

THE URBAN OPEN SPACE MANAGER

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Managing White-tailed Deer

Increased attention has been given to managing white-tailed deer in urban-suburban areas in recent years largely because of increasing densities of deer in such environments. Heightened interest in urban deer has sparked increased research focused on both lethal and non-lethal methods of controlling expanding populations. Many of the studies have been reported in past issues of *The Urban Open Space Manager* (please see the two published indexes for 1996-2001). Four additional studies are reviewed here.

Michelle Doerr of the University of Missouri and two of her colleagues recently compared four deer population reduction programs in the city of Bloomington, Minnesota. Programs included three variations of sharpshooting and controlled firearms hunting. The four programs were recommended by a deer management task force made up of local citizens. Beginning in 1991, the various programs were implemented on about 6,000 ha of public open spaces in the city. Sites included Fort Snelling State Park, Minnesota Valley National Wildlife Refuge, and Hyland Lake Park Reserve. These lands made up about 33% of the land area in the city. The researchers were interested in comparing the efficiency, safety, and costs of the four programs as well as determining the effectiveness of the combined methods in reducing deer abundance and impacts.

Controlled hunts were conducted at the state park and refuge. They were similar to traditional hunting but were more tightly regulated and controlled. The Bloomington Police Sharpshooting Program involved shooting deer over bait within public open spaces of the city. A similar approach was used in the Hennepin Parks Sharpshooting Program where parks staff did the shooting. The Conservation Law Enforcement Sharpshooting Program involved two conservation officers assigned to opportunistically shoot deer within the state park and refuge. Some deer also were shot over bait and during deer drives.

The deer population was surveyed over the entire study area from a helicopter during winters of 1991-1994. After the third year of the control program,

deer counts declined by 46% and estimated vehicular collisions declined by 30% in the city. Estimated cost per deer killed was \$117 for controlled hunts, \$108 for using conservation officers as sharpshooters, \$121 for park ranger sharpshooters, and \$194 for police officer sharpshooters. "The costs of these or any other deer control programs should be balanced against the economic benefits obtained from reducing an overabundant deer herd, such as savings in vehicle repair costs, improved road and public safety, and reduced costs in maintaining landscape and garden plantings." No accidents or injuries occurred with any of the programs and each was judged safe and effective. Shooting over bait was judged most efficient and effective and most adaptable for many urban situations. Following population reduction, deer continued to come to bait and harvest rates did not decline as population density declined. Deer attraction to bait seemed to be independent of population density. The authors concluded "Our study demonstrated that sharpshooting over bait can be done safely and discretely, even on relatively small areas within residential neighborhoods...this method could effectively maintain a herd at target levels after the population was reduced...A deer management program will need to be kept in place to prevent deer numbers from climbing to nuisance levels again."

Reference: Doerr, M.L., J.B. McAninch, and E.P. Wiggers. 2001. Comparison of 4 methods to reduce white-tailed deer abundance in an urban community. *Wildlife Society Bulletin* 29:1105-1113.

Home Range and Movement Patterns of Urban Deer

White-tailed deer have been well studied in rural areas but little research has been conducted on ecology and behavior of the species in urban environments. To help gain better understanding of urban deer, Marrett Grund of the University of Missouri and two colleagues studied seasonal home range sizes, movement patterns, and habitat use by female deer in a suburb of Minneapolis, Minnesota. The

study area consisted of 2,971 ha in northwest Bloomington. Habitat was classified as park (woodland, shrubland, or openland), residential (woodland or openland), lakes-ponds, commercial, or wetland. Most of the study area (57%) was classified as residential habitat. Hyland Lake Park Reserve constituted 15% of the study area and interspersed conservation areas made up another 15%. Deer were captured in live traps or with a dart gun and fitted with radiocollars. Movement patterns were studied during fall, winter, spring, and summer, 1996-1999.

Home range sizes of the deer varied seasonally, with the largest (averaging 144 ha) in spring, and the smallest (averaging 50 ha) in summer. Fall home ranges averaged 93 ha and winter ranges, 85 ha. Deer used woody cover habitats every season and parks-conservation areas were the most important habitat components. Patterns of habitat use were similar to published patterns for rural deer except that rural deer occupy larger home ranges. A high degree of site fidelity was noted in the Bloomington deer leading the authors to conclude that localized deer management programs may have long-term benefits because deer from surrounding areas may be slow to disperse to the managed area.

Reference: Grund, M.D., J.B. McAninch, and E.P. Wiggers. Seasonal movements and habitat use of female white-tailed deer associated with an urban park. *Journal of Wildlife Management* 66:123-130.

Fertility Control in White-tailed Deer

As noted in previous issues of *The Urban Open Space Manager*, there is considerable interest on the part of researchers in studying the potential of immunocontraception for controlling reproduction in white-tailed deer. Work has focused on PZP (porcine zona pellucida) vaccine, which inhibits fertilization of the egg. Little research has dealt with contragestination (abortion) agents as means of fertility control in deer. Prostaglandin $F_{2\alpha}$ is available commercially and is approved by the FDA for cattle where it is used to synchronize estrus and terminate pregnancy.

Robert Waddell of the University of Georgia and four of his colleagues recently tested the efficacy of the drug administered during early and late gestation in captive white-tailed deer. The study began in the fall of 1998 and was conducted at the University of Georgia. To test efficacy of the drug during early gestation, eight females were treated on 12 January 1999 (40-59 days gestation) with 25 mg of synthetic

prostaglandin $F_{2\alpha}$ delivered remotely via biobullet from a specially designed air rifle. A similar procedure was used to test efficacy of the drug on eight females during late gestation when the drug was administered on 20 April 1999 (113-154 days gestation).

Results showed that treatment during late gestation was more effective than treatment during early gestation. The sample size for early treatment was reduced from eight to five because three females were not pregnant at the start of the experiment. Two of the five (40%) females from the early test aborted and both rebred. Seven of eight (88%) females treated during late gestation aborted and none from this group rebred.

Although treatment during late gestation was more effective for reducing production of young, the authors caution that such treatment results in abortion of well-developed fetuses and may include fetal cannibalism by the mother, which may be objectionable to residents. Future research might test efficacy of treatment during mid-gestation (80-100 days) when fetuses are relatively small. Another issue is whether or not enough females can be treated during the appropriate stage of gestation to slow population growth. Finally, FDA has authorized use of prostaglandin $F_{2\alpha}$ on an investigational basis. The drug has not yet been approved for free-ranging deer herds. More trials will have to be conducted by the drug manufacturer before FDA grants such approval and an open question is whether demand for the drug will justify cost of obtaining regulatory approval.

Reference: Waddell, R.B., D.A. Osborn, R.J. Warren, J.C. Griffin, and D.J. Kesler. 2001. Prostaglandin $F_{2\alpha}$ -mediated fertility control in captive white-tailed deer. *Wildlife Society Bulletin* 29:1067-1074.

