



The Royal National City Park as a green resource for Loudden

A CRITICAL SYSTEMS ANALYSIS OF RECREATIONAL AND BIODIVERSITY VALUES.

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Abstract

The Stockholm Royal Seaport (*Norra Djurgårdsstaden*) is an urban development that aims to transform a former industrial area into a sustainable city area. The aim of this study is to investigate how the planned development of a particular area within the Stockholm Royal Seaport (**SRS**), called Loudden, will affect the surrounding areas of the Royal National City Park (**RNCP**), which borders the area of Loudden to the west and south, and also to determine how the development of Loudden can benefit from the services provided by the RNCP. The developers of the SRS view the RNCP as a valuable resource with regard to the ecosystem services it can provide for the residents of Loudden, particularly biodiversity- and recreational ecosystem services. A critical systems perspective will be applied to analyse the predicted effects of the development and to identify possible solutions that can be taken into consideration by the city's planners in the future planning of the area.

Foreword

This report is the result of a project work within the course Environmental Management in Planning at Stockholm University. The course is a mandatory part of the multidisciplinary Master programme Environmental Management and Physical Planning at the Department of Physical Geography and includes both Swedish and international students. The course comprises ten weeks of study (15EHTC), of which the project part covers five weeks. The aim is to give the students an opportunity to apply their acquired knowledge on environmental management in planning on a realistic and relevant case.

This time we have chosen to study the Stockholm Royal Seaport (SRS) and its surroundings. The different project groups have focused on remediation and implementation of urban gardening in Loudden (the last area to be developed in SRS), retrofitting of neighboring residential areas as well as The Royal National City Park as a green resource for SRS.

The students alone are responsible for the results and conclusions of this report and it cannot be regarded as the position of Stockholm University. The project supervisor has been Salim Belyazid, Bo Eknert, Nadja Stadlinger and Ingrid Stjernquist from the Department of Physical Geography.

We want to thank all those who have been helpful in providing the students with information and materials as well as having taken time for interviews. Without your help this project could not have been realised.

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1. Introduction

1.1 Project Aim

The Stockholm Royal Seaport (*Norra Djurgårdsstaden*) is an urban development that aims to transform a former industrial area into a sustainable city area. The particular area within the Stockholm Royal Seaport (**SRS**) that this study is focused on is called Loudden, which is bordered by the Royal National City Park (**RNCP**) to the west and south. The SRS does not only consist of Loudden but also Värtahamnen, Hjorthagen and Frihamnen (Stockholms stad, 2017a). The aim of this study is to take a critical systems perspective: to investigate how the planned development of Loudden will affect the surrounding areas of the RNCP; to investigate how the development of Loudden can benefit from the services provided by the RNCP; and the ultimate goal is to determine how the ecological and sociological values in the area can be increased in order to create a sustainable city area in Loudden.

1.2 Research questions

The project aim will be achieved by answering the following research questions:

1. What kind of ecological values exist within the RNCP and what threats do they face from the development of Loudden?
2. What kind of sociological values exist within the RNCP and what threats do they face from the development of Loudden?
3. How can the current planning vision be improved so that ecological and sociological values will be improved?

1.3 Boundaries and limitations

Considering the project's limited time and resources, it was necessary to create appropriate boundaries to limit the scope of the project, but which still allowed the research aim to be achieved. The following boundaries were defined:

- ❑ A particular demarcation of sustainability aspects that were considered;
- ❑ Spatial boundaries, which means the geographic area that was investigated; and
- ❑ Temporal boundaries, which limited the study to a particular time frame.

1.3.1 Limited evaluation of sustainability

In order to conduct research towards the research aim of determining how the RNCP can be used as a green resource to create a sustainable city area in Loudden, it was necessary to demarcate a specific and clear understanding of numerous key concepts, including “sustainable development”, “green resource” and “sustainable city area”.

Sustainable development

The most common definition of “sustainable development” is “development that meets the need of the present without compromising the ability of future generations to meet their own needs”, as defined in the World Commission on Environment and Development's Brundtland Report of 1987 (Metzger and Olsson, 2013). This definition was based on the recognition that economic and social development requires the consumption of natural resources, but only a limited supply of non-renewable natural resources is available to support continued growth. Since non-renewable natural resources cannot be replaced, development will therefore only be sustainable if economic- and social development does not lead to environmental degradation. The political and scientific debate about whether economic and social development is possible with minimal environmental impact is ongoing (Metzger and Olsson, 2013).

Against this background, it was decided that this study will only investigate ecological and social sustainability aspects, while the economical perspective of sustainability was not considered. Although this approach only allowed for a limited evaluation of the sustainability of the study area, it was decided that this approach would nevertheless provide valuable insight into the issue, which could be combined with related research on sustainable urban development in the future.

Green resource

The authors' understanding of what constitutes a "green resource" was shaped by related concepts, such as "urban green space" and "green infrastructure".

Urban green space refers to parks, forests, green roofs, streams, and community gardens, which provide critical ecosystem services that promote the ecological integrity of cities and promote public health (Wolch et al., 2014).

According to Matthews et al., green infrastructure typically refers to an interconnected network of multifunctional green spaces that are strategically planned and managed to provide a range of ecological, social, and economic benefits (Matthews et al., 2015). The examples of green infrastructure provided by Matthews et al. (green roofs, permeable vegetated surfaces, green alleys and streets, urban forests, public parks, community gardens and urban wetlands) show that there is some overlap between "urban green space" and "green infrastructure. Therefore, to distinguish the concept of "urban green space" from "green infrastructure" Matthews et al. suggested that it must be made clear that "green infrastructure" refers to the planned and intentional use of biological resources that serve ecological functions in an urban setting for the public benefit (ibid.).

For purposes of this study, "green resource" therefore includes elements of both the concepts "urban green space" and "green infrastructure". The RNCP is therefore a green resource because planners of the urban development in Loudden can exploit the ecological services provided by nature in the RNCP to fulfill various functions in the study area and to improve human well-being.

Sustainable city area

For purposes of this study, a sustainable city area would therefore be a city area that has been intentionally planned to benefit from the ecological services provided by urban green spaces without causing degradation of the natural environment, in order to contribute to the economic and social development of the city.

1.3.2 Spatial boundary

The study area comprises the area of Loudden in the SRS and the parts of the RNCP that border Loudden to the south and to the west. The area of Loudden, as defined by the City of Stockholm, consists of the oil harbour and container terminal south of Frihamnen (Stockholm stad, 2019a). The area of Loudden falls outside the boundaries of the RNCP.

Due to the fact that the RNCP covers an area of 26 km² and extends over three municipalities (Solna municipality, Lidingö municipality and Stockholm municipality) (Stockholms stad, 2009a), it was considered unnecessary to focus on the entire RNCP for purposes of the research project. The areas within the RNCP that the research project focussed on are Ladugårdsgärde and Kaknäs, as defined in

Länsstyrelsens Stockholms Läns report *Vård- och utvecklingsplan för Kungliga nationalstadsparken* (2012). These are the two areas of the park that surround Loudden. It is therefore most likely that the development of Loudden will have the biggest impact on these areas and the residents of Loudden will likely use these parts of the RNCP most frequently. The southern part of Frihamnen is also within the boundaries of the project and the development of Frihamnen will also affect the park, but this study has mainly look at what impact Loudden will have on the area.

Figure 1 below shows the boundaries for the study area. The study area will be referred to as NSD (the northern part of Södra Djurgården). While other surrounding areas, both inside and outside the RNCP, may affect the study area, these effects were not taken into consideration to answer the research questions.



Figure 1. Figure 1 shows the spatial boundaries of the project. The area within the red markings constitutes the area of the project. Figure 1, own creation.

1.3.3 Temporal boundary

According to the estimated time plan for the development of the SRS, construction in Loudden will be completed around 2030 (Stockholm stad, 2019a). While some of the impacts of the development of Loudden on the RNCP will be visible instantly, others will only become apparent over time.

Therefore, a time perspective of twenty years, i.e. from 2030 to 2050, is considered to be appropriate.

This timeframe also coincides with the most recent regional development plan for Stockholm published by Stockholms läns landsting, RUF5 2050, which looks at Stockholm's future development up to the year 2050 (Stockholms läns landsting, 2018).

1.4 Methods

Different methods were used to obtain data and knowledge about the area in order to answer the research questions. Information was primarily gathered through literature studies, supplemented by interviews and a site study of the area. A conceptual loop diagram (CLD) was constructed to visualise and enhance the understanding of the system. The CLD was also used to analyse the different effects of the development in the study area. A “strengths, weaknesses, opportunities and threats” (SWOT) analysis was conducted in respect of each of the suggested future scenarios. More details about the various methods are provided below.

1.4.1 Literature review

Scientific literature, collected using Google Scholar and the Stockholm University library database, was reviewed to improve the authors' understanding of, amongst other topics: the effects of urban development on biodiversity; urban green spaces; urban sustainability; urban ecosystem services; urban ecology; ecosystem management; conservation; outdoor recreation; and user conflicts.

Information and data about the study area was obtained from various official sources and include documents such as: management plans for the RNCP; government policies and legislation relating to the RNCP; detail plans and development plans for the SRS; and plans regarding the future development of Stockholm published by municipal and regional authorities.

1.4.2 Interviews

Two interviews were held to complement the literature review:

- ❑ The first interview was held on 11 March 2019 at Kungliga Djurgårdsförvaltningen with Henrik Niklasson, the person

who is primarily responsible for the management of the natural areas in the RNCP.

- ❑ The second interview was held on 19 March 2019 with Henrik Waldenström at World Wide Fund For Nature (WWF) Sweden. WWF Sweden is part of an alliance of stakeholders promoting the conservation of nature in the RNCP.

The purpose of the interviews was to gain the officials' opinions, knowledge and concerns about the development of Loudden as well as about the management and development of the RNCP. The interviews were conducted in a semi-structured manner, based on a few introductory questions that were emailed to the interviewees prior to the interviews. However, the discussions with the interviewees expanded beyond the emailed questions. The questions that were emailed are the following:

- ❑ The legislative framework for the park is in the environmental code, but is relatively short. What do you consider as its weaknesses and strengths?
- ❑ How is the park being managed today besides the legislation? The park in general but also the area closest to the Stockholm Royal Seaport and Loudden?
- ❑ Has the Royal National City Park been affected negatively or positively from the already finished parts of the Stockholm Royal Seaport?
- ❑ Are there any plans regarding the management of the Royal National City Park in relation to the Stockholm Royal Seaport?
- ❑ What is your own opinion regarding the Stockholm Royal Seaport in relation to the Royal National City Park?

Lars-Gunnar Bråvander, who was involved in writing the management plan for the RNCP, was also contacted with the same questions and a request for an interview. He replied to the questions by email but an interview was not scheduled.

1.4.3 Site research

A site visit to the Ladugårdsgårde- Kaknäs area and the area outside Loudden was done on 11 March 2019 in order to experience the park and its values, the structure of the area and the area's connectivity to its surroundings. Before the visit, maps and satellite images of the area were studied with GIS and Google Earth. The site research was important from the perspective of obtaining a general familiarity with the study area.

1.4.4 Comparative case studies

A number of urban green areas that are comparable to the study area were examined to determine what role different green areas play in different surroundings; whether similar challenges have been experienced before and how they have been overcome; and how those areas are currently managed. The purpose of the comparative study was to find good examples of possible solutions that may be implemented in the study area.

It is noted that none of the locations that were examined faced the exact same circumstances as the study area. The RNCP was the first “national urban park” of its kind in the world and remains the only national urban park in Sweden, holding some unique characteristics that will not be found in other parks (Nationalstadsparken, 2019a). However, there are many areas that display some similarities with the study area and that can contribute to the future development of the study area.

The areas that were chosen are the following: Nackareservatet; Hammarby Sjöstad; completed developments in the SRS; the old residential area of Gädesstaden; and other parts of the RNCP, notably Norra Djurgården, Södra Djurgården and Museiparken.

1.4.5 Systems analysis

Systems analysis is an analytical approach that can be used to conceptualise and form a better understanding of complex systems. A system is a group of interconnected elements that relate to and/or feed back into each other, forming a unified whole with a specific function or purpose.

Systems are often interconnected to other systems and are often dynamic, i.e. they change over time, adding further complexity and making it difficult to predict how the various interrelated parts of a system will behave over time (Arnold and Wade, 2015).

A simplified, conceptual model of a dynamic system can be visualised with the help of a *causal loop diagram* (CLD) such as the one shown in figure 2 below, which shows how the variables within the system of a simple bank account are interrelated and how they influence each other. The first step in drawing a CLD is to identify a key phenomenon or response variable, such as the ‘Savings’ in a bank account. Next, the factors that drive or inhibit the response variable as well as the influences that those factors exert on each other must be identified. Each variable is represented by a node on the CLD and the causal relationships between the variables and the direction of influence is represented by connecting arrows.

A positive causal relationship is indicated with a '+', meaning that both variables will change in the same direction, i.e. an increase (decrease) in the driving variable will cause an increase (decrease) in the dependent variable. A negative causal relationship is indicated with a '-', meaning that a change in one variable will cause the other variable to change in the opposite direction, i.e. an increase (decrease) in the driving variable will cause a decrease (increase) in the dependent variable (Columbia University, n.d.). Feedback loops exist where output from one node eventually influences input to that same node (Thwink.org, 2014). A reinforcing feedback loop exists where an action produces a result which creates more of the same action, leading to growth or decline (Bellinger, 2004a). A reinforcing loop is indicated with a 'R'. A balancing feedback loop exists where an action produces a result which counteracts the action, leading to stability (Bellinger, 2004b). A balancing loop is indicated with a 'B'.

