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Indicators for ecosystem services in urban green space management

Indikatorer för ekosystemtjänster inom urban grönyteförvaltning

Johan Lundh

Abstract

Indicators for ecosystem services in urban green space management

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Urban green spaces are put under high pressure due to increasing population density in cities. This problem will potentially accelerate where the densification in the cities continues. Consequently, this sets high requirements on the management, if the green spaces are to generate the benefits and values that are associated with greens spaces as urban parks. One way to increase these benefits and values could be to incorporate ecosystem services and indicators for ecosystem services in a multi-stakeholder management system. Is it possible that ecosystem service indicators could facilitate collaboration between stakeholders and thus improve the value of urban green space?

This master thesis aimed to identify ecosystem service indicators for a green space and incorporate them in a multi-stakeholder management system. The study was made to clarify if indicators can facilitate collaboration between stakeholders and thus improve the management of an urban green space. In order to achieve that, the first step was to let the stakeholders express what they desired the green space to generate in terms of benefits and values. These expressed benefits and values were formulated into target variables which were linked with the ecosystem services that the green space was assessed to generate if the target variables are achieved. A literature study was conducted to identify applicable indicators for the chosen ecosystem services. These indicators were quantified and incorporated into an already existing management system. This management system performed as a framework and a fundament which was further developed to incorporate more functions as indicators and ecosystem services.

The thesis resulted in two identified indicators for ten ecosystem services and the development of a multi-stakeholder management system. Identified indicators were birds and compliant seating. Birds were identified as an indicator because they indicated many of the same ecosystem services as the ones that are generated in the green space. These ecosystem services are linked with the benefits and values that are associated with the target variables. In addition, the birds were chosen because they were possible to quantify. Compliant seating was the second indicator, and it has the potential to function as a control indicator as it can be seen as a manifestation of the cultural ecosystem services generated at the green space. A multi-stakeholder management system was developed with the incorporation of indicators for ecosystem services. The developed management system aimed to facilitate the collaboration between stakeholders with the use of ecosystem service indicators. Taken together, the findings suggest a role for ecosystem service indicators in multi-stakeholder management plans to improve the value of green spaces.

Keywords: Ecosystem service indicator, cultural ecosystem service indicator, green space, green space management method, multi-stakeholder management, park management, urban planning, birds, seating.

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Referat

Indikatorer för ekosystemtjänster inom grönyteförvaltning

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Grönytor i städer är satt under hög press på grund av ökande befolkningstäthet vilket leder till att fler människor behöver dela på samma mängd urban grönyta. Detta fenomen ökar kraven på förvaltningen av grönytor då de behöver generera fler nyttigheter och mera värde. Ett sätt att öka dessa värden skulle kunna vara att använda sig av indikatorer för ekosystemtjänster inom ett förvaltningssystem där flera förvaltare verkar. Är det möjligt att indikatorer för ekosystemtjänster kan underlätta samarbetet mellan olika förvaltare och därigenom öka värdet av en grönyta?

Den här masteruppsatsen hade målet att identifiera indikatorer för ekosystemtjänster genererade av en grönyta och sedan inkorporera dem i en förvaltningsmetod som ökar samverkan mellan förvaltare. Studien syftade till att tydliggöra om användandet av ekosystemtjänstindikatorer kan underlätta samarbetet av mellan olika förvaltare för att förbättra förvaltningen av en grönyta. Det första steget för att åstadkomma detta var att låta förvaltarna uttrycka vilka värden och nyttigheter de vill att grönytan skulle skapa. Dessa värden och nyttigheter formulerades som målvariabler vilka länkades till de ekosystemtjänster som grönytan bedömdes generera. Genom en litteraturstudie identifierades indikatorer som kunde indikera de ekosystemtjänster som genererades vid grönytan. Indikatorerna kvantifierades och inkorporerades in i ett redan existerande förvaltningssystem.

Studien resulterade i två identifierade indikatorer och i utvecklandet av ett förvaltningssystem som underlättar samverkan genom användandet av indikatorer. Fåglar identifierade som en indikator på grund av att fåglar indikerade samma ekosystemtjänster som genereras på grönytan. Fåglar valdes också för att det var möjligt att kvantifiera fåglarna vid grönytan. Villkorlig sittplats var den andra indikatorn och den har möjligheten att fungera som en kontrollindikator eftersom den kan beskrivas som en manifestation av de ekosystemtjänster som genereras på grönytan. Sedan så utvecklas även ett förvaltningssystem där indikatorerna inkorporerades. Förvaltningssystemet hade målet att underlätta samverkan mellan de olika förvaltarna med hjälp av indikatorerna. Sammanfattningsvis så bedöms det att indikatorer för ekosystemtjänster har potentialen att användas i ett förvaltningssystem och därigenom kunna bidra till att öka värdet av grönytan.

Nyckelord: Ekosystemtjänstindikator, indikator, indikatorer, indikatorer för ekosystemtjänster, ekosystemtjänster, kulturella ekosystemtjänster, grönytor, grönyteförvaltning, förvaltningsmetod, parkförvaltning, fåglar, fåglar som indikator.

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Preface

It’s time!
It’s time to say goodbye to my studies at the Master Programme in Environmental and Aquatic Engineering at Uppsala University (UU) and the Swedish University of Agricultural Science (SLU). I do so by finalizing this grand piece of a master thesis which quite obviously will contribute to save the world. Well, of course this planet will be fine but the management of it clearly needs some help if a bunch of humans are going to live on it. We can see the indicators for a future crash and I have heard that the improvement must start now. Maybe some more nature into urban city life can help?

Ingrid Nilsén Boklund and Lars Johansson, my supervisors at Ramböll, you gave me the opportunity to do this project and I highly appreciate the daily inspiration and all the well-formulated guidance. Moreover, I would like to give my gratitude to the people from the Church of St:Per, Uppsalahem and The Municipality of Uppsala that contributed with vital information and participated in the workshop. The result of this study would not have been completed without the efforts of the bird watchers Johan Björk (with assistant), Arne Lundberg and Michelle Nordkvist and for that I am grateful.

I want to articulate my sincere gratitude to my academic supervisor, Antoinette Wärnbäck at the Department of Urban and Rural Development, SLU. Your important help and challenging questions gave the thesis its direction.

To my family and friends, I am so thankful for your genuine and enthusiastic support.

Lovisa, I am unbelievable grateful for your love and care. It means the world to me and you truly are my greatest source of inspiration.

Thank you and good night!

Tro och tvivel, trägen vinner.

Johan Lundh

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Populärvetenskaplig sammanfattning

Indikatorer för ekosystemtjänster inom grönyteförvaltning

Johan Lundh

Vad vill vi ha ut av våra parker idag? Under soliga dagar på sommarhalvåret fylls parker och grönområden med människor. De umgås, spelar fotboll, grillar eller bara njuter av omgivningarna och slappnar av. Folk som bor i städer uppvisar ett tydligt behov av att vilja använda parker och grönområden och uppskattar dess värden. Det kan exempelvis vara ett sätt att komma i kontakt med stadens djurliv. In en nyligen gjord underökning rankades fågelkvitter som det mest lyckoframkallande ljudet av alla. En god anledning att besöka en park om något.

Idag är det dock fler och fler människor som flyttar in till städerna vilket medför att uppbyggnaden av städerna måste planeras bättre för att fler människor ska kunna tillgodose sina behov på en mindre yta. När urbaniseringen ökar sker ofta även en förtätning av städer för att fler ska få plats vilken ibland leder till att grönområden bebyggs. Den ökade befolkningstätheten leder alltså till det blir fler människor per area grönyta vilket minskar tillgängligheten till grönyta.

Vad får det för konsekvenser? Studier visar att det finns omfattande fysiska och psykiska fördelar med att vistas i urbana naturområden. Både barn och vuxna använder grönytor för att leka och träna på vilket ger tydliga hälsofördelar. Det har även visat sig att genom att vistas i en park eller grönområde så motverkas stress, depression och andra mentala sjukdomar. Helt enkelt har parker och grönområden i städer förmågan att bidra till människors välbefinnande.

Det är ekosystemen på grönytorna som skapar en stor del av detta välbefinnande. En del är kopplat det sociala utbytet andra urbana faktorer men en stor del av välbefinnandet genereras av träden, buskarna och djuren. De direkta och indirekta bidragen från ekosystemen till mänskligt välbefinnande kallas ekosystemtjänster. Ekosystemtjänster är ett sätt att synliggöra värden som naturen och ekosystem skapar åt oss människor. Att njuta av fåglarna i en park kan associeras med ekosystemtjänsten rekreation.

Kan ekosystemtjänstperspektivet användas inom förvaltningen av grönytor? För att tillgodose det ökade behovet av grönytor och därmed öka möjligheten till välbefinnande behövs en förbättrad förvaltning av grönytor. Särskilt när flera förvaltare ska samverka saknas det verktyg för att göra det på ett förtjänstfullt sätt. Här skulle ekosystemtjänstperspektivet kunna bidra och underlätta samverkan inom förvaltningen av grönytor. Ett exempel på det skulle kunna vara att kvantifiera ekosystemtjänsterna genom att identifiera indikatorer för dessa ekosystemtjänster och därmed skapa konkreta mål och verktyg som kan ingå en förvaltning.

Med detta perspektiv i beaktning genomfördes en studie på en grönyta i Uppsala som gick ut på att identifiera indikatorer för ekosystemtjänster som förvaltarna önskade att grönytan skulle generera mer av i framtiden. Dessa indikatorer skulle vara mätbara och kunna används inom förvaltningen av grönytan och delvis också i stadsdelen Kvarngärdet där grönytan är placerad. Studien ämnade visa om kvantifierbara indikatorer kan användas inom förvaltningen och om dessa underlättar samverkan mellan olika förvaltare som är involverade i stadsdelen. Dessa förvaltare är Uppsala kommun, Svenska kyrkan och kommunen bostadsbolag Uppsalahem. Det är Svenska kyrkan som äger grönytan som ligger precis vid St: Pers kyrka och i dagsläget sköter underhållet. Kommunen är ansvarig för andra gröna strukturer i området och Uppsalahem representerar många boende i området och har förvaltning av sina områden.

Skulle dessa förvaltningar kunna samverka skulle Kvarngärdets grönytor utveckla sin kvalitet och ge mer välbefinnande till kyrkas besökare, boende och barn.

Studien genomfördes utifrån att förvaltarna fick uttrycka vilka värden och nyttigheter de anser att grönytan ska leverera till människor som uppehåller sig på ytan. Det kunde uttrycka sig i att ”-barn ska kunna leka”,”-människor ska kunna sitta vid en bänk och vila” samt att ”ytan ska vara en del i en grönstruktur”. Dessa värden och nyttigheter formulerades till målvariabler som trivsam plats, lekplats, djur i rörelse och några till. Dessa målvariabler kopplades sedan till ekossystemtjänster som grönytan skulle generarea mer av för att uppnå målvariablerna i högre grad än vad de gör idag.

För att kunna kvantifiera dessa ekosystemtjänster identifierades fåglar och villkorad sittplats som indikatorer för dessa ekosystemtjänster. Valet av indikatorer motiverades av att fåglar och en viss typ av sittplatser skapar samma typ av värden och nyttigheter som de ekosystemtjänster som önskas öka från grönytan. Dessa indikatorer kan då kopplas samman via ekosystemtjänsterna och det finns då ett mätbart verktyg som indikerar utvecklingen mot uppfyllandet av målvariablerna.

Fåglar sägs bidra till människans välbefinnande genom att motverka mental ohälsa, framförallt genom sin sång och ge rekreationella värden med sin närvaro i urbana grönområden. En bänk som är placerad på en bra plats som har ett gott mikroklimat, medför en fin utsikt och samtalsvänlig ljudnivå har förutsättningar att manifestera ekosystemtjänsterna som genereras från grönytan. Manifestationen sker genom att chanserna för välbefinnande ökar genom att sittplatsen uppfyller nämnda krav.

Fåglarna i St:Persparken inventerades och resultatet jämfördes med fågelinventeringar i andra parker. St:Persparken visade sig ha minst närvaro av fåglar vilket motiverar en åtgärd för att öka fågelnärvaron in parken. Detta kan göras genom att ha en högvariation av vegetation, sätta upp fågelholkar samt placera ut vattenbad och sandbad. Från villkoren för en bra sittplats utvecklades en kontrollmetod som har potentialen att användas i förvaltningen.

Indikatorerna integrerades även in i en förvaltningsmodell som ska underlätta samverkan mellan olika förvaltningsorganisationer. Förhoppningsvis kan indikatorer för ekosystem-tjänster kunna användas för att utveckla gemensamma mål för olika förvaltningsorganisat-ioner att enas mot. Indikatorerna kan också ha potentialen att underlätta kommunikationen mellan planeringsorganisationen och den verkställande underhållningsenheten.

Indikatorer för ekosystemtjänster ha potentialen att konkretisera begreppet och underlätta förvaltningen av grönytor vilket kan medföra en förbättrad förvaltning som förbättrar uttaget av ekosystemtjänster från en grönyta. Det leder till att människor upplever mer välbefinnande när de vistas på ytan och deras behov av naturnära aktiviteter tillgodoses.

Abbreviations

ES - Ecosystem Services

CES - Cultural Ecosystem Services

SEPA – The Swedish Environmental Protection Agency

TEEB – The Economics of ecosystems and Biodiveristy

CICES - Common International Classification of Ecosystem Services

MSI – Multi Stakeholder Involvement

MA – Millennium Ecosystem Assessment

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1 Introduction

The world population is today more than 7 billion people and the number is increasing. By now, half of these people live in cities but in the year of 2050, two thirds will be living in towns and cities (UNFPA, 2011). This means that the urbanization will continue and the densification will cause a decrease in urban space per capita. Consequently, there will be a loss of urban green space per capita (James *et al.*, 2009) and therefore the daily exposure to natural environments will decrease (Barton & Pretty, 2010). Exposure to natural environments can play an important role in the work against lifestyle diseases as obesity, depression and other stress-related illnesses (SEPA, 2017). Therefore, the World Health Organization (WHO) is encouraging local administrators to further develop the management of urban green spaces (WHO, 2006).

Of Sweden's forthcoming population growth, will 70% be concentrated in the regions nearby to the three big cities Stockholm, Gothenburg and Malmö (SCB, 2012). The following densification in these regions will potentially intensify the need for urban green spaces to create a satisfactory urban environment.

In order to accomplish these satisfactory urban environments, is one of Sweden's 16 environmental objectives formulated as *A good Built Environment* (SEPA, 2012b). It states that cities and towns must provide a healthy living environment and that natural and cultural assets must be protected and developed. In addition to that should sound environmental principles be used and sustainable management must be promoted.

Included in this environmental objective is the management of urban green spaces and the care of important ecosystem services which a urban green space produces (Miljomal, 2015). In the year of 2014 the Swedish government decided that in 2018, the value of ecosystem services should be generally known and be integrated in economical statements, political guidelines and other decision in the society where it is relevant (Swedish Ministry of the Environment and Energy, 2014). By integrating ecosystem services in urban green space management is it possible to conceptualize the functions and values that nature deliver to human beings. This gives new arguments for the importance of nature in the society and it also contributes to multifunctional land use and reaches organizations outside the nature conservation sector (SEPA, 2016).

Ecosystem services generate benefits which are vital to human survival and well-being, therefore is a judicious management of these ecosystem services important (Brown *et al.*, 2014). It has been concluded that there are challenges to structurally integrate ecosystem services urban green space management (de Groot *et al.*, 2010). However, indicators for ecosystem services has been recognized as a key assessment tool in order to clarify whether the management of ecosystem services is appropriate and sustainable (Brown *et al.*, 2014). Proper indicators for ecosystem services are necessary and recently a development of an European framework for ecosystem service indicators have started within the Mapping and Assessment of Ecosystems and their Services project (Rocha *et al.*, 2015). To ensure a more sustainable development should ecosystem services be incorporated into urban green space management (Rall *et al.*, 2015). Hence, ecosystem service indicators need to be identified and incorporated into a management system of urban green spaces.

The inclusion of ecosystem services in urban green space management is a key foundation in a research project newly founded in Uppsala. The project has the objective to develop management methods that will overcome institutionalized and social boundaries through planning and management of ecosystem services. The study area is the neighbourhood of Kvarngärdet in Uppsala, Sweden. The first step in the project is this master thesis which aims to identify indicators for an urban green space in Kvarngärdet and incorporate them in a management system.

1.1 Objectives

The objective of this thesis is to identify site specific indicators for ecosystem services at a green space, and further to develop recommendations for a multi-stakeholder management system with incorporated indicators. Present study can be seen as a pre-study with the purpose to clarify if indicators can facilitate collaboration between stakeholders in order to improve the management of an urban green space with the use of ecosystem services.

1.2 Research questions

Which are the indicators of the ecosystem services at the green space at the Church of St:Per?

In what way are the indicators relevant and quantifiable?

How can indicators for ecosystem services be incorporated into a management method?

1.3 Delimitations

This thesis mainly focuses on the green space that is on the property owned by the Church of St:Per, located in the neighbourhood Kvarngärdet, Uppsala, Sweden. One exception from that is the organizational matter that is connected to the management system. The indicators were not supposed to be a result of an inquiry directed towards the users of the green space. Instead it was the stakeholders associated with management that were in focus. This approach would increase the chances to identify generalizable indicators. The time-limit was constrained to 20 weeks between January and June which had some consequences in the indicator measurement. The perspective used in this master thesis is the ecosystem service perspective. Ecosystem services are anthropogenic and nature´s intrinsic value is not taken into account and the main focus lay on the connection between ecosystems and the well-being of humans. The result is specified indicators and a recommendation for a management system.

2 Theory

This thesis combines several different subjects and therefore is it necessary to first present the theoretical background to understand the interconnections between the subjects. Firstly, this theory section describes what benefits and values parks and urban green spaces create to humans. It also explains the concepts of ecosystem services and ecosystem service indicators. In the final part of this section, are the existing methods regarding urban green space management presented.

2.1 City life and urban green spaces

The UN has predicted that by the year 2050, 66% of all humans will be inhabitants in cities (UNFPA, 2011). This means that many of the children, in the future, will have their first contact with nature in an urban environment. However, urban small-scale nature does not get as much attention as larger natural areas that have a higher biodiversity and have relatively untouched ecosystems (Chiesura, 2003). Recently, an increasing number of reports states that urban natural areas contribute to life quality for humans are growing in numbers. This is because urban green spaces have the capacity to give environmental and ecological services but also offer social and psychological values to urban citizens (Chiesura, 2003).

Awareness of this is not recent as Ulrich (1981) described that park experience may reduce stress while Kaplan (1983) writes that parks may provide a sense of peacefulness and tranquillity and enhance contemplativeness. Many empirical studies have been conducted about the restorative functions of natural environments. In one of those, it was discovered that patients on a hospital recovered faster if they could look out at trees and nature outside their window instead of just only look at buildings (Ulrich, 1984). In a survey made by Godbey *et al.* (1992), a significant result showed a positive relation between perceived state of health and peoples usage of urban green spaces. Natural elements ability to function as "natural tranquilizers" is possibly particularly beneficial in cities where a life full of stress is more common (van den Berg *et al.*, 1998). This is in line with later research as Nordh *et al.* (2009) presented that there is a potential for physiological restoration connected to urban green spaces.

