

THESIS

UNLOCKING THE POTENTIAL OF INFORMAL GREENSPACES: INSIGHTS INTO
ECOSYSTEM SERVICES, COMMUNITY BENEFITS AND URBAN INTEGRATION

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In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Spring 2025

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ABSTRACT

UNLOCKING THE POTENTIAL OF INFORMAL GREENSPACES: INSIGHTS INTO ECOSYSTEM SERVICES, COMMUNITY BENEFITS AND URBAN INTERGRATION

Rapid urbanization requires cities to prioritize sustainable development and resident well-being. Urban greenspaces enhance city resilience and health, yet development and access barriers remain. Informal greenspaces (IGS) are liminal urban spaces such as vacant lots and brownfields that are minimally managed and randomly dispersed, providing a resource-efficient alternative to address the challenges of traditional greenspaces. While the benefits of IGS are increasingly recognized, understanding local use and community perspectives—particularly those of disadvantaged groups—is critical to aligning these spaces with diverse needs and for exploring the potential of integration into city planning.

Our research aims to understand how residents interact with IGS, the perceived ecosystem services and benefits, and how these vary by socio-economic status. Additionally, perspectives from City officials provide insights into management priorities, challenges, and opportunities for integrating IGS into urban planning.

Our study employed a mixed-methods approach, combining systematic observations and semi-structured interviews. Using GIS mapping, 15 sites were identified and categorized by socio-economic status. Interviews and observations at IGS sites offered valuable insights into user interactions and perceived ecosystem services. Additionally, interviews with City officials

explored how IGS could be integrated into urban planning and managed in the future. Through grounded theory analysis, we identified themes reflecting frequently mentioned ideas to explore our research aims.

Residents perceived multiple ecosystem services provided by IGS, including those benefiting ecological health, social cohesion, as well as unique personal well-being services. Cultural ecosystem services were most frequently noted, underscoring the cultural significance of these spaces. Potential differences in perceived ecosystem services among socio-economic groups suggest a need for further research to address diverse community needs. While many of our sites were used at least once, some were notably underutilized, seeing no visitors. City officials recognized multiple functions of IGS, both for human and ecological purposes and highlighted future management opportunities and challenges. This study emphasizes the potential importance of IGS in urban landscapes and initiates discussions on their future role.

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Chapter 1: Introduction & background to the study

1.

1.1 Urban areas & greenspaces

By 2050 it is estimated that 68% of the world's population will live in cities (Profiroiu et al., 2020). Amid this rapid urbanization, it is crucial that cities invest in infrastructure that promote well-being. A vital component of healthy urban living and increasingly recognized as essential for human well-being and livelihoods, is a connection to nature through access to greenspaces (Hunter et al., 2019). Urban greenspaces (UGS) offer numerous benefits to urban areas, enhancing both human well-being and the natural environment.

1.2 Ecosystem Services

Many benefits of UGS can be categorized as ecosystem services (ES). UGS are known to contribute to physical and mental health by encouraging recreation and physical activity, which help reduce chronic illnesses (Hartig et al., 2014, Lee et al., 2015, WHO, 2016) and provide restorative effects through nature contact, aiding in stress management and improving focus. Additionally, UGS enrich daily life by fostering social cohesion and interactions among residents (Jennings & Bamkole, 2019; Xin et al., 2020). Beyond their direct benefits to individuals, UGS also play a crucial role in addressing environmental challenges that impact urban functioning and livelihoods, such as pollution, flooding, and the urban heat island effect (Lee et al., 2015; Hunter et al., 2019).

The significance of ES in everyday life has been widely explored (Haines-Young & Potschin, 2010; Summers et al., 2012), offering a valuable framework for understanding the connection between people and their environment and how such services directly impact human well-being (Millennium Ecosystem Assessment (MA, 2003). ES are broadly defined as the benefits that people obtain from ecosystems and are categorized into four types: provisioning, cultural, regulating, and supporting services (MA, 2003). Provisioning services refer to the direct products obtained from ecosystems, such as food, fuel, and fiber (MA, 2003). Cultural ecosystem services include non-material benefits such as spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (MA, 2003). Regulating services encompass benefits derived from ecosystem processes, such as climate and water regulation, while supporting services are essential for sustaining all other ecosystem functions, including primary production (MA, 2003). By delivering these services, UGS contribute to both urban sustainability and the well-being of city residents, reinforcing their importance in urban planning and development.

1.2.1 Urban ecosystem services

Modern cities face significant challenges, including climate change, an aging population, and dwindling natural resources. Ecosystems play a crucial role in driving the transformations needed to address these issues. Healthy ecosystems provide critical regulating services which enhance the adaptability of urban landscapes, enabling them to effectively manage problems such as increased risks of heatwaves and flooding (Haase et al., 2014). Equally important, cultural ES provided by UGS improve quality of life and promote human health in cities. Cultural ES also foster environmental awareness, strengthen social cohesion, and encourage community interaction, underscoring their critical role in urban living (Dushkova et al., 2021).

The economic benefits of prioritizing ES are also evident. For example, green roofs in Singapore have been shown to reduce energy consumption and be cost-effective for cities (Wong et al., 2003). Urban ecosystem services (UESs) are provided by various land uses, such as parks, cemeteries, golf courses, waterways, gardens, and green roofs (Haase et al., 2014). Managing these ecosystems requires a deep understanding of the social-ecological dynamics of urban areas and acknowledgment of cities' reliance on surrounding landscapes (Haase et al., 2014). A study in Stockholm examined six UESs and found that locally generated ES significantly improve urban quality of life and should be prioritized in land-use planning (Bolund & Hunhammar, 1999). Understanding UESs—where they come from, who benefits from them, and the roles they play in everyday life—is essential for fostering sustainable and resilient urban environments.

1.3 Challenges

Although the importance of UGS and their ES is widely recognized, numerous challenges hinder cities' ability to provide these benefits to all residents. This limitation negatively impacts human well-being and the ability to address urban challenges. Key challenges include access, resource availability, planning, and management. Studies highlight the unequal access to UGS, disproportionately affecting disadvantaged groups such as racial minorities and individuals of lower economic status (Dai et al., 2011; Sister et al., 2009; Byrne & Wolch, 2009), making this an environmental justice issue (Wolch et al., 2014). This may stem from income disparities, cultural norms, racial and ethnic considerations, willingness to visit, age-related disparities, physical disabilities, and geographical location (Haque & Sharifi, 2024). Furthermore, systemic and cultural barriers—such as historical segregation in park systems, land-use policies, zoning, and cultural histories of park-making—restrict access for marginalized communities (Byrne, 2012). For example, a study of Los Angeles parks (Byrne, 2012) revealed that Latino participants

felt unwelcome or excluded due to factors like predominantly White park visitors, the racial makeup of nearby neighborhoods, lack of Spanish-language signage, fears of persecution, and discrimination. These barriers create a sense of exclusion and inequity in UGS. In addition to access issues, planning and managing UGS present significant challenges, often tied to limited resources. UGS face threats from limited availability of space, increasing demands for housing and development, high maintenance costs, and the need to balance resources with other public services (Lee et al., 2015). Successful UGS development requires viewing these spaces as part of a larger system, involving collaboration among stakeholders and coordination across sectors like transportation, housing, and urban planning (Lee et al., 2015). Furthermore, effective planning must align with community needs to prevent issues like eco-gentrification (Wolch et al., 2014), which requires enhanced communication, outreach, and time. Trade-offs must also be carefully managed to balance social-ecological requirements, ensuring biodiversity and environmental processes are supported alongside human needs (Aronson et al., 2017). Given these challenges, the benefits of UGS are often hindered, emphasizing the need for alternative approaches to ensure equitable access and sustainable management.

1.4 Informal greenspaces

A potential solution, increasingly referenced in the literature and gaining momentum in urban planning discourse are areas called informal greenspaces (IGS). IGS have been defined as those spaces which have spontaneous vegetation, a lack of maintenance, no formal recognition and are a socio-ecological entity as they are a function of both human origin and biological factors (Sikorska et al., 2020, Rupprecht, Byrne, 2014, Rupprecht et al., 2015, Mahmoudi Farahani & Maller, 2019). A commonly adopted definition by Rupprecht and Byrne (2014) describes IGS as “an explicitly socio-ecological entity.” IGS consists of any urban space with a

history of strong anthropogenic disturbance that is covered at least partly with spontaneous vegetation. It is neither formally recognized by government institutions or property owners. Vegetation is not managed. Informality of IGS is caused by the fact that IGS are not planned or intentionally created. The space is not recognized by, nor is it being maintained to perform any defined function. Importantly, Rupprecht and Byrne also mention that formality and informality are not fixed concepts; they depend on various factors such as accessibility, control, management, and maintenance frequency. The level of informality is relative and differs based on specific characteristics and qualities.

1.4.1 Role in urban systems

The increasing interest in IGS stems from their potential to address many of the challenges associated with UGS while providing comparable ES and benefits. Developing larger parks often requires significant financial investment, extensive planning, and resources. In contrast, utilizing more informal infrastructure can serve as a viable and cost-effective alternative (Wolch et al., 2014). For example, research on reducing park congestion- density or crowding in parks- in disadvantaged communities suggests that increasing the number of smaller, optimally placed parks can improve access more effectively than creating larger parks (Sister et al., 2010). Studies on IGS highlight their dispersed and often random placement across urban areas, which enhances accessibility for residents, particularly those underserved by formal UGS (Mahmoudi Farahani & Maller, 2019; Sikorska et al., 2020; Kim et al., 2018). Additionally, IGS address resource and planning constraints that limit the expansion of formal green spaces. By definition, IGS require little to no maintenance, yet they still serve a variety of purposes for residents (Kim et al., 2018; Mahmoudi Farahani & Maller, 2019). Unlike managed spaces intended for

recreation, agriculture, or forestry, IGS are typically unmanaged, making them a resource-efficient solution for increasing urban greenery (Rupprecht et al., 2015).

1.4.1.a Ecosystem services, benefits & uses

In addition to addressing the complex challenges urban areas face in implementing UGS, studies have shown that IGS provide numerous benefits, including delivering important ES. A literature review done by Luo and Patuano (2023) found that IGS offer a diverse range of ES that complement those provided by formal UGS. Their study also highlighted that habitat services, climate regulation, and cultural services are the most frequently discussed ES associated with IGS. The literature indicates that IGS contribute across multiple ES categories, including cultural, regulating, supporting, and provisioning services. For instance, IGS provide cultural ES such as recreation, health and well-being, aesthetic enjoyment, creativity, and exploration (Sikorska et al., 2020; Kim et al., 2018; Rupprecht & Byrne, 2014; Luo & Patuano, 2023; Rupprecht et al., 2015). Regulating ES offered by IGS include temperature regulation, air quality improvement, runoff and flood prevention, and pollination (Sikorska et al., 2020; Sikorski et al., 2021; Rupprecht et al., 2015; Mahmoudi Farahani & Maller, 2019). Supporting ES are tied to IGS's role in promoting biodiversity and ecological functions, such as providing habitats (Kim et al., 2018; Pietrzyk-Kaszyńska et al., 2017; Rupprecht et al., 2015). Finally, IGS have demonstrated capacity to deliver provisioning services, including food production (Luo & Patuano, 2023). IGS have also been shown to provide a variety of activities for residents to enjoy, such as walking, dog walking, animal and plant observation, biking and exploring (Rupprecht et al., 2015). These findings underline the essential role of IGS in urban ecosystems, showcasing their ability to deliver a broad spectrum of ES and benefits that enhance urban sustainability and well-being.

1.4.1.b Unique benefits

To further highlight the benefits of IGS, research suggests that these spaces provide unique advantages compared to formal UGS, largely due to their distinctive characteristics. Their lack of restrictions and management often allows for more creative uses and diverse benefits (Pietrzyk-Kaszyńska et al., 2017; Mahmoudi Farahani & Maller, 2019). Cultural ES provided by IGS are often more intangible and highly personal, shaped by individual perspectives and experiences. For example, Luo and Patuano (2023) found that IGS foster greater opportunities for freedom, exploration, and unique interactions, making these spaces particularly special. IGS are often perceived as natural and wild, resembling untamed nature despite their urban setting. This perception allows residents to feel removed from the urban area, offering opportunities for animal and plant observation as well as passive experiences that help connect people to nature (Luo & Patuano, 2023; Pietrzyk-Kaszyńska et al., 2017; Rupprecht et al., 2015). Moreover, these spaces provide children with opportunities to explore and interact with nature, fostering excitement and discovery—an experience increasingly rare in urban areas (Luo & Patuano, 2023; Rupprecht et al., 2015). These additional benefits illustrate how IGS can offer unique, meaningful experiences and interactions that are often absent from traditional green spaces. As resource-efficient and valuable urban assets, IGS play a role in urban well-being and sustainability.

1.4.2 Disservices

While IGS are often praised for addressing many inequalities associated with UGS and delivering comparable benefits with less effort, negative perceptions surrounding these spaces can hinder their use and inclusion in urban planning and discourse. Although the naturalness and lack of maintenance of IGS are seen positively by some, these same characteristics can lead to

perceptions of the spaces as unsafe or unkempt, potentially deterring residents from fully accessing their benefits (Mahmoudi Farahani & Maller, 2019; Sikorska et al., 2020, Włodarczyk-Marciniak et al., 2020). For instance, a study in Melbourne, Australia found that residents' use of IGS was dependent on a minimum level of maintenance and accessibility (Mahmoudi Farahani & Maller, 2019). Safety concerns, such as fears of crime or natural hazards like snakes, are also associated with the lack of infrastructure and management in IGS (Mahmoudi Farahani & Maller, 2019). Additionally, some residents, particularly those with limited experience with urban nature, may not recognize or accept IGS as legitimate green spaces, which can limit their ability to provide equitable benefits since these residents are hesitant to use these areas (Kim et al., 2018; Rupprecht et al., 2015). This highlights a critical challenge for planners to address when integrating IGS into urban systems. Incorporating IGS into city planning could help overcome negative perceptions while enhancing biodiversity, accessibility, and ecosystem services (Rupprecht et al., 2015) while protecting undesignated IGS from development (Pietrzyk-Kaszyńska et al., 2017, Sikorska et al., 2020). However, it is essential to balance this with preserving the intrinsic informality of IGS, which fosters freedom, ecological processes, and spontaneous social interactions (Luo & Patuano, 2023). It is also worth mentioning that additional maintenance increases cost (Sikorska et al., 2020). While some level of maintenance may be necessary to increase use and acceptance (Mahmoudi Farahani & Maller, 2019), design interventions should prioritize maintaining the openness, inclusiveness, and self-regulated ecological processes that define IGS. Thoughtful planning can support these natural dynamics while addressing residents' concerns, ensuring that IGS retain their unique characteristics and continue to provide meaningful benefits while still being resource-efficient (Luo & Patuano, 2023; Pietrzyk-Kaszyńska et al., 2017, Sikorski et al., 2021).