Immunocontraception of White-tailed Deer

Researchers continue to study PZP (porcine zona pellucida) immunocontraception in white-tailed deer. Among the outstanding issues under investigation are any long-term physiological effects PZP treatment may have on deer. Lowell Miller and three of his colleagues at the National Wildlife Research Center in Colorado and Pennsylvania State University recently studied the effects of repeated PZP treatment on health of female deer over a 9-year time period. Treated animals were part of the captive deer herd at Penn State University; they were compared to a con-

control group of deer from the same herd. Blood chemistry of both groups was analyzed to evaluate the function of major organs and physiological systems including the liver, kidney, heart, pancreas, immune system, and electrolyte balance.

Miller and his team observed differences in the breeding behavior of deer between the two groups. In the control group, most females bred and conceived at the first observed estrus each year (in November). Control females averaged 1.2 estrus events per year and breeding occurred over a 44-day time period. PZP-treated females averaged 3.6 estrus events per year and breeding extended over a 98-day time period from November to March. The breeding periods were significantly different between the two groups.

Production of fawns also differed between the two groups. The control group averaged 1.88 fawns per female, whereas the treated group averaged 0.25 fawns per female. The PZP-treated deer were monitored for 5 years beyond the 4-year study period and no adverse long-term health effects or decreased longevity were observed. All but one treated female returned to fertility.

No significant changes in weight of animals in either group occurred over the course of the study. Differences were noted, however, between the two groups during spring when deer in the control group were heavier than deer in the treated group, probably because most deer in the control group were pregnant. No difference in weight between the two groups was noted in the fall.

Miller and his colleagues concluded, "Serum chemistry profiles from this study suggest that the PZP treatment has no major physiological effects on the health of deer, at least in a managed, penned setting... The immunocontracepted deer may survive better and live longer under limited food conditions because of the limited demands of the nonpregnant status as compared to pregnant and nursing deer. This study supports the hypothesis that PZP immunocontraception is a safe as well as effective population control method."

Reference: Miller, L.A., K. Crane, S. Gaddis, and G.J. Killian. 2001. Porcine zona pellucida immunocontraception: long-term health effects on white-tailed deer. *Journal of Wildlife Management* 65:941-945.

Fertility Control in Kangaroos

European settlement of Australia altered the landscape, replacing much of the natural habitat with

agricultural fields. In addition, predators were eradicated. These factors have led to increased populations of the larger macropodid marsupials, some of which create conflicts with people similar to overabundant white-tailed deer populations in North America. The traditional technique for solving conflict problems was to lethally remove excess animals by shooting. Today, however, particularly in some areas such as metropolitan parks and nature reserves, shooting is publicly unacceptable. The potential of fertility control is being studied as an alternative technique for controlling selected overabundant populations.

Researchers at the University of Melbourne, Victoria, recently tested the effectiveness of a levonorgestrel implant as a contraceptive agent in captive and free-ranging adult female eastern grey kangaroos. Levonorgestrel is the active ingredient in Norplant, which has been used for many years as a contraceptive implant for women. Captive animals were obtained from wild Victorian populations and were retained in open grassy yards at the Keith Turnbull Research Institute, in Frankston, Victoria. In January 1999, three animals each were given two 70-mg levonorgestrel implants and three individuals each were given two control implants. Implants were inserted subcutaneously between the shoulder blades following appropriate surgical techniques. The free-ranging population studied was located along the southwestern coast of Victoria, an area consisting of farmland, natural coast heathland, and small wetlands. The eastern grey kangaroo population was considered overabundant in the area. From February to April 1999, eight kangaroos were given control implants and 18 were given levonorgestrel implants.

Levonorgestrel inhibited reproduction in captive and free-ranging populations of kangaroos. All captive controls gave birth to new young within 3 months of treatment; none of the captive treated animals did so. In the control group of the free-ranging population, seven of eight kangaroos produced young the first year and all eight produced young the second year of the study. In the treated group of free-ranging animals, three of 16 produced young the first year and none of 15 animals produced young the second year. The researchers concluded "Our study has shown that levonorgestrel implants provide a long-acting and highly effective method of contraception in the eastern grey kangaroo. Moreover, levonorgestrel has no adverse behavioral effects... Therefore, levonorgestrel implants provide a promising method of population control for the management of overabundant captive and selected wild populations of

macropodid marsupials.”

Reference: Nave, C.D., G. Coulson, A. Poiani, G. Shaw, and M.B. Renfree. 2002. Fertility control in the eastern grey kangaroo using levonorgestrel implants. *Journal of Wildlife Management* 66:470-477.

Bird Use of Street Trees in Madrid, Spain

Little research has been conducted on bird use of street trees. The topic is of interest to Esteban Fernández-Juricic of the University Complutense of Madrid who recently studied bird use of street trees in that city. He was particularly interested in determining whether or not wooded streets connecting to parks served as corridors for birds. He also studied vegetation complexity of wooded streets and human disturbance relative to bird use of these habitats.

The study was conducted May to August of 1997 and 1998. Fifteen urban parks were sampled, ranging in size from 0.4 ha to 118 ha. Thirty wooded streets were sampled. These were a mix of deciduous and coniferous trees at least 4 m high and spaced 2 m – 3 m apart on both sides of the street. As controls, 13 streets without vegetation cover were sampled.

Bird surveys were conducted in parks four to five times per year in the morning between 0700 – 1100 hours. In large parks, birds were surveyed in 50 m x 100 m fixed transects. Small parks were thoroughly covered. Researchers surveyed streets six to seven times per year by walking sidewalks at a steady pace and recording birds using the trees.

Urban parks contained 24 species of birds; wooded streets 14 species. Generalists species predominated

over specialists in wooded streets. Species not recorded in streets were ground and bush nesters (robin, *Erithacus rubecula*; wren, *Troglodytes troglodytes*; Sardinian warbler, *Sylvia melanocephala*; Bonelli's warbler, *Phylloscopus bonelli*) and those needing large areas for foraging/breeding (tree-creeper, *Certhia brachydactyla*; blackcap, *Sylvia atricapilla*; long-tailed tit, *Aegithalos caudatus*). The number of species using wooded streets was greater when streets connected to parks and was positively influenced by tree density, shrub height, and amount of coniferous cover. A negative association was noted between number of bird species and pedestrians. In conclusion, the author notes that his study supports the following:

1. Differential use of corridors by species with different habitat requirements.
2. Potential use of corridors as alternative habitats providing feeding and nesting substrates.
3. The importance of corridor placement in the landscape (corridors connecting to parks had more bird species).
4. The importance of vegetation structure (more complex structure resulted in more bird species).
5. Human disturbance negatively influenced bird use of wooded streets.
6. Wooded streets functioning as corridors can potentially reduce effects of forest fragmentation.

Reference: Fernández-Juricic, E. 2000. Avifaunal use of wooded streets in an urban landscape. *Conservation Biology* 14:513-521.

