Journal of Forestry, 2020, 1–11
doi:10.1093/jofore/fvaa055
Research Article - urban & community forestry
Received June 29, 2020; Accepted November 23, 2020
Advance Access publication December 29, 2020

Research Article - urban & community forestry

Natural Area Forests in US Cities: Opportunities and Challenges

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Abstract

Not all urban greenspace is the same. Natural area forests can provision more benefits than designed landscapes, and healthy natural area forests can provide more benefits than degraded and invaded forests. Yet there is little information about the scale of natural areas in cities and their management systems. We used data sets on city parkland from across the United States and surveyed practitioners to understand urban natural area forest extent and management. We find that urban natural areas are a dominant greenspace landcover, accounting for 68% of total city parkland across 96 of the most populous cities in the United States in 2019. In the same cities over a five-year period (2014–2019), natural area parkland decreased by 4% (15,264 hectares). At municipal scales, most cities are managing forested natural areas to conserve native species. Across the 108 organizations and 92 cities that responded to our online survey, many different management interventions are being used to steer forest structure and composition. These activities and their outcomes are being tracked nearly 70% of the time by the managing organizations, suggesting a strong data basis for adaptive management. However, challenges exist: 94% of organizations cite invasive species and limited funding as primary challenges. Lack of data and low public awareness of the value of natural areas are also considered primary challenges by more than 70% of the organizations surveyed. As cities embark on efforts to expand and improve greenspace, protecting natural area parkland from development and addressing the challenges managers of these ecosystems face are two very important goals.

Study Implications: Urban forested natural areas contribute to improving the livability and sustainability of cities. However, urbanization has environmental consequences that can lead to declines in tree canopy, introduced species, and the degradation of forest condition. Because urban forested natural areas are both vulnerable and valuable, ambiguity orbits around appropriate policies and management priorities. We provide the first national assessment of urban forested natural area coverage in cities and their management systems. This baseline data can be used by cities as a point of reference to begin to understand and contextualize natural area forests and common management challenges. This study highlights an emerging field of common forest management strategies adapted to dealing with urban situations that could lead to best-management practices for complex human-impacted forest ecosystems.

Keywords: urban forestry, urban tree canopy, invasive species, urban ecology, forest restoration, urbanization, land development, urban planning, forest management

Expanding the amount and improving the quality of greenspace is a common strategy to make cities more livable (Livesley et al. 2016). As cities look to greenspaces to mitigate heat, absorb stormwater, and provide areas for recreation, the type of greenspace influences the magnitude of benefits provided (Kondo et al. 2015, Mexia et al. 2018, Vieira et al. 2018). Natural area forests can provision some benefits at disproportionately higher rates per area compared with designed parkland. For example, forests can have a greater cooling effect on cities than designed greenspaces, and the bigger the forest, the greater the effect (Jaganmohan et al. 2016). In addition, forested natural areas provide critical habitat for native plants and animals safeguarding and connecting local biodiversity in a fragmented landscape (Ives et al. 2016). The provision of ecosystem services and protection of biodiversity are two commonly reported metrics in city sustainability goals (Nilon et al. 2017), with natural areas therefore having potential to contribute to these goals. However, natural areas are not featured prominently as nature-based solutions in city plans (e.g., policy reporting, climate action plans, and city resiliency plans) (Nilon et al. 2017). This lack of representation may arise from the lack of common descriptive data for urban natural areas, which could contribute to a lack of awareness and hence incorporation of natural area forests into actionable greenspace planning.

Common measurements of any natural resource are important to raise awareness, shape policy, contextualize patterns and processes, and allow for comparisons among management outcomes. Existing methodologies to assess and value urban forests across cities include remote sensing of urban tree canopies (Nowak and Greenfield 2010, Alonzo et al. 2016) and field-based, plot-level sampling to measure forest structure and composition (Nowak et al. 2008). Such approaches show the value of urban forests (Nowak et al. 2007), have been the basis for broadscale justifications and planning of urban tree planting programs (Locke et al. 2010), and inform urbanization and climate models (Lin et al. 2019). However, assessments that have focused on measuring the entire urban forest or city tree canopy (e.g., all trees in the city) typically do not distinguish between natural area forests and trees growing in designed environments (e.g., street and yard trees). The distinction between these canopy types is important for accounting, policy, management, and assessment of greenspace. For example, an assessment in New York City that stratified and measured natural areas apart from the rest of the tree canopy showed that the majority of trees and forest biomass occur in natural area forests; albeit they are a minority (25%) of the total tree canopy area (Pregitzer et al. 2019). Furthermore, the management required and challenges faced are different in natural areas compared with trees growing in designed landscapes. Street and yard trees are managed on a more individual basis (e.g., planted and removed upon mortality), drawing on arboriculture principals. Trees growing in these highly constructed environments can experience challenges to their growing environment such as confined rooting zones, which can lead to tree mortality (Roman and Scatena 2011). Natural area forests, in contrast, are managed as a stand of trees or a collection of stands, where trees can naturally regenerate and upon mortality are typically left in place to decompose. The management of forested natural areas applies silvicultural and ecological restoration principals. These differences make characterizing the condition, types, and management systems of urban natural areas an important part of urban greenspace management and policy.

