DEGREE PROJECT IN THE BUILT ENVIRONMENT,
SECOND CYCLE, 30 CREDITS
STOCKHOLM, SWEDEN 2021

Public urban green space: Exploring priorities and challenges for managing and valuing green space, using Stockholm as a case study

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TRITA-ABE-MBT-21486

Acknowledgements

I would like to give thanks to my primary supervisor, Sara Borgström, whose guidance during the initial creation of this work was invaluable. I am grateful for all our discussions, and for your confidence in me. I would also like to note particular gratitude for my secondary supervisor and examiner, Henrik Ernstson, who leapt into overseeing the completion of this project with very short notice. Thank you for your useful feedback, and for your assistance when it was most needed.

A huge thanks to all the interviewees, whose voluntary participation in this research gave life to the results and discussions within the project. It was a privilege to share your time, and to learn from your thoughtful answers and concerns about the subject. Here's to hoping that public urban green space receives the recognition in research and policy that it deserves.

I want to give special thanks to all my friends and family who gave their assistance, thoughts, and feedback during the final stages of this project. Every encouragement helped in finishing this work during an exceptional year. Finally, I am grateful for the continual support from Love, without which I don't believe writing an entire master's thesis from the kitchen table would have ever been possible, or so enjoyable. Thank you.

Abstract

Public urban green space has never been more important: Its past contributions and potential to promote future public health, climate mitigation, and biodiversity are invaluable to cities experiencing population growth and urban densification. This research explores complexities of multiple demands on public urban green space in cities, using Stockholm as a case study. Semi-structured interviews with local professionals in the environmental planning field, supported by an analysis of key documents, assist in identifying key priorities and challenges, and highlighting considerations for the use of tools which value these spaces and their associated ecosystem services. Key priorities for the management of public urban green spaces are found to be: Adapting to effects of climate change, protecting biodiversity, and provision of cultural ecosystem services. Key challenges facing the management of public urban green spaces were highlighted as: Urban densification, green-washing, unclear definitions of concepts such as 'green space', and expectations of spaces being multifunctional. There are discussions that valuation tools do not have the ability to accurately measure and assess cultural ecosystem services, that collaborative tools can be more effective, and that there are both benefits and drawbacks concerning monetary valuations. Findings have implications for Stockholm's management of public urban green space, and can be used to inform environmental planning policies. Recommendations for future research include investigating tools available for the assessment, mapping, and valuation of the qualities of green spaces, as well as identifying assessment tools Stockholm City Council have previous experience with.

Key words

Urban planning, environmental planning, sustainable development, nature protection, assessment, nature valuation, public space, ecosystem services.

Sammanfattning

Stadsnära grönområden och parker har aldrig varit viktigare: dess tidigare bidrag och potential att främja framtida folkhälsa, motverka klimatförändringar, och främja biologisk mångfald är ovärderliga för städer som upplever befolkningstillväxt och ökande befolkningstäthet. Denna studie utforskar komplexiteten av olika krav på allmänna grönområden i städer, med hjälp av Stockholm som en fallstudie. Semistrukturerade intervjuer med lokala yrkesverksamma inom miljöplaneringsområdet, stödda av en analys av nyckeldokument, hjälper till att identifiera viktiga prioriteringar och utmaningar och belyser överväganden för användningen av verktyg som värderar dessa utrymmen och deras tillhörande ekosystemtjänster. Nyckelprioriteringar för hanteringen av allmänna grönområden i städerna visar sig vara: Anpassning till effekterna av klimatförändringar, skydd av biologisk mångfald och tillhandahållande av kulturella ekosystemtjänster. De viktigaste utmaningarna för hanteringen av offentliga grönområden i städerna lyfts fram som: ökande befolkningstäthet i städer, green-washing, oklara definitioner av begrepp som ”grönområde” och förväntningar på att utrymmen ska vara multifunktionella. Det diskuteras att värderingsverktyg inte har möjlighet att noggrant mäta och bedöma kulturella ekosystemtjänster, att samarbetsverktyg kan vara effektivare och att det finns både fördelar och nackdelar med monetära värderingar. Resultaten har konsekvenser för Stockholms skötsel och av allmänna grönområden och kan användas för att informera miljöplaneringspolitiken. Rekommendationer för framtida forskning inkluderar att utreda verktyg som är tillgängliga för bedömning, kartläggning och värdering av grönområdens kvaliteter, samt identifiering av bedömningsverktyg som Stockholms stad har tidigare erfarenhet av.

Nyckelord

Stadsplanering, miljöplanering, hållbar utveckling, naturskydd, utvärdering, naturvärdering, allmän plats, ekosystemtjänster.

Key definitions and concepts

Biodiversity: The term refers to the diversity of species present within an area, and to the "variety of life and its processes" (European Commission, 2021).

Ecosystem services: These services are "the benefits that flow from nature to people" that are derived from greenery and green space. They are grouped into categories depending on the type of service provided (European Commission, 2021). Category groupings include provisioning, regulating, supporting, and cultural services (Stockholms Stad, 2021b). An example of a regulating ecosystem service is ground filtration of rainfall, and an example of a cultural ecosystem service is the ability to spend time and cultivate plants in nature or green spaces (ibid).

Environmental sustainability: "Environmental or ecological sustainability is about a society with closed eco-cycles and a balance between processes that build up and break down, without unnecessary waste of natural resources and energy and that preserve biodiversity and genetic variation" (Stockholms Stad, 2018, p.166).

Green infrastructure: This is "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services' in both rural and urban settings" (European Commission, 2021a). The Swedish Environmental Protection Agency (Naturvårdsverket) adds to this by stating that green infrastructure is able to "connect the habitats of flora and fauna, and is a basis for the well-being of people" (Naturvårdsverket, n.d., p.1).

Public urban green space: Within this study, this term refers to any land within the municipality boundary of Stockholm, that is owned by the Stockholm City Council which contains plants (e.g. trees, grassed areas, etc.) and is developed for public use. This definition draws on information from several sources, particularly, the definition provided by Stockholm City Plan which indicates that public space is "an umbrella term for streets, squares, parks and corridors" (Stockholms Stad, 2018, p.167).

Sustainable development: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

Sustainable Development Goals (SDGs): The 17 SDGs expressed by the United Nations aim to promote global partnership in ending poverty and achieving "peace, prosperity and opportunity for all" (United Nations, 2020, p.2).

Sustainable society: "The term refers to building a society that is founded on the three pillars that together form the sustainability concept – environmental, economic and social sustainability" (Stockholms Stad, 2018, p.167).

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1. Introduction

1.1. Growing cities, green space, and sustainable development

Urbanisation is a global trend causing significant population increases in major cities (United Nations, 2018). It is projected that by 2050, 68% of the global population will reside in cities (ibid). With the majority of people expected to live in cities, there is high demand for physical infrastructure, and effective urban development plans, including the provision of housing (Stockholms Stad, 2021; Naturvårdsverket, 2015). With increasing pressures to provide more housing developments, among other facilities, cities with growing populations are facing more pressure to build (Naturvårdsverket, 2015). This has led to a shortage of space available for development, and increasing pressures on green spaces within cities. As such, green space is coming under threat from development as the urbanisation process leads to densification, which can often be achieved by building on green space (SEPA, 2021; Naturvårdsverket, 2018a, p.23; Elmqvist et al., 2004).

Planning for green space within cities is increasingly recognised as an essential part of urban planning, and is accepted as a means of facilitating sustainable development (Boverket, 2018). The concept of sustainable development highlights the necessity to provide for the future needs of societies, with reference to economic, social and environmental aspects (WCED, 1987). Consequently it has been incorporated into international objectives, such as the United Nations Sustainable Development Goals, which Sweden and Stockholm aim to achieve (United Nations, 2020, p.2). Goals such as these highlight the need to consider environmental and social sustainability when planning urban developments in cities; to build a society which meets the comprehensive needs of people and wildlife (Stockholms Stad, 2018, p.167).

1.2. Green infrastructure and ecosystem services

The loss of green space within cities raises concerns for accessibility and proximity to green spaces for outdoor recreation (SEPA, 2021). Due to the recent Covid-19 pandemic and the resulting global message to 'stay local', the importance of accessibility to green space has been highlighted, and has become a key social-environmental issue (Lehberger, et al. 2021; Ugolini, et al. 2020). Research indicates that spending time in green space is beneficial for human health, emotionally and mentally, psychologically, and physically (World Health Organisation, 2016 and 2017; De Oliveira, 2017, p.140). The diversity of flora and fauna within green spaces is also understood to support human health, and 'many natural and cultural environments are important sites for outdoor recreation' (SEPA, 2021). It is also understood that proximity to green space is "'important for public health, since proximity to quality green spaces encourages more people to use them regularly for relaxation and physical activity", and so can heavily influence public health (Stockholms Stad, 2018, p.87). With green space in cities at risk, this raises questions for planning, such as: how much green space is necessary for people to receive benefits from it? And do different types of vegetation and green spaces provide the same cultural and recreational benefits?

Further, the loss of green spaces in cities creates concerns for the overall connectivity and health of a city's green network[1], which requires "a new, holistic perspective and new work methods" in order to protect these spaces (Naturvårdsverket, 2018, p.3). The green network within an urban landscape, and its connectivity, is reduced with every individual loss of green space. Reduced connectivity, and increased fragmentation of green spaces within a city increases the difficulty for species to migrate to suitable habitats, risking their survival (Naturvårdsverket, 2019). This in turn, affects biological diversity within a city, which is critical to preserve 'if ecosystems are to function and provide benefits such as purifying water and air' (SEPA, 2021). There are also issues related to the loss of green infrastructure, in that fragmentation creates pressures on ecosystems which could diminish their capabilities to provide ecosystem services (Borgström et al., 2006; SEPA, 2021). This translates to concerns regarding the extent of green space connectivity required to effectively support biodiversity, and the ecosystem services and functions derived from it. Moving forwards, it could be beneficial to quantify how much green spaces contribute towards ecosystem services such as air purification, water filtration or climate regulation. Additionally, this goal would be best met through the development of novel metrics to better assess the contributions of these aspects.

The natural benefits that green spaces provide, ecosystem services, are categorised into four types of service: provisioning, regulating, supporting, and cultural (European Commission, 2021a). Ecosystem services provided by green spaces occur naturally, and are diminished along with the loss of any green spaces that provides them. Many regulating and supporting ecosystem services, such air purification and flooding prevention, contribute to local climate regulation, and in turn can assist in mitigating the effects of climate change (European Commission, 2021a; Stockholms Stad, 2015, p.11). Climate mitigation techniques are becoming ever more crucial, with cities facing risks of flooding, drought, and heat waves due to the increasing likelihood of extreme weather events (Van Staden, 2014). With this in mind, the pressures to build on urban green space expose concerns and raise questions regarding city planning and the significance of the qualities of green spaces. For instance, how much does one tree contribute to sequestrating carbon or shading its surroundings on a polluted city street, and what is the value of that? And how might this value be quantified or accounted for?

These questions surrounding the value of the qualities of urban green spaces, and their associated ecosystem services, are particularly relevant as these types of data could support informed decision-making concerning urban green space management[2]. Traditional long-standing methods of environmental assessment which identify and map floral and faunal

[1] A series of natural and semi-natural areas of green infrastructure within a landscape (European Environment Agency, 2020).

[2] "Management" refers to the methods used to decide on the priorities for, and the design of public urban green spaces. The ongoing development of approaches to urban environmental management is an essential part of urban planning and the sustainable development of cities.

species, including terrestrial habitat classification schemes such as the UK's Phase One Habitat Surveys, succeed in mapping existing habitats and species but do not attempt to quantify or value the qualities of these elements (Joint Nature Conservation Committee, 2021). This ability to value the qualities of green spaces could be essential for the future protection and management of urban greenery.

1.3. Planning for green space: tools for valuing

There is a growing demand for methods and tools that can quantify and value green space qualities and ecosystem services. Tools have been developed to focus specifically on different aspects of green spaces and ecosystem services, and produce valuations in different terms. Some tools attempt to calculate monetary and economic valuations, which involve the development of new valuation scales and metrics. These developments have resulted in the creation of terms such as 'natural capital' which aim to refer to the economic worth of natural assets (Ecosystems Knowledge Network, 2021b). Further, tools have been developed for valuing specific types of vegetation, such as trees, or green roofs, and for different scales and stages in the planning processes (Gómez-Baggethun, 2010).

When planning and managing green spaces within cities, the physical size of a space, and the types of vegetation present will determine the ability of a green space to meet its desired functions. These proposed, desired, or required functions of a green space determine the types of tool that is chosen to assess the value of those specific green space qualities. For instance, this means that in theory a green space could be valued very highly for its recreational qualities but in practice might appear with a low value if it is assessed using tools which consider its other qualities, such as its regulating ecosystem services. Each individual green space has its own functions, and so the tools chosen to assess the value of these qualities will be dependent on the individual space. As there are many aspects of green space and ecosystem services to value, there are many different tools being used, tested, and developed, as well as inventories of these tools. This leads to the consideration of issues such as: Which tools are appropriate for valuing the functions of public urban green spaces? Which tools might be useful for public authorities and public land? Is there an inventory of tools available for use? Which tools are suitable for specific functions, needs and requirements?

2. Literature Review

Governance, social networks, and management

Evaluations of the merits of the trading of ecosystem services, such as carbon sequestration, have been given consideration for some time (Daily et al., 2000), and since 1999, it has been noted that “locally generated ecosystem services have a substantial impact on the quality-of-life in urban areas” and therefore should be considered and included within planning decisions for land use (Bolund and Hunhammar, 1999, p.1).

The governance frameworks and social networks of a city can influence the management of public urban green spaces, and thus also affect the ecosystem services which are provided by these spaces (Borgström et al., 2006; Ernstson, et al., 2010). An “incomplete knowledge of ecosystem dynamics and institutional constraints” can frequently be the cause of governance practices and frameworks that do not effectively meet the needs of ecological processes at specific scales, and can often be the case in urban landscapes (Borgström et al., 2006). This is of particular importance as the ability of ecosystems to provide ecosystem services diminishes with increased landscape fragmentation (Borgström et al., 2006). Other studies also find that the development of methods to value ecosystem services and biodiversity is needed in order to achieve adjustable and adaptable policies and management approaches for green spaces (Haines-Young, 2009).

Further, understanding how actors, such as governments, and social networks influence the governance of urban ecosystems might assist city councils in creating more effective frameworks for the governance and management of urban green spaces and ecosystem services. Research in Stockholm investigated how social networks affect the governance of ecosystem services, and found that the functional connectivity of green spaces in the city was not overseen by any one local actor (Ernstson, et al., 2010). However, it was noted that the influence of particular actors, namely civil society groups, on local ecosystem management was beneficial to supporting local ecosystem services (Ernstson, et al., 2010). Similar studies exploring urban social-ecological systems find that land-use planning and management do not often take the influence of local stewards into consideration, in relation to their supporting of urban ecosystem services (Andersson et al., 2014). One suggestion to combat these issues of mis-matched frameworks is to support the “creation of adaptive governance systems to support practical management” (Borgström et al., 2006, p.1). Further research into the effects of social networks on the management of green space has investigated “selective social articulation processes” whereby the protection and management of nature, green space, and ecosystem services are determined by specific social movements (Ernstson and Sörlin, 2009). This research has taken place in relation to civil society organisations’ involvement with value-creating processes for the Stockholm National Urban Park (National City Park) (Ernstson and Sörlin, 2009).

In terms of developing management approaches for urban green space, in 2004 Elmqvist et al. highlighted the need to further investigate how management might reduce the fragmentation of habitats within Stockholm and enhance green network connectivity. They found that adaptive co-management has the potential to support and enhance biodiversity in urban landscapes, and indicated that an evaluation of how these methods could supplement current management would be required (Elmqvist et al., 2004). Further, research finds that areas of biodiversity in public spaces, such as near-natural urban grassland habitats, could potentially be supported by the public, if it were to appear with "a generally tidy appearance" (Fischer et al., 2020, p.2). A similar public affiliation with biodiversity was found in research which observed that biodiversity is a contributing factor for why people visit national parks (Siikamäki, et al., 2015). Understanding the dynamics of governance and social networks surrounding the management of public urban green spaces, and the priorities and motivators of these key actors, is key to furthering knowledge of how these socio-ecological systems function. This knowledge could inform best-practice green space management techniques, though does not present the possibility of assessing the qualities of green space, of the ecosystem services provided within these systems.

Monetary valuation and a natural capital approach

Methods and tools for the valuation of the qualities of natural features and ecosystem services can be categorised into economic and non-economic approaches (Defra.gov.uk, 2007). The values of ecosystem services are often addressed subconsciously, and assumed as free services, though whenever valuations are attempted, the common measuring unit is typically monetary (Daily et al., 2000). In discussion on natural resource management and environmental assets in 1973, Schumacher referred to them as 'natural capital' and stated that: "we steadfastly insist on treating [it] as expendable, as if it were income, and by no means the most important part". He continued: "If we squander our fossil fuels, we threaten civilisation; but if we squander the capital represented by living nature around us, we threaten life itself" (Schumacher, 1973, p.7). Acknowledgements of the importance of natural capital, referred to by the Ecosystems Knowledge Network as "the stock of natural features and processes that collectively provide flows of ecosystem services" (2021a), has led to key developments in the field of ecological economics such as the creation of tools and accounting frameworks for the valuation of environmental assets and ecosystem services. There is a growing interest in the use of these tools and frameworks, which aim to "inform planning, management and investment decisions that minimise risks and maximise opportunities" (Ecosystems Knowledge Network, 2021).

