

THE URBAN OPEN SPACE MANAGER

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Restoring Pine Forests in Boulder, Colorado

The city of Boulder, Colorado owns and manages about 14,600 ha of open space and mountain parklands, some 3,240 ha of which are montane forests dominated by ponderosa pine. The forests consist mostly of young, small-diameter trees in dense stands because of fire suppression and logging over the last 100 years.

Historically, surface fires were common in ponderosa pine forests of the area. These generally were low-intensity fires that burned through grasses, herbaceous plants, and tree seedlings and samplings. Beginning in the late 1800s, fire suppression became a major management goal and this activity, along with logging, resulted in the current dense stands of small trees. In addition, livestock grazing has caused woody plant encroachment at the forest-grassland boundary because selective grazing pressures favor unpalatable woody species. These stands pose high potential for devastating crown fires, which are more hazardous to humans, and they alter ecological processes. For example, less sunlight reaches the forest floor in the dense pine forests resulting in lower diversity and productivity of ground vegetation. Dense pine stands also result in reduced nutrient cycling and stream flows, and there is evidence that increased homogeneity of the forests leads to more extensive outbreaks of insect infestations.

The city of Boulder has developed a forest management plan designed to restore variability in forest structure and disturbance processes that mimics historical processes to the extent possible and practical. The plan calls for thinning many of the current stands but leaving, in most cases, trees greater than 30 cm DBH (diameter breast height). This practice will promote development of old-growth forest conditions and will allow regeneration of pine at lower densities. Douglas-fir (less fire resistant and probably less abundant historically) will be removed from some stands in preference to ponderosa pine.

Once pine stands are thinned, prescribed fire will be used to maintain conditions in a more historically

natural state. These low-intensity surface fires will promote greater diversity in the vegetation, will enhance nutrient cycling, and will reduce tree encroachment on the forest-grassland boundary. The plan calls for monitoring responses to management actions so that future treatments can be altered if needed.

The plan outlined above applies to low-elevation forest stands. At higher elevations and on the steep slopes of the mountains west of the city, natural lightning fires will be allowed to burn under prescribed weather conditions.

The city recognizes that successful implementation of the plan depends upon support by local residents and adherence to air quality standards in the area. A recent survey showed that 72% of Boulder residents support use of prescribed fire as a management tool to enhance ecological values and to reduce fire hazards.

Reference: Brown, P.M., D.R. D'Amico, A.T. Carpenter, and D. Andrews. 2001. Restoration of montane ponderosa pine forests in the Colorado front range: a forest ecosystem management plan for the city of Boulder. *Ecological Restoration* 19:19-26.

Converted Railroad Habitat Corridors

In recent years, considerable interest has developed in converting abandoned railroad corridors to linear recreation trails for hiking, biking, and wildlife viewing. However, little evaluation has occurred regarding the wildlife habitat value of such areas. Kevin Poague, Ron Johnson, and Linda Young of the University of Nebraska, Lincoln studied two abandoned railroad corridors in Lancaster and Cass Counties, Nebraska, 1992-1994 that had been, or were being, converted to public recreation trails. Sites included a 42-km section of the Missouri-Pacific Railroad from the center of Lincoln east to near the town of Wabash and a portion of the Rock Island Railroad in Lincoln. Both corridors ran through residential and commercial portions of the city.

Birds were classified as neotropical migrants, short-distance migrants, or permanent residents and

were surveyed in 30-m by 400-m transects during spring, summer, autumn, and winter. Transects were walked by the observer four times during the spring season and five times each during the other seasons. Twenty-eight rural and 14 urban transects were surveyed and habitat of the transects was classified as woody (50% or more tree canopy coverage) or mixed vegetation (less than 50% canopy coverage).

The authors point out that "...urban and rural transects were used by a variety of bird species and relative attractiveness of these for some species shifted with the seasons." One hundred twelve species were recorded in the study—47% were neotropical migrants, 38% short-distance migrants, and 15% permanent residents. Thirty-five species were recorded only in rural transects and 13 species only in urban transects.

Bird abundance generally was greater in rural woody habitat and urban mixed vegetation habitat but no clear distinction was detectable specifically between urban and rural sites. Species commonly recorded in both urban and rural areas included the mourning dove, American robin, dark-eyed junco, blue jay, and black-capped chickadee. On the other hand, species common only in rural areas were the house wren, brown thrasher, Harris's sparrow, and brown-headed cowbird, and species common only to urban areas were the common grackle, northern cardinal, and house sparrow.

The species richness and diversity of neotropical migrants and short-distance migrants generally were higher in the rural sites. Abundance of neotropical migrants also was higher in rural sites. Conversely, permanent residents generally reflected greater abundance, species richness, and diversity in urban areas, perhaps due largely or in part to readily available supplemental food resources (bird feeding) in urban areas.

Poague and his co-authors recommend that one consider the biome and surrounding landscape when planning conversion of abandoned railroad corridors to public recreation trails. They question, for example, the appropriateness of planting trees along such corridors in the grassland biome of southeast Nebraska. With regard to this area of the United States, perhaps woody vegetation could be planted along such corridors near houses and towns where such vegetation already is established and open grassland could be maintained for native grassland species in rural areas.

The authors conclude that "Our results demonstrate that railroad rights-of-way in conversion to recrea-

tional trails can sustain a wide variety and abundance of birds where they are observed easily by birders and other trail users. Findings indicate that migratory guilds and species differ in their response to urban versus rural surrounding land use and to right-of-way vegetation. Management includes a blend of wildlife and public considerations for urban versus rural segments, vegetation components on the right-of-way, adjacent land use (agricultural vs. suburban landscaping), and bird species or guilds of interest. Although public-use issues and linear shape add complexity to wildlife management along such rights-of-way, our results indicate opportunities for wildlife and people."

Reference: Poague, K.L., R.J. Johnson, and L.J. Young. 2000. Bird use of rural and urban converted railroad rights-of-way in southeast Nebraska. *Wildlife Society Bulletin* 28:852-864.

Breeding Birds of Urban Woods in Seoul, Korea

Researchers Chan-Ryul Park and Woo-Shin Lee of Seoul National University, South Korea studied breeding bird species composition, along with nesting, foraging, and migrating habits of birds, in relation to habitat area in Seoul from mid-May through late June 1992 and 1993. The city landscape was a mosaic of forests, roads, buildings, and rivers. Major vegetation consisted of oaks (*Quercus acutissima* and *Q. mongolica*), aspen (*Populus x tomentiglandulosa*), and pine (*Pinus rigida*). Birds were surveyed by line transect in the early morning hours within 43 urban woodlots ranging in size from 0.15 ha to 356 ha. Vertical structure of vegetation (foliage height) was measured and birds were classified by nesting, foraging, and migrating habits.

