THE URBAN OPEN SPACE MANAGER

A newsletter about wildlife and nature conservation in urban areas
(ISSN 1094-9844)

Volume 12, Number 1 2007

Publication Note

I will stop publishing *The Urban Open Space Manager* in December 2007 (Volume 12, Number 4). The last issue mailed will include an Index for Volumes 10-12. I have enjoyed very much producing the newsletter these past 12 years but am now redirecting more of my time to other things, including increased involvement with international programs of the University of Maryland and Partners of the Americas. Thank you for your patronage these past 12 years. I hope the newsletter has been useful to you. And best wishes to you all.

--Lowell Adams, editor and publisher

Grassland Habitat Restoration and Biodiversity

During the latter half of the 20th Century, grassland birds experienced greater declines than any other avian group in North America. In the state of Iowa, and in Kane County, Illinois, less than 1% of original prairie habitat remains. Research indicates that prairie habitats should be in the neighborhood of 400 ha to maintain species diversity. Small prairie habitat fragments, on the order of 40 ha or less, may function as population sinks. In other words, some birds may use the small areas, but over time production in such areas will not exceed mortality. Bird presence in the areas is dependent on immigration from larger source populations.

Given this scenario, do small-scale habitat restoration projects in urban and urbanizing areas have wildlife value? This question was of interest to James Miller of Iowa State University. In a recent paper, he presents two case studies from the upper Midwest of the United States and argues that both large-scale rural prairie restoration and small-scale urban restoration projects are important.

The Broken Kettle Grasslands Preserve of northwest Iowa comprises some 1,200 ha. It is large enough to allow prescribed burning to simulate natural fires that historically swept the area. Plans are being prepared to reestablish a bison herd.

Some 700 km east of Broken Kettle is Kane County, Illinois, located in the central forest-grassland transition zone. The county is undergoing urbanization because of its proximity to nearby Chicago. Currently, the largest contiguous grassland in the county is 142 ha. A focus on large-tract restoration is highly unlikely due to high land prices and development pressure.

Miller argues that, based on habitat requirements of grassland birds, Broken Kettle is much more valuable than the small grasslands present in Kane County, Illinois. But he also argues that one should not remove the human element from the equation. Without thought given to open space planning and management, people growing up and living their lives in urban areas tend to loose contact with nature. And people are not likely to support what they do not know and cherish. So the presence of small prairie restoration projects, like those of Kane County, can provide links to nature for urban residents. By maintaining some contact with nature and the natural world, people will better appreciate the functional value of ecosystem elements and their importance to maintaining quality human environments. Miller concludes: "Thus, the goals of conservation and ecological restoration at various points on the land-use gradient are somewhat different but complementary and inter-related. Conservation scientists have an obvious role in the restoration and management of large reserves, but they also have an important part to play in restoring and maintaining elements of biodiversity in cities and suburbs."

Reference: Miller, J. R. 2006. Restoration, reconciliation, and reconnecting with nature nearby. *Biological Conservation* 127:356-361.

Managing Nuisance Raccoons

The raccoon (*Procyon lotor*) is one of the most common species causing wildlife nuisance complaints in many metropolitan areas of the United States. Animals using chimneys and attics of houses

as den sites cause the most problems. Translocating problem animals to new areas was a common management practice used in the past. Many states, however, including Connecticut, do not permit translocation of raccoons now because they have become a rabies-vector species. Captured animals must either be euthanized or released on site where caught. Most residents prefer not to kill the animals.

In Connecticut, most homeowner complaints occur April – June when adult females are raising young. Little information is available regarding behavior of lactating females removed from houses and released on site. Do they find new den sites in natural habitat or return to constructed structures? Are young abandoned in the process?

Michael O'Donnell of Trinity College, Hartford, Connecticut and Anthony DeNicola of White Buffalo, Moodus, Connecticut recently investigated these issues. Work was conducted in single-family, low-density (less than 5.0 houses per ha) to medium-density (5.0 – 10.0 houses per ha) residential neighborhoods of 10 suburban towns in north-central Connecticut April 1998 – April 2001.

Lactating female raccoons were captured from houses with live traps overnight. The next morning they were anesthetized and fitted with radiocollars. Each adult was then placed in a covered cage to recover from the anesthesia. Young were manually removed from the house and placed in a covered box near the point of access to the residence. After sunset, captured females were released and tracked 3 consecutive days following release and once per week thereafter for about 12 weeks. After 12 weeks, animals were located once or twice per month. After observing a low rate of offspring retrieval (36%), the investigators modified procedures by placing an entire family group in a covered trap until release after sunset. This procedure resulted in a higher rate of offspring retrieval (45%), but the difference was not statistically significant. The overall retrieval rate was 38%. All young not retrieved within 48 hours were considered abandoned and were euthanized.

Twenty-four females with young were radiocollared and tracked. Fifteen returned to another constructed structure at least once; four used natural areas only, and five were never located. One year later, 80% of the adult females had returned to houses. Most of the females with young used human-built structures for the first 1 – 2 months after on-site release. Thus, the animals most likely created problems for other homeowners in the neighborhood. O'Donnell and DeNicola concluded: "Most nuisance raccoon situations (as well as other nuisance wildlife situations) can be avoided by the following: 1) use of chimney caps [60% of surveyed houses in the study lacked chimney caps], 2) securing garbage cans, 3) home maintenance to eliminate easy points of access, and 4) not feeding wildlife."

Reference: O'Donnell, M. A., and A. J. DeNicola. 2006. Den site selection of lactating female raccoons following removal and exclusion from suburban residences. *Wildlife Society Bulletin* 34:366-370.

Resident Attitudes Toward Wildlife in Brisbane, Australia

Sean FitzGibbon of The University of Queensland and Darryl Jones of Griffith University, Queensland, Australia suggest that community residents have a level of knowledge of local wildlife that can be used as a wildlife survey technique. Species need to be easily identifiable by the public. In Australia, residents have helped to determine distributions of koala (*Phascolarctos cinereus*), spotted-tailed quoll (*Dasyurus maculatus*), and tree-kangaroo (*Dendrolagus lumholtzi*). Public surveys also are useful in understanding citizen attitudes and concerns regarding wildlife.

Recently FitzGibbon and Jones conducted a community-based wildlife survey focused on the northern brown bandicoot (*Isoodon macrourus*). Their interest was in determining the abundance and distribution of bandicoots, and other species, and how these measures have changed over the last 30 – 45 years. The researchers also were interested in any conflict issues residents might have, as well as positive associations, with wildlife.

In February 2003, they hand delivered a short questionnaire survey to 300 houses located adjacent to one of 38 bushland fragments in the Local Government Area of Brisbane. The return rate for the survey was 57%. Eighty-three wildlife species were recorded, with possums (common ringtail, *Pseudocheirus peregrinus*, and common brushtail, *Trichosurus vulpecula*), Australian brush-turkey (*Alectura lathami*), and flying foxes (*Pteropus* spp.) being the most common. The researchers believed these responses probably reflected the ease of identification of these animals as well as their abundance in the metropolitan area. The species also pose some conflict issues—noisy possums in roof structures, flying foxes raiding fruit trees, and brush-turkeys disturbing gardens.

