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ECOLOGY

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1 Introduction

Ecology is a discipline that has produced a robust body of knowledge on the interactions between organisms and their environments. It is primarily concerned with questions such as how species interact or whether altering a community will impact the population structure of the associated habitats.

Ecology as a science covers areas as diverse as natural history patterns, community ecology, ecosystem analysis, behavioral ecology, and systems ecology, to name just a few.[1] Working across scales that range from molecules to the biosphere, various scientific methodologies are employed to sample ecological systems through programs of data collection that happen in real time or remotely through the use of technology.[2] For this, ecology has benefited from technological advances including remote sensing (see Chapter 17). Subsequently qualitative and quantitative ecological models can be developed that become testable ingredients of theory to explain causal explanations of the interactions between species (and between species and their environment).

In early ecological thought, cities were either irrelevant in the study of these interactions, or urbanization was at best seen as a driver of change (often degradation) of natural ecosystems. However, in the past decades, there has been a revolution in ecology as it relates to human-dominated landscapes.

The gradual interaction between ecology and the social sciences has resulted in cities being reimagined and studied as ecological units, or ecosystems,[3] in their own right. This has largely resulted in a transdisciplinary toolbox that utilizes concepts from diverse disciplines ranging from ecology, earth science, and forestry to network analysis, urban planning, and architecture. This has led to both an expanding knowledge base about cities and a phalanx of professionals determined to improve the condition of our urban centers and peripheries.

This chapter discusses the evolution of ecological thought as it relates to the study of cities and urban systems and how it has been deeply influenced by closer interaction with the social sciences (Sections 2–4). Section 5 makes the case that such interactions need to be deepened if issues of ethics are to be tackled more effectively. Section 6 summarizes the evolving definitions of the urban within ecological thought.

2 The urban as artificial: Early ecological thinking about cities

In early ecological thought, cities were seen as artificial, the product of humans not nature, and thus they stood in direct contrast to "natural" landscapes like wilderness. Many early ecologists like Aldo Leopold decried the wanton destruction of wilderness, of which urbanization was seen as a major driver (Leopold 1949). These concerns were not idle, given that the pace of urbanization, land transformation, and natural-resource consumption was (and still is) rapidly accelerating worldwide.

Other ecologists such as Arthur Tansley (1935) sought to integrate both natural and social activity into a common framework using the idea of the *ecosystem*. The Odum brothers, Howard T. and Eugene, also drove a stake in the ground for the inclusion of humans (and their actions) in ecology and led the discipline's scholarship with the first integrated ecology textbook (Odum and Odum 1953). On the whole, however, the developers and guardians of the discipline followed a more biologically defined path, focusing on the dynamics of flora and fauna rather than on its interaction with human systems, including cities.

Interestingly, the work of the urbanist and activist Jane Jacobs (see Chapter 12) paved the way for conceptualizing cities as real ecosystems (Section 3). Her 1961 work *The Death and Life of Great American Cities* ushered in a way of considering "urban" that was contiguous with the rest of nature. In fact, her idea was to consider the city as a result of the social ecology of humans. For Jacobs, it was a given that cities exist as interrelated complex systems of economic, social, and structural elements and, more importantly, that it is a mistake to understand or manage any of these elements in isolation (Bettencourt and West 2010) (see also Chapters 12 and 21). Many of the contemporary initiatives in urban ecology build upon the framework set out by Jacobs (Schubert 2014), including the linkages between green infrastructure and crime (Troy and Grove 2008) and urban health (Putnam and Quinn 2007). For more details about the link between urban ecosystems and health, see Chapter 15.

3 The urban as an ecosystem: The emergence of urban ecology

Five decades since Jane Jacobs, urban ecology has forged new definitions and perspectives on the urban experience. With the emergence of urban ecology, cities have been conceptualized as ecosystems in their own right, with the main tools and methodologies of conventional ecology both being applied and offering salient insights for urban ecosystems. Such urban ecosystems are understood as dynamic, adaptive, multiscalar, and requiring a thorough integration of the human socioeconomic and biophysical forces that shape the city and its inhabitants (Pickett *et al.* 2001, Grimm *et al.* 2000, Grove and Burch 1997) (see also Chapter 21).