Forty-one bird species were recorded in the study and area of woods was a good indicator of species richness. Park and Lee recommend the following management guidelines:

- "1. Larger areas of woods should be maintained.
- "2. More green areas should be protected around woods.
- "3. More nest holes should be provided by preserving the trees of high DBH class, and by installing artificial nests.
- "4. Shrub and ground layers should be restored by plantation and limiting human use."

Reference: Park, C.-R., and W.-S. Lee. 2000. Relationship between species composition and area in breeding birds of urban woods in Seoul, Korea. *Landscape and Urban Planning* 51:29-36.

Javelina in Prescott, Arizona

The distribution of javelina has expanded in Arizona over the past 100 years and it is not uncommon to now see these mammals in a number of metropolitan areas. Some people provide food and water for javelina, which respond positively to these resources. Urban javelina, especially if attracted by food and water handouts, can cause conflicts with humans by destroying residential landscaping, injuring pets, and frightening homeowners.

Bed sites are recognized as important habitat components for javelina, and Cindy Ticer of the Arizona Game and Fish Department and two of her colleagues recently studied characteristics of these sites with the goal of obtaining information useful in managing urban javelina. Cindy and her colleagues captured and radiomarked eight javelina from six herds in Prescott, Arizona, March-September 1992. They tracked the animals from April 1992 through March 1993 and located and studied 46 bed sites. Habitat features of these sites were compared to 49 random plots within the study area.

Several differences were noted between bed sites selected by javelina and the random plots. One difference was that bed sites were located in steeper, more rugged terrain. Also, during warmer months (April-October), greater use was made of east-facing and north-facing slopes but during colder months (November-March), south-facing slopes were favored. The authors speculate that the shift to warmer south-facing slopes when the weather cools may allow the animals to inhabit cooler environments than were used historically. A study in Tucson (within the Sonoran Desert) found that javelina favored north-facing and east-facing slopes. Ticer and her colleagues reported that bed sites were closer to hiding cover and farther from canopy openings than random points and dominant trees at bed sites were greater in diameter. Also, bed sites contained more shrub, cactus, tree, and rock cover than random points.

In conclusion, these authors state, "We found that javelina prefer areas with dense cover, varied habitat structure, and aspects that optimize solar warming in cold months. This information will help design vegetation manipulations to reduce attractiveness to jave-

lina, while preserving most elements of vegetation corridors. When the threshold of public acceptance of javelina is exceeded and agency action required ...we believe vegetation modification at bed sites is the most feasible option in our study area."

Reference: Ticer, C.L., T.E. Morrell, and J.C. Devos, Jr. 2001. Diurnal bed-site selection of urban-dwelling javelina in Prescott, Arizona. *Journal of Wildlife Management* 65:136-140.

Home Range Size of Deer

There is a great deal of current interest in urban white-tailed deer, largely because the species is considered overabundant in many communities throughout its range, particularly in the eastern United States. Despite this interest, we know little about the ecology of urban deer. David Henderson of the University of Georgia and three of his colleagues recently added to our knowledge base in this regard. These investigators documented the effects of a 50% localized herd reduction on seasonal home range size of remaining adult females. Work was conducted in Sea Pines, a 2,137-ha residential-resort community at the southern tip of Hilton Head Island, South Carolina.

Twenty-one adult females were captured and radiocollared at Sea Pines (11 at Baynard, the treatment site, and 10 at Gull Point, the control site). Each deer was located every day from 11 January through 14 March 1996 and 6 January through 14 March 1997. Between the two sample periods (in the fall of 1996) 53 deer were removed from Baynard (no radiocollared animals were removed), an approximate 50% reduction of the herd. The deer removed were transported to a deer pen within a forest preserve of the community where they were held until after the experiment and then released (on 22 March 1997).

Before herd reduction at Baynard, deer density and home range size were similar between the two study areas. However, following herd reduction at Baynard, home range size for the radiocollared deer there increased an average of 30%. From a management standpoint, this could mean that a 50% reduction of a deer population will not necessarily lead to a 50% reduction of damage to landscape plants or to a 50% reduction of deer-vehicle collisions.

In a related article, Henderson and his associates used mail surveys to determine resident perceptions of deer abundance at the two study sites before and

after herd reduction at Baynard. Residents of Baynard reported seeing about 50% fewer deer and perceived a decrease in relative abundance of deer using their yards after herd reduction. Residents of Gull Point saw about the same number of deer following herd reduction at Baynard and did not perceive a decrease in relative abundance of deer using their yards. Henderson and his colleagues conclude that "...costs to implement deer-herd reduction programs in urban and suburban areas may be justified based on the benefits perceived by the residents."

Reference: Henderson, D.W., R.J. Warren, J.A. Cromwell, and R.J. Hamilton. 2000. Responses of urban deer to a 50% reduction in local herd density. *Wildlife Society Bulletin* 28:902-910.

Henderson, D.W., R.J. Warren, D.H. Newman, J.M. Bowker, J.S. Cromwell, and J.J. Jackson. 2000. Human perceptions before and after a 50% reduction in an urban deer herd's density. *Wildlife Society Bulletin* 28:911-918.

Suburban Landscape Use by Female White-tailed Deer

Howard Kilpatrick and Shelley Spohr recently studied seasonal home-range size and use of residential developments by female white-tailed deer in the Mumford Cove and Groton Long Point communities of Groton, Connecticut. They captured and radiocollared 39 females between March 1995 and March 1997. Once per week they recorded animal locations for a 24-hour time period (six locations at 4-hour intervals).

Over a 2-year time period, data were obtained and analyzed for 25 of the 39 females that survived at least 1 year. Mean annual home-range size was 43.2 ha. Core-area size, representing 50% of an animal's locations, was 7.3 ha. Home ranges and core areas did not differ among seasons. However, seasonal home ranges averaged 80% to 85% smaller than home ranges reported in the literature for forested and agricultural landscapes. Henderson and Spohr

speculate that fragmentation and insular characteristics of suburban landscapes restrict deer activity and home-range size. They conclude that "Small annual home ranges of deer suggest that localized management efforts would provide residents relief from damage associated with local deer populations." Deer tended to avoid houses during fawn-rearing season. However, they fed routinely at birdfeeders during winter and winter-spring transition seasons. According to Henderson and Spohr "Birdfeeders in residential areas may provide urban deer with a supplemental food source and may increase deer visitation rates in communities." About half of the residents with birdfeeders were unaware that deer were using them and most preferred to see fewer deer in their community.

