Impacts and Perceptions of Environmental Changes in the Hadwen Arboretum, Clark University, Worcester (MA)

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Abstract

Clark University's Hadwen Arboretum, located at the heart of Worcester, Massachusetts, is a cherished community asset. This research's overarching objective was to qualitatively analyze this urban greenspace and its multifaceted impact on the community using Participatory Geographic Information Science (PGIS) techniques. A total of twenty interviews were conducted with three cohorts: local officials and residents of the Columbus Park Neighborhood, specifically those with frequent interactions with the arboretum, members of Clark's facilities management, and faculty and students actively engaged with the arboretum. The results revealed that the Hadwen Arboretum has garnered widespread positive feedback, particularly regarding aesthetic improvements and overall community satisfaction, with specific commendation directed towards its aesthetic appeal, maintenance efforts, and positive impact on the community's well-being. Additionally, the negative perceptions identified along May and Lovell streets highlight the subtle challenges of greenspace management, necessitating a multifaceted approach to address environmental and community engagement. These findings offer valuable guidance for shaping the future trajectory of the arboretum, providing a roadmap for refining the bottom-up management model. The significance of this methodological approach is indicated by the potential applications of sketch mapping in informing social policies and its relevance to a wide range of research topics across disciplines.

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The urbanization process, characterized by the expansion and in-filling of urban areas at the expense of greenspaces and tree canopy cover, has ushered in significant transformations in landscape patterns and ecological processes over the past few years (Yu et al., 2020). As a result of economic and population growth, there is a rapid progression in urbanization, which leads to a substantial increase in impervious surfaces and a decrease in blue-green spaces across cities (Milani de Quadros & Mizgier, 2023). Simultaneously, urbanization has far-reaching effects on the near-surface atmospheric composition, resulting in various urban meteorological phenomena, such as the Urban Heat Island effect, which the presence of maintained urban greenspaces can mitigate (Oke et al., 2017).

The Urban Heat Island (UHI) effect is a distinctive climate phenomenon induced by human activities, characterized by areas of elevated temperatures (1-7℉ during the day and 1-5℉ during nighttime) in impervious surfaces, compared to the vegetated land in an urban area (Oke et al., 2017; Manoli et al., 2019). The Urban Heat Island (UHI) effect, as outlined by Elmes et al. (2020), is marked by significantly higher air temperatures in urban areas compared to nearby rural, grassy, or forested regions. This temperature differential has risen globally over the past three decades, concurrent with the overall warming trend in cities and an increase in the frequency of heat waves. The UHI effect is expected to intensify further due to ongoing urbanization trends, with the projected global urban population set to increase from 54% to 70% by 2050. This urban warming poses significant health risks, especially during heatwaves,

including dehydration, heat exhaustion, heat stroke, and increased mortality risk, particularly among vulnerable populations such as young children and the elderly (Elmes et al., 2020).

Ramifications of the UHI effect are multifaceted and extend to numerous aspects of urban residential life. As a consequence of impervious urban locations experiencing higher temperatures than their green urban counterparts, there is an augmented demand for energy and water resources, a surge in carbon dioxide emissions, increased heat stress on residents, and heightened air pollution levels (Gunawardena et al., 2017). These consequences collectively threaten urban populations' health, well-being, and comfort (Yu et al., 2020). As cities continue to evolve, understanding the complex relationships between urbanization, population growth, and urban densification and their impact on the thermal environment is pivotal for informed decision-making in urban planning and resource management (Chen et al., 2023).

In urban environmental management, the significance of urban blue-green spaces as an effective and sustainable solution to counter the Urban Heat Island (UHI) effect has garnered increasing recognition (Ke et al., 2021; C. Wang et al., 2022). Urban blue-green spaces encompass diverse elements, such as water bodies, urban parks, forest parks, woodlots, grasslands, and other greenspaces, all contributing to cooling the urban environment (Pickett et al., 2011; Fan et al., 2019). Urban parks, in particular, are a notable embodiment of urban blue-green spaces, often comprising a combination of water bodies and greenspace patches. Parks are recognized as a distinct landscape category, often showcasing the synergy between water elements and greenery in urban settings. Unlike alternative solutions, such as using lighter shades of paint for the roofs of the buildings, which reflect more sunlight than they absorb, blue-green spaces are celebrated for their cost-effectiveness, environmental friendliness, and political acceptability (Martins et al., 2016; Carvalho et al., 2017).

Understanding the public perception of urban greenspaces is critical to effective environmental management because it helps bridge the gap between municipal planning goals and the diverse perspectives of urban greenspace users (Xia et al., 2023). While ecosystem services are often evaluated through scientific lenses, involving the perspectives of those directly affected by urban greenspaces and their services is vital to ensure fairness, transparency, and equity in assessing the ecosystem services offered by these urban greenspaces (McHale et al., 2018). Rapid urbanization and global environmental changes introduce complexities of land change into the socio-ecological systems, such as gentrification and converting greenspaces to urbanized areas. These complexities significantly impact the availability of environmental services (Hou et al., 2013). They are further compounded by managerial decisions, which may or may not be influenced by the diverse perceptions of urban greenspace users (Pahl-Wostl et al., 2007). Top-down management strategies may overlook these diverse perceptions, potentially resulting in injustices, particularly in recognizing the value of urban greenspaces (Brück et al., 2022). Adaptive management, an integrated learning-based approach for social-ecological systems, can address these challenges by promoting decision-making that considers and manages urban greenspace in line with societal needs and preferences (Folke et al., 2005; Gunderson et al., 2016).

Although social perceptions of urban greenspaces have historically received less attention than ecological or economic valuation, recent literature highlights the growing significance of these perceptions (Scholte et al., 2015). Studies now emphasize urban greenspaces' perceived importance and performance in delivering environmental services (Hua & Chen, 2019; Das & Basu, 2020; Gai et al., 2022; Z. Wang et al., 2022). This dual focus on importance and performance generates insights into societal satisfaction and priorities regarding urban

greenspaces, contributing to effective management strategies such as the integration of public opinion into park planning (Z. Wang et al., 2022; J. Zhang et al., 2020). Researchers have developed various participatory methods, with questionnaire surveys being the most common, to assess social perceptions of urban greenspaces (Scholte et al., 2015; Xiang et al., 2021).

Analyzing public perceptions of urban greenspaces is essential to contemporary urban planning and greenspace management (Stępniewska, 2021). Acknowledging the perspectives of greenspace users is essential for ensuring that proposed objectives and management practices align with the needs of residents and gain community acceptance. Balancing land use decisions to provide sustainable environmental service faces challenges due to the gap between a park's environmental service-providing capacity and its social perception, necessitating a focus not only on cultural services but also on the local, directly experienced benefits within regulating environmental services (Stępniewska, 2021). Scientific exploration of public views is crucial, especially in densely populated urban areas where urban greenspace management and planning are often centered around managerial perspectives instead of community-driven perspectives (Lo & Jim, 2010). Research findings illuminating varied expectations among different socioeconomic sectors aid in crafting community-specific, inclusive greenspace planning and refining the bottom-up management models. Addressing disparities in park access and rectifying mismatches between park management and user needs become achievable through such insights, facilitating a more socially relevant and community-inclusive approach to urban greenspace management (Jay & Schraml, 2009).

