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Assessing invasive plant species in Louisville's Urban Forest

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Within Louisville, KY's network of urban green space and forests, invasive plant management is vital to protecting biodiversity and allowing native species to thrive. Partners across the city have been working to identify non-native invasive species, map their spread, monitor how they affect native species, and mitigate damage from invasive plants. Much of that falls into three categories:

1) Mapping patterns of invasive plant presence in relation to disturbance

2) Recording the effects of various management practices and

3) Tracking forest health through the regeneration of native tree seedlings and saplings

This data is used to inform management plans and falls under two broad categories: qualitative/descriptive and quantitative/measured. Both data types work together to support a prioritization outline or triage plan for treatments and to understand the effects of land management practices.

Keywords

urban forest assessment, urban ecology, invasive plant management, urban park management, tree regeneration, quantitative data, qualitative data

INTRODUCTION

Invasive plant species significantly impact the health of natural areas worldwide (Barney et al. 2013, Hess et al. 2019, Kalisz et al. 2021, Powell et al 2013). Louisville, KY, is no exception. Both Olmsted Parks Conservancy (OPC) and Jefferson Memorial Forest (JMF) have been managing urban forests to remove invasive species, and along the way, both partners have been collecting qualitative data about the effects of the work. Additionally, some quantitative data is being collected on the patterns of invasive plant presence relative to canopy gaps and on native tree regeneration in areas where invasive plant management (IPM) has occurred.

This case study briefly outlines what each partner has learned and compares lessons and approaches. We hope this provides a starting point for further discussion with other Forests in Cities partners and the broader urban forestry practitioner community.

CONTEXT

JMF is the largest municipal urban forest in the United States at 6,500 acres. This forest is part of Louisville Parks and Recreation (LPR), headquarters of the LPR Natural Areas division, and partners strongly with the nonprofit Wilderness Louisville (WL) to promote development, stewardship, and community awareness. OPC manages a system of 17 parks designed by Frederick Law Olmsted and his sons that cover about 1,000 acres in Louisville. Both JMF and OPC do hands-on work in their respective natural areas, and both WL and OPC advocate and educate about their respective natural areas. A major component of management within JMF and OPC is to monitor and protect biodiversity and natural area health, including through the removal of invasive plant species and replanting and protection of native vegetation.

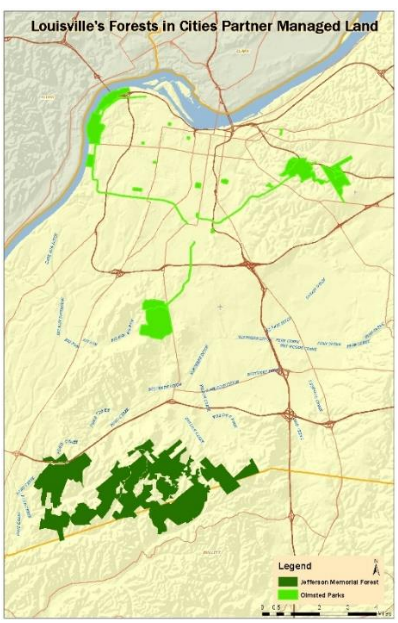

Figure 1. Jefferson Memorial Forest and Olmsted Parks in Louisville, KY.

GOALS

Over the past two decades, both partners have tried various treatment (tx) approaches for invasive management. Qualitative observations are widely used to understand what is and is not working in local IPM. To further inform management decisions, quantitative data has also been collected as a tool to evaluate the effectiveness of management techniques and inform future priorities.

In both approaches, the goal is the same. First, invasive plants are removed from a site (generally on a schedule that will prevent seed formation and spread for that year); second, regeneration of native species is fostered to restore as much ecosystem function as possible. Sometimes, plantings occur to re-introduce species diversity to heavily impacted areas. To achieve this goal, we must know what works.

APPROACH

Many tools can be used across methods. However, there are some differences between qualitative and quantitative data collection. The first chart helps to compare these differences. There are also pros and cons to using each approach, which we compare in the second chart.