The natural capital approach and application of monetary values has also attracted critique, as research suggests that it could lead to the commodification of ecosystem services which could compromise biodiversity conservation in the long-term and the equity of access to its benefits (Gómez-Baggethun and Ruiz-Pérez, 2011). Further, it's been argued that the intrinsic worth of nature is reduced through monetisation (Adams, 2014; Silvertown, 2015), and that environmental objectives risk becoming overlooked in favour of financial aims (Spash, 2010). Additionally, the ecosystem services themselves can be inherently idiosyncratic and their quality can be found to be quite unique to each location where they are produced (Daily et al., 2000). Despite this, research in Stockholm has attempted to quantify the value of ecosystem services in monetary terms. For instance, a previous study in Stockholm investigated the economic valuation of ecosystem services within an urban landscape, specifically, the valuation of seed dispersal by the Eurasian jay (Garrulus glandarius) in the Stockholm National Urban Park (Hougner, et al., 2006). Research has also investigated how best to analyse trade-offs surrounding changes in land-use, using spatial analysis and dynamic modelling tools to examine these issues (De Groot et al., 2010). This research addressed concerns regarding how to ascertain the total economic value of "different management states" and concluded that efforts to value ecosystem services have influenced wider discussions surrounding perceived conflicts between nature conservation and development (De Groot et al., 2010).

Application and history of valuation tools for green spaces and ecosystem services

In terms of applying planning policy tools for the valuation of green spaces and ecosystem services, and using natural capital accounting frameworks, certain cities can be found to be particularly progressive. In 1994, the Green Space Factor (GSF) tool was employed in Berlin with the aim of improving green infrastructure in private open spaces (The Guardian, 2021). The tool allows for the allocation of different values, depending on specific needs of a location, to different aspects of green-blue space, such as a pond. This enables the tool to be responsive to the unique needs of an area (ibid, 2021). However, there are concerns regarding the use of these types of planning policy tools for the valuation of green space and ecosystem services. Regarding GSF, a concern is that it would become prescriptive, and would not be used to accurately reflect the needs of individual locations. Another concern is its potential use in the process of green-washing[3]. In conversation about project Bo01 ('Bo' meaning "to live" in Swedish, and '01' representing the year 2001, when the project officially opened), a landscape architect at Malmö's planning department commented on GSF, saying: "There's an obvious risk that it becomes a bit of a green-washing tool. But I think the danger is that everyone involved believes that using the GSF makes everything long-term greener. And I'm not sure it does; we don't know if it does" (The Guardian, 2021). Further, the director of conservation at London Wildlife Trust commented on the use of GSF, saying: "For all the benefits of these tools – and they are tools – they are not necessarily the final answer … having informed ecological expertise is still critical" (ibid, 2021).

In 1998 Malmö's project Bo01 used the Green Space Factor in order to become the world's first neighbourhood to be completely carbon neutral (The Guardian, 2021). Malmö's city policy ensured that every development provided part of the space for greenery, and provided "biodiversity-focused bonus points for anything from tall fruiting trees and potted plants on the roadside, to tiny birdhouses and frog-filled ponds" (The Guardian, 2021). Stockholm has also used the Green Space Factor, adapting it so that it attributes individual scores for aspects such as biodiversity, climate adaptation (including water management), and the aesthetic of a potential development, and applying it to recent development areas such as Norra Djurgardsstaden (Stockholms Stad, 2021d). Other cities have since also used tailored versions

[3] Green-washing: Behaviour or activities that are intended to lead people to believe that a company is doing more to protect the environment than it really is (Cambridge University Press, 2021).

of the Green Space Factor (GSF), including Seattle, Helsinki, Hamburg, and Southampton (The Guardian, 2021; Seattle.gov, 2021; Juhola, 2018).

Another example: inspired by Malmö's Bo01 project, the latest City plan for London unveiled by the mayor of London, Sadiq Khan, aims to try to be the biggest city to successfully implement a green space system for planning. The plan, called the 'Urban Greening Factor (UGF)', outlines using planning policy tools such as the Green Space Factor (GSF) to prompt urban greening and thus "increase the quantity and functionality of green infrastructure in the built environment, by setting minimum standards for new development projects" (The Ecology Consultancy, 2017, p.4). Further, with growing interest in public spaces, some tools are being developed for use specifically in public areas, such as the development of the Green Area Factor for development districts (Sw. Grönytefaktor för kvartersmark, GYF KVM) which is being developed for use in public spaces (Sw. Grönytefaktor för allmän platsmark, GYF AP) and is a Swedish version of the Biotope Area Factor (BAF) (C/O City, 2020).

Different tools also have very different focuses and consider different types of ecosystem services. Some tools such as ESTER, currently being developed by Boverket (The Swedish National Board of Housing, Building and Planning), aim to highlight the values of all types of ecosystem services that a green space provides (Boverket, 2021b). Other valuation tools, such as i-tree, focus on the value of individual aspects of green space. For example, the value of ecosystem services provided by trees within a green space (Deak Sjöman, and Östberg, 2020). The increasing number of tools for the valuation of ecosystem services has also led to the development of services which attempt to catalogue tools, such as Tool Assessor, created by the Ecosystem Knowledge Network in Oxford (Ecosystems Knowledge Network, 2021c). Further, the Environmental Change Institute at Oxford University has categorised tools into four groups depending on their purpose: mapping existing assets, opportunity mapping (for potential locations to enhance existing assets), site design for potential developments, and the valuation of environmental assets. Tools have been categorised and are being tested to investigate the possibility of producing natural capital maps which could inform the development of local county plans (Environmental Change Institute, 2020). With so many different tools being developed for specific aspects of greenery, and focusing on different ecosystem services, questions regarding the key aims and priorities for a city such as Stockholm's urban green spaces need to be addressed: what are the key challenges for the urban green spaces, and which tools might be best suited to measure their associated ecosystem services?

2.1. Theoretical framework

2.1.1. Systems ecology and sustainable development

This research uses the concepts of systems thinking and systems ecology, and tries to consider a small selection of ecosystem services, in order to facilitate practical action-orientated discussion (Naturvårdsverket, 2020a). The concept of systems thinking, and "the Ecosystem approach, emphasises that decisions about biodiversity and ecosystem services have to be looked at in a wider, social and economic context" (Haines-Young and Potschin, 2010, p.15). In other words, a holistic approach to understanding the entirety of systems is encouraged, in order to understand the purpose and functioning of minor parts. Therefore this research has tried to utilise information concerning the priorities for green space and ecosystem services, gained from specific specialists in the field, as well as reflecting on these findings within the context of the aims and objectives of Stockholm, identified through a desk-top study.

Further, the research relies on, and works on the assumption that sustainable development for urban planning for a good built environment is a necessary and preferable process, and that to achieve this, greening cities and employing the use of green infrastructure are both beneficial methods. It is understood that sustainable development applies environmentally, economically, and socially, and that despite a variety of perspectives and different definitions of sustainable development, this research works within the definitions provided by the Brundtland commission within the 'Our common future' document (WCED, 1987). It is understood that environmental planning and the management and future development of public urban green spaces is an essential part of the physical urban fabric of cities, and that the sustainable development of these public green spaces is essential to the city's ability to reach environmental and social sustainability.

3. Aim

This research aimed to investigate the key challenges facing the management of public urban green spaces, and explore the potential of using valuation tools and methods to assess the qualities of these public urban green spaces, and their associated ecosystem services, using Stockholm as a case study.

3.1. Research questions

1. What are the key aims, and current priorities, for the management of public urban green spaces and their associated ecosystem services in Stockholm?
2. What are the key challenges for the management of public urban green space owned by the Stockholm City Council?
3. Which tools might be appropriate for valuing aspects of, and ecosystem services provided by, Stockholm's public urban green spaces?

4. Background

4.1. Sweden and Stockholm: A case study

4.1.1. Growth and urbanisation

Stockholm, the capital city of Sweden, is situated on the eastern coast of the country (see Figure 1). The municipality of Stockholm is one of Sweden's 290 municipalities, and is one of 26 municipalities that collectively make up the Region of Stockholm, which was previously known as Stockholm County (Stockholms Stad, 2020). With 900,000 of the 10 million plus national population, Stockholm municipality is host to the largest municipal population in Sweden (SCB, 2021a). With regards to population growth, the population of Sweden's large cities is predicted to increase by 10.7% from 2019, resulting in a population of 2,101,200 people by 2030 (SCB, 2021).

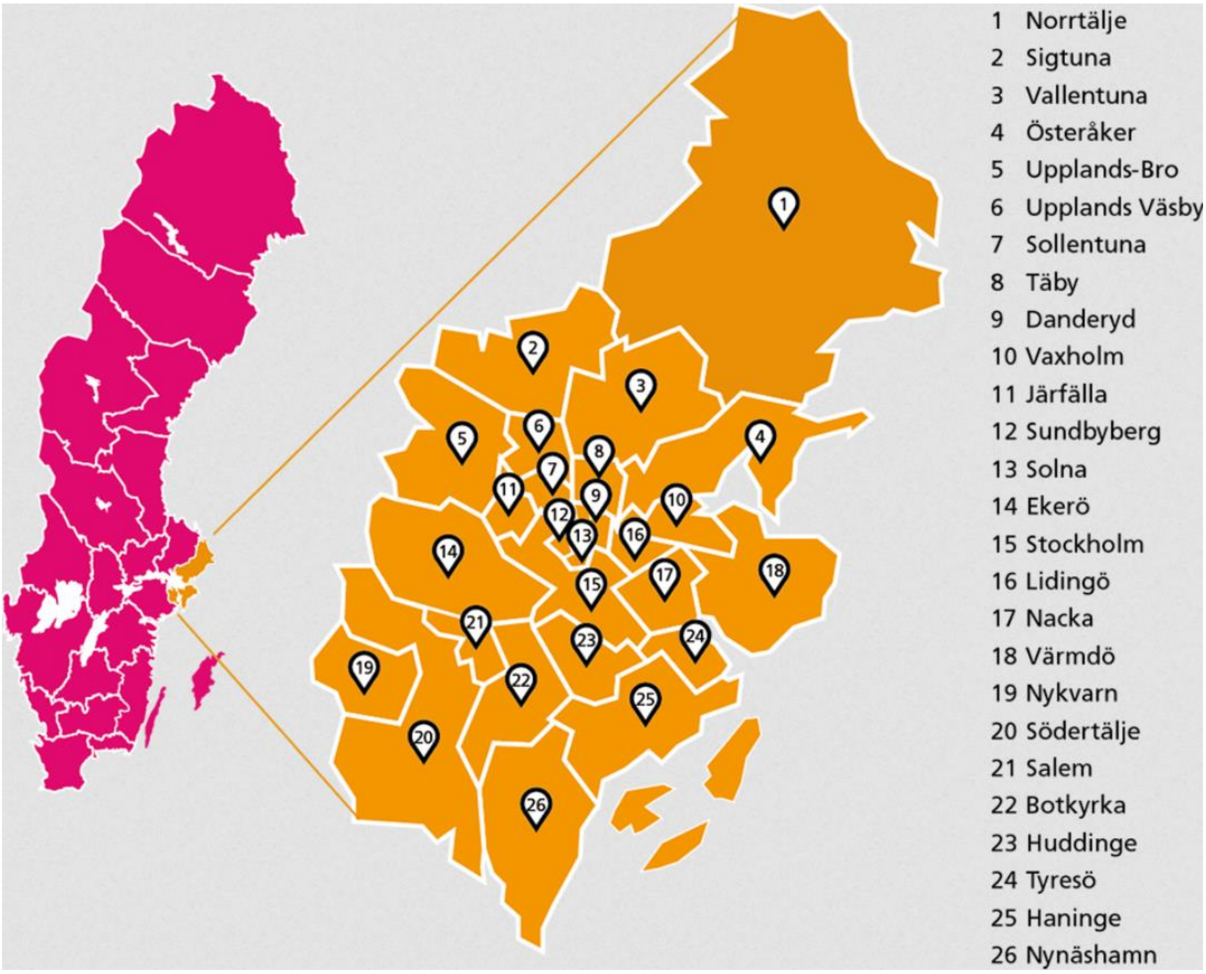

Figure 1 - Map of Stockholm municipality (shown as number 15) in relation to the Region of Stockholm, and Sweden (Region Stockholm, 2021a).

4.1.2. National and regional green space management

At the national level, the Swedish Planning and Building Act (Sw. Plan och bygglagen, PBL) is a key piece of legislation concerning Sweden's urban city development planning (Boverket, 2018). The PBL acts as the regulatory framework for physical planning and is meant to be applied to development projects in ways that "offer great environmental benefit, along with the development of local authority comprehensive planning" (Boverket, 2021a). Concerning planning at the regional level, the Region of Stockholm follows guidance from the Swedish Environmental Protection Agency (SEPA) which produces guidelines that Sweden's county administrative boards are expected to adhere to when developing their regional plans for green infrastructure (Naturvårdsverket, 2020). In 2010, the European Commission named Stockholm the first 'European Green Capital' which formally recognised the city's developments in its journey to being sustainable (Stockholms Stad, 2015).

RUFS 2050 (Sw. Regional utvecklingsplan för Stockholmsregionen, RUFS) is the development plan for the Region of Stockholm and provides four regional goals; one of which focuses on attractive living environments. RUFS 2050 is valid until 2026 and acts as the strategic development plan for the entirety of the Region of Stockholm. One of the six key challenges identified for the Region of Stockholm highlights the challenge for the overall region of attempting to 'facilitate population growth, while improving the region's environment, and the health of its inhabitants' (RUFS 2050, 2018). The plan provides goals, targets, and regional priorities which should help to facilitate the realisation of the plan, and these in turn inform the individual plans of municipalities within the Region of Stockholm.

The Region of Stockholm also has a history of managing and conserving its green infrastructure and green spaces through use of protective mechanisms and designations. The Region of Stockholm is host to a series of green wedges stretching outward connecting the inner central city to the outer suburbs, acting as corridors connecting green spaces for flora and fauna (Region Stockholm, 2021). The green wedges, shown below in Figure 2, are "large, contiguous green areas adjacent to the buildings that have several overlapping values" including that of providing ecosystem services and supporting biodiversity (Region Stockholm, 2021).

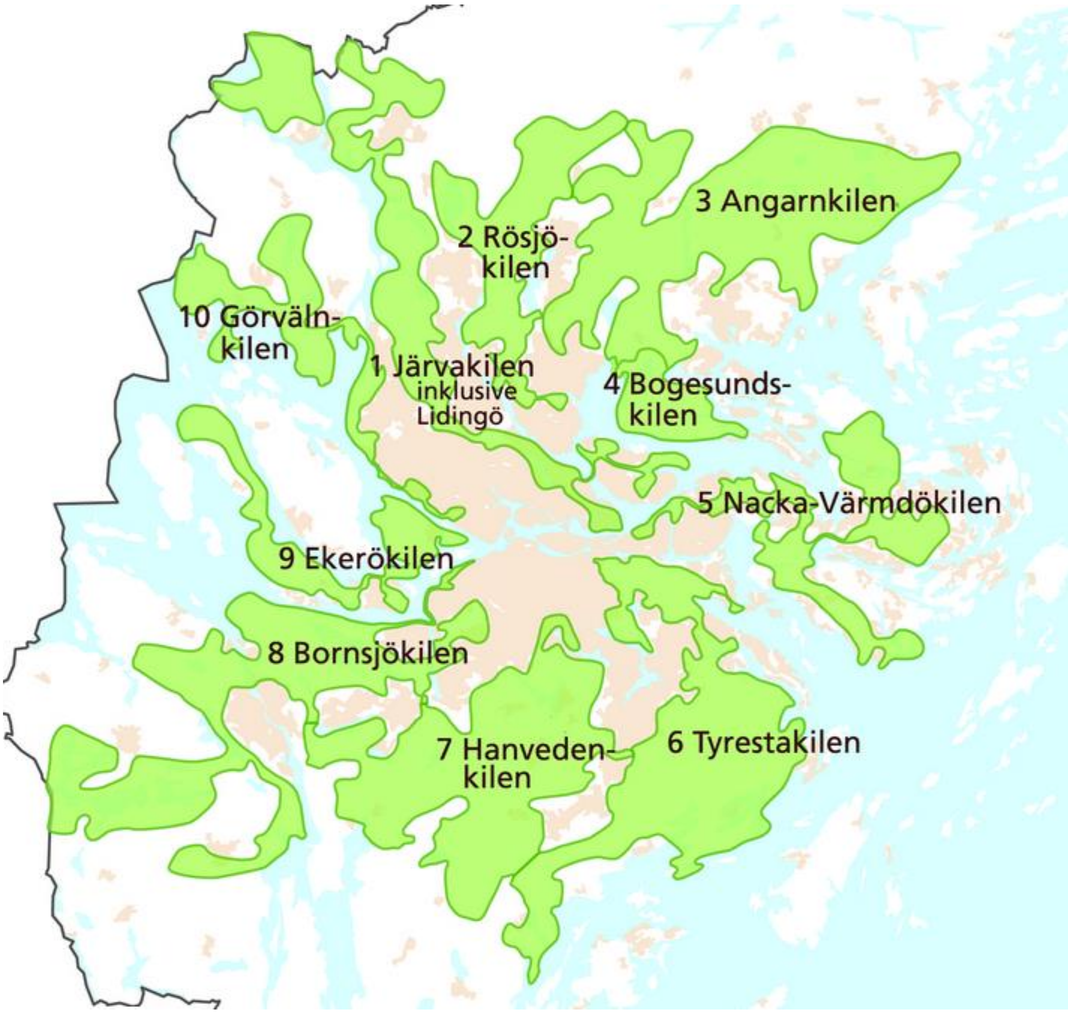

Figure 2 - Map of the green wedges surrounding Stockholm municipality (Region Stockholm, 2010).

