



Urban shades of green

Current patterns and future prospects of nature conservation
in urban landscapes

Doctoral thesis in Natural Resource Management

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Abstract

Urban nature provides local ecosystem services such as absorption of air pollutants, reduction of noise, and provision of places for recreation, and is therefore crucial to urban sustainable development. Nature conservation in cities is also part of the global effort to halt biodiversity decline. Urban landscapes, however, display distinguishing social and ecological characteristics and therefore the implementation of nature conservation frameworks into cities, requires reconsideration of what nature to preserve, for whom and where. The aim of this thesis was to examine the current urban nature conservation with special focus on formally protected areas, and discuss their future role in the urban landscape. A social-ecological systems approach was used as framework and both quantitative and qualitative methods were applied. The studies were performed at local to regional scales in the southern part of Sweden. Four key questions were addressed: i) What are the characteristics of nature conservation in urban landscapes? ii) How does establishment of nature conservation areas affect the surrounding urban landscape? iii) In what ways are spatial and temporal scales recognized in practical management of nature conservation areas? and iv) How can the dichotomy of built up and nature conservation areas be overcome in urban planning? Nature reserves in urban, compared to rural landscapes were in general fewer, but larger and included a higher diversity of land covers. They were also based on a higher number and different kinds of objectives than rural nature reserves. Urbanisation adjacent to nature reserves followed the general urbanisation patterns in the cities and no additional increase in urban settlements could be detected. In general, there was a lack of social and ecological linkages between the nature conservation areas and the urban landscape and practical management showed a limited recognition of cross-scale interactions and meso-scales. Such conceptual and physical isolation risks decreasing the public support for nature conservation, cause biodiversity decline, and hence impact the generation of ecosystem services. A major future challenge is therefore to transform current conservation strategies to become a tool where urban nature is perceived, planned and managed as valuable and integrated parts of the city. To enable social-ecological synergies, future urban planning should address proactive approaches together with key components like active enhancement of multifunctional landscapes, cross-scale strategies and border zone management.

Keywords: urbanisation, nature conservation, urban planning, urban systems, nature reserves, Sweden

List of Papers

This thesis is based on the following papers, referred to by their Roman numerals. Paper I and IV are reproduced with the kind permission of the publishers.

- I. Borgström, S. 2009. Patterns and challenges of urban nature conservation - a study of southern Sweden. *Environment and planning A* 41:2671 – 2685.
- II. Borgström, S., S. Cousins, and R. Lindborg. Outside the boundary - land use changes in the surroundings of urban nature reserves. *Submitted to Applied Geography*
- III. Borgström, S., R. Lindborg, and T. Elmqvist. Nature protection for what? Analyses of urban and rural nature reserves in southern Sweden 1909-2006. *Biological Conservation in review*
- IV. Borgström, S., T. Elmqvist, P. Angelstam, and C. Alfsen-Norodom. 2006. Scale mismatches in management of urban landscapes. *Ecology and Society* 11:16.
- V. Erixon, H., S. Borgström, and E. Andersson. Challenging dichotomies – exploring resilience as an integrative and operative conceptual framework for large-scale urban green structures in Stockholm, Sweden. *Manuscript*

In **paper II** and **III**, I initiated the project, collected data and performed analyses. The co-authors guided analyses and interpretation of the results, while I performed a major part of the writing. In **paper IV**, Elmqvist initiated the project, while I performed data collection and analyses. All co-authors contributed in interpretation of results, while a major part of the writing was done by me and Elmqvist. In **paper V**, the project was initiated by Erixon. I contributed in development of the methodology, data collection, analyses and interpretation of results. All co-authors contributed in the writing process that was headed by Erixon.

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Introduction

Cities are nothing new. Humans have for long time been attracted by the benefits of living close to each other in communities, and the process of urbanisation is an important part of human history. Some of the drivers of urbanisation relate to cities being nodes of culture, power and economic activity, and hence centres of decision making (Jacobs 1961). Compared to the historical record, the current migration of people into cities has become a global vector of change as it occurs at unprecedented pace and scales, and with increasing impact beyond the city boundaries (Rees 1996, Folke et al. 1997, Cohen 2004, Grimm et al. 2008). Urbanisation means change and intensification of land use. Land use change is one of the most important causes of current loss of biodiversity and ecosystem services, and hence a key process to be recognised in sustainable development strategies (Vitousek 1994, Dale et al. 2000, McKinney 2006, Haines-Young 2009). Although covering less than three per cent of the land surface, cities hold the majority of the world population (Grimm et al. 2008). This results in a concentrated use of energy and resources that makes many cities unhealthy and threatens human wellbeing and ecosystems on local to global scales. It also makes cities one of the most important environments in the struggle for sustainable development, although cities have for long time been rejected by ecologists as environments forever lost to the human enterprise (Pyle 2003, Dunn et al. 2006, Nassauer 2006, Grimm et al. 2008, Dearborn and Kark 2009, Bai et al. 2010, Kareiva et al. 2010).

All human activities are more or less directly dependent on viable ecosystems providing essential ecosystem services that to variable degrees depend on biodiversity (Costanza et al. 1997, Daily 1997, Millennium Ecosystem Assessment 2005, Elmqvist and Maltby 2010). Social and technological solutions can temporarily decrease this dependence, but ecosystems can never be completely substituted. When living in a city this dependence easily becomes invisible (Turner et al. 2004, Miller 2005). However, effects of exploitation of resources and human dominance of many ecosystems are becoming more and more obvious as species loss alters the ecosystem functioning and interrupts the flow of ecosystem services (Vitousek et al. 1997, Steffen et al. 2005, Rockström 2009, Secretariat of the Convention on Biological Diversity 2010). It is estimated that more than 60 per cent of the ecosystem services are degraded or unsustainably used (Millennium Ecosystem

Assessment 2005). Despite this urgent situation we still have limited knowledge about the linkages between biodiversity, ecosystem function and ecosystem services (Hooper et al. 2005, Kremen 2005, Haines-Young 2009, Elmquist and Maltby 2010). Moreover, human activities today impact all ecosystems, adding social dynamics to the ecological complexity (Vitousek et al. 1997, Westley et al. 2002, Steffen et al. 2005). The environmental challenges are largely a result of neglecting this coupled social-ecological complexity, where management strategies characterised by optimisation and control tend to simplify the system and increase the risk of management failure in the long-term perspective (Holling and Meffe 1996, Acheson 2006).

