9

PEOPLE'S DECISIONS SHAPE URBAN HABITATS

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Introduction

There is increasing awareness that the patterns and mechanisms explaining urban ecosystems and the biodiversity therein can only be understood by including people in urban ecological explorations. People's decisions shape the planning, design, and management of urban habitats and cityscapes. Selecting trees to grow along roadsides, leaving space for parks in new residential development, cultivating soils in garden beds, lawn mowing, and placing bird seed or water baths in private yards are all examples of decisions made by urban planners, managers, and residents at various spatial scales that have direct and indirect effects on urban biodiversity and the ecology of urban habitats (Goddard et al. 2010; Aronson et al. 2017a). The integration of social theory around human decision-making is needed in contemporary research that aims to understand the ecology 'in, of and for' cities (McPhearson et al. 2016).

In this chapter, we introduce typologies of decision-making mechanisms, attributes, and actors to help make sense of decision-making related to urban habitats. In addition, we review some of the main concepts and theories in the social sciences that have been used to explain human decision-making in this context. We describe how humans can shape urban habitats as decision-makers, how their values and preferences and political processes interact with structural constraints and biophysical factors to shape these decisions. In doing so, we use some case studies and examples from across the world to provide a broad picture of diverse management decisions, actions, and outcomes for urban habitats. We have three main objectives: to (1) identify the major mechanisms by which human decisions shape urban habitats; (2) explain the attributes of human decisions, including spatial and temporal dimensions and intentional versus unintentional effects; and (3) describe the main drivers of human decision-making.

Key decision-making mechanisms that influence urban habitats

Millions of decisions that influence urban habitats are made every day by people in different capacities, all over the world. Mechanisms by which people influence urban habitats include governance, policy and regulation, planning and design, and management.

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Governance

Governance can be defined as 'the collection of institutions, rules, and processes of collective decision-making that allows stakeholders to influence and coordinate their needs' (Ordóñez et al. 2019). The concept of governance includes government, private enterprise, community actors, tools such as policy and legislation, community engagement, risk and project management, accountability, and the reproduction or reinforcement of social norms. While some environmental governance directly engages with urban habitats (e.g. threatened species legislation, community stewardship of local parks), governance strongly shapes the way cities and towns are designed, planned and managed, in turn indirectly shaping habitats and biodiversity conservation outcomes (Puppim de Oliveira et al. 2011). Governance arrangements can vary greatly across countries with different political and economic systems. They can be formally codified in processes, policies, rules, and regulations, or more informal with a greater dependence on social relationships. They can change over time in ways that affect biodiversity outcomes, such as the recent shifts in the postindustrial West to greater community participation in decisions traditionally made by technical experts on the design and management of urban landscapes (Gulsrud et al. 2018). Understanding governance can help to explain how power is accumulated and wielded in cities and how this translates to habitat management.

Policy and regulation

City policies and regulations help to formalise governance arrangements. Policies are statements of intent by particular institutions describing how they would like the world to be, for example, urban biodiversity strategies by local governments (Nilon et al. 2017). Regulations are enforceable rules such as legislation, ordinances, and bylaws that constrain decisions and actions to achieve desired outcomes and implement policy. Policy and regulation can direct planning and design of green spaces (e.g. mandating certain plant species; mandating amount of minimum green space areas), constrain adverse behaviours (e.g. restricting cat roaming or the cultivation of invasive species), identify desirable outcomes (e.g. canopy cover targets), identify which habitats need to be preserved and which are permitted to be cleared in urban development, protect threatened species, and specify rules for biodiversity offsets.

Planning and design

In urban areas, planning heavily influences the arrangement of space and therefore habitat structure, patch size, and connectivity. Planning decisions apply regulation and policy to shape the size and location of parks and the amount of space left for vegetation along roadsides and in residential gardens (Larson et al. 2020). In a review of 135 plans from 40 cities around the world, more than 80% of plans incorporated at least one goal for enhancing ecosystem services (Nilon et al. 2017). Most plans also included goals for conserving biodiversity and habitats, but few plans included quantitative targets (e.g. increasing amount of area under protection), reducing the likelihood of plans being achieved (Nilon et al. 2017).

