THE URBAN OPEN SPACE MANAGER

A newsletter about wildlife and nature conservation in urban areas
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Protecting Open Space

"Metro," the Portland, Oregon area's directly elected regional government, serves Clackamas, Multnomah and Washington Counties, and the 24 cities in the Portland metropolitan area. It provides a forum for resolution of planning issues related to growth. Metro also manages regional parks and greenspaces in the area. It recently published a report *Protecting Open Space: A Review of Successful Programs and Landowner Perspectives* that covers regulatory and non-regulatory strategies for protecting open spaces for people and wildlife throughout the United States, and including one example each from South Africa, Canada, France, and New Zealand. Some indication of landowner attitudes was obtained from interviews with 17 property owners residing in the Portland metropolitan region.

Elements of Successful Programs

Review of the selected programs revealed the following important elements.

Offer a Range of Options

Programs that are successful in protecting open space typically offer a range of options to landowners. Non-regulatory options include acquisition and incentive programs. Acquisition is effective, but can be expensive. Funds for land purchase often are derived from bond issues, taxes, or lottery proceeds. (See also Iten 7 below.) Incentive programs include purchase of development rights and transfer of development rights. Other financial incentives may work. A Pennsylvania County provides funding to cities and towns that agree to develop plans consistent with the County's "Livable Landscapes" map. Other non-regulatory approaches may work. In an effort to protect desert open space, an Arizona county developed a regional advisory body to provide voluntary direction to local governments and to encourage use of tools like clustering, early notification of proposed development, and sales tax for land acquisition. Regulatory options include zoning, buffers, setbacks, mitigation, and impact fees. Regulation often is used when adequate funding for land purchase is not available, when the area of concern is geographically large or has complex ownership patterns, or development is occurring at a rapid pace. Where regulation is used to protect open space it is a good idea to reduce tax assessments on such properties.

Design a Representative Governance Structure

Key stakeholders from local, state, and federal levels should be included in a governing body.

Start with a Plan and a Well-defined Geographic Identity

An overall plan should be developed for the area of interest and it should be adhered to. "It is important that people are able to visualize and understand the boundaries of a resource that is targeted for protection."

Earn Public Support

A local commission can be established to help disseminate information to the surrounding community and to help develop protection programs, including review of proposed acquisitions. Recreation and education programs can build a sense of ownership and stewardship of open space areas. Thirdly, publicity can be offered as an incentive to contribute to open space protection.

Build a Solid Foundation

"As they are starting out, new programs should focus on smaller projects that are manageable and can involve the local community." This helps to build a foundation of public support for future efforts.

Keep Regulations Clear, Certain, and Simple

Keeping regulations clear, certain, and simple to understand helps to increase support for the regulations by both the development community and agency administrative staff. To ensure effectiveness, regulatory agencies need to monitor the development activities and enforce regulations. This requires adequate agency staffing.

Establish Effective Funding Mechanisms

A variety of funding approaches is being used to acquire and manage open space. Sales and property taxes are well-established means for local jurisdictions to generate funds. In addition, the real estate transfer tax is increasing in popularity. This tax typically is levied at a 0.5%-2% rate on real estate transactions. Other means of funding for open space include lottery receipts, developers fees, sale of mitigation credits, and bonds. Bonds are a popular source of funds for open space acquisition, but there is little public support for using them to obtain funds for operation and maintenance. Public bond issues must be voted on by local citizens. Approval for issuing bonds to generate funds for open space acquisition can be obtained if public support for open space is high.

The report also discusses strategies for specific resources like greenways and corridors, trails, and natural areas.

Reference: *Protecting Open Space: A Review of Successful Programs and Landowner Perspectives*. 1999. A publication of Metro's Regional Parks and Greenspaces Department, 600 NE Grand Ave., Portland, OR 97232, 109 pp + App.

Urban Deer Relocation

Many metropolitan areas, particularly in the eastern United States, are grappling with ways to manage overabundant white-tailed deer populations. Lethal means, like hunting and sharp-shooting, are efficient and effective, but public interest remains high in nonlethal approaches for managing such populations.

Live-capture of deer and relocation elsewhere is one non-lethal approach with public appeal. Jennifer Cromwell and two of her colleagues at the University of Georgia recently studied this approach at Sea Pines Plantation, on Hilton Head Island, South Carolina. Sea Pines is a 2,137-ha intensively developed residential-resort community with a 242-ha forest preserve. Cromwell and her associates compared movement and mortality rates of live-captured and relocated deer with movement and mortality of deer that were live-captured but not relocated. During 1995, 19 deer were captured with rocket nets, immobilized with an anesthetic, and marked with ear tags and radiotransmitter collars. Ten deer were moved to the forest preserve, about 3 km from capture sites. Nine deer were released at capture sites to serve as controls.

Relocated deer exhibited higher dispersal and mortality rates than did control deer. In fact, no control deer dispersed from release areas, but five of ten relocated deer dispersed from the forest preserve within 4 days of release. During a 3-month time period after release, the mortality rate for control deer was 24.5%--about half the mortality rate for relocated deer (47.9%). These researchers concluded that "relocating deer from the southern part of Sea Pines to the forest preserve was not a viable method of deer population control. Relocated deer initially experienced greater mortality rates from the stress of capture and relocation, and some animals returned to their capture site. In addition, the deer that remained in the forest preserve area used the surrounding residential neighborhoods and continued to cause damage through deer-vehicle collisions and browsing in yards."

Reference: Cromwell, J.A., R.J. Warren, and D.W. Henderson. 1999. Live-capture and small-scale relocation of urban deer on Hilton Head Island, South Carolina. *Wildlife Society Bulletin* 27:1025-1031.

Nonlethal Nuisance Bird Control

Alpha-chloralose, a chloral derivative of glucose, has been used as an anesthetic in laboratory animals for more than 100 years. It also has been used in field settings to capture Canada geese, mourning doves, wild turkeys, American crows, and other species. In the United States, the Food and Drug Administration (FDA) has granted approval for U.S. Department of Agriculture (USDA) certified biologists or their designees to use the drug for capturing nuisance waterfowl, American coots, and pigeons.

Jerrold Belant, Laura Tyson, and Thomas Seamans of the National Wildlife Research Center, Sandusky, Ohio recently summarized alpha-chloralose use by USDA Wildlife Services during 1994-1995 in a paper published in the *Wildlife Society Bulletin*. They reported the capture of 3,767 birds in 124 field operations during this time period. Alpha-chloralose was delivered in corn and bread bait and most captures

were of mallards (including domestic birds), muscovies, Canada geese, domestic geese, American coots, and pigeons. Capture sites were predominantly parks (39%), residential/urban areas (24%), and golf courses/resorts (19%).