Analyzing public perceptions of urban greenspaces is vital due to its profound impact on psychological health and well-being (Yue et al., 2022; Zewdie et al., 2022). Studies emphasize the critical role of urban greenspaces, including parks, trees, and gardens, in promoting

psychological health, evidenced by reduced stress, depression, and anxiety and increased life satisfaction (James et al., 2015; Frumkin et al., 2017; Fong et al., 2018; Kondo et al., 2018). Greenspaces have been associated with lower externalizing psychological behaviors and higher scores in protective psychological domains, highlighting their importance for emotional well-being, particularly in youth and young adults (Richardson et al., 2017; Putra et al., 2021; Dockx et al., 2022). The therapeutic effects of visible outdoor greenery, known as the Attention Restoration and Stress Recovery theory, indicate greenspaces' restorative and stress-relieving benefits (Ulrich, 1984; Kaplan & Kaplan, 1989; Lega et al., 2021). Specifically, streetscape greenery has been linked to improved mental health and well-being in older adults, with visual, auditory, and cognitive factors mediating the positive effects of greenspaces on mental health (Pheasant et al., 2010; Liu et al., 2019; R. Wang et al., 2021; R. Zhang et al., 2021). Understanding the complexities of greenspace exposure and its impact on mental well-being, including factors like noise reduction and specific types of greenery, is crucial for crafting urban spaces that enhance the mental health of residents. Consequently, incorporating these nuanced perceptions into urban planning and greenspace management ensures that greenspaces meet the diverse needs of communities, fostering a more mentally and physically healthy urban environment (R. Wang et al., 2020; Yue et al., 2022).

Furthermore, analyzing public perceptions of urban greenspaces is essential for fostering social cohesion and community progress. Studies demonstrate that vegetated open areas enhance neighborhood ties and a sense of community, intertwining human emotional attachment to nature with a sense of belonging to their community (Tuan, 1974; Kuo et al., 1998). Urban greenspaces, acting as communal meeting venues, nurture social capital by providing both open space and a sense of place, creating valuable social encounters and interplay among community members

(Lo & Jim, 2010). Listening to local voices is crucial in understanding place-specific issues, aesthetic preferences, social systems, and cultures related to greenspaces, enabling appropriate design responses that align with community needs. Residents' preferences and priorities can inform urban forest design and planning, enhancing the community's use and appreciation of trees and greenspaces (Sheppard & Meitner, 2005). Mature trees, natural plantings, and native species have been highlighted as crucial elements in creating a sense of place, promoting neighborhood self-identity, and increasing resident satisfaction (Barron et al., 2021). Including the users' perceptions in urban planning and greenspace management enriches urban forest design and ensures that greenspaces promote interpersonal relationships and social cohesion by serving as inclusive, community-driven spaces (Wolf & Kruger, 2010).

Participatory/Qualitative GIS methods, particularly the integration of sketch maps with GIS techniques, have emerged as valuable tools for capturing individual spatial narratives and enhancing qualitative research (Boschmann & Cubbon, 2014). As Kičić et al. (2022) demonstrated, the workshop participatory mapping approach offers a flexible combination of qualitative and quantitative data collection, resulting in detailed information that enhances the understanding of the public perception of different greenspace infrastructures such as greenways, tree lines, and urban parks. This approach is particularly advantageous in exploring less-represented urban greenspace infrastructures and revealing their nuanced relationships with cultural ecosystem services (Kičić et al., 2022). Such participatory techniques are instrumental in revealing diverse perceptions and satisfaction levels with greenspaces, emphasizing the importance of accounting for local context in understanding urban greenspace perception (Kičić et al., 2022; Maurer et al., 2023). Maurer et al. (2023) also highlight that participatory GIS tools contribute to more just outcomes by potentially allowing marginalized voices to shape planning

and policy. By integrating local perspectives, these tools generate outputs that facilitate meaningful conversations among stakeholders and bridge gaps regarding public perception within urban governance, thereby contributing to more inclusive and equitable decision-making processes (Maurer et al., 2023). The capacity of participatory GIS techniques to span scales, from public to governance, and integrate local voices aligns with the ongoing democratization of mapping. Participatory GIS techniques accentuate the growing synergy between qualitative research and GIS in exploring urban greenspaces and their multifaceted impact on communities.

This study aimed to analyze the recent environmental changes within the Hadwen Arboretum, owned by Clark University in Worcester, Massachusetts, USA, through the perceptions of Columbus Park neighborhood residents, facilities management at Clark University, and other members of the Clark community who engage with the arboretum. This study was vital in understanding the reception of the Arboretum's environmental services and the attitude towards the recent biophysical changes in and around it.

Study Area

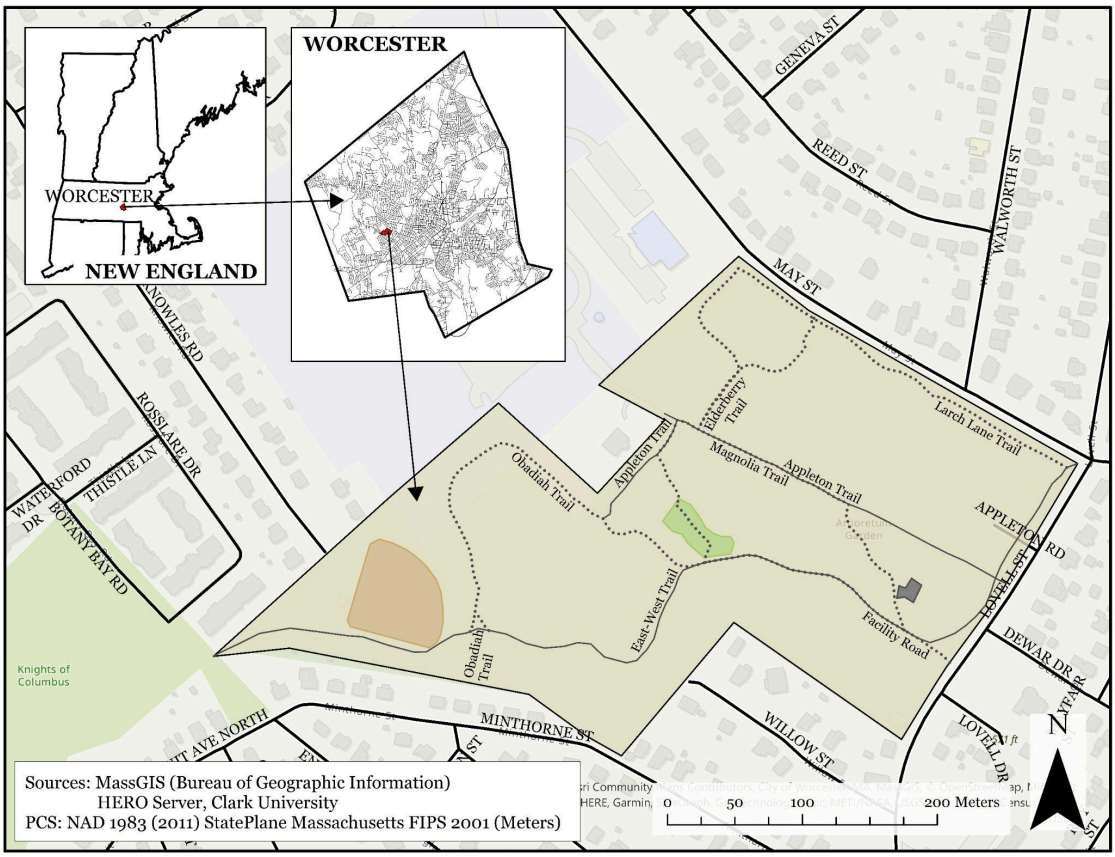


Figure 1. Study area

This study is focused on Hadwen Arboretum, a research forest bequeathed to Clark University, Worcester, Massachusetts, in 1907 by its previous owner, a Worcester resident and known horticulturist, Obediah Hadwen. The arboretum, with a collection of more than 66 tree species, is a 26-acre woodland green space in the heart of Worcester at the intersection of Lovell and May Streets on the ancestral land of the Agawam and Nipmuc peoples. The Hadwen Arboretum has a rich history that it has accumulated during its past years of existence and has never been fully forgotten (*Clark University's Hadwen Arboretum*, 2023). Nevertheless, it deteriorated over time without greater community support and prevalent issues like trash