Communicating priorities, understanding conditions, and implementing management and monitoring are a part of adaptive management strategies foundational to forest ecology and management. Forest management principals have been adapted to the urban context and have documented successful outcomes—for example, management of exotic invasive species and tree planting (Oldfield et al. 2014, Johnson and Handel 2016, Simmons et al. 2016)—but these outcomes are not well summarized beyond an individual site or project. The full breadth of management actions taken to deal with urban conditions has not, as far as we are aware, been assembled at a national level, and many questions and challenges about the applications of local findings to other city contexts remain (Oldfield et al. 2013). Management efforts are usually embedded within the structure of city parks and recreation departments, but little is understood about the challenges that cities face on a collective national basis. To characterize natural area parkland across the United States, we asked a series of questions about natural areas in cities and their management. To first understand the basic composition of urban natural area parkland, we asked: How commonly occurring are, and what is the area of, urban natural area forest in major cities of the United States? Is the amount of urban natural area changing over time? Then, to understand the management of urban forested natural areas, we asked natural resource practitioners who specifically manage these areas: (1) What are your primary factors (goals)

considered in management? (2) What management interventions do you conduct? (3) What are the main challenges you face? (4) What management plans, policy reporting, and data do you use?

Methods

We drew on two data sets to describe trends in urban natural area parkland and its management across the United States.

Characterizing Natural Area Parkland Nationally

To characterize the amount of natural area parkland nationally, we used existing data compiled as part of the "city parkland survey" by the Trust for Public Land, Center for City Park Excellence (www.tpl.org). On a biannual basis, the 100 most populous cities in the United States self-report attributes about their city's parkland. The attributes we used were hectares of total parkland, natural area parkland, and designed parkland in each city. Their working definition of natural area parkland is as follows: "Natural and undeveloped areas are pristine or reclaimed lands that are left largely undisturbed and managed for their ecological value (i.e., wetlands, forests, deserts). While they may have trails and occasional benches, they are not developed for any recreation activities beyond walking, running, and cycling." Their working definition of developed parkland is the following: "Designed areas are parklands that have been created, constructed, planted, and managed primarily for human use. They include playgrounds, neighborhood parks, sports fields, plazas, boulevards, municipal golf courses, municipal cemeteries, and all areas served by roadways, parking lots, and service buildings." Using data from 2014 and 2019, we calculated the total hectares of natural area parkland, designed parkland, and total parkland. We then calculated the proportion of natural area parkland of the total, the total change between 2014 and 2019, and the percent change of natural area parkland in each city. Three cities did not report values for both years, so we excluded them from our analysis (Richmond, VA; Ft. Wayne, IN; and Indianapolis, IN). Anchorage, AK, reported having >283,400 hectares of city parkland (Supplementary Table 1), close to the collective amount of the rest of the cities combined; because this skewed the overall results substantively, we chose to not include it in our analysis. Because estimates of natural area parkland include more than just forested natural areas (e.g., also open grasslands and marshes), we treat those numbers we report as the maximum (and presumably an overestimate) of forested natural area. However, because forest can be the dominant landcover type historically in many cities, we expect the results do reflect general trends in forested natural area cover, as a type of natural area parkland across cities in the United States.

Urban Forested Natural Area Survey Development and Deployment

To understand the goals, activities, and challenges of managing urban forested natural areas, we developed a survey and solicited responses to a questionnaire from practitioners that specifically work in urban forested natural areas in cities having more than 50,000 people across the entire United States. The survey creation was an iterative process, with questions developed and then revised with input from external advisors and potential respondents (see "Acknowledgments"). The survey was administered online using Qualtrics Survey Software (Qualtrics, Seattle, WA, USA) under site license to Yale University. Because there is no active network for this specific type of land manager, we relied on existing networks of urban park professionals and urban forestry professionals to broadly distribute the questionnaire. We provided the following operational definition of urban forested natural area: "Forested natural areas refer to woodlands and remnant forests which occur as a forest stand, or a collection of stands. Forested natural areas are often managed at the stand level, with trees considered collectively as a forest, rather than on an individual basis. Street trees or park trees are not part of forested natural areas, and are often managed individually. Forested natural areas can be different ages and sizes but typically are >0.25 acre and can be young developing stands or mature remnant forests."

