1

The Science of Cities

Urban Ecology

Few people associate nature with cities, and most would admit to little knowledge of urban ecology or to any understanding of natural processes in urban areas. Yet many city dwellers appreciate the trees, parks, rivers, and lakes in their city, professing a personal attachment to green spaces and the sense of place they create (fig. 1.1). People also understand intuitively that good things come from nature; some are life-sustaining, such as clean air and water; others are benefits that make their city more enjoyable, such as cooler temperatures and opportunities for recreation. These ecosystem services associated with nature in cities make them livable, healthy, and beautiful. While cities are human-made and primarily anthropogenic (human) biomes, humans are not the only inhabitants. Many other animal and plant species live in urban areas, and most people can and do express the enjoyment and feelings of care and concern they have for them, acknowledging the emotional and psychological benefits. This concern was expressed by the citizens of Melbourne, Australia, when the city assigned every tree an email address and asked citizens to email any issues with the trees. The unexpected and delightful result was the number of love letters written to trees in the emails. People thanked trees for all they do for them, wished them well, expressed concern for their health, hoped that no harm would ever come to them, and sometimes just simply wanted to say hello and express their love for the trees (LaFrance 2015).

The Coupled Relationship between Humans and Nature

Ecology of urban areas concerns three interconnected systems that create a city—the natural environment, including soils, water, vegetation, wildlife, and climate; the built environment, including roads and buildings; and the social environment, including people and their activities. The

FIGURE 1.1. London, England: a tree for hiding and climbing to "get away from it all" in a downtown London park.

natural world, of course, does not need buildings or roads; but people do, and it is their needs that create the "urban" in urban ecology. People are the dominant element in the ecology of urban areas, which is why recognizing the social environment is important. The social side of urban ecology considers our beliefs and behaviors, how we value nature, our attachment to nature, why we need nature, and how we create and care for natural urban environments. Urban ecology also considers how we design and build human-made natural areas, with a focus on our design choices and the natural elements we use to create parks, yards, gardens, and stormwater features. And finally, urban ecology is also a field of study that looks to the future, advocating environmental solutions to create sustainable cities with equitable ecosystem services for all city dwellers.

The international scientific journal *Urban Ecology* defines urban ecology as "the study of ecosystems that include humans living in cities and urbanizing landscapes. . . . the term, urban ecology, has been used to describe the study of humans in cities, of nature in cities, and the coupled relationship between humans and nature." (Urban Ecology Field Station 2019). As a field of study, urban ecology is about ecology *in*, *of*, *and for* cities that considers the impact of humans on the environment. Urban ecology is unique from natural ecology in that humans highly impact ecology by

disturbing soil composition, removing and planting vegetation, changing water flows, reducing air quality, and introducing non-native species. In addition to traditional ecological considerations, urban ecology includes social, cultural, economic, and development pressures. As a result, urban ecology is a multidiscipline field that can play a significant role in improving cities at this defining moment when climate change, growing population, migration, cultural shifts, and economic stressors are challenging sustainability and resilience of cities (McPhearson, Pickett et al. 2016, 199). Resilience and sustainability are concepts that describe the ability of cities to improve their economy, adapt to increasing populations, protect their natural resources, and survive extreme weather events while continuing to meet the needs of inhabitants and maintaining livability. To be sustainable a city must be forward looking, balancing economic, ecological, and human well-being today and for the future. The goal to provide for future populations requires an understanding of the importance of maintaining biodiversity and ecosystem processes to ensure ecosystem services and ensure the continued health of nature and people.

City Nature

People may have the perception that cities are devoid of nature, but to rephrase a quote from the book *Life of Pi* by Yann Martel, "you might be amazed at the animals that fall out if you turned a city upside down and shook it." Squirrels and birds, racoons and rats, frogs, dogs and cats (fig. 1.2), even lizards, snakes, and alligators might fall from the city (Martel n.d.). These animals have become city dwellers; many thrive in cities, adapting quite well to unique food sources and habitats for shelter. Other animals are in cities, not by choice, but because of circumstances. P-22 is the official name of a male mountain lion in Los Angeles that has become the poster boy for the plight of animals that have been trapped by urban sprawl. Nicknamed the "Brad Pitt of the cougar world" in the #SaveLA-Cougars campaign, the handsome cougar is isolated by freeways in his conservation park without a chance of finding a mate. Californians have stepped up and taken responsibility with a plan to build the largest freeway wildlife crossing in the world, using mostly private donations (Solly 2019). Animals aren't the only nature to thrive in cities. Hardy little plants, weeds to some, sprout and thrive in sidewalk cracks and building walls. Green spaces such as residential yards, private gardens, and urban parks support an amazing variety of species; edible plants are grown in community

gardens, recreation parks provide grassy playfields, and botanical gardens grow unique and beautiful plants (fig 1.3). Street trees help cool the sidewalk, and planted roadways and utility corridors provide passage into and out of the city as seeds and plants hitch a ride on the cars and people who travel the corridors.

The biological, engineered, and social systems all interact to create complex urban systems. However, the social and built systems of humans exert the greatest impact and create the most profound alterations to the biological systems (McPhearson, Pickett et al. 2016, 206). City planning and design, construction and management of green spaces, and environmental behaviors of citizens impact the health of the environment and people. Urban heat islands are examples of how human behaviors and the social, ecological, and technical systems interact to create unhealthy conditions in the city. The urban heat island effect occurs when tall, closely spaced buildings trap reflected heat, increasing city temperatures. Although the entire city is affected, the lack of urban vegetation, especially large trees, to mitigate the heat island is most prevalent in less affluent areas. Here the elderly, poor, and minority populations have fewer resources for coping and are disproportionally affected based on location, resources, and lack of technical means such as air conditioning. This is one example of the inequitable distributions of ecosystem services that could be improved with

FIGURE 1.2. Izmir, Turkey: feral dogs lying on grass seating steps along the Izmir waterfront promenade.

FIGURE 1.3. Perth, Australia: photos of plants are examples of data used for stewardship and management of parks such as the Kings Park and Botanic Garden that features native plants from SW Australia.

better planning and management of nature in cities (McPhearson, Pickett et al. 2016, 206). Managing ecosystems in urban areas is challenging; aside from the strategies needed to keep natural systems healthy and growing in less than ideal conditions, there is the social expectation for visual quality and provision of recreation opportunities. The recognition of human impact on biological systems evolved over several decades from the concepts of ecology *in* cities, to ecology *of* cities, and currently to ecology *for* cities and the science of cities.

Ecology *in* Cities

The study of urban ecology is a relatively new field in ecology studies. Investigations began in the 1970s when a growing awareness of environmental impacts in rapidly expanding cities pushed biological ecologists to study habitats that were familiar to them in the city context, such as remnant forest patches, meadows, and wetlands and streams. Initially,