Design specifies the initial configuration of built and natural elements within a site. Important aspects of design include tree species selection, which can have long-term effects on biodiversity (White et al. 2005), spatial arrangement of natural elements that define connectivity and structural complexity (Peng et al. 2020), and edge treatments that connect biodiverse areas to their surrounding urban landscapes (Nassauer 1995). Design can be formalised in landscape plans and architectural drawings, such as in urban parks, or can be informally implemented based on spontaneous decisions by the relevant landholder/manager, such as in many residential gardens.

Planning and design decisions work together to influence biodiversity. For example, trees can exist in cities where planning allows enough space for trees to grow and designs choose trees over alternative treatments such as turf. Planning and design for multifunctionality is increasingly occurring in urban green spaces, where the same space can provide ecosystem service benefits such as cooling and flood reduction, biodiversity outcomes, amenity, and recreation (Lovell and Taylor 2013). There are often trade-offs and synergies across these multiple objectives that must be negotiated in the planning and design processes (Dobbs et al. 2014).

Management practices

Management practices include the planned and unplanned activities that implement and maintain designs within urban habitats (Aronson et al. 2017a). This includes regular maintenance such as mowing, replanting, and removing undesirable species and populations, and interventions such as installing artificial habitat including 'bat boxes' and bird baths. Management activities can be conducted by different actors, from municipal arborists to home gardeners. Management can also incorporate public involvement in urban habitats (Andersson et al. 2014) and ecological restoration (Clarkson and Kirby 2016). Management regimes, such as frequency of mowing, can have significant ecological effects on the composition and abundance of species at different trophic levels (Threlfall et al. 2016b; Lerman et al. 2018). Other management decisions can have unexpected impacts on ecological communities. For example, fencing the edge of vacant lots in Chicago (USA) resulted in the creation of distinct plant communities along the fence line (Anderson and Minor 2020).

Monitoring the ecological effects of management decisions is an often-overlooked area of management. It has been adopted in some areas of management, such as street trees, primarily to manage risk and costs. Increasingly, citizen science programs are being used to monitor urban biodiversity to collect data and for community engagement and education.

Attributes of human decisions

Intentional and unintentional, positive and negative effects

Human decisions have intentional and unintentional effects on urban habitats and urban biodiversity. Some decisions are intended to directly affect particular habitats or species. For example, when urban residents place bird feeders in their yards, this decision has the intentional effect of increasing resources for a small group of bird species. Decisions to manipulate urban habitat, such as planting or removing urban trees, and starting wildlife-friendly gardening for birds and bees (Apfelbeck et al. 2020; Goddard et al. 2013), are decisions with intentional effects. Decisions that add or remove wildlife from the habitat, such as using pesticide to eliminate arthropod or rodent pests, also have intentional effects.

Many decisions may have large unintended consequences on urban habitats and biodiversity. For example, urban planning and design decisions that maximise human population density and profit for developers may leave little room for large trees in the landscape or may heavily fragment existing vegetation. The aforementioned bird feeder could reduce natural insect or seed predation if bird seed is favoured over 'natural' prey, and the pesticides could eliminate non-target species. The timing of mowing can allow grassland species to set seed (or not), affecting the composition of species in neighbouring landscapes. Simplifying urban yard vegetation due to preferences for 'tidy' landscapes (Nassauer 1995) can reduce wildlife species richness and abundance. Allowing house cats to roam outside may decrease parental feeding of chicks and increase nest predation for urban songbirds (Bonnington et al. 2013).

As these examples show, decisions can have either positive or negative outcomes on urban biodiversity, often without explicitly considering impacts on biodiversity. Sometimes the same decision can have both positive and negative effects on different species or taxonomic groups. When considering the effects of decisions on urban biodiversity, it must be recognised that decisions can affect multiple species, taxonomic groups, and ecological communities, sometimes in different ways. While it is possible to plan for multi-species outcomes, this is difficult, particularly in complex social-ecological systems such as urban areas.