Table 1. Comparison of qualitative and quantitative assessment methods.

Category	Qualitative	Quantitative
Invasive plant presence ***(What plants are present? How widespread is the invasion?)***	Cameras may be on phones, handhelds, drones, or even satellite imagery and verify what our own eyes see. Apps such as iNaturalist can also be used to provide basic location and photographic data about which plants are at a location on a given date.	Quantitative data is collected along a series of points/plots laid out in ArcGIS through each natural area. Distance between points is scaled based on the size of the area being surveyed. • Small natural areas (1-13 acres) are surveyed every 50 meters, • medium areas (45-240 acres) every 100 m, and • large parks (>300 acres) of natural areas are surveyed every 200 m. At each point %, age of plot with invasive presences is recorded. ArcGIS maps allow visualization of the data, and Excel tables allow summaries/data evaluation.

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Prioritization **(Triage)**	Management plans and strategies include many considerations *(not limited to)* • funding sources and restrictions, • public visibility and use • connectivity/risk of invasive species spread to other areas • quality/health of the area with the invasion, • autecology of the targeted invasive species *(lifecycle considerations such as when they will produce seed, when the recommended tx window falls, etc.*) • available resources	Generally, our management strategy focuses on all the same considerations, but weights some factors more heavily: • quality/health of the area with the invasion (high quality areas receive extra resources to protect them/keep invasive pressures out as much as possible) • available resources (in some areas, we simply aim to contain/mitigate damage as we recognize we may never be able to eradicate some species from our woods) • autecology of the targeted invasive species (tx is scaled to consider whether a plant is likely to produce fruit/meaningfully spread that year)
Treatment (Tx) approaches	Work generally follows best management practices as outlined by local managers. This may be communicated in writing via email or verbally.	Daily work records are kept using FieldMaps/ArcGIS to specify area covered, target species, tx method, and type and amount of herbicide used (if any).
Evaluation	Visual data is collected on walk-throughs of the areas that have been treated to gauge how effective tx was and to re-evaluate when and how intensely further tx should happen.	Invasive plant surveys are repeated as resources allow (about every five years). Tree regeneration data is collected (species and age classification (seedling, sapling, or larger)) to understand how succession is proceeding differently in areas with different invasive species patterns/tx patterns and to assess the need for supplemental planting projects.

Table 2. Pros and Cons of each assessment style.

Assessment style	Pros	Cons
Qualitative	• Easy and accessible • Less time-intensive than field surveys • Can offer broad information quickly	• Loss of information from staff turnover • Does not allow for numerical tracking, data reporting to verify how well tx works or to demonstrate/compare results
Quantitative	• Shows patterns you might not notice otherwise • Gives hard numbers for grant applications, board presentations, etc. • Can directly compare results to scientific literature	• Time spent completing surveys is not spent doing tx • Requires some basic pre-work to set up survey system and data collection in ArcGIS/Field Maps/Excel • Should be repeated periodically

RESOURCES

Qualitative observations require knowledgeable staff/volunteers that can correctly identify, record, and share information about what species are present, where, and what changes have occurred over time.

Quantitative studies require knowledgeable staff/ volunteers as well, and additionally, we needed to have an ArcGIS license, access to Microsoft Teams (or another cloud-based spreadsheet), 50m measuring tapes, stakes to clearly ID the centers and corners of plots, a DBH (diameter at breast height) tape, and a densitometer for tree canopy readings. Many of these studies were done in conjunction with students from the University of Louisville or Kentucky State University, and the designs were informed by research being done across the region. Funding comes from various sources, including US EPA Regional Watershed Demonstration Projects, Congressional Community Project Funding Requests, and the NFWF Five Star and Urban Waters Restoration Grant Program.

KEY RESULTS

Qualitative data has helped to track progress for IPM work in meaningful ways. This has been and continues to be valuable and indispensable to informing management decisions.

Additionally, quantitative data has allowed us to visualize, prioritize, and explain what we see in the parks.