An emerging urban landscape pattern

Urbanisation is often discussed as a global process with many negative consequences that are difficult to manage. However, in most cities urbanisation is addressed at the landscape scale through some kind of spatial planning. In a similar way the global biodiversity loss is addressed at national, regional and local levels, and the most common measure is to set a side land as protected for nature conservation (Dudley 2008). This thesis addresses urbanisation and nature conservation at the scale of urban landscapes.

Strategies for spatial planning and nature conservation have long been conceptually and spatially separated. One reason for this is that nature conservation has a strong tradition of protecting nature from humans. This perspective has fostered a view of urban nature as trivial and disturbed, and it has therefore been largely neglected within nature conservation. Today there is an increasing awareness of the ecological and social importance of urban nature. Many cities are situated in biologically rich areas, e.g. flood plains, estuaries, along coastlines, and therefore the nature within these cities is rich and might even be of importance for global biodiversity (Pimentel and Stachow 1992, Cinotta et al. 2000, Ricketts and Imhoff 2003), e.g. Cape region in South Africa. Furthermore, the role of urban nature in mitigating local urban environmental problems is increasingly acknowledged in urban ecological research and planning practice, e.g. the ability of trees to absorb air pollutants (Nowak et al. 2006, Gill 2007). There is also a rapidly increasing knowledge about the importance of urban nature for citizen's wellbeing and health, e.g. green areas as spaces for social integration, recovery from stress illnesses and for outdoor recreation (Swanwick et al. 2003, Chiesura 2004, Maas et al. 2006, Tzoulas et al. 2007, Matsuoka and Kaplan 2008). Since the urban dependence and impact on external ecosystems are largely invisible, environmental challenges easily become abstract to the citizens. In this sense, urban nature is of importance for providing accessible arenas where ecological knowledge and sustainable development issues can be conveyed

to the public and discussed in a context with direct contact with nature (Miller and Hobbs 2002, Miller 2005, Dunn et al. 2006).

The recognition of urban nature is part of a larger change within nature conservation policy, where it is seen as necessary to sustainable development (UNEP 1992, IUCN 2003, Trzyna 2007). In many cities this change is manifested by establishment of nature conservation areas. One key benefit and driver in the urban landscape is proximity, and this driver usually results in a high level of competition among different land use interests. As a result, nature conservation needs to apply strong tools, such as protection by law to be successful. At the same time the urban land use is commonly dictated by the strong regulation of spatial planning. This poses conceptual and physical challenges to both nature conservation and spatial planning. Physically it results in a new urban landscape pattern, where nature conservation areas, with limited degree of exploitation, border dense built up areas with small fragments of vegetation. One conceptual challenge is represented by the process where the long term and highly formalised institutions of nature conservation are implemented in a landscape that is very different compared to where they were developed. This imply a reconsideration of the basis for nature conservation addressing the issues about what nature (e.g. biodiversity/ecosystem services) should be preserved in cities, for whom and where. Above all the crucial question is if this measure is working: Is formal means of protection of nature a successful tool for safeguarding ecosystem services provided by urban nature?

Scope of thesis

Using a social-ecological systems approach the aim of this thesis is to examine the interface between nature conservation, especially formally protected areas, and urban development at the scale of urban landscapes. By analysing urban nature conservation in southern Sweden over time and at several spatial scales, I intend to add formal aspects to the existing knowledge on less formal ways of managing urban nature (Barthel 2006, Colding et al. 2006, Andersson et al. 2007), as well as the general knowledge in spatial planning and conservation biology. I also intend to discuss ways forward for urban nature conservation in relation to sustainable cities. Figure 1 illustrates the scope of the different papers. The core questions of this thesis are:

- What are the characteristics of nature conservation in urban landscapes? (**paper I, III**)
- How does establishment of nature conservation areas affect the surrounding urban landscape? (**paper II**)
- In what ways are spatial and temporal scales recognized in practical management of urban nature conservation areas? (**paper IV**)

- How can the dichotomy of built up and nature conservation areas be overcome in urban planning? (**paper V**)

The following chapter depicts the inter-disciplinary, theoretical framework used for studying cities, nature within cities and nature conservation, as well as recent research advances in these topics. Then the choice of southern Sweden as a study area is motivated, and the area is described with focus on urbanisation and nature conservation. In the next chapter the methodology and specific research questions for each paper are summarised. The major findings from the papers are compiled into short statements and then discussed in relation to historical, current and future urban planning and management. This synthesis is continued by a discussion about an alternative urban nature conservation focusing on strategies for multifunctional urban landscapes, bridging of borders and scales, and proactive approaches.

