components such as natural cover will enhance the availability of nesting habitat for Red-tailed Hawks in urban areas. Based on our findings, we recommend that at least 16% of urban land be left in natural habitat with approximately 40% wooded and 60% herbaceous cover. This natural habitat should be distributed among residential and industrial land in approximately 16 separate tracts within the landscape area (706.9 ha). Wooded areas should be approximately 9 ha to provide suitable nesting woodlots."

Reference: Stout, W.E., R.K. Anderson, and J.M. Papp. 1998. Urban, suburban and rural red-tailed hawk nesting habitat and populations in Southeast Wisconsin. *Journal of Raptor Research* 32:221-228.

Habitat Conservation for Birds

Considerable concern has been expressed in recent years over the conservation of forest birds. Research

has shown that many such birds are "area-sensitive," meaning that they require fairly large tracts of land for breeding. Small, fragmented, and isolated woodlots do not support breeding populations of these birds.

In a recent paper published in *Urban Ecosystems*, researchers Lonnie Darr, Deanna Dawson, and Chandler Robbins demonstrate how use of GIS, local zoning, a local forest conservation ordinance, and avian-habitat research can be used to better conserve area-sensitive forest birds. These investigators sampled the breeding bird community by point counts during the nesting seasons of 1992-1994 on the 7,700-ha Western Branch Watershed of the Patuxent River, in Prince George's County, Maryland. Birds were surveyed within forests of different sizes, ranging from 0.5 ha to over 500 ha.

Darr and his colleagues recorded 100 bird species, 24 of which were classified as area-sensitive. Area-sensitive species favored the larger forests in the watershed. Thirty-eight of the 479 forest tracts in the watershed had an expected number of area-sensitive species of 10 or more. This threshold was used to begin the process of identifying priority areas for conservation.

As their interest was to conserve area-sensitive forest interior species, these researchers focused on a planning approach that would "maximize the amount of contiguous forest and the area of forest interior within the watershed, thereby preserving and enhancing habitat for area-sensitive birds, while still allowing for development." Interior habitat was defined as habitat more than 100 m from a forest edge. Forest tracts with at least one patch of interior habitat 10 ha or larger was designated priority habitat. Seventeen tracts (31% of the total land area) met this criterion.

Zoning overlay maps were used to define zoning of the 17 tracts. Zoning categories were: 1) low-density residential (with a 20%-50% woodland conservation requirement resulting from a local ordinance requiring a forest conservation plan before developing forested properties); 2) high-density residential (with a 20% woodland conservation requirement; and 3) commercial-industrial (with a 15% woodland conservation requirement). The total woodland conservation requirement for the study area was 1,297.3 ha. The low woodland conservation requirements for high-density residential and commercial-industrial zoning areas makes preservation of large tracts of forests difficult. Forests falling within these zoning categories were removed from consideration for preserving.

The final step was to consolidate and link priority sites to increase interior habitat. Four categories of designated conservation areas were created and are listed in descending order of importance: 1) "prime preserves" (1,289.3 ha) consisted of 15 priority interior patches (with additional 100-m forest buffer); 2) "infill preserves" (269 ha) consisted of existing forest areas contiguous with forest buffers surrounding priority interiors (not required to maintain priority interiors, but would enhance them); 3) "afforestation sites" (581.3 ha) when used in conjunction with infill preserves would link prime preserves; and 4) "potential elimination areas" (341.2 ha) consisted of forests attached to prime preserves but not contributing to forest interior habitat. Combining prime preserves, infill preserves, and afforestation sites would result in 2,139.6 ha being preserved. This would result in preservation of 842.3 ha of forest above the minimum required but would greatly enhance conditions for area-sensitive forest interior birds.

Reference: Darr, L.J., D.K. Dawson, and C.S. Robbins. 1998. Land-use planning to conserve habitat for area-sensitive forest birds. *Urban Ecosystems* 2:75-84.