The technique worked better for capturing waterfowl and coots than for capturing pigeons. At least 68% of waterfowl and coots that consumed bait were captured but only 6% of drugged pigeons were captured. The overall mortality rate of target birds was 5%, but was 12% for nontarget birds, which made up less than 3% of total captures. The authors speculated that the small size of nontarget birds (blackbirds, sparrows, magpies) may have resulted in drug overdose (i.e., the dose delivered was based on estimated weight of target species). In addition, two of three mute swans drugged died, so obviously there is need to better define a dose for these birds that will immobilize but not kill them. Overall mortality was less that the 10% level allowed by FDA for field operations.

Belant and his co-authors point out that research is continuing in an effort to improve use of alpha-chloralose by the Wildlife Services program. They believe that the drug is an effective tool in removing nuisance waterfowl from locations where other techniques are either less efficient or impractical and concluded that "Alpha-chloralose is a humane, safe, and effective nonlethal technique to capture waterfowl and coots in various nuisance situations...We recommend continued tabulation of operational AC [alpha-chloralose] use and additional research to improve existing techniques so as to provide AC as an additional tool for other nuisance species (e.g., gulls, blackbirds, house sparrows)."

Reference: Belant, J.L., L.A. Tyson, and T.W. Seamans. 1999. Use of alpha-chloralose by the Wildlife Services program to capture nuisance birds. *Wildlife Society Bulletin* 27:938-942.

Home Range Size of Urban Cooper's Hawks

Nest densities of the Cooper's hawk in urban-suburban settings are among the highest reported for the species. Bill Mannan and Clint Boal of the University of Arizona have studied these birds in Tucson and, among other things, are interested in learning how increasing density of birds affects individual home range sizes. These investigators studied movements of nine radio-tagged male hawks in Tucson during the breeding seasons of 1996 and 1997. Remnants of natural vegetative communities persist in the city but much natural vegetation has been removed or replaced with exotic plants. Land use in the study area was primarily private residences, businesses, parks, and golf courses.

Home range size for the Tucson hawks ranged from 13.3-130.6 ha, with a mean of 65.5 ha and a median of 45.6 ha. Published reports of home ranges for rural birds vary from 400-1,800 ha. Mannan and Boal speculate that an abundance of prey in Tucson most likely has a major influence on home range size. With an abundant food source, hawks do not have to travel far from the nest site to hunt. Mourning doves, Inca doves, and white-winged doves are abundant in Tucson and make up 84% of identified prey of the hawks. Home range size probably also is influenced by season and age and sex of the hawk. These results seem to fit a developing pattern of smaller home range size that has been reported for other birds and also mammals in urban-suburban environments (see Adams 1994 for a review).

No strong evidence of habitat selection was noted based on the land-use categories studied (all were used), indicating that the Tucson birds are flexible with regard to the types of urban environments they use. (See Volume 4, Number 2, and Volume 5, Number 1 of *The Urban Open Space Manager* for more information on Cooper's hawks in Tucson.)

References: Adams, L.W. 1994. *Urban Wildlife Habitats: A Landscape Perspective*. University of Minnesota Press, Minneapolis. 186pp.

Mannan, R.W., and C.W. Boal. 2000. Home range characteristics of male Cooper's hawks in an urban environment. *Wilson Bulletin* 112:21-27.

Burrowing Owls in Florida

The burrowing owl is a non-migratory raptor in Florida that feeds on a variety of invertebrates, reptiles, amphibians, small mammals, and small birds. It is found in open grassy landscapes where it excavates its own burrow. Although the species has expanded its range in Florida as a result of clearing of forests and filling of wetlands, and occurs frequently in urban areas, it is thought that burrowing owl numbers are declining statewide.

Brian Millsap of the Florida Fish and Wildlife Conservation Commission, and Cindy Bear of the School Board of Lee County, Florida studied a burrowing owl population along an urban gradient during 1987-1990 in Cape Coral, Florida. Development consisted mainly of single-family homes ranging from 20 houses/km^2 to 820 houses/km^2 interspersed with grassy vacant lots

maintained by regular mowing.

The percentage of lots with houses increased during the study period as did the number of occupied nest sites, indicating that the owl population increased. Nesting density of owls increased with housing development until about 45-60% of lots were developed. Development beyond this level resulted in decreased nesting density. An increasing prey base (arthropods and anoles responding particularly to watered lawns) was primarily responsible for higher owl densities and higher owl reproductive performance at moderate levels of development. Where more than 60% of lots were developed, other factors tended to offset the positive influence of a high prey base. Leading causes of nest failure were nest destruction during construction of houses, harassment of the birds (largely by school-age children), and flooding. Productivity (number of young fledged) was influenced noticeably by presence of a buffer zone of no development around nest burrows. On developed lots with no buffer, 0.1 young fledged. On developed lots where a buffer zone of a least 10 m was maintained, 1.9 young fledged, and on lots not affected by construction, 2.1 young fledged.

Millsap and Bear present three management actions that may lessen the negative impact of high levels of urban development. One, a formal, mandatory burrowing owl education program in the Cape Coral public schools was associated with a decline in nest failures due to human harassment. Thus, these authors believe that education is an important management component in urban settings. Two, buffer zones as small as 10 m around nesting burrows where construction occurred during the breeding season were effective in maintaining productivity and should be used in conjunction with future development. Three, maintaining burrows in sodded yards after development may assist owl populations but number of young fledged is significantly lower than in undeveloped lots and may not be enough to maintain populations. The authors conclude that "Ensuring the long-term persistence of burrowing owl nest sites where [60% or more] of lots are developed in the urban landscape of Cape Coral will prove challenging given the growth rates and cost of real estate. One approach that would not involve buying land would be to enter into agreements with the managers of public facilities such as schools, athletic fields, churches, parks, libraries, and office building complexes that already provide burrowing owl habitat. The primary management needs for these sites would be a long-term commitment to not plant trees and shrubs, to maintain regular mowing around burrows with devices not likely to cause burrows to collapse, to provide opportunities for owls to excavate their own burrows by strategically removing 1-m diameter plugs of sod to allow direct access to soil (Wesemann 1986), and to control excessive human disturbance while allowing for public viewing."

References: Millsap, B.A., and C. Bear. 2000. Density and reproduction of burrowing owls along an urban development gradient. *Journal of Wildlife Management* 64:33-41.

Wesemann, T. 1986. Factors influencing the distribution and abundance of burrowing owls (*Athene cunicularia*) in Cape Coral, Florida. Thesis, Appalachian State University, Boone, North Carolina, USA.