Spatial and temporal attributes of the effects of decisions

The effects of all human decisions have temporal and spatial extents (Figure 9.1). Some decisions, such as planting a tree, have a small spatial extent but a long temporal extent (possibly hundreds of years). Other decisions, such as municipal mowing, may have a direct effect that only lasts a few days or weeks but can cover many hectares. Decisions such as city planning and state or national laws may have particularly large spatial and long temporal effects. Decisions may also vary in frequency. Lawn irrigation may be very frequent, even daily, which can cumulatively lead to long temporal effects. Decisions with small spatial and short temporal effects, such as residential lawn mowing, can be repeated frequently by many different decision-makers, leading to large cumulative effects across space and time. Decisions have legacies that may lead to large temporal

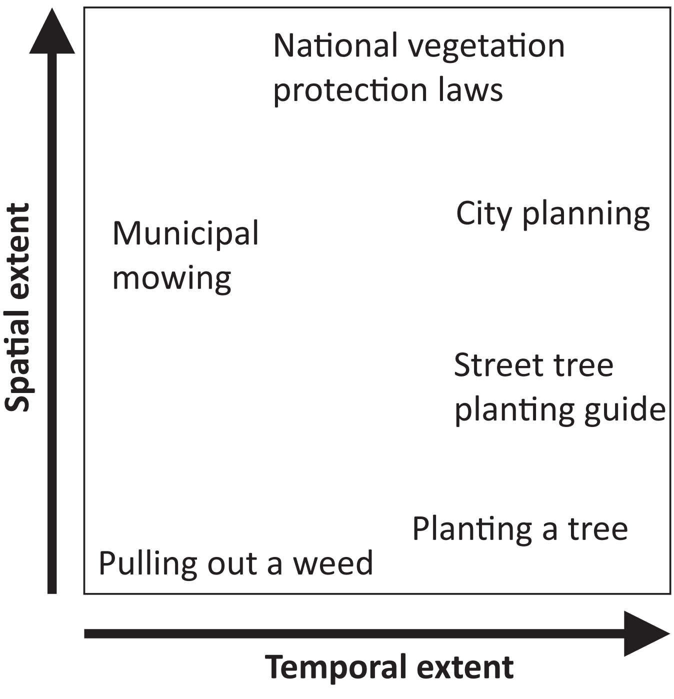

Figure 9.1 The temporal and spatial extent of different decisions.

extents. Urban tree diversity and structural complexity are good examples of decision-making at different temporal scales: long-term landscape-scale planning around forest diversity and structure is needed, while removal and pruning decisions may be very short term and sporadic (Stagoll et al. 2010). All these management decisions are important for influencing habitat availability.

Land use types and their decision-makers

In many cities, land use planning spatially segregates the effects of decision-making through regulation. In developing countries, there is often less strict segregation of land uses and a greater emphasis on informal planning, including green spaces (Chishaleshale et al. 2015). Decisions in different land uses are the responsibility of different actors encompassing individuals or organisations responsible for different spatial extents (Table 9.1). For example, municipal authorities may be responsible for public land, including parks and streetscapes, while residents, businesses, and homeowners' associations may have greater responsibility in the private realm of residential or commercial landscaping. Some actors, such as landscape architects, may make decisions that influence both public and private landscapes. However, decisions are fluid, and decisions made about a particular land use can affect others, and many different actors may be involved in decisions within a particular land use. In the next section, we outline some important land use types shaping urban habitats, the decision-making mechanisms that influence them, and how these land uses are typically associated with different actors.

Understanding drivers of human decision-making

Much exploration of decision-making related to urban biodiversity assumes that decision-making is a rational process, based on predictable choices people make in response to evidence and evaluation of alternatives (Laurans et al. 2020). Within this rational framework, key influences on decision-making include policies and planning, individual cognitive factors such as values and preferences, sociocultural drivers such as demographic variables, economic factors, and knowledge of the biophysical environment (Sutherland and Freckleton 2012). To support better decision-making within this framework, more information is collected, and a range of decision-support systems are implemented. Information can include spatial information on biodiversity assets (e.g. occurrence, species distribution models), as well as information on individual factors (e.g. preferences for particular species) and sociocultural data (e.g. demographics and cultural background of residents).

However, decision-making is not always rational. Individuals can make decisions that are inconsistent with the information available and their own values and preferences. Decision-making can also be seen as a political process. For example, theories in political ecology and environmental justice show how decision-making can favour powerful interests over those less powerful, leading to the unequal distribution of environmental goods (Heynen et al. 2006). A rich body of literature has demonstrated patterns of biodiversity, and tree canopy are associated with patterns of socioeconomic advantage. This has been dubbed the 'luxury effect' and has been explained using rational approaches, such as 'economic wherewithal' of residents to plant vegetation or move to vegetated areas (Hope et al. 2008). Yet individual actions are not the only explanation for this association. Political processes also play an important role in many places. Public decision-making can lead to private benefit from public goods (such as street trees or biodiversity) for advantaged sections of the community (Landry and Chakraborty 2009). Policies, ordinances, and rules that restrict resident behaviours in private landscapes (e.g. when renters are unable to plant trees, or