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Classifying and Mapping Urban Habitats

Habitat is key to wildlife populations but to date little effort has been made to understand urban habitats on a city-wide scale. Bill Shaw, Lisa Harris, and Margaret Livingston of the University of Arizona recently studied the habitats of metropolitan Tucson, Arizona. Their objectives were to classify land cover types, determine habitat characteristics, and develop a mapping procedure for the greater Tucson area. Land cover was determined from recent aerial photography and was classified as residential, commercial-industrial-institutional, recreational, water, natural open space, graded vacant land, or agricultural land. Data were entered into a GIS database using ARC/INFO computer software.

Vegetation was sampled within each cover type. Attributes measured included plant species (and whether tree, shrub, ground cover, etc.), height, diameter, whether native or exotic, overlap of vegetation, and basal area of vegetation.

More than 360 plant species were measured and four vegetation series were recorded in the study--Sonoran desert scrub-palo verde/mixed cactus, leguminous short tree, scrub-grassland/shrub-scrub disclimax, and mixed riparian desert scrub.

These researchers stressed the importance of percent plant cover and percent native plant cover. Neighborhood park, regional park, and golf course offered the most area covered by vegetation, whereas roadway, regional mall, river with stabilized banks, and rail yard provided the least. However, the highest percent of native plants was provided by low density housing (1 unit/2.7 or more hectares), river with partially stabilized banks, naturally occurring wash, and natural open space. These also provided the best escape cover for wildlife. The least amount of native vegetation was provided by agricultural land, regional mall, urban golf course, and regional park land. These, plus roadway, school, fully stabilized river, neighborhood park, and rail yard also provided little escape cover.

Also noted as important to wildlife were vegetation structure (tree, shrub, ground cover, vine, lawn, etc.) and contiguity of habitats, both of which can be determined from the database.

Reference: Shaw, W.W., L.K. Harris, and M. Livingston. 1998. Vegetative characteristics of urban land covers in metropolitan Tucson. *Urban Ecosystems* 2:65-73.

Managing Old Stone Walls in Hong Kong

Limited land area and rugged terrain in Hong Kong have led to terracing of hillside slopes to accommodate growth of the city. In the past, vertical or near-vertical faces of terraced hillsides were supported by stone retaining walls. Some walls, particularly in the hilly northern part of Hong Kong Island, are over 100 years old. Over time, most walls have been colonized by mosses, lichens, ferns, herbs, shrubs, climbers, and trees. However, recent redevelopment in the city has damaged or destroyed many walls and new retaining structures are made of reinforced concrete rather than stone and do not provide as good a substrate for plant growth as do stone walls.

Researcher C.Y. Jim of the University of Hong Kong has been studying the vegetation of stone walls and has formulated some recommendations for their future conservation and management. During the summer of 1996, he studied 505 walls and 1,275 associated trees. Most walls were located on northern Hong Kong Island, were 2.5-5.0 m high and 25-50 m long, and were associated with low- to medium-density residential areas.

About one-half of the walls studied by Jim contained trees, with 30 species represented. The top four species, making up 78% of the total, were native figs of the Moraceae family. Only one of the top 12 species was exotic. The Chinese banyan made up 50% of total trees. This evergreen is naturally found in local woodlands. It is commonly planted as an amenity tree in the city and provides wildlife habitat, especially for birds. According to Jim, "The hanging vegetation, not taking up precious ground-level space, furnishes a unique landscape element for the dull city environment, often contributing the main if not the sole greenery in the

hilly neighborhoods." However, plants, particularly trees, may compromise wall stability, and unstable walls may pose a threat to human safety.

Jim argues that old stone walls, especially those more than 100 years of age, should be preserved as part of Hong Kong's cultural heritage. He states, "Unless it can be proven absolutely necessary by objective evidence, the heritage walls should not receive damaging or disfiguring treatments. Research should be conducted to develop a reliable scientific method to detect wall instability. Research should also probe the means of stabilizing walls without degrading their heritage qualities. Any new walls can be designed to invite vegetation colonization or be installed with receptacles to accommodate plants. To accomplish the above goals, the active support of developers and relevant professionals both within and without the government is essential."

Reference: Jim, C.Y. 1998. Old stone walls as an ecological habitat for urban trees in Hong Kong. *Landscape and Urban Planning* 42:29-43.