Important in this process have been two long-term research projects (i.e., over 20 years in duration) funded by the US National Science Foundation (NSF) (http://www.lternet.edu): the Baltimore Ecosystem Study (BES) and the Central Arizona Phoenix Project (CAP). These studies serve as on-going living laboratories of urban ecosystem function and of the development of best practices for managing the city as an ecosystem. Additionally, 21 other cities, including Boston and Los Angeles, received support from the NSF and the United States Department of Agriculture (USDA) Forest Service to assemble interdisciplinary teams to look at the dynamic interactions among people and ecosystems embedded in the urban context.

Urban ecology research has unraveled a surprising complexity of processes in urban ecosystems and has called for a thorough revision of the school of thought that characterized cities as only having degraded ecological characteristics (Pickett *et al.* 2008). Once considered biologically depauperate (i.e., species-poor), these new models suggest that urban ecosystems are vital laboratories for studying evolutionary process and change (Alberti 2015). For example, it has been found that cities can harbor significant biodiversity,[4] sometimes richer than surrounding agricultural areas (Pickett *et al.* 2008).

Cities are indeed heterogeneous systems, comprising natural and human-made elements, each varying considerably throughout a single city. However, research efforts have moved beyond the comparison of urban habitats with surrounding ecosystems to studying the evolutionary patterns that drive the structure of the assemblages and the potential for human decoupling of those ecological relationships (Shochat *et al.* 2006). Because of such efforts, we have a much better understanding of cities as unique *ecosystems* with distinct patterns. Compared to rural landscapes, cities are patchier and warmer and have faster moving water, ample but less diverse biota, and altered biogeochemical cycles (for a concise review, see Pickett *et al.* 2008).

The study of ecological processes within urban ecosystems entails the application of several of the standard ecological methods in urban settings, including urban long-term ecological research sites (Niemela *et al.* 2011, Pickett *et al.* 2008), see also Section 1. Given that urban habitats are highly fragmented, the identification of spatial patterns has become an element of urban ecology, which requires the significant use of geospatial tools (see Chapter 17).

Lately, attempts to develop the transdisciplinary scholarship of urban ecology involved the forging of a holistic way to understand cities as a living entity with a metabolism that could be measured and compared across cities (Bettencourt and West 2010). If there existed a universal suite of characteristics, then comparative studies could be conducted across cities to guide human efforts and make cities more sustainable and resilient. According to Bettencourt and West (2010), three fundamental characteristics of cities scale with the size of the city (see also Chapter 21). First, as populations increase, the amount of space necessary to support them decreases, due in part to the efficiencies of densification. Second, productivity increases as a function of enhanced socioeconomic activity. Finally, this process results in higher social interdependence and specialization.

However, we should point out that the urban mosaic, as part of its efficiencies, also brings with it vulnerabilities (Grimm *et al.* 2008). To take a prominent example, many cities are built along the coastal margin or near large water bodies. This spatial relationship provides enhanced natural resources such as food, trade, and transportation, but it also increases the risks from sea-level rise, storm flooding, and altered hydrologic flows. This presents a daunting challenge as human populations of coastal cities continue to swell (Johnson 2006).

4 The urban as a socioecological system: Ecosystem services

The roots of urban ecology lay in an ancient insight that our social and built landscapes are inextricably connected to the nonhuman world. This reflected an emerging ecological worldview that emphasizes the relationships between people and their built, social, and natural environments. This worldview was particularly concerned with how people create a good and just life. The conceptual emphasis was thus on *oikos* (the relationships between people and their built habitats), *ecumene* (the connections between nature and society in the inhabited world), and *eudaimonia* (the flourishing of individuals and communities) (Glacken 1967). Nature's benefits are usually finite, localized, and vulnerable (Marsh 1865, Leopold 1949).

