14 Urban Forests and Habitat Elements

New York, New Orleans, Boston, Auckland, Seattle. These are just few of the world's cities that developed in what were once forested landscapes. But now, that forest is gone and it has been replaced with roads, buildings, utility systems, and parking lots. Habitat lost, right? Well, yes, lost for some species, but not all. And with a bit of planning and forethought, even cities can provide habitat for a wide range of species, and even some of the same species that occupied the site before it became a city. Some habitat elements are provided serendipitously as a result of city development and others must be planned into the city system to ensure that they are effective, not ecological traps, and are sustainable. This chapter will focus on how an urban forester and a biologist can think collaboratively about providing habitat elements in the urban forest.

DEFINING URBAN FORESTS ALONG AN URBAN–RURAL CONTINUUM

Over half of the world's population lives in cities or in associated suburban areas. Less than half are now living in rural environments, a marked shift over the past 100 years. The problem is that the boundaries of cities are continually expanding as populations rise, and what was once rural is now suburb, and what was once suburb is now urban. A gradient of urban development radiates from an urban center and the boundaries of that gradient may be continually changing. So, not only are species adapted to more rural forest and farm habitat types displaced, but the probability that they will wander into urban areas from rural areas is quite high for many species. The further from the rural environments, the less likely that dispersers would be encountered, but regular reports of bears in suburbia make it clear that encounters between humans and animals we may consider associated with extensive forests are increasing. Indeed, these urban–rural interfaces are at the front line of those responsible for resolving human–wildlife interactions. Moose jams and moose–auto fatalities are all too common now in urbanizing parts of the northeastern United States.

The impact of human development on a landscape varies from minimal in many wilderness areas, to greater where forests are managed for economic gains but on long rotations, to greater on commercial timberlands, to greater where forests are cleared for agriculture, and still greater where agricultural and forested lands area converted into houses and roads, and finally into urban centers where the build environment dominates. Simply, human population density, though related to urban environments, is not always the best indicator of urban impacts on habitat elements. Building height and density, impervious surface percentage, and road densities may be better indicators of impacts on animals, and on the people who live there. Many suburbanites travel to rural areas to see wildlife, while others, who are unable or unlikely to travel or may be inner city residents, may seek parks and other open spaces to relax. Encountering wildlife may not be a goal for many urbanites.

Many people who live in cities or suburbs enjoy seeing animals in their parks or backyards, while others view them with fear or disdain. A raccoon sprawled on a branch on a summer afternoon, sleeping, may attract some urbanites with cameras, others to call the police concerned that it is rabid, and another calling animal control convinced that the animal has been the one raiding the trashcan and making a mess. Reactions to other species such as snakes, bats, coyotes, and cougars are even more extreme. So, although we can provide habitat elements in cities that will encourage species to cohabitate with us, is that what the residents want? Will they tolerate these species? Managing habitat in urban forests must engage the residents to know what they would like, and it must be adaptable because the residents of a community change their values over time. Once the hard social work is done to understand the goals and limits of tolerance for a community, then, the easy work begins in providing the habitat elements.

HOW SOME SPECIES INTERPRET THE "BUILT ENVIRONMENT?"

There are some species that do surprisingly well in cities. Peregrine falcons nest on ledges on cliffs, and forage out from that nest site to capture birds and small mammals. To a peregrine, skyscrapers and tall bridges are a sea of ledges on human-made cliffs. And all these pigeons (rock doves) and squirrels that people love to feed are scrumptious. What more could a peregrine want? Well, perhaps a few less cars and fewer bioaccumulated toxins (Park et al. 2011), but for the most part, peregrines in cities are doing quite well (Cade et al. 1996). Chimney swifts and Vaux's swifts are equally as adaptable to using masonry chimneys as nest sites (Rioux et al. 2010). Where did chimney swifts nest before there were chimneys? Hollow trees no doubt. White storks in Europe select chimneys and house roofs for nest sites too (at least until electrical utility poles were erected), but still occasionally nest in large flat-topped trees and snags. These species are taking advantage of serendipitous similarities between what humans build and the habitat elements that they used before humans built tall buildings and chimneys.