In a survey made in Copenhagen (Peschardt *et al.*, 2012), 686 respondents answered how they mainly used smaller urban green spaces which resulted in that "socializing" and "rest and restoration*"* were the most common ways to primarily use urban green spaces. When students in Oslo were asked roughly the same questions the main activities were "relax and philosophize" or "read" but also "eat/drink" (Nordh & Østby, 2013). To promote such activities, the previous mentioned study concludes that urban green spaces should be designed with components that are natural and, shielded from surrounding and furnished with some seating. These design aspects should have the potential to encourage social meetings and opportunities for restorative experiences. When investigating what components people are looking at when they are evaluating the chances of rest and recovery in a park, Nordh (2012) found that trees, followed by the benches and bushes, got the most attention.

The values and benefits described above are all the results of functions and processes generated by the ecosystems in the urban green spaces. Together, the natural components of the urban green spaces create well-being for humans and these functions and processes are summarized under the concept of ecosystem services.

2.2 Ecosystem services

The concept of ecosystem services was first used by ecology economists in the 1970s (Gómez-Baggethun *et al.*, 2010) but it was the study of Millennium Ecosystem Assessment (MA) that made the concept well-known among decision makers and the public (Fischer *et al.*, 2009). The framework of MA was developed to show the ecosystems contribution to human well-being and has since then been the foundation for the methodology in other studies related to ecosystem services.

There are several definitions of the concept of ecosystem services that have both similarities and differences. MA stated that ecosystem services are "the benefits that people obtain from ecosystem" (MA, 2003). The *Swedish Environmental Protection Agency (SEPA)* (2012a) use TEEB:s definition "the direct and indirect contributions of ecosystems to human well-being" in an compilation of ecosystem services. This definition is used in this study and it contains all the processes and functions in the ecosystem that contribute to biodiversity and the production of benefits like food and water. An ecosystem is defined as the dynamic complex of plants, animals, microbes and their interactions with a non-living physical environmental which creates a functional unit (UN, 1992).

As a concept, ecosystem services are anthropogenic and nature´s intrinsic value is not considered and the main focus lay on the connection between ecosystems and the well-being of humans. Well-being is defined in MA (2003) and Common International Classification of Ecosystem Services (CICES)(Haines-Young & Potschin, 2011) as access to basic materials to maintain freedom of choice, freedom of action, health, god social relations and safety. A certain level of material prosperity is connected to the well-being of humans (UN development goals). The connection between ecosystems and human well-being is illustrated in Figure 1.

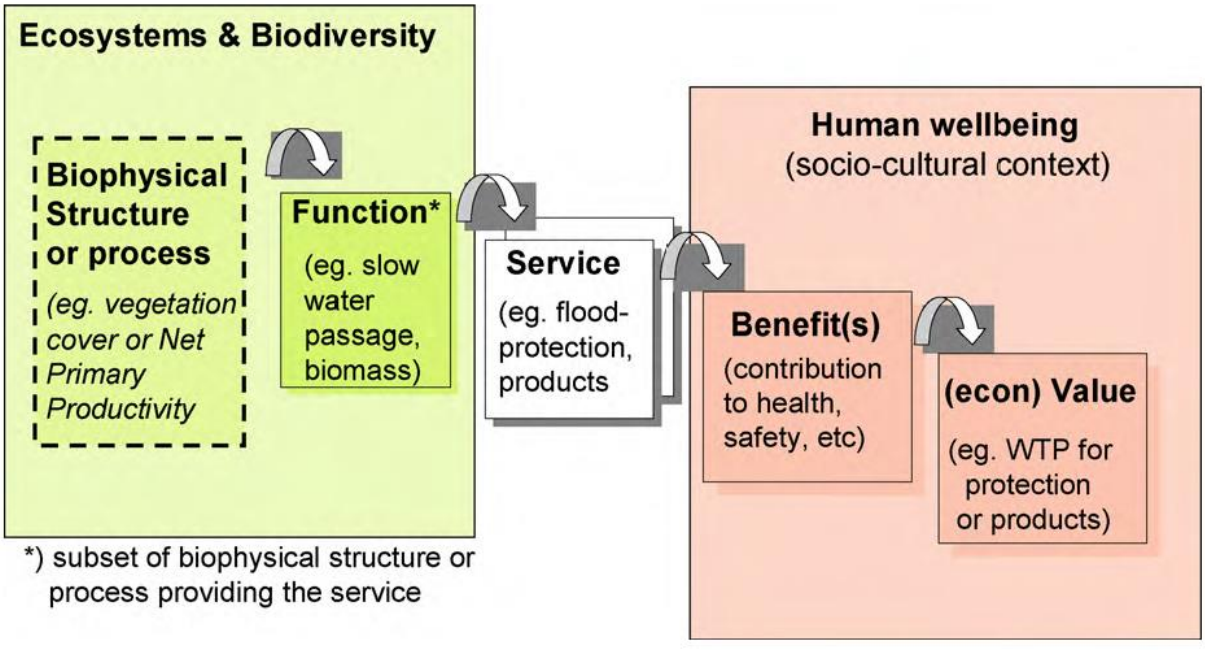
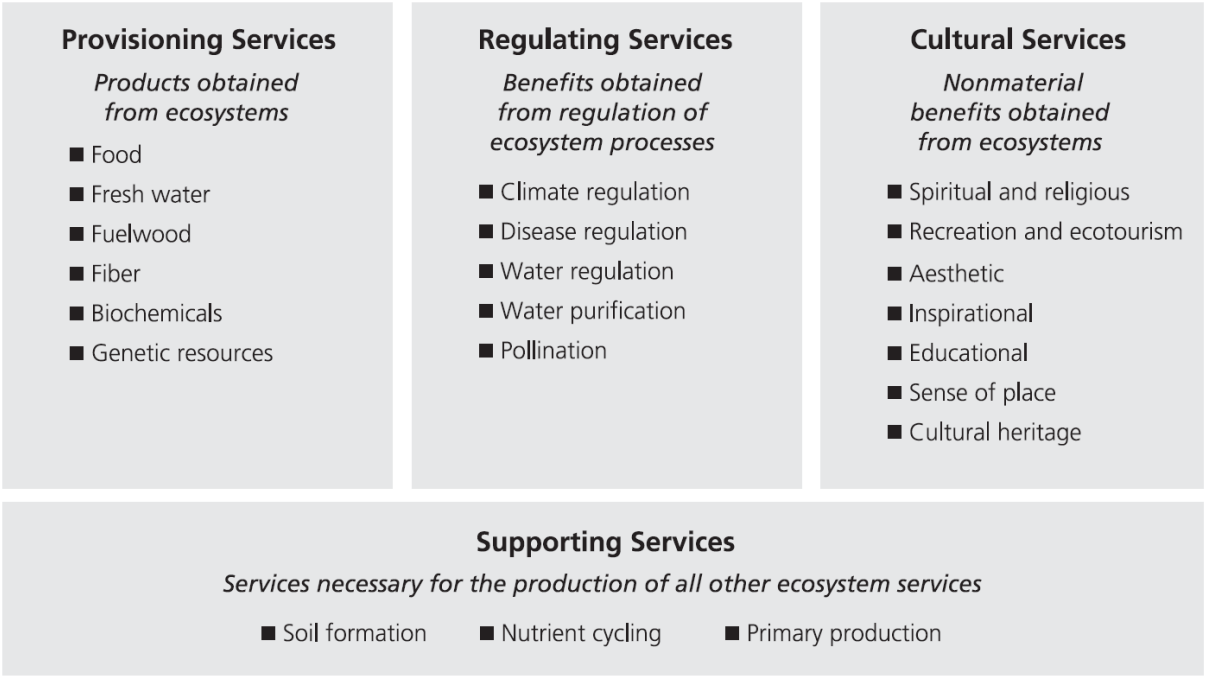


Figure 1. *The Cascade model which illustrates how the ecosystems and the biodiversity create services which generates human well-being. Source: Modified from Haines-Young & Potchin (2011).*

It is widely acknowledged to divide the ecosystem services into four different categories: provisioning, regulating, supporting and cultural services (MA,2003). This is demonstrated in Table 1 although there are other ecosystem services that are not shown in the table.

Table 1. *Millennium Ecosystems Assessment categorization of ecosystem services. Source: Modified from MA (2003).*



Provisioning ecosystem services generates products which can be extracted from an ecosystem by humans and an ownership is possible to define. It is a direct outtake of biomass that is favourable for human and consists, as an example, of eatable crops, fresh water, flowers and fibre (Haines-Young & Potschin, 2011).

The *regulating* and *supporting* ecosystem services are functions of the ecosystems. Regulation of the environment which is directly favourable for humans is a defining factor for regulating services while the utility of supporting ecosystem services is more indirect. Our environment is regulated by the regulation of air, water and soil. Survival and progress for ecosystems are made and by the enabling of reproduction and rejuvenating of species. There is a large amount of synergies, considerations and losses between different ecosystem services because they can both support and prevent each other (Rodríguez *et al.*, 2006).

Cultural ecosystem services (CES) can be described as the products of the dynamic, complex, physical or spiritual relationships between humans and ecosystems, often over time across all kinds of landscapes (Plieninger *et al.*, 2013). The MA defines cultural ecosystem services as "the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences" (MA, 2013, p74). Blicharska *et al.* (2017) argues that MA, by the usage this definition merge service and benefit and prefer the CES definition by CICES: "as the physical settings, locations or situations that rise to changes in the physical settings, locations or situations that rise to changes in the physical or mental states of people, and whose character are fundamentally dependent on living processes" (Haines-Young and Potschin, 2011, p12). The many definitions indicates that cultural ecosystem services are the hardest to value (*SCB, 2013*).

It is not straightforward to determine what the term cultural ecosystem services incorporates because of the low conformity on what cultural means and which values are connected to it (Scholte *et al.*, 2016). In order to highlight the nonmaterial outputs from ecosystems that affect the psychological and physical state of people cultural ecosystem services aim to distinguish those values from other (Haines-Young & Potschin, 2012). A variety of socio-ecological interactions have been placed under the CES category and emphasizes the importance of CES according to their role in the well-being of humans, their use in personal environment behaviours and policy-making arenas and their usefulness for examining wider socio-ecological relations (Hirons *et al.*, 2016). Their occurrence starts with the human-ecosystem interactions and can exist in all ecosystems, from unexploited wilderness, deltas to urban green spaces (Chan, 2010). The importance of CES originates from its central role in the well-being of humans. When balancing the evidence, experiencing nature has positive effects on our happiness and health (Russell *et al.*, 2013).

Because cultural ecosystem services generate human well-being, CES become an important aspect in environmental decision-making in a wide range of scales, from international to personal. With that said, even though interest in CES and related research is growing, the inclusion of CES in international and national decisions is still an exception (Hirons, 2016). Potentially, CES could work as a concept in framing future assessment connected to non-economic loss due to climate change. In recent literature some writers focuses on cultural ecosystem services inclusion in management (Pröpper & Haupts, 2014), but a bias towards leisure-oriented CES as recreation, aesthetic and tourism can be noticed. On a more local and personal level, CES can motivate local land management decisions (Plieninger *et al.*, 2013).

In contrast to biophysical landscape services, socio-cultural services are specific of stakeholder, location and time, which aggravates the validation of qualitative measurement, for example landscape aesthetics and cultural heritage (Hein *et al.*, 2006). This is confirmed by Layke *et al.* (2012) who state that cultural ecosystem services are context specific and must be adapted to location and purpose. Also, the individual perceptions of cultural ecosystem service are often very qualitative and do vary by nature. To avoid misinterpretation of the CES, transparent communication is important because of the different dimensions of uncertainty (Walker *et al.*, 2003). The lack of standardized definitions and measurements can prohibit the incorporation of cultural ecosystem services in decision making processes (Hernández-Morcillo *et al.*, 2013).

Urban system services is a concept defined in the book Principles of social-ecological urbanism written by Stephan Barthel *et al.* (2013). These are services that function as principles that underlie resilient urban design and can be categorized under the category cultural ecosystem services. Public urban services are services that are created by design elements in the urban landscape. Some design elements are then divided into the different services even though they are closely entwined. A design component described in the book is green arteries, which are spaces that manage access and flows for both people and animals. This can be illustrated by a pedestrian walkway bordered with trees leading to parks. The urban system service accessibility is generated as well as the ecosystem services habitat for species, air regulation, seed dispersal and several more. The service publicity is very important to make a public place feel attractive and the area in question does not evolve into a monoculture where only a certain group of people feel welcome. All urban designs should supply and support a multitude of services, including ecosystem services. (Barthel *et al.*, 2013).

2.3 Indicators

A complex system or phenomena (indicandum, i.e what is being indicated) can be represented in a quantitative way through measurement of an indicator (Czúcz & Arany, 2015). Another definition of an indicator can be as a measure that is based on data that can be verifiable and it conveys information about more than just itself (BIP, 2011). Indicators can work as fundamentals in goal formulations and achievement evaluation but also facilitates information and communication (Heink & Kowarik, 2010). Indicators are commonly used in a wide area of sectors where the systems used are of a complex kind. An easy way to define an indicator is to comprehend that the temperature is an indicator for the weather.

From a scientific perspective, indicators can be regarded as measure that quantifies a pertinent property of the indicandum. How close the connection between indicator and indicandum is a key aspect and it has to reach a level of 'close enough' to be declared useful. Therefore, it is a property which is hard to formalize and has inborn factors of association (Czúcz & Arany, 2015). More complexity is added when the system of indicator-indicandum is nested with hierarchy. As an example, the indicandum biodiversity can be evaluated with the indicator species richness, but can also be an indicator for ecological quality in the area (Turnhout *et al.*, 2007; Hernández-Morcillo *et al.*, 2013). Nested aggregation in complex systems can be a way of formulating indicators by identify components and subsystem and quantize them all and make an indicator of the summarized statistics (Bauler, 2012).

2.3.1 Indicators for cultural ecosystem services

Over the years, human have been benefitted from tangible goods and intangible assets, the later called cultural ecosystem services. Research regarding cultural ecosystem assessment has increased over the last decade but it still remains in the periphery and is mostly used in marketable services as tourism. Using accounting of cultural ecosystem services in decision making processes has challenges in the evident difficulties regarding standardization of definitions and measurements. (Hirons, 2016).

In a review by Hernández-Morcillo *et al.* (2013) are cultural service indicators examined within the research of ecosystem services. When they searched for methods of accounting CES indicators, a wide-ranging variety was found, mostly because of diverse aim of the studied reports. For assessing educational, inspirational and recreational services, benefit indicators were the measure mostly used. Furthermore, they found that a majority of the cultural services indicators were lacking clarity regarding definitions, purposes and understanding of the measured processes while trade-offs and bundles with other services were marginally referred to. In numbers, multi-temporal assessments were only performed 17% of the times and spatially explicit information was used in 23% of the cases. It is concluded that indicator quality could be improved greatly if the effort of including relevant stakeholders in conceptualization and communication phases were increased.

Arguably, cultural ecosystem services do have an intuitive logic but the concept brings along a number of challenges to ES accounting (Norton *et al.*, 2010; Hernández-Morcillo *et al.*, 2013). One challenge can be the inborn difficulties to establish a clear link between the CES connected to certain elements of the ecosystem and its multitude of functions (Vejre *et al.*, 2010). Another problem, even if a distinct biophysical carrier to a cultural ecosystem service is identified, is that it is often problematic to calculate the value which works as an outcome. Many CES are also hard to put a monetary value on because of the intangibility and incommensurability characteristics associated to them (Goldstein *et al.*, 2011). Gee & Burkhard (2010) writes that the relationship between the environment and observer must be considered, not only the services produced by the ecosystem. That includes the personal and

social driving forces which influences the demand side in all ecosystem services. Too many present ecosystem service assessments are focused on the supply side (Plieninger, 2013). The demand (the observers) side is almost always affected by individual factors, such as habits and belief systems, cultural and social background, way of living and traditions (Kumar & Kumar, 2008; Martín-Lopez *et al.*, 2012). Qualitative information on individual perceptions therefore makes the foundation of many CES which complicates verification (Fagerholm *et al.*, 2012) It could be argued that there are few, if any, measures that could be used when monitoring the actual delivery of most CES (Feld *et al.*, 2007; Layke, 2009). However, Hernández-Morcillo *et al.* (2013) concludes that CES indicators can be built without individual validation.

2.4 Indicators used today for different urban ecosystem services

In 2016 the fourth report of Mapping and Assessment of Ecosystems and their Services was published (MAES, 2016). It is initiated by the European commission to improve the knowledge and the base of evidence for the biodiversity policy under Target 2 Action 5 of the European Biodiversity Strategy to 2020. This report contains guidance for mapping and assessing urban ecosystem services and an indicator framework to quantify ecosystem services. The list of indicators in that report was firstly published in Rocha *et al.* (2015) and the list was put together after a survey done all over the EU. Part of the indicator list is available in Appendix A.

Another source of urban ecosystem indicators is C/O city:s presentation (2014) where indicators for several ecosystem services in a variation of scale is described. Indicators needed to describe the interaction between ecological process and ecosystem services are provided by de Groot *et al.* (2010). For cultural ecosystem services, La Rosa *et al.* (2016) reviewed 63 reports and presented a list with indicators. This list is also available in Appendix A.

2.5 Indicator quality

An urge for concrete results in terms of ecosystem service accounting has been called upon and that raises the demand for practical indicators. To achieve this, indicators should be specific, measurable, achievable, relevant and time-bound, or "SMART" indicators (UNDP, 2009). Therefore, SMART indicators do have a vital part to play in result-oriented management. To fully establish an indicator, the indicator has to be objectively verifiable which means that a given indicator should produce similar information when used by different researchers (Hernández-Morcillo *et al.*, 2013). A thorough guidance of developing ecosystem service indicators can be read in Brown *et al.* (2014). Down below follows a description of a similar developing guidance that focuses on CES indicators and uses BIP (2011) as source, which also Brown et al. (2014) does.

For every assessment for CES, indicator quality should be granted by achieve minimum conditions (Hernández-Morcillo *et al.*, 2013). Accordingly, UK National Ecosystem Assessment proclaim that "measures of cultural services should be context specific, fluid and mutable, as meanings, values and people's behaviours change over time and space in response to economic, technological, social, political and cultural drivers" (UK NEA, 2011). Thus, the creation process of effective cultural indicators almost seems as important as the result itself. One way to develop indicators is to use the SPICED framework. It is developed by Roche (1999), who claims it is suitable when developing indicators with the use of subjective information.

Definition of the entire development process for responsive SPICED cultural services indicators is illustrated in Figure 2 (Hernández-Morcillo *et al.*, 2013):

Conceptualization phase: The initial stage where the aim of the CES indicator must be defined. It must be clear of what question the indicator will answer. When measuring intangible assets there is a subjectivity inherent so clear definitions and involvement of relevant stakeholders in a conceptual framework is crucial if the measure should relate to its purpose. In most cases can not one single CES indicator be an effective measure, it has to be combined with others.