The emergence and application of the ecosystem services approach has been a consequence of the ever-greater formal recognition of the strong interdependence between humans and ecosystems. Despite some earlier attempts (for example, Daily 1997, Costanza *et al.* 1997), it was the Millennium Ecosystem Assessment (MA) (2005) that defined ecosystem services as the benefits that humans derive directly and indirectly from nature[5] and brought them to the center of academic inquiry and policy discussions.[6] Additional fine-tuning of the ecosystem services approach was accomplished by follow-up initiatives, such as The Economics of Ecosystems and Biodiversity (TEEB 2012), the UK National Ecosystem Assessment, and IPBES, that helped to raise further awareness of the multiple benefits of ecosystem services (including economic benefits) and improve their valuation (economic or otherwise). However, moving from theory to a fully integrated multidimensional valuation of ecosystem services has been a challenging task.

Common ecosystem services assessment methods come from both the natural sciences (e.g., land-use change modelling, hydrogeological modelling, biomass surveys, and pollination surveys) and the social sciences (e.g., household surveys, expert interviews, focus groups). Recently, integrated ecosystem services assessment toolkits have been developed. These toolkits combine some of the methodologies mentioned above with geospatial tools such as geographical information systems (GIS) in order to capture the ecosystem services trade-offs of alternative land-use decisions (for a comparison see (BSR 2011]). While none of these toolkits has been entirely urban in focus, some of them, such as InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs), have been developing modules specifically for urban applications.

Ecosystem services can be valued through radically different approaches, ranging from the preference-based methods commonly used in economics to purely biophysical metrics (e.g., ecological footprint, energy synthesis, or material-flow analysis) and multicriteria analysis (TEEB 2012) (see Chapter 19). The Total Economic Value (TEV) framework has gained prominence recently as a means of integrating the use (direct, indirect, option) and non-use (altruist, bequest, existence) values commonly associated with biodiversity and ecosystems (TEEB 2012). Tools that can capture these diverse values encompass market valuation, revealed preference valuation (travel cost method, hedonic pricing method) and stated preference valuation (for example, contingent valuation, choice experiment, deliberative group valuation) (TEEB 2012).

Urban systems are key in the ecosystem services discourse as both providers of ecosystem services locally and appropriators of ecosystem services from their hinterlands as a means of increasing the wellbeing of their residents (Gomez-Baggethun and Barton, 2013) (see Chapter 19 for a discussion on appropriation from hinterlands). Armed with the ecosystem services approach, attempts could be made to account for the role of nature in the anthropogenic domain, building a theoretical bridge between humans and ecosystems (DeFries *et al.* 2004).

Failure to maintain urban ecosystem services typically results in expensive and energy-intensive interventions. Well-known examples include the Los Angeles River (http://www.larivercorp.com) and the Charles River in Boston (http://www.crwa.org/charles-river-history), where the loss of riparian buffer habitat created the need for extensive human fortification of riverbanks and coastal margins. Not only did these ecosystems support a diverse biota, but they also served to regulate the impacts of flooding, storm surge, and extreme weather events (Redfield 1972). Their degradation or outright removal required extensive infrastructure investments in water diversion systems to protect vulnerable sites of human development (e.g., Ballona Wetlands, Section 5). Recent efforts by the US Environmental Protection Agency seek to reverse these impacts through ecosystem restoration (http://www.epa.gov/landrevitalization/urbanrivers).

It should be mentioned that maintaining and enhancing the flow of ecosystem services has been a key tenet of green infrastructure[7] that has gained significant international interest for urban planning. This might result in interesting intersections between urban ecology and professional fields such as architecture (Chapter 10), civil engineering (Chapter 11), urban planning (Chapter 12), urban governance (Chapter 13), and public health (Chapter 15).

5 The ethical dimensions of urban ecology

Over time, the discourse of ecology spun off into two complementary directions, both of which are directly relevant to the study and management of urban socioecological systems. One was the science of ecology itself, producing a robust body of knowledge on the interactions between organisms (including humans) and their environments. The other was a moral–political sensibility about humanity's connection to (and responsibilities regarding) other people, animals, and nature. This latter breaks out into a variety of perspectives on nature–society relations with a strong emphasis on ethics, for example, ecotheology, green political theory, animal ethics, and environmental ethics (Worster 1985, Peterson 2013).