collection, overgrown paths, and hazardous trees. An active student volunteer group, the Arboretum Advocates, currently maintains it and engages in stewardship efforts such as cleanups, trail construction, and signage installation. However, the endeavors required to restore the arboretum fully surpass the cumulative capacity of a student volunteer group.

As characterized by the College of Forestry's extensive forestland holdings in Oregon, a research forest represents a deliberate and comprehensive approach to forest management (*Research | Research Forests*, n.d.). It encompasses multiple tracts of forested land dedicated to scientific inquiry, education, community engagement, and outreach in forestry. These forests contribute to global models for the active and sustainable management of forest ecosystems, which involves advancing forestry through scientific research and imparting knowledge, including traditional ecological knowledge, to the broader community (*Research | Research Forests*, n.d.). Each research forest is designed to serve as a multifaceted resource, offering opportunities for education, research, and outreach activities deep-rooted in addressing the current and future generations' economic, social, and environmental values ("Why Use a Research Forest?," n.d.). The core research focus lies in the active management of these forests, which is integral to ensuring their long-term sustainability. In their actively managed state, these forests serve as living demonstrations of how sustainable forest management practices can contribute to economic prosperity, biodiversity conservation, and the resilience of forest ecosystems in the face of disturbances and global changes (Wetzel et al., 2011).

Like research forests, university forests, such as Harvard University's Arnold Arboretum, represent vital research, education, and conservation hubs. These living collections, comprising thousands of unique plant taxa, serve as significant examples of historic landscapes while facilitating essential educational endeavors and playing a crucial role in the community

(Friedman et al., n.d.). University forests such as the Arnold Arboretum contribute substantially to scientific knowledge and environmental conservation efforts by comprehensively understanding diverse plant species (*Research | Research Forests*, n.d.). They further impart knowledge to communities, promote economic prosperity, conserve biodiversity, and enhance the resilience of forest ecosystems in the face of global changes (Wetzel et al., 2011). This emphasis on education, research, and conservation positions university forests, such as the Hadwen Arboretum, as essential entities in fostering understanding between greenspaces and their users, including nearby residents and the college community, meanwhile shaping the relationship between the people and their natural environment.

Inspired by the success and impact of university forests like the Arnold Arboretum, the managers of Hadwen Arboretum at Clark University aspire to transform it into a similar research forest. Their vision aligns with the Arnold Arboretum's role as a space for extensive scientific research, education, and conservation. Despite differences in size, both arboretums play crucial roles in their respective communities, and the Hadwen Arboretum, though smaller in scale, holds the potential to contribute significantly to scientific understanding, ecological conservation, and community engagement. The aim is to leverage the arboretum's rich history and diverse plant collection to create a multifaceted resource that benefits current and future generations, echoing the model set by university forests like the Arnold Arboretum.

Methodology

Data Collection

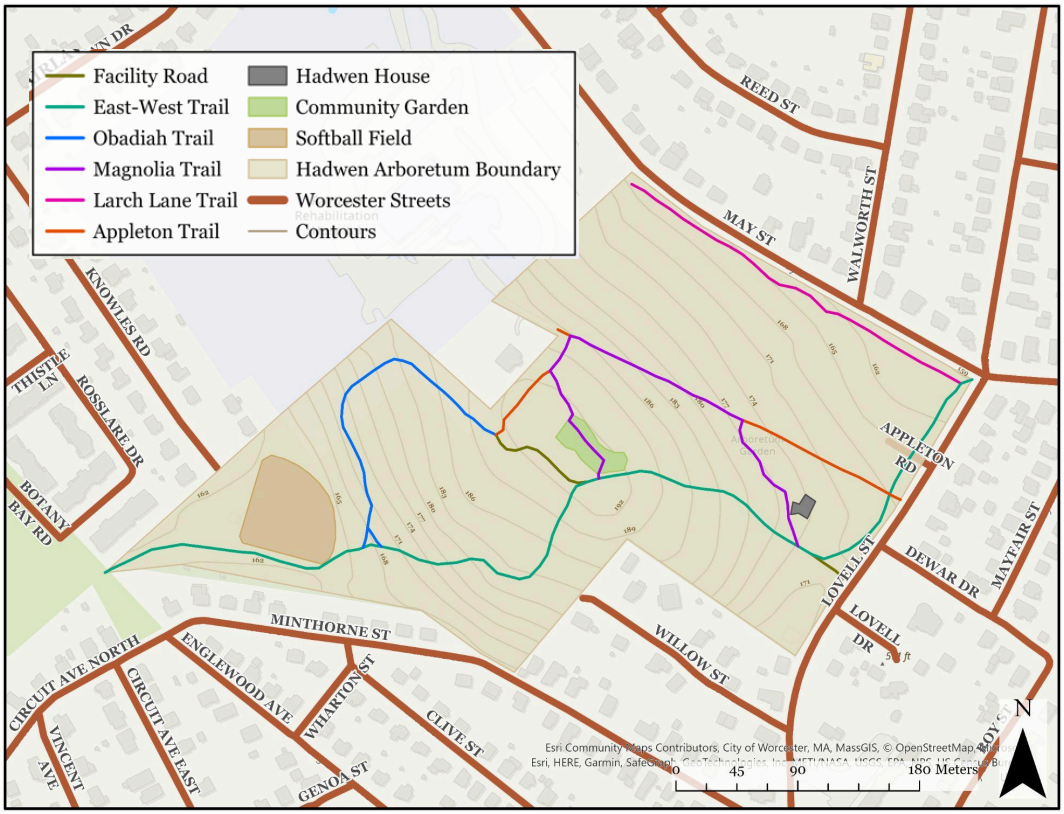


Figure 2. The base map used during interviews

To ensure a comprehensive exploration of the perceptions surrounding the Hadwen Arboretum, this research adopted a qualitative approach, centering on three distinct cohorts: local officials and residents of the Columbus Park neighborhood, specifically those with frequent interactions with the arboretum; members of Clark University's facilities management overseeing arboretum stewardship; and faculty and students actively engaged with the arboretum. Employing a non-probability, purposive sampling strategy (Blackstone, 2018), the study focused on individuals well-versed with and frequent users of the arboretum. This intentional sampling strategy aimed to garner insights from individuals deeply connected to the arboretum, avoiding

the randomness inherent in probability or snowball sampling methods. The resulting sample comprised residents actively participating in Columbus Park neighborhood monthly meetings and exhibiting enthusiasm for the arboretum, faculty members teaching classes at the arboretum, and students affiliated with the Arboretum Advocates Club at Clark University. While the outcomes may exhibit a bias toward individuals possessing a heightened awareness of the arboretum, this deliberate sampling approach ensured a comprehensive exploration of perceptions within this specific cohort.