1.4.3 Gaps in the literature

To address the challenges associated with promoting IGS in urban areas and enhancing human well-being, it is useful to explore gaps in the literature that warrant further research and discussion. IGS play a vital role in urban greenery, offering increased access and benefits to residents. Their spontaneous nature presents a unique opportunity for integration into city planning as a resource-efficient nature-based solutions. Intentionally incorporating IGS into planning could protect these spaces from development, preserving their ability to deliver ecosystem services and benefits (Rupprecht et al., 2015; Sikorska et al., 2020; Włodarczyk-Marciniak et al., 2020). However, how to effectively integrate IGS into urban planning remains unclear, with limited research on the roles of government and other stakeholders in this process (Kim et al., 2018). This issue becomes especially complex given that most IGS are not publicly owned and are subject to legal constraints, creating challenges for planners attempting to intervene (Rupprecht et al., 2015). While some studies briefly mention potential interventions, such as small management initiatives (Mahmoudi Farahani & Maller, 2019) there is insufficient exploration of participatory approaches. Understanding residents' perceptions, concerns, and lived experiences of IGS through in-depth consultation is critical to aligning interventions with community needs and expectations (Mahmoudi Farahani & Maller, 2019). However, participatory actions and the involvement of local users have not been studied in sufficient detail (Rupprecht et al., 2015). Additionally, differences in perceptions and preferences between planners and residents further complicate the development of effective interventions (Mahmoudi Farahani & Maller, 2019). Addressing these gaps is crucial to creating strategies that balance the social and ecological benefits of IGS. For instance, while participatory management by community members could reduce resource burdens on city planners, it may inadvertently

disrupt the biodiversity and ES provided by IGS, underscoring the need for further research on these trade-offs. Balancing the social-ecological heterogeneity of IGS is a recurring theme in the literature, with an emphasis on sustaining biodiversity while providing recreational opportunities to increase community acceptance (Rupprecht et al., 2015; Sikorski et al., 2021). It is important to examine ES trade-offs to develop comprehensive strategies that enhance the environmental, ecological, and social benefits of IGS (Luo & Patuano, 2023). Such strategies require collaboration among multiple stakeholders and careful consideration of diverse perspectives. Another significant gap in the literature is the lack of focus on how race, ethnicity, education, and income influence the perceptions and use of IGS (Rupprecht et al., 2015). If IGS are to address inequities in UGS availability, it is crucial to determine whether they align with the needs and preferences of disadvantaged communities. Including these communities' perspectives in IGS planning is essential to ensure equitable representation and outcomes (Kim et al., 2018). For IGS to fulfill their potential in providing urban greenery and associated benefits, future research must explore ways to overcome challenges that come with the management and planning interventions. Key questions include determining the extent and nature of interventions, identifying stakeholders to involve, understanding trade-offs, and ensuring equitable representation in decision-making (Rupprecht & Byrne, 2014). Addressing these gaps will be critical to unlocking the full potential of IGS in urban areas.

1.5 This study

1.5.1 Structure

Chapter 1 of this thesis provided an overview of urban greenspaces, their associated ES, and the challenges cities face in providing equitable and high-quality greenspaces. It introduced informal greenspaces (IGS) as a potential solution—unmanaged, liminal spaces that offer

comparable benefits to residents at little to no cost. The chapter also addressed the challenges associated with IGS, including negative perceptions and the risk of development, and explored strategies for overcoming these obstacles through research and informed planning.

Chapter 2 will introduce the research topic and the rationale for conducting this study. It will detail the methods used, including semi-structured interviews and systematic observations, explaining their implementation and purpose. The chapter will then present the findings from interviews with both residents and City professionals, as well as the results of the systematic observations. Finally, it will conclude with a discussion section that highlights the key findings and their significance, demonstrating how this research contributes to the broader understanding of IGS.

These findings enhance the growing body of research on the importance of IGS in urban living and well-being, particularly through the delivery of ES. By offering new perspectives and ideas, this study contributes to the evolving conversation on the future of IGS in urban planning and management.

Chapter 2: The Role of Informal Greenspaces in Fort Collins' Social and Ecological Systems: Ecosystem Services, Community Benefits, and City Perspectives

2.

2.1 Introduction

Informal greenspaces (IGS) are increasingly recognized for their ability to deliver ecosystem services (ES) and benefits to urban residents. While prior research has explored IGS perceptions and uses, further examination of resident perspectives provides valuable insights for urban planning. This study focuses on Fort Collins, Colorado, analyzing various IGS sites across different socio-economic areas. Fort Collins is an ideal place to study informal greenspaces because its active residents frequently engage with formal greenspaces, suggesting a potential interest in and reliance on urban nature for recreation and well-being. As a fast-growing city balancing development and greenery, and with officials involved in nature-based solutions, Fort Collins provides a unique opportunity to explore both community interactions and policy perspectives on informal greenspaces. The informal greenspace sites for our study are particularly unique as they are owned or co-owned by the City of Fort Collins, offering a distinctive perspective on how IGS can be integrated into municipal planning. Our research aims to understand how residents interact with IGS, the perceived ES and benefits, and how these vary by socio-economic status (SES). Additionally, perspectives from City officials provide insights into management priorities, challenges, and opportunities for integrating IGS into urban planning.

Our specific research questions were: **(1)** How do residents of Fort Collins interact with informal greenspaces and what ecosystem services and benefits do users perceive these spaces to provide? **(2)** Do interactions, and perceived benefits change with the socio-economic status of IGS location? **(3)** What are the perspectives of City officials regarding these sites, and what opportunities and challenges do they foresee in integrating informal greenspaces into urban planning?

While many definitions of informal green spaces (IGS) exclude government-owned areas, our study argues that these sites represent a novel form of IGS—spaces that remain unmanaged or irregularly maintained yet provide valuable ecological and social benefits. Including these areas in the IGS framework makes the concept more relevant as local governments have the capacity to influence and manage these spaces, unlike privately owned lands. We propose defining these areas as additional government-recognized spaces that are irregularly managed or unmanaged, not developed, maintained or documented for recreational or human use, but preserved for specific municipal purposes. These areas are characterized by predominantly naturally occurring vegetation that is neither intentionally planted nor managed for particular objectives, with their form and function shaped by human influence and designation.

The significance of this study lies in recognizing IGS as resource-efficient solutions that provide multiple societal benefits while serving as nature-based insurance systems (Włodarczyk-Marciniak et al., 2020). Our selected sites, often designated as water detention areas or ditch easements, highlight opportunities for cities to reevaluate existing open areas and infrastructure and their potential as IGS. Since these spaces are already documented in municipal records but

not classified as green spaces, they provide valuable insights into how IGS integration into urban planning may influence future management and resident perceptions.

This research contributes to the growing discourse on the role of governments and planners in incorporating IGS into city planning—an aspect that is often overlooked (Kim et al., 2018). While most studies focus on IGS benefits and user perceptions (Rupprecht et al., 2015; Włodarczyk-Marciniak et al., 2020), our study also highlights City officials' perspectives, identifying key challenges and opportunities for policy implementation. Collaboration among stakeholders is essential for effective integration, and this study offers a foundation for future planning strategies. Additionally, we address underexplored factors such as income in shaping IGS perceptions and use (Rupprecht et al., 2015). Understanding these differences can help ensure that IGS planning aligns with diverse community needs. To further bridge research gaps, we employed a mixed-methods approach, incorporating systematic observations to examine actual IGS use. While this study does not directly analyze use versus non-use factors, it lays the groundwork for future investigations.

These findings contribute to the growing body of research on IGS and their role in urban well-being, particularly through ES delivery. By offering new perspectives, this study advances discussions on the future of IGS in urban planning and management, reinforcing their importance in sustainable city development.

2.2 Methods

2.2.1 Study site

Fort Collins, Colorado, has a population of 169,810 (*Census Profile*, n.d.), an increase of 17.94% since 2010 (United States Census Bureau, 2021) and has been growing at an annual rate

of 0.31% since 2020. The median household income is \$78,977, and the population is 82.8% White, 12.4% Hispanic or Latino, 3.4% Asian, 1.4% Black or African American, 0.8% American Indian and Alaska Native, and 0.2% Native Hawaiian or Other Pacific Islander. Politically, the City leans more Democratic than the state overall. Located along the Rocky Mountain Front Range, Fort Collins boasts 966 acres of developed parks, 52 conserved natural areas, and 114 miles of trails (*About Us || Natural Areas*, n.d.), (*Parks in Fort Collins || Parks*, n.d.).

2.2.2 Site selection

For our site selection we followed the definition mentioned in the introduction of this paper. To begin to identify IGS in Fort Collins, we used a high-resolution 1m² land cover dataset with seven land cover classes (Rasmussen et al., 2021, Abram et al., 2022, Rasmussen et al., 2022). Spatial data for the City's Growth Management Area (GMA) was reprojected to match the dataset's coordinate reference system, forming the basis for distinguishing between formal and informal greenspaces. Formal greenspaces were identified by overlaying land cover data (tree canopy, grass/shrub, bare soil, water) with City and county shapefiles of parks, natural areas, agricultural zones, and certified open spaces. These areas were excluded from the IGS layer. To define IGS, formal greenspaces and privately owned residential parcels were removed, along with built-up residential areas, multi-family housing, HOA-owned spaces, and prominent commercial greenspaces. Retained areas included natural land cover types and were limited to City-owned properties. Patches under 0.25 acres were excluded to focus on accessibility for use. The final IGS layer identified 34 potential IGS sites for fieldwork.

To examine socioeconomic status (SES) variations, IGS sites were categorized based on the income level of their surrounding census tracts. Low-income areas had household incomes below \$50,000, while high-income areas exceeded \$100,000, based on census data (*Census*

Profile, n.d.). The intersection of income data and the IGS layer helped identify sites for further analysis, considering area, shape, and proximity to water.

To ensure that sites identified hadn't changed, and were accessible, we ground-truthed all 34 sites. We eliminated 18 sites due to various conditions (Table 1) resulting in 16 for data collection. In total eight sites were characterized as high SES and seven as low SES that met all criteria (Figure 1). One low SES site was removed following the commencement of data collection as a no trespassing sign was posted after ground truthing occurred. Sites ranged in size from 1-9 acres, and some contained water (n=7). Sites and their information can be found in Appendix A. Example pictures of sites can be found in Figure 2.

Table 1: Traits that eliminated a site from our site selection list for data collection.

Conditions	Reasoning	Example
Accessibility	Unable to access the site due to reasons like infrastructure, safety, trespassing, fencing	A site with no trespassing signs and a partial fence surrounding the area
Size	Too small of an area for potential use/data collection	A site <0.25 acres and next to a sidewalk, researchers would have been taking up majority of the site
Part of formal infrastructure	Connected to a formal greenspace/infrastructure with no formal boundary	A front lawn of a powerhouse building
Safety	Perceived safety of the sites: if anyone felt unsafe, site was eliminated	A large area with unhoused people camped throughout the area, in an isolated part of town
Fragmentation	A site that was highly fragmented by buildings or infrastructure creating a mosaic instead of one greenspace	A medical park with a green strip around it but fragmented into pieces by buildings

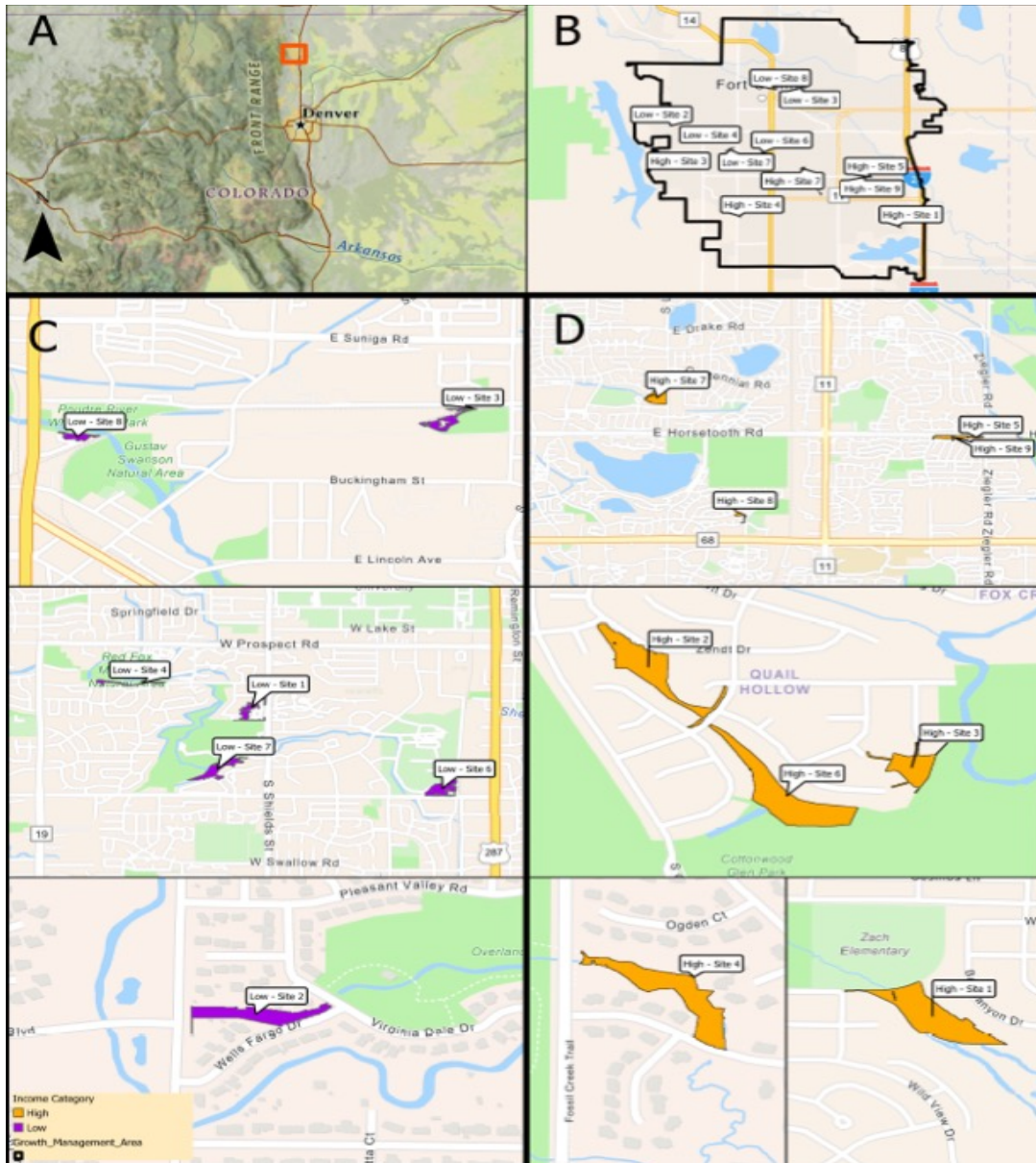


Figure 1: Informal greenspace (IGS) sites within Fort Collins, Colorado. Box A shows Fort Collins' location within the state. Box B displays all IGS sites within the city's Growth Management Area. Boxes C and D provide zoomed-in views of low-SES and high-SES sites, respectively.