Table 9.1 Some of the actors involved in decisions across different land use types

Land use type	*Description*	*Householder*	*Arborist/ Horticulturist*	*Municipal planner/ policymaker*	*Landscaper*	*Landscape architect*	*Property developer*	*Nursery manager*	*Ecological restorationist*	*Conservation planner*
Public parks	Planning influences size, connectivity, and human use of parks, and design influences species composition and habitat structure. Parks are infrequently developed but are likely to have fairly stable management after establishment. They often comprise larger patches, and have larger trees, than other urban habitats.		X	X	X	X	X	X		
Streetscapes	Trees are often the main element in this land use (although turf or understorey vegetation can be important), and tree management for safety and amenity has historically been a key driver of decision-making (Ordóñez et al. 2019). Initial planning and design are important, but decision-making is frequent due to the stressful environment, public risk, and high mortality of street trees (Roman et al. 2014). These areas are individually small but cumulatively can cover a large area (Marshall et al. 2019).		X	X	X	X	X	X		
Conservation areas	Urban expansion has resulted in patches of ecologically-important communities being preserved in cities (Kendal et al. 2017b). Planning affects patch size, quality, connectivity, and surrounding land uses. Some ecosystems require disturbance regimes (e.g. fire) that have been difficult to implement in urban areas due to public opinions, although there is increasing evidence that the public can support these management			X			X		X	X

	approaches (Farrar et al. 2020). Design, particularly around edges and entrances, can shape public opinion towards these patches (Nassauer 1995).								
Riparian zones	Areas subject to flooding are spared from development in many cities. These can be important areas for habitat and landscape connectivity, although they can also contribute to connectivity for non-native species (Aronson et al. 2017b). The planning of riparian corridors is increasingly regulated to allow for multifunctional use e.g. linear paths, recreational areas.		X	X	X	X	X	X	X
Cemeteries	These are an important refuge for many species with different patterns of management (and therefore disturbance) than many other urban green spaces (Kowarik et al. 2016; Smith and Minor 2019)		X					X	X
Institutional/ Botanical gardens	Many cities have botanic gardens, natural history museums, zoos, and other institutional landscapes, which may be relatively small but contain very high levels of plant and animal species diversity. Botanic gardens can play an important role in conservation and education for the public to learn about plants and the role they play in ecosystems (Ballantyne et al. 2008).	X	X		X				

(*Continued*)

Table 9.1 (Continued)

Land use type	*Description*	*Householder*	*Arborist/ Horticulturist*	*Municipal planner/ policymaker*	*Landscaper*	*Landscape architect*	*Property developer*	*Nursery manager*	*Ecological restorationist*	*Conservation planner*
Residential gardens	These green spaces are typically small but cumulatively can cover a large proportion (35–50%) of Western cities (Kendal et al. 2012b; Loram et al. 2007), although often much less in large, high density cities. Planning and regulation shape the size and arrangement of spaces. Frequent, uncoordinated, small-scale decisions by homeowners can lead to very high levels of plant diversity (Kendal et al. 2010). While these decisions can be lightly regulated, in some places a range of policies and regulations by local municipal authorities or subdivision developers can constrain decision-making (Sisser et al. 2016)	X		X	X	X	X	X		
Constructed green spaces	Green roofs, facades, and green interiors can be important for biodiversity conservation (Oberndorfer et al. 2007). Habitat design and management decisions, e.g. plant species diversity and ground cover, may influence arthropod diversity and community composition (e.g. Braaker et al. 2014; Kratschmer et al. 2018). The decision to install green roofs and facades may be driven by climate mitigation policies (Norton et al. 2015).			X	X	X	X	X		
Commercial landscapes	Shopping areas and industrial precincts are often managed for low maintenance and safety rather than for biodiversity. Nevertheless, they can still be habitats for biodiversity, though these sites often support generalist taxa and not habitat specialists (Cook and Faeth 2006).				X	X		X		