Resident attitudes toward bandicoots also were determined. These animals dig holes about the size of golf balls or tennis balls in lawns during foraging activities. They also may consume vegetables from gardens and pet food. There was a high degree of acceptance or tolerance of digging behavior with 81% reporting that such holes were not annoying to them.

Another potential conflict issue with regard to bandicoots is ticks. The paralysis (scrub) tick (*Ixodes holocyclus*) can cause severe discomfort in humans and death in cats and dogs. Three percent of respondents reported they were wary of bandicoots for this reason.

There was a high level of appreciation for native wildlife and bushland fragments. Animals particularly liked included possums, kookaburras (*Dacelo novaeguineae*), and wallabies. Disliked animals included crows, cats, dogs, brush-turkeys, foxes, and flying foxes because of conflict issues. FitzGibbon and Jones concluded: "Most respondents expressed an appreciation for the presence of native wildlife (96%) and bushland fragments (97%) in their local area, emphasizing the importance of incorporating human dimension values into the management of this urban biodiversity...The general goodwill of people living alongside bandicoots in Brisbane bodes well for public involvement in their conservation."

Reference: FitzGibbon, S. I., and D. N. Jones. 2006. A community-based wildlife survey: the knowledge and attitudes of residents of suburban Brisbane, with a focus on bandicoots. *Wildlife Research* 33:233-241.

White-winged Choughs in Australia

White-winged choughs (*Corcorax melanorhamphos*) are large, ground-foraging, cooperatively breeding birds of eucalypt woodlands of south-eastern Australia. They are opportunistic foragers, but primarily insectivorous. The birds are common breeding residents in older established areas of Canberra, although evidence indicates numbers are declining across their natural range.

White-winged choughs are social birds and live year round in groups of 3 – 20 individuals. Most groups number 6 – 8, with one monogamous breeding pair and young of several years. Groups maintain overlapping home ranges and birds do not defend stable territories.

During the breeding seasons of 2003 and 2004, Nadeena Beck and Robert Heinsohn of the Australian National University studied breeding biology of the birds in urban areas of Canberra and in a large (1,000 ha) nature park on the outskirts of the city. Birds were only found in older (more than 40 years), established suburbs. Nest sites were located near gardens, parks, or nature strips with mature trees. Choughs were live-trapped and fitted with individually numbered leg bands, and nesting groups were monitored at least three times per week. Failed nesting attempts were nests abandoned without fledging any chicks. A successful nest was recorded if at least one chick left the nest.

One hundred twelve nesting attempts were recorded for 40 different bird groups. No significant difference was noted in group size between urban and rural birds. Average group size for urban birds was 6.5 and for rural birds, 6.2. There was a significant difference in average group age. Urban groups averaged 3.3 years and rural groups 4.1. Differences in dispersal behavior of the birds between the two areas may be a factor contributing to this observation.

Nesting began more than a month earlier in the city and extended over a longer time period, although nesting success in the city (53%) was lower than in the nature park (79%). No difference was noted in the number of young fledged between urban and rural nests. The authors suggested that predation may be the major cause of lower nest success in the city, with the pied currawong (*Strepera graculina*) most likely responsible. This bird occurs at high densities in Australian urban environments.

Fledgling survival also was lower in the city (60%) compared to the nature park (74%). This may be due to predation by cats and dogs and by greater mortality from cars. The authors suggested that: "...increased rates of nest predation and fledgling mortality in the urban environment may have a negative effect on reproductive success and remove any advantage that might be gained through a longer breeding season." Further study is needed regarding causes of a longer breeding season, greater rate of nest failure, and lower fledging survival in the urban environment. More work on dispersal behavior of the birds also is needed.

Reference: Beck, N. R., and R. Heinsohn. 2006. Group composition and reproductive success of cooperatively breeding white-winged choughs (*Corcorax melanorhamphos*) in urban and non-urban habitat. *Austral Ecology* 31:588-596.

Forest Loss and Bird Extirpations

In 1859, before European settlement, the area encompassing present-day Vancouver, British Columbia, Canada was completely covered by coastal western hemlock forest. Eighty-seven percent is now converted to urban development. Three bird species are known to have been extirpated from the area. Kenneth Er and three colleagues, all of the University of British Columbia, Vancouver compared known number of extirpations with predicted number based on the Theory of Island Biogeography. Both historical and recent data on birds were available for analysis.

The researchers study area was 126.7-km^2 Vancouver City, which lies within the Fraser River lowland Coastal Western Hemlock biogeoclimatic zone. Thirty-six bird species were identified as being closely associated with lowland forests. Three birds—spotted owl (*Strix occidentalis*), yellow-billed cuckoo (*Coccyzus americanus*), and marbled murrelet (*Brachyramphua marmoratus*)—have been extirpated from the area.

The species-area function of Island Biogeography Theory predicted a loss of 14 species, given the amount of forest habitat lost. This number does not compare well with the three known extirpations. Constraining the 36 species data set to species considered to be restricted in their geographic distribution yielded nine species and the predicted loss in this case was four species, a number much closer to actual loss. According to the researchers, this suggests that: "bird species closely associated with lowland forest and restricted in their geographic distribution are most prone to extirpation as a result of forest loss." With an eye toward maintaining species diversity, the authors concluded: "A shift in the land-use planning paradigm from one based solely on social and economic factors to one that places importance on the incorporation of natural habitat from the onset is required. Early incorporation of these natural habitats, coupled with the enhancement of habitat quality in the landscape matrix through appropriate urban greening, provide the best chance for us to maintain the full natural complement of wildlife species within the urban landscape."

Reference: Er, K. B. H., J. L. Innes, K. Martin, and B. Klinkenberg. 2005. Forest loss with urbanization predicts bird extirpations in Vancouver. *Biological Conservation* 126:410-419.

The Urban Open Space Manager is a quarterly newsletter for land managers and planners, landscape architects, biologists, and others interested in wildlife and nature conservation in the metropolitan environment. It is published by Urban Wildlife Resources, 5130 W. Running Brook Rd., Columbia, MD 21044, USA, Lowell W. Adams, Ph.D., editor (Phone, 410-997-7161; Fax, 410-997-6849; E-mail, uwr24@netscape.net; Web site, http://www.erols.com/urbanwildlife). Annual subscription rate is $15 (airmail shipping beyond North and South America add $3.00), U.S. funds only. Printed on recycled paper.

THE URBAN OPEN SPACE MANAGER

A newsletter about wildlife and nature conservation in urban areas
(ISSN 1094-9844)

Volume 12, Number 2 2007

Koala Conservation in Semiurban Landscapes

How do natural factors and human influences (anthropogenic factors) affect koala (*Phascolarctos cinereus*) distribution in semiurban landscapes of eastern Australia? Is one more important than the other in determining koala distribution?