During the spring of 2018, the survey was distributed in partnership with the Trust for Public Land to the 100 most populous cities across the United States, the same network that completed the city parkland survey. Then, to reach a broader audience, the survey was further distributed to urban forest managers in cities that had >50,000 people. In our solicitation, we asked that if the recipient's organization did not own or manage urban forested natural areas, for the recipient to forward the survey to appropriate urban forest managers in their city or network. In each case, we sent the original solicitation and two follow up requests. The survey respondents were asked to represent their organizational views, not their personal views, as

most questions were focused on land management activities and approaches of the organization at large, rather than the individual's role or experience. Only completed surveys were used. Any respondents that completed the survey but explicitly did not manage forested natural areas were identified by a filter question and removed from analysis. In total, 1,314 individuals received the survey over e-mail. One hundred sixty-six people started the survey, and 108 responses qualified for analysis. Therefore, we estimate a response rate of 8.2%. Just under half of responses (48) were from the 100 most populous cities—meaning that a response rate of 8.2% translated to responses from approximately half of those eligible cities—and the remaining responses (60) were from less populous cities (but still with >50,000 people). For 10 cities, we received more than one response, each representing a different organization. In all cases, either the land ownership, management jurisdictions, or scale at which the organization worked were different. We therefore included these responses, treating them as independent because they represented management in urban forested natural areas for an organization's distinct mission and goals.

The survey questions included both qualitative and quantitative questions. Questions were focused on the care of forested natural areas through management activities, reporting and planning, data and information available for decisionmaking, organization size, education of staff, and challenges for management. Our quantitative (both ordinal and categorical), closed-end questions used a predefined set of response categories facilitating direct comparison across all respondents. Qualitative, open-ended questions, by contrast, provided respondents the opportunity to develop their own answers. Organizational demographic data were also collected to determine organization size and education of both field and managerial staff. In this article, we report on a subset of the questions. The full questionnaire is in the Supplementary Materials.

Data Analysis

Closed-ended questions were primarily analyzed by calculating the proportion of the total number of respondents to that question (n = 108). In a handful of cases (n = 3), a respondent did not populate answers to each field in a multipart question. Because the majority of that question was answered, we kept these responses and reduced the sample size for that field to the total completed responses (n = 105–107). In cases where a range was given as a multiple choice (e.g., 1–10), we used the median value in totaling responses (e.g., total hectares). In this article, we specifically focus on the subset of the questions related to forested natural area management themes and challenges. The questions included in this survey are indicated in the Supplementary Materials. Summary statistics were calculated using the open-source statistical software R (version 3.6.2; R Core Team 2020).

Results

Characterizing Natural Area Parkland across the United States

The majority of city parkland is natural, rather than designed (68% in 2019). The total amount of natural area parkland reported across 96 US cities was 317,465 hectares in 2014 and 302,201 hectares in 2019 (Table 1). The mean percent of total city area for natural areas parkland was 7% in 2019. In total, natural area parkland declined by 4% (15,264 hectares) over the five-year period. The amount of natural area parkland per city ranged from 0 (Newark, NJ;

Table 1. Total hectares of designed and natural area parkland in 96 of the most populous cities in the United States.

	2014	2019
Natural area parkland		
Total hectares reported	317,465.6	302,201.2
Mean (± standard deviation [SD]), median hectares per city	3,306.93 (±4,885.0), 1,005.9	3,147.93 (±4,635.3), 1,130.97
Designed parkland		
Total hectares reported	125,436.4	141,515.0
Mean (±SD), median hectares per city	1,306.63 (±1,261.6), 981.4	1,474.11 (±1,442.6), 1,013.2
Total parkland		
Total hectares reported	443,455.1	443,716.2
Mean (±SD), median hectares per city	4,619.3 (±5,560.5), 2,145.3	4,622.04 (±5,282.7), 2,309.7

and Helali, HI) to 24,114 hectares (Jacksonville, FL), and designed parkland ranged from 110 (San Diego, CA) to 20,224 (New York, NY) hectares in 2019. Just over half (51 cities) lost natural area parkland cover, whereas just under half (45 cities) saw an increase in natural area parkland cover over the five-year period. The percent change in natural areas parkland ranged from –100% to a +3797% per city (Supplementary Materials). Of the 51 cities that saw a decrease, the mean percent change was –22.9%, and of the 45 cities that saw an increase, the mean change was 169%, but the median was +10%. During the same period of time, overall parkland increased by 261 hectares and designed parkland increased by 16,078 hectares (Table 1), which suggested then that designed parkland is at least in part replacing natural area parkland.