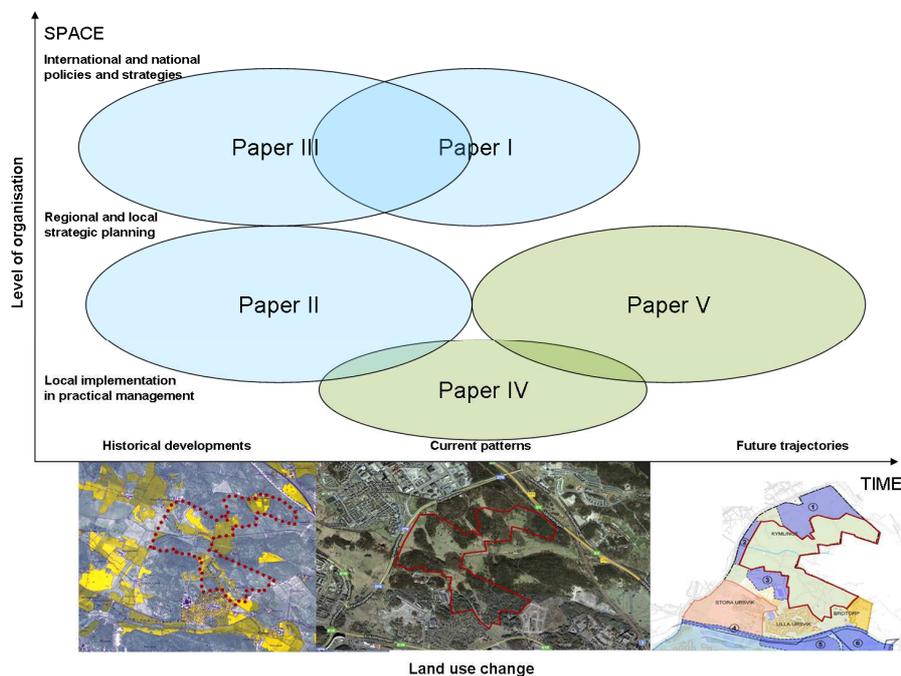


Figure 1 Scope of thesis

The figure illustrates what spatial and temporal scales covered by the papers in the thesis. The spatial scales are depicted as levels of organisation and taken together the papers address local to national levels. All papers address the current situation while some look into historical patterns and others focus on future perspectives. **Paper I-III** are quantitative studies (blue ovals), while **paper IV-V** are qualitative (green ovals). The red outlines on the maps represent a nature conservation area in an urban landscape over time.

The theoretical framework

Any project addressing sustainable development is forced to integrate knowledge from different disciplines and sources (Daily and Ehrlich 1999, Fry 2001, Gallopin et al. 2001, Kates et al. 2001, Young et al. 2006), e.g. bridging social and natural sciences (Tress et al. 2001) and combining science with other sources of knowledge (Max-Neef 2005, Hadorn et al. 2006, Reyers et al. 2009). Therefore, to investigate nature conservation in cities I applied several frameworks and the main theoretical influences came from systems ecology, landscape ecology, conservation biology, spatial planning, sustainability science and urban studies. In order to clarify the interdisciplinary research framework that evolved, I elaborate on the following statements upon which the thesis is founded:

- Cities constitute a special type of complex social-ecological systems and urban sustainable development requires viable ecosystems at local, regional and global scales.
- Land is a critical resource in cities. Land use planning and management can be seen as results of the interaction of the urban ecological and social aspects (fig. 2).
- Protection of nature is one of several nature conservation strategies and can be described as a formal institution directing land use decisions and management to legally protect certain values from degradation or destruction.

Cities as social-ecological systems

This thesis applies a systems view of cities (c.f. Alberti 2008). Systems analyses aim to describe, assess and find ways of coping with complexity (Levin 2000, Olsson and Sjöstedt 2004). They generate models of systems as consisting of interacting compartments that in turn interacts with the surrounding environment, resulting in continuously changing conditions and reorganisation, nonlinear behaviours, emergent properties and hence a high degree of uncertainty (ibid). Cities express all the characteristics of complex systems (Antrop 2004, Alberti 2008, Batty 2008) and hence the future urban sustainability is dependent on how the governance of the cities is scientifically addressed and practically organised in relation to these understandings.

Integrated social-ecological models were used in this thesis to explore the interface of urban development and nature conservation. These models have been developed by ecologists that started to acknowledge cities as a new kind of ecosystem in the late 1990s (Botkin and Beveridge 1997, Pickett et al. 1997, Niemela 1999, Collins et al. 2000, Grimm et al. 2000, McIntyre et al. 2000, Pickett et al. 2001, Alberti et al. 2003). In contrast to previous studies in urban ecology, focusing on the urban nature (reviewed by Sukopp 2002), these models were more holistic and included the whole city. It soon became apparent that urban systems are unique in their social and ecological signatures (Alberti 2008) and therefore any scientific or practical urban approach need to be adapted to this specific context. Many of the distinguishing characters are related to the domination of human activities (fig. 2)

The understanding of nature as consisting of complex and integrated social-ecological systems has resulted in development of new approaches in natural resource management where resilience is one example (Holling 1973, 1986, Berkes and Folke 1998, Berkes et al. 2003, Folke 2006). Resilience is defined as “*the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks*” (Walker et al. 2004). The challenge for management is to define what functions are desirable and to find strategies for sustaining or increasing the capacity of the system to retain them. Since the framework is still under development in both theory and practice, there are multiple interpretations (ibid). Not least in urban systems, which are different to the natural resource management contexts where the framework was developed, e.g. in cities most local human activities are not directly related to a resource (Alberti and Marzluff 2004, Pickett et al. 2004, Wilkinson et al. 2010).

This thesis is inspired by resilience thinking, but the studies did not assess resilience *per se*. However, elements of resilience thinking guided the formulation of objectives as well as interpretation and discussion of the results, e.g. diversity, cross-scale interactions and adaptive capacity (**paper I-V**). In **paper V** resilience was used as a conceptual platform in a trans-disciplinary work process that aimed at exploring operative and integrative approaches to challenges of large-scale urban green structures within urban planning.