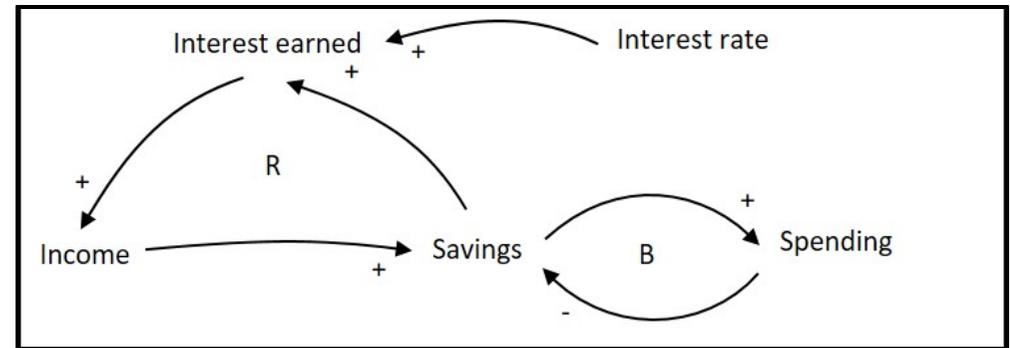


Figure 2. CLD of a simple bank account (Kim, 2018).

Systems analysis can therefore be used as a framework in decision-making relating to complex issues, such as the interaction between urban development and the environment, and is an appropriate method to obtain insights and investigate possible solutions for purposes of this study.

However, it is important to note that a CLD is only a qualitative description of how variables affect each other and does not describe the magnitude or significance of links between variables. This insight can be gained from numerical simulation, which falls beyond the scope of the current study (Sterman, 2002).

1.4.6 Strengths, weaknesses, opportunities and threats (SWOT) analysis

The final proposals of actions to increase the ecological- and social sustainability in NSD and Loudden will be presented with a shorter SWOT-analysis to represent the strength, weaknesses, opportunities and threats for each proposal. The SWOT-analysis is based on the guide by Hydén (n.d.), which describe how you should look at the potential future outcome of a certain aspect, by questioning how they will be affected by internal aspects (strengths and weaknesses) and external (opportunities and threats). This study have made some adjustments to the original model to fit the projects purpose better. Therefore, the study look at probability/possibility aspects instead of internal/external aspects, but the principles of the method stays the same.

1.4.7 GIS

The two maps were produced had its source from Lantmäteriet. Additional layers and symbols were crafted by the authors' in ArcMap. The configuration of these layers are based on information from other parts of the study, such as the baseline, background information, conceptual model and results.

2. Background

2.1 The Royal National City Park

During the early 1990s the area of Ulriksdal-Haga-Brunnsviken-Djurgården was subjected to exploitation pressure due to its central location in Stockholm (Nationalstadsparken, 2019a). There was growing concern for the protection of the area due to its ecological importance to the Stockholm region, its recreational and health value for people living in the urban area, its historical landscape with both natural and cultural values and the area's national cultural heritage. The area had (and still has) a high biodiversity, with numerous animal and plant species that have been classified as endangered or rare by the Swedish Environmental Protection Agency and whose conservation was therefore regarded as a national interest (ibid).

Legislation that was in force at the time was regarded as inadequate to secure the protection of the area. In order to protect the area from

continued exploitation, a proposal was made to the Swedish Parliament in 1994 to declare the area Ulriksdal-Haga-Brunnsviken-Djurgården as Sweden's first national urban park. A national urban park refers to a national interest that has significance to the national cultural heritage, for an urban area's or urban region's ecology and for people's recreation (prop. 1994/95:3).

The proposal was accepted and in 1995 the area of Ulriksdal-Haga-Brunnsviken-Djurgården was designated as the Royal National City Park (see figure 3). The RNCP comprises a total area of 26 km² and is divided between three municipalities: Stockholm, Solna and Lidingö, with the largest part of the RNCP falling within Stockholm municipality.

Throughout history, the area has been used for several different purposes, such as for grazing and cultivation, hunting grounds and military exercise fields and these diverse uses are still reflected in the landscape today (Stockholms stad, 2009a).

Ladugårdsgårde in the southern part of the RNCP is the park's biggest open ground and has long been a place for events and gatherings, for example Mayday demonstrations and music festivals (Länsstyrelsen

Stockholms Län, 2012). During the middle ages, the field served as grazing grounds and croplands and at the end of the 17th century it started being used for military exercises, which lasted until the beginning of the 20th century (Stockholms stad, 2009a).

The Kaknäs area to the east of Ladugårdsgårde is dominated by forests, but there are also wetlands and meadows used for horse grazing. Many buildings are left from the beginning of the 19th century. During the middle ages, Kaknäs was a village and there are several remnants such as grave fields and old house foundations from prehistoric times (Länsstyrelsen Stockholms Län, 2012).

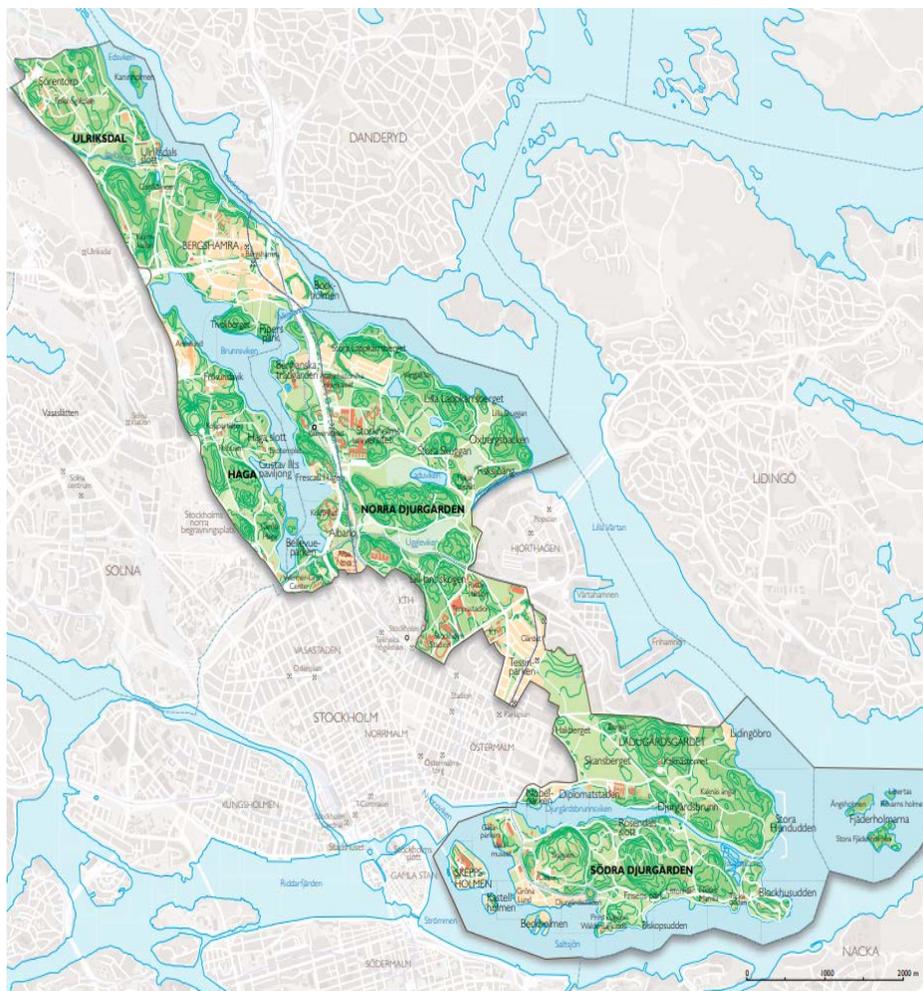


Figure 3. The boundaries of the Royal National City Park. Source: Länsstyrelsen Stockholms Län, 2012.

2.2 The Stockholm Royal Seaport

The SRS is located north of the Östermalm district. The SRS is in total 236 hectares and divided into four subareas: Hjorthagen, Värtahamnen, Frihamnen and Loudden (see figure 4). The SRS is characterized by its old industrial infrastructure (Stockholms stad, 2017a). The second gaswork that was built in the city of Stockholm was the gaswork in Värtan, Värtagasworks, and it was done in 1893. The placement of the gaswork in Värtan was strategic due to the closeness of the harbour, railway and the area had potential for expanding. In total there were five gas holders built in the area. In the area Hjorthagen, housings were built for the workers at the gaswork (Stockholms stadsmuseum, 1984). Year 2011 the production of gas stopped due to the fact that Stockholm city replaced it with natural- and biogas (Stockholms stad, n.d.a). The oil activity will stop in the end of 2019 (Stockholms stad, 2019a).

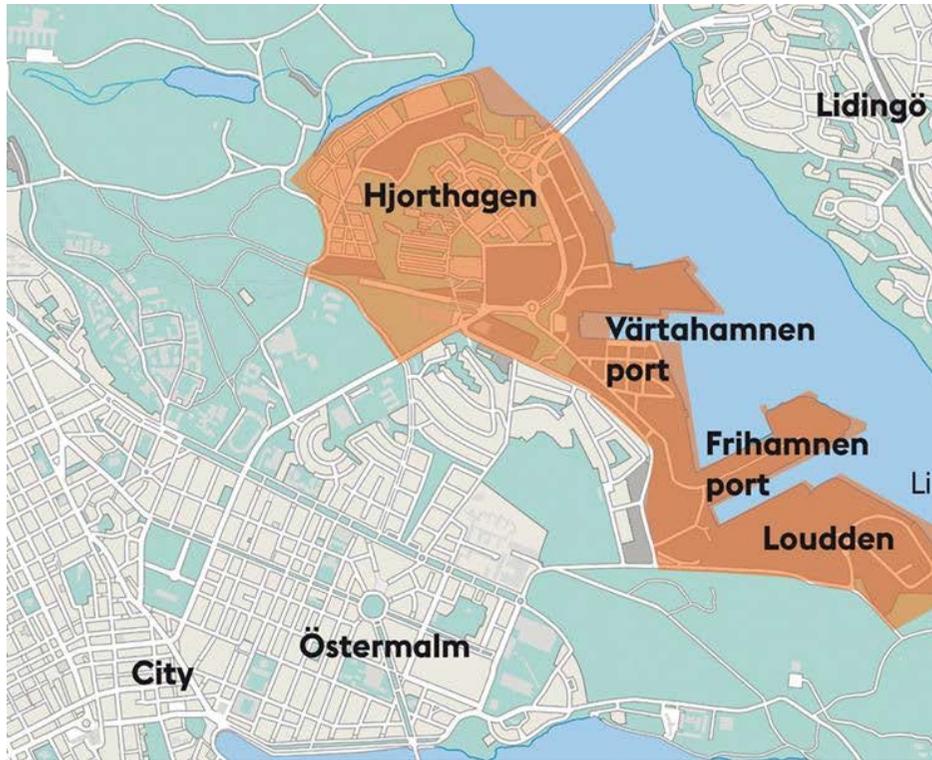


Figure 4. The figure shows the Stockholm Royal Seaport. Picture retrieved from Stockholms stad (n.d.b).

In year 1879 **Värtahamnen** developed to be a harbor for goods. At the time that the harbor activity established, the nearby area was undeveloped and offered area for storage. What was stored in the area was coal, ore, iron, wood and more. In the late 1960s, Silja Line established a ferry-transport service (Stockholms Hamnar, n.d.a). The

purpose of **Frihamnen** was that goods could be stored there without having to go through customs. After its establishment year 1926 Frihamnen developed quickly and also adapted commercial boat traffic like ferry- and cruise services (Stockholms Hamnar, n.d.b). **Loudden** has an oil harbour since 1926 and it is characterized by its cistern buildings (Stockholms Hamnar, n.d.c)

2.3 Legislative Framework

2.3.1 Background

The most important measures laid down by the Environmental Code (*Miljöbalken*) (1998:808), the Cultural Heritage Act (*Kulturmiljölagen*) (1988:950) and the Planning and Building Act (*Plan- och bygglagen*) (2010:900) that operate to protect the RNCP's natural, cultural and historical values are discussed in this section.

The Environmental Code sets out the fundamental legal framework for environmental management and the promotion of sustainable

development in Sweden. Some of its main objectives are to protect the environment from the harmful impacts of development and to preserve biological diversity (SFS 1998:808, chapter 1, section 1).

The Cultural Heritage Act aims to protect Sweden's cultural environment, which includes place names, ancient monuments, remains and finds (graves, burial grounds, cemeteries, raised stones, memorials, remains of homes, ruins etc.), cultural heritage buildings and ecclesiastical cultural heritage property (SFS 1988:950, chapter 1, section 2).

The Planning and Building Act regulates the physical planning process in Sweden. It aims to ensure that land and water areas are used for purposes for which they are best suited, in view of their nature, location and different public interests (SFS 2010:900, chapter 2, section 2).

2.3.2 The Environmental Code

Basic management provisions for land and water areas

Chapter 3, section 6 of the Environmental Code requires the general protection of all land and water areas in Sweden that are important due to their natural, cultural or outdoor recreational value against damage, with green spaces in urban areas requiring special consideration. If such an area is of national interest in terms of chapter 4 section 7, it must be protected from activities that can cause significant damage.

Protection of a national urban park

The RNCP is formally protected as a *national urban park* in terms of chapter 4, section 7 of the Environmental Code, which states:

“The Ulriksdal-Haga-Brunnsviken-Djurgården area is a national urban park. New development, new buildings and other measures shall only be permissible in national urban parks if they can be undertaken without encroaching on park landscapes or the natural environment and without detriment to any other natural and cultural assets of the historical landscape.”

This provision provides the RNCP's ecological, cultural, historical and recreational values its basic, long-term protection (Länsstyrelsen Stockholms Län, n.d.a). However, this provision is supplemented by several others (discussed below) that safeguard different values.

While natural and cultural values can also be protected in a national park, nature reserve or cultural reserve, designated in terms of chapter 7 sections 2, 4 and 9 respectively, a *national urban park* must contain an unique combination of these values in an urban landscape.

In terms of the National City Park Regulations (SFS 2009:55) the County Administrative Board of Stockholm County must decide on a care and development plan for the RNCP. The plan must provide an overall picture of the goals and guidelines for the park's care and development, which must be incorporated into planning documents under the Planning and Building Act.

Protection of national interests

As a result of the RNCP's status as a national urban park in terms of chapter 4 section 7 of the Environmental Code, the entire area is also protected as a national interest (SFS 1998:808, chapter 4, section 1), further enhancing the RNCP's status as an area with significant natural and cultural value. Development inside the RNCP may only

occur if it does not encroach on park landscapes or the natural environment and without detriment to any other natural and cultural assets of the RNCP.