Land Manager Survey Demographics

Results represent 108 survey responses from 36 states in 92 cities across the United States that actively manage urban forested natural areas. The majority of respondents (66%) were from municipal governments, 16% were from nonprofits, 8% were from state and local governments, and 10% of the respondents listed "other," which often included unique governance structures of private-public partnerships. The total hectares of forested natural areas represented by the respondents include an estimated 124,936 hectares. Most of the organizations (84%) are the primary landowner, whereas 8% manage but did not own the land, and 7% did not know the number of hectares owned or managed by their organization. Responding organizations have been managing forested natural areas for different amounts of time, with 28% managing forested natural areas for less than 20 years, 34% between 20 and 50 years, 31% for more than 50 years, and 8% "did not know." Forty-three percent of field staff, and 74% of senior management had a college degree in some field of natural resources.

Primary Factors Considered in Management Decisions

Conservation of native species was a primary factor in decisionmaking with a majority of respondents (61%) listing it as one of their top three factors. Plant biodiversity was the second most common factor considered with 40% of respondents listing it in the top three (Figure 1). Urban heat island, climate change, public access, and proximity to low-income neighborhoods had the lowest number of respondents (<10%) listing them as primary factors in their decisionmaking. This could be a signal of general lack of consideration in decisionmaking for these same factors, rather than them being secondary to another factor, because the majority of respondents (>50%) listed these factors as something they did not consider (Figure 1).

Types of Management Interventions

Invasive understory species removal is the most commonly conducted management activity, with 91% of respondents conducting this activity (Figure 2). Most respondents were conducting all listed management activities except for release thinning[1] of native trees (Figure 3). Although the focus is on conservation of native trees, release thinning as a type of forest stand improvement is reported as a rare type of management activity for urban natural area forests. Invasive tree removal is, however, commonly conducted (75% of respondents; Figure 2). When management activities are implemented, in all cases the outcomes were monitored nearly 70% of the time for all types of management (Figure 2).

Challenges to Natural Area Forest Management

All the challenges listed were considered important or very important by the majority of respondents (Figure 3). Limited funding or staff and invasive species were ranked jointly as the top challenge, with 94% of respondents listing them as very important or important. Limited data was ranked as an important challenge with 77% of organizations listing it as important or very important to achieving their goals. Uncertainty in management approach was considered to be the least important of the listed challenges, yet 56% of all respondents still considered it important or very important (Figure 3).

Data Available and Used for Management

Maps of conservation zones are the most common type of data available, with 68% of respondents having and using these maps. Half of respondents (50%) reported having ecological baseline data on measures of groundcover composition and cover (Figure 4), and 43% reported having and using measures of forest structure and composition in their decisionmaking. Climate change projection data were used for management decisions by only 26% of respondents, despite most organizations (68%; Figure 3) listing climate change as a challenge that natural area forests face. Less than a quarter (23%; Figure 4) reported having data on understory tree regeneration. Some data on social measures such as the number and