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Immunocontraception of Suburban White-tailed Deer

In recent years, a vaccine called PZP (porcine zona pellucida) has received considerable attention as a non-lethal approach to managing urban-suburban deer populations (please see Volume 4, Number 3 and Volume 3, Numbers 1 and 2 of *The Urban Open Space Manager* for related articles). Newspaper stories often portray the technique as a workable alternative to culling deer in reducing overabundant populations. However, biologists working to perfect the technique are more cautious, pointing out that the method is still experimental. Treatment of free-ranging wildlife populations requires authorization by the U. S. Food and Drug Administration and one of its requirements is that all treated animals be individually identified. This typically requires capture and ear-tagging animals--no small feat.

Use of PZP on captive deer has proven effective in inhibiting or greatly reducing reproduction, however, little information is available on effectiveness of PZP in free-ranging populations. Several field studies are underway, one of which is located in the town of Irondequoit, New York.

Brent Rudolph of the State University of New York, Syracuse, and two of his colleagues recently reported on work in Irondequoit. Specifically, they present effort required to treat individual deer and assess the potential of the technique to control population growth of free-ranging deer in a suburban community.

Forty-seven female deer were captured and tagged in 1997 and 1998 in the 43-km^2 study area that had about 400 deer. These investigators found an inverse relationship between deer density and capture effort (defined as time to capture deer by immobilization with a mixture of ketamine-xylazine using a dart rifle at ranges up to 35 m). At 10 deer/km^2 average capture time per deer was 20.8 hours, whereas at 30 deer/km^2 the average was 9.6 hours.

Treatment time to apply PZP remotely with a dart rifle depended on deer density, approachability, and access. Some deer were easy to approach and those animals got treated first. Treatment time increased as more deer became treated because deer difficult to approach tended to be treated last. Use of radiocollars helped to reduce treatment time by improving the efficiency of locating deer that needed to be treated. With radiocollars, average time to treat the first deer was 0.34 hours and for deer number 20, 1.11 hours. Comparable figures for treating deer without radiocollars were 2.77 hours and 8.98 hours. Access to deer as an influencing factor affecting treatment time involved things like lack of cooperation among landowners, type of vegetation, and features like playgrounds and traffic.

With regard to controlling population growth, these investigators estimated effort involved using immunocontraception in conjunction with culling and secondly use of immunocontraception alone. To maintain a population of 512 animals in 2003, 3106 hours would need to be expended over the 4-year time period 1998-2001. This estimate assumes no use of radiocollars and treatment efficiency of 70% (70% of deer vaccinated remotely with dart gun do not produce young). Under this scenario, 129 animals would have to be culled from the population. With use of radiocollars, the population could be maintained at 474 individuals in 2003 by culling 97 animals and expending 3154 hours of effort.

Considering immunocontraception alone (no culling), the authors cautiously estimate that to maintain a publicly acceptable deer population in Irondequoit would require a minimum of 1000 hours of effort per year. The uncertainty in this figure is due largely to the fact that the researchers captured and treated only 47 female deer, far fewer than would be necessary to manage the townwide population. "Radiocollars can reduce effort and may pay for themselves through decreased personnel time." This editor believes that, as more immunocontraception studies are published, estimates of effort and effectiveness will be refined and a better understanding will emerge of the applicability of the technique for managing urban-suburban deer populations.

Reference: Rudolph, B.A., W.F. Porter, and H.B. Underwood. 2000. Evaluating immunocontraception for managing suburban white-tailed deer in Irondequoit, New York. *Journal of Wildlife Management* 64:463-473.

Fish Community Structure in Berlin, Germany

Researcher Christian Wolter of the Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany and three of his colleagues recently reported the effects of human influence on fish community structure and fisheries in Berlin. Work was based on a fish monitoring program begun in Berlin in 1992, review of fisheries statistics since 1952, and review of historical records of fish assemblages in Berlin waters. Water courses in Berlin total some 5700 ha (6.4%) of the city. The main water bodies are the Spree and Havel rivers, both of which are impounded and make up about two-thirds of the water area. Since the 13th century, Berlin waters have been impacted by shipping, hydraulic engineering, pollution (including high nutrient loading), and recreation. These impacts have caused a decline in riverine species and an increase in species tolerant of variable environmental conditions.

Thirty-three species comprised the original fish assemblage in post-glacial Berlin waters. By the 1990s, the fish assemblage had changed greatly. Seven species were extinct, including the Atlantic sturgeon (*Acipenser sturio*) and Atlantic salmon (*Salmo salar*), and 10 non-native species had been introduced, including goldfish (*Carassius auratus*), common carp (*Cyprinus carpio*), and rainbow trout (*Oncorhynchus mykiss*). The authors identified two faunal breaks. The first was due largely to river damming beginning in the 13th century and continuing through the 19th century. This created fish migration barriers (and extinction of anadromous species) and loss of typical riverine habitats. The second break occurred in the 1960s and 1970s with eutrophication of waters. High nutrient loads have resulted in increased abundance of species tolerant of eutrophic waters (common bream *Abramis brama*, silver bream *Blicca bjoerkna*, roach *Rutilus rutilus*, and perch *Perca fluviatilis*, which now make up 85% of the fish community).

Changes also have occurred in fisheries yield. From the end of the Second World War to 1960, "coarse" fish like roach, common bream, and perch were caught for human consumption. However, consumer tastes changed in the 1960s, with preference for salmonids and sea fish over freshwater fish. With decreased market demand, coarse fish populations increased.

In the early 1980s, the Berlin Fishery Board began implementing a water quality management program. Sewage treatment plants were reconstructed and as a result, phosphate input has decreased by more than 90% since 1986. The program also includes increased removal of coarse fish for an enhanced growing environment for more desirable species. Since 1995, increased abundance of more desirable asp (*Aspius aspius*) and ide (*Leuciscus idus*) has been noted. Also, increased fishing pressure on coarse fish (low market value) has been subsidized by the Berlin government and has resulted in faster growth rates for roach, common bream, and silver bream, and the bigger fish are of greater interest to recreational anglers.

Reference: Wolter, C., J. Minow, A. Vilcinskas, and U.A. Grosch. 2000. Long-term effects of human influence on fish community structure and fisheries in Berlin waters: an urban water system. *Fisheries Management and Ecology* 7:97-104.

Biodiversity Concepts and Urban Ecosystems

Research has shown that personal experience with nature in everyday life creates sensitivity to environmental issues. Thus, with increased urbanization, the nature of urban ecosystems becomes more and more important in shaping people's views and attitudes toward the natural world.

Jean-Pierre Savard of the Canadian Wildlife Service and two of his colleagues argue that biodiversity concepts should be applied to management of urban ecosystems. According to these authors, biodiversity concerns of most importance are threefold: 1) those related to the impact of a city on adjacent ecosystems, 2) those dealing with how to maximize biodiversity within the urban ecosystem, and 3) those related to management of undesirable species. They review some important concepts and the value of local and landscape attributes for birds, and identify approaches and activities to enhance urban bird diversity.