Calculation phase: When the indicator foundation is defined it must be assigned to its operational units. These should embody the suitable spatial and temporal context and a baseline ought to be established so the indicator can be responsive to contextual changes. It is in this phase data is gathered and the data should be easy accessible for the sake of future assessments. Further data-validity needs cross-checking, even when purely qualitative information is used.

Communication phase: A significant process is the interpretation of indicators where local stakeholders should be involved to build a coherent storyline. The cultural ecosystem service indicators should be easy to understand for the target audience so a careful selection of graphics, language and media is good when presenting the findings. In the end, ensuring that indicators are relevant to stakeholder's needs and measuring capacities.

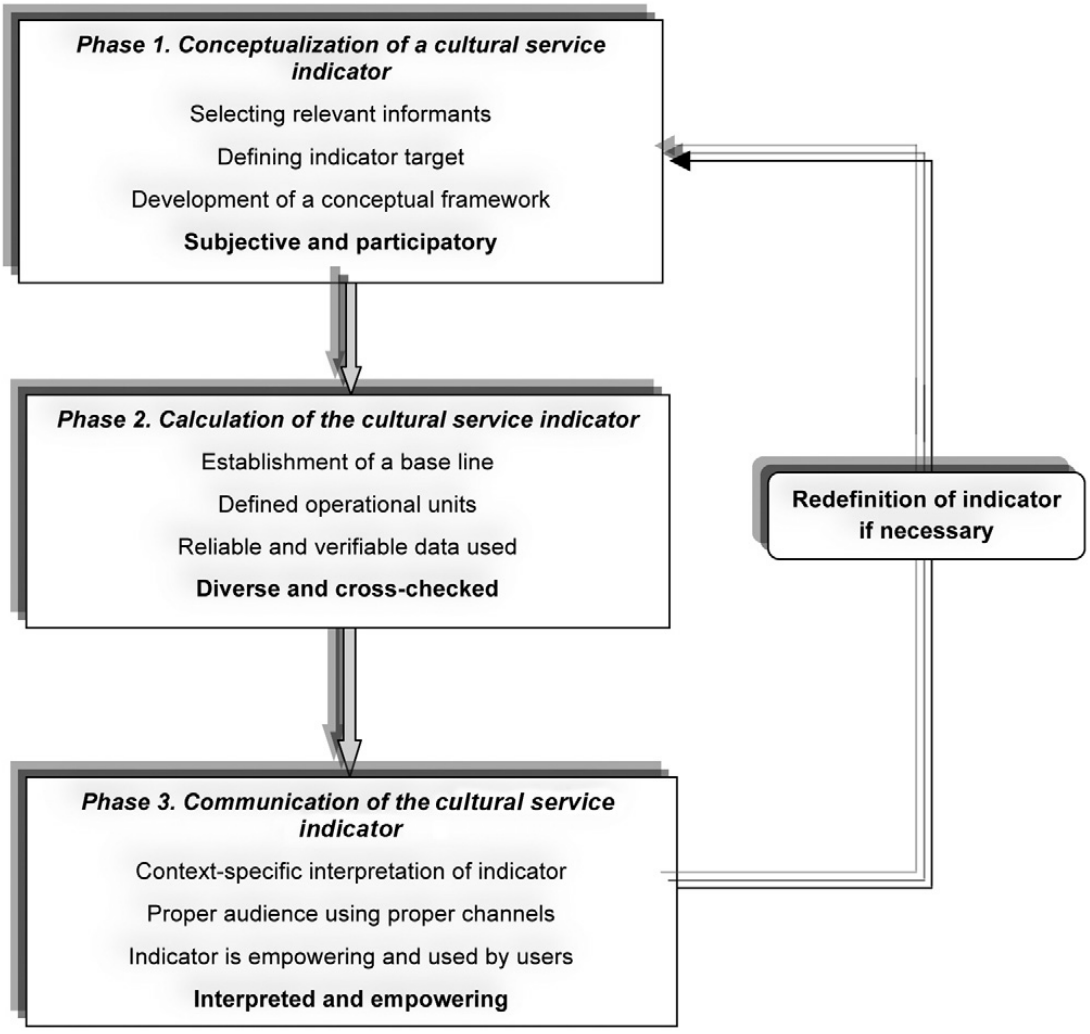


***Figure 2**. Conceptual model to develop ecosystem service indicators. Source: Adapted from BIP (2011).*

2.6 Birds in urban green spaces

In a recent systematic literature review, Hedblom *et al.* (2017) concludes that birds are strongly linked with urban green spaces and the sight and sound of them may provide non-monetary values as increased well-being and stress reduction. It is also discussed how knowledge about people's perception of birds can be useful in the management of urban green spaces.

In the urbanized world, humans have distanced themselves from nature, both emotionally and physically which have decreased their contact to animals. Several animals have followed into the cities and apart from smaller taxa like insects, birds are the wild fauna that people most commonly encounter in daily life (Koford *et al., 2011*). A great deal of previous research on urban bird fauna has focused on the ecology, evolutionary processes and urban adaptation of birds. But recently, a growing body of literature has investigated how the acoustic and visual effects from bird encounters affect human well-being and other cultural values (Grahn & K Stigsdotter, 2003; Bjerke & Østdahl, 2004; Fuller *et al.*, 2007; Luck *et al.*, 2011; Belaire *et al.*, 2015).

The growing interest of the potential cultural values related to birds in an urban environment is not surprising. Because of the high bird density in urban environments, there are many encounters between urban citizens and birds (Marzluff, 2001; McKinney, 2002). To date, a number of studies have shown that bird sightings have become easier as bird behaviour has changed when they have adapted to urban environments (Jerzak 2001; Randler 2008). Furthermore, the amount of interactions between humans and birds can increase with bird houses and by food provisioning (Fuller *et al.*, 2012).

Human interactions with birds can possibly be analysed with the use of ecosystem services. Hedblom (2017) proposes that MA (2005) potentially could provide a useful framework of CES for assessment of birds' cultural values or immaterial services. Most certainly can encounters between birds and humans have values connected to mentioned services which are exemplified by numerous studies where contact to nature is shown to reduce stress (Kaplan 1995; Grahn & Stigsdotter 2003; Hartig *et al.*, 1991). The measurement of potentially applicable variables, such as bird's visual aesthetic appeal has been proven difficult (Belarie *et al.*, 2015). Therefore have previous studies that have been made on the perception of birds mostly relied on self-evaluated estimations of effects considered to be variables on people's well-being (Hedblom *et al.*, 2017).

Human appreciation of birds is mostly connected to their visual appearance and acoustic presence together with behavioural characteristics (Cocker & Tipling, 2013). Small song birds with pleasant songs are highly regarded as they are associated with spring and summer (Bjerke & Østdahl, 2004). On the other hand, a number of studies have described the disservices of birds (Högblom *et al.*, 2017) and Belaire *et al.* (2015) suggest that negative experience with birds are perceived more clearly than positive experiences. Negative attitudes towards various species in French urban environment were found by Cleargeau (2001). Birds like herring gull, european starling, house sparrow and rock dove were all described as unpleasant. In another study, Belaire *et al.* (2015) investigated people's experience of birds in Chicago but argued that negative experiences found where exaggerated and could not be seen as a major problem because they did not reflect the true characteristics of the birds. This analysis is supported by Cleargue *et al.* (2001). They found that 69-74% of the interviewees liked the presence of the birds even though many had negative perceptions of some species.

Nonetheless, attitudes towards many bird species in urban areas *are* positive (Högblom *et al.*, 2017). In a study (Bjerke & Østdahl, 2004) were "small birds" and "ducks" ranked in the top

among urban animals which indicate that birds does not have to be vibrant to get appreciation from people. It is easier to hear birds than it is to see them and natural sounds of wind water and birdsong are acknowledged to have restorative effects on humans (Ratcliffe, 2015). According to experimental studies (Alvarsson *et al.*, 2010; Annerstedt, 2011), do nature sounds, including birds, help stress recovery and supports well-being. This corresponds with the findings made by Björk (1986) were some bird species associated with relaxation. In an inquiry made by Ratcliffe (2013), birdsong received the highest score (35%) in potential for reducing human stress, ahead of sounds of water (24%) and non-avian animals (18%). These findings resulted in her proposal that certain birdsongs have more restorative perception (described as reducing stress) than others. Why birds contribute to human well-being and restoration is not fully clarified, however one possible explanation is that the brain pathways associated with vocal learning is quite similar in birds and humans (Jarvis, 2004).

The way humans perceive birds is complex and depends on a variety of factors, such as the gender, age, proximity to green space and knowledge about the birds (Bjerke & Ostdahl 2004; Cooper & Smith 2010). To generalize, older women who have a good knowledge about birds and live close to areas where they are frequently sighted experience a higher amount of benefits. However, human appreciation of certain birds and bird song relate to complex mechanisms and is therefore a subject that has not been fully investigated as of yet (Hedblom *et al.*, 2017).

Taylor *et al.* (2013) writes that progress can be made in urban planning and greenspace management to encourage diversity in urban bird populations. These can be accomplished by imitating natural environments and grow a high variation of vegetation in urban green spaces.

There is a relatively small body of literature that has been concerned with birds as indicators for cultural ecosystem services. One is a presentation made by Andersson-Sköld *et al.* (2016). The concept is illustrated in Figure 3 below.

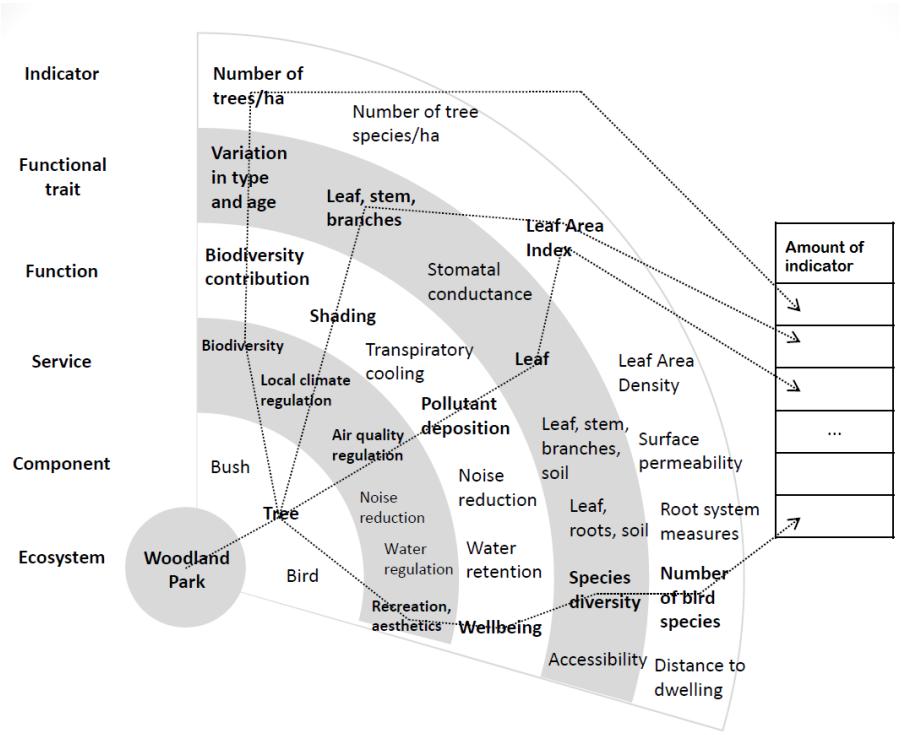


Figure 3. *An illustration of how birds can function as an indicator for well-being and the ES recreation and aesthetics in a natural environment. Source: Modified from Andersson-Sköld et al. (2016)*

2.7 Requirements for good seating

In public spaces, protection against risks, physical injuries, insecurities and unpleasant sensory influences are key foundations (Gehl, 2010). In the next level, spaces must deliver good comfort and people must be invited to core activities that constitutes the use of public space- walking, standing, sitting, seeing, talking, hearing and self-expression (Gehl, 2010). In the same book, Gehl constitutes 12 quality criteria and one of them is "opportunity to sit". He also describes underlying advantages linked to sitting, the advantages view, sun and people. Here, it is easy to include birds and the opportunity to sit is also a way to utilizing and creating ecosystem services when interacting with the ecosystems in place.

When places for recreation are chosen, aesthetic experience is ranked in the top. When spending time in urban green spaces, comfort and meeting other people are the two important factors (Berglund & Jegeby, 1998).

People who need to stay at a place for any amount of time will find it tiring to stand and will be looking for a place to sit (Gehl, 2010). The longer the predicted stay is, the more selective will the choice of seating become. Quite obviously, the best seating almost always has numerous advantages and few disadvantages (Gehl, 2010). In a study in Stockholm, Gehl (1990) established four general requirements for good seating: a pleasant microclimate (the climate in a local atmospheric zone, just as small as a bench surrounding), a good view, good placement (back covered, offers protection) and noise-levels low enough for conversation. So when local climate, placement, protection and view come together the seating gathers all the best parts.

Seating is put into the ecosystem service terminology by Bieling & Plieninger (2013) as they identified benches as visible manifestations of CES. In their study were benches associated with aesthetic experiences and recreation. Further on they write "Recognizing a landscape element as a manifestation of a cultural service implies judgements about its potential uses: a bench, for example, is used for sitting down, resting, enjoying scenery and, thus, is seen as serving aesthetic and recreational purposes." (Bieling & Plieninger, 2013, p 11).

2.8 Management of a urban green space

The concept of Urban Forestry was first described in Randrup *et al.* (2005) and then redefined as Green Space Management by Randrup & Persson (2009). They define green spaces as individual trees, designed smaller areas and nature-like areas of larger size and management as planning and maintenance. In the later report, it is explained that they are convinced that strategic work in park management must be increased to ensure its position in municipal planning.

To explain and illustrate the relations that can be associated with urban green spaces can the Park Management model in Figure 4 be practical. The actors, stakeholders and human interest are defined on one side while the affecting aspects are defined on the other side. The model is an illustration that summarizes what has been written in international literature regarding management of urban green space. As such, is the management of urban forests described as a procedure where integration of economic, environmental, political and social values of the community is the key to develop a management plan that is comprehensive (Miller, 1996). Comprehensive management is a term also used by Grey (1996) when he defines six requirements for urban forest management. These are: centralized organization with authority and responsibility, knowledge about biological, institutional, social and legal factors connected to the urban forest environment, understanding of what the urban forest needs, a plan for how the needs can be met, sufficient budgets and effective implementation of

Hitchmough (1994) focuses more on the maintenance aspects of management and less on the long-term strategies. In similarity to other sources, Steidle-Schwahn (2006) describes the relations for the main influence factors to green space management. They are economy, functions (aesthetic, cultural, ecological and social), users and knowledge from research in biology, forestry, history, medicine, etc. That report also focused primarily on the actual green space maintenance. Basically, there is common agreement on what aspects should be included in modern green space management. Actors that affect the green space are the formal decision makers and its administrative staff. Other actors are private owners, planners and designers, citizens and persons who have a close relation to the actual green space (Randrup & Persson, 2009).

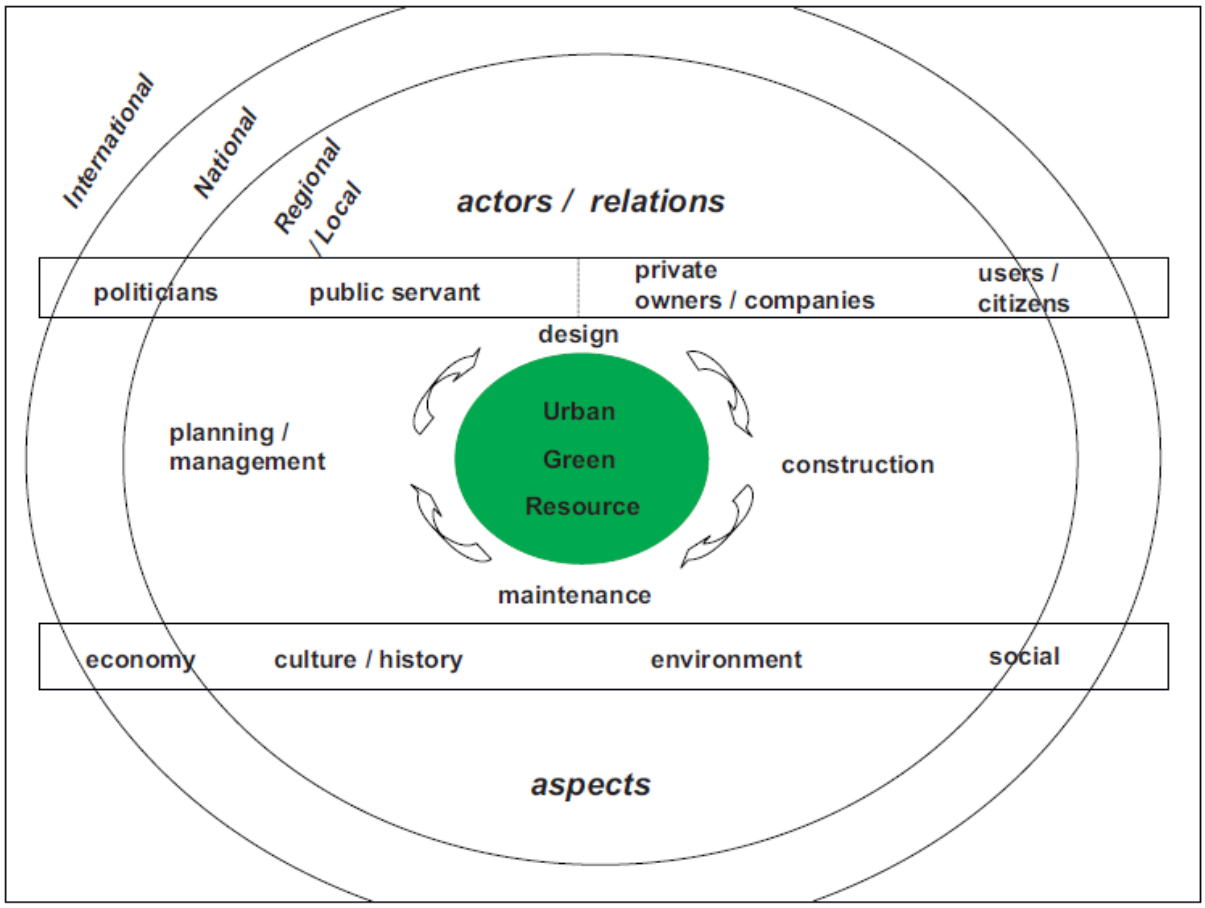


Figure 4. *The park management model that demonstrates the actors, relations and the aspects associated with a green space. Modified from Randrup & Persson (2009).*

Randrup & Persson (2009) concludes that nordic park administrations are mainly focused on organizing maintenance activities and less attention is given to long-term planning activities. If maintenance work gets too much focus there is a risk that green spaces will fade away when other, more well-formulated, matters get a higher prioritization. Just operate is not enough for park organization, which has been proven in the UK (DTLGR, 2002; Beer, 2002). If greens spaces, being dynamic systems, are just maintained they will gradually de-generate. Park organizations are often separated in project-planning functions and maintenance function which require new skills when there is cooperation between public mangers and private organisations. In both public and non-profit organizations, Bryson (2004) highlights the need for strategic planning to work and prosper. CABE Space (2006, p.3) states that a strategy is needed to "reinvigorate parks and green spaces with features and facilitates and with activity

and community support that will put them in the centre of urban renaissance, as well as at the centre of the life of communities." As mentioned before, the management of urban green spaces concentrates on maintenance and what is included in strategic green space management has not been explained in literature.