Human land use in eastern Australia has resulted in loss, fragmentation, and degradation of koala habitat. But, the relative importance of natural factors, such as habitat, and anthropogenic factors, such as roads and dogs, have not been determined. Jonathan Rhodes of The University of Queensland, Brisbane, Australia and six of his colleagues believe that, by better understanding these factors, they can offer sounder advice to officials regarding conservation planning. These researchers used a mixed-effects logistic regression model with several natural and anthropogenic variables to predict koala distribution in the southeastern region of the Port Stephens Local Government Area, New South Wales, Australia. Variables tested in the model were: primary, secondary, and marginal habitats; index of fire history; road density; traffic volume; human population density; and domestic dog density. The habitat variables were classified as natural factors and the remaining variables as anthropogenic factors. Data on koala distribution in the study area were collected February through April 2002.

Investigators found high correlations between fire and road density, and between human density and dog density, so fire and human density were deleted from further analyses to reduce the effect of multicolinearity. The most important variables, in descending order, were primary-secondary habitat, road density, and marginal habitat. Primary-secondary habitat was positively related to koala distribution; the other two variables were negatively related.

Based on results of the study, the authors concluded that the model could be useful as an aid in conservation planning. For example, if natural habitat quality is high in a given area and anthropogenic influences (in this case road density) are also relatively high, then a focus on reducing the latter would make most sense. On the other hand, if both natural habitat quality and anthropogenic influences are low, then focus on improving habitat would be best. The authors stated: "We demonstrated that this modeling approach, combined with the visual presentation of predictions as a map, provides important information for making decisions on how different conservation actions should be spatially allocated. This method is particularly useful for areas where wildlife and human populations exist in close proximity."

Reference: Rhodes, J. R., T. Wiegand, C. A. McAlpine, J. Callaghan, D. Lunney, M. Bowen, and H. P. Possingham. 2006. Modeling species' distributions to improve conservation in semiurban landscapes: koala case study. *Conservation Biology* 20:449-459.

Urban Green Space and Wildlife

What effects do large natural or semi-natural areas on the outskirts of cities have on wildlife biodiversity found downtown? This question was of interest to Robbert Snep of Wageningen University and Research Centre, The Netherlands, and six of his colleagues. These investigators developed a simulation model to study the role of urban green space and adjacent natural or semi-natural areas (called peri-urban areas) on wildlife diversity in urban neighborhoods. They focused on Hoogvliet, a small neighborhood in the Dutch city of Rotterdam where planned redevelopment would likely result in loss of a considerable amount of urban green space. Snep and his associates were interested in whether or not more natural design of the peri-urban area around Hoogvliet could act as source habitat and aid in retaining biodiversity in the neighborhood.

The model developed simulated animal movements between peri-urban and inner-city areas. Butterflies were selected as model species because they had suitable characteristics. From the scientific literature, movement parameters, life span data, and habitat preferences were obtained. Three types of dispersing

species were distinguished: poor, moderate, and good. Poor dispersers tended to be rare habitat specialists and were not included in the study because they are not usually found in urban areas. Good dispersers tended to be common habitat generalists and the small tortoiseshell (*Aglais urticae*) was selected as a model species. Moderate dispersers were considered intermediate between poor and good dispersers and the meadow brown butterfly (*Maniola jurtina*) was selected as a model species for this category. Probabilities were determined for mobility, life span, and border crossing between habitat types.

Two sites of source habitat were considered, 25 ha and 50 ha in size, and source habitat was classified as either optimal or sub-optimal (the latter being one-half the carrying capacity of optimal habitat). Two potential source locations were nearby. An assessment was made of existing butterfly habitat in the study area by using GIS software to show habitats (based on known habitat preferences of butterflies) and non-habitats on a digital topographical map.

The model predicted that good dispersers would cover the entire residential area from the source population and that moderate dispersers would be distributed over about one-third of the residential area. About 14% of good dispersers and 5% of moderate dispersers would be able to move to the residential area from the source population. Some butterflies would be expected to disperse in other directions, experience road mortality, or remain in the source area. Some 7% to 36% of the butterflies in the residential area would be expected to be moderate dispersers from the outside source population and some 19% to 56% would be expected to be good dispersers from the source population.

The authors pointed out that the scenarios tested would provide butterflies for people to enjoy in the residential area but the urban area may serve as a population sink for butterflies. It would be best to establish complete habitats in urban areas that would include both larval and adult butterfly plant resources. Such urban green space should be managed by rotation of habitats to accommodate both larval and adult life stages of butterflies. The authors stated: "We conclude that peri-urban nature areas, if large enough, can have a potentially positive influence on the presence of fauna in inner-city neighborhoods. In addition, results suggest that connectivity between inner-city and peri-urban habitat patches enhances contribution of peri-urban migrants to inner-city populations. By providing a range of different habitats, from inner-city up to peri-urban area, moderately mobile habitat specialists could better compete against the small set of successful habitat generalists that are increasing in urban environments all over the world."

Reference: Snep, R. P. H., P. F. M. Opdam, J. M. Baveco, M. F. WallisDeVries, W. Timmermans, R. G. M. Kwak, and V. Kuypers. 2006. How peri-urban areas can strengthen animal populations within cities: a modeling approach. *Biological Conservation* 127:345-355.

Predation by Domestic Cats

The United Kingdom (UK) contains some 813,000 feral and 8 million pet cats (*Felis catus*). Little is known about the impact of these predators on prey populations. Philip Baker and three of his colleagues of the University of Bristol, UK recently surveyed householders in northwest Bristol to quantify cat density and numbers of prey killed by cats. These investigators delivered a questionnaire to all 3,494 householders in a 4.2-km^2 area in northwest Bristol October – December 2002. Participants were asked to record data during the four seasons: winter, spring, summer, and autumn. Predation rates were estimated by comparing the minimum, intermediate, and maximum number of animals killed annually with published estimates of prey abundance and productivity.

Eighty-nine householders (with 131 cats) participated in the study. In all seasons, the majority of cats did not return any dead prey. Nonetheless, 358 prey animals were recorded (271 dead, 87 living). The wood mouse (*Apodemus sylvaticus*) was the most common species captured. The house sparrow (*Passer domesticus*) was the most common bird preyed on by cats. The house sparrow is declining in urban areas nationally and is a species of concern. Minimum estimated predation rates of pre-breeding prey density plus annual productivity were: house sparrow, 45%; dunnock (*Prunella modularis*), 46%; and robin (*Erithacus rubecula*), 46%. Predation rates were considered high for these species and the investigators recommended further research be conducted on the impact of cat predation on these populations. In conclusion, Baker and his colleagues stated: "Collectively, despite occurring at very high densities, the summed effects on prey populations appeared unlikely to affect population size for the majority of prey species...However, for three species there was evidence that the impact of cat predation may be significant."

Reference: Baker, P. J., A. J. Bentley, R. J. Ansell, and S. Harris. 2005. Impact of predation by domestic cats *Felis catus* in an urban area. *Mammal Review* 35:302-312.