The ethics of urban ecology may not be as well understood as its science (Sections 3–4), but it is nonetheless its long-term companion. It focuses on the moral values, responsibilities, and consequences of our individual and collective lives as they relate to both the social, natural, and built environment (Rolston 1988, Jamieson 2008). Indeed, such ethical considerations contributed significantly to the formation of the ecosystem services approach (Section 4.3), and for good reason. Humans have a unique capacity for what George Perkins Marsh called "geographic agency, i.e. the ability to shape the surface of the earth for good or ill" (Marsh 1965). Cities are a prime example of this agency, and the urban landscapes in which the increasing majority of humanity now lives can do much to help (or hurt) human and nonhuman individuals and communities (Hadidian *et al.* 2006, Sheppard and Lynn 2004, Wolch *et al.* 1995).

So whether as part of an explicit commitment or its implicit import, urban ecology informs and is informed by a variety of normative questions about the wellbeing of nature and society in cities. These questions include how we ought to live in cities; how our cities impact other people, animals, and nature; how we promote the wellbeing of urban communities; and how we therefore think about social justice, animal protection, ecological integrity, and sustainability.

Together, the scientific and ethical dimensions of urban ecology complement each other as twin points of navigation in developing deeper and better understandings of our place in the urban landscape. More importantly, they can help inform the policies that make cities more ethical and sustainable socioecological systems (Lynn 2006, Shrader-Frechette 1994).

One way to illustrate this complementarity is to look at the differing value judgments and controversy expressed over the future of one such urban socioecological system, the Ballona Wetlands in Los Angeles, California (Box 7.1).

BOX 7.1: BALLONA WETLANDS

The Ballona Wetlands was, at its peak, a 1,012-hectare complex of dunes, estuaries, marshes, mudflats, salt pans, rivers, streams, and upland habitat covering a significant portion of the Los Angeles metropolitan area. Prior to European settlement, it was also home to the Tongva First Nation and had an abundance of native flora and fauna, being a major stop-over for birds on the Pacific flyway.

The wetland suffered a major hydrological and geological shock in the 1850s due to a series of earthquakes and extreme weather events that shifted the course and mouth of the Los Angeles River. Thereafter, human activity steadily degraded and destroyed its habitats. Farming, overhunting, channelizing the Ballona River for flood control, draining the wetlands for oil production, destroying the dunes, building Hughes Airport, dredging for the construction of Marina del Ray, and filling the remaining wetland for the development of Playa Vista all took a vicious toll on Ballona. Today, 95 percent of southern California's wetlands have been lost, with the 243 hectares left of Ballona being a rare and highly degraded remnant of the past (Dark, Stein, Bram *et al.* 2011; Stein, Cayce, Salomon *et al.* 2014).

Proposals to protect and restore the wetlands have percolated since the 1960s. In 2003, the state of California bought what was left of Ballona and created the Ballona Wetlands Ecological Reserve, transferring its management to the California Department of Fish and Wildlife. In 2004, the State Coastal Conservancy authorized the issuing of bonds for Ballona's restoration. As part of a community-engaged planning process, several restoration alternatives were articulated for consideration under the California Environmental Quality Act and the National Environmental Policy Act. These include a fully naturalized creek, a partially naturalized creek, an oxbow wetland, and a no-restoration option (Ballona Wetlands Restoration Project, 2015).

The state of California was unable to foot the bill for any kind of visitor center due to its ongoing budget crises, but in 2013 the Annenberg Foundation entered into an agreement with the state to build an urban ecology center in the wetlands. As part of a USD 50 million project, the proposal envisioned a certified green interpretive building occupying half a hectare out of the reserve's 243 hectares. It also included 12 hectares of upland restoration and multiple years of staffing support (Annenberg Foundation 2013a, 2014b). Yet in December of 2014, the Annenberg Foundation suspended its participation in the face of public debate over what values and ecosystem services should be prioritized in Ballona (Ballona Wetlands Restoration Project 2015b; Groves 2014).

This is because, in the process, a number of competing viewpoints emerged. For some stakeholders, the project should have focused on restoring the absolute maximum acreage within Ballona, as so much of the wetland had been lost. They saw the fight to protect what was left as so arduous that the construction of any interpretive center within the wetlands appeared unconscionable.