San Joaquin Kit Foxes in Bakersfield, California

The San Joaquin kit fox is listed as an endangered species by the U.S. government and as a threatened species by the state of California. Populations of this small fox have suffered considerably from conversion of fox habitat to agricultural, urban, and industrial land uses. During 1988 and 1989, Brian Cypher and Nancy Frost of the Endangered Species Program of the Naval Petroleum Reserves in California studied urban foxes in the city of Bakersfield and exurban foxes at the petroleum reserves. Both sites are located in the southern San Joaquin Valley of central California.

Urban foxes tended to weigh more than their exurban counterparts, particularly juveniles. The authors point out that food availability was low at the exurban site during the study because of drought conditions, but both food and water were abundant and consistently available in Bakersfield. Common food items at the petroleum reserves included kangaroo rats, San Joaquin antelope squirrels, San Joaquin pocket mice, deer mice, black-tailed jack rabbits, desert cottontails, grasshoppers, and Jerusalem crickets. In Bakersfield, foods included California ground squirrels, Norway rats, house mice, deer mice, birds, insects, and anthropogenic items like discarded human foods and pet food. Some city residents specifically fed the foxes.

Blood chemistry analyses indicated hemoconcentration in exurban foxes, probably from dehydration associated with low food or water intake. Exurban foxes also had higher blood urea nitrogen and lower cholesterol, perhaps related to dietary differences or tissue catabolism due to nutritional deprivation. Prevalence of antibodies to canine parvovirus, canine distemper, and infectious canine hepatitis was similar between populations.

The authors concluded that "...urban kit foxes may be able to maintain a higher nutritional plane. Kit fox abundance and reproduction also may be more stable in urban areas. Kit foxes persisting in urban environments could increase the size of the kit fox metapopulation, provide a buffer against extirpations in exurban areas, and serve as a source of animals for reintroduction efforts."

Reference: Cypher, B.L., and N. Frost. 1999. Condition of San Joaquin kit foxes in urban and exurban habitats. *Journal of Wildlife Management* 63:930-938.

Managing Urban Magpies in Australia

The Australian magpie is a crow-sized bird somewhat similar to the blue jay of North America in behavior and life requirements. The magpie is widely distributed throughout most of Australia. The bird prefers short grass with scattered tall trees for nesting and has benefitted from agricultural and urban development. In cities and towns, magpies inhabit parks, residential yards, and other open spaces.

One particular characteristic of magpie behavior that creates conflict with humans is the bird's aggressive defense of its territory, which is particularly strong around the nest during the breeding season. People walking, running, or cycling near nests at this time may be attacked by the birds, usually males, which presumably regard the individuals as threats to nests and young. Darryl Jones and Leoni Thomas of Griffith University, Queensland, Australia, summarized the issue, including present management approaches, in a recent issue of the *Wildlife Society Bulletin*. They reviewed information from multiple sources, including agency reports, interviews with managers, published studies, and their own ongoing studies in Brisbane.

According to the authors' data for the Brisbane area, almost 80% of respondents to a survey reported being attacked by a magpie at some time during their lives. Few data are available on injury rates; most seem to be

minor scratches or abrasions. However, there is potential for more serious injury. Although aggressive magpies typically swoop at a person's head from above and behind, some cases have been documented whereby the birds attack from the ground in front of a person. In such cases, there is increased potential for eye damage or loss. Although the proportion of Brisbane residents who have been attacked by magpies is high, most magpies are not aggressive towards humans. Jones and Thomas report that only 7% of breeding pairs in Brisbane contained an aggressive bird.

Several management approaches are suggested to deal with aggressive magpies. In the past, the traditional approach was to shoot the offending bird. However, there is increasing community opposition to this approach. Translocation is an alternate removal technique sometimes proposed, but the technique has not been tested and there is a lack of information on the fate and welfare of translocated birds and the impact of translocated birds on birds in the release area. Preventative measures include avoiding areas with aggressive birds, not running or cycling in areas with aggressive birds, not attempting to "rescue" chicks found outside nests, placing large artificial eyes on the back of ones head when traversing the territory of an aggressive bird, using tall flags on cycles, walking in groups, and adults accompanying children walking through an aggressive bird's territory. Protective actions that can be taken include wearing a hat or helmet and carrying an umbrella. Pro-active measures include disseminating information via TV and newspapers and at various public locations before and during the breeding season, extension education visits to schools, and posting of warning signs near aggressive birds.