Breeding Bird Comparisons in European Cities

In recent years, urban wildlife researchers have compared bird communities of cities in Europe and North America and among cities of varying latitude in Europe, looking for broad similarities or differences. Continuing this line of research, Klaus Witt and Alexander Mitschke of Germany and Maciej Luniak of Poland looked for evidence of an east-west gradient in bird communities in Europe. They analyzed breeding bird data for Hamburg (farthest west) and Berlin (middle) Germany, and Warsaw (farthest east), Poland, looking for bird density-habitat relationships and any patterns of similarities or differences along the gradient. Data were derived mostly from three published monographs on avifauna of the three cities.

The researchers identified four habitat classifications: 1) total city area, without bodies of water; 2) built-up zone, including urban green areas; 3) forests, including urban green areas; and 4) farmland, including built-up zone. Birds with wide habitat distribution (total city area) typically showed highest densities in the West (Hamburg) and lowest in the East (Warsaw). Most were bush or tree breeders and habitat may well have been a contributing factor to these observations. Urban green areas in the two German cities have more shrubs and trees than urban green areas in Warsaw. The authors believed also that synurbization—the adaptation of organisms to the urban environment—may explain the gradient for some species such as blackbird (*Turdus merula*), wren (*Troglodytes troglodytes*), and song thrush (*Turdus philomelos*). One prominent exception to higher densities in the West was the oriole (*Oriolus oriolus*), which showed highest density in Warsaw. Reasons for this observation are unclear.

Three species of built-up areas—house sparrow (*Passer domesticus*), feral pigeon (*Columba livia*), and jackdaw (*Corvus monedula*)—had highest densities in the East (Warsaw) and the researchers speculate about these differences. They point out that the house sparrow has noticeably declined in parts of western Europe, and the current data may be a reflection of that phenomenon. Pigeons are well tolerated by people in Warsaw but are often persecuted in the two German cities, which may account for observations of this species. The reason for higher density of jackdaws in Warsaw is unclear.

Forest birds were restricted mostly to parks and cemeteries. For most species, highest densities were recorded for Hamburg. Higher densities along the western end of the gradient may be because of habitat features, particularly trees and shrubs. Microstructure of habitats probably also accounted for differences in density for three farmland species.

In summary, the authors found a gradient of increasing density from east to west for 16 of 39 species. They speculated that major reasons for this observation were the greater richness of vegetation in the West because of higher precipitation and better soils, older tree stands, and more nature-friendly maintenance of urban green areas. Another major factor responsible for this "western" gradient is believed to be the stage of synurbization of some species, such as the wood pigeon (*Columba palumbus*), wren, blackbird, song thrush, mistle thrush (*Turdus viscivorus*), and jay (*Garrulus glandarius*).

Reference: Witt, K., A. Mitschke, and M. Luniak. 2005. A comparison of common breeding bird populations in Hamburg, Berlin and Warsaw. *Acta Ornithologica* 40:139-146.

Wildlife Rabies in Europe

Katja Holmala of the University of Helsinki, Finland, and Kaarina Kauhala of the Finish Game and Fisheries Research Institute recently reviewed the topic of wildlife rabies in Europe. They focused particularly on interaction of two vector species—the red fox (*Vulpes vulpes*) and raccoon dog (*Nyctereutes procyonoides*). The red fox has been the main vector species in recent history, but increasing numbers of rabies cases have been detected in the raccoon dog in the last few years, particularly in north-eastern Europe. The co-existence of two vector species adds to the complexity of the epidemiology of the disease. For one thing, the density of either species alone may be below the threshold density for spread of the disease but combined densities of the two species may exceed the threshold density.

The domestic dog and domestic cat have been the main hosts and primary transmitters of infection in humans in the past. Pet vaccination programs have reduced human infection markedly and urban rabies is almost completely eradicated, except from Turkey and Russia. The number of rabies cases in wild and domestic animals has increased in Russia in recent

years with some 90% coming from the red fox. The noted increase may be because of increased numbers of stray dogs and cats and increased numbers of foxes in human settlements. Highest fox densities have been noted in heterogeneous landscapes of urban, suburban, and agricultural areas.

In urban areas with dense populations, home ranges of red fox family groups are typically smaller than in rural areas and may overlap and/or gradually shift to new areas. Territories are more stable over generations in less urbanized areas. Historically, fox populations were reduced by lethal means in attempts to control the disease. Such practice was not particularly effective in most cases. More recently, oral vaccination has been used and found to be effective. The potency and safety of vaccines have improved over the past 20 years. Seven European countries now are rabies free because of oral vaccination.

The epizootiology of raccoon dog rabies has been little studied. The home ranges of foxes and raccoon dogs overlap and researchers speculate the two species probably transmit the disease to each other. If so, spread of the disease may be faster than in a fox population alone. The researchers concluded: "New rabies models, based on two vector species and their interaction, and which take into account the hibernation period of raccoon dogs, are needed for northeastern Europe."

Reference: Holmala, K., and K. Kauhala. 2006. Ecology of wildlife rabies in Europe. *Mammal Review* 36:17-36.

The Urban Open Space Manager is a quarterly newsletter for land managers and planners, landscape architects, biologists, and others interested in wildlife and nature conservation in the metropolitan environment. It is published by Urban Wildlife Resources, 5130 W. Running Brook Rd., Columbia, MD 21044, USA, Lowell W. Adams, Ph.D., editor (Phone, 410-997-7161; Fax, 410-997-6849; E-mail, uwr24@netscape.net; Web site, http://www.erols.com/urbanwildlife). Annual subscription rate is $15 (airmail shipping beyond North and South America add $3.00), U.S. funds only. Printed on recycled paper.

THE URBAN OPEN SPACE MANAGER

A newsletter about wildlife and nature conservation in urban areas
(ISSN 1094-9844)

Volume 12, Number 3 2007

Burrowing Owls in Washington

Burrowing owls (*Athene cunicularia*) may be declining in the state of Washington and there is some concern for the species throughout its North American breeding range. In Washington, nesting densities appear to be higher in agricultural and urban areas than in native shrub-steppe habitat. Researchers at the University of Arizona and the U. S. Bureau of Land Management studied the birds in an agricultural area of east-central Washington and in an urban area of southeastern Washington 2000-2004. The agricultural area was some 3,600 km^2 in Adams and Grant Counties and was mostly irrigated cropland. The urban area was approximately 1,500 km^2 and focused on the towns of Pasco, Kennewick, Richland, and West Richland.

Breeding densities of owls were calculated from a standardized roadside survey. The researchers monitored 1,006 nesting attempts during the study period, 512 of which were in the agricultural area, and 494 in the urban area. Birds banded included 1,132 juveniles in the agricultural area, 863 juveniles in the urban area, 416 adults in the agricultural area, and 271 adults in the urban area.

Some differences were noted in populations between the two areas. Nesting density in the agricultural area was 0.67 nests/km^2 compared to 0.28 nests/km^2 in the urban area. The mean date for the first egg laid was 10 March in the urban area and 18 March in the agricultural area. Clutch sizes were similar (8.6 eggs in the agricultural area and 8.4 eggs in the urban area). A significant difference was noted in nest success—51% in the agricultural area and 41% in the urban area—although there was no difference in the number of fledglings/successful nest (3.2 in the agricultural area and 3.1 in the urban area).