When humans build cities and suburbs, they bring with them the plants and animals that they enjoy having around them, including those species from other ecosystems that can become invasive. Many plants used in the landscaping industry have escaped and now create problems as invasive plants. Import of species that could be invasive is more carefully monitored now, but we are living with a legacy of imported plants and animals—European starlings and House finches in northeastern cities, pythons in Florida (Reed 2005), Monk parakeets in the eastern United States (Simberloff 2003), and many more. Some of these invasive exotic species become food for native species, but too often native species are displaced by the exotics, and there are extreme cases of this displacement in many parts of Australia where placental mammals were introduced and had devastating effects on mid-sized native marsupials. Unfortunately, cities become the focal points of spread for many of these invasive species or nonnative species that natives are not adapted to use.

Parking lots, roads, sidewalks, railroad tracks, rooftops, and compacted soil all preclude the growth of plants (unless they are designed to), and as such, form a maze of potential barriers to animal movement in a city. In addition to the risk of being run over by a car, any animal crossing an impervious surface has no cover from a predator such as a free-ranging pet dog or cat, peregrine, coyote, or red-tailed hawk. Hence, many patches of vegetation that could be managed to provide habitat elements are isolated in this maze of concrete and asphalt, unless active efforts are made to connect the patches. Tunnels under roads, riparian areas with greenway strips, and even wildlife overpasses are all possible, but expensive or impossible to retrofit into an urban area (Glista et al. 2009). The stepping stones of multiple backyards may be the most likely means of connecting larger patches for some species, and backyard habitat management is becoming increasingly popular (Palmer 2004). But for species that are inhibited by curbs, fences, and other barriers, such as salamanders and large mammals, corridor connections may be the most effective (Angold et al. 2006). Wildlife corridors, managed with appropriate habitat elements needed by the focal species, can also be urban greenways and simultaneously provide walking paths, bikeways, and other recreational opportunities (Teng et al. 2011). Urban foresters and wildlife biologists will need to team up with landscape architects and urban planners to design these multipurpose greenways. In doing so, and with an accompanying educational effort, more people in urban environments can be in contact with more wildlife species and raise the level of awareness around habitat management and species conservation.

FINDING SPACES FOR HABITAT MANAGEMENT

Greenways and wildlife corridors connect patches of habitat. But habitat for which species? Urban parks come in many forms, from those that are primarily used for athletic events, picnicking, and are highly manicured, to those that maintain a more full complement of native plants and other habitat elements important to native species. Spreading shade trees distributed over a manicured lawn may provide a habitat for mourning doves and gray squirrels, but not for species associated with shrubs, leaf litter, or dead wood. Parks containing a shrub layer, dead wood such as snags and logs, hollow trees, and few invasive plants are most likely to support a diverse animal community. These patches, if maintained as primarily native vegetation, can also act as an island from which plants and animals can disperse should a "new" habitat develop as a result of urban renewal and brownfields reclamation.

Habitat patches can also be found in some unexpected places. Green and brown roofs can provide a habitat for some species while also mediating stormflow and adding insulation to a building. Green and brown roofs may be important sites for invertebrate conservation and some species of nesting birds (Baumann 2006, Kadas 2006). Species richness in spider and beetle populations on green roofs is associated with plant species richness (Gedge and Kadas 2004). These findings have led some scientists to begin discussions with engineers to design green roofs to maximize biodiversity (Oberndorfer et al. 2007). Of course, there are limits to the types of plants that could be grown on some roofs, but increasing the diversity of native plant species including grasses, forbs, and shrubs, could substantially aid as a habitat for birds and invertebrates.

HABITAT ELEMENTS LIMITING SPECIES IN URBAN AND SUBURBAN SETTINGS

Even where there are opportunities to manage habitat elements in cities, some elements present logistical problems for urban biologists and foresters. Because humans are such a dominant part of the urban ecosystem, human safety becomes a primary consideration when designing urban areas for recreation and habitat. Dead wood, burrows, and shrubs are habitat elements that present special challenges.

Dead wood. Dead limbs on both living and dead trees are viewed by urban foresters as potential hazards to humans and their property, and consequently, whenever there is a chance that some or all of a dead, dying, or decayed tree or limb has a chance of falling on someone or their property, then it is removed. Of course, if the dead wood is removed before it has fallen, then there is no opportunity to recruit fallen logs into the urban environment. The challenge for urban foresters and wildlife biologists is to find places in the urban environment where the risk to people and property is low and dead wood resources can be maintained or created. For instance, if a tree has died and it is within 30 feet of a sidewalk, then topping the tree at 15-feet high would provide a short snag that could then be used by woodpeckers and secondary cavity nesters without significant risk to people or property. Indeed, I have colleagues living in suburbia who have created short snags that will not fall on their houses and that are used by primary and secondary cavity nesters, bats, and raptors as perches.