Golf courses	These spaces can be relatively large in area but homogenous and simplified in their ecological structure: for example, turf grass is often the dominant plant species, and there is relatively little canopy cover (Threlfall et al. 2016a). However, in some regions, golf courses support endangered habitats (e.g. wetlands in England) and can be essential habitats for supporting urban biodiversity if carefully designed (Colding and Folke 2009). The design of golf courses requires some areas (e.g. greens, fairways) to be intensively managed turf grass, yet other areas can support greater vegetation complexity and provide habitat for biodiversity (Threlfall et al. 2016b).	w	X		X
Community and allotment gardens	These spaces are often managed by multiple individuals who have been allocated a space within the garden, although sometimes the whole garden is communally managed (Egerer et al. 2018). Management is often intense and diverse due to the many gardeners involved, leading to high levels of habitat heterogeneity and species diversity. Policies can restrict decisions in some gardens.	X		X	
Informal green spaces	These areas are not subject to traditional land use planning and management, and include vacant or abandoned lots, street and railway verges (Rupprecht et al. 2015), and "wastelands" (Kowarik 2018). They may be publicly or privately owned but are subject to little organised planning, design, or management. Spontaneous ecosystems can emerge from these systems.				

particular species are labelled as weeds) can also reinforce the political drivers of urban landscape configuration (Rappaport and Horn 1998). In this model, additional information does not necessarily lead to 'better' decisions but instead tends to reinforce inequality in outcomes as information is also unequally distributed.

Individual preferences, beliefs, and values

In psychology, people's values, beliefs, and preferences are seen as key determinants of decision-making (Ives and Kendal 2014). **Transcendental values** are the broad, guiding principles that shape the way people interact with the world (Schwartz 1994). While there has been much research on people's environmental values and how they shape pro-environmental behaviours (Stern et al. 1995), research has also identified a 'value-action' gap that highlights that many people act inconsistently with their values (Shove 2010). However, in rational decision-making processes, values are seen as important in shaping objectives and priorities and are increasingly being elicited from stakeholders through activities such as structured decision-making that explicitly seek to understand stakeholder values and objectives (Martin et al. 2018). **Beliefs** are the things that people hold to be true (although they may not be supported by evidence). A variety of beliefs are important in decision-making, including beliefs around the consequences of decisions and normative beliefs around the way people think the world should be, and are influenced by environmental concerns and awareness. **Preferences** are a type of attitude that describes people's judgments about how much they like a thing, often from a set of alternatives. In urban ecology, preferences have been identified as a key filter operating in urban ecosystems to determine species composition (Williams et al. 2009). A range of theories in environmental psychology have been used to explain people's preferences. Evolutionary theories argue that humans have an evolved preference for landscapes that provide good habitat, while cultural approaches show that preferences can vary between different cultural groups. Values, beliefs, and attitudes are often placed in a hierarchy, where values are seen to influence beliefs, which in turn are seen to influence preferences/attitudes (Ives and Kendal 2014).

Psychological theories based on individual values, beliefs, and preferences have been used to explain decision-making and behaviours around urban habitat. The theory of planned behaviour (Ajzen 1991) proposes that people's beliefs (e.g. about their ability to take an action), personal and social norms, and attitudes influence behavioural intentions. Value-belief-norm theory (Stern et al. 1995) argues that values and beliefs about the consequences of actions are important predictors of decision-making. Theories from sociology and human geography tend to focus less on the individual and more on the political and social structures individuals are acting within. An important theory bridging social structures and individuals is practice theory – rather than focussing on individual agency. as psychological approaches do, practice theory focuses on behaviours that are reproduced and negotiated by individuals as part of their sense-making in the world (Hargreaves 2011).

Social/cultural and evolutionary drivers

As well as individual factors, cultural and social factors can be strong drivers of decision-making around urban habitats. Social norms are the informal rules that shape everyday decisions and behaviours within social or cultural groups. A range of studies have shown that people's gardening decisions and behaviours around plant selection are shaped by their cultural background. For example, people from Mediterranean cultures are more likely to plant food plants, while people from British cultures are more likely to plant shade trees (Fraser and Kenney 2000). Food preferences and cultural associations with specific plant species and varieties can shape the flora of a garden habitat (Glowa et al. 2019). Social norms around lawn care can lead to the homogenisation of urban residential habitats (Goddard et al. 2010). Another group of theories suggest that people's response to the environment around them is genetically determined – humans have evolved to prefer particular landscapes and live in the landscape in particular ways that maximise genetic fitness (Orians and Heerwagen 1992). For example, people liking plants with large green leaves can be seen as an evolutionary response to an environment – humans are programmed to prefer signs of high nutrient and water availability (Kendal et al. 2012a).