4.1.3. Stockholm municipality green space management

Stockholm municipality has its own measures for protecting green space within the city. In 1995 Stockholm became host to the world's first National Urban Park shown below in Figure 3 (County Administrative Board of Stockholm, 2021). The park is primarily owned by central Government through the National Property Board (SFV), and is protected against exploitation by directives in Chapter 4, Section 7 of the Environmental Code. The National City Park was established to secure the qualities of the space for future generations, and by doing so protects the green space and assists in conserving the connectivity of the overall green space network within the urban landscape (County Administrative Board of Stockholm, 2021).

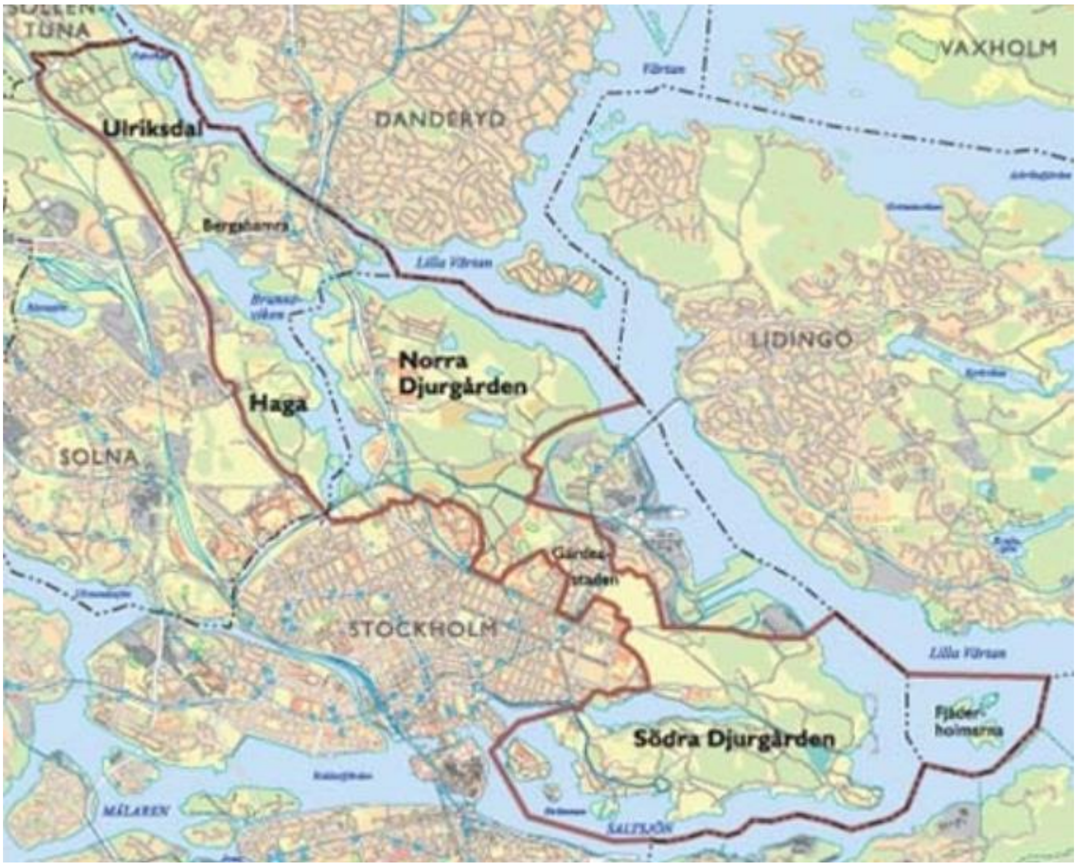

Figure 3 - Stockholm National City Park (Stockholm City Council Urban Planning office, 2021).

Stockholm municipality is also host to eleven nature reserves which together, in total cover almost 2,500 hectares and are designated as protected areas for nature (Stockholms Stad, 2021a). The decisions regarding these protected nature reserves are made by the Stockholm City Council, and for a number of Stockholm's reserves the significance of their contribution to assisting the regional green structure is highlighted (ibid). Further, the Stockholm City Council recognises that it is essential to protect biological diversity in order to achieve ecologically sustainable development (Stockholms Stad, 2021c).

Concerning urban development planning, the Stockholm City Council is dedicated to protecting and enhancing its public urban green spaces. Stockholm's City Plan (Översiktsplan för Stockholm) states that the vision for Stockholm means that "wherever you live, you should be able to … enjoy access to high-quality squares, parks and green spaces" (Stockholms Stad, 2018, p.3). Furthermore, the Greener Stockholm plan was adopted in February 2017 and provides guidelines for planning, action and management of the city's parks and green spaces. The document comprises three overarching objectives and one strategic guideline on how green assets are to be safeguarded in the city's processes. These set out the approach the city is to take in the long term on parks and green spaces, and how the need for ecosystem services is to be met on the basis of planning directions and strategies in the City Plan and the Environment Programme. The plans acknowledge that "green land will sometimes be built on", however "the city's overall ambition is to improve people's access to Stockholm's green spaces" (Stockholms Stad, 2018, p.25).

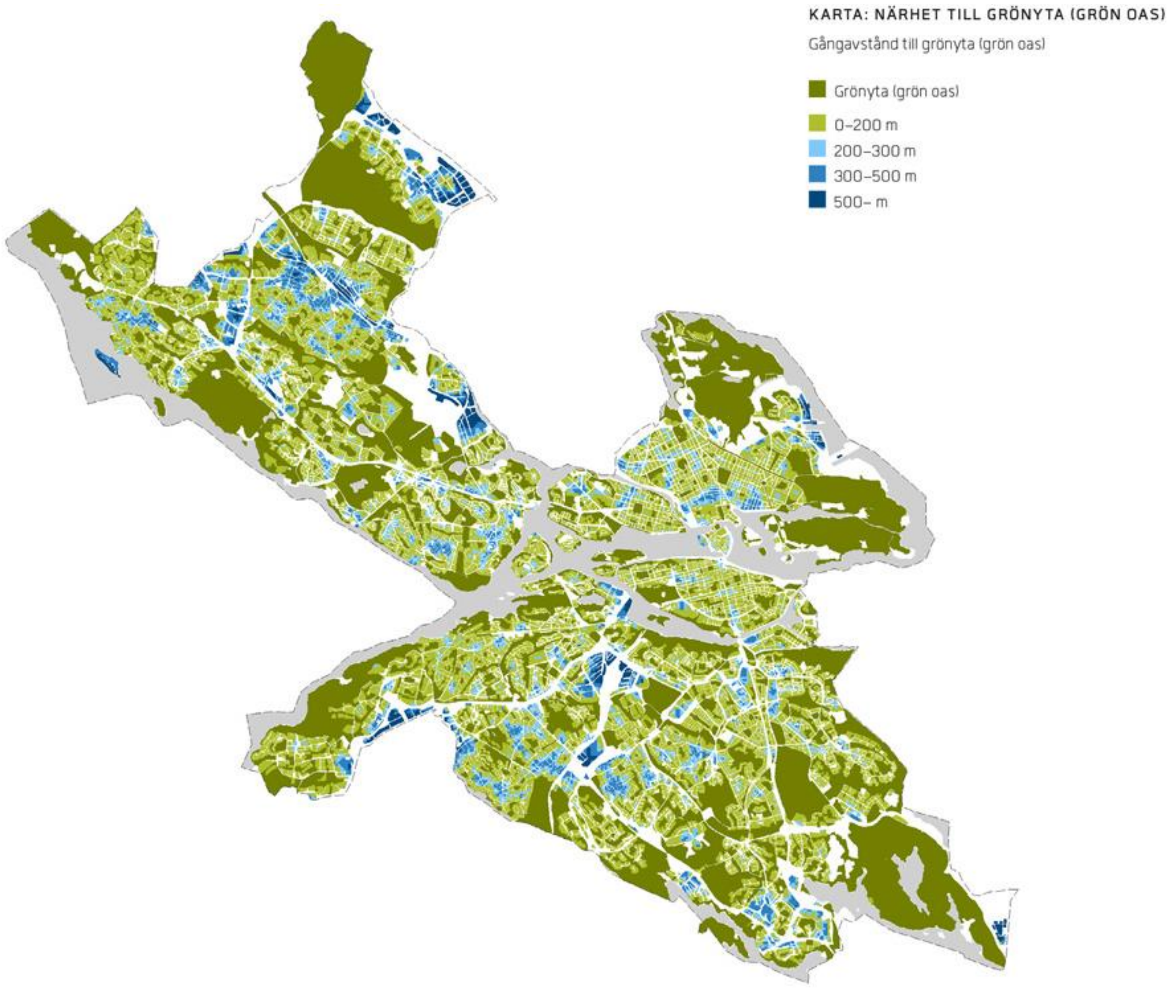

Figure 4 - Map of public green space[4] within Stockholm municipality (Spacescape, 2015).

The total coverage of all types of green space within Stockholm municipality comes to 26,818 hectares (SCB, 2015). This includes "all types of green areas that build up the overall green structure within the urban boundary, such as public parks and open grass areas as well as other tree or grass-covered areas, impediment left over during construction, residential gardens, green areas between apartment buildings or industrial buildings and also green areas between roads, etc." (SCB, 2015). Stockholm municipality, the Region of Stockholm, and the Swedish national government together own 11,927 hectares, or 44% of the total green space coverage within the municipality borders, of publicly accessible green space within the

[4] The public green spaces shown in this map are 0.1 hectares or larger, with green floors and walls (Stockholms Stad, 2006). This map therefore does not include smaller public green spaces or greenery such as individual street trees.

Stockholm City Council's municipality (SCB, 2015). Figure 4, above, shows a map of access to public green space in Stockholm with green spaces displayed in dark green.

4.2. Stockholm and Stockholm City Council: Green space management

Within Stockholm City Council, the Department for Transport, City Planning Office, Environmental Affairs Department, and Department for Sustainable Development are the key departments which would have responsibilities relating to the management of public urban green spaces in Stockholm municipality (Stockholms Stad, 2019).

4.2.1. Environmental sustainability: Aims and objectives

Stockholm City Council, the Region of Stockholm, and the country of Sweden, adhere to aims and objectives which promote environmental sustainability and sustainable development. The Swedish Environmental Quality Objectives (SEQO) are a series of objectives which focus on welfare and aim to safeguard the environment which Sweden follows (Sveriges Miljomal, 2020). The sixteen Environmental Quality Objectives, provided by the Swedish Environmental Protection Agency, indicate the quality of the environment that Sweden aims towards achieving, in addition to outlining clarifications (Sveriges Miljomal, 2020; Swedish Environmental Protection Agency, 2020).

One SEQO is regarding *A Good Built Environment*. The responsible authority for achieving this objective is Boverket (The Swedish National Board of Housing, Building and Planning). The Swedish Environmental Protection Agency state that "the built environment accounts for almost 40 per cent of Sweden's total energy consumption" and hence the built environment is of particular importance when considering sustainable urban development (Swedish Environmental Protection Agency, 2020a). Concerning the specifications for *A Good Built Environment*, the Swedish Environmental Protection Agency state that "there [should be] good-quality and accessible natural areas and green spaces and corridors close to built environments" and that "the built environment is based on and supports people's needs, facilitates experiences of beauty and pleasure" (Swedish Environmental Protection Agency, 2020b).

Concerning sustainable urban development, milestone targets within the SEQO state there should be an "integration of urban greenery and ecosystem services into urban environments"' and that "the majority of the municipalities must utilise and integrate urban greenery and ecosystem services into urban environments in the planning, building and administration of towns and cities and densely populated areas by no later than 2025". Further, the milestone targets state that "municipalities must have access to a developed method for utilising and integrating city greenery and ecosystem services into urban environments in the planning, building and administration of towns and cities and densely populated areas by no later than 2020" (Swedish Environmental Protection Agency, 2020).

In 2015, the United Nations Member States adopted the 2030 Agenda for Sustainable Development which provided 17 Sustainable Development Goals (SDGs) to be achieved by 2030 (United Nations, n.d.). Sweden is part of the United Nations and so by default Sweden follows these directives. SDG 11 outlines the need to make “make cities and human settlements inclusive, safe, resilient and sustainable” (United Nations, n.d.), and through target 11.6 aims to “reduce the adverse per capita environmental impact of cities” (United Nations, n.d). Aiming to achieve these qualities is therefore of particular relevance to the public urban green spaces owned by Stockholm City Council. Additionally, under the UN Convention on Biological Diversity, Sweden is committed to the preservation of biodiversity whereby the natural environment should be protected in order to conserve endangered and threatened species (SEPA, 2021).

5. Methods

5.1. Case study approach

Stockholm was chosen as a case study due to Stockholm's success in being named the first European Green Capital, and its progress towards becoming a sustainable city (Stockholms Stad, 2015). Additionally, the city has acknowledged the importance of continuing discussions concerning the management of new and existing green spaces, to achieve social, as well as environmental sustainability (Stockholms Stad, 2018, p.87). The primary data collection concerning Stockholm was complemented through use of a desk-top study of key documents which highlighted key needs for the city's public green spaces.

5.2. Document analysis

A desk-top study was conducted, because as well as needing a well-structured approach, the method of data collection is cost-effective and can incorporate a variety of sources inclusive of formal documentation, literature, and online sources (Juneja, 2021). The study used existing sources to identify Stockholm's key urban green space challenges and to compare these with information concerning the key goals and aims of the Stockholm City Council, regarding their public green spaces. The desk-top study identified key sources of information within grey literature, in the form of regional and municipal government websites, environmental related reports published by the Stockholm City Council, and national, regional and local guidance documents. Key documents identified for analysis in this study were used for a document analysis which assisted in identifying the needs, aims and ambitions for Stockholm's public urban green spaces. The document used for analysis were chosen to reflect the different political and legal scales that Stockholm's regulations adhere to, including the municipal, regional, national, European and international scales. Documents included:

- Stockholm City Plan (Stockholms Stad, 2018)
- RUFS 2050 (Region Stockholm, 2018)
- Sweden's Environmental Objectives: An Introduction (Naturvårdsverket, 2018a)
- Stockholm A Sustainably Growing City (Stockholms Stad, 2013)
- Building Green Infrastructure for Europe (European Commission, 2013).
- Green Infrastructure (GI) — Enhancing Europe's Natural Capital (European Commission, 2013a).
- Urban Green Spaces: A Brief for Action (WHO, 2017).

Some documents[5] relevant to the study were excluded from the desk-top study due to not being available in English. Additional information concerning the Swedish planning process and environmental standards, for Stockholm, was considered and used as supplementary material for this investigation (Boverket, 2021). From the most interview transcripts, key terms and phrases were identified which signified the key topics and concepts raised in the interview discussions. These included: 'climate', 'flooding', and 'rainfall', and 'biodiversity', 'species' and 'habitat', as well as 'social', 'recreation', and 'community', and 'transport' and 'accessibility', as well as 'densification', 'multifunctionality', 'ownership' and 'responsibility', and 'green-washing' and 'politic'. The frequency of these terms and phrases was then searched for within the key documents chosen for analysis. This search assisted the investigation as the frequency of key terms provides some indication of the extent to which a topic is discussed, regardless of a negative or positive tone (Bryman, 2016).

The desk-top study was also used as a method to explore potential tools that could be used to value aspects of green space and ecosystem services that were considered a priority for future management in Stockholm. Research used a variety of online sources, including websites of independent organisations which research and develop tools, and international government guidance on the use of tools for the valuation of aspects of green space and ecosystem services. These sources were considered to be reliable due to the professional and specialised nature of the organisations.

5.3. Interview study

5.3.1. Stakeholder identification and analysis

A stakeholder analysis was conducted to allow the researcher to identify knowledgeable stakeholders to invite for interview. The stakeholder identification and interviews with stakeholders was identified as a useful method due to the potential for in-depth insights and information, despite its time-consuming nature (Reed, et al., 2009. P.1937). Table 1, below, shows the roles of the stakeholders who were invited for interview and who were able to accept. Stakeholders invited for interview included professionals from different departments within Stockholm City Council in order to gain a range of perspectives within the public sector. Interviewees also included consultants from companies in the private sector to balance the viewpoints received from both public and private organisations. Not all the stakeholders invited for interview were able to accept, and so there is potential for some bias in the results. Despite this, the interviewees represent a fairly broad variety of professional roles and organisations related to the management of green spaces and ecosystem services, as can be seen in Table 1 below.

[5] Including, but not limited to: Grönare Stockholm, Styr med sikte på miljömålen, Bostadsnära natur - inspiration & vägledning, Barns och ungas utemiljoer er, Gronplanering i Sverige, Grönstrukturplan.

Table 1 - Stakeholders selected for interview.

Role	Department	Organisation
Ecosystem services specialist	Environment and Health Department	Stockholm City Council
Urban planning strategist	Planning Department	Stockholm City Council
Landscape architect	Traffic Department	Stockholm City Council
Senior adviser	N/A	Naturvårdsverket (Swedish Environmental Protection Agency, SEPA)
Landscape architect	Unit of Urban and Rural Areas	Boverket (The Swedish National Board of Housing, Building and Planning)
Landscape architect	N/A	Ekologigruppen (Ecology group)
Landscape architect	N/A	White Arkitekter (Architects)
Consulting manager	N/A	Scandinavian Green Roof Institute (SGRI)

5.3.2. Interview method and transcription

After the relevant stakeholders were identified, individuals were invited to interview online via zoom (due to the Covid-19 pandemic), between the 10th of March and 8th of April 2021. Semi-structured interviews were used, opposed to structured, so as to provide opportunities for interviewees to expand on points of interest, and to allow for some degree of flexibility within the discussion. The semi-structured interview format was preferable to a completely unstructured format as this ensured that key information was not omitted, and that both interviewee and interviewer had sufficient understanding of which topics the interview discussion should cover (Grix, 2018, p.127-128). Interviewees were not all asked the same questions as the interviews were semi-structured which enabled spontaneous follow-up questions concerning specific information provided by interviewees. Interviewees were provided with information concerning the topic of research beforehand in an information sheet, and provided their permission for the interviews to be recorded, transcribed, cited, and referenced (See Appendix Two). Consent from interviewees was received concerning how they would like to be referred to and cited.