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Deer Ecology in Suburban Chicago

Although white-tailed deer are thriving in many metropolitan areas of North America, they have not been well studied in such habitat. Dwayne Etter of the Forest Preserve District of DuPage County and six of his colleagues recently added to our knowledge base of urban deer ecology with data on the survival and movements of white-tailed deer in the western suburbs of Chicago, Illinois. Most of the research was done in Cook and DuPage Counties. Over 57% of the study area was classified as urban-suburban, another 14% was urban grassland, and some 14% was designated forest/woodland, with lesser amounts of other cover types. Forest preserves occupied about 11% of the two counties, with individual preserves ranging in size from 0.29 to more than 20 km². Deer densities ranged from 0 to 105.6 deer/km². During 1994-1998, 200 deer were captured with rocket nets, drop-nets, and dart guns. Eight additional newborn fawns were captured by hand during May-August 1995-1996. All deer were ear-tagged for future identification. In addition, 140 of the adult deer and six of the newborn fawns were fitted with radiocollars.

The survival rate of deer in the study was high as a result of limited hazards and avoidance behavior associated with roads. Collision with vehicles was the greatest mortality factor, although there was some evidence that deer learn to avoid collisions. Adult does appeared to be better at timing vehicles than younger deer. Highest deaths in yearlings and fawns were during spring movements when adult females were not present.

Dispersal distance was short when compared with dispersal of rural deer in Illinois. Five to 7% of females dispersed, depending on age of the deer. Five to 9% of yearling and adult males dispersed, whereas 50% of male fawns did so. As young males mature, they tend to be less tolerated by resident adult does. Mean dispersal distance was 5.4 km for males and 7.6 km for females. Dispersal distances ranging from 13 to 49 km have been reported for rural deer in the state. Dispersal distances in the present study may

have been influenced particularly by large, multilane interstate highways and dense urban development.

Home range size was determined only for female deer. Summer home range in the Chicago suburban study area averaged 26 ha compared to 55 ha reported for rural areas in east-central Illinois. Home range size during other seasons of the year also tended to be smaller in the suburban study area when compared to rural areas.

Etter and his colleagues concluded that high survival and site fidelity of deer contribute to overabundance in metropolitan areas. However, survival is highly dependent on habitat patterns, nearness of deer to roads, and on traffic volume. In this study, collisions were a function of population size and habitat patterns. They were most frequent adjacent to remaining forested areas (riparian areas and forest preserves), and most involved dispersing females during spring. Effective mitigation of deer-vehicle collisions might include:

“(1) educating motorists about when and where DAC [deer-auto collisions] are most likely to occur,

(2) lowering speed limits on roadways adjacent to deer habitat during spring, and

(3) using roadway ice removal agents other than salt.”

Reference: Etter, D.R., K.M. Hollis, T.R. Van Deelen, D.R. Ludwig, J.E. Chelsvig, C.L. Anchor, and R.E. Warner. 2002. Survival and movements of white-tailed deer in suburban Chicago, Illinois. *Journal of Wildlife Management* 66:500-510.

Urban Foxes in Switzerland

Researcher Sandra Gloor of Urban Ecology and Wildlife Research, Zurich, and four of her colleagues recently studied urban fox populations in Switzerland. As part of a television series on urban foxes in 1997, Swiss city residents were asked to report fox sightings to authorities. In addition, a 1999 telephone

survey about foxes was conducted of individuals or institutions charged with wildlife management in all 30 cities in the country with >20,000 inhabitants. Hunting statistics supplemented other data collection methods in Zurich.

Breeding populations of foxes were recorded in most cities of Switzerland where they were perceived as a recent phenomenon. It seems that urban populations have increased rapidly since the mid-1980s, in contrast to British towns where colonization began in the 1930s, first in residential suburbs and then farther downtown.

Gloor and her colleagues pose two hypotheses that might account for fox populations in Swiss cities. The "population pressure" hypothesis states that high fox density in adjacent rural areas pushes foxes into urban areas. If this force is at work, the dynamics of the urban populations should be correlated with the dynamics of adjacent rural populations and the two should be genetically similar. The "urban island" hypothesis states that urban foxes adapt to urban conditions and urban populations are independent of rural populations. If true, population dynamics of urban foxes would not be expected to correlate with population dynamics of rural foxes. Additionally, urban and rural populations would be genetically isolated. Gloor points out that researchers in England observed foxes moving readily into and out of the city of Oxford. Certainly, future studies can be designed to test the two hypotheses. Regardless, foxes are the main vector of rabies in Europe and urban areas had been considered barriers to spread of the disease. Rabies control strategies will have to be redesigned.

Reference: Gloor, S., F. Bontadina, D. Hegglin, P. Deplazes, and U. Breitenmoser. 2001. The rise of urban fox populations in Switzerland. *Mammalian Biology* 66:155-164.

Suburban Red-shouldered Hawks in Southwestern Ohio

The red-shouldered hawk is a species of special interest in Ohio and several other midwestern and eastern United States because of restricted distribution resulting from habitat loss over the years. Cheryl Dykstra of the U.S. Environmental Protection Agency and three of her colleagues recently studied home range size and habitat use of suburban hawks in southwestern Ohio. The 20-km² study area was located in western Hamilton County. Housing in-

cluded relatively dense sections (5.1 houses/ha) with lawn and exotic plantings and low-density sections (1.2 houses/ha). Most of the area was fragmented, with small (<1 ha) patches of various habitats more common than large (>15 ha) tracts. Most of the undeveloped forest was on steep slopes along two small streams. No natural wetlands occurred in the study area but many small constructed ponds were present. Twelve birds (7 males, 5 females) were trapped and fitted with backpack-mounted radio transmitters and tracked year-round from March 1998 through January 2000.

No significant difference was found in home ranges of males and females. During the breeding season, average home range size was 90 ha. Non-breeding season home ranges were significantly larger, averaging 189 ha. On an annual basis, home ranges averaged 165 ha. These ranges are smaller than those of rural nesting birds in the eastern United States, and the researchers speculated that this may indicate that habitat is adequate or perhaps better than more typical rural habitat. The many backyard birdfeeders and constructed ponds may provide a more abundant prey base. The larger red-tailed hawk may not be as abundant in suburbia, thus reducing competition with a larger predator. Based on other published work, the reproductive rate of suburban birds in Ohio is similar to that of rural birds in the state.

Suburban hawks in the study showed preference for some habitats over others. Most birds selected riparian zones and pond edges more than expected based on availability of those habitats. Residential areas and lawns were used less than expected or in proportion to availability. For nesting, suburban birds selected habitat similar to that selected by rural birds. Interestingly, some birds seemed to be more tolerant than others of humans and human disturbances.

Reference: Dykstra, C.R., J.L. Hays, F.B. Daniel, and M.M. Simon. 2001. Home range and habitat use of suburban red-shouldered hawks in southwestern Ohio. *Wilson Bulletin* 113:308-316.