Biodiversity concepts discussed by Savard and his associates are 1) hierarchy of sale, 2) role of species in the community and species preference by people, and 3) habitat fragmentation-habitat quality. With regard to scale, biodiversity may be considered at the genetic level, species level, or community level. The authors focus on species and community biodiversity. Increasing spatial scale within the urban environment might focus on individual lots, sectors (e.g., industrial, commercial, residential, recreational), city, and adjacent landscapes. Temporal scale (e.g., season, time of day) also is important to consider.

With regard to species, a focus on "umbrella species," those at the top of food chains or ones having large home ranges, would indirectly benefit species lower on the food chain and those with smaller home ranges. A focus on "flagship species," those highly charismatic, might well help to gain public support for conservation efforts.

Habitat fragmentation and habitat quality are enormously important considerations. Vegetation corridors linked to the countryside can help to reduce fragmentation and maintain urban biodiversity. Stream corridors, greenways, and vegetated residential areas also are important in this regard. Habitat quality is positively related to the extent of vegetated areas. In addition, spatial heterogeneity of vegetation and its complex vertical structure and diverse species composition result in higher bird richness. To enhance urban bird diversity one could:

"1. Examine the countryside surrounding the city and secure or restore important bird habitats that may act as a source of birds for the city; establish a greenbelt around the city.

"2. Identify and consolidate vegetation corridors linking these areas to the city and link parks whenever possible; make use of natural streams and right of ways.

"3. Increase the volume and diversity of vegetation in the city (along streets, right of ways, industrial, commercial and residential sectors).

"4. Exploit and enhance the features of some parks that may attract particular species of birds.

"5. Increase the structural diversity of vegetation in natural and recreational parks of the city.

"6. Plant conifers and fruit trees to provide cover and food for birds; promote the night blackout of tall buildings during bird migration and encourage architecture that minimizes bird collisions.

"7. Erect special nesting structure for cavity or cliff nesting species (nest boxes for owls, chimneys for swifts, nesting platforms for falcons or storks).

"8. Encourage homeowners to manage their property for birds, to restrain their pets and to minimize the use of pesticides and herbicides.

"9. Distribute guidelines as to the proper planting of trees and shrubs to attract birds.

"10. Maintain bird feeders, nest boxes, bird baths in backyards."

These authors conclude that "Enhancement of biodiversity in urban ecosystems, if well done, can have a significant and positive impact on the quality of life and education of the increasingly growing urban population and thus, indirectly facilitate the preservation of biodiversity in natural ecosystems."

Reference: Savard, J.-P. L., P. Clergeau, and G. Mennechez. 2000. Biodiversity concepts and urban ecosystems. *Landscape and Urban Planning* 48:131-142.

Restoring Urban Habitats

The process of urbanization alters landscapes and greatly impacts native species of plants and animals. Nonetheless, metropolitan areas retain sizeable areas of open space lands and waters and there is considerable opportunity to better manage such lands.

Researchers Roberto Lindig-Cisneros and Joy Zedler of the University of Wisconsin-Madison are interested in this subject. They distinguish between reclamation and restoration of habitat impacted by urbanization with three examples in a recent issue of *Ecological Restoration*. Example one is the Lake Texcoco project, an 8200-ha reclamation effort within a former natural lake bed of the Valley of Mexico at the northeastern edge of Mexico City. When the conquistadors arrived in 1519 there were six interconnected lakes in the area. The lakes were slowly drained over the years and by the beginning of the 20th century the lake system was almost completely gone. Logging and cattle raising in the surrounding area increased flooding, so to reduce this impact, drainage canals were built to the north. Thus, by 1960, the former bed of Lake Texcoco encompassed 8200 ha of dry saline ground, often creating major dust storms that were particular problems for Mexico City and its airport.

Reclamation efforts at Lake Texcoco began in the early 1970s. Plans called for the creation of five retention basins and one lake, construction of erosion control structures, and reforestation with both native and exotic plants. These measures were designed to reduce peak stormwater outflows, control erosion in the surrounding mountains, and to provide infrastructure to manage water resources. Two wastewater treatment plants were built to discharge secondary-treated wastewater into the constructed impoundments. The impoundments would serve as wildlife habitat, especially for waterfowl, and would provide water for agricultural use.

Between 1976 and 1985 four reservoirs were constructed and 5200 ha of uplands were revegetated at Lake Texcoco. The dry and saline soils limited the number of species planted and few native species were included. These actions have reduced soil erosion and dust storms

in the area. The main water body, Lake Nabor Carrillo, attracts large numbers of waterfowl and four species have nested there: blue-winged teal, cinnamon teal, ruddy duck, and the endangered Mexican duck. Sixty-four species of birds other than waterfowl have been recorded, with estimates of more than 350,000 birds using the area in a single year. With regard to aquatic organisms, fewer benthic species have been recorded than found in natural lakes and dominants are pollution-tolerant species such as tubifex worms. Some native species of fish have been introduced.

The second example discussed by Lindig-Cisneros and Zedler is the University of Wisconsin-Madison Arboretum, which totals some 570 ha of the city and is surrounded by low-density housing, commercial development, and a golf course. In the mid-1930s efforts were initiated to restore prairie and other habitats. The 24-ha Curtis Prairie restoration project began in 1935 and now supports 170 species of prairie plants. Although prior to 1935 the site was used for agriculture, intact soils were maintained and these have allowed establishment of native plant communities. Fire was experimented with in the 1940s as a means of controlling woody invaders and exotics. This research helped to document the importance of fire in the ecology of tallgrass prairies.

The third example discussed by Lindig-Cisneros and Zedler is a wetland in the San Diego Bay region of southern California, where less than 10% of the original wetlands remain. There, the 128-ha Sweetwater Marsh National Wildlife Refuge contains the largest remnant wetlands in the area, plus two constructed wetlands. Between 1984 and 1990, a 12-ha salt marsh restoration project was constructed with goals of creating deep-water fish habitat for foraging by endangered California least terns, and marsh plains and channel edges for the endangered light-footed clapper rail. Cordgrass was transplanted for the rail in hopes of establishing nesting habitat. However, the cordgrass did not grow well due to sandy substrate and low nitrogen availability. It was too short to provide nesting habitat. Research now suggests that salvage and reuse of fine soil and excavation of tidal creek networks with micro-topographic relief will favor tall cordgrass. This is being tested further. In summary, native plants dominate the site now and many native animals use it as well, but the endangered rail does not nest there.

Habitat corridors (connectivity) to surrounding habitat is limited by urbanization in all three examples. This limits colonization and use by many species. Use of native species was emphasized at Sweetwater Marsh and the Arboretum, but not at Texcoco. The authors argue for reclamation projects to more closely approach restoration and state, "This can be done by facilitating the development of natural ecosystem processes, providing communities rich in native species, increasing the connectivity among habitats, and incorporating research into the restoration program. This approach may require more effort than reclamation, but it should also increase chances of sustaining species and processes that once existed."