Interviewees were asked about key challenges surrounding the management of public urban green spaces in Stockholm, concerning multifunctionality and the provision of ecosystem services. Questions also included queries regarding the most important aspects of green space, or ecosystem services, that interviewees viewed as most important for immediate prioritisation, as well as questions about tools which are currently used for valuation of these spaces (see Appendix One). Conducting interviews assisted in gaining information regarding

Stockholm's urban green space priorities and challenges; and information concerning which tools are currently used in Stockholm, along with which tools are potentially appropriate for valuing public green space qualities at the local level of Stockholm's urban planning. Interviews also highlighted some of Stockholm's urban green space needs that existing tools do not address.

5.3.3. Interview analysis

Interview transcripts were typed using audio recordings, and thematic analysis was conducted on the transcripts through use of categorisation and applied triangulation (use of multiple methods to identify associations) (Bryman, 2016, P.392). Categories were created by using themes, such as: types of ecosystem services, types of key challenges facing Stockholm, and valuation tools that were mentioned. These themes were dictated by the research questions which aimed to discover the aims and priorities for public urban green spaces in Stockholm, key challenges for these spaces, and which valuation tools were already in use. The transcripts were sectioned corresponding to these themes by identifying key terms and phrases. Key quotes were also identified and coded accordingly. Sub-categories were developed as the categorisation process continued, to allow for more nuanced and accurate analysis when identifying commonalities between transcripts. This coding of interview transcripts and identification of categories and codes was an iterative process whereby codes were created and developed throughout the categorisation process, across the transcripts (Saldaña, 2021). This meant that transcripts were viewed separately for each research question. The process of viewing the same data multiple times will have had an effect on the outcome, though it will have reduced the risk of the codes and categories developing or accidentally changing as they were applied. The number of interviewees who mentioned topics was counted, and used as a minor indicator of the importance of these topics. However, the content of all the discussions was used as the primary indicator of the key aspects needing consideration.

The desk-based study of secondary materials, including the literature and theoretical framework, was analysed using the same themes and categories that were applied to the interview transcripts. This categorisation allowed for the application of triangulation whereby it was possible to identify associations and commonalities between the data collected through different methods (Grix, 2018, P.135-137). Connections could then be drawn between the secondary data sources of literature and the results from the transcripts by identifying similarities. The commonalities and patterns identified between the transcripts and literature enabled an analytic and evaluative discussion of all the data simultaneously, along the lines of the identified key themes. Data that overlapped and could be classified within multiple categories were placed within both options, and considered on a case-by-case basis when summarising results. Finally, transcripts were examined to locate any information of significance that was unexpected.

5.4. Scope, framing, and limitations

The research focus was limited to the case study of Stockholm, which has been used to inform the aims, objectives and research questions. Research for this study was conducted between January and May 2021, during the Covid-19 pandemic, and so was affected by restricted travel and home-working situations. This research project is framed by the need to identify the requirements of the public urban green spaces within Stockholm municipality, and owned by the Stockholm City Council, as it has previously been noted that this perspective of public space requires further consideration (Wikström, 2020). Thus, the focus of valuation does not incorporate private urban green spaces such as private gardens or private allotments, or private development districts.

Key limitations to the research included personal knowledge and skills of the interviewee, and reliance on interviewees for time and ability to coordinate for arranging interviews. Further, interviewees may have had different personal interpretations of some of the key concepts discussed. For example, personal understandings of 'green space' might differ, and be dependent on an interviewee's own experiences and knowledge. These differences could influence the answers that interviewees provide, and hence could compromise the results of the research. To minimise this risk, interviewees were provided with definitions of the key terms that were used within this study, such as 'public urban green space' before the interviews commenced. Additionally, the semi-structured interview format allowed the interviewees to exemplify on particular points and to engage with the subject which increased the robustness of the data. Finally, another limitation to the research was that not all the potential interviewees who were invited to participate in the study were able to contribute. This meant that the anticipated breadth of interviewees was not attained.

6. Results and analysis

5.1. What are the key aims, and current priorities, for the management of public urban green spaces, and their associated ecosystem services, in Stockholm?

Results from the document analysis are shown in Table 2 below. The key documents used are indicated in the far-left column, and the key terms searched for are listed along the first row.

Table 2 - Frequency of key terms in documents

Document / Frequency of key terms	Green space / ecosystem services	Tool / valuation	Aims, priorities, and challenges							
			Climate, rainfall, flooding	Biodiversity, habitat, species	Social, recreation, community	Transport, accessibility	Densification	Multi-functional / multifunctionality	Ownership, responsibility	Green-washing, politic
Stockholm City Plan	59	18	131	30	210	299	3	5	13	4
Stockholm: A sustainably growing city	4	1	22	2	13	28	0	0	2	1
RUFS 2050	2	1	7	0	4	36	0	0	4	0
Sweden's Environmental Objectives	4	3	18	45	19	8	1	0	5	3
Building GI for Europe	17	1	10	44	15	7	0	4	0	1
Enhancing Europe's Natural Capital	15	4	16	25	14	2	0	1	0	0
Urban green spaces – a brief for action	131	4	3	10	65	8	0	0	7	2
Total:	232	32	207	156	340	388	4	10	31	11

Notes: Frequency includes mentions in titles but excludes mentions in references. The number of times that the key terms appear in the documents is indicated, and the total number of times the terms are mentioned in the last row of the table. The colours yellow and green highlight occasions where key terms were found in the documents between 11-50 times (indicated with a yellow colour), and over 50 times (indicated with a green colour).

5.1.1. Priorities for public urban green spaces

Green space, ecosystem services, and valuation tools

From the document analysis, together the terms 'green space' and 'ecosystem services' were mentioned a total of 232 times across the documents (see Table 2 above). Over half of these references were from the Urban green spaces – a brief for action document (WHO, 2017) and 59 came from Stockholm's City Plan (Stockholms Stad, 2018). The high number of references to 'green space' and 'ecosystem services' is expected as all the documents intend to provide guidance on planning for a sustainable future, with consideration of the natural environment in some form. For example, within the document Enhancing Europe's Natural Capital, 'ecosystem services' are referred to in the context of green space and green infrastructure: "When appropriate, such approaches use green infrastructure solutions, because they use biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to or mitigate the adverse effects of climate change" (European Commission, 2013a, p.4). Additionally, the term 'green space' was used frequently throughout the documents, for example in Urban green spaces – a brief for action the document stated: "Qualitative data compiled through interviews is helpful to explore the meaning of urban green spaces to an individual, and to understand personal preferences and concerns" (WHO, 2017, p.15). From this, it is understood that green space, and its associated ecosystem services, are a high priority to the Stockholm City Council, when considering that the topic is mentioned significantly from the municipal to the European level.

In contrast, Table 2 above shows that the terms 'tool' and 'valuation' were mentioned only 32 times across all the documents. The majority of these references were made in Stockholm's City Plan (Stockholms Stad, 2018) and these instances were not used in reference to public urban green space. Instead, as the document covers many different aspects of planning for the city, these phrases were mostly used in terms of using other tools for different uses. This has been noted, for example, in that the term was used in connection to the creation of community cohesion: "Public transport is an important tool in creating a more cohesive city" (Stockholms Stad, 2018, p.22). Therefore the use of tools for the valuation of green space, and its associated ecosystem services, is not necessarily a prioritised, nor a de-prioritised concern for the public urban green spaces of Stockholm.

Key aims, priorities, and challenges of interest

Assuming the frequency of key terms indicates an approximate extent of the discussions surrounding the related topics (Bryman, 2016), at first glance, the aims and priorities for Stockholm's public urban green space appear to be shared between concerns for 'climate', 'biodiversity and species', and 'transport and accessibility'. In contrast, the topics of 'multifunctionality', 'densification', 'green-washing and politics', and 'ownership and responsibility' were barely mentioned in the documents (see Table 2). The small number of times that these topics were mentioned suggests that they are perhaps not issues that are being given so much attention, or priority in relation to public urban green space in

Stockholm. The terms that were mentioned the most when totalled across all the documents, were ‘transport’ and ‘accessibility’. However, with 299 of these mentions coming from Stockholm’s City Plan, a key word search found that the majority of these references to ‘transport’ and ‘accessibility’ are not specifically related to public urban green spaces, and are related to other topics such as transport infrastructure within the city, and accessibility within and across the city districts. Only occasional instances found that the word ‘transport’ was being used in reference to public green space, for example: “South-west Bromma is well provided with parks and nature areas and the area is well served by public transport and other infrastructure, which is a resource for urban development” (Stockholms Stad, 2018, p.127). Similarly, the term ‘accessibility’ was seldom used in relation to public green space, but was on rare occasion, for example: “improve parks and nature areas so they offer more features and better accessibility” (Stockholms Stad, 2018, p.87).

Climate, biodiversity, and cultural services

The terms which were noted most frequently across all the documents were ‘social’, ‘recreation’, and ‘community’. These terms were mostly applied in relation to cultural ecosystem services which provide recreation and social opportunities, and facilitate community cohesion. For example: “The green pedestrian and cycle path network complements the city’s streets and public spaces, offering an alternative landscape for moving through the city. This is an important recreational asset to develop further, as many Stockholmers appreciate daily contact with the countryside, and children being able to move freely and safely through their home neighbourhood. Developing well-maintained green links to popular functions along well-used walking routes can enable green spaces to make an even greater contribution towards the cohesive city” (Stockholms Stad, 2018, p.23). Further, the term community was used often in relation to green space, for example in Stockholm: A sustainably growing city: “gardens become beautiful, looked after, safe and vibrant places that also offer a sense of community in the local area and clearly show ways of having a positive influence on the local environment” (Stockholms Stad, 2013, p.30).

Further, the terms ‘climate’, ‘rainfall’ and ‘flooding’ were mentioned a total of 207 times across all of the documents, and the high frequency of the terms indicate that the topic of climate mitigation, and the effects of climate change are of high importance in relation to the planning and management of Stockholm’s public urban green spaces. The majority of the total number of times that these terms were mentioned were from the Stockholm City Plan document. For example, “Climate impact must be mitigated as the city expands. The city needs to develop a network of green spaces and expanses of water that even out temperatures and increase flood resilience.” (Stockholms Stad, 2018, p.27). In comparison, the terms ‘biodiversity’, ‘habitat’ and ‘species’ were mentioned a total of 156 times with a fairly equal distribution across all the documents. In Sweden’s Environmental Objectives document the term ‘species’ was used almost 20 times, once in reference to the use of natural environments in protecting species: “Valuable natural areas are being protected and action plans are being drawn up to preserve our most threatened species” (Naturvårdsverket, 2018a, p.24). However, in RUFS 2050, the terms ‘biodiversity’, ‘habitat’ and ‘species’ were not used at all. In general, across the documents, these terms were mentioned much less than in comparison with 'social', 'recreation', and 'community', and 'climate', 'rainfall' and 'flooding', which indicates that the topic of biodiversity in relation to public urban green space is much less of a current priority for Stockholm.

Interview results

Interviewees were asked which aspects of green spaces or ecosystem services that they would suggest should be prioritised for immediate management within public urban green spaces owned by the Stockholm City Council within the municipality of Stockholm. The aspects mentioned included climate (change, mitigation, and adaptation), green connectivity for biodiversity, and cultural values and services. The overall views of the interviewees, for the prioritisation for public urban green spaces, was summarised succinctly by one who stated that, "the potential need in Swedish cities could be to protect and enhance urban green areas for biodiversity, green infrastructure, recreation, storm water management and climate regulation" (Landscape architect, Boverket). Another interviewee summarised that "biodiversity, recreation, and climate adaptation" are the most important issues for prioritising (Urban planning strategist, Stockholm City Council). However, along with these recommendations for prioritising certain aspects of green space, or ecosystem services, it was reiterated that: "the need for specific ecosystem services is always place specific" (Landscape architect, Boverket).

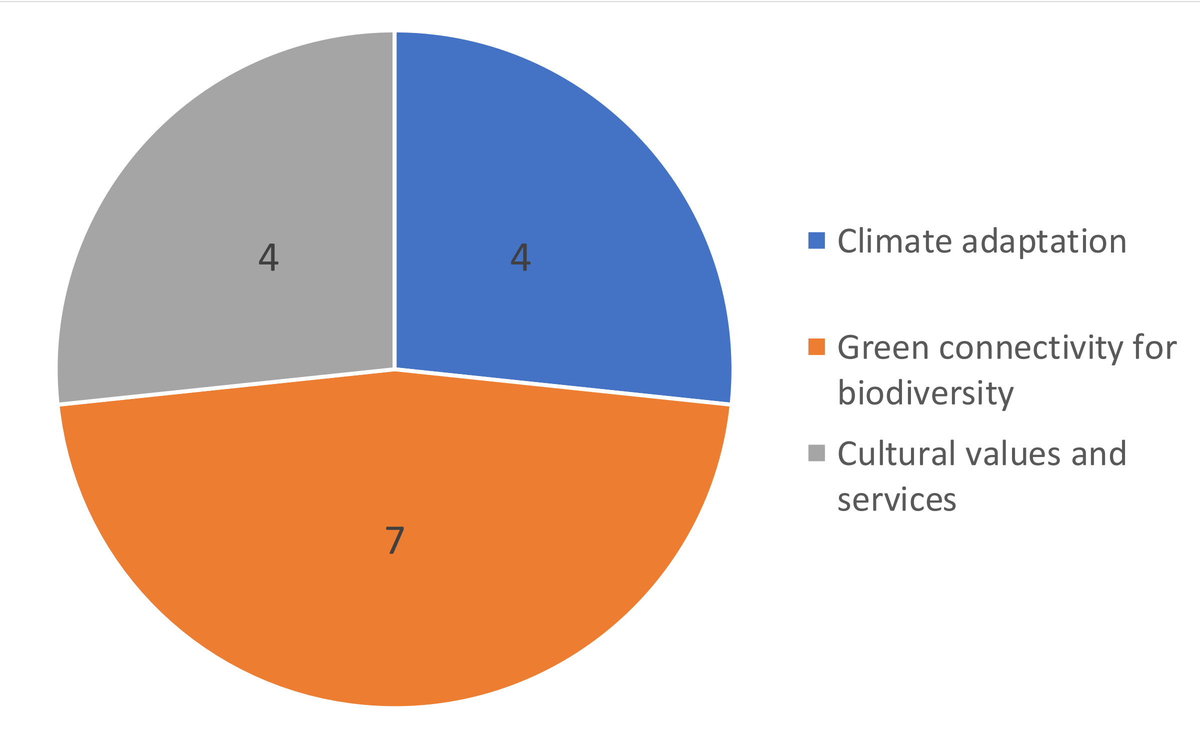

Figure 5 - Number of interviewees who suggested each aspect for prioritisation[6].

[6] The whole shows the total aspects discussed summed over all interviews.

As can be seen in Figure 5, the highest number of interviewees who suggested an aspect for prioritisation most often was seven, in relation to maintaining green connectivity for biodiversity. The other aspects recommended for prioritisation were both discussed in four interviews.

Climate change, climate mitigation, and climate adaptation

With reference to climate mitigation in general, one interviewee stated that “it’s definitely like the climate mitigation question is for one, maybe of the biggest [importance] when it comes to urban parks” (Landscape architect, Ekologigruppen). Concerning the need for climate adaptation, multiple interviewee’s comments were made with reference to heavy rainfall and flooding. One interviewee related it to current issues arising within their work, saying: “things that we are dealing a lot with right now is skyfall [heavy rainfall] and water management so I guess areas the ecosystem services that are connected to those are important” (Landscape architect, Stockholm City Council). Another interviewee stated that: “the demand to use the public spaces for downpour retention areas or heat wave adaptation measures is also really really important” (Ecosystem services specialist, Stockholm City Council). Further to this, another interviewee discussed the issue of climate mitigation in relation to how existing vegetation can support the creation of micro-climates and water management: “protecting like, existing vegetation to have something to work with when it comes to creating a better micro-climate … possibilities to support stormwater management, that that is a real huge question” (Landscape architect, Ekologigruppen). Additionally, they stated: “when you’re working especially with new parks, creating a good local climate, and some, and working with green space for climate mitigation is, I would say, the most important part” (Landscape architect, Ekologigruppen).

Another aspect relating to climate adaptation that interviewees discussed, were regulating ecosystem services. One interviewee stated that: “All of them that are energy saving are the most important ones. So water management is energy saving because we don’t have to use energy to manage water in the traditional way. Shading is also maybe even more important as an energy saving ecosystem service so just shading buildings, shading roads and pathways, and I would say it’s so much easier to just make room for and accept big trees in the streets, rather than greening all walls for example” (Consulting manager, SGRI). A similar concern for regulating ecosystem services was also raised by another interviewee who mentioned that there was consideration needed for the urban heat-island effect. An interviewee who referenced specifically: “flooding, rainfall and heat-island effect. That’s the two most important concerning the main issues in the climate adaptation” (Urban planning strategist, Stockholm City Council).