Jones and Thomas conclude that the "broad array of management actions promoted and advocated by agencies across the country remains almost entirely untested." Research should be conducted to determine effectiveness of the various proposed management actions and to perhaps discover better solutions to the problem.

Reference: Jones, D.N., and L.K. Thomas. 1999. Attacks on humans by Australian magpies: management of an extensive suburban human-wildlife conflict. *Wildlife Society Bulletin* 27:473-478.

Conditioning Waterfowl to Turn Down Food Handouts

Hand feeding waterfowl on urban lakes and ponds is a widespread and popular outdoor activity. However, managers generally discourage such practice on the grounds that it is not natural for the birds and usually contributes to future nuisance situations from overabundant populations. Public education campaigns and laws making such feeding illegal generally are not effective.

Michael Conover of Utah State University is interested in determining whether or not waterfowl can be conditioned to avoid food handouts. In 1989 in Connecticut he tested two chemicals--methiocarb and dimethyl anthranilate--on Canada geese and mute swans. On ingestion, these chemicals result in some short-term discomfort for the birds but do not kill them. Methiocarb causes gastro-intestinal distress and dimethyl anthranilate irritates the trigeminal nerves.

In controlled studies, Conover hand fed treated bread to geese and swans. Results tended to support his hypothesis that waterfowl can be taught to avoid food handouts. Geese accepted fewer food handouts after being fed chemically-treated bread but the effect was not long lasting. Most geese quickly learned to detect lack of a chemical and started eating bread again within a day after the chemical was discontinued. Swans, on the other hand, continued to avoid bread handouts during the entire 10-day post-treatment period. Conover pointed out that other chemicals may be more effective and that "More research will be required before conditioned food aversions can be adopted as a management technique or before approval can be sought from the United States Environmental Protection Agency to use these chemicals to manage nuisance wildlife. Yet given the difficulty of convincing people to stop feeding wildlife, it ultimately may prove easier to change the behavior of animals than that of humans."

Reference: Conover, M. 1999. Can waterfowl be taught to avoid food handouts through conditioned food aversions? *Wildlife Society Bulletin* 27:160-166.

Archery Hunting to Control Urban Deer

Many urban-suburban communities, particularly in the eastern United States, are grappling with methods to control overabundant deer populations. The use of managed archery hunts is one possible option, but few data currently exist on effectiveness and public acceptability of such hunts.

Howard Kilpatrick and David Walter of the Con-

necticut Department of Environmental Protection recently studied the cost and effectiveness of a controlled archery hunt in the 95.7-ha Groton Long Point residential community in Groton, Connecticut. A survey of homeowners indicated that 53% of respondents were experiencing deer damage to landscape plantings, that 75% believed there were too many deer, and that 83% supported reduction of the local deer herd. The community voted to support an archery hunt under a defined set of guidelines for hunters, which included: 1) completing a bowhunter education course, 2) passing a shooting proficiency test, and 3) undergoing an interview with a 7-member citizen committee that focused on hunter experience, responsibility, and ethics.

A 2-year hunt was conducted in 1996 and 1997. The deer herd was reduced by 50% the first year (16 deer were taken) and an additional six deer were removed in 1997. No hunting-related accidents occurred and Kilpatrick and Walter point out that community mandated requirements were important in maintaining safety, minimizing conflicts between user groups, and reducing resident concerns about hunting. Total cost of the hunt was $2,499, 88% of which was attributed to law enforcement needed to respond to protesters of the hunt. A post-hunt community survey showed that most residents (67%) were satisfied with the hunt. The authors state "We believe that under controlled circumstances, a well-designed archery hunt with a rigorous hunter-selection process can be an effective management tool to reduce urban deer herds."

Reference: Kilpatrick, H.J., and W.D. Walter. 1999. A controlled archery deer hunt in a residential community: cost, effectiveness, and deer recovery rates. *Wildlife Society Bulletin* 27:115-123.