Other stakeholders replied that a "place-making" structure would draw people to appreciate the ecological, educational, and recreational values of the wetlands.

For other stakeholders, the major issue was not the interpretive center itself but the presence of domestic animals in its programming. Annenberg Foundation's proposal would have integrated the teaching of environmental and humane education, the latter of which focuses on the interrelationships between human and nonhuman animals, both domestic and wild. This is anathema to those who view urban ecology and urban conservation as focused solely on remnant habitats and wild species. In their view, environmental education has nothing to do with humane education.

Finally, for some stakeholders, the issue was pet adoption, as the proposal of the Annenberg Foundation envisioned an adoption program for some of the companion animals used in its humane-education component. This idea produced an outcry from those who believe that the proposed center was simply a ruse to locate an animal shelter and adoption facility within the wetland (Agostoni 2013, Los Angeles Times Editorial Board 2013).

The case elaborated in Box 7.1 clearly shows the numerous challenges, competing interests, and value judgments as they relate to the management of urban social-ecological systems. What is interesting to see is that several of these value conflicts are fundamentally about what ecosystem services the wetlands will provide to the surrounding urban communities.

Development has been so extensive that the wetlands no longer serve as an important source of provisioning (e.g., food, water) or certain regulating services (e.g., waste filtration) for its surrounding urban areas. It does, however, provide some regulating services as a storm protection by absorbing ocean storm surges and upland flooding. This will be increasingly important as the climate changes, storm severity increases, and sea levels rise (Bergquist *et al.* 2012).

In light of these constraints, the main urban ecosystem services a Ballona restoration could provide include a habitat for resident and migrating species (supporting services), as well as education and recreation for the people of the region (cultural services). For several stakeholders, Ballona's significance lays not in returning it to some pre-Columbian wild state but in serving the mixed community of people, animals, and nature in metropolitan Los Angeles.

As the case of the Ballona wetlands illustrates, the science of urban ecology can provide guidance on the options for managing urban social-ecological systems. Decisions about

FIGURE 7.1 Ballona Wetlands, Ballona Creek, and Marina Del Rey Harbor.

Source: Digital image by Cromagnom, 1 August 2011. https://en.wikipedia.org/wiki/Ballona_Wetlands#/media/File:Ballona_Wetlands.jpg This work is licensed under the Creative Commons Attribution 3.0 Unported License. To view a copy of this license, visit http://creativecommons.org/licenses/by/3.0/ or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA.

whether (and how) to restore the wetland and upland habitats of the Ballona are an illustrative example. Yet science alone cannot tell us what values and ecosystem services should be prioritized. Given its current condition, should Ballona be used primarily for supporting or cultural services? Should we maximize the restoration of its habitat or devote more of it to activities such as recreation? Why should we choose one over the other? These are values-based questions about what people ought to do as they create and remake urban ecologies, a process in which ethics-based and science-based reasoning are mutually complementary in making good public-policy decisions (see Chapter 9).

6 Defining the urban in ecology

This chapter suggests an evolving definition of the urban within ecology. In early ecological thinking, cities and urban systems were conceptualized as human-dominated artificial systems that have manipulated landscapes beyond what can occur through natural processes. In this way, urban systems were either considered irrelevant to the field of ecology or, at best, they were seen as a driver of ecosystem change and subsequently critiqued for their negative impacts.

Interactions of ecology with social sciences led to the emergence of the field of urban ecology. Urban ecology has made the case that cities and urban systems are ecosystems in their own right and that they should be studied as multiscalar adaptive systems.

The ever-closer interactions with the social sciences have led to urban systems being conceptualized as coupled social-ecological systems whose ecological and social components are so inextricably linked and interdependent that they cannot be separated (Machlis *et al.* 1997). Apart from being a driving force in the socioecological system, humans are also agents whose wellbeing is affected positively or negatively by the effects that ecosystem change (within and outside the urban system) can have on the continuous flow of ecosystem services. These effects may bode well or ill for nonhuman animals and communities.