Similarly, there has been little effort to recruit fallen logs into urban environments. Usually, hazard trees are cut, small pieces are chipped, and large pieces are removed to landfills or other dump sites. Placement of these logs in parks, greenways, along streams, and in backyards can provide a habitat for reptiles, amphibians, and invertebrates (Guderyahn et al. 2010), probably at no greater cost than traditional disposal approaches.

Although the role of arborists in creating or removing habitat elements has been known for some time (Dunster 1998), very little is known about the use of dead wood in urban environments (Blewett and Marzluff 2005). As urbanization continues across our planet, there is an increasing need to understand the possibilities for providing key habitat elements within the matrix of the built environment.

Burrows. Although very little work has been done to understand the potential for supporting burrowing animals in urban and suburban environments, we can surmise that two factors would restrict the availability of burrow sites for mid-sized burrowing species: creation of expansive impervious surfaces and compaction of the remaining soil due to human and vehicular traffic. Indeed, increases in the impervious surface area that increases stormwater runoff can be expected to also have removed the potential den sites for burrowing animals (Arnold and Gibbons 1996). By 2004, the impervious surface area in the lower 48 states of the United States was enough to equal the land area of the state of Ohio (Elvidge et al. 2004). Add to that compaction in parks, playgrounds, and other areas with human and vehicular impact that few areas may remain for species such as woodchucks, burrowing owls, and gopher tortoises to live.

Shrubs. The shrub layer is important for many species of birds and mammals that either nest in the shrubs, use shrubs for cover, or eat the fruit, leaves, or twigs of the plants. In many urban areas, exotic shrubs can tend to dominate, but maintenance of native shrubs may be advantageous, at least for some species (Savard et al. 2000, Hostetler and Main 2010). But shrubs present a problem in a park. Many park managers will systematically remove shrubs and other cover, for humans, along trails and sidewalks. Unfortunately, due to the risk of muggings, rapes, and attacks, shrubs are not allowed in areas where people might be vulnerable to other people. Consequently, the management of a safe zone along walkways and paths may be needed, but shrubs could be allowed outside the safe zone. In Europe, habitat islands have been proposed where shrubs are a key component of the island (Fernández-Juricic and Jokimäki 2001), but connectivity among islands becomes challenging, especially once the built environment forms the matrix condition within which habitat islands are embedded. In most cities, we are retrofitting the habitat into an already-built environment. Only where urbanization is affecting rural environments along the urban fringe can we proactively plan islands and corridors. Within the existing city infrastructure, only a few possibilities remain for creation of new islands and corridors. One is to recover former industrial sites that are no longer used (brownfields reclamation) or incorporate habitat management into abandoned railways as part of rails to trail projects. Both approaches require a commitment of money and management to achieve habitat goals. Given the potential for environmental contamination of brownfields, additional concerns remain about the impacts on animals using these islands, especially if phytoremediation (using plants to uptake and hold contaminants) is used as a technique for sequestering contaminants (Bañuelos et al. 2002). Should contaminants accumulate in plants designed to take up contaminants and then animals feed on those plants, then we could easily create a biological trap for species using the newly created island. Again, little research has been done into this potential effect, though work on insects suggests that there could also be effects on herbivores and insectivores using these sites.

URBAN STREAMS AND WETLANDS

Urban streams and associated wetlands provide an opportunity to create connections and habitat patches for many species in urban and suburban environments. Unfortunately, many urban streams have been altered markedly as a result of years of changes occurring in the urban environment. First, and foremost, many urban streams are constrained or channelized to ensure that they do not erode land that is now part of the urban area. This may be as marked as concrete channels or may be large rocks along the bank (rip rap). No longer are many streams in urban areas allowed to meander and create channel complexity important to many aquatic species. In addition, due to the increase in impervious substrates in urban environments, any contaminants on those impervious surfaces are washed into the stream unless measures are taken to clean the water first. And because rainwater falling on impervious surfaces moves directly into the stormwater system and is not absorbed into soils, stream levels can fluctuate wildly following rains. In many cases, streams have become simply channels to move water away from the city as rapidly as possible rather than functional stream and riparian systems (Paul and Meyer 2001).