Urban Bird Diversity and Landscape Context

What are the major factors influencing species diversity of birds in urban areas? Is the landscape adjacent to an urban area important in this regard? Or, do birds primarily colonize new cities from already urbanized populations? These questions are of interest

to Philippe Clergeau of INRA SCRIBE and UMR EcoBio, Rennes, Cedex, France and two of his colleagues from the University of Lapland and the Canadian Wildlife Service. Clergeau and his associates recently studied the relative importance of local and regional landscapes in shaping the structure of urban bird communities. At the biogeographical scale, the researchers reviewed other studies where bird species richness (BSR) was estimated in both urban and periurban landscapes (limited to breeding birds in temperate and boreal landscapes). Eighteen published studies met pre-selection criteria of classifying bird species into three landscape types—town center, suburb, and periurban (area surrounding a town or city).

At the regional scale, winter bird data were collected from towns of three regions: western France, northern Finland, and eastern Canada. For France and Finland, birds of two traditional suburban landscapes were studied: blocks of large apartment buildings and areas of single-family detached houses. In Canada, birds in two types of parks of four cities were studied: managed parks (<20% tree cover and >50% lawn) and more natural parks (<50% lawn). Only parks 4-10 ha in size were studied to avoid size effects.

At the local scale, breeding season data were collected from three cities of different sizes in western France: Angers, Rennes, and Nantes. For each city, one park in town center, one in the suburbs, and one at the edge of town was selected for study. Only parks 4-10 ha in size were studied to avoid size effects.

At the biogeographical scale, latitude and level of urbanization were most important in explaining variation in BSR. Both were negatively associated with species richness (BSR decreased with latitude and generally with level of urbanization). BSR decreased from periurban (21.5 species) to suburban (16.9 species) to town center (10.2 species). However, in Finland and Canada some BSR was higher in suburban than in periurban landscapes, perhaps because of greater habitat diversity and/or artificial feeding of birds. BSR of the periurban landscape was positively correlated with BSR of suburban and town center landscapes. No significant correlation was found between suburban and town center landscapes. Bird communities were more similar between periurban and suburban landscapes than between periurban and town center landscapes. In town center, about 50% of the avifauna was independent of periurban species. Perhaps some species emigrate to a new

town from other urbanized areas. This would explain presence of species not common in surrounding landscape and suggests that local rather than regional factors are more important in shaping the structure of urban bird communities.

At the regional scale, BSR was similar between cities of a given biogeographical area, and type of periurban landscape, number of inhabitants, and town diameter did not affect BSR. Bird communities were more similar between similar habitat types of different cities than between different habitats of the same city.

At the local scale, distance from the periurban landscape did not affect BSR, community similarity, or guild composition. The authors concluded "...at regional and local scales, urban bird communities are independent of the bird diversity of adjacent landscapes, and that local features are more important than surrounding landscapes in determining BSR. Whatever the biodiversity quality of the periurban landscape, site-specific actions such as shrub and tree planting, water restoration and increasing vegetation diversity can change bird diversity in towns and improve the quality of human-wildlife contacts."

Reference: Clergeau, P., J. Jokimäki, and J.-P.L. Savard. 2001. Are urban bird communities influenced by the bird diversity of adjacent landscapes? *Journal of Applied Ecology* 38:1122-1134.

Predation on Bird Nests

Although some research has shown expansion of avian nest predators in urban areas the last few decades, little information is available on how nest predation affects the structure of bird communities. Jukka Jokimäki of the University of Lapland and Esa Huhta of the University of Oulu, both of Finland, recently studied nest predation in three towns of northern Finland—Rovaniemi, Oulu, and Kemijärvi. Managed and unmanaged parks were studied in two areas of each town—town center and residential periphery. Managed parks consisted of hedges and shrub and small tree plantations. Lawn mowing and shrub pruning were common practices. Unmanaged parks contained more trees, shrubs, and more ground vegetation, and the vegetation was more natural. The surrounding forests at Rovaniemi and Kemijärvi were used for comparison.

Artificial nests were hand-made cups in the soil under a small tree or shrub designed to mimic nest sites of many ground-nesting birds in the area (e.g.,

buntings). One Japanese quail egg was placed in each nest except for one year in Rovaniemi when two eggs were placed in a nest. Experiments were initiated the beginning of June and were concluded after 21 days. At that time, a nest was considered preyed upon if one or both eggs had disappeared or were broken. In Rovaniemi in 1998, one quail-sized plasticine egg painted to resemble a quail egg was placed in each of 50 nests in an effort to gain insight to types of predators impacting nests.

Birds were surveyed by the point-count method and were grouped in nesting guilds as ground nester, shrub-tree nester, or hole nester. Data also were collected on vegetation, abundance of potential nest predators in the area, and on human activity in the parks.

Nest predation was higher in town center than in residential periphery and in surrounding forest habitat. Also, the predation rate was higher in managed parks than in unmanaged parks. Higher ground cover and numbers of pines and deciduous trees decreased predation risk, and covered nests were preyed on less frequently than uncovered nests. Greatest predation was on uncovered nests in managed parks in town center.

In town center some 35% of predation was attributed to predaceous birds (no mammal predators detected). In residential periphery about 11% of predation was attributed to birds and 44% to mammals. The magpie was more abundant in town center than in residential periphery in all study towns. In Rovaniemi and Kemijärvi, the black-headed gull was more abundant in town center, and in Oulu the hooded crow was more abundant downtown.

Thirty species of breeding birds were recorded in the three towns and six of these were ground nesters. Abundance of ground nesters was lower in town center than in residential periphery, which may indicate that nest predation influences breeding habitat selection by ground nesting birds in the area. Other factors might also be important in this regard as pointed out by the authors, "...disturbance by humans, amount of food, food-based competition, lack of suitable nest sites, high management level of the parks, and recreational activities may work in concert to increase nest predation and affect bird populations in urban environments."

Reference: Jokimäki, J., and E. Huhta. 2000. Artificial nest predation and abundance of birds along an urban gradient. *The Condor* 102:838-847.

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Conserving Birds in Urban Landscapes

Esteban Fernández-Juricic of Oxford University (UK) and Jukka Jokimäki of the University of Lapland (Finland) recently presented a conceptual model for urban bird conservation. They argue that urban parks are important "habitat islands" because research has shown that such areas are richer in bird diversity than other urban habitats. The researchers draw on their own work in southern and northern Europe and review the literature pertaining to habitat island ecological theory (an extension of island biogeography theory). The discussion focuses on habitat island size, isolation, habitat structure, human disturbance, edge effects, and bird guild representation.

With respect to island (park) size, Fernández-Juricic and Jokimäki point out that species-area curves generally level off at 10-35 ha, giving some guidance to planners and others of minimum park size needed to retain a majority of birds. Research in Madrid, Spain shows that wooded streets have value as connecting corridors (thus reducing isolation). Such areas are used more by habitat generalists than by specialists though, and further effort should be focused on how to better conserve specialist species. Greater habitat complexity supports a greater variety of birds and park age is important in this regard. Older parks typically have more complex habitat structure, which may allow colonization by some specialist species. Human disturbance may influence bird use and edge habitat generally favors a different group of birds than does interior habitat. Urban bird communities are composed of species not common in the surrounding landscape, thus local, rather than regional, factors are important.