Five in-person interviews were conducted with Clark University faculty and facilities management members. Students and residents who volunteered to participate in the survey received the questionnaire via email and during the monthly neighborhood community meetings, respectively. The survey instrument encompassed inquiries regarding participants' positive and negative perceptions of the arboretum, patterns of usage, and a sketch map exercise where respondents marked preferred, disliked, and areas requiring attention on a provided base map (figure 1). Subsequently, these marked points underwent digitization for spatial analysis.

Analysis

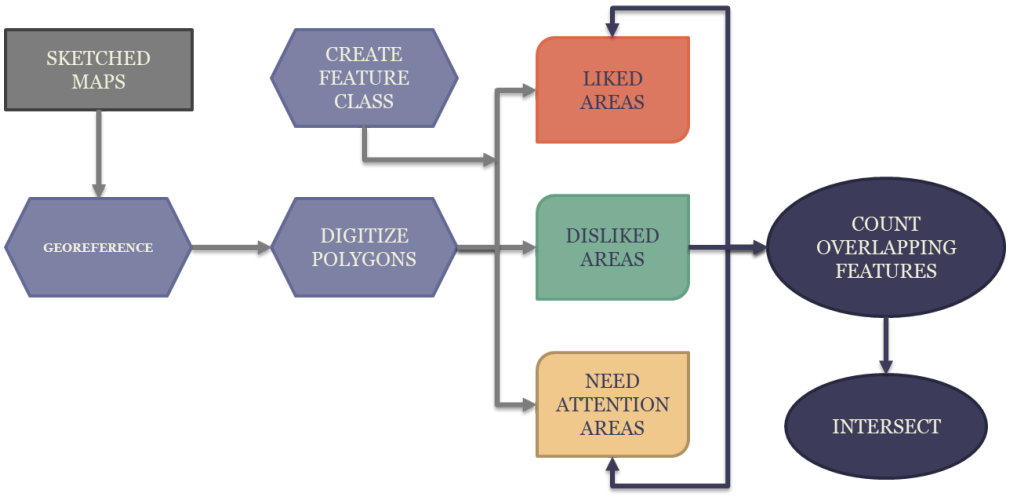


Chart 1: Flow chart of each step used to achieve the goals of this project

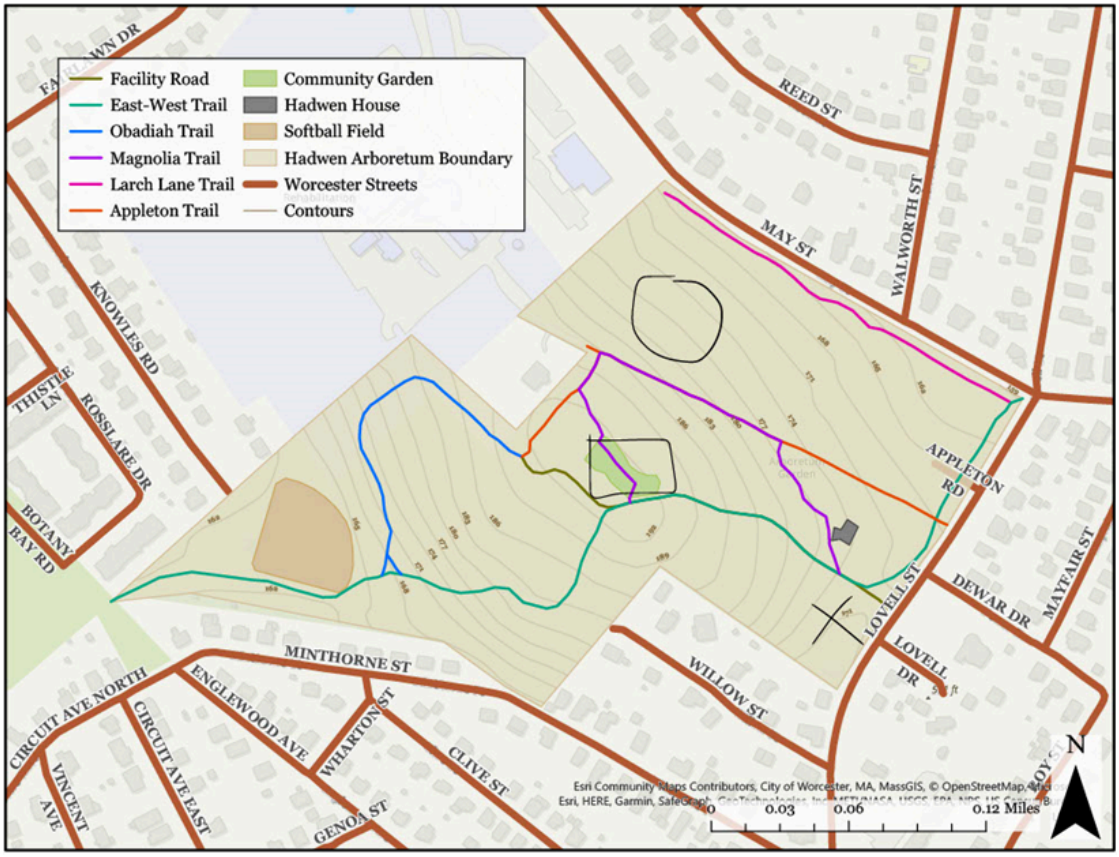


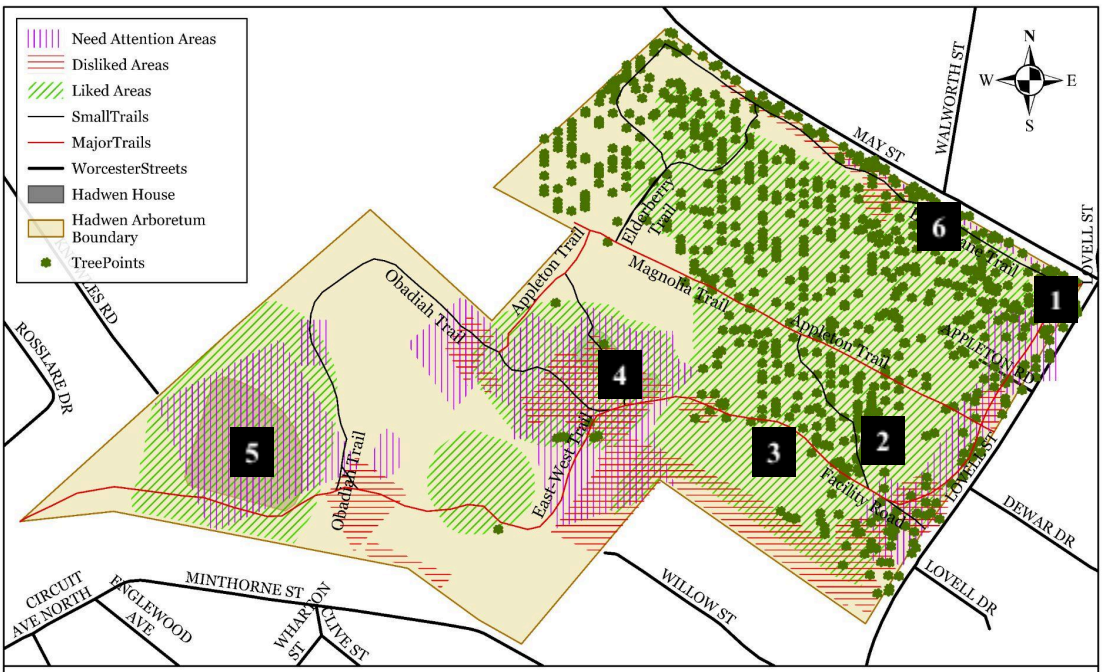
Figure 3: Sample sketch map from the interview data showing the three types of areas delineated on the printed map - areas that were liked (denoted by an O), disliked (denoted by an X), and perceived to need more attention (denoted by an □)