For instance, in Figure 2 below, we have the results of invasive species monitoring in one park. This helps us create a triage-management plan that prioritizes protecting biodiversity and helps us strategize the time and resources needed to address each area with an invasive plant presence. In 2021, OPC completed this survey for four of our seven parks with natural areas. In 2022, the remaining three will be surveyed.

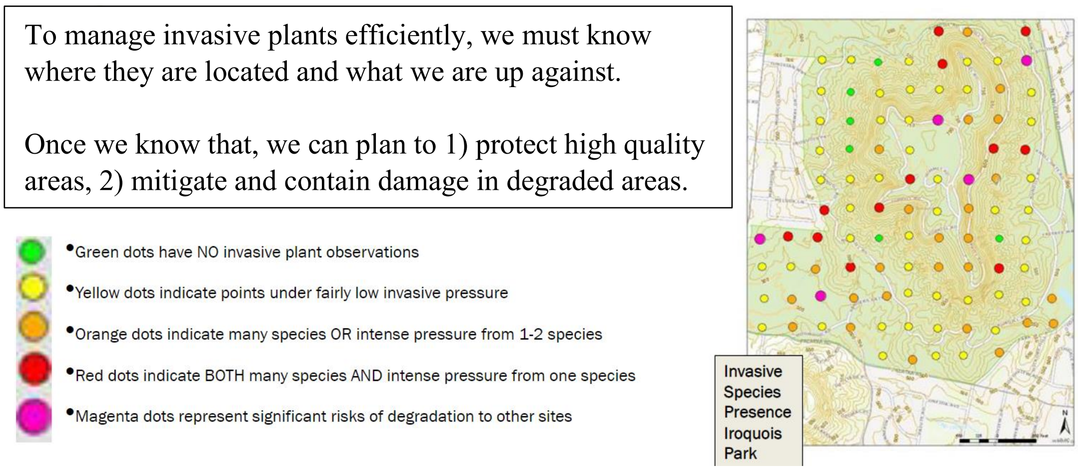

Figure 2. Results of a quantitative study of invasive plants in Louisville's Iroquois Park (an Olmsted Park) that are used to create a triage plan for management.

Figure 3 below demonstrates how we are evaluating tree regeneration in areas where we have managed to remove invasive plants such as *Lonicera maackii*. Plots were sampled first in 2007-2008 to evaluate species and size classification in one urban forest area, then revisited in 2020-2021 to collect the same data. Over the 15-year period, we completed an initial clearing of all invasive shrubs from the area. Data was evaluated through multiple lenses, including the Shannon-Weiner Diversity Index. The Shannon index is one of the oldest and most widely used ways to measure diversity, measuring the proportions of each species against the makeup of the entire community. The richness is representative of species number count, and the evenness tells us if just a few species dominate the ecosystem. We found increasing richness (# of species) in seedlings and saplings as we released the pressure by removing invasives. However, we found low evenness (the consequence of a maple-heavy forest). Additionally, we saw tree diversity values decline. This may be a result of about four decades of invasive shrub growth suppressing trees that should have been growing during that time. The Emerald Ash Borer has also impacted our woodlands contributed to this decline. A final factor to consider is the potential effects of drought and climate change on mature trees in the past decade. Considering all that, our diversity index values are still trending up overall, indicating that the forest is becoming healthier each year.