Green connectivity for biodiversity

As can be seen in Figure 5, multiple interviewees indicated that maintaining green network connectivity within urban areas, to support ecosystem services as well as biodiversity, is an essential aspect that should be prioritised for the management of public green spaces. One interviewee declared that, the "overall importance is biodiversity, since biodiversity is one of the key driving factors for other ecosystem services, but in terms of what is the most important on a political scale, it is biodiversity and it is climate adaptation" (Ecosystem services specialist, Stockholm City Council). Another indicated a similar line of thought, saying that "biodiversity is a prerequisite for the rest of the, all [ecosystem services]" and so recommended to prioritise, "services that biodiversity is a prerequisite for: those that we are focusing on right now are those with the heat and water" (Landscape architect, Stockholm City Council).

In terms of referring to the importance of green connectivity, for biodiversity, another interviewee explained: "One priority we have is the green infrastructure … and to have connections that is green infrastructure from the outside into the city and through the built-up areas and so on, so that's an important mission to us. And if we lose this network then we lose quite a lot of the qualities in the green areas" (Senior adviser, SEPA). This point was expanded in more depth by another interviewee who cautioned, "the key thing we normally miss is that we go to one area and we say 'ok, here in this place we can make a perfectly fine place for biodiversity, we can have many flowers for the pollinating insects, we can have some dead wood for mammals and birds', but when we do that, normally we just concentrate it in one place instead of thinking of bridging between these places in the city. So instead of just, … having a little plantation in a square, we should just focus on connecting existing parks ... So instead of creating … beautiful little islands in this grey desert, it would be much more effective, … to create beautiful thriving parks between the existing green spaces" (Consulting manager, SGRI). This concern was echoed by another interviewee who referred to Stockholm's green wedges when indicating the importance of "the green network within the city, the small parks, the green corridors, the possibility to spread for different species, apart from the very important green wedges, also put these demands on how should we make networks of green parks and green streets and city trees" (Ecosystem services specialist, Stockholm City Council).

The recommendation for prioritising green connectivity, for the benefit of biodiversity, was also echoed by another interviewee who described and explained the benefits of using the abilities of public urban green spaces to contribute to supporting green connectivity and biodiversity. They stated: "urban parks are extremely important for biodiversity, and especially the urban woodlands or urban forests because they're so old … that's where you actually do find, like, very old and stable habitats for some species, like old oak trees" (Landscape architect, Ekologigrupen). This reference to specific woodland and tree habitats was referred to by another interviewee: "in the 1990's we identified that the biodiversity are depending on this structure, that we have this structure, and not divided green areas, and we also identified that the biodiversity in Stockholm the most important nature areas was this old trees, and woods, and wetlands and beaches and so on" (Urban planning strategist, Stockholm City Council).

Cultural values and services

Cultural ecosystem services and values, such as recreation services and aspects of green spaces which generate cultural contributions, were recommended to be prioritised for the future management of public urban green spaces. Mentioned examples included: playgrounds, health, well-being, recreation, proximity to green space. One interviewee referred to the importance of cultural values attained through the city's public green spaces by saying: "the social part is one of the most important for the city of course, it needs to be functioning" (Landscape architect, Stockholm City Council). The understanding that aspects of green space can influence human health, and the growing need to prioritise a focus on this were mentioned: "I think to most of us, we have seen the importance of ecosystem services for providing health and wellbeing for people and outdoor recreation, and just the nearness of green space, and space where you can walk, and just listen to birds, and look at a part of nature, even if it's a park" (Senior adviser, SEPA). This sentiment was echoed by another interviewee who reflected on the "soft values for people … recreational values, cultural values, playgrounds for children and such" (Consulting manager, SGRI).

5.2. What are the key challenges for the management of public urban green space owned by the Stockholm City Council?

The results of the interview questions concerning the key challenges that face public urban green spaces in Stockholm, are listed in brief below. Figure 6 indicates the number of interviewees who mentioned these topics within the interviews, and is complemented with interview quotations and explanatory text.

Key challenges facing public urban green spaces:

- Urban densification
- Multifunctionality
- Ownership, tools, and resources
- Political aims and green-washing
- Defining concepts: ecosystem services and green space

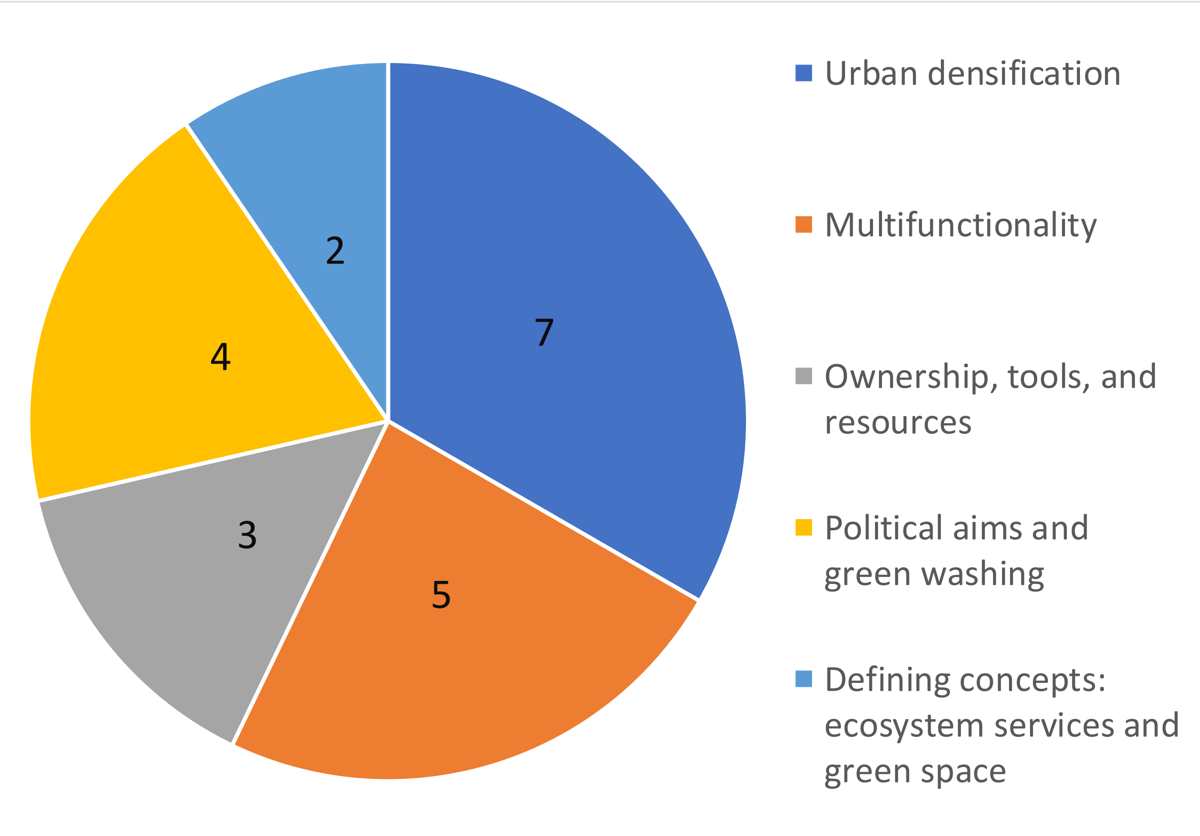

Figure 6 - Number of interviewees who mentioned each challenge facing public urban green spaces.

Figure 6 indicates the number of interviewees that mentioned each key challenge. The aspect that was mentioned by the most interviewees was urban densification, with seven interviewees choosing to discuss this as a key challenge for public urban green space in Stockholm. Following closely behind was the aspect of multifunctionality which was discussed by five interviewees, and referenced as a challenge in terms of managing the large variety of expectations and demands that are placed on public urban green spaces. Concerns regarding political aims and greenwashing, in terms of ensuring the longevity of projects, were mentioned by interviewees four times. Aspects mentioned the least included the challenge surrounding a lack of definition of key concepts such as 'ecosystem services' and 'green space', and the complexities surrounding ownership. These were only discussed in detail in two, and three interviews respectively.

Urban densification

Concerning urban densification, interviewees indicated that this was a key challenge due to the growing population of the city, and thus the increasing pressures to build housing and infrastructure: "Stockholm's inhabitant numbers are rapidly growing and the demand for housing and apartments are still high" (Ecosystem services specialist, Stockholm City Council). Another consideration was that there is no unanimous agreement on how much densification within a city is acceptable, whilst maintaining satisfactory living standards: "it's really good to consider how dense that it should be and still be a good social place to live" (Urban planning strategist, Stockholm City Council). In relation to unknown limits of densification, interviewees also highlighted the lack of knowledge surrounding how much physical space is required for living activities. For instance, "living infrastructure takes a lot of space, and makes it more difficult, I mean if you want to have functional ecosystem services you need space for it, so I think that's the key problem. We don't really know exactly how much space we do need" (Landscape architect, Stockholm City Council). Moreover, urban densification promoted concerns for the city's green network, in terms of structure and connectivity and biodiversity. An interviewee stated that: "when it comes to the city development, the urban and new houses that are being built, we have both the problem with keeping the green structure, as we have a lot of biodiversity, as we have a lot of old woods and also small areas with old trees" (Urban planning strategist, Stockholm City Council). This matter is of key concern due to the direct relation that the size and location of green spaces have to their ability to provide certain ecosystem services, such as the provision of habitats for migrating species (MacArthur and Wilson, 2016; Andren, 1997).

Multifunctionality

Concerns regarding the multifunctionality of public urban green spaces, and the ability of green spaces to be multifunctional were raised frequently throughout the interviews. It was considered to be a key challenge as it could be assumed to be a solution for all the demands placed on green spaces. Interviewees suggested that the expectation that public urban green spaces should be multifunctional was a challenge in itself, and that the variety of demands placed on these spaces was problematic. For instance, it was implied that the ability of a space to be multifunctional is directly related to the physical size of the area: "we try to plan for multifunctional spaces so they will be green, they don't have to do everything, but if they are too small …" (Landscape architect, Stockholm City Council). This infers that smaller green spaces might not be able to fulfil certain functions to the same extent that larger spaces might be able to. Additionally, it was proposed that multifunctionality is perhaps not always necessary or possible, and that instead it is best to "choose your focus, and when the pressure is high, I think it's not possible to maintain the multifunctionality" (Senior adviser, SEPA). Specific difficulties in relation to managing the multifunctionality of public urban green spaces are introduced and expanded upon in chapter 5.2.2. Multifunctionality of public urban green spaces: key difficulties.

Ownership, tools, and resources

Concerns of ownership, tools, and resources were also mentioned within the interviews, as it was indicated that these factors can influence the management of green spaces, and the abilities of the responsible persons to manage the spaces. For example, it was said that "the city [council] does not have accessibility to all parts. Lots of the parts of the city is private, and private gardens which could form an important network for, for instance, biodiversity, this we need to address in another way than demands – own actions, more about communication and inspiration" (Ecosystem services specialist, Stockholm City Council). This concern that private green spaces influence the overall green network within the city is a key point; the abilities of public urban green space, such as its ability to contribute to green network connectivity, could be viewed differently when put into context with privately owned green spaces in Stockholm. Further, regarding the tools and resources used, it was said that "there are so many demands to balance, and that would call for this measurement and evaluation, and people evaluate this in the process but it's not being clear how this [evaluation] is being made" (Ecosystem services specialist, Stockholm City Council). Further to this, the lack of public resources for management was raised as an issue as: "it's no doubt that most important actually is that the city districts that are responsible for the management they get and have a lack of resources for the management" (Urban planning strategist, Stockholm City Council). It is thus understood that the transparency of measuring and evaluating the demands on green spaces, and the ability of the green spaces to fulfil these demands, is a key challenge facing public urban green spaces.

Political aims and green-washing

Political aims and green-washing were raised as key challenges for the management of public urban green spaces. It was stated that "one of the measures and main targets for the politicians is to build a lot of apartments" (Ecosystem services specialist, Stockholm City Council). These political aims to meet the growing demands for housing and infrastructure put pressure on politicians to focus on using available space for urban development. At the same time, there is concern that legislation to protect the qualities of green space, and its associated ecosystem services within public green spaces, is lacking. It was said that there is a "lack of tools to ensure protection of existing ecosystem services within public green spaces.

The legislation (planning and building act) in Sweden, is very weak when it comes to protect and manage public urban green space. In the detailed regulation plan a park can be planned as a park, but it can change over time and greenery and trees can easily be removed in order to enhance safety or manage increased societal use" (Landscape architect, Boverket).

There were concerns regarding the ability to accurately compensate for the development of green spaces and lost or depleted ecosystem services, along with concerns that of green-washing. It was said that despite all attempts to compensate for development on green spaces: "when you exploit an area, when you do that, when you remove green spaces by exploiting an area then there won't be a way to compensate really. Depending on the area of course." (Consulting manager, SGRI). This was echoed by another interviewee who explained that "the challenge is to not allow yourself to be too focused on the ecosystem services as a selling point, as a term, or as a concept, you should be in each and every project, specific about what you actually want the project to be" (Landscape architect, Ekologigruppen). Regarding green-washing, interviewees stated: "we're definitely always on the edge of green-washing when we talk about ecosystem services. We should always keep very clear what we're talking about, and be very practical about what kind of projects or measures that we're talking about, because it's so easy to just say that if we're working with ecosystem services, but then making it mean something for real" (Landscape architect, Ekologigruppen). Similarly, another highlighted the same concern, saying, "even though everyone has very good intentions, there is some form of greenwash involved I would say" (Consulting manager, SGRI). These quotes illustrate some of the interviewee's opinions regarding green-washing, inferring that it can occur both intentionally and unintentionally.

Defining concepts: ecosystem services and green space

Lastly, a challenge facing the management and work surrounding public urban green spaces that was mentioned the least number of times within the interviews was the concept of 'ecosystem services', and the reluctance to define the term 'green space'. It was said that "when it comes to planning, ecosystem services is such a broad concept, it's an important concept, and I think it's useful that it is broad. It does encompass a lot of the different questions that we need to work [with]. But things can kind of be forgotten along the way and there are always also conflicts of interest within the ecosystem services umbrella" (Landscape architect, Ekologigruppen). Further to this, the potential for the concept to be used in anthropocentric terms was also raised: "that's the whole beauty with the ecosystem service concept. It conceptualises how nature can solve things for people. Putting it that way, it's a very anthropocentric perspective" (Landscape architect, Ekologigruppen). Further to this, referencing the longevity of greening projects for public urban spaces, an interviewee noted that "there's a lot of talk about it, ecosystem services, but no one really knows how to work with it in practice for real, for a long time, l like it's easy to have a plan for a specific project, how we should support ecosystem services, in this way, but to make it last, and to work with it over time I think that's a real challenge" (Landscape architect, Ekologigruppen). This concern for the durability of work concerning ecosystem services and green spaces links to the uncertainties surrounding the term. In addition to the term 'ecosystem services', the inability, or reluctance to define ‘green space’ was highlighted as a potential challenge to working with public spaces in cities: “we have a lot of building going on and also on green space, but sometimes you might not want to talk about it as green space” (Landscape architect, Ekologigruppen). The reluctance of wanting to define ‘green space’ might be due to the fact that gaining planning permission and conducting environmental surveys could potentially be more complex depending on the categorisation of the land.

5.2.1. Multifunctionality as a challenge for public urban green spaces

As mentioned earlier in 5.2., multifunctionality is considered to be a key challenge for public urban green spaces in Stockholm. The results regarding the difficulties associated with the multifunctionality of public urban green spaces in Stockholm, are listed in brief below. Figure 7 indicates the number of interviewees that mentioned these aspects within the interviews, and is complemented with interview quotations and explanatory text on the pages below.

Key issues regarding the multifunctionality of public urban green spaces:

- Perceived as a panacea
- Recreation and biodiversity
- Transport and accessibility
- Communication and responsibility

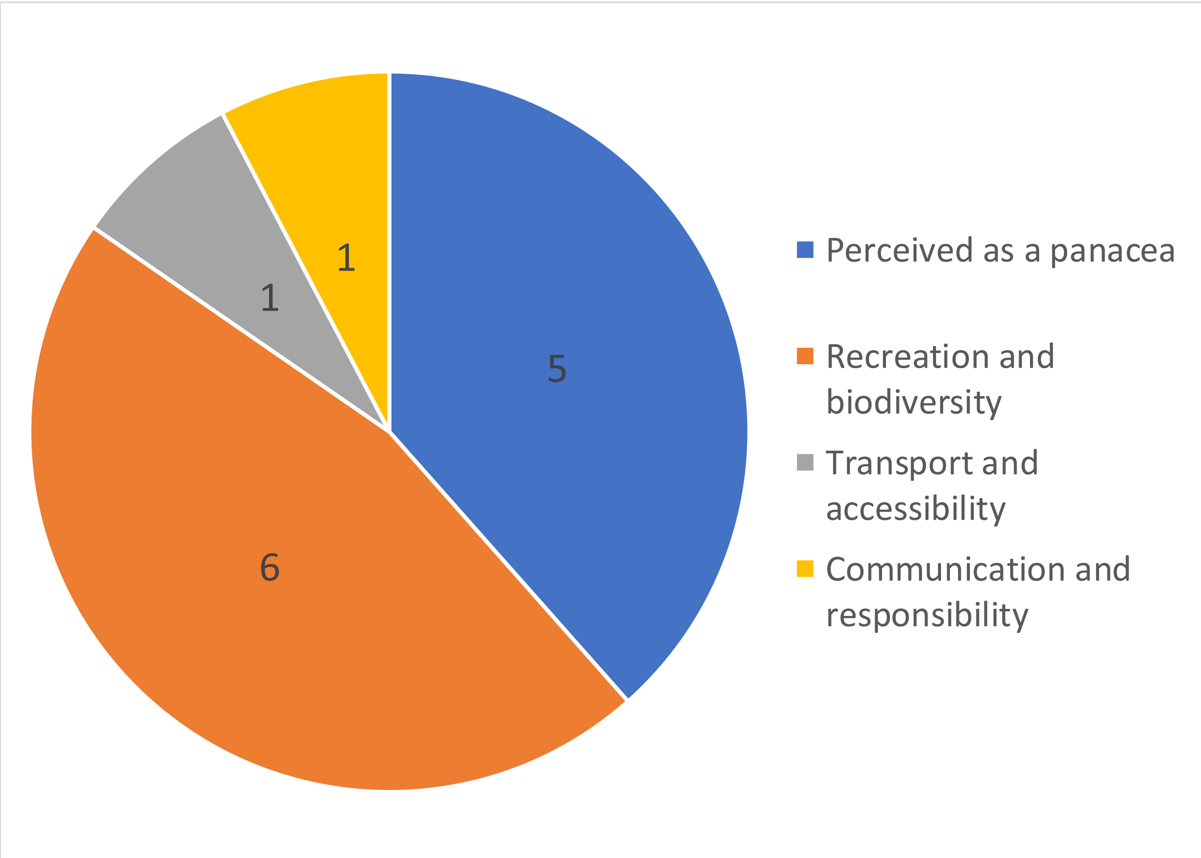

Figure 7 - Number of interviewees who mentioned each issue regarding the multifunctionality of public urban green spaces.