A total of twenty interviews were conducted, comprising surveys from residents (6), facilities management members (2), faculty (4), and students (8). The subsequent spatial analysis in ArcGIS Pro, depicted in chart 1, unfolded through the following sequential steps:

- Georeferencing the sketched map: Scanned images of sketched maps from interview data were imported and individually georeferenced in ArcGIS Pro (figure 3). Georeferencing was executed using the "Add control points" tool to align the scanned images with the boundaries of the pre-existing base map, rectifying distortions in shape and size relative to the arboretum boundary. The pre-existing map file was projected to the desired coordinate system (NAD 1983 (2011) StatePlane Massachusetts FIPS 2001 (Meters)).
- Digitizing the sketched areas: The "Create Feature Class" tool established three distinct feature classes, each corresponding to areas liked, disliked, and deemed to require attention. Digitization involved tracing sketched polygons from individual map images and categorizing them into their respective feature classes.
- Count Overlapping Features: The intensity analysis utilized the "Count Overlapping Features (Analysis Tools)" tool to generate separate vector layers, with a minimum count of one feature for each, indicating the count of areas marked as liked, disliked, or needing attention. The tool planarized the output, illustrating the frequency of each type of marking.
- Intersect: The final analytical phase utilized the "Intersect" tool to determine the most accessed trail by interviewees. Respondents were asked about their preferred trail, and

this information was cross-referenced with the areas marked as liked on the base map. This analysis intersected digitized polygons of liked areas with the identified trails, quantifying the percentage of trail length intersecting with liked areas. The goal was to spatially determine the most accessed trail by investigating the hypothesis that it would exhibit a higher percentage of overlap with liked areas in the arboretum.

Results



Liked, Disliked, and Attention Needing Areas

1. Main Entrance Signage

2. Hadwen House Foundation

3. Classroom

4. Community Graden

5. O'Brien Softball Field

6. A Section Along May Street

Figure 4: Spatial visualization of all the digitized polygons from the 20 collected sketch maps and a photo montage of all the key locations at the Hadwen Arboretum

As depicted in figure 4, the spatial analysis encapsulates the delineation of areas marked by interviewees on the base map, subsequently transformed into digitized polygons within the ArcGIS Pro environment. These polygons were systematically categorized into distinct classes,

including liked areas (depicted in green with hatched lines), disliked areas (depicted in red with hatched lines), and areas perceived as needing attention (depicted in purple with hatched lines). A notable observation emerged as several areas designated for attention coincided with those designated as disliked by the interviewees, especially around the community garden. However, a particularly intriguing spatial pattern surfaced around the vicinity of the community garden, where marked areas exhibited a simultaneous classification of being liked, disliked, and in need of attention. This paradoxical characterization raises questions about the underlying complexities influencing interviewee perceptions in this locale. Subsequently, the analysis delved into the transcriptions of collected surveys, aiming to discern the rationale and prevailing trends contributing to the heightened frequency of certain areas being consistently recognized within specific categories.

Figure 4 encapsulates a nuanced portrayal of the perceptions articulated by interviewees concerning the Hadwen Arboretum, and the digitized map serves as a visual synthesis of the community's sentiments, unraveling both the communal appreciation and discernible concerns, thereby illuminating the multifaceted nature of the arboretum's perception. The combination of liked, disliked, and areas needing attention on the digitized map provides a comprehensive lens through which the community's collective viewpoint is interpreted.

The concluding phase of the analytical procedures undertaken in this investigation involved an intersect analysis to discern patterns within the preferred trails of arboretum users. Leveraging the interview data, identifying the two most traversed trails within the arboretum was pivotal. The East-West trail emerged as the predominant choice for six out of fifteen interviewees, followed closely by the Appleton trail, favored by four. Subsequently, these trails

underwent an intersect analysis, whereby their alignment with areas marked as "liked" on the base map was assessed.

The results of the intersect analysis were summarized to ascertain the total length of each trail enveloped by the identified liked areas. The East-West trail exhibited a cumulative coverage of 455 meters, representing approximately 57.57% of its total length. Similarly, the Appleton trail, with a total length of 228 meters, demonstrated an intersection of approximately 57.12% with liked areas. Intriguingly, despite a greater preference among interviewees for the East-West trail than the Appleton trail, both trails manifested nearly identical percentages of coverage by liked areas.

This spatial convergence between trail usage and positively perceived areas is a foundational observation, potentially informing future interventions and enhancements within the arboretum landscape. As delineated through the intersect analysis, the intricate interplay between user preferences and spatial patterns indicates the understated dynamics inherent in the utilization and appreciation of arboreal spaces.

Discussion

Positive Perceptions

Within the broader context of the Hadwen Arboretum, a prevailing sentiment of positivity emerges from the interview data. Interviews across different respondent groups uniformly conveyed an unequivocal love and appreciation for the arboretum, underscoring its significance as a communal asset. As one of the Columbus Park neighborhood residents mentioned during the interviews, “the neighborhood has become more inviting and appealing” since the faculty and

student volunteer groups started the stewardship at the arboretum. The collective efforts invested in stewardship and maintenance were widely recognized and commended (figure 6), reinforcing the arboretum's welcoming ambiance.