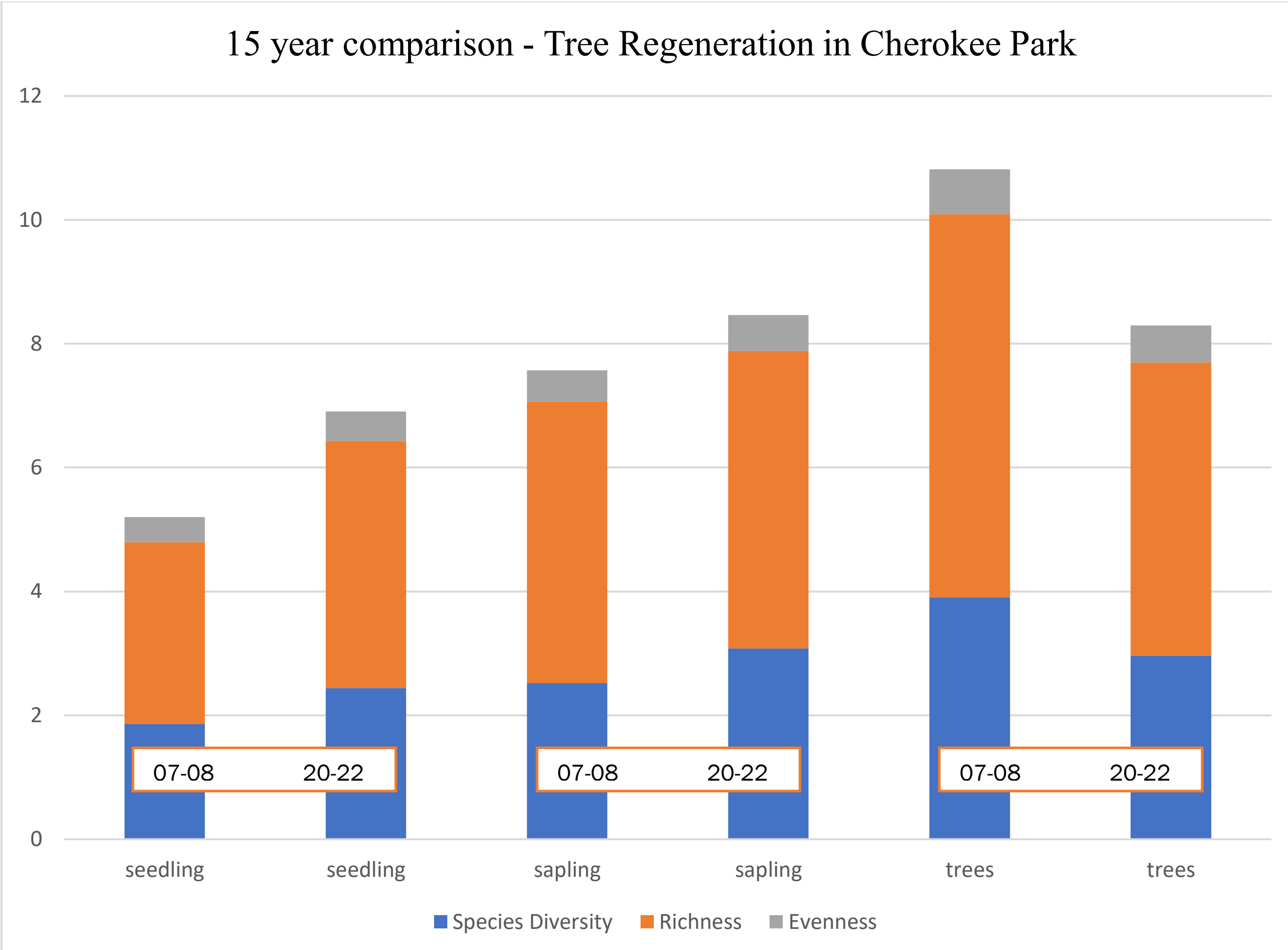

Figure 3. Shannon species diversity index, Margalef richness, and equitability/evenness comparison for tree regeneration plots sampled in 2007-08 and again in 2020-2022.

To understand more about the equitability values, we converted DBH values into basal area to infer the canopy makeup of our forests. Figure 4 below clarifies that *Acer saccharum* (Sugar maple) trees dominate our forest in 2022. This reinforces that the invasion of these areas was essentially a disturbance to the site and impaired tree regeneration for quite some time.