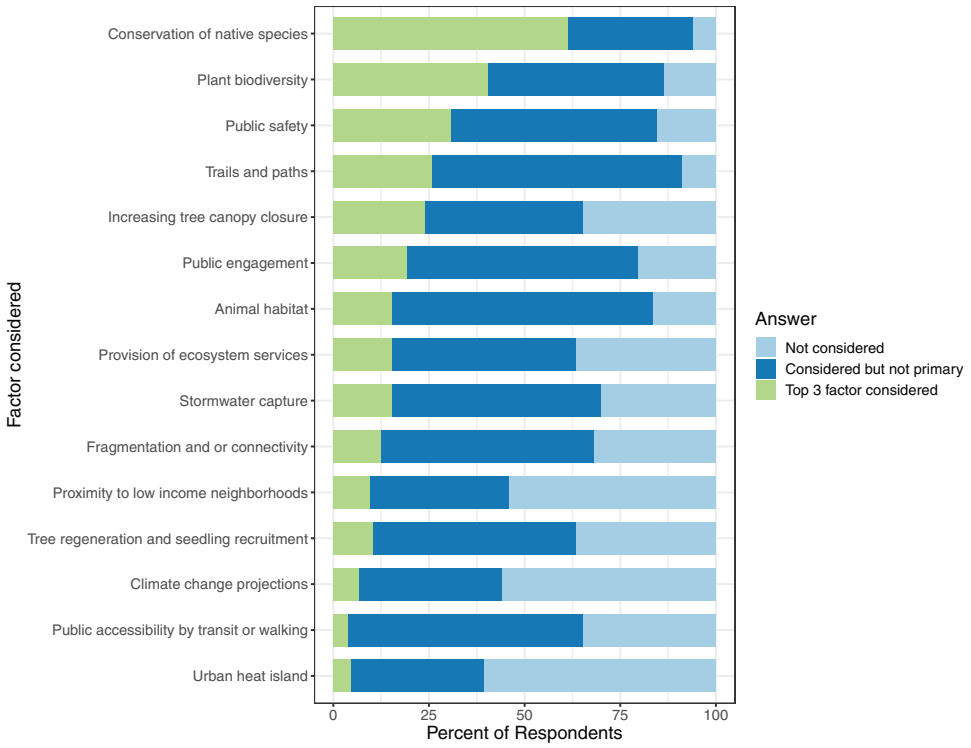

Figure 1. Primary factors survey respondents (n = 108) considered in decisionmaking for urban natural area forest management. Green bars represent the proportion of each factor that was ranked in the top three, by the 108 organizations that responded, of all the listed factors considered for decisionmaking.

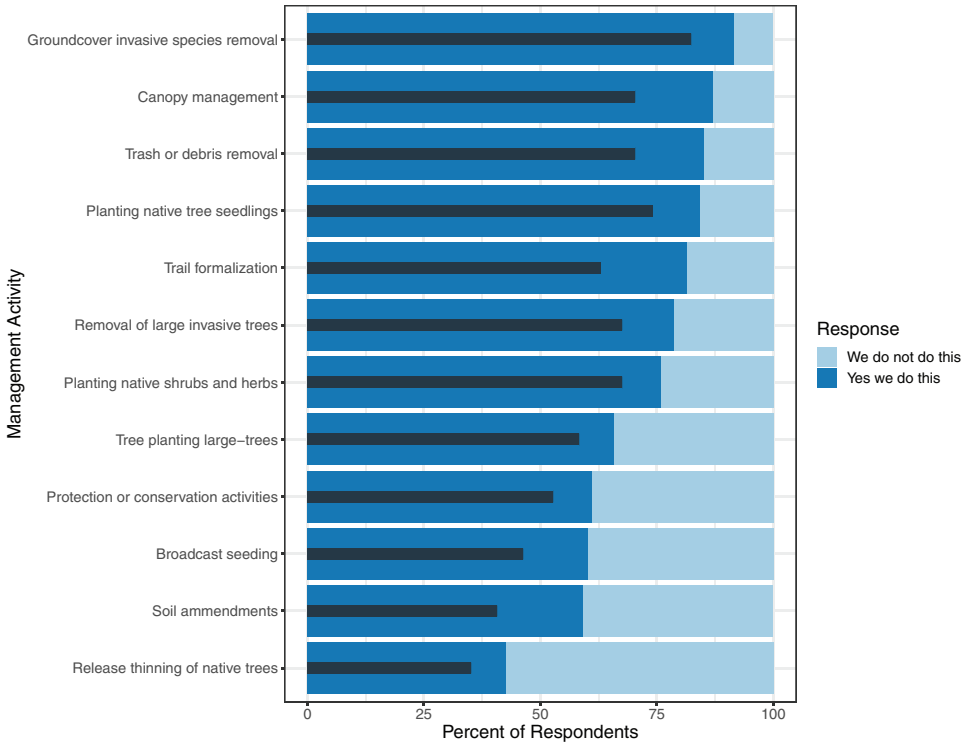

Figure 2. Management activities conducted in urban forested natural areas by organizations (n = 108) in cities across the United States. Responses show the proportion of the responding organizations that do each activity (dark blue) and, if they do that activity, the proportion that does some monitoring of those actions (gray, narrow embedded bars).