Protection of nature and culture

A nature reserve can be established in terms of chapter 7 section 4 of the Environmental Code in order to preserve biological diversity, to protect and maintain valuable natural environments or to satisfy the need for outdoor recreation.

A cultural reserve can be established in terms of chapter 7 section 9 of the Environmental Code in order to preserve valuable cultural landscapes, which may include buildings of significant cultural historical value listed in terms of the Cultural Heritage Act (see below).

Two nature reserves are found within the RNCP: Igelbäcken and Ulriksdal (Länsstyrelsen Stockholms Län, n.d.b). However, both Igelbäcken and Ulriksdal fall outside the study area.

2.3.3 Cultural Heritage Act

In terms of the Cultural Heritage Act, anyone who plans or carries out development or construction must ensure that damage to the cultural environment is, as far as possible, avoided or limited (SFS 1988:950, chapter 1, section 1). It is prohibited, without permission, to disturb, remove, excavate or in any other way, by building or development, alter or damage ancient monuments and remains (SFS 1988:950, chapter 1, section 6).

Ancient remains such as burial grounds, rock formations and traces of a medieval settlement have been found in Ladugårdsgärde and Kaknäs (Länsstyrelsen Stockholms Län, 2012).

Buildings of particularly significant cultural historical value can be designated as listed buildings (*byggnadsminnen*) with detailed stipulations for care and maintenance in order to preserve their heritage (SFS 1988:950, chapter 3, section 1). Note that state buildings such as royal palaces are listed in terms of a different law, the Listed State Buildings Ordinance (SFS 1988:1229).

A number of listed buildings are included within the study area:

- ❑ Kungliga Borgen, or the royal pavilion, a royal meeting complex consisting of 9 buildings constructed in 1818, providing the king with a vantage point from where he could oversee military exercises (Riksantikvarieämbetet, n.d.a);
- ❑ Lindarängens Flyghangar, an aircraft hangar constructed in 1931 for civilian passenger aircraft (Riksantikvarieämbetet, n.d.b); and
- ❑ Bergshyddan, a residential villa constructed in 1838 (Riksantikvarieämbetet, (n.d.c).

2.3.4 Planning and Building Act

Municipalities have the main responsibility for the planning of land and water areas within their boundaries (SFS 2010:900, chapter 1, section 2), with County Administrative Boards playing a coordinating role.

The planning system consists of:

- ❑ comprehensive plans, guiding the overall, long-term direction of development within a municipality;
- ❑ regional plans, where two or more municipalities jointly plan how land and water areas are to be used;
- ❑ area regulations, regulating the use of land and water areas within a municipality in line with the comprehensive/regional plan; and
- ❑ detailed development plans, stipulating specific local building requirements.

Relevant provisions in the Environmental Code, such as ensuring that land and water areas are used for purposes for which they are most suitable, must be applied in the planning process (SFS 2010:900, chapter 2, sections 2).

3. Result

3.1 Baseline environment

3.1.1 Biodiversity baseline

According to Article 2 of the Convention on Biological Diversity, biodiversity is defined as:

the variety of variation among living organisms in all environments (including land-based, marine and other aquatic ecosystems) as well as the ecological complexes in which these organisms are included; this includes diversity within species, between species and by ecosystems (Mörtberg and Ihse, 2006).

The RNCP is a good example of a green area with biodiversity that is important both on a national and an international level and that is also connected to an urban developed area (Mörtberg and Ihse, 2006). Since 1999, it is a national environmental goal of Sweden to maintain the biodiversity in urban environments and to have an interplay between developed area and a “countryside”-like environment (prop. 1997/98:145).

The RNCP has a rich and meaningful biodiversity (Mörtberg and Ihse, 2006). The history of different land use within the park has made it possible for the area to develop and for the different flora and fauna to thrive there. Many different species have been introduced by humans, either on purpose or by accident. Regardless of how they were introduced, these species have adapted to the environment. The proximity to the city's harbours and roads have, over time, continuously contributed to the species-richness. The introduction of new and adapted flora is usually followed by fauna, in form of butterflies, hymenoptera and beetles (Bråvander, 2010). In addition, many of the species that are found in the park are red-listed and rare (Mörtberg and Ihse, 2006).

The oak (*Quercus robur*) is a characteristic symbol of the RNCP and the area is extraordinary for Europe; only a few places in Europe have such a high number of old oaks in such a dense area as the RNCP. The oldest oak in the park is estimated to be up to 800 years old (Bråvander, 2010). In Stockholm city there are about 1500 "giant oaks" that have at least one meter as a diameter. The biggest

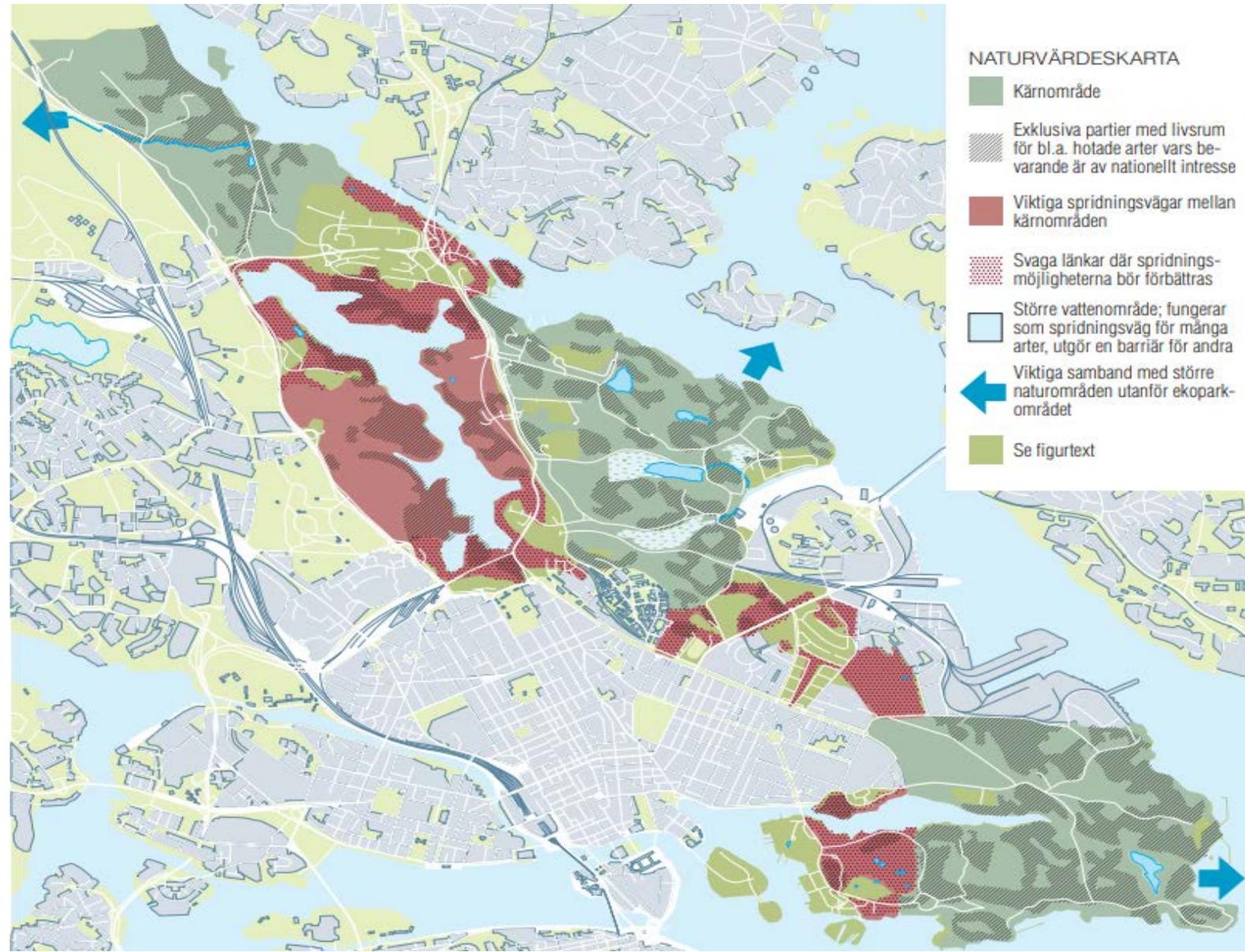
⁶ A bigger green area with high ecological values that needs to be maintained and protected to preserve the biodiversity and recreational values in the RNCP (Löfvenhaft, 2002).

concentration of "giant oaks" is found at northern and southern Djurgården. The oak is a tree that usually grows close to other oaks, but year 1830 deforestation of oak became legal and millions of oaks were cut down and a lot of the oaks have become isolated. What is problematic about that is that the biodiversity that thrives on the oak have adapted to the close structure of oaks. Mörtberg et al. (2007) state that it is very important to maintain and develop the connective pathways between the single oaks and areas where there are multiple oaks, which is to prevent the local extinction of species thriving of the oak (Mörtberg et al. 2007) The oaks in the park have an important connective pathway through Järvlakilen to a region of oaks around Mälardalen. A major benefit of this connective pathway is that species that depend on oaks can spread more freely across a wider area (Bråvander, 2010). In year 1992, a map of the interests of nature conservation in the RNCP was proposed. The map shows core areas⁶ for biodiversity in the park and important connective pathways⁷ between the core areas within the RNCP (figure 5). The map also shows two important connective pathways to the nearby environment (Löfvenhaft, 2002). The area of Ladugårdsgärde and Kaknäs, which

⁷ An identified connective pathway helps to secure the quality and accessibility in high ecological valued biotopes within the core areas (Löfvenhaft, 2002).

fall within the study area, belongs to one of these core areas (Stockholms stad, 2009a).

Figure 5. Core areas (green) and connective pathways (red) between them (Lövfénhaft, 2002).



80% of the insects found in the RNCP depend on the oak (Löfvenhaft, 2002) and over 1000 different insect species can nurture and thrive on one oak in the RNCP. About 60 of the insect species are red-listed and about half of the red-listed species are acutely threatened. One of the few habitats in Sweden for *Plagionotus detritus*, a very rare beetle, is found in the RNCP. The species nurses of dead or dying oak (Nationalstadsparken n.d.a). The reason why many species are dependent on oaks is that there is such a big individual variety between the different oaks. One usually says that an oak grows for 300 years, lives for 300 years and dies for 300 years. The oaks life span is important for its biodiversity and different species are depending on different stages of the life span. As a result, species need to move from one oak tree to another oak tree when the stage of the oak changes and that is why the connectivity between oaks is critical (Mörtberg et al. 2007).

There has been up to 250 number of bird species observed in the RNCP and 100 out of these are nesting birds. Northern goshawk (*Accipiter gentilis*), is a bird of prey that is nesting in the RNCP, it is

very sensitive to disturbance and its presence in the RNCP is remarkable (Nationalstadsparken. n.d.b).

Bats are species that prefer dense broadleaved tree forests and nutrient rich water that provides a good habitat for insects and therefore good hunting places for the bats. The big hollow oaks in the park are something that many of the different bats species favour for hibernation. There are fourteen different species of bats in Sweden and nine of them exist in the RNCP. The whiskered bat (*Myotis mystacinus*) and natterer's bat (*Myotis nettereri*) are threatened to be extinct in Sweden but are common in the RNCP (Nationalstadsparken. n.d.a).

In the RNCP you can find amphibians in form of Smooth newt (*Lissotriton vulgaris*), Northern crested newt (*Triturus cristatus*), Common frog (*Rana temporaria*), Common toad (*Bufo bufo*) and Moor frog (*Rana arvalis*). You can also find the three different species of snakes in the RNCP, Smooth snake (*Coronella austriaca*), Common European viper (*Vipera berus*) and Grass snake (*Natrix natrix*). There are around 140 species of fish in Sweden and around 40 of them are found in the RNCP. The bigger animals that exist in the RNCP are red fox (*Vulpes vulpes*), Roe deer (*Capreolus capreolus*), Red squirrel

(*Sciurus vulgaris*), Mink (*Mustela vison*), European badger (*Meles meles*) and European hare (*Lepus europaeus*) (Nationalstadsparken, n.d.a).

The RNCP is not only rich in fauna but also flora. The variety of different species of plants that can be found in the RNCP is over 800 (Nationalstadsparken, n.d.c). Due to the topography and the different human activities within the park, the park has a variety of environments such as deciduous forest, coniferous forest, wetlands, lakes, coastal environments, meadows and pastures. Wych elm (*Ulmus glabra*), European ash (*Fraxinus excelsior*), Tilia (*Tilia cordata*) and Norway maple (*Acer platanoides*) is other examples of broadleaved trees that exist in the park (Nationalstadsparken, n.d.d).

The Kaknäs area is unique due to the broad variety of trees the forest contains. The big part of the forest is deciduous forest, mainly oak. But the area also contains valuable coniferous forest. The Kaknäs area also contains wetlands. The Ladugårdsgårde area is mainly open grass field and is the only breeding place for Eurasian skylark (*Alauda arvensis*) in Stockholm city (Länsstyrelsen Stockholms Län, 2012).

3.1.2 Recreation baseline

During several hundreds of years, the RNCP has had a great importance for people's recreation. The easily accessible Ladugårdsgårde is the biggest open area in the RNCP and is valuable for recreation activities such as exercise, dog walking, playing, skiing, ball sports and for different events (Länsstyrelsen Stockholms Län, 2012) such as competitions and festivities (Stockholms stad, 2009a). In the Kaknäs area east of Ladugårdsgårde you can experience a true sense of forest. There is an absence of traffic noise and lighting (Länsstyrelsen Stockholms Län, 2012), and the Kaknäs forest is one of the ten most quiet areas in Stockholm (Stockholms stad, 2009a). The area additionally contains varied recreational possibilities with walking and running tracks, outdoor gym, beach walks and riding paths (Länsstyrelsen Stockholms Län, 2012).