In a related article discussing management options in the two communities, Kilpatrick and Spohr conclude that "Our results suggest that bowhunting may be a more effective management tool on residential properties adjacent to undeveloped land during the late archery period [15 January – 15 February] than during the fall hunting period [1 October – 31 December] because of increased access to deer during the day... We recommend implementing a late archery hunting season to reduce urban deer populations or to remove problem deer in communities where firearms hunting is limited." With regard to sharpshooting, another deer population reduction technique, Kilpatrick and Spohr state that "Sharpshooting effectiveness may be enhanced by distributing bait piles every 40-50 ha (mean home-range size) to ensure access to all segments of the deer population."

Reference: Kilpatrick, H.J., and S.M. Spohr. 2000. Spatial and temporal use of a suburban landscape by female white-tailed deer. *Wildlife Society Bulletin* 28:1023-1029.

Kilpatrick, H.J., and S.M. Spohr. 2000. Movements of female white-tailed deer in a suburban landscape: a management perspective. *Wildlife Society Bulletin* 28:1038-1045.

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Creating Meadow Habitat

If one is interested in establishing and maintaining a species rich wild meadow as part of an urban open space management plan, attention should be given to soil fertility. Research in England shows that use of agricultural fertilizers on semi-natural grassland soils reduces the soils capacity to support diverse grassland species, but the relationship is not completely understood. Some recent work on the relationship between plant species richness and soil conditions was conducted by researchers at the University of Wolverhampton. Investigators there studied two meadows—Pendeford Mill and Ettingshall. Pendeford Mill Meadow is a 2-ha site on the outskirts of the city that is part of the Pendeford Mill Nature Reserve. It was established in 1985 and is managed by an annual summer cut followed by cattle grazing. Ettingshall Meadow is located on an old quarry site in a residential area of the city. It was established in 1986 and is managed by an annual late summer cut for hay. Vegetation surveys documenting percentage species cover were conducted in June 1995 (Pendeford Mill) and June 1996 (Ettingshall). Soil samples also were taken and included measures for nitrogen, phosphorus, and potassium.

Past research has shown that plant species richness generally is associated with low soil fertility, and it is widely believed that nitrogen is a key nutrient inhibiting species richness. However, the Wolverhampton researchers found that nitrogen was not a major influencing factor at Pendeford Mill and Ettingshall, probably because of generally low levels of the nutrient at both sites. Phosphorus and potassium were most important in explaining species composition at the two meadows. Low phosphorus levels were associated with high plant species richness, which supports other research. The Wolverhampton University researchers recommended soil phosphorus levels less than 7 mg (Truog's extraction) per 100 g of soil for reasonable levels of plant species richness in created meadows. Low potassium, on the other hand, was associated with low diversity. Intermediate levels of this nutrient, 10-30 mg (ammonium acetate extrac-

tion) per 100 g of soil, are recommended. The researchers hope these recommendations will be useful in evaluating the suitability of future sites for grassland habitat creation.

Reference: McCrea, A.R., I.C. Trueman, M.A. Fullen, M.D. Atkinson, and L. Besenyei. 2001. Relationships between soil characteristics and species richness in two botanically heterogeneous created meadows in the urban English West Midlands. *Biological Conservation* 97:171-180.

More on Meadow Soils

In another study, University of Wolverhampton researchers determined which of several selected crops (barley, potatoes, corn, or tobacco) was most effective in depleting soil nutrients to a suitable pre-condition for meadow habitat creation. Work was conducted at the University of Wolverhampton, Wolverhampton, England on a sandy silt loam that was in permanent pasture. The site had been limed in 1993 but no nitrogen-phosphorus-potassium fertilizer applications had been made in recent history. The site was prepared for study by mowing, plowing, and harrowing. Experimental crops were first planted in the spring of 1995 and were harvested when they reached maturity.

Barley was most successful in depleting nutrients from the soil; corn also was particularly effective with regard to phosphorus depletion. Incorporating results from other studies, the authors concluded "Therefore, cereal crops, particularly winter varieties that are in the ground for longer, appear to be suitable crops for fertility depletion prior to habitat creation...Barley depleted soil concentrations of nitrate, extractable phosphorus and bioassay yields significantly more than other treatments and therefore appears to offer the best pre-conditioning for future habitat creation. A cropping period of 2 years or more appears necessary on a sandy silt loam, although this will vary depending on initial soil type and fertility. It is postulated that seeding immediately after cereal harvesting would allow the establishment of a species-rich sward, particularly if accompanied

by appropriate management.”

Reference: McCrea, A.R., I.C. Trueman, and M.A. Fullen. 2001. A comparison of the effects of four arable crops on the fertility depletion of a sandy silt loam destined for grassland habitat creation. *Biological Conservation* 97:181-187.

Lizards in Tucson, Arizona

Reptiles have not been studied as much as birds and mammals in urban areas. Consequently, we know less about reptile-habitat associations and effects of urbanization on these animals. Two researchers with the Arizona Game and Fish Department (S.S. Germaine and B.F. Wakeling) recently investigated lizard-habitat relationships along an urban gradient (a range of residential habitats) in metropolitan Tucson, Arizona. Field surveys were conducted 12 July – 14 September 1994.

Natural habitat of the study area consisted of Lower Sonoran desert scrub, Upland Sonoran desert scrub, riparian, and xeroriparian (mixed riparian-desert scrub). Natural habitat was reduced, fragmented, and replaced with ornamental (largely exotic) landscaping as urbanization increased.

Germaine and Wakeling recorded nine species of lizards, although whiptails were identified only to genus and several species of this group are known in the area so the true number of species would have been slightly more than nine. As a group, whiptail lizards were most abundant and most widely distributed. The most abundant species was the tree lizard; the least abundant was the regal horned lizard.

Habitat along the urban gradient affected species distributions. House density and amount of Lower Sonoran vegetation were most important in this regard, but distance from remnant patches, lightly-treed areas with a high proportion of exotic vegetation, Upland Sonoran vegetation, and study plot heterogeneity also affected species distributions. The lesser earless lizard was most abundant at lowest housing densities; the tree lizard (the most urban-adapted species) at high housing density. High levels of Upland Sonoran vegetation and plot heterogeneity were most attractive to the zebra-tailed (which also was influenced by riparian vegetation), lesser earless, greater earless, desert spiny, and Clark's spiny lizards. High levels of Lower Sonoran vegetation were attractive to whiptail lizards.

Total abundance and species richness of lizards were highest below 1.25 houses/ha. Both measures

decreased steadily as housing density increased. The largest drop in abundance occurred when density exceeded 1.25 houses/ha; the largest drop for species richness when density exceeded 3.75 houses/ha.

These researchers concluded that “In our study, tree lizards readily exploited the urban environment, desert spiny lizards, Clark's spiny lizards, and greater earless lizards were found in moderately developed areas, and whiptail, zebra-tailed, and lesser earless lizards displayed sensitivity to low levels of urban development... Proactive management and development decisions that take into account habitat attributes identified in our study will mitigate the effects of urban residential development on lizard populations in the future.”