Public Acceptability of Urban Wildlife Management Options

White-tailed deer, beaver, and Canada geese are abundant in many urban-suburban areas of the United States. Increasingly, public concern is raised regarding human health and safety or economic, nuisance, and aesthetic issues in connection with high populations of these species. Management agencies must work closely with local residents in resolving conflicts. A general perception is that lethal approaches to reducing overabundant populations are not tolerated by urban-suburban residents, and this greatly restricts ones ability to alleviate problems.

Cynthia Loker, Daniel Decker, and Steven Schwager of Cornell University provide further insight into public acceptance of management options for these species by residents of three communities in the state of New York. These investigators surveyed resident attitudes regarding white-tailed deer management in Amherst, a northern suburb of Buffalo, beaver management in Oneonta, a small city in central New York, and Canada goose management in Riverhead, on eastern Long Island. Results showed a positive relationship in all three communities between first-hand experience with a problem and degree of concern about the issue. Also for all three communities, those most concerned about problems tended to accept more invasive methods to solve the problem. Concerns about economic, nuisance, or aesthetic problems appeared more strongly related to preference for lethal methods of control than concerns about human health and safety. These researchers concluded that "Residents with a high degree of concern were most likely to support invasive management actions, regardless of the species involved, but overall support for invasive methods was unexpectedly high irrespective of level of concern. Most residents were supportive of either invasive or lethal methods...Although it is unlikely lethal methods will be acceptable to all suburban residents in any particular situation, wildlife professionals may have more options available for mitigating problem wildlife situations in suburban areas that they thought."

Reference: Loker, C.A., D.J. Decker, and S.J. Schwager. 1999. Social acceptability of wildlife management actions in suburban areas: 3 cases from New York. *Wildlife Society Bulletin* 27:152-159.

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Urbanization and Plant Extinction

Researchers Ken Thompson of The University, Sheffield, and Allan Jones of the University of Plymouth, both of the United Kingdom, point out in a recent article in *Conservation Biology* that the commonness and rarity of plants in Britain are linked to human land use. In the densely populated countries of Western Europe in general, plants with increasing populations tend to be fast-growing and tolerant of disturbed landscapes. Plants with decreasing populations tend to be slow-growing and mostly restricted to fragments of older, less intensively managed landscapes like unimproved grasslands, heathlands, and ancient woodland. Wildlife communities are dependent on plant communities and loss of plants has direct negative effects on wildlife.

Thompson and Jones were interested in learning whether or not human population density could be linked to local plant extinctions. Data were available to them on the distribution and abundance of scarce (defined as relatively uncommon but not rare) British plants as well as the change in abundance since 1970. Two hundred fifty-four species fit the definition of scarce plants.

The land unit selected for study was the "vice-county" devised by H.C. Watson, father of British plant mapping. The unit has been used since 1852 and is still the basis of recording by the Botanical Society of the British Isles. The scheme divides larger counties into two or more vice-counties and merges the smallest counties into larger neighbors, resulting in 112 vice-counties. Human population density data were derived from the 1991 census.

Thompson and Jones found that eight of the ten vice-counties that proportionately lost the fewest scarce plants were in sparsely populated Scotland or Wales. In England, predominantly rural areas like Dorset and Westmorland lost the fewest species. By their analysis, human population density accounted for 35% of the variability in scarce plant loss. Human population density is an indicator of land use modifications, and activities such as construction (road building, urban development) and human recreation are more directly responsible for scarce plant loss. Thompson and Jones conclude that "Our results confirm that a direct effect of human population density on local plant extinctions can be detected at the regional scale in Britain. Although intensive agriculture is conventionally regarded as the greatest threat to British wildlife, our analysis suggests that urbanization may be at least as significant a danger."

Reference: Thompson, K., and A. Jones. 1999. Human population density and prediction of local plant extinction in Britain. *Conservation Biology* 13:185-189.