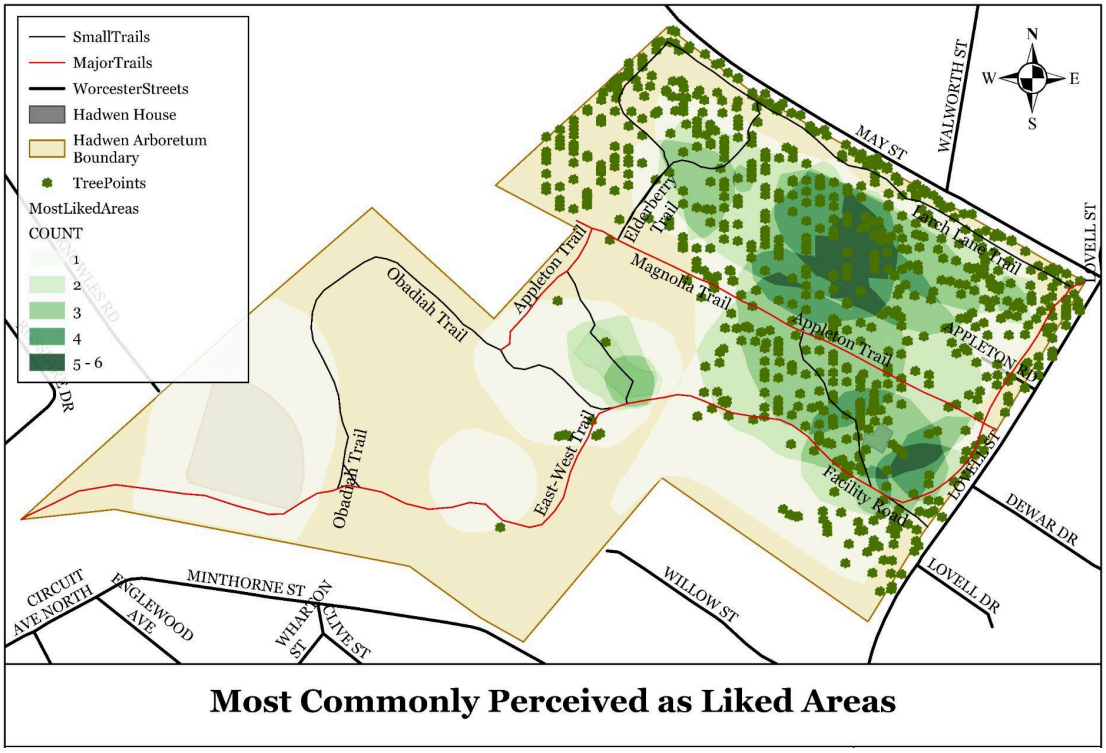


Figure 6: Frequency of areas considered Desirable by the interviewees

Residents of the Columbus Park neighborhood conveyed a profound appreciation for the arboretum's symbolic representation of life, care, and community support. Resident interviews consistently highlighted the positive impact of the newly built trails on walkability, the intentional vegetation density, and the aesthetic enhancement of the neighborhood. They perceived tangible improvements in community happiness, physical and mental health, and overall satisfaction, attributing these positive changes to the arboretum's meticulous maintenance. The arboretum emerged as a valuable resource, fostering a sense of pride and

satisfaction among residents who recognized its role in enhancing the quality of life within the urban landscape.

Facilities members at Clark University articulated positive perspectives by emphasizing the arboretum's significance within the community. Their appreciation extended beyond the physical aspects of the arboretum, encompassing its symbolic value in fostering a sense of shared responsibility among the residents of the Columbus Park neighborhood and the Clark community. The positive influence of the arboretum on community engagement and satisfaction accentuated its significance as more than a greenspace but a dynamic entity contributing to the campus's overall vibrancy.

Faculty members echoed the positive sentiments expressed by students, emphasizing the aesthetic value and the intentional, well-maintained appearance of the arboretum. Their observations extended to the growing happiness and satisfaction within the community, indicating a positive influence on the overall neighborhood atmosphere. The appreciation for variation in the recently planted tree species, the cleared section along May and Lovell streets, and the presence of informative signage showcased a holistic perspective on the arboretum's positive development.

Students, integral contributors to the arboretum's stewardship, expressed a profound appreciation for the variety of tree species and dense vegetation. The aesthetic improvements and well-maintained appearance resonated positively with them, contributing to a growing sense of satisfaction and engagement within the community. Their pride in contributing to the stewardship efforts highlighted a personal connection with the arboretum, reinforcing its significance as an integral part of campus life. From a student’s perspective, the positive

feedback on the arboretum's aesthetic and walkability improvements emphasized its significance in providing a pleasing and accessible natural space affiliated with the campus.

Additionally, the received feedback accentuates the dichotomy between the arboretum's tranquil atmosphere and the bustling environment surrounding the campus. While the arboretum is a verdant oasis, the campus surroundings witness emerging urbanization trends, marked by crowded streets and impermeable surfaces. This contrast emphasizes the arboretum's unique restorative character and underscores its role as an antithesis to the prevailing urbanization trends within the broader campus landscape.

In summary, the positive feedback from all stakeholder groups reinforces the Hadwen Arboretum's status as a cherished community asset, with specific commendation directed towards its aesthetic appeal, maintenance efforts, and positive impact on the community's well-being.

Negative Perceptions

While the collective sentiment from the interviews overwhelmingly expressed positive perceptions of the recent environmental changes in the Hadwen Arboretum, a few locations marked as disliked or needing attention shed light on specific concerns within the greenspace. Notably, the negative perceptions were not uniform across respondent groups, and the criticisms mainly centered around specific areas rather than the overall impact of the recent changes.

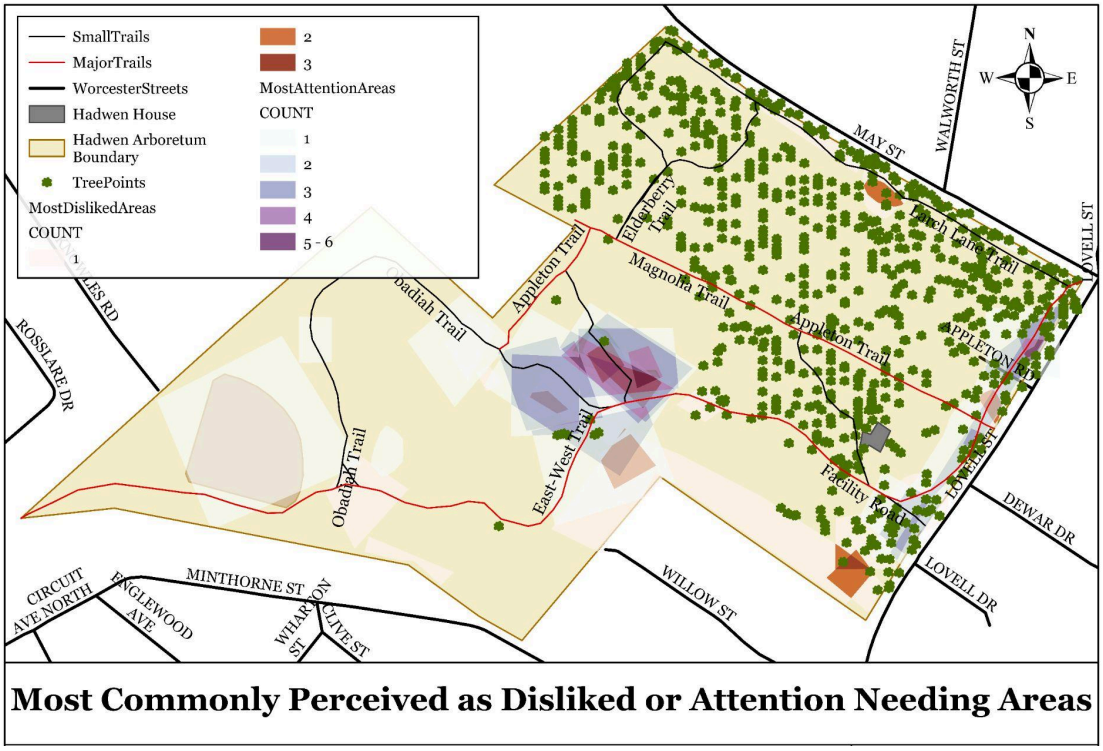


Figure 7: Frequency of areas considered Undesirable and Needing Attention by the interviewees

Community Garden. One prominent area consistently marked as disliked and in need of attention by both students and faculty was the Community Garden. Despite being appreciated as a shared productive space within the residential community, dissatisfaction prevailed due to perceived mismanagement and disorganization. While most residents were indifferent to or appreciative of the community garden because it is a communal vegetative area amidst an urban landscape, students, in particular, voiced concerns about excessive vegetative overgrowth and an abandoned appearance, emphasizing the need for more frequent monitoring and administration. During the interviews, one of the students mentioned that the community garden "has so much potential, but often gets overgrown and is left uncared for." Faculty members echoed these sentiments, aligning with student perspectives on the need for increased attention to the Community Garden. While recognizing the potential benefits of a shared space, faculty

interviews emphasized the importance of establishing clear guidelines for the usage and maintenance of this area. Regardless of the positive feedback and appreciation from residents, the shared opinion among students and faculty underlines the need for management strategy improvements within this particular arboretum section.