Reference: Germaine, S.S., and B.F. Wakeling. 2001. Lizard species distributions and habitat occupation along an urban gradient in Tucson, Arizona, USA. *Biological Conservation* 97:229-237.

Forest Bird Conservation in Sweden

Ulla Mortberg of the Royal Institute of Technology (Stockholm) and Hans-Georg Wallentinus of the Swedish University of Agricultural Sciences (Uppsala) recently conducted a study to determine if forest remnants and green space corridors in Stockholm can support forest birds in need of conservation in Sweden. Sixty-seven sample sites of natural and semi-natural habitat were studied along a gradient from forest fragments close to the city center to large forests in the suburbs. Coniferous forests of Scots pine and Norway spruce predominate in the area. Also common are mixed stands of conifers and oaks (and other deciduous trees).

Breeding birds were surveyed at study sites 1987-1990. Two visits to a site were made during May and June in the early morning hours following the Swedish Bird Atlas protocol.

Seven forest bird species classified as “care-demanding” were recorded as probable breeders in the city. Birds placed in this category require continuous care to preclude their becoming threatened or endangered.

Mortberg and Wallentinus found that “forest area” was the most important variable determining the distribution and abundance of these birds. Clear-cutting and changing deciduous forest to coniferous forest and removal of mature trees were the most frequent threats. These investigators concluded that

“The large natural areas left in between the main transportation routes of Greater Stockholm supported several red-listed forest bird species that were found breeding close to the city centre. Important properties of the remnants of natural vegetation were large areas of forest on rich soils, together with connectivity in the form of amount of this habitat in the landscape... Implications for the design of urban green space corridors would be to treat mature and decaying trees and patches of moist deciduous forest as a resource, and to conserve large areas of natural vegetation together with a network of important habitats in the whole landscape, in this case forest types on rich soils, also in built-up areas.”

Reference: Mortberg, U., and H.-G. Wallentinus. 2000. Red-listed forest bird species in an urban environment—assessment of green space corridors. *Landscape and Urban Planning* 50:215-226.

Managing Black Skimmers

Coastal development has resulted in loss of nesting habitat for many seabirds that use sandy beaches for nesting, including the black skimmer. Because of reduced population levels, the bird is listed as a Species of Special Concern in Florida.

In recent years, black skimmers as well as some other species have begun using flat roofs of buildings for nesting, perhaps because of natural habitat loss, predation, disturbance by humans, or other factors. In northwest Florida, roof-nesting and ground-nesting black skimmers have similar (but low) reproductive rates. Lara Coburn and two of her colleagues of the Florida Fish and Wildlife Conservation Commission recently published recommended management techniques to protect and enhance nesting areas for both ground-nesting as well as roof-nesting birds.

Managing and Protecting Ground Colonies

Limit Human Disturbance

Human activity at nesting sites can result directly in crushed eggs and chicks, and indirectly in loss of both to gulls and other avian predators by flushing parent birds from nests. Signs posted around the periphery of nesting colonies may help to reduce disturbance by humans. The authors also recommend use of plastic fencing for the same purpose, but caution against use of wire fencing as wire may injure young birds. Signs and fencing should be in place

before April when migrating birds return to nesting grounds. Both can be removed following nesting, usually in August. Public education is an important and useful tool in reducing human disturbance of nesting sites. Such information as plight of the birds, population status, and nesting requirements should be conveyed to the public. Information should be directed both to the public at large as well as to bird watchers and biologists who may have more direct interest in the birds. Finally, state and federal laws designed to protect the birds should be enforced.

Exclude and Control Predators

Use of fencing around nesting colonies can prevent or help to reduce predation by dogs, foxes, and coyotes. To help control avian predation, human disturbance should be limited. Also, gulls should be discouraged from nesting nearby. State and federal laws must be adhered to with regard to predator control.

Minimize Effects of Weather and Flooding

Use of wooden pallets or boards can provide shelter and shade for chicks. Also, wooden pallets placed end to end and covered with sand can be used to elevate low-lying areas prone to flooding.

Control Vegetation

Black skimmers like open, unvegetated sites for nesting in Florida but often nest with terns and, in Florida, least terns prefer nest sites with about 4% vegetative cover in dispersed clumps. To arrest plant succession and to maintain open nesting areas, vegetation can be removed by hand or with a tiller, bulldozer, plow, or covered with clean dredged material. Work should be completed before April.

Protect and Maintain Feeding Sites

Skimmer eggs and nearby fish populations (food source for the birds) and water bodies should be monitored periodically for environmental contamination.

Provide Additional Habitat

Clean dredged material can be used to enlarge beach-nesting areas, to cover vegetated areas, or to create new islands where birds can nest. Sand and shell dredged material works well; material containing

clay and silt should be avoided as it can coat eggs and young chicks. Created islands should be high enough to avoid wash-over by high tides and should be designed with a slight slope for drainage. Wooden pallets can be used for cover and shade and signage can be used to deter human disturbance. Placement of decoys on the site and playing of non-aggressive sound recordings of nesting terns and skimmers also may be effective.

Managing and Protecting Roof Colonies

Limit Human Disturbance

This factor is not as big a problem for roof-nesting birds as it is for ground nesters. Maintenance workers and biologists are generally the only humans who might disturb roof-nesting birds. During the nesting season, roof visits by these individuals should be limited to 30 minutes duration in the early morning hours. Care should be taken not to step on eggs or chicks or to cause chicks to run (they can sometimes fall from rooftops and be injured or killed).

Predator Control

Cats and raccoons may be able to access roof-nesting sites. Access by these predators should be denied. If that is not possible, trap and removal may be necessary. Avian predation can be reduced by limiting human disturbance at nesting sites. Minimizing human disturbance will reduce the time adult birds are away from nests. Wooden pallets can be used for cover by chicks.

Minimize Effects of Weather and Flooding

Well-constructed roofs should have a slight pitch and

should not collect standing water. Wooden pallets can be used for shade and to provide shelter for chicks from storms.

Maintain and Protect Feeding Sites

Skimmer eggs and nearby fish populations and water bodies should be monitored periodically for environmental contamination.

Increase Nest Depth

Cracking of eggs from rooftop stones is the primary impact on hatching success in roof-nesting skimmers. Increasing nest depth (by adding additional gravel) may be effective in improving hatching success. The authors recommend an average depth of at least 4 cm and further advise that any added gravel be of similar size (or smaller), shape, and color as existing gravel. One also must consider the structure's capability of withstanding the additional weight on the roof.

Fence Roof Edges, Drain Pipes, and Vents

Fencing will keep chicks from falling from rooftops. It should be at least 15 cm in height and constructed of plastic screen, plastic-coated wire, or galvanized hardware cloth.