Restoration of degraded urban streams is a significant challenge. Site-specific local changes to the stream structure or riparian area are unlikely to be effective because the scale of impacts is basin wide. Consequently, changes to the drainage system must be approached in a more holistic manner (Walsh et al. 2005). This will involve multiple landowners with multiple objectives, as well as newly designed holding areas for stormwater that mediate peak flows in the stream. Palmer et al. (2005) proposed five guidelines for assessing the success of stream restoration:

1. The design of an ecological river restoration project should be based on a specified guiding image of a more dynamic, healthy river that could exist at the site.
2. The river's ecological condition must be measurably improved.
3. The river system must be more self-sustaining and resilient to external perturbations.
4. No lasting harm should be inflicted on the ecosystem.
5. Pre- and post-assessment must be completed and data must be made publicly available.

In addition, Jansson et al. (2005) proposed that the restoration plan is based on a conceptual model of a functional ecosystem agreed upon by all stakeholders.

Achieving success as indicated by these guidelines over the watershed is a daunting task that requires the managers to meet social demands with ecological goals. Including both riparian and in-stream conditions in the design of urban watersheds adds complexity to the problem but also adds significant value as a habitat and connections for many species of animals. Any plan will have constraints; cities will not tolerate flooding. Some landowners will prefer a manicured streamside, while others will want a wilder environment. Space is at a premium; so, unless the municipality buys lands for greenways, landowners may or may not be inclined to participate. An ecological restoration venture becomes a joint effort among sociologists, biologists, and politicians to achieve long-term ecological and social goals (Pickett et al. 2001).

URBAN EXPANSION, WETLANDS, AND MITIGATION

Regardless of how much planning is conducted and how much attention is given to habitat needs across an expanding city, urban growth replaces the rural habitat with impervious surfaces and buildings. The habitat for many species will be lost (McKinney 2002). More than 5% of the surface area of the United States is urban or suburban land use (USCB 2001). Further, McKinney (2006) suggests that because cities, regardless of where they are in the world, have commonalities in design and growth and tend to homogenize the biota associated with them (Figure 14.1). Consequently, McKinney (2006) argues that we should focus our efforts on native species, although that too can

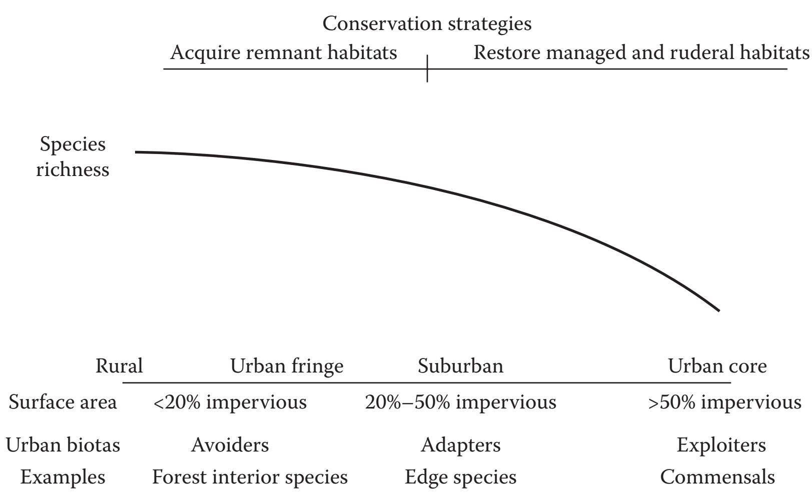

FIGURE 14.1 Generalized pattern of species diversity as a function of urbanization. (McKinney, M.L., Urbanization, biodiversity, and conservation, *BioScience*, 2002, by permission of Oxford University Press.)

be problematic unless we are sure that our management actions are contributing to increasing, and not declining, population fitness.