Wolch et al. (2014) have compiled some of the health benefits of urban green space according to research in the area. Urban green

space can enhance psychological as well as physical benefits, through for example physical activity which often takes place in parks. A park visit can reduce stress as well as revitalize the visitor and bring peace and tranquillity. It also gives opportunities to experience wildlife (ibid.). Skärbäck et al. (2014) also bring up examples of research, which state the same or similar benefits as above. It has been shown that natural environments can normalize people's heart rate and blood pressure in stressful situations.

On the other hand, high-density living has shown to be associated with both mental illness and physical health issues such as heart attacks and respiratory diseases (ibid).

Skärbäck et al. (2014) identified the following seven characteristics that are important to meet the recreational needs of urban dwellers:

- Serenity, referring to values such as peace, silence, the sounds of nature and no man-made noises;
- Nature, which includes a sense of wilderness;
- Species richness, referring to the variety of wild species of animals and plants;
- Space, meaning there should be enough space to feel removed from the normal city environment;

- Prospect, meaning there must be views of a green landscape;
- Refuge, referring to a safe and secure environment where you are able to pursue recreational activities freely;
- Social, which means that urban green spaces must be meeting places for social interaction and pleasure; and
- Culture, referring to the historical value of the location (ibid.).

As a result, their research supports the importance of having large green areas, since some recreational qualities do not fit together, for example social activities and serenity. With a large green space, it is therefore possible to include different recreational qualities, which is beneficial for well-being (Skärbäck et al., 2014).

Regarding stress, a study from the Swedish University of Agricultural Sciences also showed that visiting urban open green spaces had a positive effect on stress reduction. People with a greater distance to

urban green spaces visit these spaces less and suffer more from stress, than people living closer to urban green spaces. Additionally, people's level of stress suffering was found to be higher in the city center than in the suburbs. These findings were independent of people's sex, age or socio-economic status (Grahn and Stigsdotter, 2003).

3.1.3 Accessibility baseline

There are some different ways to access the study area. By public transport you can access Ladugårdsgärde with the subway line 13 to Ropsten (from station Gärdet). You can also take bus 76 to Ropsten, bus 1 to Frihamnen or bus 72 to Frihamnen, which all pass nearby. If you want to go to the Kaknäs area you can take bus 69 to Kaknästornet or Blockhusudden (Nationalstadsparken, 2019b; SL, 2019). Right now public boat transport only stops at Blockhusudden and Frihamnen, but in the future there is a good possibility that boats stop at Loudden, which means that public transport between Nacka and Lidingö to Kaknäs and Ladugårdsgärdet will improve. If you want to access the park with bicycle you have good opportunities. There are bike paths from Gärdet that goes through the core of the area and you have ability to access the different corners of the park with bicycle

(Länsstyrelsen Stockholm län, 2010). The same paths is accessible by walk, though the time to move will take some time. There are available roads and parking slots within the park that is open for common use, which means that accessibility with car is available, but it is limited.

3.1.4 Observed impacts

When Kungliga Djurgårdsförvaltningen got the knowledge about the plans for the development of the SRS, they started measuring how many visit passages there are at Oxberget, north of Husarviken (see

figure 6 and 7). The measurements are from 2007 to 2018. This was to see how the activity would change in the park with more population living in SRS. The chart shows measurements only in May, the month with the most passages and also December, the month with least passages, which shows there is a rising trend in passages during the whole year. Even though the measurements are better for May, one can see that it is a significant rise in passages in relation to the new developed area nearby. Some months there have been disorders that have resulted in missing measurements (Niklasson, 2019a).

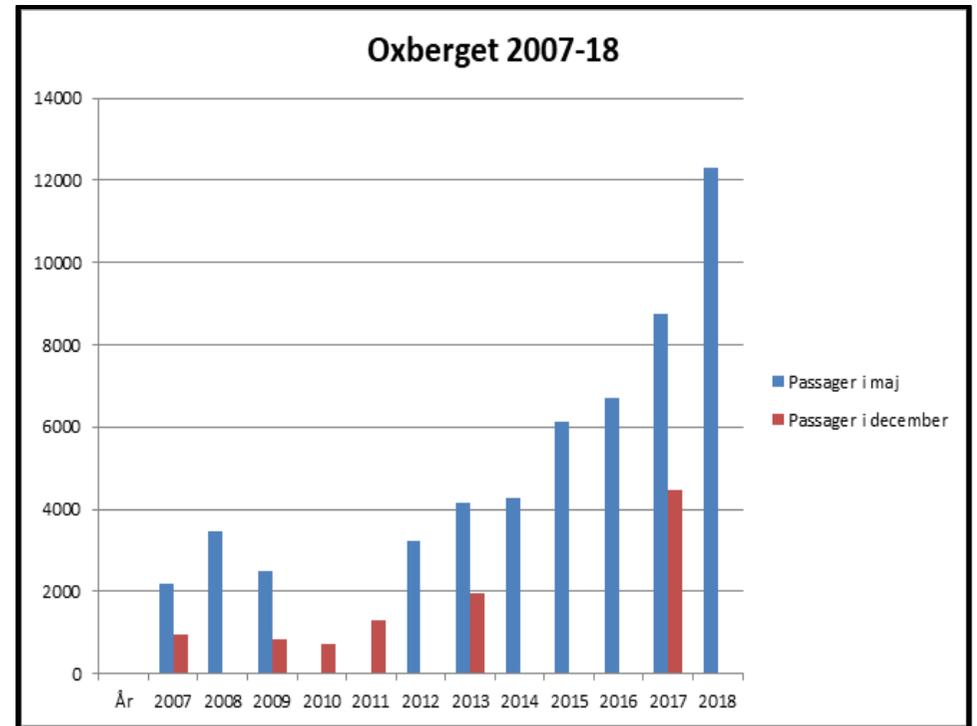


Figure 6. The figure shows population increase in Oxberget between 2007-2018. Figure retrieved from Niklasson (2019a).



Figure 7. The figure shows the study's research area. The red dot represents the measurement point. Figure retrieved from Niklasson (2019a).

Kungliga Djurgårdsförvaltningen have also noticed more negative impacts coming along with more visitors such as:

- More littering and graffiti that have made the maintenance cost of the park higher.
- There is overall more degradation of the area.
- Usage of disposable grills and grilling in places that is forbidden have also increased.
- There are also more problems with dogs in the area that complicates the care of wildlife.
- The trend of visitors not using the existing paths in the park have made it harder for wildlife refuges (Niklasson, 2019b).

3.2 Predicted impacts

3.2.1 Impacts on biodiversity

Even though the development of Loudden will not directly encroach on the RNCP, the development and the subsequent rise in number of inhabitants close to the RNCP, can affect the quality of green space and biodiversity, indirectly (Stern et al., 2008). For example, before the SRS was developed, there were many calm areas in the RNCP which was good for the wildlife. After the development there are big differences in visitor frequency in the park (Niklasson, 2019a; Niklasson, 2019b). It is possible that an increased number of visitors could degrade the area through things like littering, pollution, collection of valuable species and increase the risk for forest fire. This is something that is noticeable in the RNCP after the first stage of the development of the SRS (Niklasson, 2019b).

Niklasson has also seen an increasing trend in the RNCP where mostly mountain bikers do not stick to the designated trails. If people start using off track areas as a consequence of crowding in the Kaknäs area, it could have implications for the biodiversity. Since wildlife reacts less sensitive to disturbances it is used to, for example trail activities (Stern et al., 2008), it implies that wildlife reacts more sensitive to disturbances taken place off trail.

Deterioration of habitats of flora and fauna and disturbance of species can arise as a consequence of recreational use in protected areas. Many studies on recreational impacts on wildlife have found the impacts to be negative and the consequences can be especially serious in areas near urban settlements (Stern et al., 2008).

Some of the consequences include injure and killing of plants by trampling by feet and horses' hooves, which can affect the growth rates and reproductive capacities. A change toward more tolerant species can arise as a result of recreational activities since tolerant species are more resistant (Hammit et al., 2015, p.7). Direct disturbance mostly affects large animals, which can lead to reduced reproduction and migration, while a change in habitat is what mostly affects small animals (Hammit et al., 2015, p.9).

Also Stern et al. (2008) mention studies that have shown that movement, noise and the presence of dogs, especially unleashed ones, can disturb wildlife. The sensitivity to disturbance varies between species, but can also vary over time. During the winter season, when there is no forage and cover, wildlife can be especially sensitive. Although as mentioned above, wildlife can react less sensitive to disturbances it is used to, for example activities taken place on trails (Stern et al., 2008). The species that are most vulnerable to disturbance are those with limiting factors such as a need for special food or shelter. An overall decrease in species diversity is the general effect of recreational activities in an area (Hammit et al., 2015 p.57,76).

Although the wildlife responses depend somewhat on different factors of recreational disturbances. These different factors are: type of activity, behavior of recreationalists, predictability, frequency and magnitude and timing and location. This implies that the impact on wildlife differ depending on if people bike or walk, if they move fast or slow, if the animals expect the disturbance or not, if areas are visited frequently or not, the magnitude of visitors, what season it is, if the disturbance occurs close to nest or dens, to mention some examples (Hammit et al., 2015, p.56).

Bråvander (2010) writes that the biggest threat for the biodiversity in the RNCP is that if nature and green areas within the park is exploited for buildings and other infrastructure that disconnect the ecological infrastructure and connection with the surrounding area of the RNCP. Although since the development of Loudden takes place in an industrial area and the RNCP is a protected nature area, the development will not per se lead to a loss of green space,

Stern et al. (2008) further bring up studies showing the importance of information and education to make people aware of their disturbance on wildlife.

3.2.2 Impacts on recreation

Haaland and Konijnendijk van den Bosch (2015) state that as a result of a densified city, recreation areas can be put under higher pressure, and they bring up examples of a study which has shown that this form of crowding can be perceived as a problem by visitors in a recreation area. The authors also list several risks regarding green space planning associated with densification in city areas, which can impact recreation possibilities. Three of these risks are:

- ❑ risk for insufficient green space provision in areas under densification
- ❑ risk for quality loss of existing green space and for provision of green space with low quality
- ❑ risk for low priority of green space planning in the context of exploitation (ibid.).

From a study of the effects of crowding on visitor displacement in Mount Rainier and Olympic national parks, it was shown that because of crowding, some visitors were displaced in different ways. Some had stopped visiting the parks completely, some visited the parks during low-use periods instead of during high-use periods and some had gone to lesser-used locations within the parks to avoid crowds,

for example the backcountry. One reason for visiting the parks at low-use periods were to experience a more natural park (Gramann, 2002).

At Mount Rainier national park, the motives for recreation among people who were displaced because of crowding included: enjoying the smells and sounds of nature, being close to nature, learning more about nature and gaining a better appreciation of nature, but also to get away from crowded situations (Gramann, 2002). Since the recreational activities on Ladugårdsgärde consist of exercise, dog walking, playing, skiing and ball sports as well as big events (Länsstyrelsen Stockholms Län, 2012), it could be assumed that the motives for these activities do not coincide with those of the displaced visitors in Mount Rainier national park and that increased visitor numbers on Ladugårdsgärde might not contribute to severe decreases of the recreational values on Ladugårdsgärde.

The Kaknäs area on the other hand is one of Stockholm's most quiet areas (Stockholms stad, 2009a) and holds a true sense of forest with

the absence of traffic noise and lighting. Recreational possibilities in this area include walking and running tracks, outdoor gym, beach walks and riding paths (Länsstyrelsen Stockholms Län, 2012). Because of these characteristics, it is probably likely that an increase in visitor numbers will affect the recreational values in this area.

It seems that dedicating certain paths to specific activities, is able to minimize conflicts arising between visitors, since this can channelize the flow of visitors depending on their use of the area (Janowsky and Becker, 2003; Klanjsček et al., 2018).

Crowding and user conflicts could also mean that people from other parts of Stockholm and tourists do not visit the area. There is a risk that the area becomes exclusive for the neighboring inhabitants, which contradicts the RNCP's purpose of being available for everyone (Niklasson, 2019b). Good accessibility to the park may lower this risk.

Apart from crowding, natural resource degradation can also cause displacement from natural areas (Gramann, 2002), and biodiversity

loss can diminish the perceived recreational values by visitors in an area (Qiu, 2014).

3.3 Future planning vision for the study area

3.3.1 Vision for the Royal National City Park

The care and development plan for the RNCP has been produced by the Stockholm County Administration in cooperation with actors in the RNCP. The plan is not binding but is aimed to support maintenance, management and development in the park. In the plan it is pointed out that Stockholm will grow and develop in a sustainable way and that the RNCP can contribute to this development, with for example the ecosystems services that the park holds (Länsstyrelsen Stockholms Län, 2012).

The County Administration acknowledge that new residential areas are being developed near the park which will lead to an increased pressure from visitors. This will enhance the park's function as a

recreational area, which is viewed in a positive way. In the growing Stockholm region, the park will become an even more important access. However, the maintenance is neglected in some parts of the RNCP and the increased pressure must be handled actively. Furthermore, easy access to all parts of the park is of importance (Länsstyrelsen Stockholms Län, 2012). Henrik Niklasson, at Kungliga Djurgårdens förvaltning, is of the opinion that the first part of the development of the SRS is too densely built and that more recreational areas such as sports fields, should be added in the developed area. The RNCP is not supposed to serve as a substitute for other green areas since it could risk becoming a green space exclusively for the residents of the SRS (see 3.2.2).

The management plan for the RNCP is produced on the initiative of *Kungliga Djurgårdens förvaltning*, who manage parts of the RNCP. The plan brings up ecological, cultural historical and outdoor activities-connected values in the overall goals for the RNCP. The

biodiversity is one of the park's fundamental values and the park constitutes the connection to the surrounding areas, enabling a rich and varied environment in the city. The cultural historical values should be preserved and strengthened, and the park should offer possibilities for different experiences and activities (Bråvander and Jacobson, 2006, del 1).

For Ladugårdsgärde, the care and development plan aims to conserve the area as an open field with a varied landscape (Länsstyrelsen Stockholms Län, 2012). Ladugårdsgärde is part of an important but weak ecological pathway between Norra Djurgården and Södra Djurgården and this pathway should be strengthened (Länsstyrelsen

Stockholms Län, 2012; Bråvander and Jacobson, 2006, part 1). The edge zones of Ladugårdsgärde should furthermore have a continuing high biodiversity. The recreational qualities shall be conserved and developed, both as a place for outdoor activities and events. The events should not damage the wildlife or hinder people from experiencing the area in other ways. Also, the number of constructed paths should be kept low (Länsstyrelsen Stockholms Län, 2012).