Figure 2: Examples of informal greenspace sites for data collection.

2.2.3 Data collection

Over eight weeks beginning in June 2024, we conducted observations and semi-structured interviews at 15 IGS sites. Each day, two sites were visited for three hours each, totaling 180 survey hours. Time zones for data collection were based on local greenspace use (Wang & Wu, 2020). Weekday time slots included morning (6:30–9:30 AM), mid-morning

(10:00 AM–1:00 PM), afternoon (1:30–4:30 PM), and evening (5:00–8:00 PM), while weekends followed a slightly different schedule, starting two hours later. SES group sites were evenly distributed on the schedule. Extreme weather and lack of visitation led to adjustments, with details provided in Appendices A and B.

During our time at IGS sites, we conducted direct systematic observations, defined by Bernard (2017) as watching and recording behavior in real-time. This approach captured user interactions in a natural setting (Gorman, 2005). Using an adapted form from Tzoulas and James (2010), we recorded demographics, activities, visit details, and group size (Appendix C). Observations occurred during three-hour site visits, with each site visited four times for a total of 12 observation hours. Every individual entering the site boundaries was recorded, ensuring systematic data collection aligned with our research questions and interview findings.

To better understand the self-perceived ES and benefits that Fort Collins residents associate with IGS, we conducted semi-structured interviews (Newing, 2011) using a guided framework (Appendix D) while stationed at the sites. The guide focused on key topics, including ecosystem services, benefits, beneficial characteristics, and equity and access related to the IGS. The study was approved by Colorado State University's Institutional Review Board (IRB protocol #5771).

At each site, every third adult user (18+) was initially approached to provide a brief introduction, obtain verbal consent, and conduct a 15-minute interview, with participants free to skip questions or end the interview at any time (Appendix E). After two weeks of lower visitation than we originally anticipated, the approach was adjusted to every second adult user to increase participation. Users who were running, biking, or accompanied by aggressive or timid

dogs were not approached. Large site size or high visitor density also influenced approachability. A full description of approaches and circumstances is provided in Appendix A. In total, 54 users were approached across all IGS sites, with 30 declining to participate, resulting in 20 completed interviews. Two interviews included two participants simultaneously, accounting for the discrepancy in the total number of interviews conducted. Of those, 12 interviewees consented to be recorded. We used a PLAUD recorder device to ensure accurate transcription (Newing, 2011), with one person asking the questions and recording, while another took written notes. Interviews were conducted throughout the months of June and July, aligning with the predetermined data collection timeline. Despite this fixed timeline, the authors concluded that thematic saturation was reached, as no new ideas emerged toward the end of the period. Simultaneous coding which occurred at the end of each week further confirmed that novel themes had ceased appearing.

To gain additional insights into IGS functionality, opportunities, and challenges, the authors conducted semi-structured interviews with City professionals. An interview guide was developed to explore personal experiences with the sites, their functional roles and futures (Appendix F). Using the “City Owned Parcel” GIS layer and input from GIS personnel, the department overseeing each site was identified (Appendix A). Interview requests and consent emails (Appendix G) were sent to the relevant departments, employing snowball sampling to identify additional knowledgeable individuals (Newing, 2011). The initial contact group included City department heads (n=4), City officials known professionally (n=5), and additional recommended personnel (n=13), totaling 22 interview requests. All prospective interviewees were contacted at least twice. Nine individuals did not respond, four declined due to lack of relevant expertise, and five referred the researchers to others in their department. Ultimately, four interviews were completed, spanning three departments. Interviews were conducted via

Microsoft Teams (n=2) or in person at a location of the interviewee's choice (n=2). All interviews were recorded with verbal consent using a PLAUD recorder.

2.2.4 Data analysis

Observed behaviors and associated data (date, estimated age range, time, etc.) were coded and entered into Excel, where descriptive statistics such as frequency counts, sums and averages were calculated.

Our analysis of semi-structured interviews followed an inductive grounded theory approach (Corbin, Strauss 1994, Chun Tie et al., 2019) to identify key themes and theoretical patterns based on verifiable data (Braun, Clarke, 2006, Yu & Smith, 2021). This iterative process allowed for concurrent data analysis and revision, ensuring flexibility (Knott et al., 2022). By analyzing the data without a pre-defined hypothesis, we remained grounded in participants' responses and allowed themes to emerge naturally (Bernard, 2017).

C.A., the primary analyst, has lived in Fort Collins for five years and has a background in natural science and conservation. Their familiarity with nature-based solutions and local greenspaces provided insights into ES and benefits. However, efforts were made to minimize bias, including discussions with researchers less familiar with the project. Their positionality also fostered transparency and engagement with participants, making interactions feel less extractive.

Interview transcriptions were downloaded from PLAUD and verified for accuracy by listening to the audio and ensuring verbatim transcription (Lester et al., 2020). C.A. conducted both the interviews and transcription, enhancing familiarity with the data. Throughout the

process, memos captured initial reflections and emergent patterns (Lester et al., 2020), which were then discussed to assess potential biases and refine interpretations (Chun Tie et al., 2019).

A two-step open coding process was used (Chun Tie et al., 2019, Yu, Smith, 2021). During initial coding, we categorized and assigned meaning to data, identifying similarities and differences. Weekly coding discussions ensured consistency, reduced bias, and refined interview questions (Chun Tie et al., 2019). Axial coding followed, where similar codes were grouped into core categories (Yu, Smith, 2021), using constant comparison to analyze relationships (Lester et al., 2020).

Core themes and subthemes were developed by identifying frequently occurring categories that were logical, consistent, and interrelated (Yu, Smith, 2021). ES provided by IGS were identified through interviews and categorized based on the Millennium Ecosystem Assessment (MA, 2003) framework, which classifies ES into provisioning, cultural, regulating, and supporting services. Given the unique characteristics of IGS, theme development was informed by both literature and author interpretations of participant responses.

To ensure intercoder reliability, Dedoose software was used (*Inter-Rater Reliability Overview*, n.d.). The first author (C.A) coded 12 interviews, and three were randomly selected for coding comparison by the second author K.M. Discrepancies that came up between coders were resolved through discussion and refinement of code definitions. A Cohen's Kappa value of 0.87 confirmed consistency by using four test codes across 12 excerpts. Each author then coded 10 interviews twice to extract all themes within the data. City professional interviews followed a similar process, coding three themes, eight subthemes, and nine codes. A Cohen's Kappa value of 1.00 confirmed reliability by using three test codes across nine excerpts.

2.3 Results

2.3.1 Observations

We recorded 159 user observations across 15 IGS sites. The average time observed for each user at the sites was 3 minutes (range: 1-57 minutes). Five sites were never visited by users during the observation period. The sites visited by the most users were lowSES4 (n=42), lowSES7 (n=41), highSES7 (n=28), and highSES3 (n=20). The observed age of participants was predominantly adult (over 18) (n=152), though some children were also seen using the sites independently (n=7).

Activities recorded were dog walking (n=60), walking (n=55), cycling (n=26), and running (n=15) (Figure 3). Additional activities, not included on our original observation datasheet, included playing fetch with a dog, putting up a bird feeder, and using other modes of transportation (n=3), (e.g., scooter). Notably, all but one of the observations involved individuals passing through the area, using it primarily as a corridor or thoroughfare (n = 158).

Of the total observations, 60% (n=96) occurred in low SES areas and 40% (n=63) in high SES areas. Activity types were slightly different between SES areas (Figure 3). In low SES areas, walking was the most prevalent activity, followed by dog walking. In high SES areas, dog walking was most common, with walking as the second. Cycling ranked third for both groups. Almost all running observations (13 out of 15) came from low SES areas. “Other” activities were recorded only in high SES areas, surpassing running by one observation.

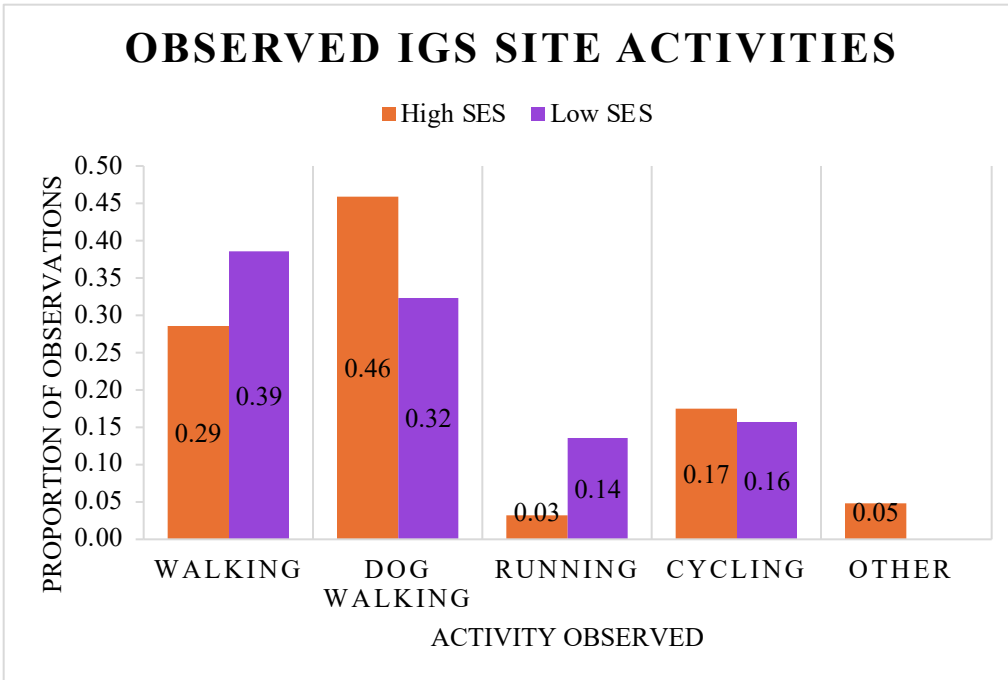


Figure 3: Proportion of visitors from different SES locations engaging in various activities at informal greenspace sites.

2.3.2 Ecosystem services

Semi-structured interviews averaged 9 minutes (range 4-19 mins). Three major ecosystem service-related themes emerged from our interviews: (1) cultural ecosystem services (2) regulating ecosystem services and (3) supporting ecosystem services. Nine interviewees provided their demographic information. Of those respondents, two were men identifying, seven were women identifying. The average age was 51 years, and the average annual household income was \$75,000. Most interviewees owned a vehicle and 88% of residents reported living within a mile of the IGS site where the interview occurred.

For the resident users, five themes, 19 subthemes, and 18 codes emerged, with three themes, 14 subthemes, and 13 codes selected to answer the research questions. Further details on themes, subthemes, and definitions can be found in Appendix H. Resident users identified cultural, regulating, and supporting ES provided by IGS sites (Table 2, Figure 4). Interviewees

recognized multiple ES, with cultural ES being the most frequently mentioned (Figure 5). Most respondents highlighted aesthetic value, recreation, and mental health as key benefits they receive from IGS. Aesthetic value, the most cited cultural ES, was linked to various elements, including wild animals, naturalness, plants, viewsheds, sounds, and water. Approximately half of respondents identified more intangible cultural ES, such as social relations, connection to nature, and freedom, reinforcing the role of IGS as spaces where people feel comfortable, engage with nature, and experience benefits associated with wild environments. Social relations encompassed both social encounters and a sense of community togetherness, while freedom was tied to the lack of restrictions users felt and the opportunities IGS provided for children to explore. Other cultural ES, mentioned less frequently, included sense of place, educational value, and spiritual value. Sense of place, cited by six interviewees, referred to the emotional, cultural, and symbolic meanings residents attached to IGS and how these influence how residents interact with spaces and was further categorized by management preferences and housing choices. Users also identified regulating services, with about a quarter of respondents recognizing benefits related to air quality maintenance, climate regulation, pollination, and storm protection. Additionally, around a quarter of respondents cited supporting services, particularly habitat provision, valuing how IGS sustain flora and fauna.

Table 2: Ecosystem services identified by interviewees, from most frequently identified to least.

Ecosystem Service	Definition	Subthemes & Definition	Exemplary Quote	Count
Aesthetic value-Cultural	Finding beauty in aspects of the ecosystem, leading to feeling of enjoyment and/or pleasure (MA 2003, Swaffield, McWilliam, 2013).	Naturalness- Finding beauty in the wildness nature of the ecosystem, leading to feelings of enjoyment and pleasure (MA 2003, Swaffield, McWilliam, 2013)	<i>"I also really appreciate that the site is not manicured"</i> P3, lowSES	12
		Wild Animals- Finding beauty in viewing or seeing wildlife of the ecosystem, leading to feelings of enjoyment and pleasure (MA 2003, Swaffield, McWilliam, 2013).	<i>"There is also a lot of wildlife viewing. We just saw a baby beaver in the canal over here and always see deer going up and down."</i> P1, lowSES	11
		Plants - Finding beauty in the plants of the ecosystem, leading to feelings of enjoyment and pleasure (MA 2003, Swaffield, McWilliam, 2013).	<i>"it's beautiful, right? Because it's got the trees."</i> P8, highSES	8
		Viewshed- Finding beauty in the views provided by the ecosystem, leading to feelings of enjoyment and pleasure (MA 2003, Swaffield, McWilliam, 2013).	<i>"This viewscape It's got a lot of nice textures, though. Broken down bodies of these dead cottonwood."</i> P12, lowSES	6

		<p>Water- Finding beauty in the water of the ecosystem, leading to feelings of enjoyment and pleasure (MA 2003, Swaffield, McWilliam, 2013).</p>	<p><i>"And when there's water in the ditch, it's, I don't know, it feels like more of a natural space again than walking on a sidewalk next to a street."</i> P7, lowSES</p>	4
		<p>Sounds- Finding beauty in the sound or no sound of the ecosystem, leading to feelings of enjoyment and pleasure (MA 2003, Swaffield, McWilliam, 2013).</p>	<p><i>"You know, the sound of the little, like, river being flowing. There's not a lot of traffic going on. It's just calming overall. And just hearing the birds chirping and the little other noises going on. It's just the right amount of sound. "</i> P8, lowSES</p>	3
<p>Recreation-Cultural</p>	<p>The ecosystem provides a preferable space for residents to spend their leisure time and to engage in various activities including walking, running, biking, birdwatching, etc. based in part on the characteristics provided (MA 2003, Dushkova et al., 2021)</p>		<p><i>"I walk through this area everyday"</i> P5, lowSES</p>	16