The key difficulties of multifunctionality which were highlighted during the interviews are summarised in the list above. In Figure 7 above, the graph indicates the number of times that the key issues relating to multifunctionality, were mentioned within the interviews. The aspects that were mentioned most often were the complications that arise between providing opportunities both for recreation and biodiversity, as well as concerns that multifunctionality can be perceived as a panacea. The other issues that were mentioned were only discussed once each. These included the complexities associated with transport, accessibility, communication and responsibility.

Perceived as a panacea

The concept of multifunctional urban green spaces may perpetuate the idea that by creating multifunctionality, it is possible to meet all the demands placed on green spaces, and to solve all the problems relating to multiple needs with a single solution. It was explained that some aspects of green spaces naturally have multifunctional qualities: “some structures in nature are multifunctional by default, like, a big tree, can be so many things, and lots of big trees of course give a lot of values, both the recreation and somewhat the management, and climate mitigation” (Landscape architect, Ekologigruppen). However, despite this, there is a concern to “not let multifunctionality become like this solution to all kinds of problems, because well there are conflicts between different kinds of ecosystem services as we already mentioned, and there’s always like kind of a limit in any kind of space, like how many functions you actually can have” (Landscape architect, Ekologigruppen).

The notion that there can be natural limits to the number of functions that might realistically be expected from some green spaces, was expanded on when the same interviewee discussed how green spaces with singular functions can be just as important as those with multiple: “there are also places that can be very important functional spaces for example, next to a railroad, if there is a big potential to manage stormwater, then it might not be a very nice place to visit, but as a stormwater management area it’s very very important, so then it becomes, then you can’t say it becomes less important than a multifunctional area, only because it has one function. So that I would say is a management issue, to not only focus on the multifunctionality but also the actual singular functions in ecosystem services … wanting an area to solve everything in practice everybody understand that that’s not going to happen” (Landscape architect, Ekologigruppen). This was expanded on, with the concern that expectations of green spaces to be extremely multifunctional can be unrealistic, and risk the quality of the services provided: “when we start to want to add more and more and more and more, that’s not really functional in practice or might even work against the whole idea of something being very functional” (Landscape architect, Ekologigruppen).

Conversely, one interviewee felt that the “increased expectations [on green spaces] lead to a high technical capacity in managing these areas, for example, storm water retention needs methods of cleaning water” (Landscape architect, Boverket). This suggests that areas such as urban water management, can benefit from new infrastructural technological solutions produced due to the pressures on, and expectations of green spaces to be multifunctional.

Recreation and biodiversity

With multifunctionality in mind, there was considerable concern about space for recreational needs, specifically in terms of a lack of children's playgrounds within green spaces. Interviewees stated: "we don't plan enough space for play" (Landscape architect, Stockholm City Council), and "they are really complaining a lot about a lack of places for children to play in" and that there is a risk of "a queue to the playgrounds" developing (Urban planning strategist, Stockholm City Council). It was also suggested that the expectation that green spaces should be multifunctional was unrealistic, and that maintaining real natural greenery and providing recreation opportunities simultaneously is not always feasible as recreation can have indirect harmful effects on flora, fauna, and biodiversity (Pickering and Hill, 2007; Larson et al., 2016). Concerning the impact on natural greenery within public spaces, due to intense recreational use, it was said that "it's a risk that we can't have any natural grass, only plastic, and that … there is no grasses only dust" (Urban planning strategist, Stockholm City Council). Similarly to this view, another interviewee explained that a key difficulty faced for the management of public green space is that "if you have a lawn, and you have too many people on the lawn, it won't be a lawn anymore, it will just be dirt and that's a problem for children's space and we don't have enough space for kids to play, in the inner city" (Landscape architect, Stockholm City Council). Along a similar vein, another interviewee said: "I saw it this week, with a swimming beach … where it's very suitable for small children, but now they need to expand it as it's very popular, and so they have to cut a lot of trees" (Urban planning strategist, Stockholm City Council).

However, in contrast it was also stated that, regarding the dynamics between recreational needs and biodiversity: "we have almost never a conflict, we can make playgrounds under the trees, and so we're very lucky there, I have realised that there's not a conflict" (Urban planning strategist, Stockholm City Council). Furthermore, one interviewee explained that "a green space developed for, and with recreation in mind can be a very good place for biodiversity, if you plan it, in a good way, but it doesn't have to be". They followed this by indicating that "sometimes like the measures that we do to support biodiversity, for example, putting out dead trees, or like having parts of parks being allowed to grow more lusciously or whatever you can call it to have insects and flowers wanting to be there, can be perceived as not well managed for people that are there, or there also can be a conflict between safety and biodiversity because biodiversity wants it dirty, people want it clean" (Landscape architect, Ekologigruppen).

Another factor relating to managing multifunctional elements of public urban green spaces, including the need for recreation and biodiversity, was the concern that there are increasingly fewer opportunities for recreational and cultural experiences "where you get at least the impression of being in nature" (Consulting manager, SGRI). It was suggested that "even though we fill a street full of trees, … we make the trees thrive and they will grow really big and they will service many different ecosystem services during their lifespan, but can they give the same recreational value as a park where you get at least the impression of being in nature, even though maybe it's not true nature, but at least you get the impression, and that recreational value I think is really important for us" (Consulting manager, SGRI). The interviewee added to this by referring to the fact that the extent to which greenery makes a difference to human health is unknown: "we talk a lot about just seeing a tree outside your window will make you feel better and less anxious, or you recover faster from surgery for example, but I haven't seen any figures like trying to measure the difference between seeing a tree or seeing a park. I think there is a difference there, it's so important too" (Consulting manager, SGRI).

In terms of addressing support for local flora and fauna, and for ecosystem services aside from cultural and recreational values, there were concerns regarding the abilities of public green spaces to provide these services which are supported by biodiversity, when there are increasing densification pressures. The "ongoing growth of the city ongoing demands of more dense cities" and "the need for the very finer network of ecosystem services driven by biodiversity", were both referenced in terms of having influence over each other (Ecosystem services specialist, Stockholm City Council). Due to increasing urban population growth, and thus growing needs for outdoor recreation opportunities, it was observed that it is becoming increasingly difficult to "maintain the green-blue network in Stockholm … at the same time as the city is rapidly growing" (Ecosystem services specialist, Stockholm City Council).

Transport and accessibility

With regards to public urban green spaces in the city, the topics of transport and accessibility were mentioned: "parking spaces, bike lanes, open green areas, grasslands where people can just chill out and do whatever they do, recreational purposes, accessibility, you need to address people with disabilities which is a demand for city construction" (Ecosystem services specialist, Stockholm City Council). These comments concerning accessibility to and within public green spaces highlight the need for conversations about accessibility, for a variety of different physical and mental health needs, to be prioritised.

Communication and responsibility

When discussing different aspects of multifunctionality within public green spaces, the concepts of responsibility and clear communication were raised as key difficulties. Interviewees expressed the complex nature of management, and explained that in part it is because "the responsibility is also shared between different stakeholders, different offices and companies within the municipality such as technical offices, water authorities, park offices, cultural and leisure offices" (Landscape architect, Boverket). Other interviewees appeared to agree about these complexities, saying for example, "there's definitely a long chain of people involved in the actual management that has to be like secured from the bottom up, that everybody knows what the, for example, a city the size of Stockholm guidelines on ecosystem services, what that means in practice" (Landscape architect, Ekologigruppen).

Furthermore, "we have also all the issues with new public management kind of society we live in that we have entrepreneurs and you know, you're hiring people, and they're hiring people, and who actually gets out there and who mows the grass might not be anyone who have ever heard about the cities guidelines on multifunctionality, because, how you actually cut the grass, or plant the flowers, or take care of the trees, is very important for how the ecosystem services are working and to have the idea of how you supposed to do things, to trickle down through the whole chain of people, down to the ones that actually take care of a place is a challenge, and I would say, that a lot of people working as gardeners, for example, are extremely well aware of how you could take care of a place to make it a better place for biodiversity for example. The question is, did the ones who wrote the contract and the ones that wrote the like, the backbone for the contract for the entrepreneurs, did they understand it?" (Landscape architect, Ekologigruppen). This quote indicates a lack of connection between policy and practice.

5.3. Key discussions concerning tools for valuing aspects of green space, and ecosystem services provided by, Stockholm's public urban green space

The interview results suggest that tool development and cooperation, and a growing interest in valuation tools are the most significant discussion points surrounding the use of valuation tools for public urban green spaces in Stockholm. The key points resulting from the discussions about using valuation tools, are listed in brief below. Figure 8 indicates the number of interviewees that mentioned these topics, and is complemented with interview quotations and explanatory text on the pages below.

Key discussions concerning valuation tools:

- Tool development and cooperation
- Growing interest in valuation tools
- Project dependent: unique situations
- Accessibility, time, and cost
- Accuracy and communication

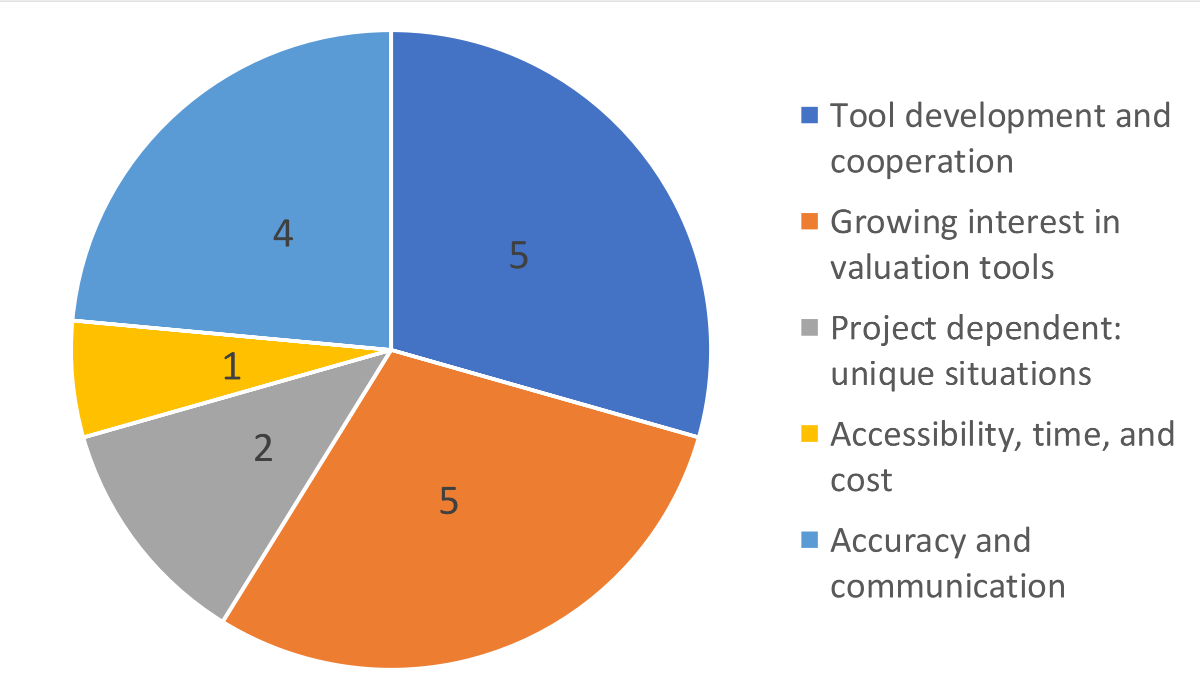

Figure 8 – Number of interviewees who mentioned the topics concerning valuation tools.

Tool development and cooperation

The further development of tools, and the need for future cooperation was one of the most frequently mentioned points when interviewees discussed key elements that they considered concerning tools for valuing qualities of green spaces. For example, interviewees indicated the need for a new system whereby tools could be easily identified and located for use in projects, and chosen according to individual project needs.

One interviewee spoke of their organisations past attempts at trying to create a catalogue documenting tools, and guidelines for these: "we tried to produce reports that showed the variety of different tools for valuation, for instance, and guidelines for how to do an economic evaluation and a little bit of … the ups and downs of different tools, and what are the problems doing it [are]" (Senior adviser, SEPA). They went on to say that this attempt was unsuccessful, and that many other organisations were trying to do the same. Though, they did reference a report which the organisation had produced, which shows: "Ten different examples with different kinds of evaluation methods and in different areas. It was published I think five or six years ago, and it was produced by consultants" (Senior adviser, SEPA). Similarly, another interviewee explained their attempts at meeting this need, and why they feel it is necessary: "We need more tools, and we need to combine tools, so we need to find out more about what's out there, and we weren't satisfied with the tools that we had, that we knew about, so we wanted to get an overview, and we also wanted to find out if is it possible that we can develop if we see what's out there, can we say 'those tools are really not useful but these were great', and 'these we'll be able to combine' so that's what we wanted to do" (Landscape architect, White Architects).

Another interviewee echoed the sentiment that organised information regarding valuation tools is needed: "I hope, and I think that there will be a development in the coming years, because up till now there has been a variety of different tools, and models and efforts to do this, and I'm looking forward to some sort of standardisation" (Ecosystem services specialist, Stockholm City Council). Evidently, despite the great need, and several parallel attempts to produce a tool catalogue, this is still an unanswered need. Other interviewees discussed the general development of valuation tools, and how more research into what is required from these tools, is needed: "We really need to be able to understand what kind of tools we need, we need to clarify those things for every tool we use and develop" (Landscape architect, White Architects). Additionally, other participants were concerned about the lack of development of tools for all aspects of green space, and that the valuation of some types of ecosystem services weren't being prioritised. For example, concerning the development of tools to value cultural ecosystem services, an interviewee summarised that, "there's still a need for other evaluation, such as, cultural ecosystem services are never measured in that way" (Consulting manager, SGRI).

Concerning cooperation, for the benefit of public urban green spaces in Stockholm, one interviewee noted that: "With the different departments, there is an urge to work together. At the same time, we have very different tasks and driving forces from different administrations. So it's very much about cooperation, but also about having very practical tools to use with. And sometimes there is a clash between the environment and health administration, and the other development, but that's our task, to help to do the city better, in every way, and we don't agree all the time of course, but we try to cooperate as much as we can" (Ecosystem services specialist, Stockholm City Council).

The concerns and arguments for cooperation and inclusion, for the benefit of public urban green spaces, were echoed by an interviewee who indicated the importance of stakeholder participation when using tools, to produce better results. When discussing the use of valuation tools, they said: “If it’s done within a collaboration between different competences, the result always gets better … you can find some different competences that is needed for different tools … a mixture or a teamwork between different competences, and also different people should be involved to do it as good as it can be. I mean, I could use it as a landscape architect … but I think that the result will be so much better, or I don’t think, it *will* be so much better if I also include my colleagues that are ecologists and cultural geographers” (Landscape architect, White Architects). The interviewee went on to discuss this further, saying: “So that’s the interesting thing, you know, whatever competence you have, or education or so on, we can all gather around this, these questions about ecosystem services, so it’s really a key, it’s so strange that [ecosystem services is] “new” because it’s really the key for sustainable cities in all matters, and it’s not really hard or expensive or anything, so hopefully it will be spread so we can also build this” (Landscape architect, White Architects).

Along a similar vein of requiring cooperation, one interviewee spoke of the ability to share knowledge through translating tools: “If Germany hadn’t translated their tool to English, we wouldn’t be able to have it in Swedish today, so of course English is a great language for sharing so I think that the most standard tools that we have and use it would be great if they could be translated into English so we can share with other countries, and as I said there need to be fundings, there need to be collaborations” (Landscape architect, White Architects).

Growing interest in valuation tools

The growing interest in valuation tools was one of the most frequently mentioned points when interviewees discussed key elements that they considered regarding tools for valuing qualities of green spaces. For example, one interviewee spoke of the interest in the tool catalogue they were creating: “since I started working with [valuation tools for ecosystem services] a lot of people contacted me and said ‘we’re really waiting for this toolbox because we need it now!’ so there is a frustration out there that as I said, people organisations and municipalities, they know they need building companies, they know they need to work with this, as sustainable development, but they don’t know how, and they need help. So that’s our goal with this toolbox, to be able to help, to be able to develop more sustainable cities” (Landscape architect, White Architects).