Urban-Nesting Great Horned Owls

The great horned owl is the most widespread owl of the Western Hemisphere and occupies a broad range of habitat types. Dwight Smith of Southern Connecticut State University and two of his colleagues recently investigated nest site selection of the bird in Connecticut, northern New Jersey, and southeastern New York. Seventy-five nest sites were studied in urban and rural areas and compared with randomly located points. Four habitat variables were measured within 50 m of a nest site (and at 24 randomly-located points for comparison): 1) tree basal area, 2) canopy cover, 3) shrub cover, and 4) conifer composition. Four landscape-level variables also were measured in relation to nest sites and 70 randomly-located points as the distance from nest (or random point) to the nearest: 1) road, 2) forest opening greater than 1 ha, 3) water, and 4) human habitation.

Over 75% of 61 owl nests of known origin were formerly red-tailed hawk, American crow, or gray squirrel nests. Almost 60% of nests were located in live deciduous trees, mostly oaks and red maple; 28% were in conifers, mostly white pine, eastern hemlock, and Norway spruce.

All four site-level habitat variables differed between urban nest sites and the randomly selected points. Urban nest sites exhibited a lower basal area, reflecting more open, park-like conditions in urban open

spaces. More conifers were found in urban areas, reflecting a pattern of human preference. Canopy cover and shrub cover were lower at urban sites. In comparing rural nest sites with randomly selected points, the only significant difference was noted in percent canopy cover, which, similar to urban nest sites, was lower at rural nest sites. The authors speculated that small openings in the canopy around nest trees may be desirable for easier access, more sun for developing chicks, and better visibility for spotting potential predators.

Comparing urban nest sites with rural nest sites relative to the four site variables, the researchers noted differences in basal area and percent of conifers. Basal area at urban sites was lower than at rural sites, and conifers were more abundant at urban sites than at rural sites.

Both urban and rural nest sites differed from random points with regard to the four landscape-level variables; nest sites showed less distance to water, forest edge, paved road, and human habitation. These observations indicate selection by the owls. Nearby water may be used for drinking and bathing. Great horned owls are known to hunt along forest and road edges. And nesting near humans may reflect benefits from associated habitat alterations (like creation of edges and openings through fragmentation) and food supply (like rats, mice, squirrels, etc.) that result from human settlement.

Differences were noted for three of the four landscape-level variables when comparing urban nest sites with rural nest sites. Urban nests were closer than were rural nests to forest edge, paved road, and human habitation. No difference was noted between urban and rural nests with regard to distance to water. The authors concluded that urban owls show a stronger degree of nest site selection than do rural owls. "The present report confirms that the adaptable Great Horned Owl purposely selects forest habitat that is fragmented and altered by urbanization and shows more selectivity in complex habitats (urban mosaic) than in monotonous ones (i.e., contiguous second-growth forest) where there are probably less choices to make during the nest site selection process."

Reference: Smith, D.G., T. Bosakowski, and A. Devine. 1999. Nest site selection by urban and rural great horned owls in the Northeast. *Journal of Field Ornithology* 70:535-542.

Effects of Deer on Forest Plant Communities

Earlier issues of *The Urban Open Space Manager* have addressed methods of controlling overabundant deer populations in urban-suburban areas (please see the Index to Volumes 1-3; also Volume 4, Number 3 and Volume 5, Number 3). An earlier article (Volume 4, Number 1) also dealt with deer browsing in suburban woodlots. The present article reviews the effects of high deer densities on forest plant communities.

David Augustine and Peter Jordan of the University of Minnesota studied this issue in 11 old-growth, maple-basswood forest fragments in Southcentral Minnesota in 1996. Most sites, ranging in size from 5-32 ha, were protected as Scientific and Natural Areas, state parks, or county parks; two were privately owned. The surrounding landscape was a mosaic of agricultural crops (primarily corn, soybeans, and alfalfa), pastures, old fields, wetlands, second-growth forests, and residential development.

These investigators studied the grazing impact of white-tailed deer on seven early-summer and seven late-summer forb species characteristic of late-successional, mesic deciduous forests in the area. They found that deer foraged selectively on the 14 understory species. Six of the seven early-summer species were palatable: trillium (*Trillium* spp.), large-flowered bellwort (*Uvularia grandiflora*), false Solomon's seal (*Smilacina racemosa*), bloodroot (*Sanguinaria canadensis*), carrion flower (*Smilax ecirrata*), and true Solomon's seal (*Polygonatum biflorum*). Jack-in-the-pulpit (*Arisaema triphyllum*), the seventh early-summer species, was unpalatable.