Three key aspects of the conservation model proposed by Fernández-Juricic and Jokimäki are management, environmental education, and research. Effort here should encourage participation of municipalities, NGOs, community centers, universities, and the private sector in conservation efforts, leading to development of policies, laws, and regulations that foster sustainable urban growth and enhanced public

valuation of wildlife, and ultimately, to better urban bird conservation. According to the authors, "Theoretical and empirical developments for understanding the functioning of wildlife in cities, along with the increasing interest placed on urban habitats as reservoirs of wildlife, open up new perspectives to direct conservation efforts with active public involvement. It is time for action and for offering urban people the possibility to learn to live in close proximity to their natural environment. Such endeavor will certainly benefit human well-being and wildlife conservation in general."

Reference: Fernández-Juricic, E., and J. Jokimäki. 2001. A habitat island approach to conserving birds in urban landscapes: case studies from southern and northern Europe. *Biodiversity and Conservation* 10:2023-2043.

Breeding Birds in Urban Parks

Studies show that parks support greater species richness (number of species) of birds than do other urban habitats. Knowing the factors responsible for this observation should allow planners and managers to do a better job of conserving birds in the urban environment. Jukka Jokimäki of the University of Lapland recently conducted a study to determine the effects of park size, small- and large-scale landscape structure, and human activity on bird assemblages in urban parks. Work was conducted in 54 urban parks in the city of Oulu, northern Finland. The city covers some 3,547 ha and had a human population of 106,419 in 1994. Study parks were bounded by roads, open areas, or buildings, averaged 1.2 ha, and ranged from 0.1 to 7.0 ha. Parks were grouped into three size classes: less than or equal to 0.5 ha (23 total), 0.75 to 1 ha (19 total), and 1.5 to 7 ha (12 total). Birds were surveyed in June 1995 by mapping breeding territories. Surveys were conducted by a zig-zag walk through a park and lasted about 10 minutes, although more time was spent in larger parks than in smaller ones. Birds in flight and nonresidents were not counted. Each park was surveyed twice.

Bird Conservation in Riparian Habitats

Twenty-two species of breeding birds were recorded in the study and most were the same as birds of central European parks. Many ground- and shrub-nesting species avoided small parks. Jokimäki speculated that this might have resulted from lack of cover and greater nest predation in small parks. Two corvids—magpie (*Pica pica*) and hooded crow (*Corvus corone*)—were abundant in the small parks and both are noted nest predators. During the past few decades many corvid species have expanded distributions into the urban environment worldwide.

Unlike ground- and shrub-nesters, cavity-nesting species were among the most common species in the parks, probably influenced by nest boxes placed by people.

Four species were not found in parks < 1.5 ha: wheatear (*Oenanthe oenanthe*), linnet (*Acanthis cannabina*), redpoll (*Carduelis flammea*), and yellowhammer (*Emberiza citrinella*). Three species were not found in parks < 0.75 ha: common rosefinch (*Carpodacus erythrinus*), garden warbler (*Sylvia borin*), and lesser whitethroat (*Sylvia curruca*).

Six of the measured variables were significant in the regression model explaining species occurrence in parks. Park size (larger parks supporting more species than smaller parks) was the most important variable, explaining 38.8% of the variation of species richness. Next in order of importance were portion of trees 5 m to 10 m in height (explaining 10.3% of the variation), number of nest boxes (9.7%), height of dominant trees (9%), mean number of people using a park (5.3% and imposing a negative influence on species richness), and tree species diversity (2.6% and also imposing a negative influence on species richness). This last relationship was unexpected and unexplained. Other research has established a positive relationship between vegetation diversity and bird species richness. Jokimäki speculated that perhaps other factors were more important in the study.

In conclusion, Jokimäki pointed out that "Most of the bird species detected in urban parks were deciduous forest species. This may be related to the fact that deciduous trees are favored over conifers in urban planning in Finland. To increase occurrence opportunities of coniferous forest species, coniferous trees must be used in park management, especially in northern latitudes where deciduous trees and shrubs drop their leaves in autumn."

Reference: Jokimäki, J. 1999. Occurrence of breeding bird species in urban parks: effects of park structure and broad-scale variables. *Urban Ecosystems* 3:21-34.

Researchers at Colorado State University and the Colorado Division of Wildlife are studying breeding bird use and nest predation along urbanization gradients of several riparian watersheds in Colorado. Work is being conducted in the shortgrass prairie at the base of the Front Range of the Rocky Mountains. Sixteen study sites were selected along Coal Creek, South Boulder Creek, and Boulder Creek in Boulder County and the Cache la Poudre River in Larimer County. Riparian woodland overstories are dominated by plains cottonwood (*Populus deltoides*), crack willow (*Salix fragilis*), and hybrids of plains cottonwood and narrowleaf cottonwood (*P. angustifolia*). Riparian woodland understory largely consists of snowberry (*Symphoricarpos occidentalis*), chokecherry (*Prunus virginiana*), and sandbar willow (*S. exigua*).

Breeding birds were surveyed by 8-minute point counts from sunrise to about 8:30 a.m. during 1995-1997. Distance to bird was estimated for calculating density. Nest predation was studied with the use of artificial nests and by monitoring natural bird nests. Artificial nests consisted of commercially available wicker canary nests modified with grass and mud to make the nests appear more natural. Two Japanese quail (*Coturnix coturnix*) eggs and one artificial egg formed from modeling clay (to obtain predator tooth/beak impressions) were placed in the nests, which were located 0.5-2.5 m above ground in trees or shrubs.

Results reported here are preliminary as the study is continuing. A pattern of decreasing species richness with increasing development appears to hold across watersheds. In addition, the percent of migratory species in the bird communities is less at more developed sites than at less developed ones. Predation rates on experimental nests were lower in more developed sites than in less developed sites. For natural nests, no difference was noted at one site, but a higher predation rate was noted for low-development at the second site.

The authors concluded, "As human populations shift toward urban areas, connections to nature become increasingly tenuous. Because conservation action, even in remote or rural areas, may depend on the support of people in urban areas, the preservation of native bird species as well as other components of biological diversity in areas where people live takes on added importance. It may be our best hope for

fostering a greater appreciation of our natural heritage.”

Reference: Miller, J.R., J.A. Wiens, and N.T. Hobbs. 2000. How does urbanization affect bird communities in riparian habitats? an approach and preliminary assessment. Pages 427-439 in J.L. Craig, N.Mitchell, and D.A. Saunders, editors. *Nature conservation 5: nature conservation in production environments: managing the matrix*. Surrey Beatty & Sons, Chipping Norton, NSW, Australia.