Another interviewee also referenced this growing interest in valuation tools, saying: “There is a variety of tools and there is emerging interest of evaluating monitoring the effect of different so to say nature-based solutions, whether they are made by nature itself or made by them so to mimic this” (Ecosystem services specialist, Stockholm City Council). Despite this growing interest in tools, it was noted that at least some departments within the Stockholm City Council do not use any specific tools for the valuation of their public green spaces: "I don’t think we use any specific tools, no. I think if it comes to some projects, we maybe contact ecologist firms working with these questions … So we don’t use any, no I can say, we don’t have a tool for how to work with green spaces" (Landscape architect, Stockholm City Council). This information should be noted when considering that the Stockholm City Council may want to use valuation tools in the future, and if so, some departments would be starting with very limited previous knowledge of these types of tools.

One interviewee discussed how the way that tools are presented to clients can really affect their interest in using them. For example, they explained how when results from the use of tools that result in numerical values, such as the Green Space Factor, clients can be more motivated and show more interest in using the tools. The interviewee mused that this might be due to the ability of organisations to use numerical results as a method of demonstrating their capabilities against strong competition: "I've come to realise that a lot of people are scared of numbers, or extremely respectful of numbers … that Green Space Factor really is a powerful tool because if you say that this area is a 5 and that area is a 10, then everybody goes 'oh but we want a 10 area, how can we get there?' It gets people going, in a way, even though in practice it's all about how much of our resources do we want to allocate to providing green space or ecosystem services solutions" (Landscape architect, Ekologigruppen). They expanded on this, saying: "Green Space Factor is a very important, powerful tool to get people talking about how much green space can we provide within a certain area, how can we become better than our neighbours? The competitive side is always good to kind of work with when it comes to municipalities, or when it comes to private builders, everyone wants to be the best, in a cheap and easy way of course, but still want to be best, so still that's a good tool" (Landscape architect, Ekologigruppen).

Another interviewee touched on the same topic, discussing the growing interest in using tools which provide numerical results: "being able to put numbers on [the benefits of green space and ecosystem services], it just makes it so much easier to communicate, and maybe that's the reason we're not so good at calculating the cultural ecosystem services because out of transition, that is not an important value: The important value is, 'can we save money?', you know, 'can we make money?'" (Consulting manager, SGRI). However, despite this growing interest in using valuation tools, one interviewee referred to the difficulty of defining what counts as a tool. They stated: "it's always a struggle for understanding what a tool really is" (Landscape architect, Ekologigruppen). This reveals that though many professionals are interested in using tools, and support the growing interest in using them, there are concerns regarding basic issues such as what instruments and methods should be incorporated within the definition of a valuation tool.

Project dependent: Unique situations

Another key topic that was raised twice during the interviews was that the choice of tools to use for valuing aspects of green space were very project dependent, and unique to different situations. One interviewee stated this clearly: "It depends on the projects. We work with projects also in different scales, we work in regional, municipality, planning, with architects, with certain places, like housing, or parks, squares, streets, so because of that, we use different tools depending on the projects" (Landscape architect, White Architects). Further to this, they specified that: “to be able to use or to be able to succeed with ecosystem services you need to find the right tool for the different projects, different schemes, different phases” (Landscape architect, White Architects). A second interviewee echoed this sentiment, saying: “When it comes to ecosystem mapping … we always kind of have to change it a little bit when it comes to different projects” (Landscape architect, Ekologigruppen). This indicates how, despite locating appropriate tools to value an ecosystem service or green space aspect, the tools themselves might need to be used differently, be flexible, or be tailored to situations.

Accessibility, time, and cost

The concerns of accessibility, time, and cost were discussed in detail by one interviewee who stated that: “the time and cost is a vital part” (Ecosystem services specialist, Stockholm City Council) when noting aspects to give consideration when choosing tools to use for the valuation of aspects of green spaces and ecosystem services.

Accuracy and communication

The topic of accuracy and communication was raised during the interviews, with interviewees citing concerns regarding accuracy of valuation tools, and how they are used to communicate the values of green spaces and ecosystem services. For instance, one interviewee commented on the difficulties and complexities surrounding numerical and monetary valuations: “when you come to monetary valuing of ecosystem services you get lost really really fast, because it’s extremely hard, it’s extremely interesting and important but putting a value, monetary values on these things are impossible I would say” (Landscape architect, Ekologigruppen) and “It doesn’t necessarily say anything about the quality … of the trees or the quality of flora” (Landscape architect, Ekologigruppen). They continued this thought concerning numerical valuation by referring to the tool i-tree, saying: “… and the very strict formal tools like, like i-tree for example I would say is the exact same thing. I-tree is powerful because it gives out a numerical value but there’s so many like loop-holes, or things that can go wrong in a calculation, so things are may overly simplified, in a calculation, but as soon as we have a number, you can open up some doors” (Landscape architect, Ekologigruppen).

Another interviewee expressed similar concerns, saying: “there are so many different kinds of evaluation techniques and people use them in a way that is, to my belief, is not very intelligent, and they sometimes tend to just add figures from different methods and some of them just virtual figures, how there are figures from real market values and so on, and it can look quite astonishing when you say that this little meadow is worth 55 billion Swedish crowns, but when you look at what is the background of these figures, sometimes it’s well, excuse me, it’s nonsense, so you have to be quite careful … when is it important to do a … qualitative, quantitative or a monetary evaluation because you can’t mix them without getting in trouble” (Senior adviser, SEPA). They expanded on this by mentioning the current situation that the Stockholm City Council finds itself in, regarding the valuation of public urban green spaces: “Some other municipalities have consultants that try to make this kind of ecosystem valuations for the whole municipalities, but I don't know if Stockholm has made something like that, I think it's a bit too big and too complicated" (Senior adviser, SEPA).

Alternatively, some interviewees spoke of the benefits of numerical and monetary valuations, citing the ability they provide for professionals when wanting to convince clients of the benefits of green space and ecosystem services: "That's the main way it is used, to influence the decision-makers, to make better decisions, to invest in green. Because for us working with it, for us it's so clear, all the benefits of the trees and it's so vivid, and you see it, just by walking around on the courtyard" (Consulting manager, SGRI). This type of thinking was echoed by another interviewee who talked about the use of the concept of ecosystem services as a communication tool in themselves. They said: "It's harder to understand for people that don't work as landscape architects or have the competence, so we found exactly this, that if we talk about ecosystem services then we can talk together … talk with politicians about it, and with people in different organisations about it, it was like a neutral communication tool that we found really useful to highlight these questions [of valuation]" (Landscape architect, White Architects).

Further, one interviewee explained the importance on not relying too heavily on one type of valuation tool, no matter how accurate it is. They expressed the need to use tools in cooperation, in order to communicate results that are more representative of reality. They said: "On the other hand, the Green Space Factor model, is a model, it's an excel sheet, you put in different kinds of areas and you get out a quote. It doesn't necessarily say everything about the quality, and when we talk about the public space and how people are using a specific space, it's so much about things that are extremely hard to measure so just saying that, 'oh we have a log here, it gives us 5 points and we have two trees so that's 10 points' it doesn't say anything about the quality of the trees or the quality of flora, if people want to go there. Is it a good place to go? Is it strategically situated in the urban fabric? No. So you kind of have to have, that's like the main reason why you have to have different kinds of tools at different levels of planning" (Landscape architect, Ekologigruppen).

In terms of communication, and the ability to share accurate information about the wider use for valuation tools, language was raised an important aspect which influenced one's ability to explain information. For example, one interviewee explained that when using some valuation tools, it was important to explain how they can assist in the wider context of connecting green spaces: "I just call that connectivity, and that's a word, we don't even have that in Swedish – we just made it up – 'connectivitet' – it's pretty much like, it's not a common word, so I only have a few colleagues using that word, 'connectivitet'. So just by using that word and explaining it, it can make quite a big difference I could say, because we don't think so much in those directions" (Consulting manager, SGRI).

5.4. What are the information gaps that exist in relation to public urban green space?

Interview results indicated that there were significant information gaps, or rather, elements to consider for the future development and research surrounding public urban green spaces and their management in the context of urban planning. The list below indicates the topics that were raised in association with questions concerning potential information gaps. Figure 9 below indicates the number of interviewees that raised these topics.

Topics raised:

- Communication and transferability
- Mapping cultural services
- Data accessibility

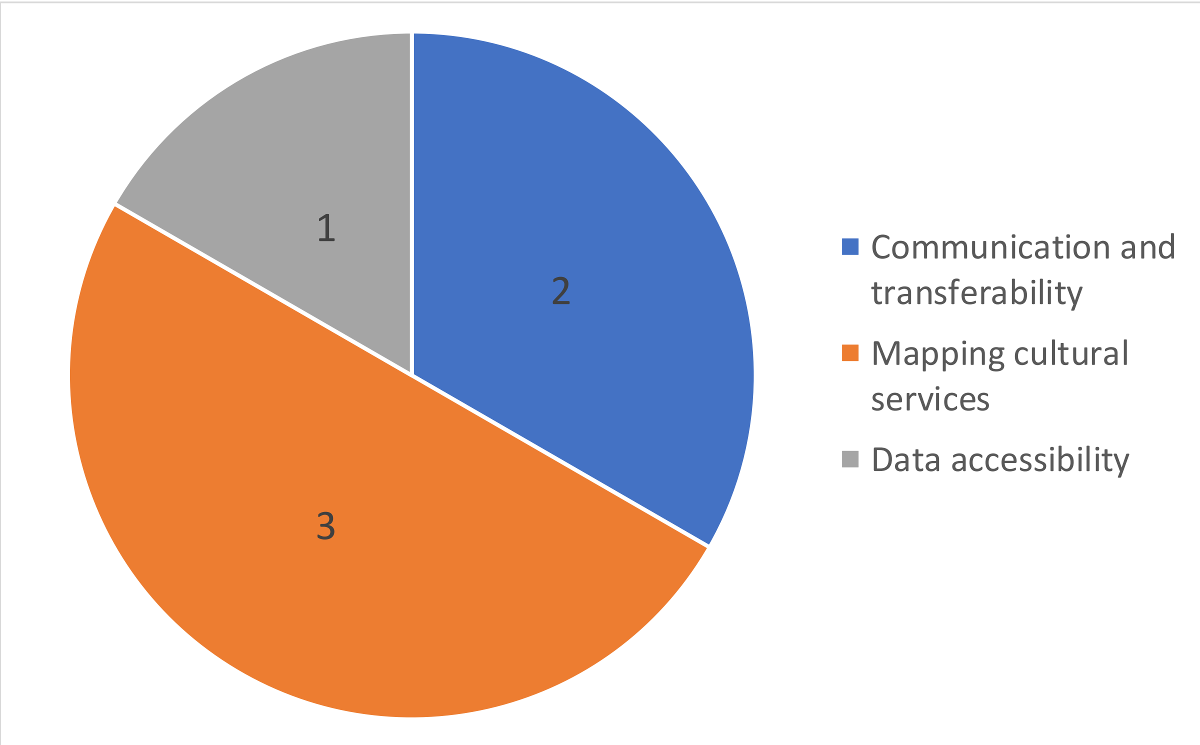

Figure 9 - Number of interviewees who mentioned each information gap concerning public urban green space.

Figure 9 shows the number of interviewees who raised each topic when asked about potential information gaps relating to the management of public urban green space, and indicates that the topic raised by the most interviewees was the lack of ability to map cultural ecosystem services. The issue of communication and transferability of information was highlighted as a potential issue twice throughout the interviews, and data accessibility was only mentioned once across all the interviews.

Communication and transferability

The issue of communication and transferability of research and policy into practice was discussed twice across the interviews. Plainly put, one interviewee stated that one of the key issues they believed faced the development and management of public urban spaces, was "not an information gap, it's a transferability gap" (Ecosystem services specialist, Stockholm City Council). They explained further, that, "there has been quite extensive research from the very start of the development of the topic of ecosystem services to value what different services deliver in terms of economic return and investment and so, but it has not been used", and that, "information that is available from different research projects about the economics of ecosystem services put into real day use in the development processes or the city management process is not in place yet, but that would be needed very much" (Ecosystem services specialist, Stockholm City Council). Similar sentiments were indicated by another interviewee who mused: "lack of information – for me it's a difference between, you talk about knowledge gap, that's something needed from research, information gap – it is maybe how you communicate" (Landscape architect, Ekologigruppen).

Mapping cultural services

The aspect that was raised most frequently when discussing potential information gaps, and knowledge that isn't readily available for the purposes of developing and managing public urban green space, was the concern for a lack of information about cultural ecosystem services. One interviewee stated: "the information gap is the recreational, or the cultural ecosystem services, that's the big gap. We don't really have the answers of how to measure them yet, but I mean, to me it's not impossible, I mean, we do lots of social service and social measurements of how people feel in an area or what their income is, and such, and with that data, that can probably tell an economist a lot about the economic benefits or not of certain areas. And then I think we just add some more biological data into that, I mean, are there any climbing trees in the area, how is the canopy cover" (Consulting manager, SGRI). Through this explanation they indicated that there is a genuine lack of tools and methods for assessing the state of recreation and human aspects that originate from the cultural ecosystem services that green space provides. Further to this, another interviewee discussed how they had started to consider types of tools that are designed for mapping more social and cultural services: "tools that our colleagues that are cultural geographers, that work with social sustainability, they have certain tools that they use for dialogue and for interviews and for finding out about cultural ecosystem services and maybe we can develop those tools to be useful in the work with ecosystem services" (Landscape architect, White). They credited the possibilities that though this is a current information gap in the context of planning for public urban green space, "the next step is to find combinations, find where do we lack tools or can we combine tools so we don't lack space anymore" (Landscape architect, White).

Data accessibility

Another concern regarding a potential information gap, was not the lack of information itself, but instead the accessibility of the information. One interviewee explained this: “More data is always really interesting, but you also need to find it. Some people in my department they don’t know where to find the data, and they don’t know it can be helpful for them even, so I think that one of the problems with the data is that it doesn’t reach the right persons in the right moments, so there’s so much data that you don’t know how to find it. That’s really the biggest problem for us” (Landscape architect, Stockholm City Council). They went on to say that: “Most data is available but you need to understand it, even if you can find it in the database you need to understand it and analyse it, and it’s getting more and more accessible because they are putting in explanations etc. but you need to know that there are, that you can search for it, you need to know that it’s possible to search for it, and you need to know that it’s important for your decision” (Landscape architect, Stockholm City Council). This concern with data accessibility is a key concern as while methods are being developed, to take into consideration cultural aspects derived from green spaces, concern also needs to be given to how these methods will be used, and how accessible the data they produce will be.

7. Discussion

7.1. Aims and priorities for Stockholm City Council's public urban green spaces

Green space and ecosystem services are considered important aspects for the development of Stockholm's future, but the use of tools for the valuation of these aspects is not a priority. Results from the interviews indicated that protection and enhancement of biodiversity and green network connectivity, cultural ecosystem services, and issues surrounding climate, in relation to water management, were priorities for the management of public urban green spaces owned by the Stockholm City Council. These results were relatively expected as concerns for climate issues and biodiversity have been internationally prominent matters in recent years (United Nations, 2021; 2021a). Recommendations for the prioritisation of cultural ecosystem services were less expected as they are difficult to provide assessment frameworks for, though many have tried through using, and assessing the use of, indicator-based assessments and valuation methods such as social media photograph analysis and visitor-employed photography (Satz et al., 2013; Plieninger et al., 2013; Stanik et al., 2018). However, research has attempted to combat the challenges of valuing cultural ecosystem services (Tian et al., 2021). These findings are of particular interest as due to the Covid-19 pandemic we have become even more aware of the value of urban green space. With changing work habits and working from home becoming more accepted, in the future it will be interesting to see if more people move to live further outside of Stockholm, which could assist in reducing urban densification and preserving urban green spaces.

A key aim and priority for public urban green spaces in Stockholm is the protection and enhancement of biodiversity and green network connectivity. Mentioned in seven out of eight interviews, the topic was discussed as a driver and prerequisite for all the other ecosystem services, and so being of utmost importance. Interviewees discussed particular habitats and their contributions to biodiversity within Stockholm, namely aged and stable woodlands. Interviewees also referred to biodiversity as being politically important, which, is echoed by the aims and objectives for sustainable development which Sweden follows (United Nations, 2021a).

One type of service recommended for prioritisation were the cultural ecosystem services. Interviewees referred to the understanding that exposure to greenery is beneficial for human health, and that there is a current lack of tools for assessing these benefits. The notion that cultural services are a priority for public urban green spaces in Stockholm is supported by results from the document analysis which indicate that the key terms noted most frequently across all the documents were 'social', 'recreation', and 'community'. These results are particularly significant when viewed within the context of the Covid-19 pandemic, as many people have recently been unable to travel far from their residences, and have been reliant on local nature to fulfil their 'green space needs', especially when they do not own private gardens. The key terms chosen for the documents analysis were determined by the results from the interviews, so there may be other terms and topics which are of relevance, but were not found through the document analysis.

Another key discussion in the interviews was the topic of climate (climate change, adaptation, and mitigation), in particular, with reference to micro-climates and water management. These issues were often mentioned in relation to how foliage and vegetation in public green spaces can support micro-climates and stormwater management.

7.2. Key challenges for Stockholm City Council's public urban green spaces

One of the most mentioned key challenges that face public urban green spaces in Stockholm was the urban densification of the city. The extent to which densification is deemed acceptable in a city, and how consistent it can be with satisfactory living standards, are both unknown. Interviewees also indicated that there is a lack of knowledge regarding how much physical space is required for living activities. Another key result concerning the challenges for Stockholm City Council's public urban green spaces were the concerns surrounding ownership and resources. It was thought that these aspects can affect the abilities of responsible actors to manage the green spaces, and that the lack of transparency when measuring and evaluating demands on green spaces, is a risk to green space management. Further, results indicated concerns about the impact of the management of privately owned green space on the abilities of public green space to effectively support wider ecosystem services, such as green network connectivity at the landscape scale, and how the effectiveness of these public green spaces would be viewed differently when viewed in context with privately owned green spaces in Stockholm. For instance, if planning for city-wide green space and habitat connectivity could include private gardens as well as public land, then the overall connectivity of green spaces would be considered much higher than otherwise.