<p>Mental health- Cultural</p>	<p>The ecosystem provides a space for exposure to nature and through experience can positively impact emotional well-being like helping to reduce stress or to relax (Dushkova et al., 2021)</p>		<p><i>"Yeah, I mean it's calming. I think that's like one of the biggest ones. Kind of get your mind off things going on in your personal life "</i> P8, lowSES</p>	<p>12</p>
<p>Social relations- Cultural</p>	<p>The ecosystem provides the space for various social interactions which promote social cohesion (Xin, et al., 2020).</p>	<p>Social interactions- The ecosystem provides the space for interactions, a place for socialization and time with others (MA, 2003, Xin et al., 2020).</p>	<p><i>"People are friendly, we meet each other"</i> P2, highSES</p>	<p>7</p>
		<p>Community togetherness- The ecosystem provides the space for community cohesion, a place for communities to gather, be together and share (MA, 2003, Xin et al., 2020).</p>	<p><i>"Last Saturday the community came together; mowed the area and threw a graduation party for two of the kids in the houses nearby"</i> P1, highSES</p>	<p>3</p>
<p>Connection to nature- Cultural</p>	<p>The ecosystem provides a space for users to foster a personal connection to nature through passive engagement (being in and around nature alone has benefits) (Luo, Patuano, 2023)</p>		<p><i>"It gives you a chance to actually go outside and disconnect from the tech world and everything. "</i> P8, lowSES</p>	<p>9</p>

Freedom-Cultural	The ecosystem and its characteristics provide the opportunity to use the space more freely, leading to more creative and explorative experiences in nature (Luo & Patuano, 2023)	Youth exploration- Characteristics of the space allow for children to experience an explorative playing environment and freedom in nature (Luo & Patuano, 2023).	<i>"I think it's better for like the kids. I think the kids rule these green spaces. Oh. Yeah. Like for them it's awesome. Paradise. Yeah. You know, to be able to come and hit these, like they link it all the way through and who knows what's in these spaces, which is great. Yeah. Like if you just go back here, there's forts and stuff everywhere"</i> P4, highSES	3
		Unrestricted use- Characteristics of the space allow for freedom to do whatever the user wants, potentially contributing to feelings of comfortability and autonomy (Luo & Patuano, 2023).	<i>"We really don't like taking the dogs to the park because when we do, we keep them on the leash. But back here, we feel a little more comfortable. Like there's not the park rangers staring at us. And we don't just let them run. You know, we go out there and play with them and then bring them back in."</i> P7, highSES	4

Sense of Place-Cultural	The ecosystem provides the space for people to develop a sense of place, which encompasses the emotional, cultural, and symbolic meanings they attach to specific environments, as well as the physical and psychological benefits they derive from these connections. This sense of place shapes how individuals interact with, value, and make decisions about the places they inhabit or frequent (Hausmann et al., 2016)	Housing selection- Reflects how ecosystems support sense of place by providing opportunities to live near nature, aligning with residents' values and fostering emotional and functional connections to place (MA, 2003)	<i>"One of the main reasons we bought the house was just that it backed up to a green space. And we had kids at the time, and we've always had dogs, so the yard's pretty small, so we definitely wanted a bigger space."</i> P7, highSES	4
		Management of greenspaces- Reflects how ecosystems support sense of place by offering communities opportunities to engage in stewardship that aligns with their values, influencing how they interact with and care for these spaces (Hausmann et al., 2016, Dushkova et al., 2021)	<i>"The neighbor down there, he's like three houses down, he mows the strip all the way to the Trail and back like six times because his wife is scared of snakes, but she likes to walk down here to get to the trail. He's such a sweetheart, he loves that for her, which we benefit from too. And then I've noticed another neighbor now is starting to just mow too, and a lot of people mow a path from their gate. I think one thing I see happening is people starting to take kind of ownership of it"</i> P7, highSES	2

Climate regulation-Regulating	The ecosystem by providing land cover, shading, etc., positively affects temperature and precipitation (MA, 2003).		<i>"The space cools off the environment, it's not hardscaped, it's soft and green, and also just provides shade, and so it reduces the heat island effect."</i> P11, lowSES	5
Air quality maintenance-Regulating	The ecosystem contributes to reducing air pollution, positively influencing air quality (MA, 2003).		"[This spot has] cleaner air than the city" P4, lowSES	4
Storm protection-Regulating	The ecosystem helps protect from storms by aiding water detention which prevents flooding and damage (MA, 2003).		"Obviously it's for flooding, so it's great to know that that's here, and we've seen that actually work" P6, highSES	4

<p>Habitat-Supporting</p>	<p>The ecosystem supports plants and animals by providing necessary characteristics such as nutrition, protection, connectivity, landscape features (MA, 2003).</p>		<p><i>"This green space, this natural area connects to this, this neighborhood right over here has an HOA and in the middle of it is a green belt. And so, the wildlife goes from here to there to, um... The Great Spring Canyon, Spring Creek Trail, so it's a corridor for them for, you know, mammals, but also the birds use it. We hear a lot of owls in the spring and the fall. Of course, there's a lot of small mammals in it, and the insects are just, there's a lot of flowering trees in that greenbelt and in the neighborhood, so yeah, it's an important corridor for wildlife. "</i> P11, lowSES</p>	<p>4</p>
<p>Educational value-Cultural</p>	<p>Attributing the ecosystem for providing some kind of educational component, whether that be formal or informal (MA 2003, Dushkova et al., 2021)</p>		<p><i>"So here I learn about birds. And I connect with my undergraduate studies, which are environmental sciences. I have 12 credits in botany, so I like plants, I notice fruit."</i> P12, lowSES</p>	<p>3</p>

Spiritual & religious values- Cultural	Feeling or attaching religious/spiritual values to the ecosystem and its components (MA 2003, Dushkova et al., 2021)		"Because wildness is sacred. I mean, it feeds my spirit. I could try to explain that, but maybe that's a good start. No, that's it. For me, it's like music and being outside are the two things that restore my soul." P4, lowSES	1
Pollination- Regulating	The ecosystem supports the distribution and abundance of pollinators and their functions (MA,2003).		"I like that this space was kept wild instead of making everything grass/mowed especially because it keeps the insects happy." P6, lowSES	2

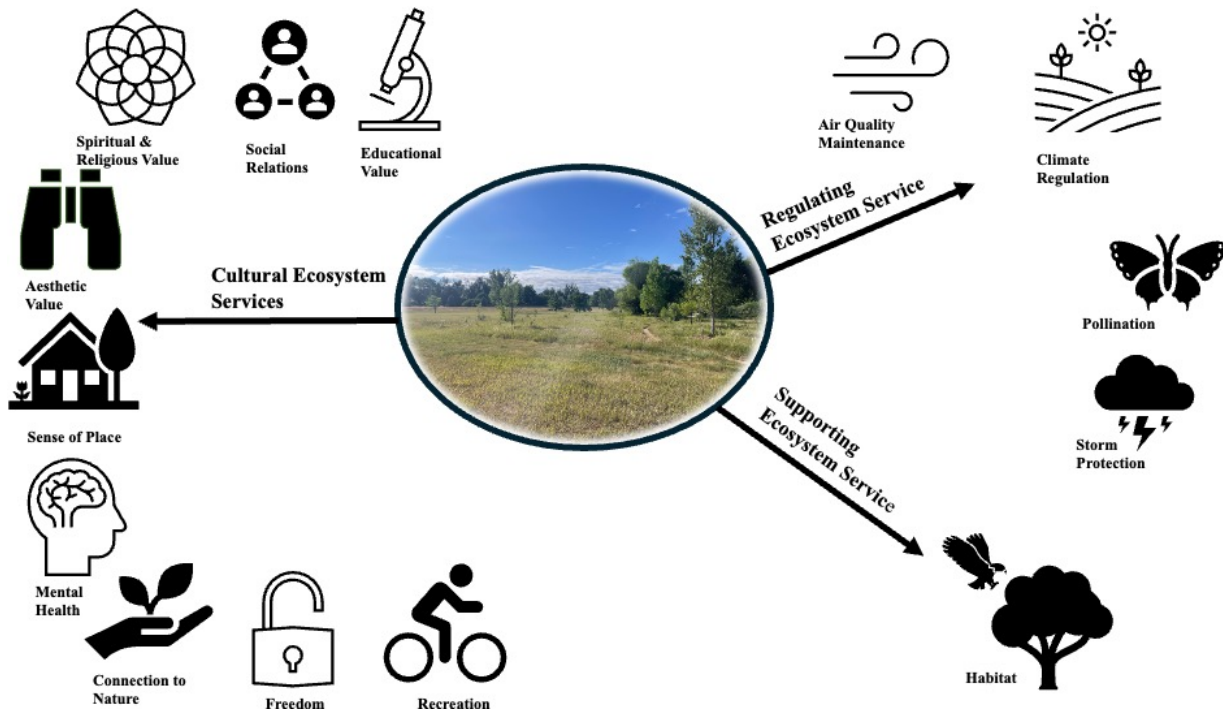


Figure 4: Resident users self-perceived ecosystem services from informal greenspaces.

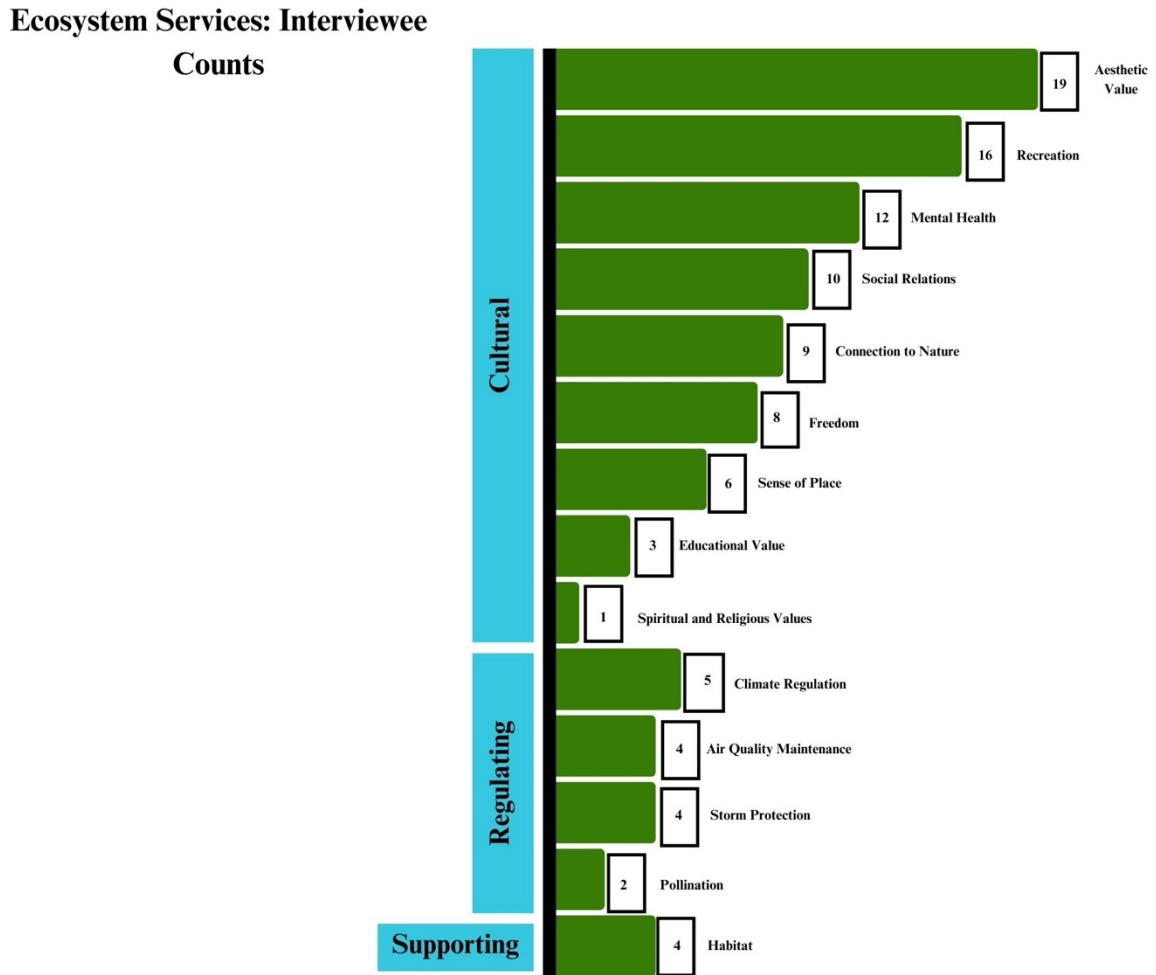


Figure 5: Total interviewee counts (number of people who mentioned it) of perceived ecosystem services residents feel they receive from the informal greenspace sites.

2.3.3 SES groups

Of the 20 interviews conducted, 12 took place at low SES sites and 9 at high SES sites.

Figure 6 provides a complete breakdown of code applications by SES group; here, we focus on the most frequently mentioned ES.

Participants in high SES sites most frequently identified cultural ES, with the most commonly mentioned being aesthetic value, sense of place, recreation, social relations, mental health, and freedom (in descending order). Similarly, participants in low SES sites also primarily

identified cultural ES, with the most frequently cited services being aesthetic value, recreation, mental health, connection to nature, and educational value (in descending order).

When comparing similarities, participants in both SES groups most commonly mentioned aesthetic value, recreation, and mental health as key benefits of IGS. However, notable differences emerged (Figure 7). High SES participants were more likely to identify social relations and freedom, whereas low SES participants more frequently mentioned connection to nature. Additionally, sense of place was frequently cited in high SES sites but not at all in low SES sites, while educational value was commonly mentioned in low SES sites but not at all in high SES sites.