The authors concluded that "Although designed specifically for black skimmer colonies, these recommendations also may benefit other beach- and roof-nesting birds in any coastal region."

Reference: Coburn, L.M., D.T. Cobb, and J.A. Gore. 2001. Management opportunities and techniques for roof- and ground-nesting black skimmers. *Wildlife Society Bulletin* 29:342-348.

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Public Attitudes Toward Canada Geese

Resident (non-migratory) Canada goose populations have been increasing in North America in recent years. Along with increasing populations, particularly in metropolitan areas, have been increasing conflicts with humans. Managing such goose populations is often difficult. To be successful, management strategies must be effective and acceptable to the public. Public attitudes toward geese and various management options are important because public attitudes influence government support or non-support for various management options.

With this in mind, John Coluccy and four of his colleagues at the University of Missouri and the Missouri Department of Conservation recently assessed public attitudes toward Canada geese in central Missouri. These investigators also determined public preference for various management alternatives and public perception of management responsibilities. In the spring of 1994, a random telephone survey was conducted of Boone and Callaway County residents. Eight hundred adult men and women (at least 18 years old) were interviewed in rural and urban portions of the two counties.

Most respondents were aware of local Canada goose populations—74% had observed geese in the area. Forty-two percent stated they would like for populations to remain at or near current levels; 32% wanted to see more geese and 9% wanted to see fewer birds. Respondents experiencing property damage, urban residents, and landowners were more likely to desire seeing fewer birds.

Most (81%) respondents enjoyed having geese in the community, although 13% of these individuals indicated that the birds sometimes cause problems. Four percent felt the birds were a nuisance in the community and 15% had no preference or did not know. Rural, non-landowner females were more likely to enjoy geese, and enjoyment was greater if birds used nearby property without causing property damage.

Coluccy and his colleagues also determined atti-

tudes with regard to lethal and non-lethal management techniques. Lethal control methods included nest manipulation, firearms hunting, and issuance of landowner kill permits. Non-lethal control methods included passage of an anti-feeding ordinance, harassment and translocation. Overall, respondents viewed lethal means negatively and non-lethal means as ineffective. However, 51% approved of traditional firearms hunting and 71% said they approved of special hunts and landowner kill permits if serious goose damage was demonstrated. An additional 13% (40% of those who initially disapproved) said they approved of lethal removal if the geese were killed in a humane manner and the meat processed and distributed to food pantries or homeless shelters.

In the United States, wildlife is a public resource, owned by everyone. Managing this public resource on private property is not always easy, particularly when the resource causes damage or creates a nuisance. Governmental agencies need to be flexible and work cooperatively with property owners in this effort, but typically such agencies do not directly pay cost of damage that may be caused by wildlife. Coluccy and his colleagues were interested in the views of central Missouri residents with regard to this issue and reported that 48% of respondents in their survey felt that private landowners should absorb the cost of goose damage to private property. Seventeen percent of respondents felt that governmental agencies should be accountable and 35% did not know or provided a response that was not catalogued. The researchers concluded that "The conflicting attitudes of a relatively small number of people who experience problems with Canada geese and the majority who do not create a difficult dilemma for management agencies. The challenge in dealing with goose problems is to develop effective management strategies that also are socially acceptable." Central Missouri residents will support an array of management approaches if they understand the situational need for management as well as the effectiveness of various management methods. Management agencies need good public education programs in order to gain public support for management strate-

gies, whether or not those strategies are lethal or non-lethal.

Reference: Coluccy, J.M., R.D. Drobney, D.A. Graber, S.L. Sheriff, and D.J. Witter. 2001. Attitudes of central Missouri residents toward local giant Canada geese and management alternatives. *Wildlife Society Bulletin* 29:116-123.

Winter Bird Feeding

Bird feeding is a popular outdoor activity throughout the United States and much of the rest of the world. In recent years, researchers have become interested in effects of such practice on bird populations. Some work has shown that supplemental feeding can enhance black-capped chickadee survival during harsh winters in Wisconsin.

Herbert Wilson of Colby College, Waterville, Maine recently studied population and individual responses of black-capped chickadees to supplemental feeding. Work was conducted on the eastern shore of Flagstaff Lake, Maine, mostly in a protected second growth forest dominated by conifers (primarily red spruce and balsam fir). The area contained no human dwellings and the closest bird feeders were some 15 km away. Wilson established 16 sites along 19 km of Long Falls Dam Road and grouped them into four blocks of four consecutive sites. Each of the following four treatments was randomly assigned once in each block:

Continuous feeding--sunflower seed provided 25 October 1995-12 March 1996,

Early feeding--seed provided from 25 October 1995-11 January 1996,

Late feeding--seed provided from 11 January 1996-12 March 1996, and

Control--no seed provided.

Feeders were constructed of 6-mm hardware cloth and measured 18 cm in diameter and 30 cm in height. Several birds could feed at once. Feeders were surveyed each week with a car by stopping at each site and counting bird visits to the feeders for 3 minutes. Wilson also mist-netted and banded birds at the four continuous sites in November 1995. Except for the last 2 weeks in December, he then visited each site repeatedly for 2-day periods every week, and during

a 30-minute observation period recorded individual bird visits when possible. Although this study is not urban-related, bird feeding in metropolitan areas is widespread and study results reported here may be enlightening to readers interested in the subject.

As one would expect, chickadees were attracted to the feeders and bird abundance was significantly higher at feeder sites than at the control site. The birds located feeders more rapidly early in the winter than they did late in the winter. Wilson speculated that this might be because birds had not yet established winter territories when the early feeding observations were made, or that birds were less likely to move widely later in the coldest part of the season in order to conserve energy.

Large numbers of chickadees visited the feeders. At one site, more than 100 different birds visited the site in a single day. Wilson wondered if perhaps the normal social system of wintering chickadees was modified by the feeders. Typical winter flocks consist of a mated pair and six to ten first-winter birds not related to the resident pair. The flock defends its territory (8-22 ha based on previous studies) against other flocks. Wilson reviewed work of other researchers showing that feeders may attract several flocks, some of which may travel across the territories of four or more other flocks to get to a feeder.

No consistent pattern was noted of greater feeding activity in early morning and late afternoon. Wilson speculated that such feeding might be expected to help the birds through long, cold winter nights. Perhaps the birds feed on natural foods at these times. A few years ago, Margaret Brittingham and Stan Temple showed that, even with feeders available, chickadees continue to feed on natural foods and so are not dependent on feeders. Wilson found that frequency of feeder use varied among birds at each site (could not be explained by age of bird) and that individual birds showed considerable variability in use over time. These observations support the notion that chickadees feed elsewhere even with the presence of feeders.