Faculty members also stressed the issues of an institutional dumping ground near the East-West trail. This area threatens the arboretum's environmental integrity and community aesthetics if utilized as a dumping ground. Faculty members desired focused attention on this location, indicating the need for institutional measures to prevent improper disposal.

Trash Accumulation along May and Lovell Streets. The stretches of the arboretum along May and Lovell Streets emerged as areas of concern for both students and residents. Repeatedly marked as disliked and requiring attention, these areas were tarnished by unprincipled trash-throwing from sporadic passersby. Students expressed frustration over the persistent issue of littering along these stretches, emphasizing the detrimental impact on the arboretum's aesthetic appeal and overall cleanliness. In their interviews, residents elaborated on the adverse effects of unregulated trash disposal in these areas, emphasizing the negative impact on the neighborhood's visual aesthetics and sanitation and expressing concern about the potential repercussions on the overall quality of life. Additionally, residents noted the detrimental effects of noise pollution from heavy traffic flow in the relatively constricted space along these streets.

The issues identified along May and Lovell streets highlight the crossroads between the arboretum's ecological role and its interface with the broader urban landscape, necessitating a multifaceted approach to address environmental stewardship and community engagement. These addressed concerns raise questions about public awareness and reiterate the need for strategic

interventions to balance the human-nature intersectionality within the Columbus Park neighborhood.

Squatting Area Between Appleton and Larch Lane Trails. A less prevalent but noteworthy concern surfaced in a student interview regarding a squatting area between the Appleton and Larch Lane trails. While this issue was not uniformly highlighted across interviews, the specific mention stresses the diverse challenges encountered within the arboretum. The call for attention toward resolving this matter signals the need for a nuanced and context-specific approach to addressing the arboretum users' distress.

In summary, while the Hadwen Arboretum has garnered widespread positive feedback, particularly regarding aesthetic improvements and overall community satisfaction, the negative perceptions of specific areas highlight the subtle challenges associated with urban greenspace management. Addressing these concerns necessitates a tailored and inclusive approach involving collaborative efforts between community stakeholders, facilities management, and the broader university community. The interpretation of negative perceptions contributes valuable information for adaptive management strategies, fostering a more comprehensive and responsive approach to urban greenspace stewardship.

Recommendations

The insights derived from interviews with stakeholders offer valuable guidance for shaping the future trajectory of the Hadwen Arboretum. These recommendations aim to inform arboretum managers and provide the Clark University administration with a comprehensive understanding of the enduring implications of recent environmental stewardship efforts.

Ownership of Hadwen Arboretum. A prevailing sentiment among students, faculty, and residents suggests a consensus that Clark University should exercise explicit ownership of the Hadwen Arboretum. The assuming of ownership requires the university to put up clear signs stating that the arboretum is a property of Clark University and also for it to be "tak(ing) a more active role in the arboretum and maybe even hir(ing) a couple of staff to maintain the grounds," as mentioned by a student during one of the interviews. Despite recent revitalization efforts over the past few years, primarily driven by a dedicated group of volunteers, including students and faculty members, the sustainability of these endeavors hinges on administrative, financial, and managerial support. Relying solely on the intermittent involvement of faculty and students for funding and labor is deemed impractical in the long term. The recommendation urges the need for institutional commitment to ensure the continuous enhancement of the arboretum, aligning with its historical significance and potential as a vital asset for the Clark community.

Investment toward Making the Arboretum More Accessible. Interviews with faculty, students, and residents yield suggestions for enhancing the accessibility of the arboretum to various user groups. Proposed measures include the construction of an approximately 1km long, multi-use pedestrian/bike path from Clark University to the Hadwen Arboretum, facilitating convenient access for students, communities, and visitors. This enhancement is anticipated to foster increased engagement with the arboretum, serving as a relaxation and stress relief space. Additionally, recommendations emphasize the importance of dismantling barriers, such as making the softball field on the western end of the arboretum freely accessible to the public, mitigating the perceived divide between the university and the surrounding community. Addressing navigation issues, interviewees propose the establishment of proper parking spaces, clear signage, and the creation of an information center. The latter is envisioned as a resource

hub equipped with map guides and pertinent information on habitat bird species, wildlife sightings, and a diverse range of tree species, enhancing the overall visitor experience.

Suggestions for Environmental Changes. The recommendations for environmental changes are closely aligned with the identified disliked or attention-needed areas mentioned in the interviews. Key proposals include the removal of accumulated trash along May and Lovell streets, addressing markings behind the East-West and Obediah trails, and labeling unique tree specimens. Noteworthy progress has been made in addressing some of these concerns since the interviews, with the eastern section of the arboretum cleared of excess vegetation and an entrance sign installed. While these accomplishments are commendable, ongoing vigilance and responsive management remain essential to ensure the sustained improvement of the arboretum's environmental quality.

In conclusion, these recommendations offer a roadmap for refining the stewardship and management of the Hadwen Arboretum. By addressing ownership, accessibility, and environmental concerns, Clark University can further elevate the arboretum's role as a vibrant and integral component of the university and the surrounding community.

Conclusion

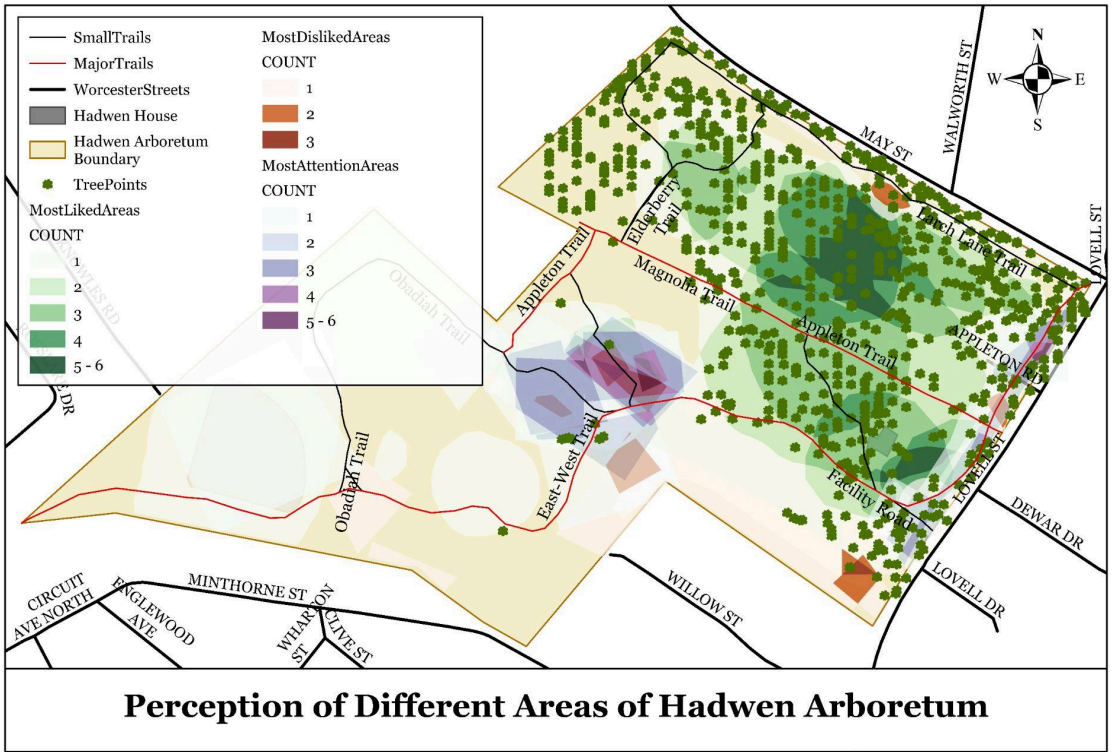


Figure 13: Resulting analysis map showing the frequency of areas considered Desirable, Undesirable, and Needing Attention.