The Kaknäs area is one of the RNCP's so called calm zones, which are aimed at being kept less accessible. The goal for the Kaknäs area specifically is to keep it as a serene nature area with its calm and quiet as well as non-illuminated places. The constructed roads and paths in the forest areas will not be extended and new especially traffic generating activities should be avoided (Länsstyrelsen Stockholms Län, 2012). In parts of the Kaknäs area there are forest and shore areas that are little affected by trails and signs, which is seen as a large value for people. The management plan therefore states an aim to safeguard these parts from further construction of both trails and information signs (Bråvander and Jacobson, 2006 del 1). Another aim is to maintain the Kaknäs area's rich wildlife, with good habitats for amphibians, insects, birds and plants, for example the wetlands at Kaknäs ängar (Länsstyrelsen Stockholms Län, 2012).

For the biodiversity in the area, the ecological core areas and ecological pathways are of importance. To stay viable, the biotopes in the park should not become isolated from surrounding nature areas. Therefore, a landscape ecology perspective is important for the biodiversity in the area (Länsstyrelsen Stockholms Län, 2012; Bråvander and Jacobson, 2006 del 1).

A large part of the old farmer landscape's mowing and grazing land is disadvantaged by nitrogen, especially coming from dog's faeces. The old flora is virtually exterminated by competition from some grasses and herbs. Besides, loose dogs can scare both people, wild animals and grazing animals (Bråvander and Jacobson, 2006 del 1). One proposal in the management plan to solve the problem is to create a dog park at Ladugårdsgärde (Bråvander and Jacobson, 2006 del 3).

It is furthermore important to pay attention to the park's connection with the surrounding areas when new development is being planned outside of the park. It has been assessed that it is possible for the SRS to integrate with the values of the RNCP. It is of importance to assess if new buildings and development will be visible from the park. The design of the new development affects how well it interacts with the values of the RNCP (Länsstyrelsen Stockholms Län, 2012).

There needs to be clear rules about how to use the park in consideration of both nature and culture values. Furthermore, information signs should be present at the different entrances to the park. Information and maps should also be present at cafés and museums (Bråvander and Jacobson, 2006 del 1). For both Ladugårdsgärde and Kaknäs, ancient monuments should be easy to spot and well cared for (Länsstyrelsen Stockholms Län, 2012). Although as stated above, some areas should not have information signs at all. Since most people visit the park for the nature and culture, people generally care for the environment and the conflicts between different users are few. People usually visit an area that correspond

with their interest and most people use the assigned trails (Bråvander and Jacobson, 2006 del 1).

On the other hand, Henrik Niklasson from Kungliga Djurgårdens förvaltning, claims that there is an increasing trend where people, mostly mountain bikers, do not stick to the designated trails but instead create their own paths which can affect animal refuges. With an increase in visitors, there will also be an increased importance of canalizing flows of people (Niklasson, 2019b).

3.3.2 Vision for the Stockholm Royal Seaport

In the document *Vision Stockholm Royal Seaport 2030* (Stockholms stad, 2009b) the goals are set for the SRS as a sustainable developed area. The three goals are:

1. The Stockholm Royal Seaport will be free from fossil fuels by year 2030. The ambition for Stockholm City is to be fossil fuel free by 2050.
2. Year 2020 the carbon emission will be below 1,5 tons per person. This can be compared to an average of 4,5 tons per person in Sweden today.

3. The Stockholm Royal Seaport is adapted to future climate change, such as increased precipitation (ibid.).

In the vision 2030 for the Stockholm Royal Seaport, the idea is to create a city that is sustainable both today and in the coming future. New innovative technique that minimize the energy use, waste and the need for transportation and new recycling management will bring the SRS a step further in the sustainability aspect (Stockholms stad, 2009b).

In the Sustainable Urban Development Programme (Stockholms stad, 2017a) the approach to the RNCP is that the SRS is going to adapt to the RNCP; that the planning and architecture should be inspired by RNCP and enhance the values of RNCP, the residents should feel like they are living next to RNCP. Yet the RCNP is only a complement and not a replacement for the green areas and parks in the SRS (ibid.).

Stockholm city has also proposed five strategies to achieve the sustainable urban development. These five strategies (i) vibrant city, (ii) accessibility and proximity, (iii) resource efficiency and climate responsibility, (iv) let nature do the work and (v) participation and

consultation addresses the ecological, economic and social aspects (Stockholms stad, 2017a).

Year 2011 before first residents moved into the SRS, the population of Östermalm were at about 66 300 people (Stockholms stad, n.d.c) and is expected to be near 90 000 people that lives in Östermalm when the SRS is finished (Stockholms stad, n.d.d). Around year 2030 the SRS is expected to have 23 700 new residents. The plan for the SRS is 12 000 new housings and 4 000 of them will be located at Loudden (Stockholm stad, 2019a). This makes the percentage of housings that will be in Loudden by following $4\,000 \div 12\,000 = 0,33$. 33% of 23 700 people is approximately 7 800 people. Loudden stands for 33% of the new housings in the SRS which is equivalent to approximately 7 800 people moving in at Loudden when the area is built, supposing that every apartment is the same size.

3.3.2.1 Let nature do the work

The strategy ‘let nature do the work’ is the most relevant for this research report. The target with this strategy is to “utilise ecosystem services to build a resilient and healthy urban environment”. The vision for this is to create **multifunctional green spaces** where the green space could serve several recreational needs for the residents. **Green buildings and courtyards** that will reinforce the greenery in the area.

The green structures in the area should be planned so it is **pleasant** for the residents to be in the **outdoor environments** and **mitigate the effects of future climate changes**, an example is that vegetation should be planned in the urban space to dampen high temperatures and make the city more pleasant during heat waves or green infrastructure that is **resistant to increased precipitation**. The public places in the city should work as a **strengthening link for the connective pathways** of oak- dependent species and **ecosystems**. The SRS should plan and build sustainable **stormwater management** in the urban area. The green spaces in the urban area should **encourage and include possibilities for urban gardening** that will both benefit recreational and ecological aspects (Stockholms stad, 2017a).

3.3.3 Vision for Stockholm

The Stockholm Region is currently one of Europe’s and the world's most successful regions. As capital of Sweden very much sought after and it attracts people all around the world and 2050 the region expects a population larger than 3.4 million people. The region puts great importance on sustainable development and put much importance of all three of the sustainable aspects, economical-, ecological-, and sociological aspects.

Stockholm want to preserve its green and blue character. The strategie is that different actors should work together to achieve its goals as Europe's most attractive region. Ecological sustainability is within the regional plan presented as the base for sustainability, where sociological sustainability operates within, and which economical sustainability in turn operates within (Stockholms läns landsting, 2018).

To future understand how the future of the NSD will look like, a shorter study of relevant trends in *RUFS 2050 (Regional utvecklingsplan för stockholmsregionen 2050)* has been done. The purpose of doing a trend analysis is to gather information about how the prerequisites for the park will look in the future. This study will be based on the conclusions of the regional plan (RUFS 2050) which one of its tasks is to depict the future considerations (Stockholms läns landsting, 2018). The trends that seem most relevant to this study will mainly be investigated. There have been trends identified that are occurring in the region of Stockholm, and that could be relevant for NSD. Increased pressure on environmental systems is the clearest trend that could affect the park. This trend is a result of anthropocene activity without regard to the environment and alter conditions could change and destroy the nature and biodiversity in the area. Urbanisation is another trend that could affect the area of the park, when the increased pressure of develop more buildings in the city makes stakeholders less capable to resist the preservation of the park in favor of develop and create more buildings. Globalisation could lead to the park getting more visitors in form of tourists, which could implicate more actors in the park as well as actors of less understanding for the valuable nature they pass through.

Digitalisation could possible in some way affect how visitors of the park experience the area. It's hard say in which manner this could affect the park, but things like for example "Pokémon Go" have affected how people move through space (Pokémon, 2019). The gather information about the trends is collected from Stockholms läns landstings rapport of regional development; RUFS 2050 (Stockholms läns landsting, 2018).

3.4 Study of other urban green areas

3.4.1 Nackareservatet

Nackareservatet is a nature reserve, with an area of about 650 ha, which is located southeast of Stockholms city. The area has a great diversity of natural life and are greatly used by humans, mostly for recreational outdoor activity. The area also holds cultural value and is a place of national interest (Länsstyrelsen Stockholms län, 2003). This area is the most well visited area in Sweden and it holds the most

biodiverse area in Nacka (Nacka, 2019). There are some aspects of this area that could be beneficial for NSD.

This area is a major hotspot for human recreational activity. A large reason for that is the park's strategic location and its friendly development to these types of activities. There are many inspirational aspects you could take from this place, when you look to develop a more attractive outdoor area. In the area you could find things such as illuminated walking, running and cycling paths, outdoor gym, park facility, toilets, cafe, golf, tennis courts and more (Nacka, 2019). To enhance NSD's recreational abilities you could implement those sorts of things into the park.

Park facilities (with toilets, information center, cafe etc) could also be used to support the commonly recurrent events that tends to happen on the field of Gärdet (and that seems to be intended to happen in the future too).

3.4.2 Hammarby Sjöstad

Hammarby Sjöstad is another newly developed area in Stockholm. This project is the forerunner to the SRS, and they have made some good planning implementations in regard to urban sustainable development. You could read more about the area and its development in *Sustainable Stockholm* (Matzger and Olsson, 2014), but this area could definitely give some inspirations to the development of Loudden when trying to integrate the park into the city area. The northern part of Nackareservatet extends in to the developed city area of Hammarby Sjöstad through ecoducts and preservation of nature reserves. This creates opportunity for the inhabitants to experience green infrastructure with good values close to home without burdening the existing areas of the park (Stockholm stad, 2019b).

3.4.3 Existing development of the Royal Seaport

The existing development of the SRS is also a good way to look for guidance when you're searching for suggestion for development of the Loudden area. In the current development they have put a big effort in developing and created green infrastructure in the developing area. Two concrete examples of this is the paths between the houses and the waterfront, which creates a good sense of openness and extension of the park on the other side. A good example of this is the development of Hjorthagen in the northern part of the SRS. Hjorthagen has in part already been developed and people started moving in in 2012 and in total 15 000 new residents are expected. As Loudden will have, the northern part of Hjorthagen has a frontier to the Royal National City Park. Green surfaces in the urban area will serve both as spaces for ecological values as for rest and exercise (Stockholms stad, 2017a). Furthermore, ecosystems for amphibians and oak-dependent species have been promoted and preserved, for example by planting oak trees and building a frog tunnel, which will also enhance the dispersion routes for these species (Stockholms stad, 2017b). Parks and other public spaces in the urban area will also contribute to the enhancement of these dispersion routes.

To furthermore reduce the impact on the park, the northern houses are low with muted colours (Stockholm stad, 2017a). In Stockholm Royal Seaport sustainability program 2017, it is mentioned that the RNCP gives the SRS identity and dynamics (Stockholms stad, 2017b) and the buildings close to the park have an irregular frontier to make more people feel like they live in close proximity to the park. There are also smaller parks in within SRS that has good connection to the national city park, which enhance the recreational experience (Stockholm stad, 2017a).

3.4.4 Gärdesstaden

Gärdesstaden has some older developed area (the city plan was created 1931), which are built in the most narrow path of the RNCP and even though the area is of older decent there is some good planning decision made in regard of the connectivity of the park. The houses in the area are built alongside the parks north-south directions which allows for green paths between the buildings that creates green infrastructure that transversed through the developed area between from one part of the park to the other. This creates connectivity in the park and is necessary for the south part of the park for allowing its inhabitants to move from the north part to the south and vice versa

(Länsstyrelsen Stockholms Län, 2012, p.122-125). If this development had been built in the other way that limited connectivity, the southern part of the park would have been cut off from the other green areas in the city. According to the current plan for the area there is of interest of preserving the current state of the development and green infrastructure in the area to ensure RNCP unique qualities and values (Stockholm stad, 2014). Now, when they are developing other areas in the narrow path of the city park they could look at this old example to enhance and improve the connectivity between the different parts of the park (or at least not impair it, which could easily be the case if the actors don't take into consideration the connectivity of the parks in the planning of the future development). The connectivity of green infrastructure could also be increased on the sport field of Gärdet, by adding more biomass were its suitable, instead of just having a large field of grass.

3.4.5 Norra Djurgården

Norra Djurgården is the biggest natural- and recreational area within RNCP and this area is today used in a way that could be possible for

NSD to be used in the future. This area is highly accessible and is surrounded by more developed areas than the southern part of the park. There is more developed infrastructure for recreational services which means that it can hold many visitors at the same time. The area has a large coherent green infrastructure, old and valuable buildings, attractive sights, supporting recreational infrastructure and more. For the future the park intends to promote recreational activities of different sorts, host arrangements on sites of less sensitive nature, avoid hosting activities that generate more traffic and make the park more accessible by foot, public transport and bicycle (Länsstyrelsen Stockholms Län, 2012, p.110-117). These areas use and function can get an insight of how NSD will be used when the development of Loudden is complet. Therefore, this areas strategies and actions plan could be relevant for NSD in the future.

3.4.6 Södra Djurgården

Södra Djurgården is contiguous to the NSD area in the north and is a valuable area in many aspects. The area holds historical buildings, many sorts of ecological values, and is widely visited be people that use the parks walking paths and boardwalk. The area is in many ways intended to be preserved as it is, to stay true to its origin (Länsstyrelsen

Stockholms Län, 2012, p.140-143). NSD will be a passage between Loudden and Södra Djurgården, for its inhabitants. This means that NSD needs to be able to the demand of transport, whatever it will be (probably transport by walking and cycling).

But this also mean that Södra Djurgården also can take care of some of the recreational activities that otherwise NSD had to take care of. NSD and Södra Djurgården has also close connected pathways for species which is very good for the whole area's biodiversity. Therefore it is good for NSD to enhance the connectivity with Södra Djurgården, both in recreational and in biodiversity aspects.