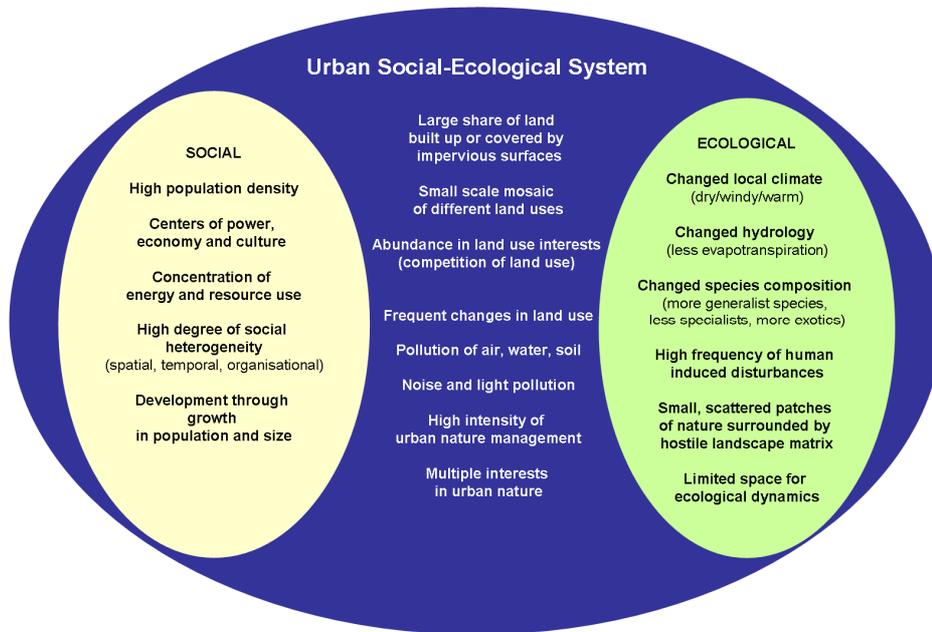


Figure 2 The city as a social-ecological system.

A selection of social (yellow oval) and ecological (green oval) characteristics of the urban system as well as characteristics shaped by social-ecological interactions (blue oval). (compiled from Rebele 1994, Hough 1995, Trepl 1995, Botkin and Beveridge 1997, Kendle and Forbes 1997, McDonnell et al. 1997, Pickett et al. 1997, Schwartz 1997a, Collins et al. 2000, Kinzig 2001, Pickett et al. 2001, Whitford et al. 2001, McKinney 2002, Berling-Wolff and Wu 2004)

Urban land use

Understanding the organisation of natural resources management and its consequences is a cornerstone in knowledge of social-ecological systems, e.g. fishing, forestry and agriculture (Berkes and Folke 1998, Berkes et al. 2003). Discussing the urban social-ecological relationships in terms of natural resource management can be perceived as far-fetched given that for most citizens the resource base is found outside urban areas (Rees 1996, Folke et al. 1997, McGranahan and Marcotullio 2005, Bai et al. 2010). However, several ecosystem services can not be provided at distance and for those urban nature is essential. The provision of these services is dependent on where the urban nature is located and how it is structured. In this sense, land is a critical urban resource and in turn the planning and management of land use can be viewed as an interplay of the social and ecological aspects of the urban landscape (fig. 2, Zipperer et al. 2000).

Land use planning is about managing land as a common resource, where the governmental agencies are usually responsible for representing and balancing different public interests. In cities these include the provision of housing, services, infrastructure and open spaces. In this thesis urban land use is addressed in terms of spatial patterns (**paper I, II, IV**), planning (**paper III, V**) and practical management (**paper IV**) of land designated for nature conservation and in relation to an urban landscape context. Because of a strong focus on the spatial dimension of the urban system, landscape ecology theories were applied in several of the studies to provide conceptual bridges between systems ecology, land use planning and conservation biology (Ahern 1999, Antrop 2001, Opdam et al. 2001, Leitao and Ahern 2002, Liu and Taylor 2002, Tress et al. 2005, Turner 2005, Nassauer 2006). One example of such conceptual linkage is scales and the necessity to recognise multiple scales and cross-scale dynamics, as promoted both in systems ecology and landscape ecology (Lee 1993, Wiens et al. 2002, Vogt et al. 2002, Cumming 2006). Another example is the use of landscape ecological knowledge in finding optimal configurations of urban nature within land use planning. For example to achieve nature conservation goals such as population viability by creating as large and connected green areas as possible (Ahern 1995, Schwartz 1997b, Ahern 1999, Hidding and Teunissen 2002, Kingsland 2002, Marzluff 2002, Stenhouse 2004).