Reference: Lindig-Cisneros, R., and J.B. Zedler. 2000. Restoring urban habitats: a comparative study. *Ecological Restoration* 18:184-192.

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Controlling Nuisance Canada Geese With Herding Dogs

In recent years, resident Canada goose populations have been increasing in many urban-suburban areas throughout North America. Typical human reaction has been enjoyment of a few birds at specific sites but dislike of them when populations become too large. Overabundant populations often become unwelcome when their droppings foul lawns, parks, playgrounds, golf courses, and waterways, and when they pose human safety concerns at airports.

Paul Castelli and Sheila Sleggs of the New Jersey Division of Fish and Wildlife recently reported on use of border collies to control nuisance geese at the Dow Jones & Company headquarters in central New Jersey, near Princeton. The 44-ha site has an extensive lawn area surrounding a 1.7-ha pond. Officials at Dow Jones were most concerned with potential safety hazards to passengers of daily helicopter flights and with goose droppings. The birds also were perceived as a general annoyance. In the summer of 1988, the chemical repellent methyl anthranilate was used in an attempt to move the birds elsewhere but the effort was unsuccessful.

Since the mid-1980s, some golf course managers in the state have used dogs to successfully chase geese from their grounds and so a "border collie program" was initiated in the fall of 1990. An underground electronic fence was constructed around the pond and 3.7-ha of surrounding lawn and a kennel placed within the fence. The plan was to purchase two dogs (providing competition as well as companionship to each other) and give them 24-hr access to the geese. The first two dogs purchased were not from working stock and were not effective in moving the geese. The second pair was from working stock and had a strong instinct to herd, although the dogs had received no training in obedience or shepherding. The initial cost of the program was about $9,400 ($2,400 for two dogs, $5,000 for fencing, and $2,000 for the kennel). Annual maintenance cost was about $2,000 from 1990-1997.

The border collies were effective in dispersing geese from the site and keeping the birds away. The dogs would herd the geese from the lawn area (feeding grounds) into the pond from which the birds would eventually fly to feed elsewhere. The goose population rapidly decreased from thousands of birds to a flock of about 100. Resident as well as migratory birds were dispersed and fewer numbers of resident geese attempted to nest at the site in subsequent years. After 3 years, few birds were present any time of year. Presence of dogs on site continually is believed to be largely responsible for the dramatic results obtained and company personnel were satisfied with the efficacy of the program. These results were obtained at a time when aerial surveys showed that fall and winter populations of geese were increasing in the region.

Based on experience with their program, Dow Jones officials suggested the following management recommendations:

"1) purchase a minimum of 2 adult dogs from proven working stock, preferably with prior experience with or exposure to live animals, particularly birds;

"2) dogs with intensive shepherding training are not necessary, but basic obedience training is recommended;

"3) for properties that are not fenced, use an electronic containment system to restrict dogs to the areas of concern;

"4) provide appropriate kennel facilities and ensure that food and water are available daily; and

"5) schedule one to 3 daily sessions, 15 to 30 minutes each, where dogs can be inspected, fed, socialized, and exercised even if geese are not present."

Castelli and Sleggs provide three additional recommendations. Firstly, a dog program should not be initiated during spring and early summer when birds are nesting, rearing young, and molting. Secondly, the planned program should be discussed with appropriate federal and state wildlife law enforcement personnel to ensure it is lawful. Thirdly, one should implement a

proactive informative effort before initiating a dog program in order to address people's concerns about care of the dogs and their effect on geese.

One should keep in mind that the technique discussed here represents a site-specific successful effort to manage nuisance geese. The dogs simply move the birds elsewhere and the program does not address the problem of goose overabundance on a regional scale. The authors concluded that "A border collie program, though costly, appears to be effective and suitable for many urban-suburban areas. However, in certain situations, such as residential areas, parks with continuous public use, areas bisected by roadways, and large water bodies, border collie use may not be appropriate."

Reference: Castelli, P.M., and S.E. Sleggs. 2000. Efficacy of border collies to control nuisance Canada geese. *Wildlife Society Bulletin* 28:385-392.

Urban Forest Reclamation

It is often desirable to speed up natural succession in urban habitat restoration projects. Research shows that birds contribute substantially in this regard to woodland succession by dispersing seeds through their digestive tracts. Use of elevated perches (from which birds defecate) and fruit displays (feeders) are helpful in promoting seed dispersal.

Researchers George Robinson of the State University of New York at Albany and Steven Handel of Rutgers University wonder if fleshy-fruited woody plants (serving as both perch sites and food sources) would do the same. They studied this issue on a degraded urban reclamation site in the Hackensack Meadowlands of New Jersey. The study area was about 15 ha of filled former marshland (abandoned landfill) surrounded by open water, roads, and freeways. Because of thin soil, additional substrate was added and topped with composted leaf mulch. The site was then sown with a commercial annual grass mixture to reduce erosion and to control weeds. Woody plants within 50 m of the site were sparse. Most abundant were native red-berried mulberry (*Morus rubra*), smooth sumac (*Rhus glabra*), and elderberry (*Sambucus canadensis*), and non-native tree-of-heaven (*Ailanthus altissima*).

In the fall of 1991, Robinson and Handel experimentally added 10 species of native trees and shrubs to the site. Plants were selected on the basis of good fruit production and availability throughout the year. For example, black cherry (*Prunus serotina*) was selected for mid-summer fruit production, arrowwood (*Viburnum dentatum*) and grey dogwood (*Cornus ammomum*) for late summer fruiting, and winged sumac (*Rhus copallina*) for availability throughout winter.

These investigators found that plots with planted trees and shrubs had higher recruitment of new woody plants than did unplanted plots, due primarily to differences in avian-dispersed seedlings. Seedlings originating from avian-dispersed seeds were located primarily around the experimental planted plots, indicating an attractive function of the experimental plantings. Forty-eight bird species were recorded on the study site, 34 of which were potential seed dispersers. However, the authors cautioned that the association of birds and dispersed seed was by inference only. They had no direct data to support their speculation.

The experimental plantings themselves did not serve well as recruitment sources. Most new seedlings came from peripheral species and the authors pointed out the importance of having seed sources nearby. This applied also to wind dispersed seeds, which were more likely on the periphery of the site and not associated with the experimental plantings.

With regard to planting small or large stock, the authors stated, "Plots with taller, more massive plantings had higher recruitment rates, but only at the end of year one. Larger plants are more costly, more difficult to install, and more vulnerable to transplant shock. In this particular setting, the combination of exposure to strong winds and the unnatural substrate may have stressed larger plants disproportionately. Therefore, given these disadvantages, the modest benefits seem insufficient to outweigh the practical value of using smaller plants."