In summary, chickadee abundance is higher in the presence of feeders and feeders may alter typical winter flock behavior. However, evidence to date suggests that the birds are not dependent on supplemental feeders. The birds continue to feed naturally as well as make use of available 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.

Wilson, W.H., Jr. 2001. The effects of supplemental feeding on wintering black-capped chickadees (*Poecile atricapilla*) in central Maine: population and individual responses. *Wilson Bulletin* 113:65-72.

Thrushes in England

Farmland and woodland birds have declined noticeably in England the last 20 years. Some species, such as the song thrush (*Turdus philomelos*) and blackbird (*T. merula*) that were once abundant now are in need of conservation.

Christopher Mason of the University of Essex, England, recently studied the distributions of the blackbird, song thrush, and mistle thrush (*T. viscivorus*) in urban and adjacent rural landscapes of an intensively farmed area of east England. He recorded distributions in relation to habitat types and formulated future conservation and planning strategies, work published recently in *Diversity and Distributions*.

Mason's study area totaled 2,636 ha of northeast Essex, including the coastal town of Harwich (population 17,000) and the adjacent rural landscape. Bird surveys were conducted (and territories recorded) four times during peak song activity periods (before 9 am and between 4-6 pm) between mid-March through May 1999. In rural areas, all roads, foot paths, and field boundaries were walked. All roads and paths were walked in urban areas. Some additional casual observations were made throughout daylight hours.

Mason found that the combined "built environment" contained 82% of blackbird territories, 59% of song thrush territories, and 46% of mistle thrush territories. For each species, significantly more territories were found in the built environment than one would expect based on the proportional distribution of habitats. According to Mason, farmland represents the greatest proportion of land area, but is no longer suitable habitat for the three species. Farms now are intensively managed for crop production and lots of fertilizer and pesticides are used. There has been a loss of hedgerows as field size increases to handle larger machinery. Measured hedgerow density in his study was 27 m/ha; 60-80 m/ha is considered necessary to support a high density of birds. The lawns and associated gardens of the built environment provide good feeding and nesting habitat for the three

thrushes. Mason concluded that "...conservation organizations at both national and local level should work closely with planners and developers at an early stage to ensure that suitable habitats are both retained and created within new developments for the benefit of both wildlife and human inhabitants."

Reference: Mason, C.F. 2000. Thrushes now largely restricted to the built environment in eastern England. *Diversity and Distributions* 6:189-194.

Restoring Plant Communities

Prior to European settlement, the Oak Openings ecological region of northwestern Ohio and southeastern Michigan encompassed over 40,000 ha of oak savanna, oak woodland, and wet prairie. Savanna and woodland were dominated by sparse overstories of white oak (*Quercus alba*) and black oak (*Q. velutina*), and fire was important in maintaining all three communities. In the late 1800s, land clearing for agriculture, logging of oaks, draining of wet prairies, and fire suppression altered much of the area.

Toledo Metroparks now manages the 1,495-ha Oak Openings Preserve Metropark. Scott Abella of Clemson University and five of his colleagues of Metroparks are testing several restoration practices at study sites in the three plant community types within the preserve. In 1998, spring and fall burning regimes were initiated. No other treatment was applied to the woodland site. However, at the savanna site, overstory oaks were partially thinned, and non-oaks were removed along with understory brush. At the wet prairie site, overstory red maples (*Acer rubrum*), sassafras (*Sassafras albidum*), and other non-oak species were removed along with understory brush. Sites were inventoried twice in 1998 before restoration practices were applied and twice each year in 1999 and 2000.

Response to the treatments varied somewhat among the three community types, but a pattern emerged. Within the oak woodland, plant species composition remained about the same, but percent cover of native species increased due primarily to an increase in tree seedlings of black cherry (*Prunus serotina*) and white oak and increases in shrubs such as witch hazel (*Hamamelis virginiana*) and blueberry (*Vaccinium* spp.). The authors recommend thinning the overstory to 100-125 trees per ha to decrease annual litter fall and implementing a long-term periodic burn regime (every 2-5 years) to thin the surface organic litter layer. It is believed that this will result

in increased light penetration leading to greater ground layer diversity more characteristic of historic levels while continuing to support characteristic understory dominated by shrubs and sedges.

A big shift in species composition was noted at the wet prairie site following restoration efforts. Goldenrod (*Solidago* spp.) increased significantly but several characteristic oak opening wet prairie species were lacking, including big bluestem (*Andropogon gerardi*), swamp milkweed (*Asclepias incarnata*), wild bergamot (*Monarda fistulosa*), dense blazing star (*Liatris spicata*), cardinal flower (*Lobelia cardinalis*), and Virginia mountain mint (*Pycnanthemum virginianum*). This vegetation response may be influenced by the altered hydrology (past ditching and lowering of the water table). An attempt may be made to restore the original hydrology by blocking ditches.

At the savanna site, native species richness increased following restoration treatments. With continued burning, selective brush removal, and interseeding of absent and underrepresented species it is expected that ground layer diversity and grass cover will continue to increase. The authors believe that an irregular burning regime (varying the time of year

and frequency) will increase the percent cover of wild lupine (*Lupinus perennis*), which is the larval food source for several rare savanna butterflies.

In summary, urban development, farming, logging, and fire suppression have negatively impacted the original vegetation communities of the Oak Openings ecological region of northwestern Ohio and southeastern Michigan. One hundred sixty-three state rare plants are found in Lucas County, centrally located in the region, and several rare savanna insects persist in the region. Restoration practices should benefit these species. The authors conclude, "Our results demonstrate that within three years controlled burning, overstory thinning, and other restoration treatments began to increase native species diversity and restore historic structure in three degraded Oak Openings communities...Restoration, combined with key land purchases, has a central role in the future ecological health of the northwest Ohio Oak Openings region in an increasingly urbanizing landscape."

Reference: Abella, S.R., J.F. Jaeger, D.H. Gehring, R.G. Jacks, K.S. Menard, and K.A. High. 2001. Restoring historic plant communities in the Oak Openings region of Northwest Ohio. *Ecological Restoration* 19:155-160.

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Land-use Planning and Wildlife in Chiba, Japan

Toshihiko Nakamura of the Natural History Museum and Institute, and Kevin Short of Inzai City, Chiba recently studied the distribution of threatened wildlife species in relation to current land-use planning in Chiba, Japan. Their goal was to develop a sustainable land-use plan combining industrial-residential facilities with conservation and restoration of important wildlife habitats.