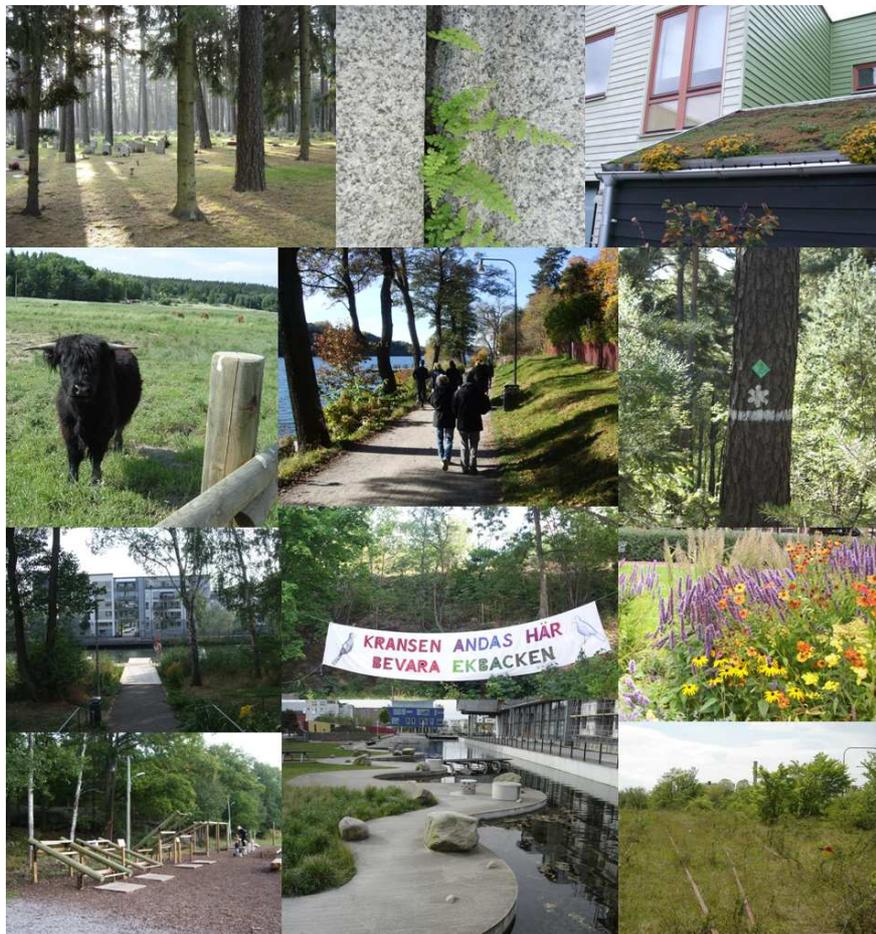
WHAT IS URBAN?

A core issue in any urban study is to define and describe what a city is. Generally a city is "an agglomeration of human settlements of a certain size" (UN 2004) and this usually refers to population size and density, and sometimes the spatial extent of the city, e.g. land with a certain percentage impervious surfaces. A country's degree of urbanisation is often represented as the share of population living in cities or share of land that is covered by urban land uses. Even though urbanisation is recognised as a global process, the definitions of what is urban are commonly national and hence context dependent (UN 2004, McGranahan and Marcotullio 2005). This calls for caution in interpreting international urbanisation statistics (Cohen 2004) and highlights the need of clarity on how the urban entity is defined in relation to specific questions.

Urban nature concepts

Conservation of urban nature is especially challenging since it is situated in a landscape dominated by social processes, and hence the term "natural" is not applicable. Instead the urban nature is in most cases best described as a result of long-term social and ecological co-evolution (Powell et al. 2002, Barthel et al. 2005). Entering the multi-disciplinary field of urban studies there is a diversity of concepts for describing biotic elements in urban systems, e.g. open spaces, green spaces, green areas, green structures,

greenways, greenbelt, commons, gardens, recreation areas, zoos, parks, nature conservation areas and urban woods (e.g. Kendle and Forbes 1997, Swanwick et al. 2003). Choice of concept depends on the issue addressed, e.g. the spatial scale (local or regional), the ownership (garden, park, common), management intensity or human impact (ranging from manicured gardens to protected areas with low degree of maintenance), spatial configuration (greenway, green belt) and kind of nature (e.g. proportion of exotic species). The concepts also mean different things in different cultural contexts and depending on profession different concepts may be used to describe the same area. **Paper I-III** report on studies of formally protected urban nature conservation areas (nature reserves, for description see box 1), **paper IV** includes five urban nature conservation areas (one combined national park and nature reserve, one national urban park, one nature reserve, one formally protected cemetery and one watershed), and **paper V** is an investigation of a section of a regional urban green structure including several formally protected nature conservation areas (nature reserves).



Perspectives on nature conservation

Protecting public interests of nature

The main goals of nature conservation have for long been, and often still are, to protect biodiversity that is rare and/or threatened and to protect enough nature to achieve a good representation of the biodiversity within a certain geographical area (Margules and Pressey 2000). These goals are approached by a diversity of measures, from sustainable resource use within forestry to establishment of strictly protected national parks far from human settlements. This thesis mainly addresses formally protected nature conservation areas, which is the most common measure of nature conservation world wide (Balmford et al. 2002, UNEP-WCMC 2008). A formally protected nature conservation area is defined as “*a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*” (Dudley 2008). Establishment of such areas was initiated at the turn of the 20th century as a reaction to the rapid degradation of environments due to industrialisation. It was seen as a necessary action to protect public interests of nature, e.g. scenic landscapes and areas for outdoor recreation, from private exploitations (Noss and Cooperrider 1994, Kingsland 2002). Today the public interest of concern when land is designated as formally protected is to preserve biodiversity and social values related to nature (Murphree 2002, Zachrisson 2010).

A formal way of natural resource management

In most cases, nature protection is performed by a governmental actor using strong juridical instruments for implementation. Within natural resource management research such top-down and exclusively expert-driven organisations of land use have in many cases been found unsuccessful, since they often become decoupled from the local ecosystem dynamics (Ostrom 1990, Holling and Meffe 1996, Folke et al. 1998, Young 2002, Cumming 2006). As a result extensive research has focused on alternative ways for management, e.g. ecosystem based, adaptive and participatory approaches (Slocombe 1993, Grumbine 1994, Christensen et al. 1996, Slocombe 1998, Dale et al. 2000, Meffe et al. 2002, Olsson et al. 2004, Folke et al. 2005). Also within policy there has been an increasing debate about the necessity and benefits of community based nature conservation for the longevity of nature conservation areas and their role in sustainable development (Wilshusen et al. 2002, Brown 2003, SEPA 2003b, West et al. 2006, Zachrisson 2010). The complexity and cross-scale characteristics of contemporary environmental challenges require that these insights are connected to formal aspects of planning and management (Dietz et al. 2003, Folke et al. 2005, Acheson 2006, Armitage 2008, Galaz et al. 2008). Therefore there is a

clear need for more knowledge about the formal ways of natural resource management in order to enable multilevel governance systems that are flexible and adaptive enough to respond to the ecosystem dynamics at multiple scales.