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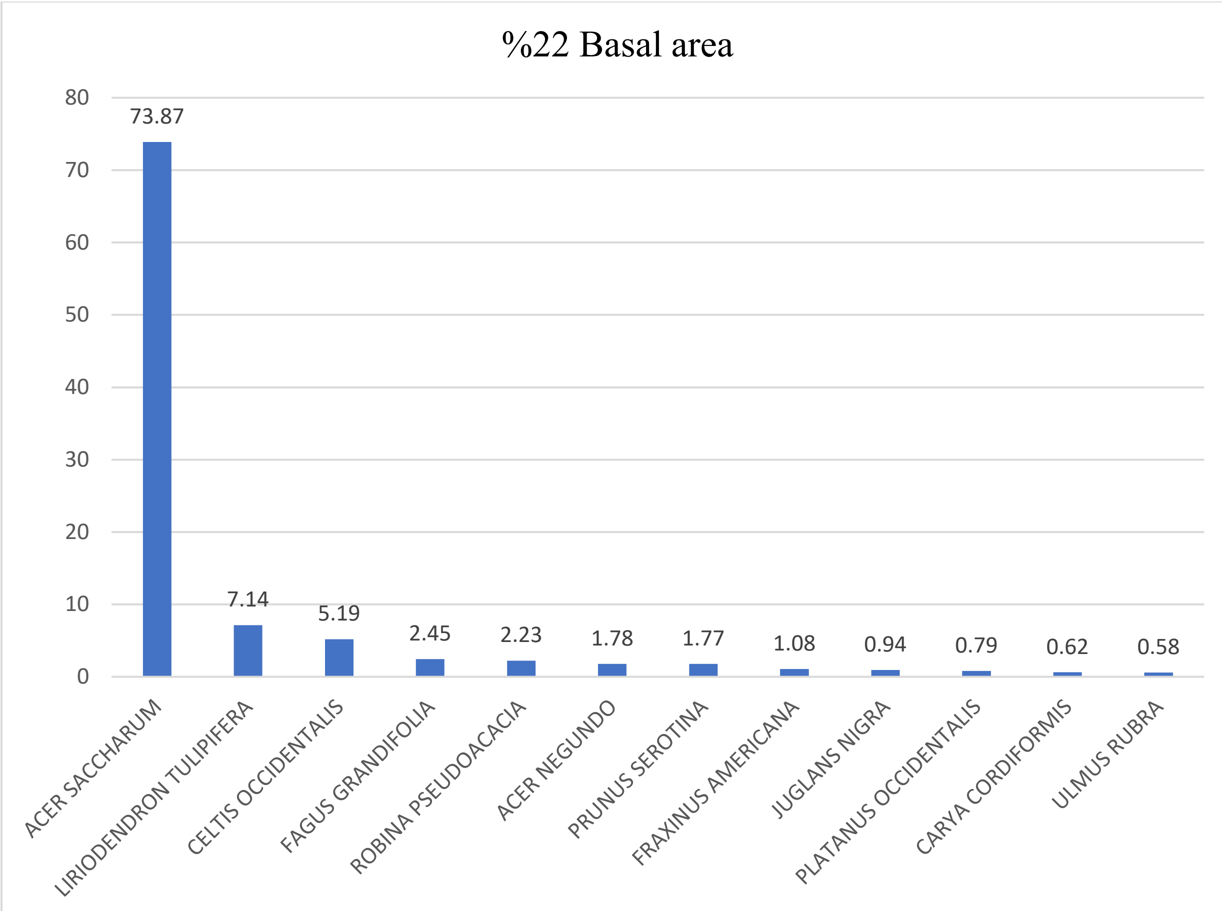

Figure 4. Evenness (equitability) has remained low across sampling years due to dominance of a single species (A. saccharum) in our woods.

CONCLUSION

Both quantitative and qualitative data have a viral role to play in natural area management. We rely on past accounts and photos, current data, and predictions for the future to create a strategic management plan to protect and restore the forests in Louisville. We hope that this article will launch a conversation with other cities about the data methodologies that they use, will invite comparisons between our data and comparable parks' data, and will offer an example of how quantitative data can inform management priorities and plans and enhance funding requests for other cities across the U.S.

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