Chiba City is located along the northeastern shore of Tokyo Bay, the northern limit of the Asia warm-temperate climax forest zone dominated by evergreen broad-leaved trees like chinkapin (*Castanopsis cuspidata*), laurel (*Machilus thunbergii*), and live oaks (*Quercus myrsinaefolia*, *Q. acuta*, and *Q. glauca*). Secondary woodlands consist largely of oak (*Q. serrata*), hornbeam (*Carpinus tschonoskii*, *C. japonicus*), zelkova (*Zelkova serrata*), and other fast-growing deciduous trees. A third forest category, managed and semi-managed forests, includes traditional coppices planted mostly in oak and conifer timber plantations.

Distributions of 1,553 species of plants and 2,838 species of animals were mapped (within 1.1-km x 0.9-km plots) according to two land-use variables—extent of green cover (farmland, forest, wetland, park) and zoning category. Green cover for each plot was further classified into: 1) <25% total green cover; 2) 25-50% total green cover; 3) >50% total green cover but <25% forest; and 4) >50% total green cover with >25% forest.

Zoning within the study area (272.5 km²) was classified as: 1) urbanization promotion zone, 45.4%; 2) parkland zone, 2.1%; 3) agricultural and urbanization control zone, 44.3%; and 4) agricultural promotion zone, 8.2%.

These researchers reported that 22 species of plants and 17 species of animals were locally extinct and 165 species (plants and animals combined) were classified under threatened status. The distribution of threatened wildlife was related to green cover and land-use categories. These species were densely dis-

tributed in and around narrow alluvial valleys (called “yatsu”), which form a complex branching pattern in the region. Much of the remaining biodiversity in the area is dependent upon managed and semi-managed habitats of the surrounding countryside, particularly the traditionally managed yatsu valleys of rice and vegetable fields, fruit and nut orchards, canals, irrigation ponds, and coppice forest.

The authors provide the following four recommendations.

1. Maintain existing natural habitats in the urban districts and surrounding farming districts of the yatsu valleys.
2. Restore degraded natural habitats. Considerable restoration is needed within urban districts and intensive agriculture zoned districts, including reconstruction or creation of coastal habitats (marshes, tidal flats, and coastal vegetation communities), riparian habitat, and city parks.
3. Create a network of wildlife habitats, including:
 - a. Core zones—large areas (100 ha or more) of protected yatsu valley and surrounding forest-riparian habitats.
 - b. Wildlife corridors—to connect core zones.
 - c. Urban reserves—preserved or restored natural habitats.
4. Increase the interaction among residents and nature. This is important if one wants to maintain biodiversity and ecosystems. “Biologically diverse habitats provide the highest quality open space.”

Nakamura and Short conclude that, “Japan’s traditional countryside landscape, with abundant wetlands and woodlands and a diverse patchwork structure, supports a great variety of wildlife. Maintenance and restoration of this landscape is one of the nation’s most pressing biodiversity issues. Hopefully, this study will help urbanizing municipalities develop future land-use policies that will combine sustainable

development with conservation of the beautiful and ecologically rich countryside landscape.”

Reference: Nakamura, T., and K. Short. 2001. Land-use planning and distribution of threatened wildlife in a city of Japan. *Landscape and Urban Planning* 53:1-15.

Small Mammal Populations in Northeastern Illinois

Since the mid-1800s, northeastern Illinois (the Chicago region) has become increasingly urbanized. Effects of urbanization on the original prairie habitat of the area and animal life associated with the prairies are of interest to Oliver Pergams and Dennis Nyberg of the University of Illinois at Chicago. These researchers speculated that museum collections of mammals may be helpful in assessing long-term habitat changes resulting from human activity. To test their hypothesis, Pergams and Nyberg studied museum collections from six northeastern Illinois counties (Cook, DuPage, Kane, Lake, McHenry, and Will). They were particularly interested in populations of the prairie deer mouse (*Peromyscus maniculatus bairdii*) and the prairie vole (*Microtus ochrogaster*) between 1850 and 1996. These two species are closely associated with prairie habitat and both have related species that are not prairie dependent—the white-footed mouse (*P. leucopus*) and the meadow vole (*M. pennsylvanicus*). For each of six time intervals between 1850 and 1996, the investigators calculated the proportion of prairie species in the collections. They did the same for the years 1850 and 1996. They also estimated rate of loss of prairie habitat and proportion of natural area that was prairie between 1840 and 1976.

The proportion of prairie species (prairie deer mouse and prairie vole) in each time interval was lowest after 1980 (proportions of the white-footed mouse and of the meadow vole increased with time). The rates of decline in proportion of prairie mammals were similar to rate of decline of prairie habitat in the region. The authors concluded that, “Even though populations of all small mammals have declined in this urbanized region due to habitat consumption by human economic activity, prairie species have become especially rare and deserve special concern in biodiversity planning.”

Reference: Pergams, O.R.W., and D. Nyberg. 2001. Museum collections of mammals corroborate the exceptional decline of prairie habitat in the Chicago region. *Journal of*

Mammalogy 82:984-992.

Bat Use of an Urban Wildlife Refuge

Little is known about bat use of urban parks and refuges in the United States. Researcher Lance Everette and four of his colleagues of the U.S. Geological Survey’s Midcontinent Ecological Science Center, in Fort Collins, Colorado recently studied these mammals at the Rocky Mountain Arsenal National Wildlife Refuge (RMA). The 6,900-ha refuge is located 16 km northeast of Denver and is considered the largest urban wildlife refuge in the National Wildlife Refuge System.

During the summers of 1997 and 1998, Everette and his associates captured bats with mist nets, generally from sunset to midnight. In 1997, they measured echolocation calls with a bat detector beginning 30 minutes after sunset and, in 1998, 12 lactating female big brown bats were radiotagged with the goal of locating maternity roosts.

These investigators captured 176 bats in their study; 151 were big brown bats (85.8% of total captures), 17 were hoary bats (9.7%), and eight were silver-haired bats (4.5%). Echolocation data yielded similar use data. Water and tree-edge habitat features were positively linked to bat activity (bat activity was more than five times greater where these features were present than at open prairie sites).

Eight radiotagged bats led researchers to 12 maternity colonies, all of which were located in buildings off the refuge in the urban core of Denver. Mean distance from maternity roosts to feeding sites on the refuge was 13.8 km, some 10 times greater than the 1- to 2-km distances reported from most other studies. Buildings in the older central core area of Denver seemed to be preferred over trees or snags on the refuge or buildings in newer suburban areas closer to the refuge. The authors concluded that, “Our study suggests that urban wildlife refuges can provide important areas for bats, with species composition, richness, and evenness likely to be dictated in part by the range of available roosting opportunities... The greater activity of bats at edge habitats at RMA, particularly trees along water, suggests that maintaining such features in otherwise structurally simple high-plains landscapes will provide more favorable conditions for bats. Although additional research specific to particular areas is needed, providing habitats suitable for foraging bats near urban areas appears to have promise as a conservation tool. Furthermore,

developing bat conservation-oriented interpretation and education programs in urban refuges and parklands utilized by bats has potential to reach large numbers of people.”