Recreational Trails and Predation of Bird Nests

Do recreational trails constructed for human use in urban-suburban open spaces alter predation rates of bird nests, perhaps negatively impacting bird populations? This question is of interest to James Miller of the University of Wisconsin (formerly of Colorado State University) and Thompson Hobbs of the Colorado Division of Wildlife. These investigators recently studied the effects of such trails on bird nest predation in lowland riparian areas along the Front Range of Colorado.

Four wooded riparian sites were selected for study in Boulder County, Colorado. Tree composition was primarily plains cottonwood, crack willow, and hybrids (*Populus x acuminata*) of plains cottonwood and narrow-leaf cottonwood. Typical understory consisted of snowberry, chokecherry, and sandbar willow. Average width of the wooded riparian zone at study sites was about 60 m. Two of the study sites were located along South Boulder Creek; the remaining two along Coal Creek. Along each stream, one of the two sites included a 2.5-m paved recreational trail in the riparian zone and the second site, serving as a reference site, did not contain a trail. Suburban development bordered the riparian area along the trail site on Coal Creek. At the South Boulder Creek trail site, suburban development was located several hundred meters away. Otherwise, sites were surrounded by a mosaic of mixed-grass prairie, agricultural land, and low-density rural housing.

During June-July 1995 and 1996, three transects of 20 artificial nests each were established along each of the two streams. One transect was located along the trail side of the stream, one on the opposite side of the stream, and the third was located at the reference site. Nests used in the study were commercially available wicker canary nests modified with grass and mud to resemble American robin (*Turdus migratorius*) nests. They were placed 0.5-2 m above

ground in trees or shrubs and alternately placed 10-15 m on either side of the transect at 30-m intervals. Two Japanese quail eggs were placed in each nest. In 1996 an additional egg formed from modeling clay was included in an effort to identify specific predators from tooth or beak marks. Nests were checked every third day for 15 days.

Nest predation was high in the study, with 226 of 240 nests (94.2%) being attacked. The authors pointed out that other studies have documented high predation rates of bird nests in edge habitat and that their study areas were all located in what could be considered edge habitat (long linear strips of woody vegetation along the streams in a sea of grass). Predation rates increased with distance from trails and rates on the reference transects were higher than those on trail transects. Birds, including house wren (*Troglodytes aedon*), blue jay (*Cyanocitta cristata*), black-billed magpie (*Pica pica*), and common grackle (*Quiscalus quiscula*) overall were greater predators than were mammals. In addition, they preyed on nests at a higher rate near trails than away from trails. Mammals, on the other hand, tended to prey more on nests away from trails.

Both trails in the study received substantial human use during the breeding season for birds. The authors concluded that “Clearly, the effect of trails and other narrow corridors on nesting success in wooded areas depends on more than the mere presence of a human-induced edge. Rates of nest loss reflect the cumulative pressure exerted by a suite of predator species, each exhibiting unique responses to the presence of recreational trails and people.” More research is needed to better understand the effects of trails on wildlife so that appropriate management practices can be recommended for these structures.

Reference: Miller, J.R., and N.T. Hobbs. 2000. Recreational trails, human activity, and nest predation in lowland riparian areas. *Landscape and Urban Planning* 50:227-236.

Breeding Birds in Olsztyn, Poland

Researcher Jacek Nowakowski of Teachers Training College, Olsztyn, Poland recently reported changes in breeding birds of the city over a 25-year time period. During that time interval, the city grew from 46 km² to 88 km², and the human population increased from 80,000 to 166,000. Industrial areas increased and small housing estates were replaced with blocks

and villas. In the process, open habitats (fields, meadows) were reduced and forests declined and became more fragmented. Many wetland areas were drained and converted to built-up areas. Nowakowski conducted breeding bird surveys in the city from mid-March through early July 1991-1993 using a modified mapping method. Birds were counted at dawn and dusk within 500-m grids.

One hundred fifty-five species were recorded and 126 of these were considered to be breeding birds or probable breeders. Six species were lost from the city and five new species moved in. Populations of 15 species declined whereas populations of 11 species increased. So, the overall pattern has been a net loss or decline of species or populations. Also noted was a change in dominant species. In the late 1960s to early 1970s, the house sparrow (*Passer domesticus*), common swift (*Apus apus*), European starling (*Sturnus vulgaris*), greenfinch (*Carduelis chloris*), and Eurasian sparrow (*Passer montanus*) were the five most dominant species in the city. In 1991-1993, the starling, greenfinch, and Eurasian sparrow were replaced by collared dove (*Streptopelia decaocto*), rock dove (*Columba livia*), and magpie. Factors influencing these changes were geographical expansion (collared dove), increase of the built-up part of the city (rock dove), and human feeding (magpie). Expansion of populations of other species on a regional or larger scale also led to increases in Olsztyn. Species included here were the woodpigeon (*Columba palumbus*), fieldfare (*Turdus pilaris*), and goldeneye (*Bucephala clangula*). The increase of urban development also was a positive factor for species such as

the jackdaw (*Corvus monedula*), black redstart (*Phoenicurus ochruros*), and house martin (*Delichon urbica*). The mallard (*Anas platyrhynchos*) and jay (*Garrulus glandarius*) were positively influenced by human feeding. One other factor—synurbization (adjustment of a species to the urban environment)—was considered an important factor influencing bullfinch (*Pyrrhula pyrrhula*), jay, and swallow (*Hirundo rustica*). These species continue to breed in typical exurban habitats but have “adjusted” to urban life as well.

On the downside, several factors have led to species loss or population declines as Olsztyn has expanded. Decrease in size of open areas and loss and fragmentation of forests and scrub habitat have negatively impacted species such as corncrake (*Crex crex*), woodlark (*Lullula arborea*), yellow wagtail (*Motacilla flava*), grasshopper warbler (*Locustella naevia*), and thrush nightingale (*Luscinia luscinia*). And degradation of banks and shores of water bodies has led to decline of species such as black tern (*Chlidonias nigra*) and Savi’s warbler (*Locustella luscinioides*). National declines in populations of the wryneck (*Jynx torquilla*), hoopoe (*Upupa epops*), and turtle dove (*Streptopelia turtur*) also are reflected in the city. Hopefully, better understanding of effects of urbanization on birds will lead to better conservation practices in the future.

Reference: Nowakowski, J.J. 1996. Changes in the breeding avifauna of Olsztyn (NE Poland) in the years 1968-1993. *Acta Ornithologica* 31:39-44.

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Blanding's Turtle in the Chicago Metropolitan Area

Blanding's turtle (*Emydoidea blandingii*) is a semi-aquatic species inhabiting freshwater ponds, streams, wetlands, and associated uplands in North America. The turtle was once common throughout the northern two-thirds of Illinois but now is rare in the greater Chicago metropolitan area (GCMA) where it is isolated in small patches. Small, isolated populations are of concern to biologists because such populations typically show reduced genetic variation over time, resulting eventually in lower reproductive and survival potential for the affected species.