A significant difference was noted in the return rate of banded juveniles—8% for the urban area and 4% for the agricultural area. The return rate in the agricultural area was similar to other migratory populations. The return rate in the urban area was the highest known for any migratory population in North America. The return rate of adult birds also was higher in the urban area. A greater proportion of birds overwintered in the urban area, probably because of warmer climate and a more stable winter food source. With regard to the agricultural area, the authors concluded: "...fewer juveniles returned to become local breeders and fewer females returned to breed each year, suggesting that owls in the agricultural area may be a population 'sink.' Despite the higher nesting densities in the agricultural area, persistence of the Burrowing Owl population appears to depend on immigration. Persistence also depends on cooperation between natural resource managers and local ranchers and farmers because most owls are nesting on private property."

Reference: Conway, C. J., V. Garcia, M. D. Smith, L. A. Ellis, and J. L. Whitney. 2006. Comparative demography of burrowing owls in agricultural and urban landscapes in southeastern Washington. *Journal of Field Ornithology* 77:280-290.

Private Gardens in England

To what extent do private gardens contribute to urban green space in a city? This question was of interest to Kevin Gaston and three of his colleagues of the University of Sheffield, England. Gaston and his associates recently studied the size and composition of private gardens in the city of Sheffield in central England to better understand the nature and role of urban gardens as green space. To determine garden area, they used digital versions of Ordnance Survey Plus maps imported to ArcView GIS, and, to determine garden features, a random telephone survey. For the telephone survey, responses were obtained for 250 dwellings in the city. Several questions were asked focused on garden features, some of which are highlighted here.

About 87% of dwellings in Sheffield had gardens. The average size was 151 m^2 for a total of about 30 km^2 (21% of the city). This is similar to work reported from other cities in the UK. Fourteen percent of dwellings with gardens also had ponds with an average size of about 2.5m^2. The authors estimated

that some 25,200 ponds were located in Sheffield. The total area of ponds was a modest 6.3 ha.

Some 26% of dwellings with gardens had nest boxes and 29% had compost heaps. Trees greater than 3 m tall were present in 48% of gardens and about 60% of gardens in the city consisted of lawn. The authors concluded, "...there is little doubt that domestic gardens contribute substantially to urban green space, and that this contribution should not lightly be ignored in auditing the provision of such space in urban areas, in determining the benefits that the space provides, or in considering how this space can best be managed to maximise those benefits." With regard to ponds, nest boxes, and trees, the authors stated, "Encouraging their wider provision, and perhaps the redirection toward 'wildlife gardening' of even a small proportion of the huge sums spent annually on garden maintenance, could have substantial effects."

Reference: Gaston, K. J., P. H. Warren, K. Thompson, and R. M. Smith. 2005. Urban domestic gardens (IV): the extent of the resource and its associated features. *Biodiversity and Conservation* 14:3327-3349.

Birds in Warsaw

Maciej Luniak of the Institute of Zoology, Polish Academy of Sciences, has studied birds in Warsaw and elsewhere. In a recent paper, he discussed the history of Warsaw and changes in its birdlife since 1945.

Warsaw is located in central Poland and is surrounded by agriculture with towns and small settlements and large forest complexes. The first known human settlement dates to 10,000 – 12,000 years BC. The city was founded in 1294 AD. In 1939, Warsaw encompassed some 135 km^2 and supported 1.3 million people. From 1939 – 1945, more than 80% of the city was destroyed and about 50% of human inhabitants lost their lives. During post-war reconstruction, high-rise housing estates, with considerable open and green spaces, were built. This urban structure is different from many western European towns and cities where small, terraced, semi-detached and detached houses with private gardens are common. Warsaw supports seven nature reserves. Unfortunately, continued urban development is not effectively controlled by nature conservation policies and strategies.

In the early post-war years following 1945, no house sparrows (*Passer domesticus*) or feral pigeons (*Columba livia*) were present in the city. Kestrels (*Falco tinnunculus*) were attracted quickly by high populations of rats and mice. Also, the black redstart (*Phoenicurus ochruros*) was an early colonizer and is still common today. Following the redstart, wheatear (*Oenanthe oenanthe*), yellow wagtail (*Motacilla flava*), crested lark (*Galerida cristata*), and partridge (*Perdix perdix*) appeared.

During the 1950s and 1960s, some 100 species were breeding in Warsaw. Common birds during this time period included crested lark, marsh tit (*Parus palustris*), middle spotted woodpecker (*Dendrocopos medius*), barn owl (*Tyto alba*), and little owl (*Athene noctua*). These species are now rare or do not occur in the city. Conversely, some of the most common birds today include blackbird (*Turdus merula*), fieldfare (*Turdus pilaris*), woodpigeon (*Columba palumbus*), mallard (*Anas platyrhynchos*), and hooded crow (*Corvus corone corix*), birds that were absent or scarce 50 years ago.

During the 1990s, the city supported more than 130 breeding species, over 50% of all species known to breed in Poland. Most numerous species included house sparrow, feral pigeon, starling (*Sturnus vulgaris*), rook (*Corvus frugilegus*), jackdaw (*Corvus monedula*), great tit (*Parus major*), and chaffinch (*Fringilla coelebs*).

About 75 species are year-round residents. Migrants come to breed or to overwinter. Many nocturnal migrants are killed from collisions with buildings, particularly skylark (*Alauda arvensis*), redwing (*Turdus iliacus*), song thrush (*Turdus philomelos*), and quail (*Coturnix coturnix*). Seasonal communal roosting activity of rooks, jackdaws, and hooded crows cause some nuisances for people. Starlings during late summer and early autumn also cause similar problems.

Built up areas constitute some 36% of the city. Such areas have little green space and support few species. Bird abundance, however, is high, largely because of substantial populations of house sparrows, feral pigeons, and wintering rooks. Also common are jackdaw, swift (*Apus apus*), collared dove, starling, magpie (*Pica pica*), house martin (*Delichon urbica*), and blue tit (*Parus caeruleus*). Some 90% to 95% of the bird community in the city center nests in or on buildings. This pattern of species diversity and bird density is similar to that reported by other investigators for other urban areas.

Parks and gardens make up six percent of the city. Old parks, with mature trees, support up to 41 breeding species, dominated by starling, blackbird, tree

sparrow (*Passer montanus*), and great tit. Also common are blue tit, jackdaw, house sparrow, and fieldfare. The song thrush, robin (*Erithacus rubecula*), and dunnock (*Prunella modularis*) are rare and the wren (*Troglodytes troglodytes*) is absent in Warsaw. These birds are much more common in cities of Western Europe. Small, intensively cultivated allotment gardens (typically 300-500 m^2) provide some habitat for birds. A common breeding species is the redstart (*Phoenicurus phoenicurus*). Fruit from cherry, pear, and apple trees attracts several species in late summer and winter.