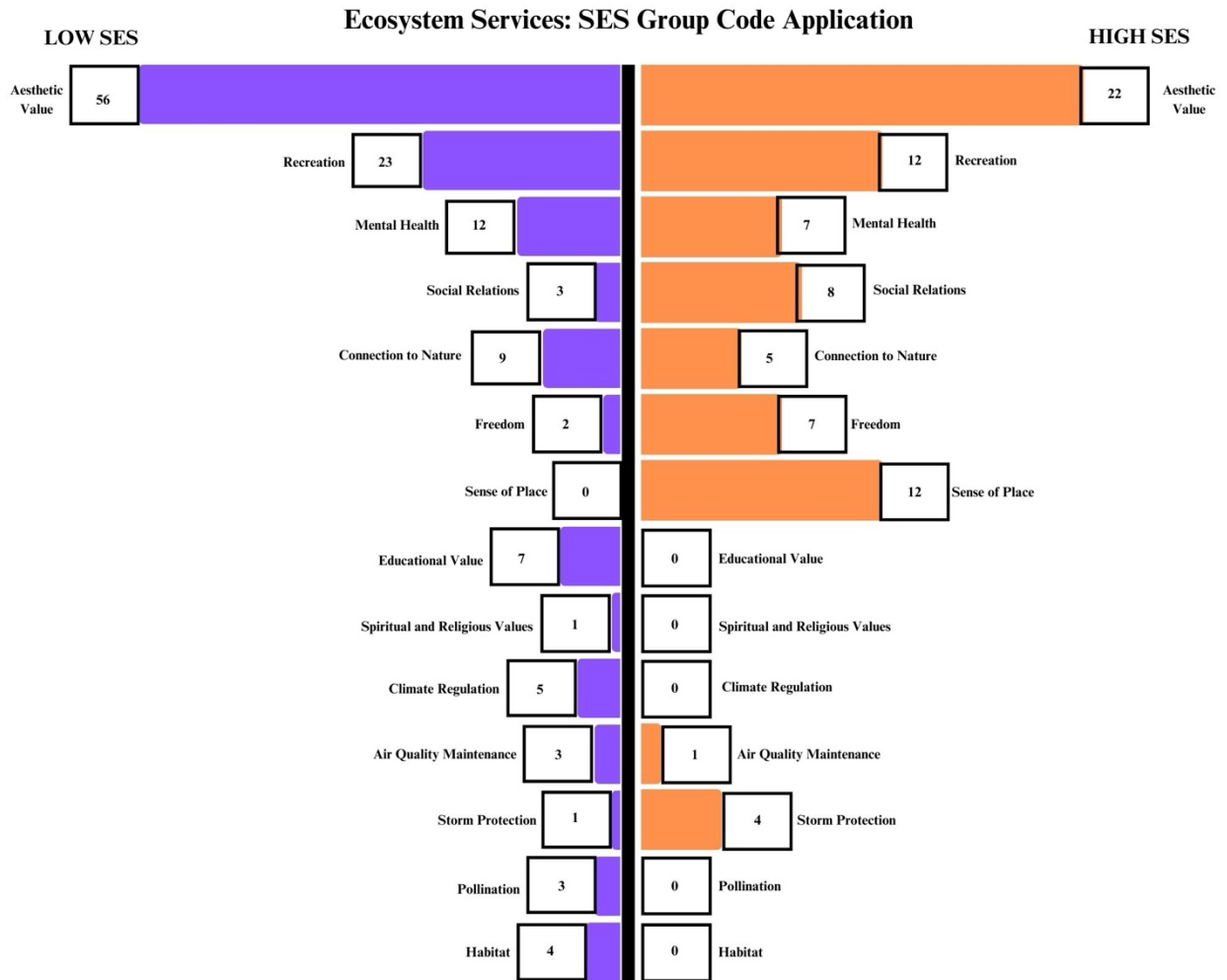


Figure 6: Number of times each SES group mentioned a perceived ecosystem service they receive from the informal greenspace sites.

		High SES	Low SES				
	Educational value	0	7				
	Aesthetic value	22	56				
Cultural ES Subthemes	Social relations	8	3				
	Sense of place	12	0				
	Recreation	12	23				
	Mental Health	7	12				
	Connection to nature	5	9				
	Freedom	7	2				
		0	10	20	30	40	50
		Frequency Count					

Figure 7: Heatmap of most frequently mentioned cultural ecosystem service subthemes by high and low SES site participants. Orange (high SES) and purple (low SES) bolded indicate a “unique” subtheme to that group. Bolded fonts indicate subthemes that were most mentioned in both groups.

2.3.4 City officials

Semi-structured interviews averaged 35 minutes, the shortest being 27 minutes and the longest being 49 minutes. We interviewed City officials working in departments focused on planning, utilities, and natural areas.

City officials identified three main themes relevant to our research questions (Appendix I): IGS site functions (both anthropogenic and natural), opportunities for advancement and management, and barriers to these opportunities (Tables 3-4). All interviewees recognized both anthropogenic and natural functions of IGS (Figure 8). Anthropogenic functions included stormwater detention, recreation, open space, conveyance, and urban cooling, while natural functions primarily involved habitat and connectivity. City officials frequently discussed opportunities to enhance IGS, with collaboration, multifunctional management, and integration into planning emerging as key themes. Collaboration and multifunctional management were the most commonly cited opportunities. Despite these possibilities, all interviewees identified barriers preventing such advancements, with dissonance cited by every

participant. Other obstacles, including resource limitations and external interference, were mentioned but less frequently.

Table 3: Site functions identified by City officials, both anthropogenic and natural identified equally.

Site Function	Definition	Subthemes & Definition	Exemplary Quote	Count
Anthropogenic	The identified functions of the space are influenced, created, or modified by human activity and perceptions, and the benefits, uses, or impacts of the space are defined according to human needs, values, and experiences.	Stormwater detention- The site was identified to help with water detention, prevent flooding and ensure water quality in developed areas	<i>" I think there's the purpose of treating storm water for water quality, so that water quality of water when it gets back into the stream is higher. It's also for preventing flooding, so that way water is releasing at a lower rate and taking properties out of the floodplain. "</i> P1	4
		Recreation- The site was identified as providing a space for various recreational activities, both passive and active.	<i>"So of course these, by being distributed throughout the city, and because they're not like a very far, they're more of a distributed type of facility, they will encourage people to recreate, whether it's active or passive."</i> P2	3
		Open space- The site was identified as providing greenery to the area and associated nature-human contact.	<i>"I guess the second value that I would think about would just be, you know, quick access to nature. I mean, you know, these areas don't have to be large to provide residents and community members with some respite, you know, and an opportunity to just reset and refocus"</i> P3	3

		<p>Urban cooling- The site was identified as helping combat urban heat island affect by cooling the area down via greenery, shade, etc.</p>	<p><i>"I mean, those that do have trees are clearly providing the shade to cool things off"</i> P4</p>	2
		<p>Conveyance- The site was identified to serve a purpose as a ditch, directing water from one place to another.</p>	<p><i>"[some of these areas came to be] as ditch easements"</i> P4</p>	1
Natural	<p>The identified functions go beyond human use and perceptions, they contribute to the ecosystem, support ecological process and maintain natural cycles.</p>	<p>Habitat- The site was identified to support diverse species.</p>	<p><i>"Providing, you know, wet areas, which are all the migratory birds and ducks, and all the small animals. It's seen, I know that this is along Spring Creek, but there was a mink at the Spring Creek, at the gardens on Spring Creek, you know, like, there's a lot of wildlife in and around everywhere. There's the bobcat that lives along the river, all the way out far east. So, it's really surprising how many different types of species are utilizing these areas. "</i> P4</p>	4

		<p>Wildlife connectivity- The site was identified for supporting species movement.</p>	<p><i>"Yeah I mean I think the ditches that we have in town are very valuable in terms of wildlife and movement you know now the corridors and wildlife movement are very species dependent you know so because you can be on the east side of the city and still see deer in the middle and that you know like, literally walking down streets at times is in large part due to a lot of these ditch corridors that we have that allow for movement that way."</i></p> <p>P3</p>	2
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Table 4: Future management considerations (opportunities & barriers) identified by City officials.

Consideration	Definition	Subthemes & Definition	Exemplary Quote	Count
Opportunity	City officials identified different opportunities that these sites could have which could increase the functionality and provide benefits for the area.	Collaboration- City officials identified that collaborating with others such as ditch companies, other departments and communities could increase the functionality of the sites and in turn provide more benefits.	<i>"And yeah, we would love to collaborate with community members on like making these spaces better and meeting their needs and our needs too."</i> P1	3
		Multifunctional management- City officials identified that by managing these sites to be multifunctional, this would support species/ecological components while still supporting human-needs.	<i>"We want to make these areas multidisciplinary, so they function as a water holding facility, as a place where birds and fauna and flora can flourish. And then we want to make sure they're some kind of recreational component if we can. So, combine the uses, and so we can have passive recreation."</i> P2	3
		Planning- City officials identified that if these sites were included in planning, they could play a role in connectivity and accessibility of greenspaces by providing alternative ways to get in nature.	<i>"I think we've talked a lot about being interested in seeing if there's ways, we can put more access into these spaces"</i> P4	2

<p>Barriers to opportunities</p>	<p>City officials identified barriers that prevent the sites from being able to achieve opportunities mentioned above and increase their functionality.</p>	<p>Dissonance- The opportunities above would require different goals and ideas to come together on agreement, something that may not be able to be reached</p>	<p><i>"Where they [ditch company] just started clear-cutting all the trees last summer just because they didn't want to deal with the maintenance associated with the trees like getting into the ditch itself and also too taking water out of the ditch and so they just started clear-cutting trees. And a lot of people were upset, me included, because I think those trees provide a lot of benefit to the community and it would be great if we could get coordinated with the ditches on things like that to try and prevent things like that happening in the future. So yeah, that's an example of the ditch just kind of doing their own thing and to the detriment I think of the community. "</i></p> <p>P1</p>	<p>4</p>
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		<p>Resources- There are insufficient resources to achieve opportunities.</p>	<p><i>"I think that it creates a different set of resource issues, and then I think when we're talking about spaces being in wealthier areas, the wealthier parts of our community will probably have more resources to provide these facilities."</i></p> <p>P1</p>	2
		<p>Interference- The opportunities above may interfere with the original function of the site and land use polices, such as dog poop or litter.</p>	<p><i>"You know, like dog poop and stormwater and things like that that would need to be addressed."</i></p> <p>P4</p>	2



Figure 8: City officials (n=4) identified functions, opportunities and barriers of informal greenspace sites located in Fort Collins, CO. Green boxes indicate total interviewee counts (number of people who mentioned it) of perceived site functions, opportunities and barriers.

2.4 Discussion

By examining both resident and City official perceptions, our study provides local insights to site specific perspectives and the unique, personal benefits of informal green spaces. Resident users of IGS in Fort Collins, CO, perceive a range of ES, primarily cultural, regulating, and provisioning. Cultural ES stood out as the most frequently identified, reflecting the intangible benefits and personal connections these spaces foster, consistent with existing literature (Luo & Patuano, 2023, Pietrzyk-Kaszyńska et al., 2017, Rupprecht et al., 2015). Exploring IGS across socio-economic contexts revealed potential differences in perceived benefits that warrant further investigation in Fort Collins. Residents in low-SES areas more frequently emphasized educational value and connection to nature, while those in high-SES areas more often highlighted personal freedom, social interactions, and a sense of ownership and management over the greenspace, suggesting differing priorities and relationships with these spaces.

Interviews with City officials provided additional perspectives on their functions, opportunities, and barriers while thinking of IGS future in city planning. These combined insights highlight the critical role of IGS in urban environments, not only for ecological sustainability but also for social and cultural well-being.

2.4.1 Current uses

Consistent with findings in the literature, our study observed that users primarily engage in recreational activities in IGS, such as walking, cycling, dog walking, and running (Luo & Patuano, 2023; Rupprecht et al., 2015; Mahmoudi Farahani & Maller, 2019). These spaces were also observed to serve as shortcuts or corridors to other areas (Rupprecht & Byrne 2014),

suggesting that residents value even a brief, routine use of informal greenspaces that can support a sense of connectedness to nature (Liu et al., 2023).

A strength of our study was the ability to compare usage patterns across multiple IGS sites citywide, offering a broader perspective on how these spaces function in different contexts. However, usage varied substantially across sites, with differences in visitation frequency. For example, four sites were visited more than 20 times, while eight sites had only one or no visitors throughout the entire data collection period. Our findings of underutilized sites align with research by Mahmoudi Farahani & Maller (2019), who observed similar patterns in an IGS in Melbourne, Australia, and suggested that negative perceptions or lack of infrastructure may contribute to low usage. Indeed, negative perceptions limiting IGS use are well documented in the literature (Sikorska et al., 2020; Włodarczyk-Marciniak et al., 2020), which may explain the absence of visitors at certain locations. However, in our study, concerns about unsafe site characteristics were mentioned only four times ($n=4$), suggesting that safety may not be the primary barrier to use. At the same time, the popularity of other sites in our study suggests that IGS usage is shaped by a combination of factors. Our cross-site observations reveal that while IGS have the potential to offer valuable recreational opportunities, some fail to attract users—possibly due to site-specific characteristics. For instance, frequently used sites often functioned as corridors, were located near formal green spaces, or were more centrally embedded within neighborhoods. In contrast, sites situated near busy roads or lacking seclusion appeared less inviting. These findings highlight the need to consider spatial context and community integration when assessing the value and use of IGS. Future research could explore community perspectives to better understand barriers to use and inform strategies to enhance the accessibility, perception, and appeal of underutilized sites.

2.4.2 Ecosystem services

Our study found that residents perceive multiple ES from IGS including regulating, cultural, and supporting services. Interviewees identified various subcategories of ES, highlighting the diverse benefits these spaces provide and their role in everyday life. These findings align with existing research showing IGS can offer ES comparable to formal UGS (Luo & Patuano, 2023, Pietrzyk-Kaszyńska et al., 2017), helping to add additional nature in urban areas (Mahmoudi Farahani & Maller, 2019). Regulating and supporting services, such as flood mitigation, urban heat reduction, and habitat provision, are well-documented in the literature, particularly given the biodiversity supported by IGS (Rupperchet, et al., 2015, Sikorska et al., 2020; Sikorski et al., 2021, Kim et al., 2018, etc.). Cultural ecosystem services were the most frequently reported benefits in our study, highlighting the central role these spaces play in how urban residents connect with and value their environment. This underscores the particular importance—and potential predominance—of cultural ES in urban settings, where other types of ecosystem services are less visible or accessible (Beckmann-Wübbelt et al., 2021; Pejchar et al., 2025).

Our study underscores the potential of IGS to provide important benefits in urban areas, not only supporting biodiversity and environmental regulation but also enriching residents' daily lives through cultural experiences. These findings emphasize the importance of IGS in urban planning and management, contributing to both ecological, personal and social well-being.

While many studies have examined the ecological and recreational benefits of IGS, our research focused on the less-documented, intangible cultural ES they provide through direct communication with local users. By conducting semi-structured interviews, we gained insight into residents' experiences and values, offering a deeper understanding of how IGS contribute to

daily life and well-being (Knott et al., 2022). Notably, cultural ES emerged as the most frequently identified ES. These intangible benefits—such as opportunities to connect with nature, recreate, and appreciate aesthetic views—are closely tied to urban residents’ well-being (Luo & Patuano, 2023). Previous research has established that IGS enhance well-being and provide spaces for outdoor activities, such as nature appreciation and recreation (Pietrzyk-Kaszyńska et al., 2017; Rupprecht et al., 2015; Rupprecht & Byrne, 2014). Our findings support this, with recreation, aesthetics, and mental health emerging as the most frequently reported ES (Figure 5). The aesthetic value of IGS emerged as a particularly significant ES, with interviewees frequently highlighting the sights and sounds of nature—such as diverse plant life and animals—as key attractions. This underscores how people tend to appreciate IGS differently from formal greenspaces, valuing their biodiversity and wild, unstructured nature (Rupprecht et al., 2015). The ability to encounter a greater variety of animals and plants further distinguishes IGS, making them uniquely appealing compared to more manicured urban parks. By highlighting additional, often-overlooked ES, our study expands the discourse on the benefits of IGS, emphasizing their role in fostering well-being and strengthening residents’ connections to nature, which will be discussed below.