Cory Rubin of the University of Illinois and three colleagues recently studied the genetic structure of two small, isolated populations of the turtle in Pratts Wayne Woods and West Chicago Prairie, both areas located in northwestern DuPage County, about 50 km west of downtown Chicago. These two populations were compared with larger turtle populations in Michigan, Wisconsin, and Nova Scotia.

These investigators found that genetic variation within each population was similar for all populations except for the one in Michigan, which was genetically more diverse. The study indicated that to date there has been no loss of genetic variation in the two metropolitan populations, perhaps because of the short time period the populations have been isolated. The authors concluded "...results of the present study indicated that Blanding's turtle populations in the GCMA were not genetically different and, therefore translocations to promote gene flow between populations will likely have little or no influence on the maintenance of genetic variation in the region. Thus, management interventions to acquire and maintain quality habitat that promotes population increases and migration are likely to be the most beneficial to the persistence and maintenance of genetic variation of Blanding's turtles in the GCMA."

Reference: Rubin, C.S., R.E. Warner, J.L. Bouzat, and K.N. Paige. 2001. Population genetic structure of Blanding's turtles (*Emydoidea blandingii*) in an urban landscape.

Biological Conservation 99:323-330.

Woodland Restoration

How can one best restore urban woodlands? This question is of interest to Cynthia Lane of Ecological Strategies, Maiden Rock, Wisconsin and Sara Raab of Harvard University who recently reported on the Great River Greening project of Saint Paul, Minnesota. These investigators tested several methods of woodland restoration and use of public volunteers in restoration efforts. Work was conducted along the Mississippi River in Downtown Saint Paul. Soils were coarse to medium-coarse textured with low to medium levels of organic matter, extremely compacted, and containing considerable building rubble such as cement, bricks, boards, and asphalt. Soil pH averaged 7.9. Land ownership was both public (parks and properties owned by the Saint Paul Port Authority) and private (mostly commercial and industrial).

Four planting design strategies were studied: 1) dense initial, 2) final spacing, 3) sparse initial, and 4) colonization patch. The dense initial strategy was used most often and involved planting trees and shrubs in densities greater than desired at maturity. The reasoning behind this strategy was that a dense planting would help plantings to out-compete undesirable species. Tree plantings were spaced 1.5 m apart and shrubs 1.2 m, with a shrub-to-tree ratio of 6:1 or 3:1. Most sites were mulched with a minimum of 10.2 cm of wood chips.

In the final spacing strategy, trees and shrubs were planted in densities and proportions desired at maturity. This strategy was most similar to traditional landscaping and focused largely on foundation plantings and street trees. This method was used near buildings or other small areas, or where specific aesthetic needs were desired.

The sparse initial strategy involved planting heat- and drought-tolerant tree species at lower density than desired at maturity. Trees, including bur oak (*Quercus macrocarpa*), aspen (*Populus tremuloides*), green ash (*Fraxinus pennsylvanica*), and hackberry (*Celtis occidentalis*), were spaced 6.1 to 9.1 m apart

and the plan called for adding shade-tolerant trees and shrubs as these trees grew and site conditions improved.

The colonization patch strategy was used on one large site and involved the planting of trees and shrubs in mulched beds distributed throughout the site. The idea was for these plantings to serve as propagule sources for colonizing the area. The trees and shrubs were underplanted with a diverse native cover mix to help build soil and to provide aesthetic and ecological value.

Plants that would tolerate harsh site conditions were selected from native community types. Both container-grown and bare root stock were used. For shrubs, container-grown material varied from 3.8- to 18.9-liter size and bare root material from 45.7 to 61 cm in length. Container-grown trees varied from 18.9- to 75.8-liter containers and bare root stock was about 2.5 cm in diameter. For planting stock, plant survival, performance in the design strategy, ease of planting by volunteers, and cost were considered.

Standard preparation at all sites included application of herbicide (Roundup™, Transline™, or Scythe™) followed 1 to 2 weeks later with addition of 5.1 cm of composted leaf material rototilled into the soil. Where possible, frost ripping was applied to a depth of 61 cm to reduce soil compaction. Planting was conducted by 100 to 500 volunteers from 1996 to 1999. For 2 years following installation, plants were monitored weekly during the growing season and monthly during the dormant season. Following that time period, landowners-managers were provided with site-specific management plans and ongoing technical assistance.

Ten sites, ranging from 185 m² to 6,875 m², received the dense initial treatment. Overall, survival and reproduction were good by the 3rd to 4th year after planting and the design was aesthetically acceptable to landowners. Initial installation costs were high because of the greater numbers of plants needed and more professional labor required to ensure proper installation.

Four sites received the final spacing treatment. These sites were near business entryways where a more formal appearance was desired. These sites provided an opportunity to showcase native species to local citizens. Because of the highly visible locations and wider spacing, more initial maintenance was required and more future maintenance probably will be required compared to the other planting schemes.

One site each was planted following the sparse ini-

tial and the colonization patch designs. Initial results indicate that these schemes may be useful for severely degraded, larger tracts of land where costs per hectare need to be low, and where naturalized appearance and a longer time frame for results are acceptable.

Good survival rates were recorded for the dense initial and final spacing planting designs. Drought tolerance was the most important factor determining survival rates for individual species, with soil compaction also playing a key role. High survival (85% or better) was noted for American plum (*Prunus americana*), chokecherry (*P. virginiana*), smooth sumac (*Rhus glabra*), bur oak, red oak (*Q. rubra*), and gray dogwood (*Cornus racemosa*). All but red oak are drought resistant.

Lowest survival (4% to 58%) was noted for basswood (*Tilia americana*), alternate-leaf dogwood (*C. alternifolia*), sugar maple (*Acer saccharum*), Allegheny serviceberry (*Amelanchier laevis*), and ironwood (*Ostrya virginiana*). All five species are drought sensitive. The dense initial design also controlled weeds well.

Maintenance and costs varied among the planting schemes. All were designed to be low maintenance. Comparatively, the dense initial and final spacing required more maintenance than the sparse initial and colonization patch. The most expensive to install was the dense initial; least expensive, the sparse initial and colonization patch. The latter was slow and unpredictable, with greatest utility near larger tracts of native plants. The authors concluded that "Great River Greening has developed a program that addresses the ecological and socio-cultural issues inherent in urban ecological restoration projects. We believe our experience may be applicable to other communities who wish to develop public and private partnerships, and community support."

Reference: Lane, C., and S. Raab. 2002. Great River Greening: a case study in urban woodland restoration. *Ecological Restoration* 20:243-251.