In conclusion, Robinson and Handel stated, "Our study shows that basic ecological processes can be directed to supply woody plant recruits even in a degraded urban setting."

Reference: Robinson, G.R., and S.N. Handel. 2000. Directing spatial patterns of recruitment during an experimental urban woodland reclamation. *Ecological Applications* 10:174-188.

Predation on Bird Nests in Sydney, Australia

Biologists are keenly interested in better understanding how humans affect predators and predation in the natural world. Research is contradictory with regard to predation rates along habitat edges compared to the

interior of habitat patches. Some work shows greater predation near or along edges, whereas other studies show no such effect. A body of research reflects greater predation in small habitat fragments compared to large fragments.

Alison Matthews of the University of Sydney, Australia and two of her colleagues are interested in this subject. They recently studied nest predation rates in different-sized bushland fragments and at different distances from fragment edges within metropolitan Sydney. These investigators also identified nest predators in the urban bushland fragments.

Matthews and her colleagues studied nest predation in 24 bushland sites. The habitat was characterized as open dry-sclerophyll forest bounded mainly by roads and housing. Eight study sites were classified into each of three size categories: 0-10 ha, 11-100 ha, and >100 ha.

Artificial nests were constructed from a halved tennis ball covered with coconut fiber and lined with Australian pine (*Casuarina*) needles to imitate nests of the eastern yellow robin (*Eopsaltria australis*), a common passerine bird of the area. Nests were secured with fine wire to an upright tree branch 175 cm to 200 cm above the ground.

Eggs were formed from non-toxic modeling clay in a mould that matched the size and shape of robin eggs. They were colored blue-green and speckled with a brown pine stain. Each egg was threaded with twine and tied to the nest to reduce the chance of removal by a predator. Twenty nests, each with 2 eggs, were placed in each of the 24 study sites during late June to early September 1994 (breeding season in the area occurs late July to late January). Nests were spaced at 50 m intervals. At four sites for each size category, nests were placed around the site perimeter (within 50 m of the edge), and at the remaining four sites for the habitat size category, nests were placed toward the center of the patch (more than 50 m from the edge, with some nests several hundred meters from an edge). After 15 days, nests and contents were collected. Nests were considered depredated if one or both eggs were damaged or removed. The predation rate was calculated as the proportion of total nests that were depredated.

Matthews and her associates found that the rate of predation varied from 45% to 100% for the various study sites, with an overall rate of 70.6%, which was considered high. No significant difference in predation was noted among the three size classes of habitat nor between "edge" nests and "interior" nests.

Birds accounted for some 62% of predated nests and mammals 9%, with 29% of predation undetermined. Based on tooth marks and behavior, major mammalian predators were black rats (*Rattus rattus*), brown antechinus (*Antechinus stuartii*), and ringtail possums (*Pseudocheirus peregrinus*). No significant difference was noted in the composition of bird and mammal nest predators in different-sized habitat fragments. The high proportion of bird predation is supported by other studies in the area.

The authors point out that predation on artificial nests may not accurately simulate natural predation. Some studies show that predation is similar for both circumstances, but others show that predation on artificial nests is either higher or lower than predation on natural nests. In the present study, the predation rate on artificial nests was higher than predation on natural nests for the eastern yellow robin in the area based on work of others. Nonetheless, researchers consider the use of artificial nests useful in studying the kinds of questions posed in the present study.

Reference: Matthews, A., C.R. Dickman, and R.E. Major. 1999. The influence of fragment size and edge on nest predation in urban bushland. *Ecography* 22:349-356.

More on Nest Predation

A sizeable base of research exists on bird-habitat associations in the urban environment. Consequently, a fairly clear pattern exists of how urbanization alters the species composition of bird communities. Less is known about predation pressures in such environments. Some biologists speculate that predation might be higher in urban areas because of greater numbers of exotic predatory species. On the other hand, others argue that predation might be lower because of lack of natural predators. Jon Gering and Robert Blair of Miami University, in Oxford, Ohio are interested in these questions and recently measured relative predation pressures on artificial bird nests along an urban gradient in and around Oxford. Study sites, ranging from exurban to urban, included a nature preserve, a recreational area, a golf course, a mature residential community, an apartment complex, and a business district. The percentage of area covered by pavement and buildings declined from the business district to the golf course (no pavement or buildings were in the recreational area or nature preserve). Conversely, tree and shrub cover and percentage of area covered by lawn showed an opposite pattern (with no lawn in the recreational area or preserve).

During the 1996 and 1997 nesting seasons, 16

artificial avian nests were placed at each of the six sites. Nests were 12 cm x 8 cm in size and cup-shaped to resemble nests of passerines. At each site, eight nests were placed on or near (<10 cm height) the ground and eight were placed about 2 m above the ground in tree crotches. Two Japanese quail eggs were placed in each nest. Twelve days after placing eggs, nests were revisited and classified as depredated or undisturbed.

In 1996, 95 of 96 nests were revisited and 49% were depredated. For 1997, all nests were revisited and 46% were depredated. The pattern of predation showed an overall decrease from the natural site to the urban sites in both years. No difference in nest predation was noted between ground nests and tree nests.

Gering and Blair also conducted breeding bird surveys to estimate bird densities at study sites during the 2-year study. Birds were classified as urban exploiters (e.g., European starling, rock dove, house sparrow), urban avoiders (e.g., ovenbird, red-eyed vireo, white-breasted nuthatch), or suburban adaptable (e.g., brown-headed cowbird, blue-gray gnatcatcher, yellow-breasted chat). Densities of urban exploiters were 2-8 times the densities of urban avoiders or suburban adaptable species. The authors speculated that decreased predation pressure noted at the urban sites may contribute to the higher urban densities noted, but other factors also may be important in that regard—like adaptable life-history characteristics of urban exploiters. The authors cautioned that other areas may show different patterns due to geographic differences in landscape attributes and predator assemblages. Also, small-scale habitat features may influence predation rates. For example, some studies show that nests closer to habitat edges are predated at higher rates than other nests.

Gering and Blair point out that artificial nest studies do not necessarily accurately reflect predation rates of natural nests. Artificial nests differ in appearance and they have no parental activity around the nest. Also, the short duration of studies may not account for annual changes in abundance of nest predators. Nonetheless, these researchers conclude that "The frequency of predation events showed an overall decrease from natural to urban sites. Predatory relaxation in urban environments may partly explain the high densities of urban exploiters in urban environments. Future studies should examine the spatial variation in urban areas and geographical variation in ecological processes to enhance our understanding of how urbanization influences ecological patterns and processes."