Environmental drivers

While social drivers are an important influence on decision-making, contextual environmental considerations are also important constraints on decision-making. For example, the climate of an urban region can shape urban forestry and greening plans or home gardeners' plant selection. Irrigation or shading may allow urban residents to grow plant species beyond their climate niche thresholds, though temperature variation can still be a challenge to manage (Egerer et al. 2019). Climate change and increasing urban heat presents many new challenges to decision-makers, from increasing temperature to precipitation extremes. Forecasted climatic conditions are often unfamiliar; city climates are forecast to shift the equivalent of hundreds or even thousands of kilometres towards the equator. It remains to be seen what plant species will be selected, how changing species selection will influence genotypic and phenotypic diversity, and how these unfamiliar species will be managed in urban habitats by human actors worldwide. A range of other important environmental drivers include soil geochemistry, wind flow, and topography.

Emerging trends in decision-making affecting urban habitats

Decision-support tools, data, and techniques

Many realms of professional decision-making are increasingly being supported by tools and technologies, interdisciplinary research methods, and citizen-science interfaces. There is increasing use of geographic information systems (GIS) to capture and disseminate information on urban habitats, such as tree cover, tree species inventories, species observation records, and the location of different land uses, including protected areas. Spatially explicit data is being collected by community members through tools such as Public Participatory GIS (PPGIS: Gulsrud et al. 2018). Some governments at municipal, state, and federal levels are starting to make data more available through open data platforms online. This allows novel data analyses to be conducted to inform decision-making (Kendal et al. 2017a). Structured decision-making, a process for capturing objectives and values and modelled predictions (e.g. ecosystem services) of the outcomes of decisions, including uncertainty, is beginning to be used more widely in ecosystem management (Martin et al. 2018).

Citizen science

Citizen science methods can affordably and effectively expand the capacity and breadth of urban ecological monitoring in relation to management decisions by involving the decision-makers in the research process, which can also help build community participants (Bonney et al. 2009). This is particularly effective for broad biodiversity assessments or hard-to-access sites in urban areas. Urban ecology research using citizen science studied residential plant management in backyard gardens and parks (Cooper et al. 2007) and garden water management (Lin et al. 2018). Participation in citizen science programs can improve environmental education in society and community engagement in science to affect management decisions (van Heezik et al. 2012).

Future research

There are many key questions that still must be answered in future research to improve human decision-making around urban habitats. This is particularly important for urban conservation and biodiversity management, the focus of this edited book. A key challenge remains to better understand the effects of decision-making scale on ecosystem properties, including diversity of different taxonomic groups, structural heterogeneity, functional redundancy, and response diversity. Many different decision-makers working in small patches from allotment plots to yards may lead to increases in plant species richness and structural complexity at neighbourhood and city scales (Kendal et al. 2010). Yet coordinating decision-making across larger scales could lead to better conservation planning for particular species (e.g. birds; Belaire et al. 2014; Goddard et al. 2010). Another key challenge is understanding how first nations perspectives can be incorporated into better decision making in urban ecosystems, an issue that is of growing importance in international policy frameworks. Research that explores the broad range of actors that influence urban habitats and their different motivations, preferences, and behaviours is needed to make sense of decision-making in complex urban social-ecological systems.

Conclusions

In this chapter, we have shown that there are a myriad of ways that human decision-making influences urban habitats. There are a range of ways of making sense of this complexity. Key mechanisms by which people influence urban habitats include governance, policy and regulation, planning and design, and management. Decisions can have both intended and unintended effects, and these effects can be positive or negative (and sometimes both for different taxonomic groups). Decisions can have very different spatial and temporal effects, and some decisions accumulate over space and/or time. There are many different actors that influence different land uses. A diverse range of social theories can be used to explore and explain human decision-making. These theories suggest that individual (e.g. values, beliefs, and preferences), cultural, and even genetic factors can influence human decision-making and behaviours. Urban habitats that support complex species assemblages, and high levels of ecosystem function and ecosystem service provision, require improved decision-making. Decision-making continues to evolve through the explosion of increasingly available data, improved tools and technologies, and processes that incorporate community views, citizen science, and scientific evidence. Such progress will improve decision-making and community support for decisions of urban habitat management.

Key companion papers

Aronson, M.F.J., et al. 2017. Biodiversity in the city: Key challenges for urban green space management. *Frontiers in Ecology and the Environment* 15(4):189–196.

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