In order to initiate a progress towards an improved management, Randrup & Person (2009) created at model called Strategic Park Management. It is created with consideration to all tasks within a public park organization as it opens up for cross-sectorial inclusion. As shown in Figure 5, the model consists of three activity rows and two columns. The three rows illustrate the levels of activities in the model, operations tactics and policies. Nowadays, Nordic park authorises have a concentration of expertise and resource down in the lower right corner of the model. This means that much of the effort is concentrated on the actual maintenance, as presented by Juul *et al.* (1998) and Steidle-Schwahn (2006). On the tactical level the plans for the green spaces may be manufactured. Hence, is the right tactical box filled with green space inventories, street tree inventories etc. and they aim at the management routines within the public green space organization. The tactical level will also be the place for relationships between the public green space and other urban space and other public administrative authorities such as those dealing with health, recreation and culture (Randrup & Persson, 2009). This fits under the description of cross-sectorial green structure planning as described by Sandström (2002). The policy level will do the work of formulating specific strategies and long-term visions for green spaces take place. The visions should apply to both public and private green spaces and be developed from analysis and plans conducted at the tactical level.

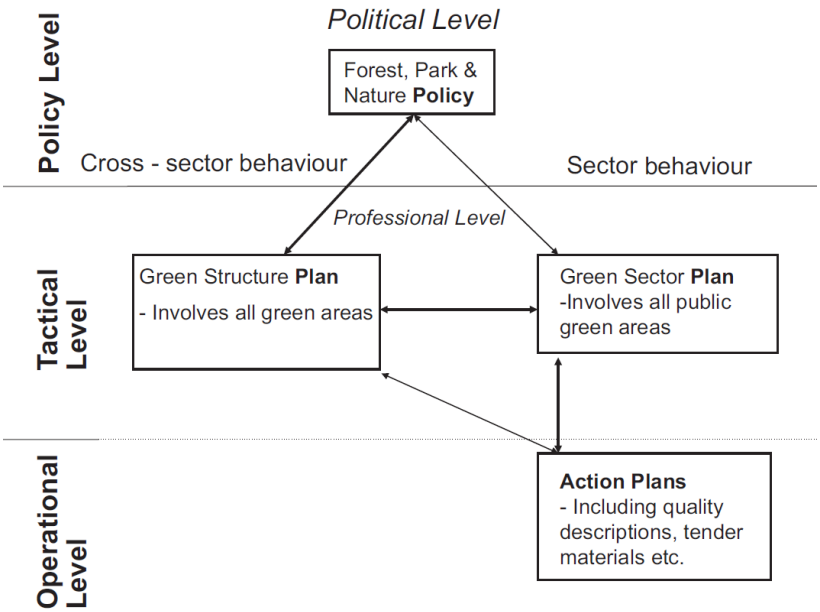


Figure 5. *The Strategic Park Management method. Contains two columns with the sector behavior and the cross-sector behavior. There are three levels that describes the different kind of activities. Source: Modified from* (Randrup & Persson, 2009).

A successful management of urban green spaces is depended on the way the managing organizations are cooperating. Baycant-Levent & Nijkamp (2004) writes that to improve the quality of urban green spaces, a collaborative and enabling partnership among local authorities and local organizations should be formed. Collaboration of this sort is defined as multi stakeholder involvement (MSI) (Hossein *et al.,* 2011). The collaboration can be formal

(instructed by municipality) or informal (intra and inter-organizational, horizontal or vertical and involve many organizations) according to Smith (2009). Associated with MIS is the multi-stakeholder process defined by Hemmati (2002). Its essentials is that it aims to gather the major stakeholders in a new form of communication and decision finding, it should achieve equity and accountability among stakeholders, three or more stakeholders should be involved, it should be based on democratic principles and it should aim to strengthen networks and develop partnerships among stakeholders. It is concluded by Hossein *et al.* (2011) that collaboration like this can be executed on every level of the urban green space development and management, from management processes down to planning and design.

2.9 General management of birds

In order attract bird, an urban green space should contain:

- Vegetation that offers shelter and a place to sleep.
- Varied vegetation structure that supplies a lookout.
- Nutrition and access to water (also during winter).
- Suitable spots nest or build shelter.

(Aronsson & Stenvång, 2013)

Management of vegetation

As shown in nature, a diversified environment generates the highest density of both species and individuals. Urban green spaces with dense shrubbery, open spaces, high and low grass, closeness to water and a big variety among vegetation caters the birds need (Wirén, 1994).In order to optimize the vegetation for the birds should the bushes and the trees be of various height and kind. Almost every tree, bush and herd contributes with shelter and protection for birds but it is the oldest individuals supply the highest biodiversity. The importance of keeping old and dead trees can't be emphasized enough. (Gustavsson & Ingelög, 1994; Höök Patriksson, 1998).

Management of birdhouses and other pro-bird constructions

There is almost a constant housing shortage for birds in urban environments which means that it is impossible to put up too many birdhouses. Bird couples of the same species cannot breed to close to each other, the distance between bird houses should be at least 20 metres in average, depending on species. Different species can breed close to each other (Aronsson & Stenvåg). The bird houses can have different design and have a varied opening size depending on bird species (Jokimäki, 1999). Birds do need water to drink and to clean the plumage which means a pond or a water bath would be helpful for bird access to water. A practical way is to put the water bath on a pedestal to keep it away from kids, cats and dogs. Another helpful detail is a small sand bath which would help the birds to keep the feathers clean. This could also bring some excitement to kids when birds splash in the sand. (Aronsson & Stenvång, 2013).

3 Method

The following is a brief description of a generalized method for identifying space specific ecosystem service indicators for a green space. Furthermore, a multi-stakeholder management system is developed to contain the identified indicators. This management method is developed with the inclusion of stakeholders' suggestion but based on an existing management system framework. It is a qualitative method that uses stakeholder involvement, recent literature and has the ecosystem service perspective. The method described below is further on the tested in the Kvarngärdet case (See section 4).

3.1 Literature study

First and foremost, the literature study had the aim to find indicators that were applicable to indicate the ecosystem services generated by the green space and restricted by the linkage to the target variables. A wide range of current reports regarding indicators of ecosystem services where scanned to find suitable indicators for different ecosystem services in urban green spaces. Search engines like Web of science, Google scholar and the electronic libraries connected to the Swedish University of Agriculture Sciences (SLU) and Uppsala University (UU) were used. Terms used in the search were "indicators for ecosystem services" and "ecosystem service indicators". Several peer-reviewed science reports were read during this study. A review of recent indicators in urban green spaces and the usage of the term cultural ecosystem services were also conducted to exert indicators and clarify definitions. Further, the conducted study wanted to show present implications on the subject of indicators. An overview of the terms ecosystem services and indicators are also presented together with a summary of the characteristics that makes urban green spaces attractive and useful. However, the search of indicators was not the only purpose with the literature study. A management system had to be found, where the identified indicators could be incorporated and the basic concept associated with green space management had to be understood. Firstly though, fundamental knowledge about ecosystem services, green urban planning and design had to be obtained.

3.2 Identifying target variables

A cornerstone in this thesis was to let organisations and stakeholders that manage green spaces contribute to the results. Different stakeholders and mangers of a green space can have varied opinions of what a green space should contribute with to beneficiaries. Representatives[1][2][3] from stakeholders lists what needs and benefits which they request a green space to achieve. These needs and benefits are thereafter formulated into target variables. These target variables are or generate benefits and values. The target variables represent what the stakeholders' wants a green space to achieve in form of benefits and values to the beneficiaries. Notice the difference between needs and benefits and benefits and values. The first one is what the stakeholders' request from a green and the second one is what the target variables are and generate to the beneficiaries when achieved to some level. Each representative listed target variables for what the green space should achieve, or achieve more of, in the future.

[1] Personal message. Elin Olovsson, Project leader Uppsalahem (2017-01.25)
[2] Personal message Ingemar Carlsson, Head City Gardner Municipality of Uppsala (2017-02-15)
[3] Personal message Hanna Wejryd, Priest Church of Sweden Uppsala Pastorate (2017-02-17)

3.3 Ecosystem service assessment

In the process of identifying and assessing the ecosystem services of a green space the target variables and the green space were the two factors restricting the ecosystem service assessment. The ecosystem services are generated at a green space but have to be linked to the target variables to be a part of the study. When these fundamentals in the assessment were articulated the method from the Swedish Environmental Protection Agency (2015) was used. That method consists of using a gross list of ecosystem services to do a broad identification of ecosystem services generated by green space. As the target variables and the spatial area of a green space working as delimiting basic premise, the ecosystem services were chosen from a gross list. The gross list used is a merge of the gross lists presented by CICES (Haines-Young & Potschin 2011), Millennium Ecosystem Assessment (MA, 2003), The Economics of Ecosystems & Biodiveristy (TEEB, 2012), Swedish Environmental Protection Agency (SEPA, 2012a) and urban services presented in Principles of Social-Ecological Urbanism (Barthel, 2013). However, the cultural ecosystem services (CES) presented as urban services and defined by Barthel (2013) are not ecosystem services as they are not by definition generated from an ecosystem. Therefore, they are not as widely used as the ES standardized by the international institutions but are used in this thesis because they are services that are seemingly important when developing an urban environment.

3.4 Identifying the indicators

The literature study was an iterative search process for suitable indicators for the assessed ecosystem services. A suitable indicator should have the capacity to indicate one or more of the identified ecosystem services. In section 2.5 was the development scheme for indicators presented and the conceptualization phase was repeated multiple times to find the most suitable indicator described in literature. The development scheme is created for CES indicators but it was efficient for indicators aimed at other ecosystem service categories as well. The indicator should fulfil certain requirements as good as possible (described in section 2.5 as well). By writing “indicators for ecosystem services” and similar in web based libraries as Web of science (and others) it is possible to find the indicators used in the context of ecosystem services. See appendix A for some of in the literature found indicators. The search process continued with objects or processes not mentioned as indicators in the literature but as objects or process that exist at urban green spaces. These objects or processes should be able to indicate the ecosystem services potentially generated by the green space or indicate the benefits and values linked to the target variables. This to affirm and substantiate the relevance of the indicator. If that was achieved it could be a potential indicator. The object or process had to indicate the ecosystem services in a relevant way and be possible to measure. Moreover, the identified indicator should preferably also have the capacity to be incorporated into a management method. However, this is not a clear analysis in any way before the development of the management method starts. In addition to the iterative literature study a workshop were conducted to let the stakeholders contribute with objects and process that they identified with St:Per’s Park.

3.5 Workshop

A workshop was held on the 20th of March 2017 and was managed by Ingrid Nilsén Boklund and Lars Johansson from the technical consult firm Ramböll and Johan Lundh in the church of St:Per. Apart from the organizing representatives from Ramböll, eleven other partnership members participated in the workshop. In total participated two representatives from SLU, three representatives from the Church, four representatives from Uppsalahem and two

representatives from the Municipality of Uppsala. The purpose with the workshop was to map actors and process on the green space to get input to the identification of suitable indicators. By doing so the stakeholder gets included in the identification of indicators. Another purpose was to investigate what obstacles and opportunities there was in the co-management of Kvarngärdet and the maintenance of St:Per's Park. After an introduction to the concept of ecosystem services they were gathered in mixed groups of three where they discussed and answered questions associated with ecosystem services and what a visit to the park should bring forth. The other set of question referred to the management of Kvarngärdet and the maintenance of the park. It is possible to read the exact questions in Appendix B.

3.6 Measurement of the indicators

In the case study of St:Per's Park in Kvarngärdet birds and compliant seating were identified as indicators. Why these two have been chosen as indicators is explained in Section 5 in this thesis and further analysed in Section 6. The section below describes how the bird indicator was quantified and how a concept model of a compliant seating measurement was developed.

3.6.1 Bird inventory

A bird inventory was made with the methodology of an Atlas inventory (Ekblom 2007), without the registration of breeding criteria. The inventory was made three times in each of the four parks displayed in Picture 1 and had the purpose to give a describing snapshot of the bird life in each park. It was a qualitative observation of the bird life and it was supposed to indicate the amount of ecosystem services generated by the birds in different park surroundings. St:Göran's Park was chosen because of its similarity to St:Per's Park while Carolina Park and Uppsala city garden was chosen for their different design compared to St:Per's Park. The design of each park is visible in Picture 2-5. Each park was visited three times on two days and the bird observation time lasted fifteen minutes per park. In Table 2 is it possible to see what time and date the inventory was made in each park. The observer was stationed on one spot in the park and used sight and hearing to identify present birds. The inventory method had the aim to duplicate a (stationary) visit in a park and then the bird experience which (supposedly) follows on a day in early May. On the first inventory were all species and all individuals counted and on the second and third inventory only the species were counted. All observed species were then summarized per park to obtain a total amount of species. The observations were done by Michelle Edel Nordkvist (M.N) (Ph.D. student in ecology at SLU), Arne Lundberg (A.L) (professor emeritus in ecology at Uppsala University) at SLU and Johan Björk (J.B) (bird-watcher with experience of inventory).

Picture 1. *The Uppsala city Centre with marks for the four parks that where the bird inventory was conducted. (1) St:Per's Park. (2) St:Görans's Park. (3) Uppsala city garden. (4) Carolinaparken.*

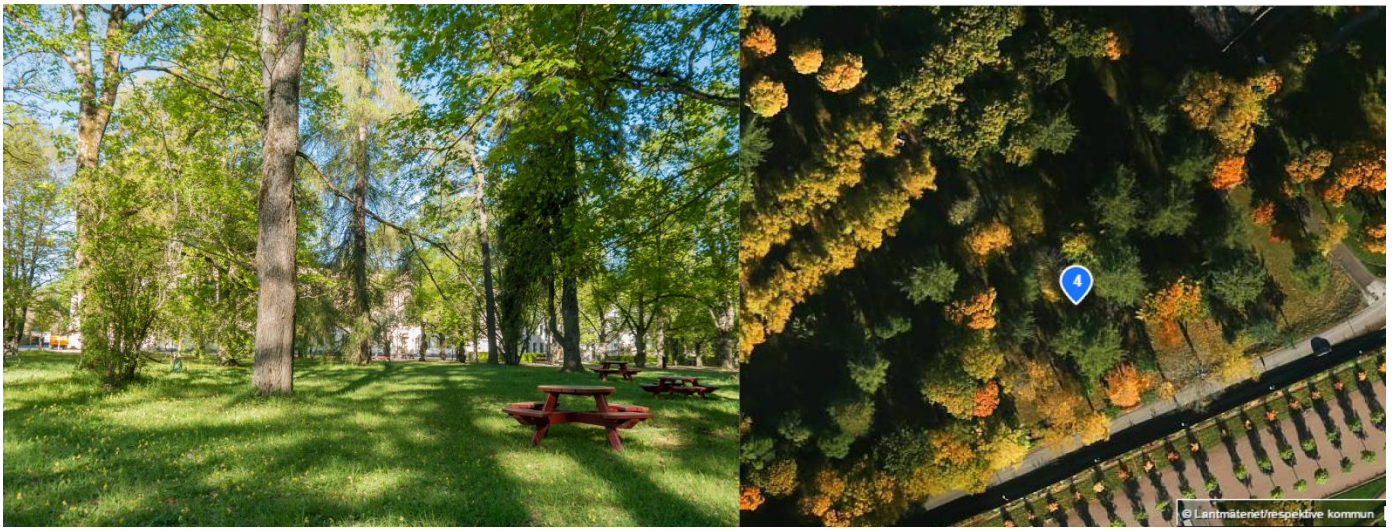
Table 2. *The date, time, observer and park of the conducted bird inventory. The observations were done by Michelle Edel Nordkvist (M.N), Arne Lundberg (A.L) and Johan Björk (J.B).*

Bird inventory			
Park	Date	Time	Observer
St:Per's Park	5th of May	06:30	MN
	5th of May	12:00	AL
	6th of May	06:30	JB
St:Göran's Park	5th of May	07:00	MN
	5th of May	12:30	AL
	6th of May	07:00	JB
Carolinaparken	5th of May	07:30	MN
	5th of May	13:00	AL
	6th of May	07:30	JB
Uppsala city garden	5th of May	08:00	MN
	5th of May	13:30	AL
	6th of May	08:00	JB

Picture 2. *St:Per's Park in Uppsala and the time, date and observer for the conducted bird inventory. Source: Lantmäteriet/Swedish Land Survey. Photograph: Johan Lundh.*

Picture 3. *St:Görans's Park in Uppsala and the time, date and observer for the conducted bird inventory. Source: Lantmäteriet/Swedish Land Survey. Photograph: Johan Lundh.*

Picture 4. *Uppsala city garden in Uppsala and the time, date and observer for the conducted bird inventory. Source: Lantmäteriet/Swedish Land Survey. Photograph: Johan Lundh.*



Picture 5. *Carlolinaparken in Uppsala and the time, date and observer for the conducted bird inventory. Source: Lantmäteriet/Swedish Land Survey. Photograph: Johan Lundh.*

3.6.2 Development of complaint seating control measurement

In order to decide if a seating in an urban green space is fulfilling the requirements of a *good seating* and work as a manifestation of cultural ecosystem services a control measurement had to be developed. A concept model that has the purpose to investigate if the seating is located in the urban green space is placed in a way that promotes the experience of ecosystem services was needed. In that way can the manifestation of those ecosystem services be confirmed. The development of this concept model is inspired by the four requirements for *good seating* formulated by Gehl (2010).

3.7 Develop recommendations for management system

The cornerstones for the development of a new management system were the result from the workshop, a management method with a ready-made structure and indicators. The existing management method should have the potential to handle the obstacles and opportunities that came from the workshop but also have the openness to incorporate indicators and ecosystem services. Moreover, the sought for management method should have a structure that could

facilitate an increased ability of co-management among the stakeholders. These are the factors that were looked for in the literature study to achieve the organizational aim with the new management system. For the second aim, it was management actions for the place specific indicators that needed to be established.