On the outskirts of Warsaw, large forest parks and woods provide better habitat for birds. These areas constitute some 15% of the city. Dominant trees are Scots pine (*Pinus silvestres*) and oak (*Quercus robur*). These forests were planted after 1945 and receive intense human recreational use. Nonetheless, the greatest diversity of breeding birds is found here. In the large forest parks (tens of ha in size) there are typically at least 40 breeding species. Common birds include great tit, chaffinch, goshawk (*Accipiter gentilis*), sparrowhawk (*Accipiter nisus*), buzzard (*Buteo buteo*), black woodpecker (*Dryocopus martius*), green woodpecker (*Picus viridis*), cuckoo (*Cuculus canorus*), and tree pipit (*Anthus trivialis*). Some fairly rare species also may be found, including raven (*Corvus corax*), mistle thrush (*Turdus viscivorus*), red-breasted flycatcher (*Ficedula parva*), long-tailed tit (*Aegithalos caudatus*), and bullfinch (*Pyrrhula pyrrhula*).

Ruderal sites include open industrial-railway land, military areas, dumps, derelict land, road verges, and construction sites. These are generally transitional areas with high disturbance and few species. Typical breeding birds include wheatear, yellow wagtail, white wagtail (*Motacilla alba*), black redstart, redpoll (*Carduelis flammea*), and tawny pipit (*Anthus campestris*).

During the last 40 years, about 20 new breeding species were added to Warsaw's bird community. Eight species not breeding in the 1960s but now regular breeders are mute swan (*Cygnus olor*), tufted duck (*Aythya fuligula*), goosander (*Mergus merganser*), common gull (*Larus canus*), Syrian woodpecker (*Dendrocopos syriacus*), Dunnock, stonechat (*Saxicola torquata*), and red-breasted flycatcher. Population increases are known for more than a dozen breeding species, including mallard, kestrel, corncrake (*Crex crex*), and woodpigeon.

On the downside, 11 species breeding in the city in the 1960s no longer do so, including the white-backed woodpecker (*Dendrocopos leucotos*), roller (*Coracias garrulous*), and woodchat shrike (*Lanius senator*). Population declines have been recorded for more than 50 breeding species, notably lapwing (*Vanellus vanellus*), partridge, turtle dove (*Streptopelia turtur*), cuckoo, and hoopoe (*Upupa epops*). Declining-vanishing species are mostly field, meadow, marsh, ground, and low shrub nesters.

The author concludes that 30% to 40% of bird species in Warsaw are threatened by increased development. Also poor park and other green space management does not favor birds. Common practices include extensive expanses of short mown grass, planting of few trees and shrubs, removal of old trees, and placing concrete along the banks of water bodies. According to Luniak, "Although Warsaw is still relatively rich in natural green areas the value of habitats for the majority of bird species of the avifauna of Warsaw continues to decrease."

Reference: Luniak, M. 2005. Warsaw. Pages 389-415 in *Birds in European cities*, J. G. Kelcey and G. Rheinwald, eds. Ginster-Verlag, St. Katharinen, Germany.

Big Brown Bats in Colorado

The big brown bat (*Eptesicus fuscus*) commonly uses buildings for summer maternity roosts, and urban structures along the Front Range of Colorado are used extensively for this purpose. Daniel Neubaum of Colorado State University and two of his colleagues recently described characteristics of buildings in urban areas selected by big brown bats for raising young, and how such buildings differed from those not selected by roosting bats. Work was conducted in Fort Collins, Colorado. From June through August of 2001 through 2004, bats were captured with mist nets in the city and on the periphery of the city. Pregnant or lactating females were fitted with a radiotransmitter and tracked to maternity colonies. For purposes of the study, a maternity roost was used by 10 or more pregnant or lactating females and young between 10 June and 20 July. For each building used as a maternity roost, a comparison building not used by bats was randomly selected. The same structure characteristics were measured at both building types. Variables measured included 12 microhabitat characteristics and six landscape characteristics.

Of the microhabitat characteristics, area of exit point (in cm^2) was most important. Larger exit areas were better than smaller ones, and the investigators

speculated that high importance of this characteristic may be due to the fact that larger openings allow access to multiple bats at the same time. The second most important microhabitat characteristic resulting from the analysis was temperature of the roosting area, with buildings used by bats slightly warmer than unused buildings. Height from the ground of the exit point used by bats was the third most important microhabitat characteristic. Maternity roosts were located in buildings with exit points averaging 1.7 m higher than random buildings. Neubaum and his colleagues speculated that this additional height may be needed by young bats to gain flight when they drop from the exit. The fourth important microhabitat characteristic was building height, with buildings used by bats averaging 2.3 m taller than unused buildings. The authors suggested that taller buildings might be easier for the bats to locate in the landscape.

Of the landscape characteristics, distance to all similarly categorized maternity roosts and building density were most important. Buildings used by bats were closer together than were random-to-random buildings and may relate to time and energy efficiencies of bats. Building density was inversely related to bat use. Street density and traffic density also were considered important, with bat roosts being associated with more streets and lower traffic volumes.

The authors concluded: "Alternatives to extermination, such as decreasing the access point size, alteration of the microclimate in the roosting area, or installation of an object that reduces the height of the exit point and interferes with the drop of the flight path all may deter use of a building by bats...well-designed bat boxes...installed near the original exit and following specifications based on important variables found in this study should be examined for effectiveness in providing an alternative to bats other than shifting to another building." Simply denying bats access to maternity roosts may negatively affect bat populations and not be desirable for bat conservation.

Reference: Neubaum, D. J., K. R. Wilson, and T. J. O'Shea. 2007. Urban maternity-roost selection by big brown bats in Colorado. *Journal of Wildlife Management* 71:728-736.

The Urban Open Space Manager is a quarterly newsletter for land managers and planners, landscape architects, biologists, and others interested in wildlife and nature conservation in the metropolitan environment. It is published by Urban Wildlife Resources, 5130 W. Running Brook Rd., Columbia, MD 21044, USA, Lowell W. Adams, Ph.D., editor (Phone, 410-997-7161; Fax, 410-997-6849; E-mail, uwr24@netscape.net; Web site, http://www.erols.com/urbanwildlife). Annual subscription rate is $15 (airmail shipping beyond North and South America add $3.00), U.S. funds only. Printed on recycled paper.

THE URBAN OPEN SPACE MANAGER

A newsletter about wildlife and nature conservation in urban areas
(ISSN 1094-9844)

Volume 12, Number 4 2007

Cooper's Hawks in Milwaukee

Since the mid-1970s, the nesting of Cooper's hawks (*Accipiter cooperii*) in urban-suburban areas has become common in North America. We are continuing to learn more about the population dynamics of these birds. William Stout of Oconomowoc, Wisconsin and three of his colleagues recently reported on 12 years of research on the species in the metropolitan Milwaukee region of southeastern Wisconsin. These investigators located nests in spring and banded nestlings with United States Geological Survey (USGS) lock-on aluminum leg bands. Adult (breeding) birds were captured with mist nets using a live great horned owl (*Bubo virginianus*) as a decoy during nestling/fledging stages. Adult birds also were banded with USGS lock-on aluminum leg bands and colored, coded leg bands.