3.4.7 Museiparken

Museiparken is located below the area of Ladugårdsgärde. This area holds some special characteristics for the RNCP because it's more of a developed area that holds several museums, which is well visited and holds big recreational values, not just to the surrounding of NSD, but for all of Stockholm, and for tourists. The area also hosts events in the park and the area also plays a significant role as entrance to the south part of the RNCP. The area has attractive boardwalks which is well used (Länstyrelsen Stockholms Län, 2012, p.130-133). This area draws visitors to it and can be used widely for the inhabitants of

Loudden for recreational services. In this case the NSD needs to be able to provide pathways between Museiparken and Loudden to make it accessible for people to use. Museiparken then has the ability to asset the NSD for some recreational activities.

4. Analysis

4.1 A systems perspective on the RNCP as a green resource

The preceding sections of the report provided insight into the baseline environment of the study area, studied the predicted impacts that the development of Loudden will have on the study area, investigated other urban green areas that face similar development pressures as the study area and provided an overview of the planning vision for the development of Loudden. A systems perspective was applied to develop these insights into a critical analysis of the planning vision and to identify possible solutions.

The CLD shown in figure 8 below was developed to illustrate the authors' conceptual model of the relationships between the multitude

of interrelated factors that will ultimately determine whether the RNCP will be a green resource that will support the creation of a sustainable city area. Furthermore, the CLD was used to identify the leverage points in the system, i.e. factors that can be managed by decision makers to increase both the sociological and ecological sustainability of the area.

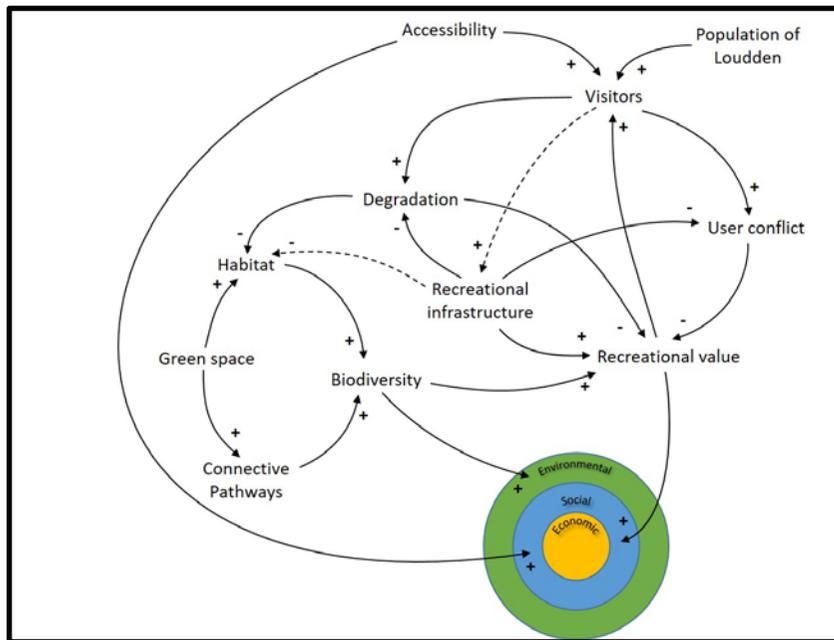


Figure 8. A conceptual model of the sustainability of the study area.

The CLD is a simplified model of reality and only the variables that are viewed as most relevant for the study area are displayed. As stated

in section 1.3.1 above, this project is focussed on ecological and social sustainability, but not on economic sustainability. Therefore, there is no representation of economic aspects on the CLD. Since “sustainability” is the key phenomenon or response variable in the model, it is important to keep this particular demarcation of sustainability in mind.

The CLD shows that the following variables can drive or inhibit sustainability:

- Biodiversity;
- Habitat;
- Green space;
- Connective pathways;
- Population of Loudden;
- Visitors;
- User conflict;
- Degradation;
- Recreational infrastructure;
- Recreational value;and
- Accessibility.

The authors' conceptualisation of each of these concepts and how they affect each other in the system will be discussed below.

Biodiversity

In this model biodiversity is the direct driver or measure of ecological sustainability, because biodiversity is the basis of all ecosystems, which are in turn the basis for ecosystem services (Millennium Ecosystem Assessment, 2005). As described in section 3.1.1 above, the RNCP has a rich and meaningful biodiversity. As long as the RNCPs biodiversity is maintained, it will continue to provide a wide range of ecosystem services that will benefit the inhabitants of Stockholm, such as: climate regulation and water purification (regulating services); recreational opportunities (cultural services); and soil formation (supporting services) (Millennium Ecosystem Assessment, 2005). However, the maintenance of biodiversity is dependent on the effects of numerous aspects. It is therefore necessary to consider how aspects such as the amount of green space, the availability and degradation of habitats and connective pathways will affect biodiversity.

While the RNCP's biodiversity is directly linked to ecological sustainability, biodiversity is also linked to social sustainability through recreational value, since it has been shown that urban green areas that are rich in biodiversity are perceived by visitors to have greater recreational value (Qiu, 2014) and could also provide better opportunities for certain recreational activities, such as wildlife viewing (Booth et al., 2011).

Habitat

Whereas green space includes all green infrastructure within an area, a habitat refers to the living environment where a plant or animal species live under specific conditions. While some generalist species that can tolerate a wide range of habitat requirements are able to adapt to increasingly urbanised landscapes, many species with specialised habitat requirements are dependent on urban green spaces that provide suitable habitats for their survival in the urban landscape (Nielsen et al., 2013).

Green space is therefore a prerequisite for habitat availability and, in turn, habitats are a prerequisite for biodiversity. Habitats are threatened even more by development of Loudden than the green space available in the study area, because the degradation of habitats may occur regardless of the fact that the development of Loudden will not intrude into the green space of the RNCP. This is because habitats can be directly impacted or even destroyed through damage from human activities such as walking, cycling and horse riding.

Therefore, the quantity of green space will remain unchanged, but the loss in habitats and resulting loss in biodiversity will lead to a decrease in its quality. However, the development of Loudden also provides the opportunity to incorporate more of the existing habitats of the park in to the developed area, which can favor the ecological sustainability and the resilience of the RNCP.

Green space

The CLD shows that green space is one of the most important aspects in the system, because direct positive links exist between green space and habitat and green space and connective pathways. Both of these factors contribute to biodiversity, which is the overall driver for the ecological sustainability of the study area and which also contributes to social sustainability through the recreational value of biodiversity. Here, the term green space means all areas within the study area that are occupied by green infrastructure. Green infrastructure is a characteristic feature of the parts of the study area occupied by the RNCP, whereas Loudden, on the other hand, consists of an industrial area which is at present not viewed as a green space, both because it currently holds little green infrastructure and also because this space is currently not available for public use. However, once the development of Loudden begins in the near future, planners will have the opportunity to add new green spaces in the study area that can complement the green space currently available in the RNCP. The addition of new green space and the preservation of existing green space in the study area is therefore a necessary feature for the sustainability of the study area.

Connective pathways

As stated in section 3.1.1 above, connective pathways play an important role to prevent the local extinction of species, because it allows for the movement of species between green spaces within the study area and suitable habitats in other green areas, thereby improving population viability (Lepczyk et al., 2017). Currently, within the RNCP, the connectivity between Norra djurgården and Södra djurgården is rather weak, since the only existing corridor that can be used by species to move between the two areas are narrow strips of vegetation between buildings, which is detrimental for biodiversity and the overall ecological sustainability of the study area.

Depending on the decisions taken by the planners of SRS the future development of Loudden can either cause further fragmentation of the landscape if the new development cuts off existing connective pathways, or alternatively connectivity can be improved with the addition of green spaces that can fulfil the role of connective pathways and which can enhance existing pathways, thereby improving plant and animal biodiversity.

Population of Loudden

Since Loudden is currently an industrial area with restricted access to the public, the number of visitors accessing the RNCP, especially the Kaknäs area, from Loudden is likely to be limited, because the current population of Loudden mainly consists of people working there and who commute into and out of the study area every day. The impact of the current population of Loudden has therefore not been investigated. As mentioned in section 2.2 above, the population in the study area will increase by nearly 8000 people once the development of Loudden is completed as planned and it is expected that this increase in population will lead to an increase in the number of visitors to the study area.

Visitors

Visitors are people who visit the RNCP for various recreational purposes. Having visitors in the RNCP is seen as a prerequisite for the park to hold any recreational value, since recreational value is based on human perception and experience. It is expected that the increase in the population of Loudden will result in a direct increase in the number of people visiting the study area for recreational purposes, which will affect the park in different ways. This is supported by the observations made by Kungliga Djurgårdsförvaltningen with regard to the increase in visitor numbers in parts of the RNCP bordering on completed section of the SRS, discussed in section 3.1.4 above. An increase in the number of visitors is expected to lead to increased degradation as well to increased user conflict. An increase in visitor numbers may also stimulate an increased demand for recreational infrastructure. However, this link is weaker than both the link between visitors and degradation and the link between visitors and user conflict.

User conflict

Since visitors of the RNCP will have different interests with regard to the recreational activities that they want to undertake in the park, different views on whether it is appropriate to undertake those activities in the park and how these activities should be provided for in the park, it is expected that user conflict will probably arise at some point due to increasing visitor numbers (Rossi et al., 2015). More visitors in the park means more people with different interests, which can lead to conflict, because certain recreational activities are not compatible in the same area. Examples of user conflict include: confrontation between horse riders or cyclists and walkers on the same trail; or visitors seeking to enjoy serenity being disturbed by dogs. User conflict may create perceptions of overcrowding and will have a negative effect on visitors' perception of their recreational experience and therefore lead to degradation of recreational value.

Degradation

Although the RNCP is protected against exploitation through laws and regulations, one of the biggest threats to the sustainability of the RNCP is degradation of the quality of green space and biodiversity due to intensive use of the park. As discussed in section 3.2.1 above, degradation results from the normal activities undertaken by visitors to the park, but with increased visitor numbers leading to increased degradation, the park may lose its ability to withstand the increased pressure on its resources. Examples of degradation include littering, dog faeces, trampling, erosion of trails, disturbance of wildlife and loss of aesthetic value. Increased degradation will lead to a decrease in the availability of suitable habitats for species and will also lead to a decrease in recreational value. Therefore, both environmental- and social sustainability will be negatively affected. Measures to protect the RNCP against degradation may be hard to implement, but examples of management measures include prohibiting certain activities in certain sensitive areas and providing appropriate recreational infrastructure.

Recreational infrastructure

Recreational infrastructure refers to the infrastructure within the study area that aims to improve the recreational value for the user by making the area more user friendly, but which also serves to relieve stress on the environment where it is implemented. Recreational infrastructure can therefore both increase recreational value and decrease degradation. An example of this could be a regular pathway, which makes it easier for visitors to experience nature, but which also channels visitors on a certain path in order to preserve sensitive areas by discouraging users to make their own trails. Recreational infrastructure needs space and it can be argued that it reduces the amount of habitat. However, this link is weaker relative to the benefit of recreational infrastructure with regard to protection against degradation. Recreational infrastructure can also help to reduce user conflict if different types of recreational infrastructure provide recreational opportunities for different types of users, like dog owners, walkers, runners, horse riders, cyclists, bird watchers etc. While recreational infrastructure currently exists within the study area, as discussed in section 3.1.2 above, it is likely that the existing infrastructure will be insufficient to deal with the predicted increase in visitor numbers.

Recreational value

Recreational value is based on the value people derive from their experience in the park and is one of the measures for social sustainability in this study. As discussed in section 3.1.2 above, spending time outdoors in nature provides many benefits for human well-being. Recreational value is dependent on many factors, including the quality of nature in itself (an increase in biodiversity will improve recreational value and an increase in degradation will decrease recreational value), the behaviour of other users of the park (an increase in user conflict will reduce recreational value) and the range of recreational possibilities (an increase in recreational opportunities provided by recreational infrastructure will improve recreational value). The higher the recreational value of the study area, the more attractive it will be for visitors and therefore will lead to an increase in visitors. As mentioned in section 3.1.2 above, the recreational activities that visitors to the RNCP participate in include exercising, dog walking, playing, skiing, ball sports, experiencing nature and serenity and taking part in different events and festivals.

Accessibility

Accessibility refers to the ease with which people can access the park and is another measure of the social sustainability of the study area. Different means of accessing the study area has been outlined in section 3.1.3 above. From a sociological perspective, it will be beneficial for the social sustainability of the study area if the future development enhances accessibility to the park. It is important that the the study area will not be used exclusively by the residents of Loudden, but must be available to all residents of Stockholm. Improved accessibility could at the same time allow people who live in close proximity to the study are to visit other places for recreation. This will allow visitors to undertake recreational activities in areas which are best suited for particular activities. Hower, improved accessibility could also lead to an increase in the number of visitors, which can have negative consequences as already discussed.

5. Discussion

5.1 Measures to improve ecological and recreational value

Based on the conceptual model that was developed in the preceding section, it is clear that significant pressure will be placed on the ecological and recreational values of the RNCP once the development of Loudden as part of the greater SRS is completed in or about 2030. The increased pressure on the system primarily stems from the anticipated increase in visitors to the study area accompanied by a potential lack of sufficient green space to support the increased number of visitors.

With an improved understanding of the relationship between different factors and potential consequences gained from the model, it is now possible to identify shortcomings in the existing planning vision and to make suggestions for the improvement of the existing plans, which the authors hope to see in their vision for the study area.

Since the model shows that ecological- and recreational values are interconnected, any measure to improve the ecological value could affect recreational value and vice versa. It is therefore necessary to approach the discussion about suggested improvements of either aspect in an integrated manner. The measures discussed below can be incorporated into the existing planning vision to enhance ecological- and recreational value.

5.1.1 Improvement of recreational infrastructure

In order to deal with the the future increase of inhabitants in the area and the predicted increase in the number of visitors to the study area, existing recreational infrastructure in the RNCP must be improved and new recreational infrastructure must be created. For example, existing footpaths must be prepared for more intensive use and new footpaths can be constructed in underutilised areas. This will have the effect of minimising user conflicts and can also be beneficial for some aspects of biodiversity, by reducing the amount of degradation.