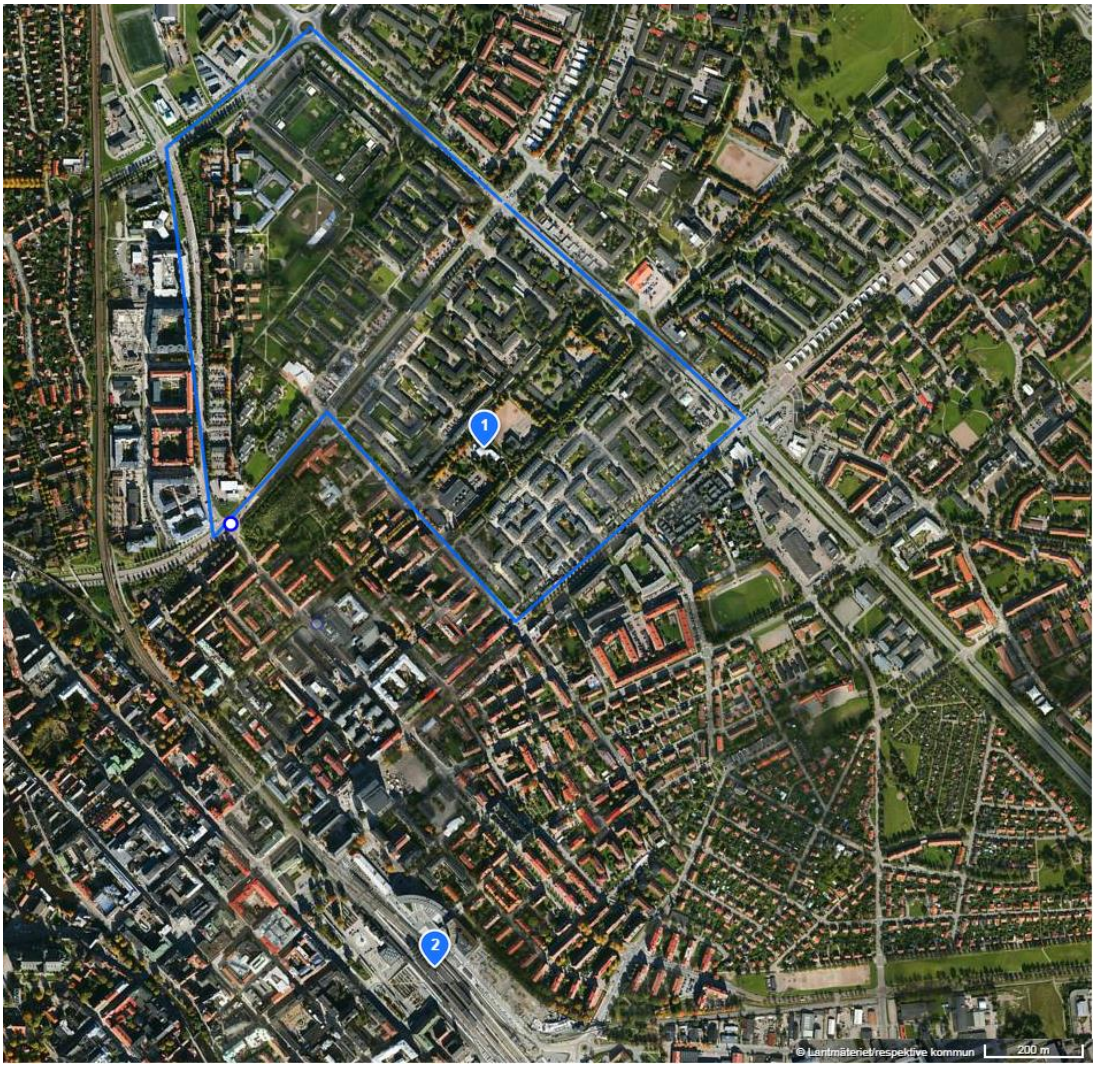
An organizational co-management system with the incorporation of ecosystem services and indicators, which also got operation actions to develop the place specific management, was developed.

When these management systems had been developed, a dialogue meeting was held with the stakeholders to establish proposed actions and concepts into each of the organizations. Representatives from each stakeholder gave feedback and commented the chances of introducing them into their organization.

From the division of church park management Lisa Gustavsson Flygt and Maria Larsson contributed with information and valued opinions, mainly about the specific green space management but also about the organizational routines. Further on, Ingemar Carlsson, Head City gardener and the Municipality of Uppsala gave feedback on the management system and the more space specific operational actions.

4 The Kvarngärdet Case

The group of Ramböll (a consultant firm working with sustainable city planning), the Swedish University of Agricultural Sciences (SLU), the Church of Sweden, the Municipality of Uppsala and Uppsalahem (a real estate company owned by the municipality) have formed a partnership where they have initiated a project where they seek to develop methods that will overcome institutionalized and social boundaries through planning and management of ecosystem services. That project study will be conducted in the neighbourhood of Kvarngärdet (Picture 6), Uppsala. This thesis focuses on the St:Per Park and the ecosystem services, indicators and management connected to it.



Picture 6. *Uppsala city centre in overview with the neighbourhooh of Kvarngärdet marked by the blue line. The church of St:Per is numbered with 1 and the Uppsala Travel Centre is marked with a 2. Source: Lantmäteriet/Swedish Land Survey.*

4.1 Background

Kvarngärdet is a neighbourhood placed in the northern part of Uppsala and it is undergoing a process of change since it was categorized as "suitable for densifying" by the Municipality of Uppsala (*Uppsala Comprehensive Plan*, 2002).

In the northwest and southeast area of the church the houses have been renovated which gentrified the neighbourhood. There is also an ongoing densification with new constructions popping up. This usually causes an increase in population density, followed by a competition of land use (Andersson & Turner, 2014). This creates higher a demand on management and development of the green spaces and ecosystem services (Green *et al.,* 2015). A demand that has been hard to meet because lack of coordination and cooperation between the stakeholders in the area[4]. As an example the Church of St:Per's is a property which is part of Uppsala's ecological network but the management is not governed with a space specific ES perspective. Today's Kvarngärdet area don't have many green spaces and the existing ones are somewhat neglected. Underused parks, gardens and missed opportunities for urban cultivation limit the area's ability to generate ecosystem services that would be good for the whole city of Uppsala. Examples on ecosystem services that potentially would be generated to the local people are recreation and social relations. With a co-management approach between the stakeholders is there a possibility to increase the generated ecosystem services. If that is achieved a higher level of human well-being could be offered to people living in Kvarngärdet, visitors to the church and kids playing in the parks.

4.2 This thesis and the Movium-project

The partnership formed above mentioned actors has the aim to remove administrational, institutional and social boundaries by develop a new breed of management where the area, ecosystem services and people get more focus. A partnership that has materialized in a Movium project. Movium is a think tank that works with urban development at SLU and has the capability to fund projects connected to urban development. The study done within the work of this thesis is a pre-study that intends to investigate if and how indicators are suitable to be incorporated into a new co-management system. Where the partnership has a focus on the whole of Kvarngärdet this report focuses mainly on the green space which is on the property of Church of St:Per.

4.3 St:Per Park

On the same property as the building of Church of St:Per, there is a green space with the size of approximately 150 square meters. The green space does not have an official name but is referred to as St:Per's Park or basically *the green space*. It is used by the church or visitors to the church almost daily with difference in numbers [5]Visitors to the church are mostly families with kids or elderly people. Visiting kids uses the lawn as playground and the elderly people see the area as a restorative place. In the summer, there is a weekly summer café which is quite popular. People walking the dog use the space which sometimes gets negative poop effects. Groups of teenagers use the green space to hang and are seen as a source of littering and some unsafety.[5]

St:Per's Park consist of a lawn surrounded by bushes and trees standing in islands shaped as a ring. There are about 50 trees (Maple is the most common) of 13 different species and 20 species of bushes where lilac is the most common one. One bench is placed in a small fenced area which is shown in Picture 9. The maintenance division on Uppsala Pastorate (Uppsala kyrkogårdar) is responsible for the maintenance of the green space and work in St:Per's Park

[4] Personal meeting with representatives from all members in the partnership
[5] Personal meeting Hanna Wejryd, Priest Church of Sweden Uppsala Pastorate (2017-03-07)

one day a week. They mostly focus on maintenance work as cutting, raking, litter picking and lawn moaning.[6]

Picture 7. *St:Per's Park photographed from the south side in early December. Photograph: Johan Lundh.*

Picture 8. *St:Per's Park photographed from the south side in early May. Photograph: Johan Lundh.*

[6] Personal meeting Lisa Flygt, Project manager at the Church park management (2017-03-07).

Picture 9. *A view from inside St:Per's Park facing northeast. Photograph: Johan Lundh.*

4.4 Stakeholders and Beneficiaries

In this thesis there is three stakeholders: Church of Sweden (Uppsala pastorate), Municipality of Uppsala and Uppsala Hem. They are all connected to Kvarngärdet and St:Per's Park in one way or another.

The Church of St:Per is a church in Uppsala pastorate and owner of the green space called St:Per's Park in this report. The Church of St:Per is running its daily work with family groups, quires and church service. Uppsala pastorate is aiming on becoming environmental certified by 2017.

The Municipality of Uppsala is governed by the politicians in Uppsala town council which has the highest executive power. Beneath the council there are administrations that manage their own area of expertise. In this case it is the town planning administration which is involved in the project. They are responsible for the public green spaces and the green structures of Uppsala. As St:Per's Park is an open private green space it is part of the green structures of Uppsala which is managed by the municipality. These structure plans is public available in the comprehensive plan and further visualized in the in-depth comprehensive plan.

Uppsala hem is housing company owned by the municipality and it owns the quarter just south of St:Per's Park. Their tenants live in close connection to the green space and are seen as highly possible visitors. Because of their houses in Kvarngärdet they do some maintenance work in the proximity of the green space.

Beneficiaries (the ones that benefit) of an improvement of the green space management is in this case are the people that will spend time in the St:Per's Park.

5 Results

The target variables given by the stakeholders could be divided into two categories, social and natural. These target variables were linked with the resulting ecosystem services from the ES assessment. One of the aims with the literature study was to find indicators that could indicate the ecosystem services from ES assessment and the two indicators found were birds and complainant seating. These were measured which resulted in that St:Per's Park got the lowest amount of birds in comparison with three other parks. Hence, indicating the lowest amount of ecosystem services connected to birds in an urban green space. An existing management method was found in the literature study and it was further developed to incorporate the indicators and the results from the workshop concerning management. Thus, resulting in a recommendation for a management system. A summary illustration of the method is shown in Figure 6.

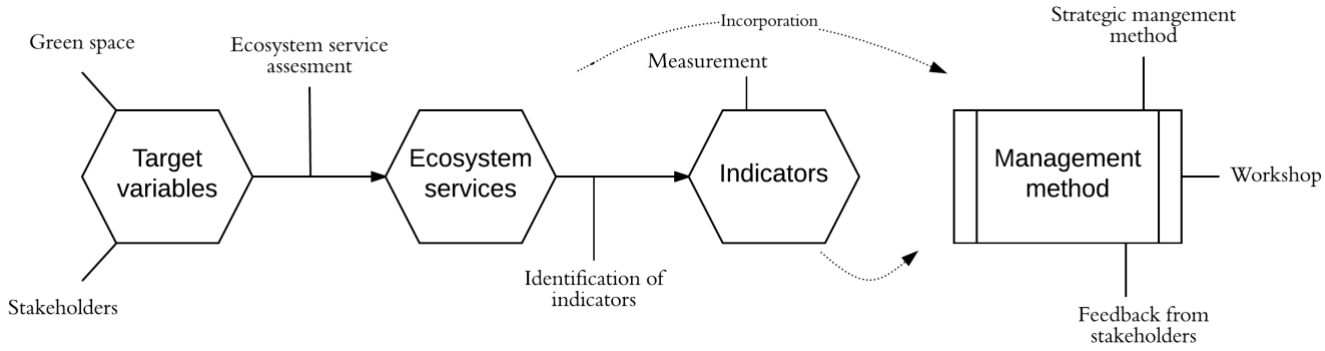


Figure 6. *A flowchart that describes the method of identifying ecosystem service indicators with the addition of incorporate into a management system.*

5.1 Target variables

The inquiring of each stakeholder resulted in a list of needs and benefits called target variables as seen in Table 3. which represent the core aim of what the stakeholders want the green space to generate. These variables are chosen by representatives from the stakeholders with the target to benefit certain beneficiaries. Seven of the target variables are of social character as they are associated with human values and experiences. Four of them have characteristics that are associated with natural environment.

Table 3. *The target variables which represents the needs and benefits the three stakeholders want the St:Per's park to generate.*

Target variables	
Social	Natural
A safe place	Animal in motion
Pleasurable place	Part in green structure
Inviting	Profiliation of plants
A meeting place	Stormwater management
Playground	
Rest and restoration	

Figure 7 presents which target variables are chosen by each stakeholder respectively. The municipality of Uppsala alone selected four nature oriented target variables. The church of Sweden selected all the social oriented variables and the other two selected four each.

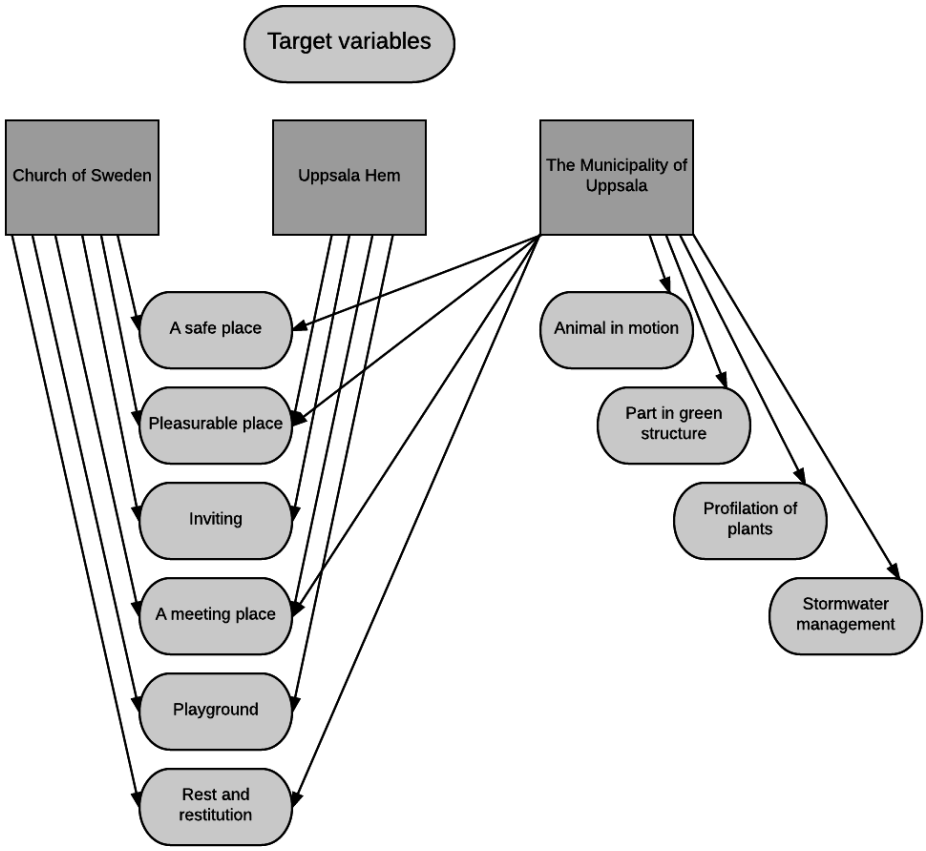


Figure 7. *Target variables for the green space chosen by each stakeholder respectively.*

5.2 Ecosystem services

The ecosystem service assessment of the green space resulted in 13 ecosystem services. An overview of the ecosystem services is presented in Table 2. These ecosystem services can be separated into three categories: cultural, regulating and supporting ecosystem services. Ecosystem services that could be generated by the green space but were assessed not to be linked to the target variables were not taken into consideration and therefore are they not in the list. CICES (C), MA, SEPA (S), TEEB (TE) and Barthel (Ba) enabled the assessment of the ecosystem services with their gross lists of ecosystem services and the column furthest to the right in Table 2 shows from which gross-list each ecosystem service was picked from.

Table 4*. The result of the ecosystem service assessment done at the green space of St:Per's Park. The ecosystem services listed to the target variables. The sources are CICES (C), MA, SEPA (S), TEEB (TE) and Barthel (Ba).*

Category	**Group**	**Ecosystem service**	**Source**
Cultural	Intellectual/ Experience	Aesthetics	MA/S
		Health	TE/S
		Recreation	MA/TE
		Social relations	MA
	Urban	Accessibility	Ba
		Publicity	Ba
		Safety	Ba
Regulating	Regulating physical environment	Local climate and air regulation	MA/S/TE/C
		Water regulation	MA/S
		Pollination	MA/S/TE/C
	Regulating biota	Seed dispersal	S/C
		Habitat for species	TE
Supporting	Biodiversity	Diversity in habitat	TE

The links between the target variables and the ecosystem services can be seen in Figure 8. The linkage process between target variables and ecosystem services is grounded into the literature of ecosystem services but also includes a bit of intuitive reasoning.

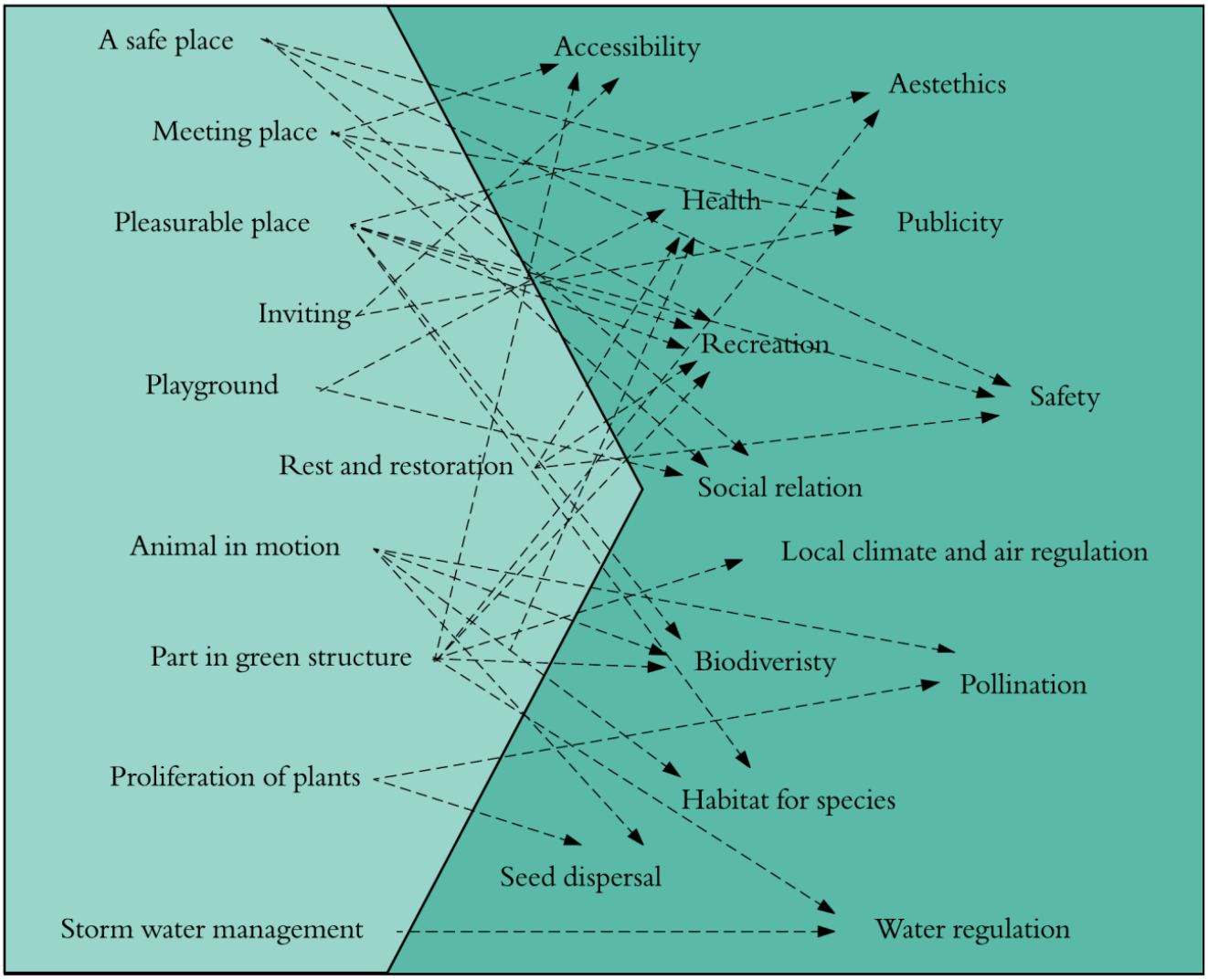


Figure 8. *The links between the target variables and the ecosystem services that are, or could be generated by the green space of St:Per's Park are displayed with arrows.*

5.3 Workshop

Figure 9 provides an overview of the actors and processes the participants of the workshop associated with St:Per's Park. The results are written under the category who & what because that was used during the workshop to make it more informal and inspiring. That result is pointed in the direction of the ecosystem services because of the potential indicators that can be found among the suggested actors.