Reference: Everette, A.L., T.J. O’Shea, L.E. Ellison, L.A. Stone, and J.L. McCance. 2001. Bat use of a high-plains urban wildlife refuge. *Wildlife Society Bulletin* 29:967-973.

Bats in Athens, Greece

Anastasios Legakis of the University of Athens and three of his colleagues recently conducted the first study of bats in Athens, Greece. They were particularly interested in documenting roosting areas, foraging areas, and threats to bats, and formulating recommendations for conservation of bats in the city.

Between 1992 and 1995, Legakis and his associates studied bats at 64 sites throughout the city. They used a bat detector device, along with visual sightings, to help record the mammals. Calls also were recorded with a cassette recorder for later species determination. Number of calls per km served as an indicator of foraging activity and general population density.

Five species of bats were recorded in the study and all were considered typical inhabitants of towns in central Europe: pipistrelle (*Pipistrellus pipistrellus*), Kuhl’s pipistrelle (*P. kuhlii*), lesser mouse-eared bat (*Myotis blythii*), notch-eared bat (*M. emarginatus*), and common serotine (*Eptesicus serotinus*). The two pipistrelle species were the most common. Although numbers of bats were generally low, they were found throughout Athens. The largest concentrations were in the foothills of mountains around the city. Most suitable sites for foraging were areas with abundant vegetation and diversity of habitats near the edge of the city in sparsely built areas. For foraging, the mammals seemed to avoid high traffic and noise. An intermediate artificial light intensity, attracting insects, seemed favorable to foraging.

Very few parks are present in Athens. Those that do exist contain trees mostly of the same age with little low vegetation. The parks support a poor insect fauna and low bat activity. Over the past 40 years, pine trees have been planted in the city but they are not attractive to bats. Streams and parks appear to serve as corridors between roosting sites and foraging grounds and between foraging grounds. The numerous caves in the surrounding mountains may be important roosting sites and hibernation sites.

Reference: Legakis, A., C. Papadimitriou, M. Gaethlich, and D. Lazaris. 2000. Survey of the bats of the Athens metropolitan area. *Myotis* 38:41-46.

Coyotes in Tucson, Arizona

Coyotes are adaptable mammals that, in recent years, have been moving eastward in North America as well as moving into urban and suburban areas. Recent research from Tucson, Arizona adds to our knowledge base regarding the animal’s home range, habitat use, and nocturnal activity in that city. Researchers Martha Grinder and Paul Krausman of the University of Arizona, Tucson trapped and radiocollared 19 coyotes between October 1996 and January 1998, and studied their movements and habitat use through four seasons--breeding (January-February), gestation (March-April), pup-rearing (May-August), and dispersal (September-December)--from October 1996 through December 1998.

Thirteen coyotes were defined as resident animals because they were located during at least 70% of all location attempts. Average home range size for these animals was 12.6 km². Three male coyotes were defined as transients because they were located during less than 50% of all location attempts. Average home range size for these animals was 105.2 km². Limited data were gathered on the three other coyotes and they were not included in the analyses. From a literature review, Grinder and Krausman point out that home range size for coyotes in western North America varies from 1.1 km² in urban areas of Los Angeles to 118 km² in Washington, with most reported values between 10 and 31 km². In their study, Grinder and Krausman found no difference in home range size between males and females or among seasons. They speculated that no seasonal differences may have resulted from a less variable food supply for urban animals. Coyotes are omnivorous, eating a variety of foods ranging from discarded items from humans to pet food to fruits and small prey. Grinder and Krausman observed coyotes preying on small rodents, lagomorphs, and domestic cats while in residential areas.

Coyotes used natural areas, parks, and residential areas in proportion to habitat availability except during the dispersal season when natural areas and washes were used but parks and residential areas were avoided. (Natural areas were defined as state and federal parks, privately owned natural open space, cropland, and residential areas with less than 1 house per 0.4 ha; parks were defined as schools, mili-

tary grounds, cemeteries, zoos, golf courses, and neighborhood, district, and regional parks, stables, and pens with horses and cows; and residential areas were defined as neighborhoods with more than 1 house per 0.4 ha.) Little use was made of other habitat patches.

Coyotes generally are most active around sunset and sunrise. However, Grindler and Krausman recorded activity peaks at 11 pm and 5 am, speculating that greater human activity in the early evening may be responsible for delaying evening activity of coyotes. These authors conclude, "The emerging picture of coyotes in urban areas indicates that they are able to fulfill their daily requirements by shifting activity to times when humans are least active, by using areas where they can avoid humans, and by concentrating their time in parks, residential, and natural areas... A greater understanding of the effects of urbanization on the way coyotes use the landscape is necessary if managers are to maintain (or reduce) habitat for coyotes in these areas. Behavior of coyotes in urban areas should be studied at a finer spatial and temporal scale to allow researchers to determine the components of each habitat patch type that are being used for specific activities."

Reference: Grindler, M.I., and P.R. Krausman. 2001. Home range, habitat use, and nocturnal activity of coyotes in an urban environment. *Journal of Wildlife Management* 65:887-898.

Managing Red Foxes

Researchers S.R. McLeod and G.R. Saunders of the Vertebrate Pest Research Unit, NSW Agriculture, New South Wales, Australia are interested in improving management strategies of the red fox, a species

sometimes considered a pest in Australia and elsewhere. Recently, these investigators studied the use of projection matrix sensitivity analysis to determine age classes that make the greatest contribution to rate of increase of fox populations. With this knowledge, McLeod and Saunders reasoned that improved management strategies might be implemented for controlling foxes.

The authors studied life table data of four fox populations—a rural population in North America, a rural population in Australia, and two urban populations in England (one in London and one in Bristol). Sizes of all four populations were stable.

Study results showed that the four populations shared a common demographic theme; juvenile and young adult foxes (1st- and 2nd-year age classes) always made the greatest contribution to rate of increase of populations. Both survival and reproduction were important factors, with survival generally registering as most important. There was some indication, however, that for the two urban populations, reproduction was more important than survival. This led the authors to conclude, "There is evidence that fertility control may be as effective as lethal control in some populations, such as urban fox populations or increasing rural populations. In other populations, survival is more important than reproduction, which suggests that fertility control may be used as an adjunct to lethal methods, but that lethal methods will remain a more effective way of reducing the finite rate of increase." The efficacy of both lethal and non-lethal methods of control may be improved by targeting juvenile and young adult foxes.

Reference: McLeod, S.R., and G.R. Saunders. 2001. Improving management strategies for the red fox by using projection matrix analysis. *Wildlife Research* 28:333-340.

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