7 Conclusion

As the previous sections make clear, urban ecology made its mark through the study of nature in cities, cities as ecosystems, and the impact of urban footprints on planetary health. Much of this work arose out of the biological sciences applying the traditional concerns of ecology to human-dominated landscapes (e.g., flows of energy, resources, and waste; urban habitat and biodiversity; the impact of alien species) and associated policy debates over human–nature relations in cities (e.g., open space, environmental education, outdoor recreation, green cities, ecosystem services).

While some of this research is empirical, with the intention of improving our theoretical understanding of urban ecology, much is applied, with a focus on improving the wellbeing of urban communities. Understood in this way, we can think about urban ecology as a new adaptation of ecological science, which is now considering fundamental questions about our relationship with nature.

The adoption of the concept of ecosystem services was a critical step in the integration of cities into the canon of ecosystems. Among others, it provided benchmarks for assessing human impact on the built environment, while at the same time focusing on the human wellbeing outcomes of ecosystem change.

Even so, a much closer merging of science, ethics, and public policy needs to take place to unlock the full potential of ecological thinking for dealing with urban systems. With this in mind, the emerging ethical dimensions of urban ecology will open new questions of how we ought to live with people, animals, and nature in urban landscapes. Such questions complement the science of urban ecology in making better public-policy decisions over managing and creating urban socioecological spaces.

Notes

1 Examples can be explored on the website of the Ecological Society of America (www.esa.org) or through ecology textbooks such as that by Cain *et al*. (2014).
2 For example, the National Ecological Observation Network (NEON), funded by the National Science Foundation, is a continental scale network of 106 sampling stations measuring ecological change and making data available through an online portal (www.neoninc.org).
3 An ecosystem is "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit" (CBD 1992).
4 Biodiversity is the "variability among living organisms from all sources including ... terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (CBD 1992).
5 According to the MA, conceptual framework ecosystem services are divided into four categories, which are linked to a multitude of human wellbeing constituents. The main types of ecosystem services include: *provisioning* services (for example, goods derived from nature, including food, water, and biomass energy);*regulating* (for example, stabilizing and resiliency functions of ecosystems including decomposition, climate regulation, purification of water, and disease control); *cultural* (for example, nonmaterial human benefits including art, scientific discovery, recreation, and spiritual enrichment);*supporting* services necessary for all other services (e.g., nutrient cycling and soil formation).
6 The ecosystem services approach has been adopted by the UN Convention on Biological Diversity (CBD) and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).
7 Green infrastructure can be defined as "as a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings" (EC 2013, 5).

References

Agostoni, Kristin. 2013. "Ground game: Annenberg Foundation's Ballona Wetlands proposal stirs debate." *Daily Breeze*. Accessed March 15, 2015. http://www.dailybreeze.com/general-news/20130427/ground-game-annenberg-foundations-ballona-wetlands-proposal-stirs-debate.

Alberti, Marina. 2015. "Eco-evolutionary dynamics in an urbanizing planet. Trends in ecology and evolution," DOI: http://dx.doi.org/10.1016/j.tree.2014.11.007

Annenberg Foundation. 2013a. "New interpretive center proposed at Ballona Wetlands." Accessed March 15, 2015. https://cdfgnews.wordpress.com/2013/01/28/new-interpretive-center-proposed-at-ballona-wetlands/.

Annenberg Foundation. 2013b. "Proposed Ballona interpretive center." Accessed March 15, 2015. http://www.annenbergfoundation.org/node/50771.

Ballona Wetlands Restoration Project. 2015a. Accessed March 15, 2015. http://www.ballonarestoration.org.

Ballona Wetlands Restoration Project. 2015b. "Ballona restoration update from the project partners (12-2-14)." Accessed March 15, 2015. http://www.ballonarestoration.org/wp-content/uploads/2015/02/Project-Partner-Update_12-2-14.pdf.

Bergquist, Sean, Jeremy Pal, William Trott, Alissa Brown, Guangyu Wang, and Shelley Luce. 2012. "Climate change implications for Ballona Wetlands Restoration." Report prepared for the United States Environmental Protection Agency Climate Ready Estuary Program.

Bettencourt, Luis, and Geoffrey West. 2010. "A unified theory of urban living." *Nature* 467:912–913.