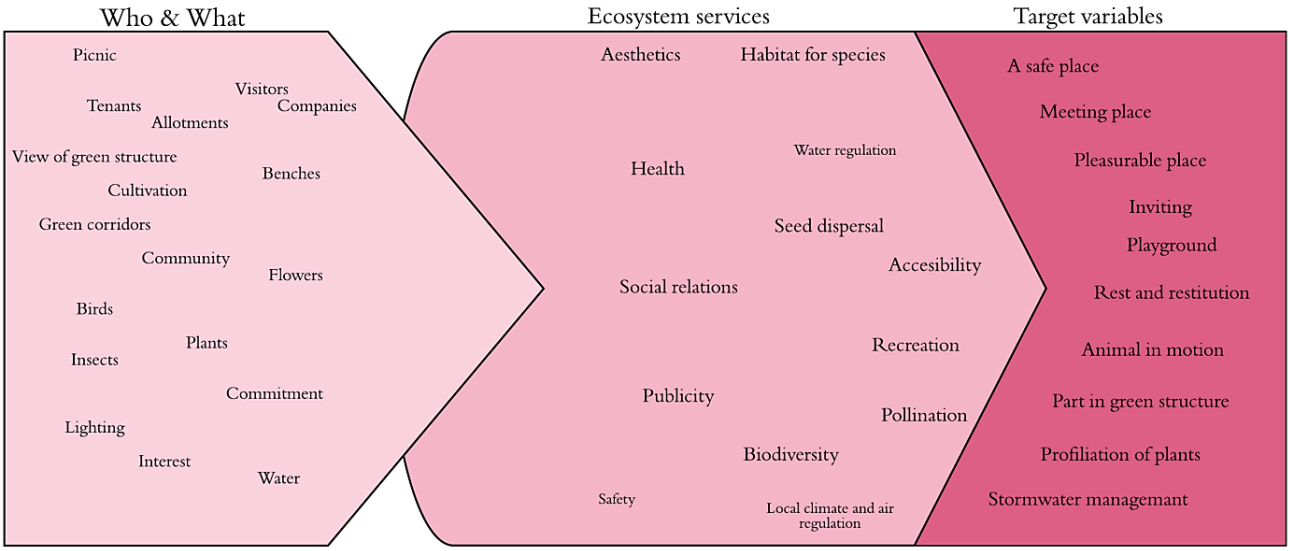


Figure 9. *The left section is the actors and processes which the workshop participants associated with St:Per's Park. These actors and processes also represent what the workshop participants thought created the ecosystem services.*

The participants at the workshop that also are stakeholders within this study presented what obstacles there are that prevents a higher degree of collaboration between the stakeholders. In a similar approach were the opportunities with an increased collaboration obtained. In Table 5 are the obstacles and opportunities displayed.

Table 5*. The obstacles that hinders collaboration and the possible opportunities that are recognized within a multi-stakeholder management between the stakeholders.*

Workshop - managment

Obstacles	Opportunities
• Different budgets	• Collaboration
• Collaboration platform is missing	• Holistic perspective • Economic improvement
• Administrative obstacles	• Ecosystem services
• Financial obstacles	• Positive learning process
• Private actors	• Improved quality

5.4 Birds as indicator

It is established that birds contribute to human well-being and have positive effects on human health when people encounter birds in urban spaces. These values are associated to certain ecosystems services which are shown in Figure 10. When people encounter birds in urban green spaces they experience the benefits from the generated ecosystem service recreation and health. With just a little knowledge of birds, the common ones in urban green spaces are not too hard to identify and they are often present in green spaces which makes them relatively practical to measure. Moreover, birds have been suggested as an indicator for biodiversity in cities by C/O City. Andersson-Sköld *et al.* (2016) also suggest birds as an indicator for urban natural environments which can be seen in Figure 3 above.

Having the above Figure 8 in mind, birds will in this study work as an indicator for ecosystem services at the green space. If birds reside at the green space, it is an indicator that several ecosystem services are generated, among them health, recreation and biodiversity. To exemplify, a certain amount of individual birds and bird species indicates the amount of ecosystem services being generated from the green space. These ecosystem services are linked to the target variables as seen in Figure 10.

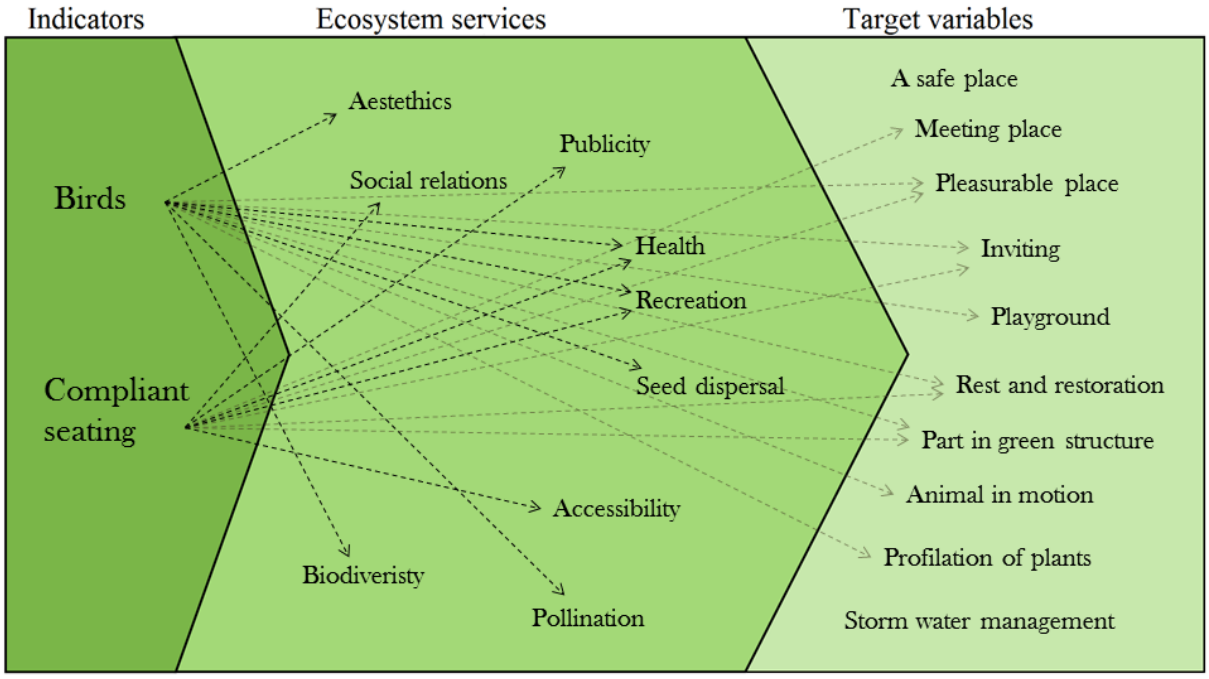


Figure 10. *The two indicators of together with the ecosystem services and target variables they indicate at the green space of St:Per's Park.*

5.4.1 Measurement of Birds

The basic bird inventory conducted aimed to show a snapshot of the birds present in the different parks. It was a qualitative study and cannot be understood as a proper bird inventory due to the short time period and basic (unsophisticated) methodology. The observations themselves can be regarded with high certitude due to the similarity in results and the small sized observations areas. The practical use of the bird inventory in this study was to demonstrate the differences in bird experiences between the parks and by doing that also show the difference in generated ES. However, the results are a representative and accurate

depiction of an early May bird experience in each park but at the same time also an indication of generated ecosystem services.

Table 6 displays all the species observed in each park during the inventory and also the amount of species. St: Per Park has the lowest amount and Uppsala Public Park has the highest amount of species.

***Table 6**. All the species found at each park during the bird inventory.*

Park	St:Per's Park	St:Göran's park	Carolinaparken	Uppsala city garden
Bird spieces	Common Blackbird	Carrion Crow	Common Blackbird	Common Blackbird
	Common Chaffinch	Common Blackbird	Common Chaffinch	Common Chaffinch
	Common Magpie	Common Chaffinch	Common Wood Pigeon	Common Wood Pigeon
	Common Wood Pigeon	Common Magpie	Eurasian Blue Tit	Eurasian Blue Tit
	Eurasian Blue Tit	Common Wood Pigeon	Eurasian Nuthatch	Eurasian Nuthatch
	Eurasian Tree Sparrow	Eurasian Blue Tit	Eurasian Treecreeper	European Goldfinch
	European Greenfinch	Eurasian Tree Sparrow	European Goldfinch	European Greenfinch
	European Robin	European Greenfinch	European Greenfinch	European Robin
	Fieldfare	Fieldfare	Fieldfare	Fieldfare
	Great Tit	Great Tit	Great Spotted Woodpecker	Great Tit
	House Sparrow	House Sparrow	Great Tit	House Sparrow
	Western Jackdaw	White Wagtail	Hawfinch	Lesser Black-backed Gull
		Yellowhammer	House Sparrow	Lesser Black-backed Gull
			White Wagtail	Mallard
				Mew Gull
				Rock Dove
				Western Jackdaw
				White Wagtail
Number of spieces:	12	13	14	18

Diagram 1 presents the summary statistics of the number of birds observed in each park during one single inventory in the morning of May 5th 2017. Table 4 display as a pattern from the lowest value in St: Per Park to the highest value in Uppsala city garden.

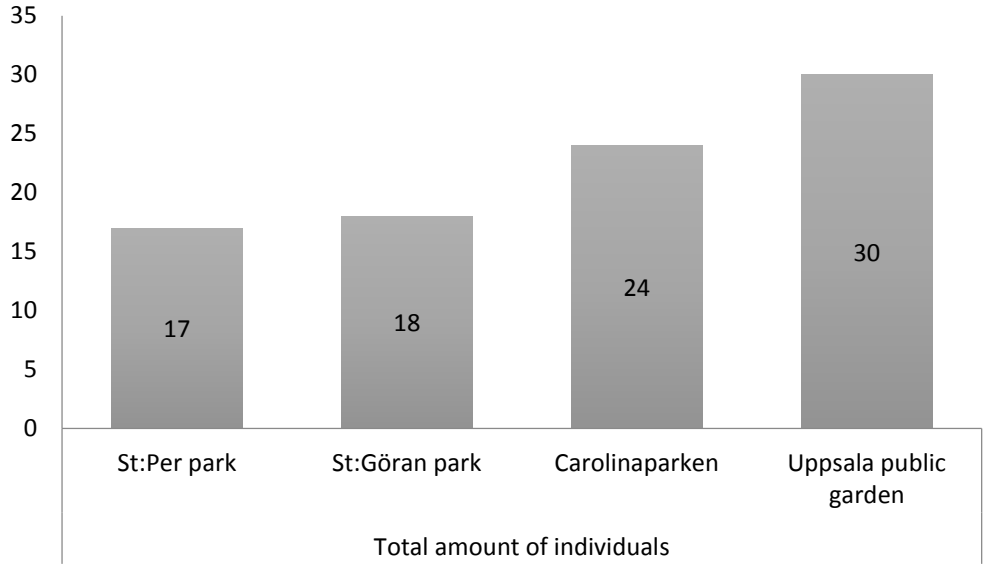


Diagram 1. *All the individual birds observed in each park during one single inventory in the morning of May 5th 2017.*

Diagram 2-5 provides the results of the bird counting in each park respectively. What stands out in Diagram 2 and Diagram 3 is the number of Eurasian Tree Sparrow. Diagram 4 and Diagram 5 shows a wider and more even spread in the bird observation.

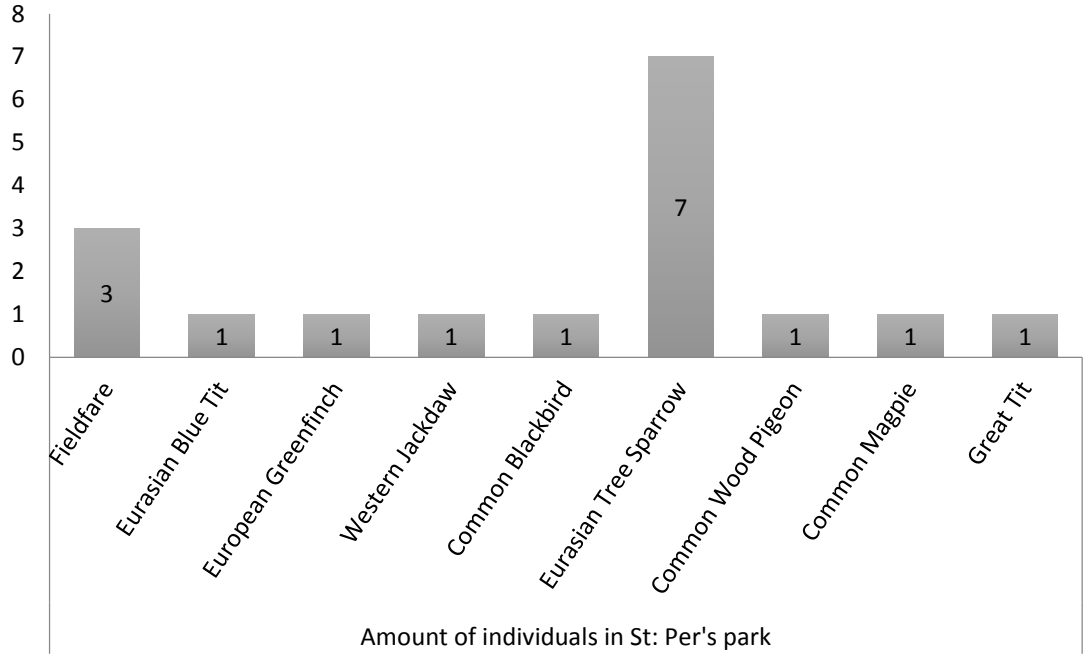


Diagram 2. *All the individual birds of each species observed in St:Per's Park during one single inventory in the morning of May 5th 2017.*

Diagram 3. *All the individual birds of each species observed in St:Görans's Park during one single inventory in the morning of May 5th 2017.*

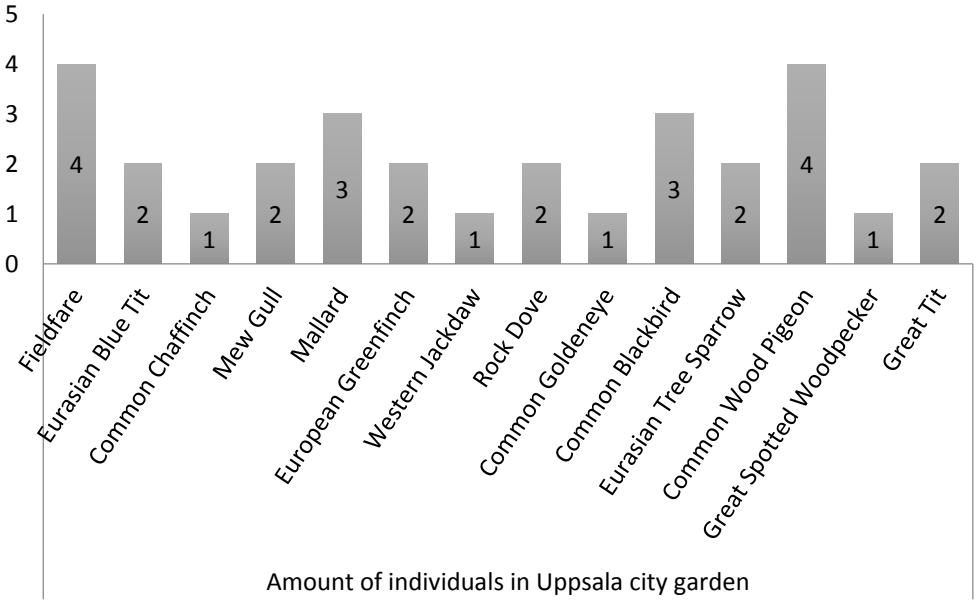


Diagram 4. *All the individual birds of each species observed in Uppsala city garden during one single inventory in the morning of May 5th 2017.*

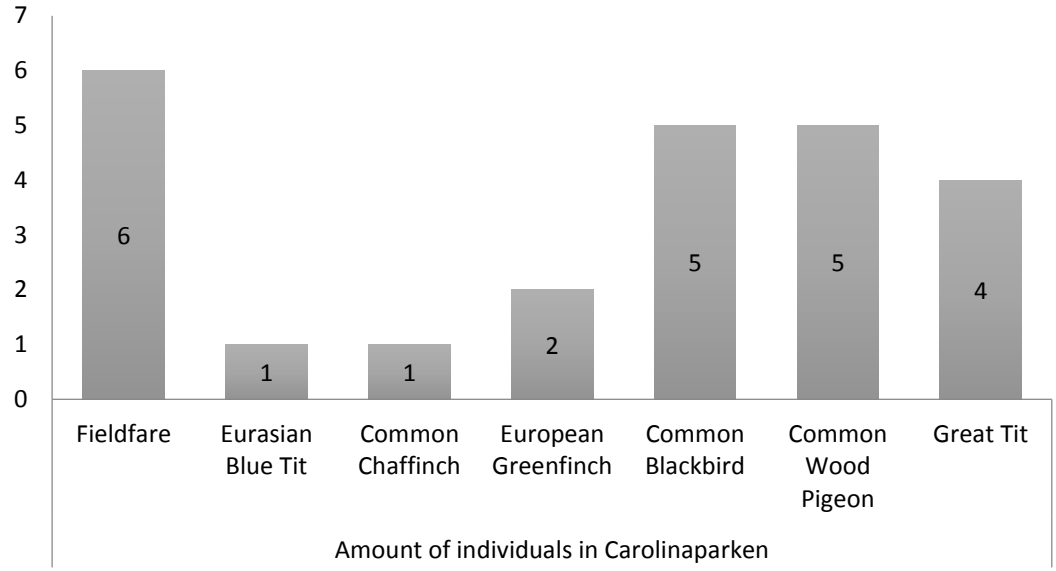


Diagram 5. *All the individual birds of each species observed in Uppsala city garden during one single inventory in the morning of May 5th 2017.*

5.5 Compliant seating as indicator

It is argued (Bieling & Plieninger, 2013) that a seating can be a manifestation of cultural ecosystem services. To achieve that the seating located in an urban green space or an even more natural environment and fulfilling the four requirements for good seating it is an indicator for several ecosystem services, as seen in Figure 10 above. More fulfilled requirements mean more manifested ecosystem services. A good seating increases the potential of people spending more time and experiencing more benefits from the ecosystem services the green space and therefore it is an indicator that more ecosystem services gets generated in comparison with bad seating. Poor seating is defined as seating were none or few of the seating requirements are fulfilled.