Mean nesting success of 65% was in the mid-range of that reported in other North American studies. Mean number of young per laying pair (2.3) was similar to other studies. Mean number of young per successful pair (3.5) was among the highest reported for Cooper's hawks. Stout and his associates believe that their metropolitan Milwaukee study area probably does not represent marginal or inferior habitat for the birds because of good reproductive rates, repeated re-occupancy of nest sites year after year, and confirmed recruitment into the population. They concluded, "Our indices of reproduction, recruitment data, apparently long-term stability in abundance of breeding adults, and lack of data that would implicate relatively high rates of mortality suggest that no management actions are needed for Cooper's hawks in Milwaukee at this time because this habitat appears favorable for sustained viability of Cooper's Hawks . . . Clearly, urban settings and their environmental conditions differ across North America, and additional ecological (e.g., demographic) information about the relatively recent and widespread, but poorly studied, phenomenon of urban-nesting Cooper's hawks will improve our overall understanding of the breeding performance and population dynamics of Cooper's hawks in human-dominated landscapes."

Reference: Stout, W. E., R. N. Rosenfield, W. G. Holton, and J. Bielefeldt. 2007. Nesting biology of urban Cooper's hawks in Milwaukee, Wisconsin. *Journal of Wildlife Management* 71:366-375.

Population Dynamics of Free-Roaming Cats

There is considerable concern among biologists and others about the impact of domestic cats on wildlife. Some of these animals, no longer wanted by humans, have become feral or semi-feral and may live in cat colonies with supplemental food provided by humans. Paige Schmidt of Texas A & M University and two of her colleagues recently studied population dynamics (survival, fecundity, and annual ranges and movements) of free-roaming cats in the city of Caldwell, Texas. Caldwell is a small suburban community of some 3,400 residents located between College Station and Austin. Schmidt and her associates trapped unowned cats with Tomahawk live traps from October 2004 through August 2005. Animals were anaesthetized and fitted with radiocollars. Owned cats were voluntarily enrolled in the study by their owners. Cats were monitored 3-4 times per week from October 2004 to December 2005 from 6 am to midnight. Cats were classified as owned, semi-feral (unowned, directly fed by humans), or feral (unowned, not fed by humans). Litters were located on a weekly basis to determine fecundity.

Fifty-four free-roaming cats were collared and tracked in the study. Owned cat survival was 100% (1.0). Survival of semi-feral cats (0.90) was higher than survival of feral cats (0.56) but variability was high and the difference was not statistically significant. Vehicles were the single largest mortality factor.

Semi-feral cats averaged litters of 3.6 kittens with 2.75 kittens surviving to 12 weeks of age. These numbers were slightly higher than those for feral cats, which averaged 3.5 kittens per litter, with 1.75 kittens surviving to 12 weeks of age.

Annual ranges were highest for feral animals, followed by semi-feral, then owned cats with the smallest ranges. Ranges for feral and semi-feral cats were smaller than those reported from other studies conducted in rural areas. Schmidt and her colleagues attributed differences to food availability in urban areas. Studies of other mammals show a similar pattern of reduced ranges in urban areas. Schmidt and her colleagues concluded: "...the ecological consequences of feeding unowned, reproductively viable, free-roaming cats are clear. Abundant food resources could increase survival and fecundity and reduce ranges and movement, thus increasing cat densities and carrying capacity."

Reference: Schmidt, P. M., R. R. Lopez, and B. A. Collier. 2007. Survival, fecundity, and movements of free-roaming cats. *Journal of Wildlife Management* 71:915-919.

Fox Squirrels in Texas

Fox squirrels (*Sciurus niger*) are commonly found in many metropolitan areas of the United States, but little research has been conducted on specific habitat features used by squirrels in such environments. Robert McCleery and three colleagues of Texas A & M University, College Station, recently studied both biotic and abiotic features used by fox squirrels in an urban environment. Their work was conducted on the Texas A & M University main campus in College Station. Four habitat substrates were identified in the 154-ha study area: pavement (54 ha), building (32 ha), grass (46 ha), and tree canopy (22 ha).

Investigators trapped squirrels from August 2003 to June 2005. Captured animals were marked and adults were fitted with radiocollars. The extended trapping period was used in an effort to maintain at least 20 animals with radiocollars. Radiocollared squirrels were tracked from September 2003 to August 2005. They were located 2 – 3 times per week by homing, which allowed precise identification of substrate being used at the time (e.g., specific trees could be identified).

Eighty-two (42 male, 40 female) fox squirrels were tracked during the study. Animals showed preference for tree canopy during all seasons and at all scales measured, both during periods of activity as well as during periods of inactivity. Squirrels showed preference for hardwoods (particularly oaks) and large trees. They tended to avoid introduced pines and other conifers. Tree size (larger better), species (oaks largely preferred), and canopy cover (larger better) were more important than tree number alone.

Some preference was shown for grassy areas during autumn and spring when animals were most active burying and retrieving nuts. Squirrels appeared to avoid grass during summer and winter. Squirrels avoided pavement as a substrate of use but did not appear to exclude it from their core home ranges. During winter and spring, inactive animals selected buildings as daytime refugia (buildings were also used to raise young). Active squirrels avoided buildings from spring – autumn.

McCleery and his associates concluded: "...our study suggests urban fox squirrels have been able, through the process of synurbanization [sic], to adapt to urban areas. They made the most of the large mast-bearing trees that mimicked the habitats they have been shown to prefer in nonurban areas, and managed to use, tolerate, or avoid the numerous nonnative and man-made features of the urban environment."

Reference: McCleery, R. A., R. R. Lopez, N. J. Silvy, and S. N. Kahlick. 2007. Habitat use of fox squirrels in an urban environment. *Journal of Wildlife Management* 71:1149-1157.

Controlling Exotic Red Foxes in Urban Reserves

The nonnative red fox (*Vulpes vulpes*) in Australia has been directly implicated in the decline and extinction of many endemic species. Managers have used techniques such as trapping, shooting, and poisoning in attempts to control fox populations. Research focused on these and other techniques continues in an effort to find better ways of controlling foxes for benefit of native wildlife.

Recently Jennifer Jackson of Edith Cowan University, Joondalup, Western Australia and four of her colleagues studied effectiveness of two kinds of baits and four bait presentation techniques for foxes in three bushland reserves in the metropolitan region of Perth, Australia. Work was conducted in Kings Park (400 ha), Bold Park (437 ha), and Whiteman Park (4,200 ha), each of which was surrounded by housing and roads.

The commercially available meat baits were dried kangaroo and a dried sausage-style product made from a mixture of meat products and a canine flavor enhancer for dog food. Bait presentation techniques were: tethered and covered, tethered and uncovered, untethered and covered, and untethered and uncov-

ered. Each park was divided into four sectors and allocated a uniform distribution of bait sites. Each treatment was duplicated in a sector. Bait was centrally positioned on a 1-m^2 sand plot of raked soil. Plots were established in late afternoon and checked for tracks and missing baits early the following morning.