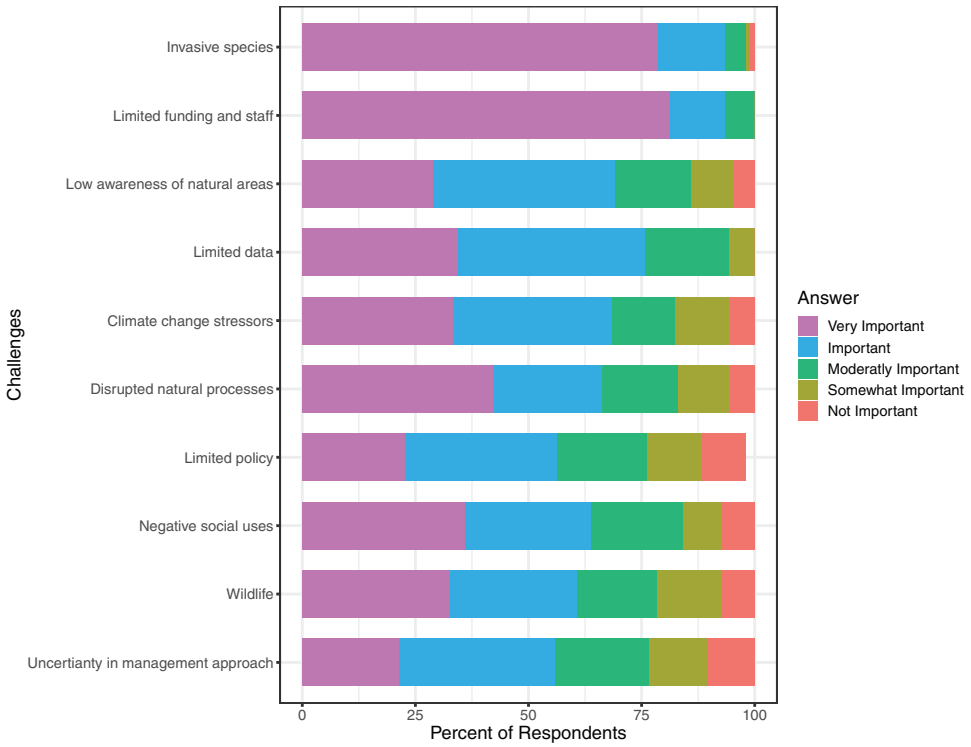

Figure 3. Challenges that organizations (n = 108) face in urban forested natural area management. Responses show the level of importance, as rated by each responding organization, of each factor.

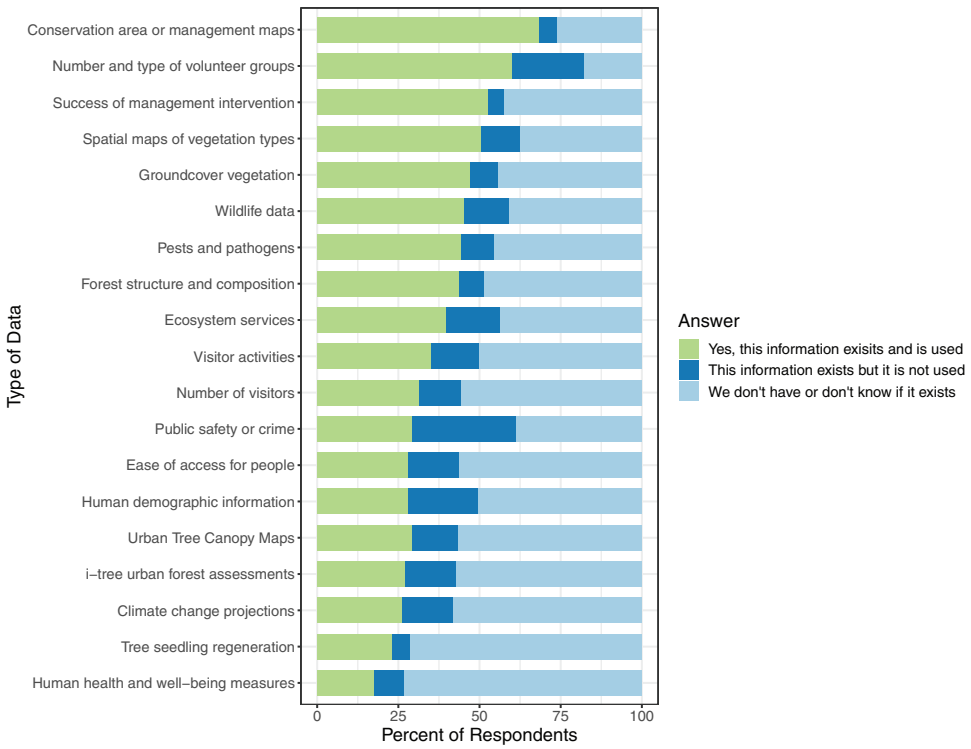

Figure 4. Data available and used for decisionmaking by organizations (n = 108) managing urban natural area forests. Responses show the proportion of responding organizations that have access to and use different social and ecological data to manage forests in their city.

type of volunteer groups were available and used by the majority of respondents (60%). Whereas other measures, such as data on human health and well-being effects of natural areas were not widely available, with only 17% of respondents having such data. In some cases, data that were available were not used for decisionmaking. For example, social data on crime, demographics (e.g., race and income), and the number and types of volunteer groups were sometimes not used (21–32%), and ecological data on ecosystem services, tree canopy cover, and i-Tree reports (www.itreetools.org) were not used by 15–16% of respondents (Figure 4).