Reference: Gering, J.C., and R.B. Blair. 1999. Predation on artificial bird nests along an urban gradient: predatory risk or relaxation in urban environments? *Ecography* 22:532-541.

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Urban-Nesting Peregrine Falcons

There has been some concern among biologists that removal of the peregrine falcon from the endangered species list might lead to removal of nest boxes and trays from buildings, bridges, and power plant smokestacks (a high percentage of urban falcon nests are found on these structures in the eastern United States). Researchers Mark Martell, Jennifer McNicoll, and Patrick Redig of The Raptor Center at the University of Minnesota were interested in this issue and conducted a survey of 19 eastern states and the District of Columbia to gain insight into the subject. These investigators identified all known urban, man-made nest sites in the region, focusing on buildings, bridges, and utility company smokestacks with occupied nest sites in 1998. Phone interviews were conducted in early 1999 with 75 site contacts to inquire about falcons and their removal from the endangered species list, and about the future of these urban nest sites. Site contacts were individuals responsible for making decisions about the future of nest boxes/trays and maintenance of peregrine falcons.

Site contacts provided information on 95 of the 117 identified nest sites. At 75 of the sites, nest boxes/trays were available to the birds. Martell and his associates found that peregrine falcons were widely appreciated and accommodated at man-made nesting sites by owners, managers, tenants and the general public. "Positive" feelings about the birds were noted at 82% of sites. The most-often mentioned positive effect was "employee and tenant enjoyment." Minor problems were noted at 26% of sites. The most-often mentioned negative effect was "re-scheduling painting or maintenance." At only one site did the contact individual indicate that the box would be removed if the bird was no longer on the endangered species list. At six sites, contacts were uncertain whether or not boxes would be retained.

From these results, Martell and his colleagues concluded that removal of the peregrine falcon from the endangered species list would not result in widespread loss of nesting boxes and trays from urban nesting sites. They cautioned, however, that "It is important to note that site owners, managers and tenants will change and the attitudes we encountered during our survey are not guaranteed to prevail over time. Almost every site contact we spoke with related some accommodation that was being made for peregrines at their site that involved time, money or inconvenience. Reducing the number and impact of these accommodations, while keeping a positive aura around urban falcons, will be a challenge that must be met if current Peregrine Falcon numbers are to be maintained or increased."

Reference: Martell, M.S., J.L. McNicoll, and P.T. Redig. 2000. *Journal of Raptor Research* 34:126-132.

Impact of Overabundant Deer Populations on Forest Birds

There is considerable concern about the impact of overabundant white-tailed deer populations in many urban-suburban areas, particularly in the eastern United States. For some time, biologists have speculated that high deer numbers, by overbrowsing available vegetation, negatively impact many forest-dependent bird species, particularly ground- and low shrub-dwelling species. In a recent paper published in *Conservation Biology*, William McShea and John Rappole of the National Zoological Park's Conservation and Research Center, Front Royal, Virginia provide evidence of such impact. These investigators established eight study sites within large forested tracts of Shenandoah National Park and the nearby Conservation and Research Center. The forest consisted of mature oak, hickory, white ash, yellow poplar, and understory shrubs of flowering dogwood, spice bush, and redbud. Study sites were 4 ha in size each and separated by at least 1 km. All woody plants >1 m in height and <4 cm in diameter were identified to species and counted in three 24 x 24 m quadrats at each site, and vegetation density was estimated with a cover board each July. Half of the sites were fenced in early 1991 to exclude deer but not small to medium-sized vertebrates. No deer hunting was allowed on either property and deer

density estimates remained high (>25 deer/km^2, about twice the state-wide estimates) throughout the study period.

Breeding birds were surveyed with mist nets from dawn to dusk on three consecutive days between 30 May and 30 June each year. Birds were identified to species and leg banded. Only the first capture of each individual was counted during each breeding season. Birds were placed in guilds based on migration (resident, migrating within the continental U.S., or migrating to South or Central America) and nesting (nest placement <2 m above ground, >2 m above ground but below canopy, or in the canopy) characteristics.

Exclusion of deer increased the density and species richness of understory woody shrubs over the course of the study. In response, bird species composition changed over the 9-year study period. Species responding positively to vegetation changes following deer exclosure tended to be migratory species considered most in need of conservation (e.g., hooded warbler, ovenbird, wood thrush). Species declining following exclosure tended to be resident species with stable to increasing populations nationally (e.g., tufted titmouse, blue jay, northern cardinal, Carolina wren). McShea and Rappole concluded that "Populations of deer in protected areas are capable of causing significant shifts in the composition and abundance of bird communities. These shifts can be reversed by increasing the density and diversity of understory vegetation, which can be brought about by reducing deer density."

Reference: McShea, W.J., and J.H. Rappole. 2000. Managing the abundance and diversity of breeding bird populations through manipulation of deer populations. *Conservation Biology* 14:1161-1170.

Breeding Birds in Japan

Yosihiro Natuhara and Chobei Imai of the Osaka City Institute of Public Health and Environmental Sciences, Japan are interested in bird use of planted woodlands in the city and the use of statistical models for predicting species richness of birds in urban woods that would be useful in urban planning. They studied breeding bird use of 28 urban parks ranging in size from 0.06 ha to 43.4 ha. Bird records for the parks were based on previously published work of the authors as well as work of other researchers. Environmental variables studied included woodland area, woodland elongation (length to width ratio), percent of woodland area and percent of field area within 25 km^2 of study site boundaries, and distance to the nearest forested mountain (8,200 ha to 64,700 ha in size) and to the nearest woods greater than 10 ha.

Variables that emerged as most important in explaining species richness were woodland area and shape (larger and more compact areas better), percent of woodland area within 25km^2 of study boundaries (the more the better), and distance to mountains (shorter distance better than longer distance). Seven species were recorded in the smallest woodlands (less than 2 ha) compared to 15 species in woodlands greater than 20 ha. The authors concluded that, "Avifauna in urban areas is influenced by area and shape of habitat, % of woodland of the surroundings, and distance to the mountains. Among these, area is the most important factor."

Reference: Natuhara, Y., and C. Imai. 1999. Prediction of species richness of breeding birds by landscape-level factors of urban woods in Osaka Prefecture, Japan. *Biodiversity and Conservation* 8:239-253.

Landscape Modification and Amphibian Populations

Many amphibian populations worldwide have been declining in recent years, alarming biologists and spurring research efforts into causes for population reductions. A combination of factors may be responsible for population declines, including habitat loss. Melinda Knutson of the Upper Midwest Environmental Sciences Center (U.S. Geological Survey) and five of her colleagues recently studied landscape-level habitat relationships for frogs and toads (anurans) in Iowa and Wisconsin. They focused on anuran relative abundance and species richness based on nighttime roadside call surveys and land cover maps for the two states. Survey locations were well distributed across both states but were selected subjectively by the volunteer observers. Surveys were conducted at study sites three times during the breeding seasons of 1991-1995, and species recorded were grouped into guilds based on preferred habitat.