Bait presentation technique affected removal by target (foxes) and nontarget (dogs and birds) animals. Untethered and uncovered baits were removed 10% more often by foxes and untethered baits were cached by foxes more often than tethered baits. Foxes removed and consumed 38% of cached baits within one week. The remaining 62% of cached baits were not accessed by foxes or other animals.

Domestic dogs and birds visited and removed baits. Dogs removed any bait type and baits offered in any presentation method and are at risk of being poisoned in a fox control campaign. Tethering and covering baits reduced the take by birds. The authors emphasize the need for public support of any effort to control foxes to facilitate native fauna populations.

Reference: Jackson, J., D. Moro, P. Mawson, M. Lund, and A. Mellican. 2007. Bait uptake and caching by red foxes and nontarget species in urban reserves. *Journal of Wildlife Management* 71:1134-1140.

Rodent Poisoning, Bobcats, and Mountain Lions in California

Use of poisons for controlling rodents, including rats and mice in and around buildings, may cause secondary poisoning of nontarget animals. Secondary poisoning may have direct lethal effects on nontarget animals or may indirectly interact with natural population stressors to negatively impact nontarget populations.

Seth Riley of the National Park Service and five of his colleagues recently studied secondary poisoning in bobcats (*Lynx rufus*) and mountain lions (*Puma concolor*) in southern California. These investigators were particularly interested in potential interaction of anticoagulant rodenticides with notoedric mange. Work was conducted in the coastal mountain ranges north and west of the city of Los Angeles. Riley and his colleagues captured and radiocollared 38 bobcats and four mountain lions 1996-2004 and subsequently radiotracked the animals several times per week. One additional bobcat had an identification collar without a radiotransmitter.

The investigators collected scat on established transects monthly to document changes in bobcat distribution and relative abundance. Where possible, cause of death of bobcats and mountain lions was determined by necropsy and a variety of standardized tests. Liver samples were tested for anticoagulants.

Anticoagulant toxicants were present in most bobcats and mountain lions tested. Thirty-five of 39 (90%) bobcat livers contained some level of anticoagulants. Livers of all four mountain lions tested had high levels of the two compounds most common in bobcats. Investigators determined that two mountain lions died directly from anticoagulant toxicity. Earlier published work showed that anticoagulant toxicity was the leading cause of death for coyotes in the area. Coyotes made up 15% and 7% of kills for the two mountain lions that died of anticoagulant intoxication and only 4% of kills overall. Both mountain lions consumed coyotes during the last month before they died. Riley and his colleagues suspect that most or all exposure of bobcats and mountain lions to anticoagulant rodenticides was from consuming poisoned prey.

Severe mange and anticoagulant exposure were highly associated. Nineteen of 19 bobcats and two of two mountain lions showed such association. Anticoagulant levels in bobcats that died with severe mange were higher than in cats that died from other causes. All bobcats except one that died of mange did not show evidence of direct anticoagulant toxicity as cause of mortality. This suggests that the association between anticoagulants and mange is a synergistic interaction. According to Riley and his colleagues "...bobcats that have been exposed to anticoagulant rodenticides appear highly susceptible to succumbing to severe mange infestations..."

The investigators found some evidence that anticoagulant levels were associated with human development. The total concentration of anticoagulants in livers of radiocollared bobcats was related to animal use of developed areas. Radiocollared mountain lions were less urban-associated than bobcats. Nonetheless, both mountain lions that were diagnosed with anticoagulant intoxication died after spending the majority of their last month in the most developed parts of their home ranges. This "...suggests that as development continues to encroach upon remaining habitat, anticoagulant exposure among carnivores may increase." The authors concluded: "Especially in areas of high anticoagulant use such as urban areas, exposure of nontarget carnivores to anticoagulant redenticides may be extensive and can result in direct mortality and possibly sublethal effects...Increased

awareness and the use of alternative pest control methods should reduce risks to nontarget wildlife, including carnivores. Where species of conservation concern may be exposed, further regulation of the use of anticoagulant rodenticides may be warranted."

Reference: Riley, S. P. D., C. Bromley, R. H. Poppenga, F. A. Uzal, L. Whited, and R. M. Sauvajot. 2007. Anticoagulant exposure and notoedric mange in bobcats and mountain lions in urban southern California. *Journal of Wildlife Management* 71:1874-1884.

Red Foxes in Illinois

Several factors have influenced red fox (*Vulpes vulpes*) population dynamics in Illinois since the 1970s. Hunting and trapping as mortality factors declined in relation to declining fur prices. Coyote (*Canis latrans*) populations increased and coyotes kill and displace red foxes. Agricultural practices intensified, with removal of fencerows and woodlands and increased use of herbicides, resulting in reduced prey populations. And urban development expanded, resulting in changes in land use patterns.

From 1996-2002, Todd Gosselink of the Illinois Natural History Survey, Champaign, and three of his colleagues studied mortality of red foxes in east-central Illinois in both rural and urban populations. These investigators captured and radiocollared 222 rural and 113 urban foxes and monitored the animals 2-3 times per week until 28 May 2002.

Mortality factors differed for urban and rural foxes. In urban areas, sarcoptic mange caused 40% of fox deaths. Mange was the largest mortality factor for juvenile foxes and an important factor for adults. The high incidence of mange in urban foxes was probably related to higher densities of foxes, smaller home ranges, and more frequent social interactions with other foxes. Vehicles were the second major mortality factor (31%) for urban foxes followed by predation (12%). The low predation rate was primarily because fewer coyotes inhabited urban areas compared to rural ones. In rural areas, vehicles (33%), predation (29%), and gunshots (24%) were the three major causes of mortality of adult foxes. For juveniles, predation (39%) and vehicles (29%) were the major factors. Most predation was caused by coyotes. In rural areas, coyotes have largely replaced hunting and trapping as a major cause of mortality.

The authors speculated about whether or not urban areas served as a population "source" (reproduction greater than mortality) or a "sink" (reproduction less than mortality) for foxes. They pointed out that during years with little or no mange, urban fox survival was high and young foxes dispersed largely into the surrounding rural countryside. However, during years of severe mange outbreaks, urban areas might serve as sinks because mortality was higher for both adults and young. "With periodic mange outbreaks, urban fox populations might cycle between source and sink status. Urban areas that are continually mange-free would tend to be long-term source populations due to high survival and density..."

Reference: Gosselink, T. E., T. R. Van Deelen, R. E. Warner, and P. C. Mankin. 2007. Survival and cause-specific mortality of red foxes in agricultural and urban areas of Illinois. *Journal of Wildlife Management* 71:1862-1873.

The Urban Open Space Manager is a quarterly newsletter for land managers and planners, landscape architects, biologists, and others interested in wildlife and nature conservation in the metropolitan environment. It is published by Urban Wildlife Resources, 5130 W. Running Brook Rd., Columbia, MD 21044, USA, Lowell W. Adams, Ph.D., editor (Phone, 410-997-7161; Fax, 410-997-6849; E-mail, uwr24@netscape.net; Web site, http://www.erols.com/urbanwildlife). Annual subscription rate is $15 (airmail shipping beyond North and South America add $3.00), U.S. funds only. Printed on recycled paper.