5.5.1 Measurement complaint seating

The concept of the control measurement (as seen in Figure 11) was created but not tested. It demands knowledge in the science of landscape architecture to guarantee a result. However, it is easy to use and it can be used by everyone but the result probably varies. Therefore, it can be used in a management purpose to control the location of the seating. The complaint seating is used in this study to complement the birds and develop a tool that can be used in the management system. There it can indicate the manifestation of cultural ecosystem services.

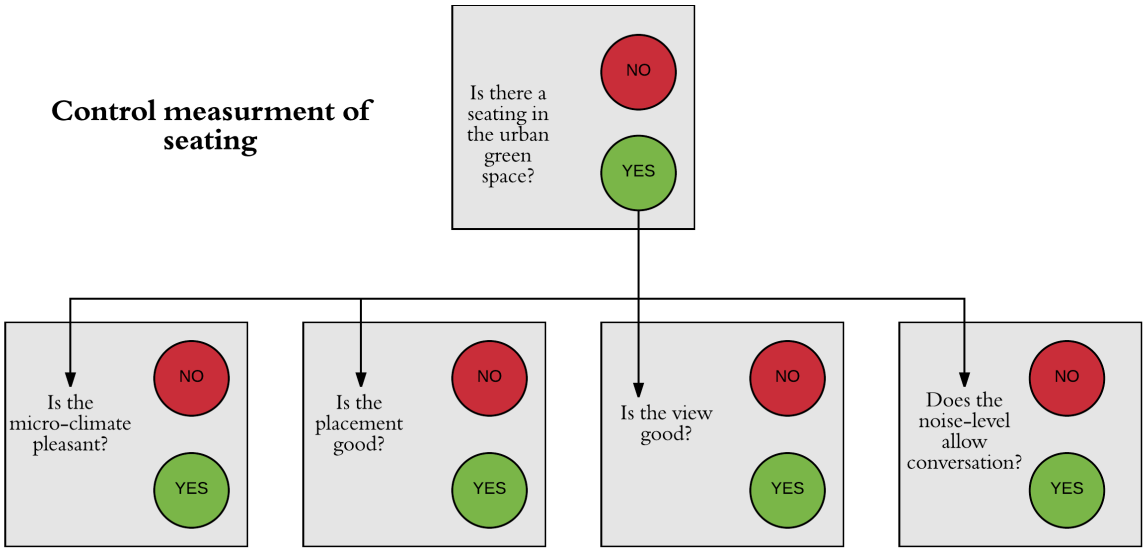


Figure 11. *The control measurement for compliant seating. By answering the question is it possible to find out if the seating meets requirements of a good seating.*

5.6 Management system

The developed management system (Figure 12) is based on the Strategic Park management method (Figure 12) by Randrup & Persson (2010). Its fundamental structure is the parts of Figure 5 while the green part is the newly developed. As shown, added to the foundation of Strategic Park Management are the results from the workshop (Figure 12, the grey square) and the concepts of ecosystem services and indicators. With an add-on of ecosystem services comes the incorporation of indicators on both the tactical level and the operational level. However, to greater extent at the tactical level, a quantified indicator can be a threshold value that different organisations can work towards. At the operational level the management of the two indicators is practical action on the physical green space of St: Per Park. However, indicators are potentially most used on the tactical level because of the knowledge about them can be a factor in the creation of Green Structure Plans. Figure 12 also illustrates how the obstacles and opportunities be incorporated into the management system. As an example, can two collaborative organisations can divide the costs and establish and joint budget by using and combined digital platform.

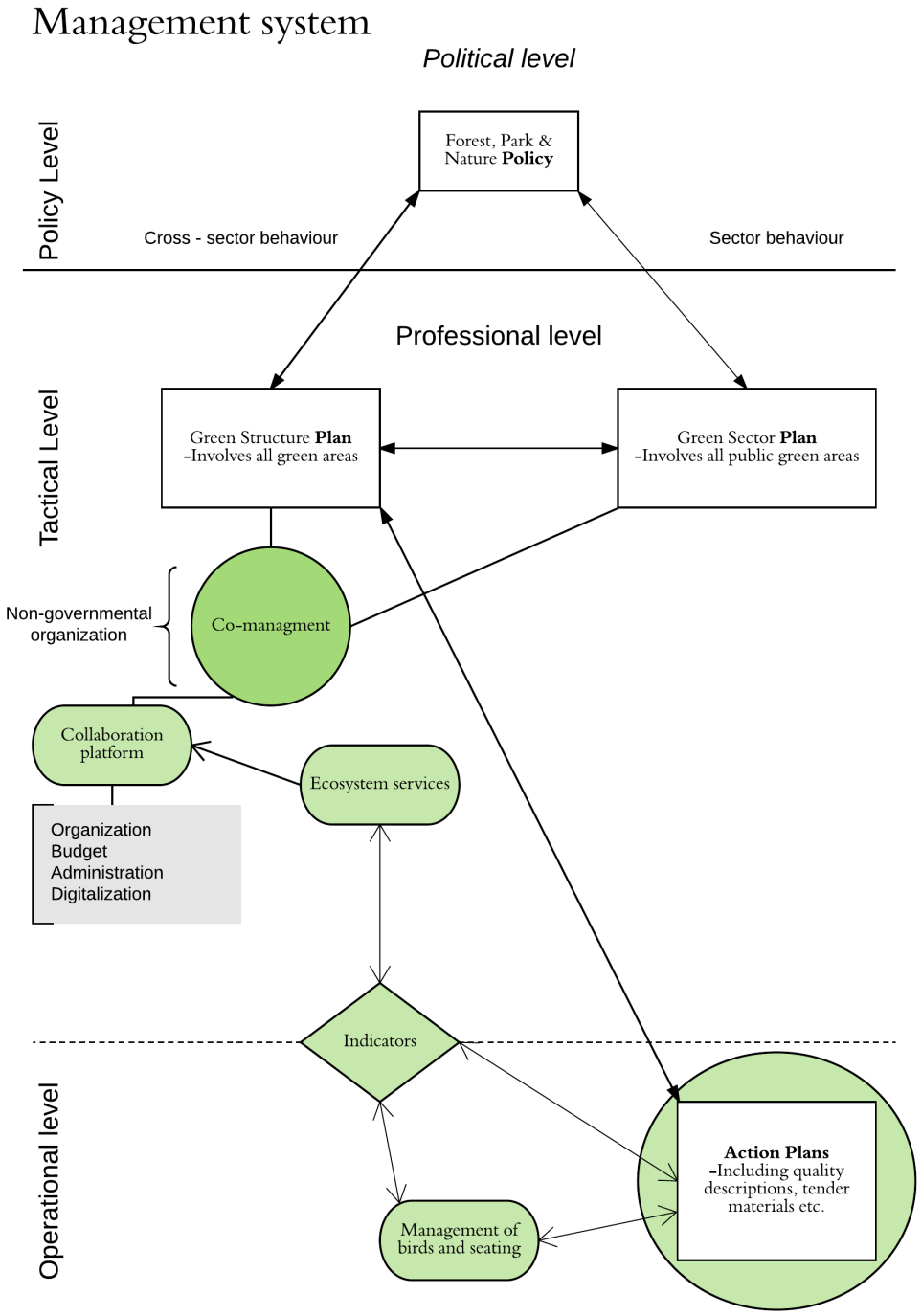


***Figure 12**. The developed management system where the indicators, ecosystem services and the results from the workshop is incorporated. Modified and developed from Randrup & Person (2009).*

5.7 Site specific management of birds and compliant seating

In order to create green spaces that increase the bird population and the manifestation of cultural ecosystem services some site-specific management actions are required. The recommended site-specific management for birds is to put up more bird houses as the vegetation structures decent. In Section 2.9 it is possible to read the general recommendations for bird management and it states that diverse vegetation is important. St:Per's Park contains a fair amount of trees and several species of bushes but lacks a water pond or a sand pond. It

stated by Aronsson & Stenvåg (2004) that it is almost impossible to put up too many birdhouses. Consequently, that becomes a recommendation to increase the amount of birds in St:Per's Park .

The measurement of the compliant seating can be done with the concept tool developed and visit the park or just look at Picture 9. Hypothetically it can be done like this: The bench in the picture is perceived to be located in a pleasant micro-climate with a view over St:Pers Park. It is not possible to have your back fully covered but the noise level should conversational-friendly.

5.8 Management feedback

From the division of church park management[7] it was confirmed that putting up birdhouses in the St:Per Park is possible within the organizational structures. However, budget is the key issue and it must be decided who is paying for the birdhouses and working hours. The Church park management had already started a project where they are putting up bird houses on their parks other than St:Per park. The church park management also have collaboration with the Municipality of Uppsala where they buy bird houses from the municipal carpentry. A higher amount of individuals and species is a practical and possible goal to achieve within the organization. In the green spaces owned by the church there is no strategic long-term plan for the management, the focus lies on effective maintenance. However, there is a group responsible for the trees planted in the church parks.

During a meeting with Carlsson[8], he describes the importance of cooperation and communication between the tactical level and the operational level. How to get the visions and workways established at the tactical level to get implemented in the operational level is a challenge. Possibly this can be even harder when collaborating between organizations on the tactical level although there is some informal collaboration on the operational level between organizations already. He does see potential in collaborative platforms at the tactical level and that collaboration would be easier with a quantitative value to work towards. The biggest challenge is money as each organisation has their budget to allocate. He suggests that a digitalized tool would be sufficient to distribute the work load and the cost.

6 Discussion

This study was set up to identify indicators for ecosystem services and examine if the indicators have the potential to be incorporated into a multi-stakeholder management system. To do this the stakeholders in the management structure had to express what needs and benefits they desire the green space to generate. These needs and benefits were reformulated into target variables and connected to ecosystem services. The next step was to find indicators that could indicate those ecosystem services. How to substantiate these indicators as a valid measure of the ecosystem services became a key question in this thesis. The incorporation of indicators into a management system were another key question in this thesis and to be able to do that, a framework of an existing management system with certain qualities had to be found.

[7] Lisa Flygt, Project leader at the Church park management and Maria Larsson, Project leader at the Church park management. Personal meeting 2017-05-15.

[8] Ingemar Carlsson, City gardener at the community development office in Uppsala. Personal meeting 2017-05-22

Ecosystem services were linked to the target variables and in order to find indicators for the ecosystem services, they had to indicate the same benefits and values as the ecosystem services as the stakeholders wish the green space to generate on a higher level.

6.1 Target variables and Ecosystem services

A first step in this study was to let the stakeholders express what need and benefits they sought after from the green space. These were formulated as target variables and together the target variables represent what the stakeholders want to achieve with the green space. The initial step of formulating target variables was central in order to establish the study in a practical reality where the results could be useful for the stakeholders. Within this study it was a quite clear coherence in the choosing of the social target variables which is reasonable and in line with characteristics sought for in an urban green space. These characteristics are described in Peschhardt *et al.* (2009). They write that pocket parks primarily used for socializing and rest and restoration which is confirmed by Chesira (2004) who also adding escape from city, to be with children and to play sport. These can be translated to the target variables pleasurable place and playground.

Obligated to take care of the whole urban green structure and urban biodiversity is the Municipality of Uppsala and the community development office. This can be read in the comprehensive plan of Uppsala (Uppsala Comprehensive Plan, 2016) and it creates a responsibility to request the target variables animal in motion and part in green structure. In the comprehensive plan, it can be read that the Municipality of Uppsala have the aim create an interconnected green structure. This aim explains why the St:Per's park is seen as an important part in that green structure. The target variables then become an illustration on the scale of responsibility as the community development office sees the green space as a part of something bigger.

What followed the formulation of the target variables was an assessment of the ecosystem services connected to the target variables. By using the ecosystem perspective, it is possible to say that the ecosystem services "create" the target variables. Therefore, could an increased amount of generated ecosystem services at the green space cause a higher possibility of achieving the target variables.

It has been said that ecosystem services are subjective and not necessary objective (Barthel *et al*., 2013). This should be kept close in mind when analysing the links between the target variables and the ecosystem services. The train of thought should consequently be explained, with the use of a question: which ecosystem services must be generated to achieve the target variable? The chosen ecosystem services together enable the achievement of a target variable. This explains the connection illustrated by the arrows in Figure 8. It would have been possible to start with the ecosystem services and then point at some target variables. The point of doing it in this order is that the focus in this study is to identify ecosystem service indicators that were or could be generated by the green space in the framework of the target variables. The resulting ecosystem services was then important when searching for indicators as it was them the indicators were going to indicate.

6.2 Indicators

When the human experience of birds in urban green spaces were linked to health and well-being (Hedblom *et al.,* 2017), the step was not far to give it the status as an indicator. This because these benefits and values described by Hedblom *et al.* (2017) are linked to the same ecosystem services as the one generated at the green space and linked to the target variables.

Health is an established ecosystem service connected with different benefits, both physical and mental. Especially the mental benefits like stress-release are associated with the acoustic presence of birds. When experiencing the visual appearance and the acoustic presence of birds the ecosystem service recreation is provided. Thus, birds became an indicator for some of the ecosystem services presented in Table 4. Additionally, the idea of birds as an indicator is presented by Andersson-Sköld *et al.* (2016) in a presentation which emphasises the selection of birds as indicator in this study.

No conformation with other studies where birds have been used as a measurable indicator for cultural ecosystem services have been done. Most of the other studies found, investigate how birds affect people in natural environments. These investigations have worked as the theoretical foundation in the identification of the bird indicator. However, C/O city (2014) suggest birds as an indicator for biodiversity and moreover the Atlas inventory which is also used in this study. The Atlas inventory is on the other hand used as indicator measurement in this study whereas in the C/O city example the inventory is used as a follow up method. The link between birds and to seed dispersal is described by Hougner *et al. (*2014) and the diversity of ecosystem service generated by birds is described in Wenny *et al.* (2010).

Further research is needed to fully understand the connections between birds and humans in urban nature but it would be valuable to establish bird as an indicator for cultural ecosystem services. This because the measurement of birds is objective and that differs from many other indicators for CES which are founded on people's opinion which is confirmed by Plieninger *et al.* (2012).

As the birds that frequent the parks in this study are quite homogenous, there is a possibility that bird's potential as a generalized indicator can be rather high. This use of birds as a quantified CES indicator has been found in the reviewed reports so the full potential is still yet to be discovered.

In this thesis, it is a lot of focus on the indicated cultural ecosystem services and in the city centres. This is because the functions that generate these ecosystems services is probably of pronounced importance in the cities (Fuller *et al.,* 2007; Irvine *et al.,* 2009).

Prior studies have shown birds habitats are decreasing in cities (Hedblom & Söderström, 2010) and the management of the ones that is left has an impact on bird configuration (Heyman, 2010) and the frequency of the bird song (Mörtberg and Wallentinus, 2000). According to Lailo (2010) this cause habitat fragmentation and therefore is a source of serious effects on animal populations. Thus, the importance of managing the bird indicator to improve the ecosystem services generated. By coordinated urban planning there are possibilities to improve maintenance of songbird diversity which enriches health and recreational experiences. As an example, to put up bird houses and design parks with plantation of diverse vegetation all over a city.

In the current study, where the amount of individual birds and bird species at St:Per's Park where compared with three other parks, one interesting finding was that St:Per's Park had the lowest amount of species (Table 4) and individuals (Diagram 1). These results are likely to

imply that there is potential to improve the maintenance of bird conservation in the park. How this can be done can be summarized in three arrangements:

- Vegetation that offers shelter and a place to sleep.
- Varied vegetation structure that supplies a lookout.
- Nutrition and access to water (also during winter).
- Suitable spots nest or build shelter.

A note of caution is due because of the limited time frame of the inventory, as some species doesn't arrive until the end of May (Wirén, 1994). It could be argued that the results were due to the size of the park Ikin *et al.* (2012) but other studies (Wirén, 1994) shows that the density of species was higher in small parks. Nevertheless, the results of these measurements display the visual and acoustic experience of birds in each park and therefore also demonstrate the indicated ES generated by birds in green spaces.

When it comes to the second indicator several reports have shown that seating is a key component in urban green spaces (Berglund & Jegeby, 1998; Nordh 2012; Gehl 2010) which reflects the results of this paper as benches are assessed to indicate generated ecosystem services (Figure 10). However, to be certain of the indication the requirements (Figure 12) of micro-climate, view, placing and noise should be fulfilled. As mentioned in the literature review, the requirements are necessary because without them probably no high amount of ecosystem services would be generated. Though, generate maybe is not the right word as a seating is not an ecosystem service but is a condition to experience the benefits of ecosystem services of health and recreation. Bieling & Plieninger (2013) call this *manifestation* of CES which is a quite describing term as a bench not is an ecosystem service itself but it is possible to sit on a bench in a park and enjoy birds singing.

To further exemplify the concept, a desolated seating on a tarmac does *usually* not generate (or is a manifestation of) ecosystem services. It can thus be suggested that the complaint seating works as a control indicator CES in urban green spaces.

If a seating is placed or designed into a green space, the measurement method can be used and if the requirements are fulfilled, it is a high possibility that cultural ecosystem services are generated. These findings will doubtless be much scrutinised as they walk into landscape architecture territory where the requirements expressed by Gehl (2010) is well known. However, the compliant seating indicator has the potential to increase the cultural ecosystem services generated at the green space. The term manifestation of CES is perceived as helpful to understand the concept of complaint seating. The measurement tool can be used by others than the urban green space designer who already has this knowledge. A possible hypothesises is that this indicator can be a management tool in relation to seating.