Discussion

Net Loss of Urban Natural Area Parkland

Overall, we found a net loss of natural area parkland across US cities. Reported changes were especially dramatic in some cities. For example, the city of Houston (TX) lost 30% of its natural area parkland (7,960 hectares), and Nashville (TN) lost 28% of natural area parkland (3,294 hectares), between 2014 and 2019. As human populations increase, open land is converted to accommodate development, and both Houston and Nashville saw an increase in population during the same five-year period. Because the total hectares of natural areas lost is greater than the hectares of total parkland lost, we expect that some of the natural area parkland remained parkland but was converted to designed parkland (which saw a net gain). The consequences of natural area parkland decline could lead to losses in quality of life for residents and of biodiversity. For example, less access to nature or lower-quality nature can lead to lower levels of physical activity for people (Oyebode et al. 2015) and lower city resilience to increased temperatures (Melaas et al. 2016), and plants and animals can become locally extinct through habitat loss.

At the same time, natural area parkland in many cities increased. The city of Detroit (MI) saw a 353-hectare increase in natural area parkland, and New York City saw an increase of 95 hectares. This could be a result of proactive park acquisition. During that period in New York City, the conversion of a former landfill, Freshkills Park, was completed and added natural area parkland to the city's portfolio. Detroit has experienced significant population decline, losing more than 50% of its population in the last 70 years (change from ~1.8 million to ~700,000 people), because of a decline in industry and economic collapse. The increase in parkland there could be connected to the conversion of vacant houses to open space and changes in zoning and land ownership because of these circumstances. Notably, the city of North Las Vegas saw a 3,797% increase, or a change from 169 hectares in 2014 to 6,595 hectares in 2019, which is due to the inclusion of natural areas under the jurisdiction of the Bureau of Land Management that fall within the municipal boundaries and not likely because of a change in land use type or ownership. This example highlights how self-reporting of land cover, rather than using common quantifiable methodologies could provide some inaccuracies. However, in all cases, these shifts are specific to the circumstances and data available in each city, and given that much of urban parkland is typically owned, regulated, and managed locally by municipal governments, there is opportunity for more coordination within and across cities on land use metrics. Urban natural area parkland is a primary way in which the majority of the population experiences everyday nature and seeks refuge (Sonti et al. 2020). Therefore, it is important to learn more about the factors driving decisions to convert natural area land to other uses and to look at drivers of decisions that add natural area parkland to a city. Factors such as the quality of natural areas or human and neighborhood demographics could be important to evaluate in the decisions to convert, protect, or acquire natural areas.

Management of Urban Forested Natural Areas

We found evidence of well-established urban natural area management programs in cities across the United States. Although many factors are considered in decisionmaking, the evidence that native species conservation is a dominant factor suggests that the functioning of native-dominated forest ecosystems in cities is highly valued. Most organizations are using multiple approaches across forest structural layers to promote native species and healthy forests. Removing invasive species and planting tree seedlings in the groundcover layer are especially common management activities, suggesting the long-term trajectories of city forests are considered. Invasive species groundcover can outcompete native species, and this could lead to a decline in forest succession and health (Martin 1999, Stinson et al. 2006). The management strategies reported to conserve native species suggest that the establishment of native species and shifting the trajectory of areas with invaded groundcover toward native species are applied across most cities.

Invasive species removal and large-scale tree planting efforts are, however, expensive. It is perhaps then not surprising that limited resources and staff are a top challenge. Despite these limited resources, our survey found that most organizations are conducting similar management activities and monitoring the effectiveness of management interventions. Yet, uncertainty in management approaches remains. Uncertainty in management approach was considered the least important challenge, yet 56% still considered it important or very important. This result may suggest that there is an opportunity to synthesize management outcomes from multiple cities to begin to document, and then establish, tested techniques in urban settings across multiple cities. Certainly, documentation of adaptive management in different contexts was the basis for establishing proven silvicultural recommendations that ultimately have turned into management principals in rural forests. The same approach might therefore be profitably adopted for urban forests. However, unlike national parks and state or national forest systems, the ownership and management of forests in cities is siloed and bounded by individual-city municipal governments and local organizations. Therefore, to cross city boundaries and distill information on urban natural area forests and their management, additional coordination and incentive will likely be needed to connect city stakeholders.