The rigorous methodology used in this study ensured a methodical and detailed examination of the perceptions and spatial preferences associated with the Hadwen Arboretum, contributing valuable insights for its future management and enhancement. This study has delved into the multifaceted nature of narratives surrounding Clark University's Hadwen Arboretum, revealing distinct perspectives shaped by individual experiences and affiliations. The richness of these narratives, as illuminated through the application of spatial techniques and sketch maps (figure 13), demonstrates the complexity inherent in people's interactions with urban greenspaces. Sketch maps provide nuanced and differentiated geographies, offering a unique lens into the individual spatial experiences of diverse groups (Boschmann & Cubbon, 2014).

The divergence in perceptions becomes evident when examining the viewpoints of different stakeholders. Residents close to the arboretum appreciate its green oasis amidst urbanity but bear the brunt of associated adversities, such as increased traffic and noise pollution. This aligns with the findings of Hofmann et al. (2012), emphasizing the influence of individual preferences and the correlation between usability and naturalness in greenspaces. Volunteering students, attuned to the arboretum's progress in stewardship, develop a deep appreciation for its diverse tree species. Faculty members view the arboretum as an asset for research and lectures, while the facilities staff, though acknowledging its presence, lack the explicit personal connection observed in other groups. As illuminated through sketch maps, these disparate perspectives underscore the need for a comprehensive understanding of how individuals experience and value urban greenspaces (Boschmann & Cubbon, 2014).

In understanding the dynamics of urban green spaces, particularly the allocation of resources and management strategies, it is essential to consider the diverse perspectives of stakeholders, including both experts and local residents. Barron et al. (2021) underscored the discrepancy between expert prioritization of urban forest indicators and the priorities expressed by local residents. While academics and practitioners often emphasize factors like tree diversity and wildlife habitat, residents' preferences are influenced by social and aesthetic attributes, reflecting their lived experiences within the community, thereby accentuating the importance of incorporating local knowledge and experiences into decision-making processes to ensure alignment with community needs and values.

Similarly, Casado-Arzuaga et al. (2013) highlighted the significance of understanding residents' perceptions and demands regarding ecosystem services provided by urban green spaces. By assessing opinions and preferences through participatory methods, decision-makers

can gain insights into societal demands and tailor management strategies accordingly. The study emphasized the importance of reorienting ecosystem management towards meeting community demands and enhancing the capacity of peri-urban ecosystems to supply various ecosystem services.

Furthermore, Xia et al. (2023) stressed the importance of increasing local participation in park management to address diverging perceptions of ecosystem services among user groups. By involving users in decision-making processes, managers can prioritize management efforts based on different stakeholders' specific needs and preferences. Adopting an adaptive management framework allows for ongoing assessment of perceptions and landscape features, facilitating responsive and inclusive management strategies.

Participatory Geographic Information Science (PGIS) offers a unique approach to understanding user perspectives and experiences in urban green spaces while maintaining spatial context. Barron et al. (2021) emphasized the value of incorporating local voices into urban forest development, noting that PGIS techniques enable the inclusion of diverse perspectives and nuanced preferences in design and planning processes. Planners can gain insights into community desires and concerns by engaging residents in mapping exercises and qualitative discussions, ensuring more holistic and inclusive decision-making.

Similarly, Klein et al. (2021) highlighted the importance of addressing social access to parks through innovative engagement and data collection methods. Traditional spatial mapping techniques may overlook the social dimensions of park use, necessitating the development of new strategies to measure social access and sense of belonging. PGIS approaches can help capture hidden voices and diverse perspectives, informing multi-use planning efforts that cater to the needs of different user groups.

Additionally, Tsantopoulos et al. (2018) emphasized the role of PGIS in assessing public perceptions of green infrastructure projects, such as green roofs. By leveraging citizen science and participatory mapping, researchers can gauge public attitudes toward environmental interventions and identify barriers to implementation. This collaborative approach enables policymakers to align green infrastructure initiatives with community preferences, promoting greater acceptance and uptake of sustainable practices.

The local insights collected from participatory research in urban green spaces have broader implications for global sustainability challenges. Barron et al. (2021) suggested future research directions that involve practitioners and academics in prioritizing indicators based on local contexts, emphasizing the importance of context-specific approaches to urban forest management.

Furthermore, initiatives to address climate change and enhance ecosystem services require public engagement and long-term support. Collins et al. (2019) emphasized providing information and supporting education to ensure public involvement in climate-resilient planning and decision-making processes.

Moreover, Maurer et al. (2021) advocated for systems-based approaches, such as Smart Environmental Tracking Systems (SETS), to address urban sustainability challenges. By integrating participatory GIS and qualitative methods, planners can develop more inclusive and just nature-based solutions that resonate with local narratives and priorities.

In a global context, urban green spaces are crucial in mitigating environmental impacts and enhancing quality of life. Tsantopoulos et al. (2018) highlighted the growing interest in green infrastructure projects worldwide, emphasizing the need for context-specific approaches to address diverse socio-environmental challenges. By prioritizing community engagement and

participatory decision-making, cities can promote more sustainable and equitable urban development pathways.

This research's overarching objective was to conduct a qualitative analysis of the arboretum, considering the diverse narratives that shape its significance. The identified variations in perspectives emphasize the importance of recognizing the arboretum not merely as an administrative asset but as a sanctuary, an integral part of daily life, and a source of tranquility for different individuals and communities. This aligns with the call for the democratization of mapping (Crampton, 2010) and the integration of qualitative research with GIS (Pavlovskaya, 2006), expanding the horizons of understanding beyond traditional empirical methods.

Furthermore, the study suggests that future investments in enhancing and maintaining the arboretum will likely be well-received by the university's academic community and the broader surrounding community. As Boschmann and Cubbon (2014) indicate, sketch mapping can contribute to breaking down barriers of positionality in research, offering valuable insights into the unique spatial experiences of individuals. The potential applications of sketch mapping in informing social policies and its relevance to a wide range of research topics across disciplines indicate the significance of this methodological approach.

Future research could explore alternative technological means of collecting sketch map data, ensuring the method remains accessible and insightful. Additionally, efforts should be directed toward understanding how spatial patterns derived from sketch maps can effectively inform social policies, addressing potential biases that may arise in preference predictions (Hofmann et al., 2012).

In conclusion, the narratives surrounding the arboretum are as diverse as the individuals and communities it serves. This study highlights the significance of recognizing and respecting

these diverse perspectives. It features the importance of employing innovative spatial techniques, such as sketch mapping, to enrich our understanding of the intricate relationships between individuals and urban greenspaces.

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