Habitat associations for relative abundance and species richness were generally similar within a state. The most consistent result across all guilds was a negative association with the presence of urban land. Upland and wetland forests and emergent wetlands generally were positively related to anurans. Edges and patch diversity also were generally positive landscape features. These measures reflected a complex of habitats, especially wetland habitat and forests adjacent to wetlands. Forests are important in providing dispersal

corridors and habitats outside the breeding season for many species. With regard to the negative association between anurans and urban areas, the authors concluded that, "We need to investigate why urban areas have such a strong negative association with anuran relative abundance and richness, and we need to identify ways to improve habitat quality in areas of high human population density."

Reference: Knutson, M.G., J.R. Sauer, D.A. Olsen, M.J. Mossman, L.M. Hemesath, and M.J. Lannoo. 1999. Effects of landscape composition and wetland fragmentation on frog and toad abundance and species richness in Iowa and Wisconsin, U.S.A. *Conservation Biology* 13:1437-1446.

Urban Wetlands in Oregon

Over one-half of the original "naturally-occurring wetlands" (NOWs) have been lost in the United States as a result largely of agricultural and urban development. In recent years, society has better recognized the value of wetlands and has required that "mitigation wetlands" (MWs) be constructed to replace NOWs that are unavoidably lost to development.

Teresa Magee of Dynamac Corporation, Corvallis, Oregon and three of her colleagues are interested in how well the constructed MWs represent NOWs being lost to development in the Portland, Oregon metropolitan area. They recently characterized plant species richness and composition of the two wetland types in the area.

These investigators focused on small, palustrine wetlands (0.2 ha or less in size) because this was historically the most common wetland type in the Willamette Valley and currently is the most frequently destroyed. Forty-five NOWs and 51 MWs were studied. Vegetation was sampled from 22 June through 12 August 1993. Land use surrounding the wetlands was characterized along with wetland hydrogeomorphology, amount of open water, and age of MWs.

Magee and her colleagues reported a significant difference between the mean percent of native species in MWs (47%) and NOWs (43%). Likewise, mean species richness for MWs (41 species/site) was significantly higher than for NOWs (30 species/site). The total number of species recorded on MWs was 306 compared to 274 for NOWs. Only 14 species were found on more than one-half of the sites and nine of these were classified as invasive introduced species. Number of introduced species per site increased with more intensive land use in the surrounding watershed. The authors considered both wetland types to be degraded because over one-half of the species of each were introduced.

The floristic composition differed between MWs and NOWs. MWs had a greater mean percent cover of water during the growing season and often were large perennially flooded areas with expanses of open water bordered by a narrow vegetated area. Floristic composition was influenced largely by level of development in the area and age of wetland. NOWs, on the other hand, had emergent or wet meadow vegetation generally distributed continuously across a site—standing water was typically shallow and not ponded. Floristic composition was influenced largely by moisture gradient (from very wet to seasonally dry). Of secondary importance was intensity of land use in the surrounding watershed. Current wetland management practices are resulting in a cumulative shift in wetland types from wet meadows and marshes to ponds.

These authors point out that "The ecological significance of greater native species richness and the apparent increased frequency of common obligate and facultative wetland species in MWs (e.g., *Typha latifolia*, *Eleocharis* sp., *Juncus* sp., *Scirpus* sp., and *Salix* sp.) compared to NOWs is difficult to assess. The potential benefit to native biodiversity of greater native richness on MWs is confounded by the concomitant increase in the occurrence of invasive species, the limited spatial distribution of vegetation on MWs, the apparent influx of introduced species that may be occurring over time on the MWs, and by shifts in the relative abundances of wetland types across the region." In their opinion, "...the naturally occurring wetlands represent disturbed remnants of an increasingly rare wetland prairie ecosystem that historically was extensive in the Willamette Valley...or of marsh communities that were previously common in floodplain locations. Thus, NOWs with high native species richness or relatively intact assemblages may be critical for conserving or restoring native biodiversity, by functioning as refugia for native wetland species and local genotypes, and for preserving fragments of endangered or rare ecosystems." Further research is planned by the authors.

Reference: Magee, T.K., T.L. Ernst, M.E. Kentula, and K.A. Dwire. 1999. Floristic comparison of freshwater wetlands in an urbanizing environment. *Wetlands* 19:517-534.

Suburban Forests in Belgium

Factors influencing maintenance of native plant species richness in urban-suburban forests have not been well studied. Olivier Honnay and three of his associates of

the University of Leuven, Leuven, Belgium recently studied the role of forest size (patch area) and habitat diversity in this regard. Their study area was some 5,000 ha located 30 km north of Brussels, Belgium. All 55 deciduous forest patches in the area (average size 6.9 ha) were surveyed at least twice (May and August) for the presence or absence of 203 native forest plant species. Species lists generated from the fieldwork were supplemented with data from local nature conservation organizations.

Honnay and his colleagues recorded 116 plant species in the forest patches. Their research showed that patch size and patch age were most important in maintaining forest species. Degree of disturbance of forests (largely trampling of soil and herbaceous understory vegetation by humans) increased in smaller patches and correlated positively with exotic species invasion. In the present study, black cherry (*Prunus serotina*), native to North America and introduced in Belgium during the late 17th century and now widespread, showed such correlation. It was more abundant in smaller forest patches than in larger ones. Seed production is higher for trees on forest edges so smaller patches (with proportionately more edge) are subjected to relatively greater invasion pressure than are larger areas. Black cherry also was more abundant in young forests, which may be less resistant to invasions than older forests. Other researchers in the area have shown black cherry to have strong negative effects on plant species richness due to nutrient, water, and light competition. It also was negatively correlated with plant species richness in the present study. Thus, the present study indicates that potential threats to maintenance of native plant species richness in urban-suburban forests are decreasing forest patch area, increasing edge effects, increasing recreation pressure (human trampling of soil and herbaceous understory vegetation), and alien species invasion. The authors conclude that, "The results of this study point at the importance of patch area for native plant species richness in suburban forests in Northern Belgium. It is likely that the effect of patch area is working through increased disturbance and biological invasion...Habitat diversity measures are poor indicators for species diversity in these cases. In more disturbed suburban and urban areas, large forest patches may be necessary for plant species conservation as they are better buffered against disturbance and invasions by alien species."

Reference: Honnay, O., P. Endels, H. Vereecken, and M. Hermy. 1999. The role of patch area and habitat diversity in explaining native plant species richness in disturbed suburban forest patches in northern Belgium. *Diversity and Distributions* 5:129-141.

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