In need of redefinition

The latest decennia nature conservation, including discursive, political, practical and research aspects, has changed. Today this is viewed as a necessary part of sustainable development since humans are dependent on functioning ecosystems for provision of ecosystem services and all nature is to various degree impacted by human activities (UNEP 1992, Daily 1997, Vitousek et al. 1997, Hooper et al. 2005, IUCN 2005, Millennium Ecosystem Assessment 2005). In addition, the ecosystems that are to be conserved are currently understood as complex, and in constant change (Bengtsson et al. 2003, Pressey et al. 2007, Fischer et al. 2009). With these new framings of nature conservation follow a need for redefining the role of nature conservation areas. For example, the need to protect nature in human dominated landscapes where biodiversity conservation and human activities must co-exist (Pimentel and Stachow 1992, Callicott 1999, Reyers et al. 2009). The more anthropocentric perspective on nature conservation is also seen in the discussions about what values are to be preserved, e.g. ecosystem services, ecological integrity and/or threatened species (Brooks et al. 2006, Chan et al. 2006, Armsworth et al. 2007). Another issue is that many environmental challenges are at large scale and hence nature conservation increasingly have to recognise landscape scales (Ahern 1999, Antrop 2001, Turner 2005, Nassauer 2006, Potschin and Haines-Young 2006a, Selman 2009). These necessary changes are to be realised within nature conservation policies and practices that in many countries are highly formalised and linked to cultural heritage and long-term traditions. In this thesis I address the challenges of one part of this transformation; to implement nature conservation into new contexts, in this case into cities.

Sweden as a study area

The empirical work for this thesis was performed in the southern parts of Sweden (box 1, fig. 3). Urban nature conservation is relevant to study in Sweden due to three characteristics. First, there is a long tradition of urban planning where modern spatial planning became regulated by law in 1874 (Alfredsson and Wiman 1997, Rudberg 1999). This planning organisation had evolved since the foundation of the first Swedish cities more than a thousand years ago (Åström 1993, Ahlberg 2005). Furthermore, Swedish cities have largely escaped war damages compared to other European cities, and therefore, the consequences of different planning strategies are part of the contemporary urban landscapes. These long records are useful in understanding and managing urban dynamics also outside the Swedish context. For example Swedish planning is used as blueprint when meeting the rapid urbanisation and urban environmental challenges in Southeast Asia. Second, the relatively long Swedish history of formal nature conservation, where the first European national park was established in Sweden in 1909 (Swedish parliament 1909, Lundgren 2005b). Already in the 1960s the nature conservation policy became formalised by organisation and legislation (Swedish parliament 1964, Lundgren 2005a). Third, Swedish nature conservation policy included social values from the start, e.g. protecting areas for outdoor recreation. Both the government and NGOs have strategically focused on spreading knowledge about Swedish nature to the public, aiming to awaken and stimulate feelings for the Swedish nature/wilderness and also ground a national culture on nature (Haraldsson 1987, Mels 1999, Sandell and Sörlin 2000, Sörlin 2008). At the same time the spare time for Swedish citizens increased and became legislated, which resulted in an increased demand for attractive environments for outdoor recreation close to where people lived (Swedish government 1940, 1971, Haraldsson 1987). This relationship between nature conservation and outdoor recreation is especially relevant to cities since an important ecosystem service of urban nature is to provide environments for outdoor activities (Chiesura 2004).

Current urbanisation and urban nature conservation

The main current Swedish urban planning strategy is densification. This means that small green areas within the built up areas are exploited as a way to avoid urban expansions into the larger green structures (Boverket 1994). The densification takes place mostly on forested land, while the cities are

expanding on agricultural land (Statistics Sweden 2003). Between 1970 and 2000 the proportion of unexploited land in Swedish cities decreased from 44 to 37 per cent (ibid). In the largest cities 27 per cent of the total land area is currently unexploited (ibid), but this proportion, as well as the amount of green area per citizen, is decreasing (Statistics Sweden 2010a). To a large extent the unexploited land consists of forest and open grassland remaining from former agricultural and forestry activities (Statistics Sweden 2003).

Urban nature has been increasingly recognised in both urban planning and nature conservation policies. One of the national environmental objectives (adopted in 1999) is “A good built environment” which addresses urban environmental challenges (SEPA 2010). It says that all municipal land use planning should be based on programs and strategies for conservation and development of green and blue structures, as well as strategies for delimitation of the impervious surfaces. However, the target is far from reached according to a recent evaluation (ibid). The general governmental strategy for nature conservation is to establish nature conservation areas (Box 01, Swedish ministry of environment 2002). In 2002 the three largest urban regions were commissioned to develop programs for protection of urban nature aiming at conservation of biodiversity, improving environmental quality as well as citizens’ well-being (Swedish ministry of environment 2002). The rate of implementation of the programs varies, and is largely dependent on municipal priorities. Recently the implementation period has been extended from 2013 to 2015.

Defining the study area of southern Sweden

All studies in this thesis were performed in southern Sweden (fig. 3), but at different scales. **Paper I** and **III** used data from whole southern Sweden, **paper II** studied a subset of the ten largest cities in this sub-national region and **paper IV** and **V** were performed in Stockholm. Southern Sweden constitutes 32 per cent of the land area and hosts 84 per cent of the population. The northern boundary of this area coincides with a division based on the physical conditions of topography, soils, vegetation, climate, and hence land use (Nordiska ministerrådet 1977). Since there is no geographically exact border, a zone was used to select the municipalities. The included 209 municipalities covered parts of the border zone and/or were located south of it. In this area 70 per cent of the nature reserves are found (as of 2006 census). **Paper IV** and **V** were performed in the Stockholm metropolitan area which is the capital of Sweden and the most urbanised region (2500 inhabitants/km²) (Statistics Sweden 2002). The population is forecasted to grow by approximately 20 000 new inhabitants per year (Regional Planning Office 2010). The nature conservation program includes creation of 71 new nature reserves before 2015 (Stockholm County Administrative Board 2003).