A vast majority of the indicators not chosen but found in the literature were not suitable because of the difference in scale. Those indicators were used on much larger areas that a small urban green space. In other reviews of ES indicators were proportion indicators common, exemplified as proportion green space are of the total city are. Other indicators found in literature but neglected in this study were the count of people or survey based indicators.

A few existing studies demonstrate that birds offer an increased self-evaluated well-being for humans when exposed to birds by eye and ear. The values provided can be described as sought after cultural ecosystem services Hedblom *et al.* (2017). In addition to that birds can be an indicator for the ecosystem services habitat keeping and biodiversity. Birds' profound

place in urban nature and the benefits they generate may establish them as an indicator and they should be taken into account in the management of green spaces.

6.3 Management

The strategic management method was used because it supplied a framework that underlined collaboration between different stakeholders. It also displays a link between planning (tactical level) and the maintenance that takes place at the green space (operational level). Together, these two workways, one horizontal and vertical creates a workspace where the indicators and the ecosystem services can be incorporated. The indicator is placed on the line between the tactical and the operational levels because it is assessed to be functional on both levels. This assessment is made because at the tactical level, an indicator can be used as a quantified objective for several organizations in the management. Possibly this objective can be transferred to a wider but similar policy. At the operational level an indicator has the potential to act as practical control measure a specific green space. One way of doing this is by using the control measurement for complaint seating. A control of a measurement indicator can then be communicated upwards in the organization. Arguably, indicators will be the most useful in the tactical level where indicators potentially can play a role in objectives formulation.

A clear result from the workshop was the need of a collaboration platform where the different stakeholders can work together. This need is an important and interesting matter because to improve the quality of urban green spaces should a collaborative and enabling partnership among local authorities and local organizations be formed (Baycant-Levent & Nijkamp, 2004). Hossein *et al.* (2011) refer to collaboration like that as a multi stakeholder involvement with an addition of a common goal for two or more stakeholders. In the created management system, indicators have the potential to work as a goal. As stated, birds can indicate the amount of some certain ecosystem services generated at a green space but they can also be developed into a goal the whole management system can work towards. This can be seen as way of showing the versatile potential with the quantified indicators.

The indicator can be formulated as a goal for all the members in the collaboration to increase the bird frequency in the managed parks.

Thereby would the ecosystem service performance in the greens spaces increase when different organizations work together in different ways. The collaboration can be formal (instructed by municipality) or informal (intra and inter-organizational, horizontal or vertical and involve many organizations) according to Smith (2009). This is in line with the stakeholders in the present study as they with the participation in the workshop and meetings in the Movium-project try new sets of collaboration, communication and approaches. The Head City Gardner, Ingemar Carlsson[8] pointed out the importance of communication in the vertical lines between the tactical level and the operational level. This is important because of the space specific information gathered in maintenance must be directed upwards to really understand the status of the green spaces. The management organization at the tactical level has the overview and creates plans but they do not always manage to implement them on the operational level. Possibly, the ecosystem perspective and indicators can have a unifying function between the two levels and between stakeholders.

Facilitation of new work methods between stakeholders is an aim of the new management system and it is coherent with the multi-stakeholder process defined by Hemmati (2002). Its essentials are the aims to gather the major stakeholders in a new form of communication and decision making.

On the highest level in the management system, the policy level, Smith (2009) argues that improved collaboration combined with networking will enhance a progressive effect on performance. This study has not truly evaluated the policy level but a policy of "more birds in the parks of Uppsala" would be a possibility. Bird houses in every park are probably not possible without collaboration and networking between stakeholders.

During the workshop budget was raised as a key issue. It is thus vital that the collaboration platform has a way of structure a joint budget and a partly joint administration for several stakeholders. This matter is not analysed in this study but it is seen as truly essential to achieve a successful collaboration. Possibly digitalization tools can simplify the administrational matters so that effective multi stakeholder-management can be accomplished.

By implementation of the proposed management system, may administrational and institutional obstacles decrease. This result can enhance that the management could have the potential to increase its performance. Ecosystem services and indicators have the potential to have a uniting function that supports collaboration and co-management of an urban green space. The management system developed in this study supply a framework but the more detailed intrinsic collaboration methods is left for further studies.

7 Conclusion

This thesis was undertaken to identify indicators for ecosystem services at an urban green space and incorporate these in a management system. The identified indicators were birds and compliant seating. These indicators do seem to have the potential to be incorporated into a management system. The management system was developed to enable multi-stakeholder management of a green space with the use of ecosystem services and indicators. One of the more significant finding of this study was the use of birds as indicator for cultural ecosystem services.

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Appendix A – Indicators used in today

Appendix A shows lists of some indicators that have been used to indicate ecosystem services. The lists are a part of the conducted literature study and the indicators in the lists have been taken into consideration in present thesis.

***Table 7**. Indicators for cultural ecosystem used in 63 reviewed papers. Source: (La Rosa et al., 2016)*

Categories of CES and used for the indicators in the 63 reviewed papers.

Paper no.	Source	Categories of CES evaluated	Indicator (s)	Spatial indicator/perti
1	Abson and Termansen (2011)	Essay	N	N
2	Barrena et al. (2014)	Agricultural heritage	2.1. Willingness to pay	N
3	Bieling et al. (2014)	1. Aesthetic values 2. Sense of place 3. Recreation and ecoturism 4. Inspirational values 5. Spiritual–religious values 6. Educational values	–	N
4	Bieling et al. (2014)	1. Identity 2. Heritage 3. Spiritual–religious values 4. Inspiration 5. Aesthetic 6. Recreation	–	N
5	Bieling and Plieninger (2013)	1. Identity 2. Heritage 3. Spiritual services 4. Aesthetic services 5. Recreation	5.1. Benche 5.2. Hiking trails and signs 5.3. Recreational facilities 5.4. Subsistence gardens 5.5. Hunting facilities 5.6. Memorials, commemorations, historical sites	Y
6	Brancalion et al. (2014)	1. Aesthetic values 2. Recreation and tourism values 3. Religious and psychological values 4. Educational values knowledge generation	–	N
7	Brandt et al. (2014)	1. Aesthetic values 2. Recreational and ecotourism	7.1. Landscape aesthetics proxy 7.2 Park visitation	Y
8	Broekx et al. (2013)	1. Recreation, amenity, 2. Education Bequest values	8.1. Willingness to pay (WTP)	N
9	Brown et al. (2012)	1. Recreation 2. Aesthetic 3. Social interaction 4. Science 5. Spiritual Cultural	9.1. Frequency distribution of Ecosystem Services	N
10	Burkhard and Gee (2012)	1. Visual aesthetics 2. Seascape character 3. Sense of place 4. Cultural heritage 5. Habitat and species value 6. Regional image Inspiration 7. Informal education 8. Knowledge systems 9. Recreation	–	N
11	Burkhard et al. (2012)	1. Recreation and tourism 2. Landscape aesthetics and inspiration 3. Knowledge systems 4. Religious and spiritual experience 5. Cultural heritage and cultural diversity 6. Natural heritage and natural diversity	–	N
12	Casalegno et al. (2013)	Aesthetic value	12.1. Density of photographs	Y
13	Chan et al. (2012)	Review paper	–	N
14	Daniel et al. (2012)	1. Landscape aesthetics, 2. Cultural heritage, 3. Outdoor recreation, 4. Spiritual significance	–	N
15	Davis and Kidd (2012)	1. Recreational values 1. Aesthetic amenity (only mentioned, not measured)	–	N
16	Dominati et al. (2010)	Cultural services in general	–	N
17	Egoh et al. (2007)	Cultural services in general	–	N
18	Escobedo et al. (2014)	Cultural services in general	18.1. Property value	N
19	Fletcher et al. (2014)	1. Aesthetic information, 2. Recreation, 3. Inspiration for art and design, 4. Cultural heritage	19.1. Frequency of terms	N

Paper no.	Source	Categories of CES evaluated	Indicator (s)	Spatial indicator/pertinence
20	Frank et al. (2013)	Landscape aesthetics	20.1. Shannon's Diversity Index (SHDI), 20.2. Shape Index (SHAPE) 20.3. Patch Density (PD)	Y
21	Frank et al. (2014)	Landscape aesthetics	21.1. Shannon's Diversity Index (SHDI), 21.2. Shape Index (SHAPE) 21.2. Patch Density (PD)	Y
22	Gee and Burkhard (2010)	Cultural services in general	–	N
23	Hernández-Morcillo et al. (2013)	Review paper	–	N
24	Iverson et al. (2014)	Editorial	–	N
25	Jakubowski et al. (2010)	–	25.1. Annual dry matter production	N
26	Kimmel and Mander (2010)	–	–	N
27	Kirchhoff (2012)	Letter	–	N
28	Klain and Chan (2012)	1. Natural beauty 2. Cultural heritage site 3. Recreation 4. Unique natural feature 5. Ceremonial site 6. Stewardship activities 7. Scientific study site 8. Spiritual-inspiration 9. Education 10. Peace 11. Sense of place-home 12. Transformational 13. Intergenerational 14. Community identity 15. Existence	28.1. Proxy of value of some ecosystem services 28.2. Proxy of threats to some ecosystem services	Y
29	Krasny et al. (2014)	–	–	N
30	Liekens et al. (2013)	1. Recreation 2. Amenity 3. Nonuse value	30.1. Willingness to pay	N
31	Lundy and Wade (2011)	1. Spiritual value 2. Educational value 3. Aesthetics 4. Recreation	–	N
32	Maes et al. (2012)	Opportunities for recreation and tourism	32.1. Recreation potential	Y
33	Mangi (2013)	Some CES cited together with data needed for their assessment	–	N
34	Milcu et al. (2013)	Review paper	–	N
35	Moleón et al. (2014)	–	–	N
36	Moore and Hunt (2012)	1. Recreation (public accessibility, physical accessibility, and recreation infrastructure) 2. Education (proximity to schools or other educational centres, history of use for educational purposes, and the presence of educational infrastructure)	36.1. Score criteria for the used categories of CES	N
37	Nahuelhual et al. (2014)	1. Heritage value associated to Chiloé native potato as a culturally significant species; 2. Systems of knowledge; 3. Relations (or social networks) established in the agri-cultural society of Chiloé Island	37.1. Agriculture Heritage (AH) as s spatial proxy of different dimensions that are spatialised with kernel density estimation	Y
38	Nahuelhual et al. (2013)	1. Recreation 2. Tourism	38.1. Recreation 38.2. EcoTourism	Y
39	Norton et al. (2012)	1. History 2. Place 3. Inspiration 4. Calm 5. Leisure-Activities 6. Spiritual 7. Learning 8. Escape	39.1. Cultural score (combination of LULC features with more qualitative landscape feature)	Y
40	O'Brien et al. (2014)	Contribution of per-urban woodlands to well being	–	N
41	Olschewski et al. (2010)	–	–	N

Paper no.	Source	Categories of CES evaluated	Indicator (s)	Spatial indicator/pertine
42	Paracchini et al. (2014)	Outdoor recreation	42.1. Outdoor recreation	Y
43	Pleasant et al. (2014)	All according to MEA framework	–	N
44	Plieninger et al. (2013)	1. Spiritual services 2. Educational values 3. Inspiration 4. Aesthetic values 5. Social relations 6. Sense of place 7. Cultural heritage values 8. Recreation and ecotourism Disservices: 1. Unpleasantness 2. Scariness 3. Noisiness	44.1. One indicator question per CES	Y
45	Plieninger et al. (2012)	1. Aesthetics 2. Cultural heritage 3. Recreation 4. Sense of place 5. Spiritual	45.1. CES as motivators for owning land	N
46	Raudsepp-Hearne et al. (2010)	1. Deer hunting 2. Tourism 3. Nature appreciation 4. Summer cottages 5. Forest recreation	46.1. Deer kills 46.2. Tourist attractions 46.3. Rare species 46.4. Tax value of cottages 46.5. Forested land	Y
47	Ripoll-Bosch et al. (2013)	In general CES	47.1. Value of CES	Y
48	Ruiz-Frau et al. (2013)	Recreation services	48.1. The average spent per person per day for each of the following activities: recreational scuba-divers, sea-kayakers, customers of wildlife viewing boat trips and seabird watchers	Y
49	Russell et al. (2013)	10 constituents of well-being (connections between nature and human well-being):	–	N
50	Sander and Haight (2012)	(i) outdoor recreation, (ii) scenic quality and tree cover Used as a "mix" providing a series of cultural, supporting, regulating, and provisioning services,	(Variables) 50.1. Mean percent tree cover on the home's parcel [%], 50.2. Mean percent tree cover in neighbourhood Land cover measured in home's viewshed: 50.3. Impervious land cover 50.4. Lawn Area of short grass (lawn) 50.5. Area of maintained tall grassland cover 50.6. Area of forest 50.7. Area of shrub 50.8. Area of unmaintained grassland 50.9. Area of emergent vegetation 50.10. Area of open water 50.11. Area of woody wetland 50.12. Area of agricultural land	Y
51	Satz et al. (2013)	Perspective essay	–	N
52	Sherrouse and Semmens (2014)	1. Aesthetic, recreation	52.1. Social-value indicator	Y
53	Sherrouse et al. (2014)	Social values: 1. Aesthetic, 2. Biodiversity, 3. Cultural, 4. Economic, 5. Future, 6. Historic, 7. Intrinsic, 8. Learning, 9. Life sustaining, 10. Recreation, 11. Spiritual, 12. Subsistence, 13. Therapeutic	53.1. Social-value indicator	Y
54	Swallow (2013)	Public goods	–	N
55	Tarolli et al. (2014)	Not specified	–	N

Paper no.	Source	Categories of CES evaluated	Indicator (s)	Spatial indicator/pertinence
56	Tengberg et al. (2012)	1. Heritage values Identity	–	N
57	Turner (2012)	Briefing note	–	N
58	Urquhart and Acott (2014)	Sense of place	–	N
59	Van Berkel and Verburg (2014)	1. Recreation, 2. Aesthetic 3. Beauty, 4. Cultural heritage, 5. Inspiration, 6. Spirituality	59.1. Respondents' willingness to pay (WTP) for landscape maintenance, 59.2. Travel time-cost estimate	Y
60	Van Poorten et al. (2011)	Recreational fisheries	–	N
61	Villamagna et al. (2014)	Freshwater recreational fishing (key benefits: relaxation, communication with nature, spiritual renewal, social bonding)	Biophysical capacity 61.1. Surface water availability 61.2. Game-fish species richness 61.3. Water quality 61.4. Forested riparian areas 61.5. Boating access sites Social capacity 61.6. Publicly accessible areas 61.7. Fishing spots 61.8. Fish stocking Demand 61.9. Fishing licenses Ecological pressure 61.10. Licensed anglers within 16.09 km of fishable waterbody	Y
62	Von Heland and Folke (2014)	Not specified	–	N
63	Weyland and Laterra (2014)	Recreation potential (such as: angling, hiking, trekking, cycling, horse-back riding and bird-watching)	63.1. Campsite density as independent variable explained by landscape metrics (variables): mean annual temperature, annual thermal amplitude, roughness, coastline density, Normalised Difference Vegetation Index (NDVI), Standard Deviation in NDVI (NDVI SD), tree cover, bare soil cover, crop area	Y

Table 8*. Indicators collected in a survey for the assessment of condition of the natural state of urban ecosystems. Source: Rocha et al.(2015)*

Condition		Biodiversity
Drivers and Pressures	**State**	
Habitat fragmentation	Ecological efficiency	Species richness (N° of Species/surface)
Soil contaminated (Surface (ha))	Tree health and stability status	Tree diversity Index
Pesticide use (Type and location)	Protected areas (ha)	Trees species composition and density (number of trees/administrative unit)
Groundwater contamination (spots and quality)	Topography (distance from sea level)	Aerial connectivity trough coppice (ha)
Pollen emissions (N^a pollen grains/crown surface)	Extent of different types of green infrastructure (ha)	Plant species richness (number)
Atmospheric contamination	Condition of Local Wildlife Sites	Plant abundance (number)
Air pollution (μg/m^3)	Soil pH (number)	Tree species (Shannon/richness)
Carbon (C ton/ha)	Air quality	Vascular plants (Shannon/richness)

Absorption pollutants (%)	Soil contamination and former landfills	Number of trees in public space (trees for inhabitant)
Flooding (mm)	Service area of green spaces (distance of residential areas)	Number of animal and plant species (number)
Noise Contamination (dB)	Green typology (% cover)	Population size
Nutrient reduction in storm water (%)	Total Public Green Urban Areas (m^2)	Pollinator abundance (number)
Groundwater contamination	Total of Urban Vegetable Gardens (m^2)	Bird abundance (number; Shannon/richness)
Heat reduction (degrees Celsius)	Total of Green Areas (m^2)	Bird species richness (number)
Susceptibility to desertification	Share of green infrastructure (%)	Mammals species (number)
Heat island effect	Km of accessible green corridors (km)	Reptiles species (number)
Urbanization rate (% per year)	Historical park (area)	Amphibian's species (number)
Education rate (% primary education)	Availability of public spaces and services (% of inhabitants within 300 m from green spaces)	Butterflies species (number)
Political instability	Spatial Ecological value	Benthonic macroinvertebrates (number)
Economic pressure (GDP capita−1 day−1)		Insects (mainly ants) (number)
Sea level rise (% flooded)	Surface water quality (Water Quality Index)	Sparrow and swift breeding locations (number)
Urban drainage flood (% flooded)	Biodiversity quality	Monitoring red list species (threats)
River peak discharges (% flooded)	Quality of the beaches	Alien species occurrences (number)
Land subsidence	Regional ecological function	Occurrence of endangered species (number)
Freshwater scarcity (% use of renewable resource)	Conservation of priority wild species	Wild plants and birds (number of species)
Groundwater scarcity (% use of renewable resource)	Conservation of natural habitats	Species composition alleys (number)
Salinization and seawater intrusion	Evolution of forest cover with native species	Pollinator species richness (number)
Flood attenuation (%)	Conservation of nature and biodiversity - Integrated area in protected areas of regional, inter-municipal or city	Various plant-pollinator network metrics (number)
Peak flow reduction (%)	Water quality in bathing areas - Proportion of bathing areas with quality acceptable or good water face full of bathing areas	Presence of domestic predators (on camera traps - n° images/hour)
	Storm water retention	Pathogens reduction (%)
	Retention capacity (m^3)	Biocenters (number/ area)
		Biocorridor (m)

Appendix B -Workshop questions

A. How is the mentioned ecosystem services generated today at the green space of St:Per's Park?
    a. How is a pleasant stay at the green space created? Regarding to:
        i. Animals and plants
        ii. What is people attracted to at this green space
        iii. What does a visitor require?
B. How is the management and maintenance of St:Per's Park conducted today?
    a. Is there any formal or informal collaboration between you (the stakeholders) in the maintenance and management of St:Per's Park?
    b. Are there any obstacles to collaborate between you stakeholders?
    c. What advantages and possibilities is there with a higher level of collaboration between stakeholders