BSR. 2011. *New Business Decision-Making Aids in an Era of Complexity, Scrutiny, and Uncertainty: Tools for Identifying, Assessing, and Valuing Ecosystem Services*. New York: BSR.

Cain, Michael L., William D. Bowman, and, Sally D. Hacker 2014. *Ecology*, 3rd Edition. Sundelin: Sinauer.

CBD. 1992. Text of the Convention on Biological Diversity. Convention on Biological Diversity (CBD): Montreal.

Cicero, Marcus Tullius. 45 BC. *De Natura Deorum* [On the Nature of the Gods], II, 60.

Costanza, Robert, Ralph d'Arge, Rudolf de Groot, Stephen Farberk, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert O'Neill, Jose Paruelo, Robert Raskin, Paul Sutton, Marjan van den Belt. 1997. "The value of the world's ecosystem services and natural capital." *Nature* 387:253–260

Daily G. C. ed., 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington (DC): Island Press.

Dark, Shawna, Eric Stein, Danielle Bram, Joel Osuna, Joseph Monteferante, Travis Longcore, Robin Grossinger, and Erin Beller. 2011. "Historical ecology of the Ballona Creek watershed." Southern California Coastal Water Research Project, Technical Report 671.

DeFries, R. S., J. A. Foley, and G. P. Asner. 2004. "Land-use choices: Balancing human needs and ecosystem function." *Frontiers in Ecology and the Environment* 2:249–257.

EC. 2013. *Building a Green Infrastructure for Europe*. Publications Office of the European Union: Luxemburg.

Glacken, Clarence J. 1967. *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century*. Berkeley: University of California Press.

Gomez-Baggethun, E., and D. N. Barton. 2013. "Classifying and valuing ecosystem services for urban planning." *Ecological Economics* 86:235–245.

Grimm, N. B., S. H. Faeth, N. E. Golubiewski, C. L. Redman, J. Wu, X. Bai, and J. M. Briggs. 2008. "Global change and the ecology of cities." *Science* 319:756–760.

Grimm, N., J. M. Grove, S. T. A. Pickett, and C. L. Redman. 2000. "Integrated approaches to long-term studies of urban ecological systems." *Bioscience* 50:571–584.

Grove, J. M. 2009. "Cities: Managing densely settled social-ecological systems." In *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*, edited by, Chapin, F. S., III, G.P. Kofinas, and C. Folke. New York, NY: Springer-Verlag.

Grove, J. M., and W. R. Burch. 1997. "A social ecology approach to urban ecosystems and landscape analysis." *Urban Ecosystems* 1:185–199.

Groves, Martha. 2014. "Annenberg Foundation suspends plan for Ballona Wetlands visitors center." *Los Angeles Times*. Accessed March 15, 2015. http://www.latimes.com/local/california/la-me-annenberg-wetlands-20141203-story.html.

Hadidian, John, Camilla Fox, and William S Lynn. 2006. "The ethics of wildlife control in humanized landscapes." In *Proceedings of the Twenty-Second Vertebrate Pest Conference*, edited by R. M. Timm, and J. M. O'Brien, 500–4. Davis, CA: University of California, Davis.

Jacobs, Jane. 1961. *The Death and Life of Great American Cities*. New York, NY: Vintage Books.

Jamieson, Dale. 2008. *Ethics and the Environment*. Cambridge: Cambridge University Press.

Johnson, Steven. 2006. *The Ghost Map: The Story of London's Most Terrifying Epidemic—and How It Changed Science, Cities, and the Modern World*. New York, NY: Riverhead Books.

TEEB 2012. *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. New York: Routledge.

Leopold, Aldo 1949. "Wilderness." *A Sand County Almanac*. New York, NY: Oxford University Press.

Lynn, William S. 2006. "Between science and ethics: What science and the scientific method can and cannot contribute to conservation and sustainability." In *Gaining Ground: In Pursuit of Ecological Sustainability*, edited by David Lavigne, 191-205. Limerick, IRL: University of Limerick.