Immunocontraception of Free-ranging White-tailed Deer

Researchers continue to learn more about the potential of the porcine zona pellucida (PZP) immunocontraceptive for controlling populations of white-tailed deer. To be effective, PZP must be administered with an adjuvant that enhances immune response to PZP. Freund's Complete Adjuvant (FCA),

which contains heat-killed *Mycobacterium tuberculosis*, is the most effective adjuvant tested to date. Unfortunately, there are some roadblocks to using FCA in combination with PZP for population control of free-ranging deer. Impediments include potential for injection-site abscesses, carcinogenicity as related to human food safety, false-positives for tuberculosis, and U.S. Food and Drug Administration (FDA) denial of wide-scale application in free-ranging wildlife (work to date with FCA as an adjuvant for PZP has been allowed by the FDA on a research permit basis under controlled conditions).

Researchers are searching for an effective adjuvant that does not have the drawbacks outlined above. Recent work in this regard was reported by David Walter of the University of New Hampshire and three of his colleagues. These investigators tested the effectiveness of a new adjuvant-PZP combination against FCA-PZP in free-ranging deer and assessed reliability of using blood titers and fecal steroid levels to indicate reproductive success of treated deer. The study was conducted in two residential communities in Connecticut. Deer were captured during 1997-1998 with a dart gun using a Telazol[®]-xylazine hydrochloride mixture and given one of the following treatments:

1. One ml of S-TDCM (synthetic trehalose dicorynmycolate)/PZP vaccine hand injected into hip muscle. Ten deer were so treated. Annual boosters of the same treatment were given to nine deer (one deer died before receiving a booster).
2. One ml of FCA/PZP vaccine hand injected into hip muscle. Ten deer were so treated. The annual booster consisted of 1.0 ml of FIA (Freund's Incomplete Adjuvant, which lacked the heat-killed *Mycobacterium*)/PZP vaccine given to 10 deer. One deer died prior to observations being made.
3. One ml of FCA (0.5 ml)/sterile water (0.5 ml) mixture hand injected into hip muscle. Nine deer were so treated. The annual booster consisted of 1.0 ml of FIA (0.5 ml)/sterile water (0.5 ml) mixture given to seven deer.

All boosters were delivered with a dart gun.

The S-TDCM adjuvant was less effective than FCA in inhibiting reproduction. Five of nine deer (56%) on the S-TDCM treatment reproduced compared with one of nine (11%) on the FCA treatment. Seventy-eight percent of deer in the control group reproduced. Blood titers (percent anti-PZP antibodies

in plasma) also varied among the three treatment groups. The mean values for the treatment groups were as follows: FCA, 100%; S-TDCM, 32%; and control, 18%. Walter and his colleagues found that a threshold titer level of 70% after the breeding season resulted in successful contraception of FCA deer. They concluded "Therefore, titer levels can assist in confirming successful contraception in future research involving PZP immunocontraceptives in free-ranging deer."

Walter and his colleagues also measured progesterone metabolite pregnanediol glucuronide (PdG) in fecal pellets of test deer to determine if such measurement could be used to assess pregnancy status of deer. Fecal PdG has indicated pregnancy in some other species but no difference was found in fecal PdG levels between adult pregnant and nonpregnant deer in this study. The authors concluded that the measure was unreliable in assessing pregnancy in deer during March-early April.

Reference: Walter, W.D., P.J. Pekins, A.T. Rutberg, and H.J. Kilpatrick. 2002. Evaluation of immunocontraceptive adjuvants, titers, and fecal pregnancy indicators in free-ranging white-tailed deer. *Wildlife Society Bulletin* 30:908-914.

Managing Urban Deer

Translocation of problem animals from urban to rural areas is a practice readily acceptable by the public but often discouraged by biologists as expensive and inefficient. The technique was studied recently in Missouri where white-tailed deer was the problem species. The community of Town and Country, an affluent 2,735-ha suburb of St. Louis, wanted a reduction in the overabundant deer population. Lethal removal was not acceptable so in cooperation with the Missouri Department of Conservation, a live capture and translocation project was initiated. The purpose of the study was to determine survival rates and movement patterns of translocated deer and to determine cost associated with translocation.

Between December 1997 and March 1998, deer were captured with rocket nets and modified Clover traps. Deer making up a control group received radio-transmitters and were released at the capture site. The remaining 80 deer received radiotransmitters and were translocated 160 km away to a 2,520-ha state wildlife management area.

Annual survival of translocated deer (30%) was lower than annual survival of control deer (69%).

Hunting accounted for some 38% and capture-related stress (capture myopathy) another 29% of mortality for relocated deer. Deer-vehicle collisions (68%) and hunting (16%) were primary mortality factors of resident Town and Country deer. Cost per deer for relocation was \$387. The authors concluded that "The use of translocation for controlling urban deer populations was costly relative to other methods and may result in significant mortality from capture myopathy and human activities at release sites."

Reference: Beringer, J., L.P. Hansen, J.A. Demand, J. Sartwell, M. Wallendorf, and R. Mange. 2002. Efficacy of translocation to control urban deer in Missouri: costs, efficiency, and outcome. *Wildlife Society Bulletin* 30:767-774.

Managing Mynas in Singapore

Mynas are not native to Singapore, but white-vented (*Acridotheres javanicus*) and common (*A. tristis*) mynas, particularly, have become well established there since the early 1900s. The birds thrive in urban areas. They roost communally throughout the year in large numbers and the noise, fecal droppings, unpleasant odors, and other factors can create conflict with people.

Charlotte Yap of the National University of Singapore and two of her colleagues recently studied myna roost site characteristics on the main island of Singapore. Their goal was to develop management strategies for long-term control of roosting activity of the birds. The researchers selected 30 roost sites for study between 20 April and 5 June 2001. Roosting birds at a site ranged from about 1000 to 17,000 individuals. Two habitat manipulation experiments also were conducted. For the canopy density experi-

ment, two experimental roosts were pruned to reduce canopy density and compared to two reference roosts not pruned. For the food abundance manipulation experiment, two experimental roost sites were compared to two reference sites. Experimental sites were kept free of garbage for the 5-week experimental period and other measures were taken to reduce human-derived food.

Mynas showed some preferences for roost site characteristics. Two tree species, angšana (*Pterocarpus indicus*) and tropical apple (*Eugenia grandis*), were most frequently used and preferred for roosting. Other important variables were canopy density, proximity of roost sites to food centers, and proximity of vegetation around roost trees. In the canopy density manipulation experiment, canopy densities were reduced about 15% and roosting myna numbers dropped significantly by 83% at one site and 51% at the second site. The food abundance manipulation experiment was less conclusive. Bird numbers significantly decreased by 68% at one experimental site but no significant difference was noted at the second site. The researchers suggested that food was probably less important than canopy density and concluded that "The canopy of existing roosts can be thinned to alleviate the problem caused by roosting mynas. Stringent control of refuse at food centers also should be implemented to make such areas less attractive to mynas. Planting large and densely covered trees, particularly angšana (*Pterocarpus indicus*) and tropical apple (*Eugenia grandis*), near food centers should be avoided by park and urban managers."

Reference: Yap, C. A.-M., N. S. Sodhi, and B. W. Brook. 2002. Roost characteristics of invasive mynas in Singapore. *Journal of Wildlife Management* 66:1118-1127.

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