Augustine and Jordan found that five of the late-summer forb species were palatable: wood nettle (*Laportea canadensis*), enchanter's nightshade (*Circaea lutetiana*), zig-zag goldenrod (*Solidago flexicaulis*), jewelweed (*Impatiens pallida*), and blue cohosh (*Caulophyllum thalictroides*). Two late-summer forbs were unpalatable: white snakeroot (*Eupatorium rugosum*) and stickseed (*Hackelia virginiana*).

Several key factors were found to be important in predicting deer grazing intensity in the forest stands. During early summer, the availability of alfalfa nearby, winter deer density, and forb flowering rate were important. During late summer, winter deer density, abundance of palatable forbs, and nearby alfalfa, row crop, and other fields were important. Nearby alfalfa and other crops lessened grazing intensity on the forest forbs. The other factors were positively related to graz-

ing intensity. Thus, within agricultural landscapes, the seasonable availability of agricultural crops will reduce grazing intensity on forest forbs. However, deer density also is a controlling factor. Low grazing intensity on forest forbs was never observed where winter deer densities were greater than 20 deer/km^2. On sites with lower deer densities, the grazing intensity was less when alfalfa and other crops were present nearby. Thus, low deer densities may not reduce grazing on sensitive forbs unless alternative forage sources are available in the surrounding landscape. Lacking alternative forage, very low densities or no deer may be necessary to conserve the most highly palatable species. This might be the case in urban parks, for example, where deer-proof fencing or deer removal may be needed.

Augustine and Jordan concluded that deer grazing is likely a serious potential threat to sparse sensitive forbs in fragmented forests. Winter deer density, along with landscape composition and forb abundance, are useful in predicting the effects of deer on plants during the summer growing season. "If the surrounding landscape is being altered with reduced cultivation of alfalfa or increased conversion of row crops to residential developments, then there may be a corresponding need to further reduce local deer numbers."

In a related paper, David Augustine and Lee Frelich report on more intensive studies into the effects of deer on trillium (large-flowered trillium *Trillium grandiflorum*, nodding trillium *T. cernuum*, and drooping trillium *T. flexipes*). Their study areas were three old-growth deciduous forest remnants in southeastern Minnesota. One site, where annual deer hunting occurred, had a deer density of 4-11 deer/km^2. Hunting had been prohibited at the other two sites for more that 5 years; winter deer densities there ranged from 25-35 deer/km^2.

These investigators reported that on the two high deer density sites deer annually removed more than 50% of reproductive plants, caused reductions in plant size, and altered the distribution of plant size-classes. Trillium is a highly preferred food plant for deer. Even though it was rare at both sites with high deer density it was still grazed heavily. The plant is resilient to grazing over the short term (1-2 years) but long-term heavy grazing could cause reduction in reproductive success. Data from Michigan indicate that, for large-flowered trillium, individual plants ranged in age from 1-30 years with the minimum age of reproductive plants being 17 years. Thus, Augustine and Frelich reason that the deer grazing intensities observed at the two high deer density sites could result in local extirpation of trillium after 15-20 years. They conclude "Although many factors may have led to the current low *Trillium* densities at the sites with high deer density, the documented levels of grazing on flowering plants indicate that high local deer densities are preventing *Trillium* populations from recovering...As a result, active, long-term management to limit deer densities in parks and preserves through hunting or other effective methods appears necessary for the conservation and restoration of fragmented forest communities in eastern North America."

References: Augustine, D.J., and P.A. Jordan. 1998. Predictors of white-tailed deer grazing intensity in fragmented deciduous forests. *Journal of Wildlife Management* 62:1076-1085.

Augustine, D.J., and L.E. Frelich. 1998. Effects of white-tailed deer on populations of an understory forb in fragmented deciduous forests. *Conservation Biology* 12:995-1004.

Urban Coyotes in Southern California

There has been an increase in reported coyote attacks on humans and their pets in California over the past 10 years. These mammals now are common in many urban areas of the state where, with food handouts and lack of persecution, they quickly lose their fear of humans. In a recent paper, Rex Baker of the California State Polytechnic University and Robert Timm of the University of California review coyote attacks on 53 humans between 1988 and 1997, resulting in 21 instances of human injury.