Participants emphasized the sense of freedom they experienced in IGS, which enhanced their positive interactions with these spaces. This aligns with existing literature, which highlights that the lack of formal restrictions in IGS fosters greater accessibility and comfort (Luo & Patuano, 2023; Pietrzyk-Kaszyńska et al., 2017). Interviewees described how this freedom allowed them to deepen their connection with nature through exploration and engage in specialized recreational activities, such as allowing their dogs off-leash. This demonstrates how IGS provide a wider range of benefits compared to more structured green spaces (Pietrzyk-

Kaszyńska et al., 2017; Mahmoudi Farahani & Maller, 2019). Additionally, the unstructured nature of IGS was particularly significant for children, enabling them to explore and play more freely. This is potentially supported by our observations of children using the sites alone (n=8) and by participant accounts indicating that children often visit these spaces independently. Such use suggests that IGS are perceived as accessible and welcoming environments for children, reinforcing the idea that these spaces uniquely support autonomy and self-directed interaction with nature. This supports findings from previous studies emphasizing the importance of IGS in providing unrestricted, direct interactions between children and nature (Luo & Patuano, 2023; Rupprecht et al., 2015). Such experiences are essential for counteracting the “extinction of experience” among youth (Pyle, 1993, Soga & Gaston, 2016), as they help cultivate a lasting connection to the natural world. These findings underscore the vital role of IGS in providing immersive natural experiences, particularly for children, and highlight the importance of preserving IGS to be able to give such opportunities within urban environments (Chawla, 2015).

Interviewees described how IGS foster a sense of place by providing space for emotional and meaningful connections to the environment, which in turn shape how they value, use, and make decisions about their surroundings—including where they choose to live and how they engage in local management. Many participants note that proximity to IGS influenced their decision to move into their neighborhoods, appreciating the opportunity to experience nature daily outside the bounds of a formal park. This aligns with the Millennium Ecosystem Assessment (2003), which highlights how the aesthetics of natural spaces can foster appreciation for nature and influence housing preferences. By illustrating how IGS incentivize residential choices while offering nearby access to nature, our study highlights their significance as an integral component of urban areas (Rupprecht et al., 2015). Participants also reported actively

engaging in greenspace management, taking personal initiative to enhance and maintain these areas. This behavior may stem from the unmanaged, wild nature of IGS—unlike formal parks, which are maintained by authorities, IGS provide opportunities for direct community involvement. Because these spaces are not regularly managed, residents often “take matters into their own hands,” fostering a sense of autonomy and stewardship. While previous studies (Pietrzyk-Kaszyńska et al., 2017; Rupprecht et al., 2015) have suggested community-led management strategies, their integration and effectiveness remain underexplored. Our study offers insights into how residents are already contributing to IGS maintenance and their willingness to engage further. Moreover, these findings expand the discourse on how IGS facilitate unique, interactive experiences that strengthen users' connection to nature due to their liminal and informal characteristics (Luo & Patuano, 2023). They underscore the critical role of IGS in fostering environmental responsibility and deepening personal ties to nature within urban environments.

Interviewees frequently identified a connection to nature through passive engagement as a key service provided by IGS. They valued the mere presence of these spaces, emphasizing their role as pockets of nature in urban settings where nature exposure can often be limited. This aligns with research suggesting that people appreciate IGS simply for existing and serving as refuges for nature (Rupprecht & Byrne, 2014). The idea that individuals derive benefits from merely being near nature highlights the significance of IGS as resource-efficient solutions for increasing urban nature access. Even with minimal management, these spaces are valued for their ability to provide nature contact. The benefits of such passive interactions are extensive, including improved focus, enhanced memory, better mood, cognitive functioning, and overall mental well-being (Norwood et al., 2019; Jimenez et al., 2021), all of which emerged in

participant responses. Recognizing that users perceive IGS as beneficial simply because they exist reinforces findings from other studies (Pietrzyk-Kaszyńska et al., 2017), which advocate for their preservation in their natural state. Our study along with others suggest that IGS do not need to be fully integrated into formal greenspace networks to provide meaningful nature benefits. Adopting this perspective could help inform more resource-efficient strategies for expanding nature access in urban environments.

IGS interviewees highlighted the important role these spaces play in fostering social interactions that might not occur otherwise. Urban green spaces have been shown to positively influence social relationships, contributing to improved social cohesion and quality of life by facilitating connections among residents (Xin et al., 2020; Jennings & Bamkole, 2019). The IGS examined in this study were located in residential urban areas, making them easily accessible gathering spaces. Participants reported using these sites to meet new people, spend time with friends and family, and host community events such as parties. Socialization has also been recognized as a value of IGS in other studies (Pietrzyk-Kaszyńska et al., 2017). Nearly all interviewees lived within a mile of the sites, suggesting that IGS primarily attract local residents. This aligns with previous research indicating that proximity is a major factor in IGS use (Rupprecht et al., 2015). When greenspaces are easily accessible, they are more likely to be used frequently, which can increase social interactions and foster a greater sense of comfort and connection among users (Xin et al., 2020). Additionally, residents expressed a sense of “shared ownership,” feeling that the space belonged to the community, which may promote feelings of empowerment and belonging (Jennings & Bamkole, 2019). One notable example was a neighborhood potluck party hosted in an IGS, demonstrating how the informal and flexible nature of these spaces allows for spontaneous and creative community gatherings (Luo &

Patuano, 2023). These findings underscore the value of IGS as essential spaces for social cohesion and community well-being.

2.4.3 SES demographics

In our study, we analyzed IGS sites based on the surrounding areas SES, identifying some differences in perceived ES while confirming that aesthetics, mental health, and recreation were the most frequently recognized benefits regardless of SES. However, several limitations must be noted. We used GIS data to classify sites by average household income in the area, but this does not guarantee that interviewees matched these SES categories, as only seven participants disclosed their household income. Additionally, the proximity of some low-SES areas to Colorado State University may have skewed income data due to the prevalence of student residents. Another limitation was the smaller number of low-SES sites available for study. Low SES areas often featured more ditch easements, or smaller IGS, making direct comparisons challenging. Efforts to match high- and low-SES sites by size and features, such as the presence of water, were hindered by these constraints. As a result, site differences may limit the accuracy of comparisons. Despite these limitations, the findings offer valuable insights and a foundation for future research on how different demographic groups perceive and benefit from IGS. Understanding these perceptions can inform equitable urban greenspace planning and enhance the accessibility and utility of IGS for diverse communities.

Our study revealed that study participants in low and high SES groups identified unique experiences and services. Freedom, social relations and acts aligning with personal values were more commonly identified in high SES areas. Interviewees often mentioned choosing to live near these spaces, managing them to suit their needs, feeling less restricted and engaging in

community socialization. These IGS were typically more centralized within communities, such that they were in-between housing or tucked away in a cul-de-sac. This sense of seclusion from these IGS characteristics may make residents feel more comfortable using IGS in more diverse and creative ways (Luo & Patuano, 2023), as they are less likely to be frequented by outsiders and are situated away from busy streets and passing pedestrians. Furthermore, this may be tied to residents' income levels, as higher-income individuals often have more flexibility in choosing housing locations near desirable green spaces and greater resources to participate in their management. In contrast, lower-income residents may have limited housing options and fewer opportunities to influence the upkeep and governance of these spaces. In contrast, codes related to educational value were only reported in low SES areas, potentially reflecting specific experiences or priorities unique to these users. Despite fewer low SES sites, they were visited more frequently than high SES sites during our observations. This aligns with research suggesting that disadvantaged communities often rely on IGS to supplement limited formal greenspaces (Sikorski et al., 2021). Although Fort Collins has an extensive greenspace network, proximity to IGS appears critical, particularly for disadvantaged groups, highlighting the importance of these spaces in addressing inequities in urban greenery. Our study starts the discourse on how different demographic groups may value and use IGS. These different perspectives are critical to consider when thinking of integrating IGS into city planning (Kim et al., 2018). The lack of in-depth data and participants to confirm findings underscores the need for further research into how IGS serve different demographics and how these perspectives must be used if IGS are to enhance urban greenspace accessibility.

2.4.4 City perspectives

City officials recognized multiple functions of IGS, benefiting both humans and nature. Officials identified these spaces as valuable for recreation (both passive and active) and for providing regulating ES. They also acknowledged the ecological benefits, such as habitat provision, which aligns with supporting ES. These perspectives mirror those of resident users, suggesting a shared understanding of the value and purpose of IGS. Some studies have highlighted the unsettling nature of unmanaged and informal greenspaces (Sikorski et al., 2021), yet our findings suggest a more positive perception of all stakeholder groups. This may be because the IGS in our study are City-owned, unlike many unowned sites in other studies. This distinction offers a fresh perspective on how minimal oversight can make IGS more approachable and functional while preserving their informal character.

City officials identified several opportunities to enhance the role of IGS, including incorporating them more into planning processes, fostering collaboration across stakeholders, and promoting multifunctional management. Collaboration—whether with residents, other departments, or external entities—was frequently cited as essential for achieving multifunctionality, allowing IGS to serve a broader range of purposes. This aligns with research indicating that even small enhancements can greatly improve the benefits residents derive from these spaces (Farahani & Maller, 2019; Rupprecht et al., 2015) and highlighting community-led management as a potential future approach for IGS (Rupprecht et al., 2015). However, City officials and the literature also recognize that changes must balance improvements with maintaining the biodiversity and informal character of IGS (Sikorski et al., 2021), presenting an area for further research into sustainable management strategies. Barriers to these opportunities were also highlighted. A primary challenge is the lack of resources, compounded by differing

visions and potential conflicts with the original functionality of the sites. Additionally, differences in perceptions and preferences between planners and residents complicate the development of effective interventions, with the most significant challenge being dissonance—aligning multiple entities on management approaches. Many IGS span departmental boundaries or involve a mix of public and private ownership, making collaboration difficult, a challenge that has been raised around collaboration in other studies (Mahmoudi Farahani & Maller, 2019). Officials emphasized that successful management would require relationship-building and shared goals among stakeholders. Standardizing IGS management within a city poses challenges but offers a valuable opportunity to enhance their functionality while maintaining their unique characteristics. This process could serve as a foundation for future research and provide insights into balancing urban biodiversity, multifunctionality, and community benefits.

2.4.5 Limitations

During our site selection process, discrepancies arose that warrant disclosure. The GIS layers available were slightly outdated and previously edited, leading to inaccuracies in ownership information, resulting in extensive groundtruthing of sites. While one of our study criteria was City ownership, parts of High SES 8, Low SES 4, and Low SES 7 were privately owned. As a result, some interviews and observations occurred outside the intended criterion. Despite these deviations, we consider these sites valid under our IGS definition. However, their inclusion requires acknowledgment that they may be subject to different management standards.

Our study relied on specific timeframes for observations, with each three-hour increment occurring at different times during each visit. This approach likely excluded perspectives of those who avoid the sites or use them at other times. Additionally, since data collection was

limited to two months during the summer, seasonal variations in usage were not captured, potentially overlooking shifts in activity patterns during cooler months or different weather conditions. While on-site interactions facilitated rich discussions with active users, they limited insights into broader usage patterns and negative perceptions. Only four interviewees mentioned negative aspects, possibly reflecting a bias toward users who inherently value the sites. An online or mail survey for City residents may capture more critical views, particularly from non-users. Additionally, while interviewees referenced community events, observations recorded only one or two individuals at a time, suggesting a gap between observed use and actual activity. This underscores the need for methodologies that engage a wider audience.

As noted, most interviewees declined to disclose demographic data, with only seven participants choosing to respond. This may have been due to the question's placement at the end of the interview guide, leading to it being skipped due to time, or participants' reluctance to disclose personal information. Regardless of the reason, this data gap limits our ability to draw definite conclusions about the perspectives of different demographic groups.

Lastly, the grounded theory approach, while valuable, is subject to potential bias as researchers bring their own experiences to the analysis (Giles et al., 2013). The lead author, CA as a resident of this community with experience in urban ecology and conservation made complete detachment from the work not possible. To mitigate bias, C.A involved multiple reviewers in interview and codebook development, ensuring diverse perspectives informed the process.

2.5 Conclusion

To support the increasing migration to urban areas, cities must prioritize sustainable and cost-effective strategies that sustain resident well-being. Access to greenspaces is essential for the mental and physical health of urban populations. For greenspaces to deliver their full spectrum of benefits, they must be both accessible and aligned with community needs. IGS, often overlooked in urban planning, present an untapped opportunity to address these needs. This study explored IGS in Fort Collins, CO, to investigate their usage, ES, and resident perceptions, providing valuable insights into their role in urban landscapes.

Findings from this research highlighted the significance of IGS in supporting both ecological and urban health. Residents identified cultural ES as particularly valuable, with recreation, aesthetics, and mental health benefits emerging as critical, similar to other findings. Unique contributions such as sense of place, freedom, connection to nature, and social relations underscore the intangible yet indispensable role of IGS in fostering personal connections to nature and meeting diverse community needs. Recreational activities, including dog walking, running, and general exercise, were the most frequently reported uses, consistent with prior research. However, disparities in usage patterns among IGS sites point to an avenue for future research to understand why some spaces are more heavily utilized than others.

This study also delved into IGS already integrated into city planning, revealing their potential to serve multifunctional purposes. Interviews with City professionals demonstrated that IGS can fulfill diverse ecological and human needs beyond their original functions. Management strategies that emphasize collaboration among multiple stakeholders were identified as essential for enhancing, preserving, and establishing IGS. These strategies could incorporate IGS into

nature-based solutions to address urban challenges such as stormwater management and biodiversity conservation. However, findings also highlighted that distinct management and ownership structures influence IGS functionality, often complicating collaboration and decision-making. Challenges such as limited resources, stakeholder conflicts, and balancing multifunctionality remain significant barriers to effective management.

Recognizing the importance of equity, this research sought to evaluate how IGS benefits diverse user groups, particularly disadvantaged communities. By examining sites across socio-economic contexts, this study initiates a critical dialogue about how IGS should be managed to address inequities in urban greenspace availability. The findings suggest that while many ES of IGS, such as recreation, aesthetics and mental health are consistent across user groups, potential differences in perceived ES highlight the importance of incorporating diverse perspectives into planning and management. Future research should further investigate these variations to ensure that IGS address the needs of all urban residents equitably.

By integrating user perspectives, this study emphasizes the multifaceted value of IGS in urban living. Residents of Fort Collins highlighted not only the ecological contributions of IGS—such as biodiversity support and flood mitigation—but also their personal and cultural significance. These findings underscore the need for urban planners and policymakers to recognize IGS as vital components of sustainable urban development. Preserving the informal nature of these spaces is crucial, as it allows for flexibility, spontaneous use, and a sense of community ownership while ensuring equitable access to their benefits.