The majority of organizations list data availability as a challenge. A lack of data does not mean a lack of appropriate management. Managers often act on experience and personal observations as evidence to justify a specific management intervention (McKinnon et al. 2015) but view that these decisions can be improved when vetted with data. Notably, baseline data (e.g., forest structure and composition and climate projection) are less commonly available/used than data on monitoring and management activities. Keeping track of management outcomes can help to justify the resources needed and being spent to achieve desired conditions and to adapt appropriately. However, it appears there could be an opportunity to come to consensus on some fundamental data sets (e.g., amount of natural area forests, forest structure, and forest composition) that could be collected uniformly across cities. These types of data across multiple cities and metropolitan regions could help to bridge understanding of forests and best-management principles across cities, regions, and the nation.

Part of the reported lack of awareness and policy in urban forested natural areas could be due to lack of common metrics across cities (aside from what we provide in this article). The use of evidence-based conservation targets (sensu Odum 1970) is an approach to connect science and data to policy and decisionmaking. Building policy or management decisions based on anecdotes and personal experience, rather than standardized evidence, can lead to unsuccessful, expensive, and repeated mistakes (Sutherland et al. 2004). In the case of cities, it appears there is growing awareness that a collective resource that documents management interventions and their outcomes might be valuable for informing forest management in urban environments. Such a structured resource could help to contextualize the unique and specific management that occurs in the urban environment and build a foundation of evidence that can expand the field of practice.

Conclusions and Opportunities for the Future

We found that natural areas are a dominant type of parkland in US cities. There appears to be an emerging field of common forest management strategies adapted to dealing with urban situations that could be further developed into best-management practices for urban environments. Investing in knowledge sharing and synthesis from land managers who have expertise and local data could help to connect local cities to a regional network of practitioners facing similar challenges. There also seems to be an opportunity to reposition the relative importance and role for this type of urban greenspace in cities. Bringing together the field of practice across cities might be one mechanism to redress the lack of awareness about natural area forests that our survey reveals. As urban land continues to expand, safeguarding natural areas within cities will have lasting impacts on the quality of life for millions of people, and yet our work reveals that in some cities and overall, there is a net decline in natural area forest cover. Below we offer opportunities to advance science and management of forested natural areas in cities:

- Accurately characterize city natural areas across the country using methodologies that produce high-resolution maps that distinguish between different types of greenspace, including natural areas across many cities (O'Neil-Dunne et al. 2014). This approach would result in more transparent and accurate estimates of natural area parkland and facilitate the incorporation of natural area planning more easily into decisionmaking.
- Establish guidelines and case studies for legal protection of existing natural area parkland and innovative approaches for land acquisition in cities.

- Further understand and synthesize the types of monitoring data that exist across cities. Use these results to build the case for increased investment in the documentation and management of urban natural areas.
- Strengthen partnerships locally, regionally, and nationally between land managers, decisionmakers, and researchers across cities. Such connectivity could lead to multicity designed experiments that allow for comparisons within and across cities of management interventions. The networks could also serve as educational opportunities for the public to increase awareness of natural resource management and governance of urban forested natural areas.
- Further understand the barriers of using existing climate change projection data for urban areas and gaps in data. Learn from city land managers and decisionmakers what data and delivery of information could support action toward mitigating the negative impacts of climate change impacts in cities. If connected with socioeconomic data, which was also rarely used in decisionmaking, it would be feasible to couple natural area management with environmental justice goals, which seems especially important given that climate change is expected to exacerbate such injustices.

Supplementary Materials

Supplementary data are available at *Journal of Forestry* online.

Acknowledgments

Thanks to all the respondents to the questionnaire. Thank you to Charlie McCabe, Ali Hipple, Bram Gunther, and Rich Hallett for assistance with survey development and deployment. Thank you to Tom Whitmer at Philadelphia Parks and Recreation, and to Rich Love from New York City Department of Parks and Recreation, for assisting with the first draft of the questionnaire. Thank you to Jennifer Greenfeld, Fiona Watt, Erika Svendsen, Lindsay Campbell, and Nancy Sonti for reviewing outcomes of the survey. The JPB Foundation, and a doctoral scholarship to C.C. Pregitzer from the Yale School of the Environment, supported this project.

Endnote

1. Removing native trees in a stand often as an approach to reduce competition and improve forest stand structure and composition toward a more desired trajectory.

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