Los Angeles Times Editorial Board. 2013. "A bad fit for Ballona Wetlands." *Los Angeles Times*. Accessed March 15, 2015. http://www.latimes.com/opinion/editorials/la-ed-0920-ballona-wetlands-20130920-story.html.

Machlis, G. E., J. E. Force, and W. R. Burch. 1997. "The human ecosystem Part I: The human ecosystem as an organizing concept in ecosystem management." *Society & Natural Resources: An International Journal* 10 (4):347–67.

Marsh, George Perkins. 1965. *Man and Nature, or, Physical Geography as Modified by Human Action*. Edited by David Lowenthal. Cambridge: Belknap Press. Originally published in 1864.

Millennium Ecosystem Assessment (MA). 2005. *Ecosystems and Human Well-Being: Synthesis*. Washington, DC: Island Press.

Niemela, J., J. H. Breuste, T. Elmqvist, G. Guntenspergen, P. James, and N. E. McIntyre, ed. 2011. *Urban Ecology: Patterns, Processes and Applications*. Oxford: Oxford University Press.

Odum, E. 1953. *Fundamentals of Ecology*. Philadelphia: Saunders.

Peterson, Anna L. 2013. *Being Animal: Beasts and Boundaries in Nature Ethics*. New York, NY: Columbia University Press.

Pickett, S. T. A., M. L. Cadenasso, J. M. Grove, C. H. Nilon, R. V. Pouyat, W. C. Zipperer, and R. Costanza. 2001. "Urban ecological systems: Linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas." *Annual Review of Ecology and Systematics* 32:127–157.

Pickett, S. T. A., P. Groffman, M. L. Cadenasso, J. M. Grove, L. E. Band, C. Boone, W. R. Burch, S. Grimmond, J. Hom, J. C. Jenkins, N. L. Law, C. H. Nilon, R. V. Pouyat, K. Szlavecz, P. S. Warren, and M. A. Wilson. 2008. "Beyond urban legends: An emerging framework of urban ecology as illustrated by the Baltimore Ecosystem Study." *Bioscience* 58:139–150.

Putnam, S. and, A. Quinn 2007. "Jane Jacobs and Urban Health". *Journal of Urban Health* 84(1):1–2.

Redfield, A. C. 1972. "Development of a New England salt marsh." *Ecological Monograph* 42:201–237.

Rolston, Holmes, III. 1988. *Environmental Ethics: Duties to and Values in the Natural World*. Philadelphia: Temple University Press.

Schubert, D. ed., 2014. *Contemporary Perspectives on Jane Jacobs: Reassessing the Impacts of a Visionary*. Surrey: Ashgate Publishers.

Sheppard, Eric, and William S Lynn. 2004. "Cities: Imagining cosmopolis." In *Patterned Ground: Entanglements of Nature and Culture*, edited by Stephan Harrison, Steve Pile, and Nigel Thrift, 52–55. London: Reaktion Press.

Shochat, E., P. S. Warren, S. H. Faeth, N. E. McIntyre, and D. Hope. 2006. "From patterns to emerging processes in mechanistic urban ecology." *Trends in Ecology and Evolution* 21:186–191.

Shrader-Frechette, K. S., and E. D. McCoy. 1994. "How the tail wags the dog: How value judgments determine ecological science." *Environmental Values* 3: 107–120.

Stein, Eric, Kristen Cayce, Micha Salomon, Danielle Bram, Danielle De Mello, Robin Grossinger, and Shawna Dark. 2104. "Wetlands of the Southern California Coast: Historical extent and change over time." Southern California Coastal Water Research Project, Technical Report 826.

Tansley, A. G. 1935. "The use and abuse of vegetational concepts and terms." *Ecology* 16:284–307.

Troy, A., and Grove, J. M. 2008. "Property values, parks and crime: A Hedonistic analysis in Baltimore, MD." *Landscape and Urban Planning* 87:233–245.

Wolch, J. R., K. West, and T. E. Gaines. 1995. "Transspecies urban theory." *Environment and Planning D: Society and Space* 13 (6):735–60.

Worster, Donald. 1985. *Nature's Economy: A History of Ecological Ideas*. Cambridge: Cambridge University Press.