Despite limitations such as site selection discrepancies and potential schedule-based exclusion, this research provides a robust foundation for future studies. Broader investigations

into IGS across diverse urban settings can deepen our understanding of demographic variations in usage and inform inclusive management strategies. Collaborative approaches among stakeholders, guided by resident perspectives, are crucial to ensuring equitable access and maximizing the ecological, cultural, and regulatory benefits of IGS. Future studies should explore how different ownership and management structures influence their functionality and integration into urban planning. This study could be replicated in other major cities to explore how residents engage with IGS locally, understand their role within the urban system, and assess their potential integration into city planning efforts.

In conclusion, a comprehensive understanding of how residents interact with IGS affirms their critical importance in urban environments. As cities face growing challenges in greenspace accessibility and sustainability, IGS offer a promising path forward. This research not only highlights the potential of IGS for integration into urban planning but also sets the stage for further exploration into their role in supporting resilient ecological and social systems.

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Appendices

Appendix A: Site list & information

Notes	How many approached/rejected	Notes on Visits	Water	Name/ Site ID	area_sq	estimate_income	Parcel_ID	parcelnum	Ownership	Type?
open space in front of homes and parallel with Horsetooth Rd.	3 approached	Visited 6/10 morning shift, 1 observation; visited 6/15 afternoon shift, no observations; Visited 6/24 afternoon shift (from 1:30-2 in car because of thunderstorm) no observations; Visited 7/15 evening shift, 1 observation (in car then left because of thunder and lightning)	No	High SES 1	3,647,080	1,065,5	3821	666915904	HQ/AT	Drainage
near spring canyon, off 2nd st, open area	1 approached, 1 interviewed	Visited 6/10, mid morning shift, 1 observation, 1 interview; Visited 6/15 no observations; Visited 6/24 evening shift (sat in car from 6:00-7:00, left because of thunder)	No	High SES 2	2,147,962	1,786	2833	972824933	Utilities	Drainage
near spring canyon, behind homes, stretch of green space	10 approached, 5 interviewed (could not approach others because still in interview)	Visited 6/15, afternoon shift, 4 observations, 1 interview; Visited 6/25, morning shift, 8 observations, 1 interview; Visited 7/13 weekend morning shift (started at 10:30am)	No	High SES 3	1,442,963	1,736	2914	972825902	Unknown, managed by HQ/AT	Drainage/Corridor
Large greenspace with water, other side of the road (hillside) is some of high SES 2 to combine with	1 approached	Visited 6/15, evening shift, 1 observation; Visited 6/25, mid-morning shift, no observations; Visited 7/13 weekend after noon shift (started at 10:30am because of extreme heat), no observations; Visited 7/24, morning shift, no observations	Yes	High SES 4	1,384,673	1,832.4	2447	980231493	Unknown- either utilities or natural areas	Drainage
Small lot behind homes, off of Horsetooth road	**Witched after 3rd visit with no visitors/interviews	Visited 6/17, morning shift, no observations; Visited 7/2, afternoon shift, no observations; Visited 7/22, evening shift, no observations	No	High SES 5	0,712,220	1,056		873112903	Utilities	Drainage
next to spring canyon park, paved area off blue leaf dr separating area, land between housing, drainage ditch	1 approached, 1 interviewed	Visited 6/17, mid-morning shift, 1 interview; Visited 7/2 evening shift, 1 observation (sat in one's waiting alongside); Visited 7/22 afternoon shift, 1 observation; Visited 7/23, mid-morning shift, 3 obs	No	High SES 6	3,038,652	1,736	2908	972833581	Utilities	Drainage/Corridor
Good greenspace with small creek and ephemeral pond in middle, has a paved trail through it and one sign but not an official park	12 approached, 1 interviewed	visited 6/6 evening shift, 8 observations; Visited 6/29 weekend morning shift, 8 observations, 1 interview; Visited 7/6 mid-morning shift, 8 observations; Visited 7/23, mid-afternoon shift, 3 obs	Yes/ephemeral	High SES 7	6,361,765	1,061.7	3476	972540859	Utilities	Drainage
between homes, follows a canal, accessible off McMurray Ave	3 approached	visited 6/12, mid morning shift, 1 observation; Visited 6/29 afternoon shift, 2 observations; Visited 7/5 morning shift, 2 observations; Visited 7/23, evening shift, 3 obs	Yes	High SES 8	2,038,501	1,753	3598	873113801	Utilities	Drainage
Densely forested greenspace w/ small creek, between homes, accessible off of Lake St	**Witched after 3rd visit with no visitors/interviews	visited 6/5 morning shift, no observations; visited 6/15 weekend afternoon shift, no observations; Visited 6/25 afternoon shift (in car from 3:35-4:00 because of thunder)	Yes	Low SES 1	4,302,048	3563	2004	971631891	Utilities	Drainage
Very small. Between homes, has drainage and is close to Overland park	**Witched after 3rd visit with no visitors/interviews	visited 6/5 morning shift, no observations; visited 6/15 weekend afternoon shift, no observations; Visited 6/25 evening shift, 1 observation (passerby)	Drainage/yes	Low SES 2	1,651,673	4844	4729	971631892	Utilities	Drainage
Right next to Sugar Beet Park	**Witched after 3rd visit with no visitors/interviews	visited 6/11, morning shift, no observations; Visited 7/1 afternoon shift (in car from 1:30-2 and from 2:30-4:30 because of heavy rain), no observations; Visited 7/14	No	Low SES 3	1,036,676	4661	5273	971212261	Streets	Drainage
Corridor to Fox Meadow Natural Area, 2nd on list	15 approached, 7 interviewed, rest running/biking	Visited 6/11, mid morning shift, 10 observations, 3 interviews; Visited 7/1 evening shift, 8 observations (in car from 5:15 because of heavy rain, left after an hour + 6)	Yes	Low SES 4	1,719,693	2,244.4		97220091, 97220090	Natural Areas	Corridor
Large pond in this greenspace, across from CSU Vet Campus	1 approached	visited 6/15 afternoon shift, 1 observation; Visited 7/3 mid-morning shift, no observations; Visited 7/15 mid-morning shift, no observations (in car from 12-1 because of thunder)	Yes	Low SES 5	3,216,501	4025	2759	972540867	Unknown, Utilities?	Unknown
Connects to Rolland Moore	12 approached, 6 interviewed	visited 6/15, afternoon shift, 5 observations, 2 interviews (could not approach one because we were still interviewing); Visited 6/30 afternoon weekend shift, 5 obs	Yes	Low SES 7	6,208,293	3563		972421903 & 972241501	Parks	Corridor
behind the powerhouse campus, near the Poudre trail	11 walking to work	visited 6/12 morning shift, 4 observations; Visited 6/30 weekend evening shift, no observations; Visited 7/6 mid-morning shift no observations; Visited 7/18, mid-afternoon shift, 1 observation	No	Low SES 9	0,7467,468	4074	3620	971221881	Parks	Corridor

Appendix B: Data collection schedule

2024 <- MAY JULY ->

JUNE

M	T	W	T	F	S	S
27	28	29	30	31	1	2
3	4	5 Low SES 1, Low SES 2	6 Low SES 6, High SES 7	7	8 off	9 off
10 High SES 1, High SES 2	11 Low SES 3, Low SES 4	12 Low SES 8, High SES 8	13 off	14 off	15 Low SES 1, Low SES 2	16 High SES 1, High SES 2
17 High SES 5, High SES 6	18 High SES 3, High SES 4	19 Low SES 7	20 Code/office work	21 off	22 off	23 off
24 High SES 1, High SES 2	25 Low SES 1, Low SES 2	26 High SES 3, High SES 4	27 off	28 off	29 High SES 7, High SES 8	30 Low SES 7, Low SES 8
1	2	3	4	5	6	7

Week days:

Weekends:

6:30-9:30 (morning)

8:30-11:30 (morning)

10:00-1:00 (mid-morning)

12:00-3:00 (afternoon)

1:30-4:30 (afternoon)

3:30-6:30 (evening)

5:00-8:00 (evening)

2024 <- JUNE AUGUST ->

JULY

M	T	W	T	F	S	S
1 Low SES 3, Low SES 4	2 High SES 5, High SES 6	3 Low SES 6	4 off	5 off	6 off	7 off
8 High SES 8, High SES 7	9 Low SES 7, Low SES 8	10 Code	11 off	12 off	13 High SES 3, High SES 4	14 Low SES 4, Low SES 3
15 High SES 2, High SES 1	16 Low SES 4, Low SES 6	17 Code	18 Low SES 8, Low SES 7	19 Code	20 off	21 off
22 High SES 6, High SES 5	23 High SES 7, High SES 8	24 High SES 4, High SES 3	25 Off	26 Off	27 Low SES 6, High SES 6	28
29 Code	30 Code	31 Code	1	2	3	4
5	6	7	8	9	10	11

Week days:

Weekends:

6:30-9:30 (morning)

8:30-11:30 (morning)

10:00-1:00 (mid-morning)

12:00-3:00 (afternoon)

1:30-4:30 (afternoon)

3:30-6:30 (evening)

5:00-8:00 (evening)

Appendix C: Observation forms

User Observation Form:

1. Date: _____
2. Location: _____
3. Time: _____
4. Weather: _____

5. Sex (female/male presenting): _____

6. Age (estimated) (years)/(presenting):

- a. <10
- b. 11 to 18
- c. 19 to 39
- d. 40 to 59
- e. > 60
- f. Child
- g. Young Adult
- h. Adult
- i. Senior

7. Activity:

- a. Dog walking
- b. Cycling
- c. Jogging/running
- d. Walking
- e. Relaxing
- f. Collecting specimen (flowers, berries)
- g. Family outing
- h. Playing a sport
- i. Playing a game
- j. Animal watching
- k. Other: _____

8. More Information on Activity:

9. Passing Through (yes/no): _____

10. Visiting (yes/no): _____

11. How Long of a Visit: _____

12. Individual (yes/no): _____

13. Group (how many): _____

Other Comments:

Appendix D: Semi-structured interview guide-Resident users

Intro:

Hello,

How are doing? - time for informal introductions

My name is Chloe Arduino, and I am a master's student at Colorado State University (CSU). For my thesis, I am working in partnership with the City of Fort Collins, to conduct in-person interviews around the Fort Collins area. The purpose of this study is to understand how community members perceive and value certain spaces in Fort Collins by understanding the services and disservices they provide. I would appreciate the opportunity to interview you regarding your experiences and viewpoints around this space you are currently using. We hope our study will help highlight any importance of these spaces in communities and provide valuable context for the City of Fort Collins in future decision making.

Depending on the length of your answers, this interview is estimated to take approximately [15 minutes]. In accordance with federal regulations, the CSU Institutional Review Board (IRB) has reviewed and approved this study. This interview is completely voluntary and if you decide to

participate you have the option to answering or declining to answer any questions and you may withdraw your consent and stop participating at any time. There are no right or wrong answers, we are solely interested in learning more about how you feel and why. Any responses you provide will remain completely confidential. Your name, contact information, and any identifying information will never in any way be released or associated with your responses in reporting of the data. In addition, there are no known risks or direct benefits associated with your participation.

At this time, would you like to participate in this interview designed to take about 15 minutes?

[*If yes*] Can you please confirm that you are at least 18 years of age?

[*If no*] Okay, thank you for your time, have a great day.

[*Once confirmed participant is 18*] Thank you, now would it also be ok if I record our conversation? I will also be taking notes periodically. Once again, all answers are completely confidential, and you will remain completely anonymous.

Now before we get started, do you have any additional questions for me?

Questions:

Intro:

1. Can you describe this space?
 - a. Describe your surroundings
 - b. Do you perceive this to be a green space or something else
2. Can you tell me about a time you were using this space in the past year or so?

Self-Perceived Benefits and Aspects of IGS:

1. Can you please list all the benefits you derive from this space?
 - a. Ecosystem services
 - b. Well-being
2. Tell me more about the aspects, characteristics of this space most contribute to your benefits
 - a. Describe the characteristics of this space that are most beneficial?
3. Do you believe there are any unbeneficial aspects of this space?
 - a. Any aspects that affect your ability to enjoy, use?
 - b. Anything that could be better?
4. What would you take a picture of, if anything, in this space?
 - a. How does this make you feel?
 - b. Why would that picture be important?
5. Tell me more about why you are using this space today?
 - a. Why are you using this space as opposed to a formal green space
6. How would you feel if this space was no longer here/ went away?

Equity and Access:

1. Do you feel welcome in this space?
2. Do you feel safe in this space?
 - a. Do you feel worried while here?
 - i. If so, what is your focus of concern?
 - ii. Do you or would you use this space in evening hours when dark?
 - iii. Would you come here alone?
3. Do others in your community (neighbors, friends, family) use this space?
 - a. Why or why not?
 - b. How do they use this space?

This last section is more about your demographic information, we are interested in this because it will help us get a better understanding of the overall makeup of our city and help inform decisions. It is always okay to skip a question or to end the interview at any time during these questions, would you like to continue?

Socio-Demographics:

1. How do you identify in terms of gender?
2. How old are you?
3. Do you live in the City of Fort Collins? If so, are you within a mile of this location, 1-3 miles away, further than 3 miles?
4. How did you get here? (walk, bike, drive)
5. How often do you come here?
6. Do you come here more often in certain seasons?
7. What is your household mean annual income from these ranges? The ranges are in increments of 20,000 from 0-200,000 and are simply to help us determine the best representation of economic ranges in our city
 - a. \$0-\$20,000
 - b. \$20,000-\$40,000
 - c. \$40,000-\$60,000
 - d. \$60,000-\$80,000
 - e. \$80,000-\$100,000
 - f. \$100,000-\$120,000
 - g. \$120,000-\$140,000
 - h. \$140,000-\$160,000
 - i. \$160,000-\$180,000
 - j. \$180,000-\$200,000
 - k. >\$200,000
8. How would you identify in terms of ethnicity? (White, African American, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander)

Closing:

Thank you very much for your time and meaningful participation in this study. When results and/or an article is published on our findings, would you like to be kept up to date? We can mail or email you to follow up. Please scan this QR code and enter your email or mailing address.

Before we depart, do you have any more questions or things to add? Thank you again, have a wonderful day.

Appendix E: Consent form-Resident users

VERBAL RECRUITMENT/CONSENT TEMPLATE: No Identifiers Collected

In conversational style, ...

Hello, my name is Chloe Arduino (*or if PI, Jennifer Solomon*) and I am a researcher from Colorado State University in the Human Dimensions of Natural Resources department. We are conducting a research study on how people perceive and experience spaces like the one within which we are standing. The title of our project is “Evaluating the potential for informal greenspaces to deliver well-being benefits and promote equity in urban landscapes”. The Principal Investigator is Jennifer Solomon and I am the Co-Principal Investigator and am doing this study for my Masters thesis.