Documenting the rate of loss of a habitat for a wide range of species is important so that species that will need particular attention can be identified. The use of species-specific habitat models is most appropriate in that case, although the number of species that could be affected can be daunting to urban planners and conservation biologists. Consequently, Hasse and Lathrop (2003) suggested more generalized land resource indicators that could be used to monitor the conversion of land taken to urban development: (1) density of new urbanization; (2) loss of prime farmland; (3) loss of natural wetlands; (4) loss of core forest habitat; and (5) increase of the impervious surface. One of these, natural wetlands, has received considerable attention. Under Section 404 of the U.S. Clean Water Act, the United States has established a no-net loss of wetlands policy. Each year, approximately 47,000 acres of wetland mitigation are required to offset 21,000 acres lost (Kihslinger 2008). When developers are permitted to destroy a wetland, they must pay for restoration or creation of wetlands to offset the loss. More recently, developers can purchase habitat credits from habitat banks that are established as new wetlands for the specific purpose of establishing a market for those developers in need of credits. Semlitsch (2008) has extended this idea to that of conservation banks where credits can be purchased for the restored or created habitat designed to replace that which has been lost. Such an approach considers not simply the acreage of wetlands mitigated but also the context for that wetland that is more likely to make it functional for more species. Fox and Nino-Murcia (2005) reported that there were 35 official conservation banks covering nearly 16,000 ha in 2003, which provided a habitat for at least 22 species listed under the U.S. Endangered Species Act. Nearly all conservation banks were established based on monetary return, with most of for-profit banks that are breaking even or making money (Fox and Nino-Murcia 2005); in 2003, credit prices ranged from $3000 to $125,000/0.4 ha (1 acre). The approach of conservation banking has also been adopted in other countries (Briggs et al. 2009).

MANAGING TREES, PARKS, AND FORESTS IN URBAN SETTINGS

Vegetation in most parts of most urban areas must be managed. Liability issues arise to landowners and public safety offices if certain actions are not taken. For instance, if a tree owner has knowledge of a hazard, he or she is required to address the danger posed by the tree (Mortimer and Kane 2004). Similarly, municipal park managers must do everything that is reasonable to protect people using bikes and trails from the risk of falling trees, limbs, or people who might attack other people. Consequently, many areas in urban environments will lack dense shrubs, or dead trees, or hollow trees simply due to the liability that landowners face by having them present. Different landowners are more or less willing to accept potential risks; so, few areas removed from human or vehicular traffic become few areas in a city where these habitat elements can be retained or recruited. Geographic information systems (GISs) provide a means of identifying these potential areas for habitat management. By buffering on all roads, sidewalks, buildings, and trails, the remaining patches have the potential as sites for management. Even after they are identified, it will be the decision of the landowner as to the risk that she or he is willing to incur.

What constitutes a tree that presents a hazard? Many aspects of a tree contribute to its potential to cause harm. Dead limbs certainly can be hazardous, but are also an evidence of decay, lean, height, and species, to name a few. A trained arborist can identify trees based on a set of characteristics (Matheny and Clark 1994), and given the liabilities involved, homeowners often contact arborists for an assessment of risk. Once the landowner is apprised of the risk, then they must conduct their own risk assessment and decide if the risks justify the expense of tree removal or pruning (Ellison 2007). Knowledge of habitat benefits could influence a landowner's decision in some cases.

Even when areas are found where habitat elements can be provided, we need a better understanding of the function of the habitat patch. Avoiding creation of habitat sinks in urban areas should be considered. Creating habitat elements and patches and having species use the patches in urban areas does not necessarily mean that the population is sustainable. For high-priority species, some evidence of reproductive rates and survival is needed to ensure that individuals who would otherwise be successful in rural patches are not attracted to urban patches simply to be unsuccessful. Indeed, the risk to many species of being killed from cats, dogs, rats, and vehicles is much higher in urban and suburban areas than in other habitat types. Should the reproductive or survival rates for species be very low in these urban patches, then the patches could be ecological traps, attracting animals to what may seem to be suitable habitat, but the population fitness is so low that over time, the population declines. Ideally, large patches connected by wide corridors may prevent ecological traps from occurring, but both these conditions are extremely rare, and very expensive in cities.

SUMMARY

Urban and suburban areas are often simply written off as habitat loss, but through serendipity more often than planning, some species do find a suitable habitat in developed areas. Active planning in cities to provide the habitat elements important to species that can use urban forests is rare but can aid in adding to the diversity of organisms sharing urban environments with humans. By integrating habitat elements into planning for urban parks, greenways, riparian areas, and new suburban developments, a habitat can be provided for a wide range of forest-associated species. Particular attention to those habitat elements that are often removed for safety purposes, such as dead wood and shrubs, can cause urban forests to meet the needs for a broader range of species than we typically find. Further, the use of green roofs, planting native trees and shrubs, and promotion of backyard habitat plans can add an additional urban habitat for shrub- and tree-associated species. Active management of urban areas for wildlife conservation is an area that has received very little attention and research is desperately needed.

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