The increase in visitor numbers will likely stimulate a demand for a greater variety of recreational activities. Certain activities can be harmful to nature and be dangerous for other visitors. For example, it is often forbidden to use motorised vehicles within nature areas. It is important that appropriate areas of the study area are used for particular activities. A practical example is to forbid cycling and horse riding on certain pathways. Not only will this minimise user conflicts, but it will also protect sensitive areas from harmful activities. As mentioned in the analysis, infrastructure could also fragment habitats, but the benefits of improved infrastructure weights stronger in this case.

Also related to the improvement of recreational infrastructure, sensitive ecological areas existing within the RNCP need protection from threats posed by increased visitor numbers. Installing barriers around especially sensitive areas can minimise unwanted public access, thereby reducing degradation and preserving ecological value. Although restricting access to certain areas may have a negative effect on recreation, the negative effect is outweighed by the positive effect for biodiversity.

In anticipation of higher visitor numbers, recreational infrastructure can be further improved by providing more waste management facilities in the study area, since more visitors to the park will likely result in more littering. Minimising the risk for littering and pollution will not only reduce degradation and the negative effects on biodiversity, but a cleaner environment will also enhance recreational value. Plastic and other non-recyclable waste materials should be banned within the park.

With the inflow of new visitors to the RNCP, many people may be ignorant about the ecological value of the RNCP and how it can be harmed through recreational activities. Various methods can be used to provide visitors with information to improve their environmental awareness and to influence their behaviour, for example by:

- Placing standardised, easily understandable information signs in and around the park;
- Demarcating the boundaries of the park with boundary markers or signs so that visitors understand that they have entered the RNCP (since the park is not fenced); and
- Constructing a “visitor centre” within the study area.

A visitor centre could, for example, be located on a “brownfield” site, either within Loudden or selected locations in the RNCP, or on the field of Gärdet to minimise the loss of green space and effects on the environment. A visitor centre located on the field of Gärdet could serve multiple purposes, such as supporting large events that are held on the field from time to time, and it could also house an information center and museum, an office for the park management, a cafe/restaurant and toilet facilities for visitors.

A visitor centre, along with the other measures to provide visitors with information, could potentially increase recreational value as a result of visitors’ increased awareness about the impact of their recreational activities on the environment, which will not only reduce user conflict, but will also reduce degradation so that ecological value can be maintained, in turn leading to enhanced recreational value. Disadvantages only relevant to a visitor centre include the cost of construction, the loss of green space and potential negative impacts on the environment. Any negative effects of the other information measures are considered to be negligible.

In summary, recreational infrastructure can be improved in the following practical ways:

- Prepare existing trails for more intensive use;
- Create new trails in underutilised areas;
- Designate specific zones for specific activities;
- Install barriers to restrict access to ecologically sensitive areas;

- Provide more waste management facilities;
- Place standardised information signs in and around the park;
- Demarcate the boundaries of the park with boundary markers; and
- Construct a visitor centre.

To get a sense of the feasibility to implement the various suggestions to improve recreational infrastructure, a SWOT analysis (Figure 9) was conducted to determine the strengths, weaknesses, opportunities and threats associated with the suggestions.

SWOT		Helpful	Harmful
Probability	Strengths	<ul style="list-style-type: none"> <input type="checkbox"/> Creates more sustainable paths (trails) <input type="checkbox"/> Steer people's movement through the park (trails) <input type="checkbox"/> Prevent user conflict and crowding (trails) <input type="checkbox"/> Cheap solution to implement (signs and entrance) <input type="checkbox"/> Support visitors by providing information about the park (visitor centre) <input type="checkbox"/> Supportive structure for management and maintenance of the park (visitor centre) 	<ul style="list-style-type: none"> <input type="checkbox"/> Reduce habitats and green space (trails) <input type="checkbox"/> Needs to occur frequently and must be maintained and updated over time to keep awareness high (sign and entrance) <input type="checkbox"/> Demands resources to develop and manage (visitor centre)
	Opportunities	<ul style="list-style-type: none"> <input type="checkbox"/> Appealing recreational environment may attract more people to the park (trails) <input type="checkbox"/> Can raise awareness about the environment of the park (sign and entrance) <input type="checkbox"/> Can be used as a resource to support many different activities within the park (visitor centre) <input type="checkbox"/> Designated zones for specific activities can lower user conflicts (designation of activities) 	<ul style="list-style-type: none"> <input type="checkbox"/> Walking paths may not fit peoples' preferred walking routes (trails) <input type="checkbox"/> Might not be sufficient (sign and entrance) <input type="checkbox"/> Dependent on financial support to construct and operate (visitor centre)
Possibility			

Figure 9. SWOT analysis of suggestions to improve recreational infrastructure.

5.1.2 Addition of green spaces

The pressure that increased visitor numbers will exert on the ecological- and recreational values of the RNCP can be offset to a certain extent by the addition of green spaces within the development area of Loudden.

Green spaces must be designed in such a way to allow for connective pathways between green spaces in Loudden and the RNCP, in order to allow for biodiversity to “spill over” from the park into the urban area. It will also be necessary to ensure the connectivity of green spaces within the study area to other parts of RNCP, in order to maintain the biodiversity of Norra and Södra Djurgården. Planning for connective pathways should consider how infrastructure will affect existing connective pathways within the study area, because infrastructure creates physical boundaries that fragment the landscape. If existing connective pathways are destroyed by the development of the SRS, it will be difficult to recreate. Barriers to connectivity should therefore be removed or, as a minimum, measures must be implemented to improve connectivity. An example of an existing barrier in the study area is Lindarsängsvägen, which separates the RNCP from Loudden (see Figure 10). It will be detrimental for connectivity if this barrier is maintained in the development of Loudden.

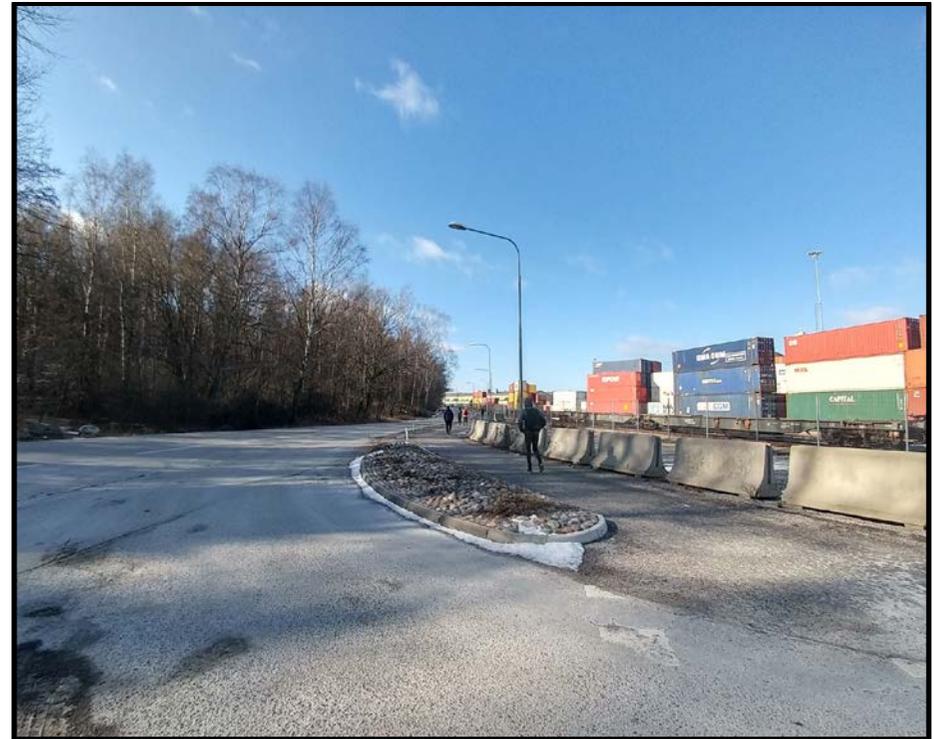


Figure 10. Lindarsängsvägen currently forms a barrier for biodiversity between the RNCP and Loudden (Photo: Marais de Vaal).

Additional green spaces should surround the urban area of Loudden, both where the development borders against the RNCP as well as where the development borders on the coastline of Lilla Värtan. Creating this green space buffer will: create the perception of being surrounded by the nature of the RNCP extending into the urban area; enhance connectivity; and reduce the negative visual impact of hard boundaries between the urban area and

the natural surroundings of the RNCP, especially from the perspective of visitors to the RNCP looking towards Loudden. This has been done with success in the northern part of the SRS, where Hjorthagen borders against Norra Djurgården and it is suggested that the same approach is taken in Loudden.

Practical examples of green infrastructure that can be included in the additional green spaces to enhance biodiversity include:

- ❑ An ecoduct (i.e. a wide, vegetated bridge) can be constructed at a suitable location across Lindarsängsvägen to serve as a connective pathway to enhance biological connectivity between the RNCP and green spaces in Loudden. Since this will be a costly and technical solution, an alternative solution could be to narrow Lindarsängsvägen at a suitable location in addition to the placement of traffic calming infrastructure and warning signs to allow for a safer wildlife (and pedestrian) crossing;
- ❑ Wetland areas can be created to enhance biodiversity within green spaces and to reduce stress on valuable existing wetlands within the RNCP, such as Isbladskärret. Created wetlands could be located within Loudden or at the water treatment plant, if the planners intend to decommission the facility (Stockholm Vatten och Avfall, 2017);

- ❑ If the planners for Loudden intend to close down the waste storage facility located to the west of Louddens Reningsverk, the facility can be adapted to create a bat refuge in the old tunnels, similar to a facility in Poland called Festungsfront Oder-Warthe-Bogen, which is Europe's biggest bat refuge (Voute, 1991); and
- ❑ A more experimental approach to expand green space in the urban area could be the creation of a “floating island” containing green infrastructure such as dead oak wood, grasses, shrubs and trees, which will be berthed in the harbour. The floating island could be moved to different locations along Stockholm’s coastline, such as Lidingö, Nacka or Slussen, which may also lead to improved connectivity for biodiversity between these areas if it remains in one location for a sufficient time before it moves to a different location.

Additional green spaces will not only create a larger habitat for many different species, which will be beneficial for biodiversity within the study area, but will also directly improve the well-being of the residents of Loudden, because additional green space will allow them the possibility to do recreational activities within the urban area, thereby reducing their dependence on the RNCP, while at the same time facilitating easier access to the RNCP.

SWOT	Helpful	Harmful
	Strengths	Weaknesses
Probability	<ul style="list-style-type: none"> <input type="checkbox"/> Creates a more coherent green area which increase the green infrastructure (green space) <input type="checkbox"/> Loudden becomes less dependent on NSD for recreational and health dependent aspects as it can provide the services by itself (green space) <input type="checkbox"/> Improves the connective pathways (connectivity pathways) <input type="checkbox"/> Creates green buffer between RNCP and Loudden to reduce visual impact when looking from RNCP towards Loud (green space) <input type="checkbox"/> Higher resilience of the connectivity between the parks as this suggestion creates multiple paths (connectivity pathways) <input type="checkbox"/> Creates refuge for threatened species (batcave) <input type="checkbox"/> Rich in biodiversity (wetland) <input type="checkbox"/> Provides regulation ecosystem services such as flood management (wetland) <input type="checkbox"/> Creates a temporary bigger connected green area on an otherwise not used area (water) (removable green island) 	<ul style="list-style-type: none"> <input type="checkbox"/> Lower density and population capacity within the developed area (green space) <input type="checkbox"/> Less suited for private transportation (green space) <input type="checkbox"/> Additional cost of maintaining more green space (green space, wetland and removable green island) <input type="checkbox"/> Interfere with physical planning decisions as connectivity pathways have to be taken into consideration (connectivity pathways) <input type="checkbox"/> Takes up place for other activities that can be viewed as more important (batcave) <input type="checkbox"/> Cost of creation (wetland and removable green island)
Possibility	<p style="text-align: center;">Opportunities</p> <ul style="list-style-type: none"> <input type="checkbox"/> Create opportunity for recreational activity within the park (green space) <input type="checkbox"/> Lower the risk for use conflicts within NSD (green space) <input type="checkbox"/> More biodiversity in Loudden (green space) <input type="checkbox"/> Allows for better exchange of species between areas (connectivity pathways) <input type="checkbox"/> Can be used for branding the RNCP and the SRS (batcave, wetland and removable green island) <input type="checkbox"/> Can spread and increase biodiversity for the area (wetland) <input type="checkbox"/> Experimental purpose, might prove to be a solution to connectivity problems (removable green island) 	<p style="text-align: center;">Threats</p> <ul style="list-style-type: none"> <input type="checkbox"/> Other activities like transport infrastructure planning could interfere with green infrastructure planning goals (green space) <input type="checkbox"/> Connectivity paths are dependent on many different circumstances, and planning within Loudden will not in it self solve the problem (connectivity pathways) <input type="checkbox"/> Damage or incomplection of one part of a connection path can disturb the whole path (connectivity pathways) <input type="checkbox"/> Bats might not want to take refuge in this area (batcave) <input type="checkbox"/> Might be viewed as useless (removable green island)

Figure 11. SWOT analysis of suggestions to improve green infrastructure.

Increasing the total green space that is available for recreation will also: reduce user conflict since visitors will be spread over a larger area; create a more exciting urban environment; and provide an opportunity to relocate activities that are not suited to be in the RNCP to the urban area.

A negative aspect of adding more green spaces within the urban area is that buildings will have to be built more densely in order to meet the targets for housing units in a smaller area, which could be less favourable from an economic perspective. However, economic factors fall outside the scope of this report.

To get a sense of the feasibility to implement the various suggestions to improve green infrastructure, a SWOT analysis (Figure 11) was conducted to determine the strengths, weaknesses, opportunities and threats associated with the suggestions.