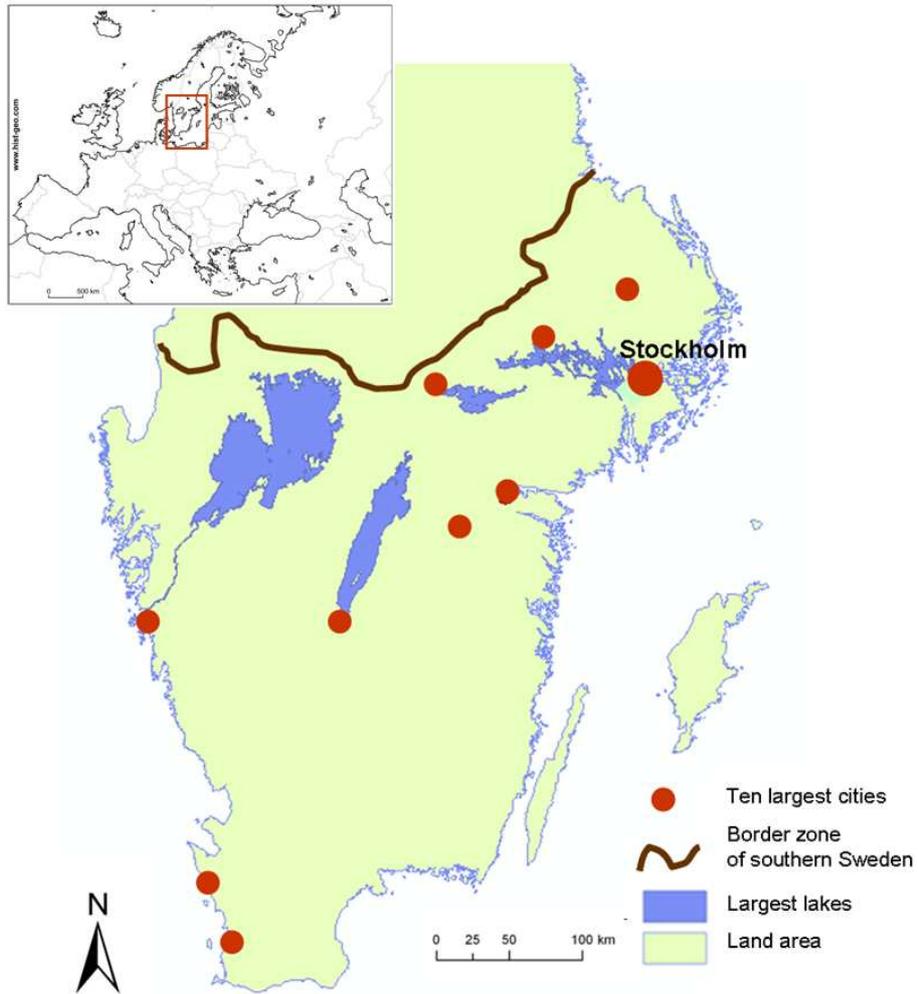


Figure 3: The study area of southern Sweden (55 - 60° N, 10 - 20° E). In **paper I** and **III** the whole region was studied. In **paper II** a subset of the ten, by population, largest cities was selected and **paper IV** and **V** examined nature conservation in Stockholm, the Swedish capital. For more detailed maps see the papers.

Box 1. Swedish urbanisation, planning and nature conservation

City definition: "An area with more than 200 inhabitants and 200 m between the buildings at the most" (Statistics Sweden 2006)

Urbanisation in numbers (Statistics Sweden 2006, 2010b):

Area: 45 million hectares, 3 % is urban land
Population density: 23 inhabitants/km² (66 in Europe)
Population prognosis: + 60 000 inhabitants/year
Population in cities: 84 % (50 % in cities with >10 000 inhabitants)
Urbanisation peak: 1860-1970 (from 13 % to > 80 %)

Municipal planning: Spatial planning is performed at municipal level, under supervision of the county administrative boards that safeguard national interests (Swedish parliament 1987). Each municipality must have comprehensive land use plans for all land within its boundaries. Such plan strategically devotes space for different societal needs. For example areas for outdoor recreation (Swedish government 1971). These plans are not legally binding, but guide detailed planning that concerns all built up land and in turn is legislated. The larger cities cover several municipalities and then regional planning is necessary, but it is completely dependent on municipal approval for implementation.

Urban nature: Green areas are formally handled by either municipal park or nature conservation administrations. Larger green structures usually cover many municipalities and their management is often coordinated by a regional authority. Many kinds of urban natures are not recognised by the formal organisations for planning and management, e.g. golf courses and allotment gardens (Barthel 2006, Colding et al. 2006).

Nature reserves dominate: 10.6 % of the land area is protected and the major part constitutes nature reserves, 8.7 % or n=3352 (Statistics Sweden 2009). The land in nature reserves may be privately owned and the rules are more flexible and closer related to the local context, compared to national parks.

Centralised nature conservation: Protecting new areas is the main Swedish governmental strategy for environmental protection (SEPA 2004). Nature conservation organisation is traditionally centralised (Sandström et al. 2008) and the nature reserves are generally created and managed by regional authorities. However, recently public participation has been promoted and decisions about nature reserves decentralised to municipal levels (Government offices of Sweden 2002, SEPA 2004).

Nature reserves for what? All nature reserves are based upon one or several of 5 main objectives, *Preserve biodiversity*, *Preserve environments*, *Outdoor recreation*, *Create/recreate habitats* and *Create/recreate environments* (Swedish parliament 1998, SEPA 2003a). These main objectives are also specified into management priorities that direct management goals and implementation.