The impact of political aims and green-washing was a concern for the management of public urban green spaces. Specifically, results indicate concerns regarding the political pressures on decision-makers to meet growing demands for housing and infrastructure using available space for urban development, and hence to de-prioritise public green spaces. In addition there are worries regarding green-washing which was noted to occur both intentionally and unintentionally. As well as this, it was found that there were concerns regarding the legislative protections afforded to protect green space and ecosystem services, and doubts about the ability to efficiently compensate for lost or depleted ecosystem services. These concerns are perhaps becoming more relevant now that the importance of appearing to be 'sustainable', 'eco', 'green', and 'environmentally friendly' for organisations and individuals in the public-eye is increasing, and is an often used in an attempt to attract custom through marketing and publicity efforts. It might be suggested, that if green-washing is as pervasive in obstructing the development and implementation of management strategies for green spaces, as it is in the corporate world, then stronger legal policies, or collaborative regulatory instruments, could be the most effective protection against this (Feinstein, 2013; Markham, 2014).

Another result of note was the difficulty of consistently and formally defining concepts such as ‘ecosystem services’ and ‘green space’. This presented a further challenge for the management of public urban green spaces in Stockholm, as interviewees were concerned that differences in understandings could present issues in relation to cooperation and coordination between different organisations. For instance, if one’s surroundings influence one’s understanding of the definitions of “green space” and “public”, one’s expectations of a space and perceptions of its purpose might be different to Stockholm City Council’s agreed objectives for public urban green spaces. It could be that there is a certain reluctance among organisations to want to define or specify terms such as ‘green space’ as this might reduce the flexibility they have when planning, especially if they do not prioritise environmental aspects. Further, it might be that public figures, politicians and companies use this lack of specificity to their advantage, and to evade more work and cost that would be required to be considered environmentally friendly.

Another key challenge discussed in depth, was the multifunctionality of public urban green spaces, specifically, how it can be perceived as a panacea. This was considered an issue for various reasons, one being that it inaccurately perpetuates the perception that multifunctionality is a solution to all the issues surrounding public green spaces. However, just because a green space provides numerous services, it does not mean that the services provided are necessarily of sufficient quality. Further, there can be conflicts between different aspects of green space and ecosystem services. For instance, within the same public urban green space, organised landscaped gardens with plant species might better suit recreational requirements such as children’s playgrounds, and biodiversity might benefit from more natural, wild greenery. This issue is particularly relevant as the results also highlighted a lack of green areas for children to play in, in addition to a lack of spaces where visitors might benefit from cultural ecosystem services, such as receiving “the impression of being in nature” (Consulting manager, SGRI). Additionally, biodiversity has been found to be a contributing factor to attract visitors to parks, and so Stockholm would benefit from protecting and enhancing the biodiversity within it’s public green spaces and National City Park, in order to indirectly assist in supporting nature-based recreation (Siikamäki, et al., 2015).

With relation to multifunctionality, results suggest that the ability of a space to be multifunctional is positively correlated with the physical size of an area, and that multifunctionality is not always needed, or even possible. The reasoning for this was based upon the ecological dynamics of green spaces, and how different types and extents of greenery and species can best support different types of ecosystem services. It was also due to the practical difficulties experienced when attempting to maintain areas of semi-natural green space whilst providing recreational areas which could experience intense use. The concept of this conflict between biodiversity and recreational opportunities was a contested topic in the interviews. Some interviewees referred to the difficulties of managing the dynamics between the two aspects due to the nature of biodiversity being dirty or messy and people preferring managed or ‘clean’ nature, whilst other interviewees stated that there was very rarely any conflict at all. As the issue was disputed, more research could assist in clarifying whether this is should be addressed as a prioritised challenge.

Another challenge raised was the complexities relating to the communication and shared responsibilities surrounding public green spaces. Interviewees highlighted concerns about disparities between policy and practice, lack of communication between decision-makers and the people who carry out the practical green space management, and difficulties relating to new public management.

7.3. Suitable tools for valuing aspects of Stockholm City Council's public urban green spaces

Results from the interviews were not comprehensive enough to be able to answer the research question regarding exactly which tools would be most suitable, or potentially applicable for valuing aspects of green space and ecosystem services. The relevant data was perhaps not obtained due to the semi-structured interviews not being specific enough when asking questions about types of tools, and that the interviewees were not as informed about these tools as expected. From this, is might be assumed either that there are not many valuation tools being used in these organisations, or that the interviewees were not aware of the tools that their organisations currently use. This notion is supported by findings from the document analysis which showed that the terms 'tool' and 'valuation' were barely used in relation to the subjects of public green space. The absence of these terms might suggest that using tools for valuing the qualities of green space and ecosystem services is not a priority or an aim for Stockholm City Council's public urban green space. However, it could be possible that different terms and synonyms were used in the documents, and that this would have a bearing on the result of the findings.

It would have been valuable to gather more information regarding tools that are currently used for the assessment and valuation of Stockholm City Council's public green spaces. These could then be compared to tools which have the potential for future use, which could assist Stockholm City Council in selecting the most appropriate tool and could inform their green space management practices. It would also have been beneficial to obtain data concerning the opportunities, limitations, and disadvantages of using particular valuation tools and methods as this would have been useful in providing Stockholm City Council with recommendations for development of their management practices for their public green spaces.

7.3.1. Considerations for the use of tools to value green space

There were several aspects raised when discussing the potential for using valuation tools for the benefit of the Stockholm City Council's public urban green spaces. One was the potential for tool development, and cooperation between interested actors to develop tools. Results indicated a growing interest in the use of tools for valuing aspects of green space and ecosystem services, and the need for a new system which could assist in identifying relevant tools for specific projects. One interviewee explained that tools which could be used in collaboration between actors with different competences would enhance results of an assessment, improving accuracy and reliability. This might, however, be difficult for Stockholm City Council whom, it was noted, have previously experienced internal complexities as the work of different departments has different aims, objectives and focuses. Additionally, interviewees from Stockholm City Council acknowledged that cooperation is essential but difficult. Therefore, improving cooperation between internal actors within Stockholm City Council when using tools for the valuation of green spaces would assist in improving the accuracy of results, and could be a priority for their consideration. Another point that was mentioned was the potential for setting a standardisation for tools. However this might be particularly difficult to achieve and could lead to further complications depending on how the standards are produced. If an open industry body produces an open standard this might be more advantageous than a single commercial entity who would be able to take advantage of owning the standards in terms of gaining market position (with potential for a monopoly). Other aspects to consider would be the interoperability of the standard, and if the needs of the tools are continuing to evolve, then a standard might have to develop along with the new research.

Another topic raised was the difficulties surrounding numerical and monetary valuations. Interviewees were not convinced of the accuracy of these types of tools, and expressed concerns about the potential for the results to lose meaning, and assist in green-washing. However, there was general consensus that these types of tools with numerical results assisted in communicating the importance of assessing the qualities of green spaces, and including environmental assessments, even if an assessment of the greenery present doesn't assess its quality. Further, there is perhaps a risk that if organisations are given specific numerical targets to achieve, this might dis-incentivise them to be cautious, and enable them to continue on their own trajectories without regard for the environmental impacts. Additionally, despite interviewees recommending specific aspects of green space and specific ecosystem services to prioritise, one interviewee cautioned that the need for ecosystem services are unique to different places, and that the appropriate tools for use would be project dependent. Thus despite locating appropriate tools to value an ecosystem service or green space aspect, the tools themselves might need to be used differently, or be able to be flexible for different situations. Therefore flexibility in a tool, and the ability to customise it could be an advantage.

7.4. Information gaps concerning valuation of the qualities of green space and ecosystem services in Stockholm's public urban green spaces

Results from the interviewees indicate that there are several aspects of information concerning the topic of valuation that are currently unknown, or require further research. These elements were recommended for consideration for future development and research surrounding the valuation of green space in Stockholm, and its management in the context of environmental planning in cities. One concern was a notable lack of tools for assessing and mapping social aspects and cultural ecosystem services, specifically the health benefits gained from recreational activities in green spaces. This could be addressed by further research into methods of assessing cultural ecosystem services which in turn could inform management practices for public urban green spaces. Another concern was the uncertainty surrounding data accessibility and comprehension. Results indicated that within Stockholm City Council there had been occasions when employees did not know how to access data available to them, or that they weren't aware of how to use the data, or how it could be helpful to them. However, this is likely to be a case of lack of knowledge, rather than lack of data. This issue might be addressed by providing more comprehensive training for employees.

8. Conclusions and recommendations

Findings indicate the aims and priorities of most significance for public urban green spaces are the protection and enhancement of biodiversity and green network connectivity. This is primarily as it is considered to be a prerequisite for all the other ecosystem services and is of current political importance; cultural ecosystem services due to the benefits they provide for human health, especially within the context of the Covid-19 pandemic; and the potential for mitigating and adapting the effects of climate changes, in relation to water management.

Key challenges, which may affect the ability of Stockholm City Council to achieve their aims and priorities, included: urban densification due to the unknown extent to which it can be consistent with satisfactory living standards; complexities surrounding ownership and resources which affect the abilities of responsible actors to manage the green spaces; the presence of green-washing, mainly due to political pressures; the ability to define key concepts which could result in organisations evading work for the benefit of the environment; and the potential for the multifunctionality of public green spaces being perceived as a panacea, which inaccurately perpetuates the perception that multifunctionality it is a solution to all the issues surrounding public green spaces; the potential conflict between biodiversity and recreational opportunities, which was a contested challenge; and finally, a lack of communication between decision-makers and practitioners. It was suggested that legislative protections and stronger legal policies for green space and ecosystem services might be the most effective protection against these challenges.

The research succeeded in obtaining key aspects which stakeholders would consider when using or planning to use tools for the valuation of green space and ecosystem services. Important aspects were the potential for tool development, as well as the need for a tool categorisation system. Others were the ability of tools to be used cooperatively between actors with different competences, and the conversation surrounding the potential for setting a standardisation for tools. Additionally, tools providing numerical and monetary valuations proved controversial due to their ability to communicate to stakeholders while simultaneously presenting risks of disincentivising stakeholders to strive for more environmentally considerate actions than is necessary. The use of valuation tools was also cautioned with the reminder that appropriate tools for use would be project dependent, and dependent on the ecosystem services needs of the location. Finally, the findings highlighted the need for more information concerning tools for assessing and mapping cultural ecosystem services, and the need for more training regarding the use of data for the valuation of the qualities of green space and ecosystem services.

The study also aimed to provide a reflection on which tools might be most appropriate for valuing the qualities of green space and ecosystem services in public urban green space in Stockholm, through critical comparison of examples and obtaining information from semi-structured interviews with professionals familiar with the Stockholm context. However the method was found not to be appropriate for gaining this information, and hence a greater emphasis on the key aims, priorities, and challenges surrounding the management of public urban green space was provided. With more time and use of methods such as a desk-top study, it might have been possible to provide a more comprehensive overview of tools with the potential for use by Stockholm City Council.

8.1. Recommendations for future research

Future research could investigate the cohesion between the current aims and priorities for Stockholm's public urban green spaces, and current and developing environmental planning policies. Further, research could explore and compare the differences of public urban green space management in similar cities internationally. Additionally, findings from this study do not provide recommendations for tools which would be most suitable for valuing aspects of public green space and ecosystem services in Stockholm, therefore future research could focus on providing a review of tools for the assessment, mapping, and valuation of the qualities of green spaces. This could be furthered by identifying more specifically which assessment tools Stockholm City Council have previous experience with. It would also be useful to consider future developments in the field such as standardisations that may be provided by independent and/or international bodies.

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Appendices

Appendix One: Interview guide

Challenges regarding ecosystem services

1. What do you see as Stockholm's key challenges concerning the management and protection of existing ecosystem services provided within public urban green spaces?
2. Are there any difficulties in managing and protecting multifunctionality of ecosystem services within public urban green spaces?
3. Are there any specific ecosystem services within public urban spaces that you would recommend prioritising for protection, management, and/or enhancement in the near future?

Valuation Tools

4. Do you use, recommend, or seek to use valuation tools which assess the quality of ecosystem services within public urban green spaces? If so, which tools, and for which situations?
5. How have these tools been chosen? What are the most important features that you look for in a valuation tool? (e.g. focus on which ecosystem services, cost, transferability between local areas, user-friendliness, etc.)
6. In what ways may the challenges mentioned earlier be alleviated using ecosystem service valuation tools?
7. Are there any information gaps regarding the quality of ecosystem services within public urban green space in Stockholm, which would be useful to know for the purpose of their protection and enhancement?

Cooperation with private sector

8. Do you cooperate with organisations and development companies to establish 'best practice' use of valuation tools for ecosystem services? For instance, do you provide guidance for which valuation tools to use for detailed plans?
9. Do you outsource work (concerning the valuation of ecosystem services within public green spaces)? If so, how do these arrangements work in terms of who sets the key goals and aspects of focus for the projects?

Appendix Two: Interview information sheet and consent form

Interview Information Sheet and Consent Form

Project Information

This master's thesis research study aims to investigate valuation tools used for ecosystem services in urban green spaces, for the purpose of future use in Stockholm. Interviews will be conducted as part of the scoping for the research, to identify the needs and requirements for Stockholm's public green spaces, as well as for gaining understanding of tools which are used to assess green spaces and their associated ecosystem services.

Participation in the study

Participation in this study is voluntary. Based on your expertise and knowledge I consider you a valuable interview partner for my research. If you agree to participate, I will ask a series of questions concerning the needs of green spaces and/or valuation tools for ecosystem services. The questions will be provided before the interview, thus allowing for a first reflection on the questions. The scheduled time frame of the interview is for a maximum of 60 minutes. The researcher will make sure that the time frame is not exceeded. If consent is given, an audio record of the interview will be taken and used only for the purposes of reflection by the researcher and will be destroyed after September 2021.

The information retrieved from the interviews serves a scientific purpose only. The researcher uses the information to identify and analyse key insights into the use of green space valuation tools. The findings will be demonstrated in presentations and published as a master's thesis on the DIVA portal (http://www.diva-portal.org).

If you choose to participate, you will be identified in the project outputs by your name, position, and your place of work. If you wish to remain anonymous, please inform the researcher and you will be assigned a pseudonym. In either case, your contact information (telephone number, email address, etc.) will not be published or shared with anyone without your consent.

Further information

For further information about this research project, please contact:
Rachel Hopkins (researcher and interviewer): rahop@kth.se
Sara Borgström (thesis supervisor): sara.borgstrom@abe.kth.se

Consent form

1. I voluntarily agree to participate in this research study.
2. I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
3. I understand that I can withdraw permission to use data from my interview, in which case the material will be deleted.
4. I have had the purpose and nature of the study explained to me in writing (see information sheet) and I have had the opportunity to ask questions about the study.
5. I understand that participation involves answering questions concerning valuation tools for ecosystem services and/or the needs of public urban green spaces.
6. I understand that I will not benefit directly from participating in this research.
7. I agree to my interview being audio-recorded for the purposes of this research only.
8. I understand that all information I provide for this study will be treated confidentially.
9. If I wish, my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of the people I speak about. I agree to inform the researcher if I wish to remain anonymous.
10. I understand that if I inform the researcher that myself or someone else is at risk of harm, they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission.
11. I understand that signed consent forms and original audio recordings will be retained by the researcher on their personal laptop until September 2021 latest.
12. I understand that under freedom of information legislation I am entitled to access the information I have provided at any time while it is in storage as specified above.
13. I understand that I am free to contact any of the people involved (see information sheet) in the research to seek further clarification and information.

Date, and signature of participant

I believe the participant is giving informed consent to participate in this study.

Date, and signature of researcher

Appendix Three: Tools for valuing qualities of green spaces and ecosystem services

Table 3 - Tools for valuing qualities of green spaces and ecosystem services.

Tool / Characteristic	Origin	Specialisation	Overview	Timing and Application	Accessibility
Parkdata using GIS	Responsible: Stockholm City Council. Used by: City management office (Stadsdelsforvatningar).	All ecosystem services, Biodiversity, Connectivity	Used for the park management map system	Assessment on regular basis, not annual	Within the Stockholm City Council
Green Space/Area Factor/Index (Grönytefaktor - GYF) for public areas (allmän plats - AP)	Original version from Berlin - Swedish version from C/O City (C/O City, 2020)	All ecosystem services	Uses Microsoft excel sheets	Different phases and scales Numerical results	All stakeholders
Parkliglinje (park like line)	Stockholm City Council	Unspecified	Unspecified	Measures for the city parks	Unspecified
Fritidsguiden (free time guide)	Fritidsguiden	Cultural ecosystem services	Unspecified	Unspecified	Easy to use Free of charge
Biodiversity Net Gain	Unspecified	Biodiversity	Unspecified	Unspecified	Unspecified
Stockholm City Council database	Stockholm City Council	Downpour Ecological networks	Unspecified	A key tool used for developments	Unspecified
i-tree	US Department of Agriculture Forest Service	Regulating ecosystem services	Requires Swedish weather, species, and climate data	Precise results and detailed calculation; Good for communicating to stakeholders	Easy to use Free of charge and open source
ESTER	Boverket	All ecosystem services	Aims to highlight important ecosystem services	For use in early stages of a planning process	Easy to use Free of charge
White Toolbox: an overview of different tools	White Arkitekter	All ecosystem services	Uses categories to compare tools: purpose, target group, application, scale and phase, data requirements, competences, results.	Different phases and scales, A variety of different types of results	Easy to use Free of charge