5.1.3 Improved accessibility

Accessibility to the park must be increased in order to avoid that the ecological- and recreational values of the study area will exclusively serve the residents of Loudden, who are likely to represent a rather homogeneous

population from a socioeconomic perspective, which will be detrimental for the social sustainability of the study area. Greater accessibility will open the study area to all residents of Stockholm and allow a more diverse population to enjoy the study area's ecological- and recreational values. Improved accessibility will also allow visitors to the study area with the opportunity to undertake recreational activities in areas most suited to the particular activity. While increased accessibility is important from a social sustainability perspective, greater accessibility will result in a greater number of visitors to the park, the effects of which have been discussed already.

With a view of creating a sustainable city area, an issue that is related to accessibility is the need to minimise vehicle traffic in the study area, especially in respect of private cars. High volumes of vehicle traffic will cause degradation of the environment in the study area, both in terms of direct impacts (such as collisions with insects and wildlife), but also

indirectly through emissions and climate impacts. Vehicle traffic will also interfere with recreational activities and reduce the recreational value of the study area. Vehicle traffic can be minimised through regulating the use of parking spaces and by providing extensive, accessible public transport services as an alternative to private vehicles.

To get a sense of the feasibility to implement the various suggestions to improve accessibility, a SWOT analysis (Figure 12) was conducted to determine the strengths, weaknesses, opportunities and threats associated with the suggestions.

SWOT	Helpful	Harmful
Probability	Strengths <ul style="list-style-type: none"> ❑ Easier to visit Loudden and NSD ❑ Easier to access other areas from Loudden and NSD 	Weaknesses <ul style="list-style-type: none"> ❑ The tram line takes up space and creates barriers ❑ The infrastructure can cost a lot of money
	Opportunities <ul style="list-style-type: none"> ❑ NSD will be more accessible for other visitors and therefore there will be less risk of Loudden to be socio-economically exclusive ❑ Residents of Loudden may be more prone to access other green areas, such as Norra djurgården ❑ Less private transport within Loudden ❑ People of Nacka and Lidingö have greater access to RNCP 	Threats <ul style="list-style-type: none"> ❑ More accessibility means that more people can visit the area and therefore the degradation of green areas can increase
Possibility		

Figure 12. SWOT analysis of suggestions to improve accessibility.

5.1.4 Controlling visitor numbers

Although the model suggests that the negative effects on the ecological- and recreational values of the study area can be controlled by limiting the amount of visitors to the RNCP, for example by charging visitors an entrance fee to access the RNCP, this is an unorthodox approach in the Swedish context and would probably not be a preferred alternative to address the threats to ecological- and or recreational values that have been discussed. It may nevertheless become necessary in the future if other restrictive strategies to protect ecological- and recreational values prove to be ineffective. This strategy has the advantage that charging entrance fees will create revenue that can be used for the maintenance of the green spaces in the study area and will also give an accurate indication of the monetary value that visitors place on recreational value of the RNCP. However, an investigation of these aspects falls outside the scope of the study.

5.2 Authors' vision for the future development

5.2.1 Vision for improved recreational infrastructure and accessibility

Considering the suggestions for improved recreational- and transportation infrastructure made in sections 5.1.1 and 5.1.3 respectively, a map has been produced to illustrate the authors' vision of how some of these suggestions can be implemented by the planners of the SRS and the RNCP (See Figure 13). Since more detailed assessments will be required to determine whether all suggestions are feasible and to determine the most suitable locations where the suggestions can be implemented, it is noted that only a selection of the suggestions are displayed on the map and the suggested locations are for illustrative purposes only.

As a minimum, the authors' vision for improved recreational infrastructure includes the preparation of existing trails for more intensive use and the construction of a visitor centre, while the vision for improved accessibility includes:

- a tram line following the existing freight rail's route, which connects to the existing subway stops at Gärdet and Ropsten

as well as the Lidingöbanan, and a new tram line from Loudden towards Östermalm along Valhallavägen; and

- the addition of several ferry terminals for SL ferries to connect to Lidingö, Nacka and Slussen.

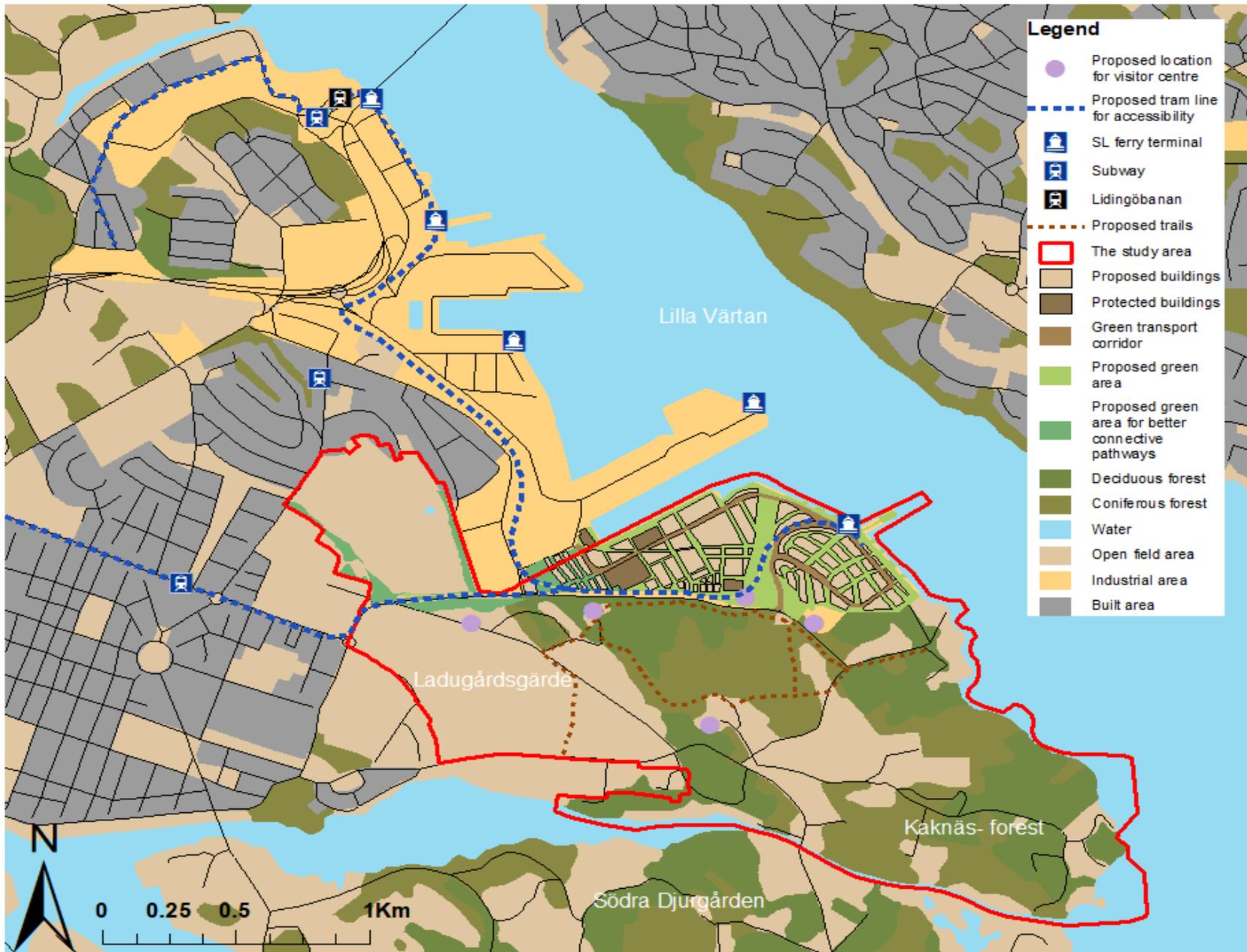


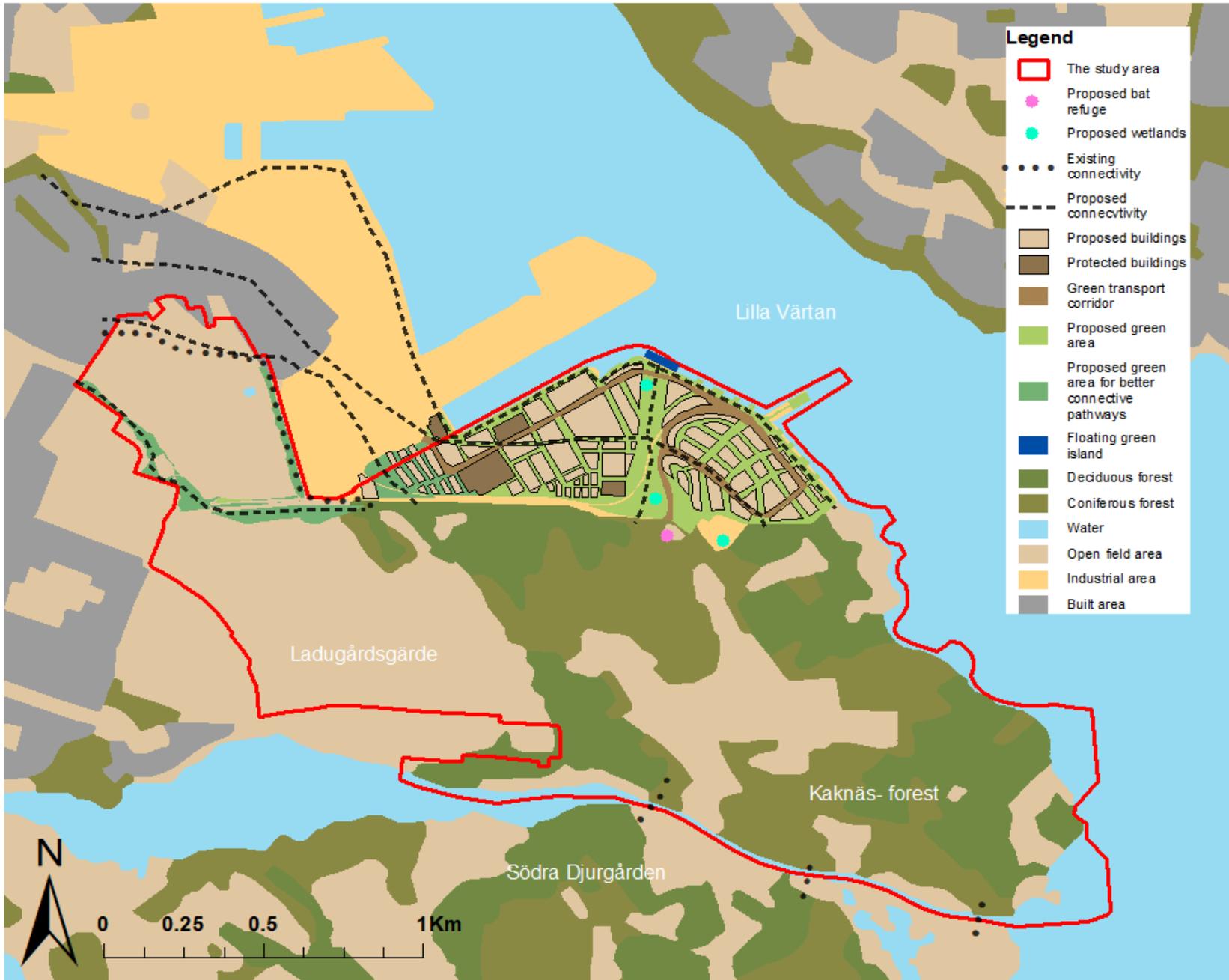
Figure 13: This map represents the authors' vision of how recreational- and transportation infrastructure can be improved in the study area. Note that the suggested locations for infrastructure are for illustrative purposes only as site assessments have not been conducted.

5.2.2 Vision for additional green spaces and green infrastructure

Considering the suggestions for additional green spaces and improved green infrastructure made in section 5.1.2 above, a map has been produced to illustrate the authors' vision of how some of these suggestions can be implemented by the planners of the SRS and the RNCP (see figure 14). Since more detailed assessments will be required to determine whether all suggestions are feasible and to determine the most suitable locations where the suggestions can be implemented, it is noted that only a selection of the suggestions are

displayed on the map and the suggested locations are for illustrative purposes only.

As a minimum, the authors' vision for additional green spaces and improved green infrastructure includes significant areas of green space within and around the urban area of Loudden, the construction of wetlands, a bat refuge and a floating island to enhance biodiversity as well as the enhancement of connective pathways between various green areas.



in the study area can supplement the RNCP. It also shows the green infrastructure that must be constructed to support greater biodiversity and to enhance connective pathways. Note that the suggested locations for green spaces and green infrastructure are for illustrative purposes only as site assessments have not been conducted.

6. Conclusion

The biodiversity and ecosystems within the RNCP has a high value both on a national and international level. The high number of oaks are the core for why many of the species exist in the park. There are many unique and red-listed species in the RNCP. It is a national interest to protect these values from local extinction. The RNCP provides different recreational values, with Ladugårdsgårde that is a big open area and the Kaknäs- area is one of the most calm areas in Stockholm. The recreational values in the park The closeness to the RNCP is also stress- relieving.

The first stage of the SRS is by some regarded to be built too densely without enough green space to complement the RNCP. This is something that can happen with Loudden as well. Without adequate green spaces in Loudden, in addition with the increased number of visitors, there will be too much pressure on the RNCP leading to reduced social- and environmental sustainability.

To create sufficient green areas within the new developed area that is reflecting the ecological values of NSD and also improving the ecological connective pathways by creating green paths between

buildings in Loudden will benefit both the recreational values as well as the biodiversity values. More green space and ecological connectivity will increase habitats and pathways for wildlife, which will be beneficial for the weak ecological connection between Norra and Södra Djurgården. It will also prevent the inhabitants to rely on NSD for their recreational needs, which will lower the risk for user conflicts and crowding in the park as well as to avoid impacts on biodiversity.

Take away message for planners

Consider the following critical elements to make Loudden a sustainable city area:

- ❑ Sufficient green spaces (quantity to relieve pressure on RNCP) but also quality (green infrastructure to support biodiversity and connective pathways) - current planning vision for Stockholm Royal Seaport perhaps not ambitious / specific enough
- ❑ Recreational infrastructure will have to be improved - current management plan for RNCP opposed to construction of additional infrastructure in park, but advantages weigh

stronger. However important to assess most appropriate measures and locations

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