A number of factors contribute to increasing coyote attacks on humans. The last decade has seen increased suburban development in southern California from valleys into nearby mountain ranges. Canyons are often left undeveloped as seasonal drainage areas and as natural open space and are used by coyotes to move in and out of urban fringe areas, where most coyote-human conflict occurs. Well-landscaped suburbia often provides a more abundant and available food source than surrounding habitat. Rabbits, pocket gophers, ground squirrels, and meadow voles often are abundant, along with fruit from landscape plantings, pets and pet food, and discarded human food items. Some people intentionally feed coyotes. Urbanites, particularly, tend to forget that coyotes are wild predators. The authors also point to suspension or reduction of coyote, rodent, and rabbit control programs in California in response to changing social values.

These factors, and perhaps others, have an effect on coyote biology, ecology, and behavior. Although weights of southern California urban coyotes are within the range reported for exurban coyotes in the western U.S., home range size is typically smaller and coyote density typically greater in urban areas. In rural and wildland areas, coyotes are most active at night and the early morning hours. In urban areas, it's becoming quite common to see them throughout the day.

The authors list the following signs of coyote behavior that typically lead to human conflict.

"a. Increase in taking of pets at night
"b. Increase in observance of coyotes on streets and yards at night
"c. Daylight, early morning and late afternoon, observance of coyotes on streets and in parks and yards
"d. Daylight observance of coyotes chasing or taking pets
"e. Taking pets on leash and chasing joggers, bikers, etc.
"f. Coyotes seen in and around children's play areas and parks in midday."

Baker and Timm provide recommendations for reducing coyote-human conflicts in the metropolitan environment. From the outset, a qualified wildlife biologist should be consulted to evaluate a given situation. Public education materials should be prepared that discuss how to reduce habitat attractiveness to coyotes and how to maintain fear of people in the animals. Information should be included on fencing, proper sanitation, scaring techniques, and proper human behavior when approached or attacked by a coyote. With regard to sanitation, composting sites and trash-garbage cans should be "animal proofed"; tree fruit should be cleaned from the ground; pets should not be allowed to run loose; and rodent-rabbit populations should be limited. Habitat attractiveness can be reduced by avoiding ornamental plants that produce fruit or that attract rabbits or rats. Ground covers should be maintained low and thin. Shrubs and trees near wildland areas or near children's play areas should be pruned several feet off the ground. A community ordinance against feeding wildlife may be needed. Scaring devices that have been successfully used include starter pistols, .22-caliber blanks, slingshots, rocks, portable air horns, auto horns, propane cannons, and halogen spotlights.

If the above techniques do not work, Baker and Timm recommend that some coyotes at a problem site be trapped and euthanized, or shot. Leghold traps with padded jaws are effective in this regard. These traps can be used with pan tension devices to avoid capture of smaller animals. Cage traps are ineffective except for capturing very young or sick coyotes. The authors state, "Of all techniques, trapping has the greatest observed effect of re-instilling the fear of humans in coyotes." The goal at a given site should not be to eradicate coyotes but to re-instill fear of humans in the local population. Trapped coyotes should be euthanized according to American Veterinarian Medical Association standards. Selective shooting also is effective in re-instilling fear in a local coyote population, but this action is difficult to implement in urban areas. If conducted, it must be well planned and coordinated with authorities and knowledgeable personnel.

The authors conclude that, "Authorities and citizens must act responsibly to correct coyote behavior problems before they become a public safety hazard. It is the experience of the senior author, and of persons interviewed, that when action is taken before pet attacks are a common occurrence, further problems can be avoided. However, this requires that aggressive actions and use of scaring devices be initiated promptly when coyotes are seen or heard close to residences. If pets are being taken frequently, or if other food sources have been used for a long period of time, leghold trap use is the best and longest-lasting behavior modification tool."

Reference: Baker, R.O., and R.M. Timm. 1998. Management of conflicts between urban coyotes and humans in southern California. *Proceedings Vertebrate Pest Conference* 18:299-312.

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