We would like you to answer some questions about your perceptions of and experiences in this space within which we stand. Participation will take approximately 15 minutes. Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participation at any time without penalty.

Are you interested in participating?

If yes: Proceed and confirm that the individual is 18 years or older.

If no: Thank you for your time.

We will not collect your name or personal identifiers. When we report and share the data with others, we will combine the data from all participants. There are no known risks or direct benefits to you, but we hope to gain more knowledge on how people throughout the City perceive and experience spaces like this one.

With your permission, I will audiotape or take notes during the interview. The recording is to accurately record the information you provide and will be used for transcription purposes only. The audio will be destroyed after we transcribe the interview. If you choose not to be audiotaped, my colleague or I will take notes instead. If you agree to being audiotaped but feel uncomfortable or change your mind for any reason during the interview, I can turn off the recorder at your request. Or if you do not wish to continue, you can stop the interview at any time. When the research is completed, I will save the transcriptions or notes for possible use in future research done by myself or others involved in research on greenspaces. I will retain the transcriptions or notes without personal identifiers indefinitely, for possible use in future research on greenspaces. No additional consent is needed for this to occur.

Do you agree to be audiotaped or would you prefer to have notes taken?

Before moving on, I want to provide you with this card (*hand card to participant*) with contact information. Additionally, on this card you can find a link that allows you to enter your email so you can receive a copy of the study results if you are interested in finding out what was learned from our research. Your email will only be used to send study results and will be discarded by the research team after results are sent. This is optional and there is no way for your email address to be connected with what you share with us today.

If you wish to receive a copy of the consent that I have read you, I can give that to you today.

Would you like a copy?

Now before we get started, do you have any questions for me?

Card information:

If you have questions about your rights as a volunteer in this research, contact the Colorado State University IRB at: CSU_IRB@colostate.edu; 970-491-1553.).

If you wish to receive the written results of the study, you can submit your email here: *will include a link to a form where they only add their email address and nothing more*

Other than your email, no other information is needed, and we will discard your email after we send you the results.

Appendix F: Semi-structured interview guide-City officials

Questions:

1. How familiar are you with the sites we have listed? What is your connection to these spaces?
2. Can you please describe these sites, their characteristics and origins?
 - a. How they differ and how they are similar in terms of landscape, management, use?
 - i. How do they differ from formal greenspaces? How are they similar?
 - b. What is the history of these spaces (when did they first come into City ownership?)
 - i. If you don't know, is there anyone you know of who may have that information?
 - ii. Have you noticed any variation in the location of these sites over the years (possibly related to development and land use policy)? Would there be a reason you can think of that we see more larger informal greenspaces in neighborhoods that are high SES?
3. How would you define these spaces?

4. Have you noticed how people tend to interact with these spaces/ have you had interactions with people while there/ do people talk to you about these spaces?
5. Can you please describe any regulations or guidelines established by the City around these sites?
 - a. As they relate to planning, management, conservation and development
 - i. What is the process like? Who gets involved, what steps need to be taken?
 - b. Why have these areas not been formally developed or conserved?
6. What are the objectives of the city for these sites?
 - a. Do they differ or are they the same throughout
 - b. How do you anticipate the objectives might change throughout time/ in the future? As related to development and land use policy? Do you have any concerns for these spaces now and in the future?
7. Can you please list all the functions you see these sites having?
 - a. To the City, Residents, Wildlife, etc
 - b. Cultural ecosystem services
8. Do you believe these sites have more to offer or can be managed in a way to enhance functionality? If time and money weren't a factor, would management change?
 - a. If so, how?
9. Do you believe these sites can play a role in accessibility to nature in Fort Collins?
 - a. As a corridor to more formal greenspaces and/or as greenspaces themselves?
 - b. If so, how?
10. Is there anything we haven't asked about these greenspaces that you think is important for us to know?

11. Do you know of any other personal who may be familiar with these sites that we can interview?

Appendix G: Consent form & email-City officials

Colorado State University Consent to Participate in Research

Evaluating the potential for informal green spaces to support biodiversity, deliver ecosystem services, and promote equity in urban landscape

Introduction and Purpose

My name is Chloe Arduino. I am a graduate student at Colorado State University working with my faculty advisor, Professor Jennifer Solomon in the Department of Human Dimensions of Natural Resources. I would like to invite you to take part in my research study, which looks at the role informal green spaces play in providing valuable ecosystem services and benefits to residents of Fort Collins.

Procedures

If you agree to participate in my research, I will conduct an interview with you at a time and location of your choice. The interview will involve questions about land use policy, management, distribution, ownership and functionality of these sites, as well as questions around your professional insights into these areas. It should last about 20-30 minutes depending on the length of your answers/ ability to answer all the questions. With your permission, I will audiotape and take notes during the interview. The recording is to accurately record the information you provide and will be used for transcription purposes only. If you choose not to be audiotaped, I will take notes instead. If you agree to being audiotaped but feel uncomfortable or change your mind for any reason during the interview, I can turn off the recorder at your request. Or if you do not wish to continue, you can stop the interview at any time.

Benefits

There is no direct benefit to you from taking part in this study. It is hoped that the research will benefit both the City of Fort Collins in their planning and green space management as well as providing insight into residents of Fort Collins perceptions of green space accessibility and benefits. We hope our study can be used as a pilot for other urban areas interested in investigating informal green spaces.

Risks/Discomforts

There are no known risks associated with participating in this study.

Confidentiality

Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names will not be used. Only your position/ working department will be used but if this may lead to identification, we will only use the name of the company/City of Fort Collins in the results to ensure confidentiality.

To minimize the risks to confidentiality, we will store data in a private folder only accessible to those on the research team as well as naming audiotapes and transcripts using a scheme that has no personal identifiers. Once audiotapes have been transcribed and results have been made, audiotapes will be destroyed.

Compensation

You will not be paid for taking part in this study.

Rights

Participation in research is completely voluntary. You are free to decline to take part in the project. You can decline to answer any questions and are free to stop taking part in the project at any time. Whether or not you choose to participate in the research and whether you choose to answer any questions or continue participating in the project, there will be no penalty to you or loss of benefits to which you are otherwise entitled.

Questions

If you have any questions about this research, please feel free to contact me at carduino@colostate.edu . You may also contact Dr. Jennifer Solomon, Jennifer.solomon@colostate.edu .

If you have any questions about your rights or treatment as a research participant in this study, please contact the Colorado State University Institutional Review Board (IRB) at: 970-491-1553, or e-mail CSU_IRB@colostate.edu . Protocol #5771.

CONSENT

Participant Consent:

Your signature acknowledges that you have read the information stated and voluntarily wish to participate in this research. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing 2 pages.

Signature of participant

Date

Name of participant

Signature of person providing information

Date

Chloe Arduino
Name of person providing information

Do you consent for your interview to be audiotaped?
 Yes
 No

If you wish to participate in this study, please sign and date below. You will be given a copy of this consent form to keep for your own records.

Participant's Name *(please print)*

Participant's Signature Date

If you agree to allow your working department or company name to be included in all final reports, publications, and/or presentations resulting from this research, please sign and date below.

Participant's Signature Date

Appendix H: Codebook definitions-Resident users

Theme=

Cultural Ecosystem Services= *The ecosystem provides the space for the users to obtain nonmaterial benefits through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (MES)*

Subtheme=

Spiritual and religious values= *Feeling or attaching religious/ spiritual values to the ecosystem and its components (MES)*

Educational value= *Attributing the ecosystem for providing some kind of educational component, whether that be formal or informal (MES)*

Aesthetic Value= *Finding beauty in aspects of the ecosystem, leading to feeling of enjoyment and/or pleasure (MES, Swaffield, McWilliam)*

Code=

Plants= *Finding beauty in the plants of the ecosystem, leading to feelings of enjoyment and pleasure*

Wildness/Naturalness= *Finding beauty in the wildness nature of the ecosystem, leading to feelings of enjoyment and pleasure*

Water= *Finding beauty in the water of the ecosystem, leading to feelings of enjoyment and pleasure*

Wildlife= *Finding beauty in viewing or seeing wildlife of the ecosystem, leading to feelings of enjoyment and pleasure*

Sounds= *Finding beauty in the sound or no sound of the ecosystem, leading to feelings of enjoyment and pleasure*

Viewshed= *Finding beauty in the views provided by the ecosystem, leading to feelings of enjoyment and pleasure*

Social relations= *The ecosystem provides the space for various social interactions which promote social cohesion (Taking “social relations” as a cultural ecosystem service: A triangulation approach, Xin et al., 2020)*

Code=

Social interactions= *The ecosystem provides the space for interactions, a place for socialization and time with others*

Community togetherness= *The ecosystem provides the space for community cohesion, a place for communities to gather, and be together*

Sense of place= *The ecosystem provides the space for people to develop a sense of place, which encompasses the emotional, cultural, and symbolic meanings they attach to specific environments, as well as the physical and psychological benefits they derive from these connections. This sense of place shapes how individuals interact with, value, and make decisions about the places they inhabit or frequent (Hausmann et al., 2016)*

Code=

Housing selection= *Reflects how ecosystems support sense of place by providing opportunities to live near nature, aligning with residents’ values and fostering emotional and functional connections to place (MA, 2003)*

Management of greenspace= *Reflects how ecosystems support sense of place by offering communities opportunities to engage in stewardship that aligns with their values, influencing how they interact with and care for these spaces (Hausmann et al., 2016, Dushkova et al., 2021)*

Recreation= *The ecosystem provides a preferable space for residents to spend their leisure time and to engage in various activities including walking, running, biking, birdwatching, etc. based in part on the characteristics provided (MES)*

Mental health= *The ecosystem provides a space for exposure to nature and through experience can positively impact emotional well-being like helping to reduce stress or to relax (Dushkova et al., 2020, Bratmen et al., 2019)*

Connection to nature= *The ecosystem provides a space for users to foster a personal connection to nature through passive engagement (being in and around nature alone has benefits) (Multiple ES of IGS, Luo & Patuano 2015)*

Freedom = *The ecosystem and its characteristics provide the opportunity to use the space more freely, leading to more creative and explorative experiences in nature (Luo & Patuano 2015)*

Code=

Unrestricted use= *Characteristics of the space allow for freedom to do whatever the user wants, potentially contributing to feelings of comfortability and autonomy*

Youth exploration= *Characteristics of the space allow for children to experience an explorative playing environment and freedom in nature*

Theme=

Regulating Ecosystem Service= *The ecosystem provides benefits obtained from regulation of ecosystem processes (MES)*

Subtheme=

Air quality maintenance= *The ecosystem contributes to reducing air pollution, positively influencing air quality (MES)*

Climate regulation= *The ecosystem by providing land cover, shading, etc., positively affects temperature and precipitation (MES)*

Pollination= *The ecosystem supports the distribution and abundance of pollinators and their functions (MES)*

Storm protection= *The ecosystem helps protect from storms by aiding water detention which prevents flooding and damage (MES)*

Theme=

Supporting Ecosystem Service= *The ecosystem provides benefits obtained from services that maintain fundamental ecosystem processes (MES)*

Subtheme=

Habitat= *The ecosystem supports plants and animals by providing necessary characteristics (USDA)*

Code=

Animal habitat= *The ecosystem provides necessary components to support animals such as nutrition, protection, connectivity*

Plant habitat= *The ecosystem provides necessary components to support the needs of plants such as nutrition, protection, landscape features*

Theme=

Disservices= *The space has attributes that users perceive as a negative and/or would change about the space to increase positive feelings*

Subtheme=

Site characteristics= *The site characteristics of the space such as plants, wildlife, structure etc., lead to negative feelings and unwanted interactions*

Code=

Unsafe conditions= *There are conditions and site characteristics within the space that users perceive as unsafe and/or could lead to dangerous interactions*

Limited maintenance and management= *Users of the space acknowledge that some of the attributes of the space could use improvement which would increase positive feelings and perceptions*

Code=

Trail issues= *The conditions of the trail could use improvement as users perceive some issues with how it is now*

Underdeveloped= *There are specific conditions or aspects of the site itself could use more development or improvements which would lead to more positive feelings around the site*

Theme=

Beneficial greenspace characteristics= *The greenspace has physical characteristics that users perceive as positive and beneficial to them*

Subtheme

Connectivity= *The greenspace is linked to other infrastructure and areas which supports movement between spaces*

Code=

Corridor access= *The greenspace allows for flow between itself and other areas such as homes, schools, other greenspaces, which promotes safer and easier access*

Accessibility= *The greenspace makes it easier for users to interact with it because of its proximity and it adds to the amount of greenspace in the city*

Secludedness= *The greenspace sees less visitors which users perceive as having a positive impact on their experience*

Appendix I: Codebook definitions-City officials

Theme=

Site Functions= *City officials identified different roles and functions that these sites play in the urban area*

Subtheme=

Anthropogenic= *The identified functions of the space are influenced, created, or modified by human activity and perceptions, and the benefits, uses, or impacts of the space are defined according to human needs, values, and experiences*

Code=

Stormwater detention= *The site was identified to help with water detention, prevent flooding and ensure water quality in developed areas*

Recreation= *The site was identified as providing a space for various recreational activities, both passive and active*

Open space= *The site was identified as providing greenery to the area and associated nature-human contact*

Conveyance= *The site was identified to serve a purpose as a ditch, directing water from one place to another*

Urban cooling= *The site was identified as helping combat urban heat island affect by cooling the area down via greenery, shade, etc.*

Natural= *The identified functions go beyond human use and perceptions, they contribute to the ecosystem, support ecological process and maintain natural cycles*

Code=

Habitat= *The site was identified to support diverse species*

Connectivity= *The site was identified for supporting species movement*

Theme=

Opportunities= *City officials identified different opportunities that these sites could have which could increase the functionality and provide benefits for the area*

Subtheme=

Collaboration= *City officials identified that collaborating with others such as ditch companies, other departments and communities could increase the functionality of the sites and in turn provide more benefits*

Multifunctional management = *City officials identified that by managing these sites to be multifunctional, this would support species/ecological components while still supporting human-needs*

Planning= *City officials identified that if these sites were included in planning, they could play a role in connectivity and accessibility of greenspaces by providing alternative ways to get in nature*

Theme=

Barriers= *City officials identified barriers that prevent the sites from being able to achieve opportunities mentioned above and increase their functionality*

Subtheme=

Resources= *There are insufficient resources to achieve opportunities*

Code=

Capacity= *The lack of people and time limits the ability to achieve opportunities*

Money= *The lack of money limits the ability to achieve opportunities*

Interference= *The opportunities above may interfere with the original function of the site and land use polices, such as dog poop or litter*

Dissonance= *The opportunities above would require different goals and ideas to come together on agreement, something that may not be able to be reached*