The right of public access: In Sweden the public has access to all land, independent of ownership, as long as acting responsibly. This is an historical informal rule that today is written in the Swedish constitution (Swedish parliament 1994).

Methods

Given the systems view of cities and the need for multi-disciplinary approaches in addressing sustainability challenges, the research questions were examined by triangulation of perspectives and methods. The studies were performed at different spatial, temporal and organisational scales (fig. 1). Generally the large scale studies applied quantitative methods, e.g. statistical analyses, while the small scale studies used qualitative methods, e.g. interviews and text analyses. In addition to the collection of empirical data from databases, maps, documents and interviews, I have worked closely with practitioners in urban planning and green area management in my study areas and particularly in the city of Stockholm. I have attended debates, seminars and forums where these issues have been reported on and discussed.

Both **paper I** and **III** aimed at investigating the hypothesised urban characteristics of nature conservation both as expressions in the landscape and in policy implementations. **Paper I** was based on quantitative analyses and the research questions were: (i) What, if any, are the relations between nature conservation patterns; nature reserve number, size, age, and land cover¹ composition, and landscape degree of urbanisation?, (ii) In what ways can these hypothesised relations be explained by general urban landscape characteristics, such as small-scale land cover patterns and high competition for land? and (iii) Based on the current state of urban nature conservation, what future challenges can be identified? **Paper III** investigated the use of objectives in establishment of nature reserves over time and the quantitative results were related to qualitative data on Swedish nature conservation policies found in official reports and governmental documents. Swedish nature reserves are based on one or several of the five main objectives stated in the Environmental Code (Swedish parliament 1998); “Preserve biodiversity” (at organism group level), “Preserve environments”, “Outdoor recreation”, “Restore or create habitats” and “Restore or create environments”. The research questions were: (i) Are there differences between the number and composition of objectives of designation in urban and rural landscapes? and (ii) In

¹ In **paper I** the term “land cover” was used since the original data consisted of satellite images, while **paper II** was based on comprehensive land use maps and therefore the term “land use” was used.

what ways have the objectives of designation in nature conservation areas changed over time? In both **paper I** and **III** an official dataset including all 1869 nature reserves in southern Sweden (2006 census) was combined with municipal land cover data in the corresponding 209 municipalities.

Paper II was based on spatial analyses of comprehensive maps from 1950-2009. They were used to examine land use² changes in the proximity of 16 urban nature reserves selected from the ten, by population, largest cities in southern Sweden (fig. 3). The research questions were: (i) Is there a current difference in the percentage of built up area in the proximity of urban nature reserves compared to the corresponding cities? (ii) If there are differences do these change over time? and particularly (iii) before or after the establishment of the nature reserves? In **paper IV** I used qualitative data to evaluate current practical managements in five nature conservation areas in Stockholm in relation to spatial, temporal and organisational scales. The following research questions were addressed; (i) Do current management practices recognise temporal and spatial scales in management?, (ii) Do current management practices recognise the complexity, interconnectedness and dynamic characteristics of ecological systems? and (iii) What strategies are currently feasible for reducing mismatches in urban landscapes? These questions were examined through a combined, qualitative dataset of management documentation dating 10 years back in time and interviews with 20 officials formally responsible for the areas' practical management. To enable a social-ecological evaluation of management of scales, the theoretical frameworks of ecosystem management (Christensen et al. 1996) and hierarchical planning (Angelstam et al. 2003, Angelstam et al. 2005) were applied.

Paper V is part of an inter-disciplinary project between scholars in architecture and design, and systems ecology. In contrast to **paper I-IV** this study addresses nature conservation from the perspective of urban planning. The project aimed at exploring how resilience, as a conceptual framework (Pickett et al. 2004, Folke 2006, Czerniak and G. Hargreaves 2007, Lister 2007), could provide more operative and integrative approaches for dissolving the current urban landscape dichotomy between nature conservation and urban development. The work process included inter-disciplinary workshops and seminars with scholars in different fields, and trans-disciplinary meetings and interviews with practitioners in urban planning. These discussions were framed by design models that in a variety of ways addressed the urban landscape dichotomy, using a suburban section of the regional green structure of Stockholm as a case.

² In **paper I** the term "land cover" was used since the original data consisted of satellite images, while **paper II** was based on comprehensive land use maps and therefore the term "land use" was used.

Synthesis of results

The major findings in my thesis are presented as statements below. These statements are in the following discussed in relation to historical, current and future urban planning and management.

- Urban nature conservation has a specific pattern compared to rural (**paper I, III**).
- Urbanisation impacts land cover inside the nature reserve (**paper I**), while the surrounding landscape is largely unaffected by the nature reserve establishment (**paper II**).
- Urban nature reserves are established based on more objectives compared to rural (**paper III**).
- The use of “outdoor recreation” as an objective for urban nature reserves’ establishments has recently decreased along with an increase in the objective “preservation of biodiversity” (**paper III**).
- In practical nature conservation area management cross-scale interactions and meso-scales are seldom recognised (**paper IV**).
- Urban development planning is forward looking based on forecasted future changes, whilst urban nature conservation is backward looking and focusing on existing values (**paper III, V**).
- To overcome the urban landscape dichotomy, urban planning needs strategies to seek social-ecological synergies, to clearly address the challenges of dynamic urban natures, and to integrate local and informal means of nature management (**paper V**).

A specific urban nature conservation pattern

It has been shown that urban systems are different compared to other systems (Alberti 2008, Elmqvist et al. 2008). Similarly, the studies in **paper I** and **III** showed that urban nature reserves share certain characteristics that distinguish them from nature reserves in rural landscapes (fig. 4). These characteristics can be related to more general urban patterns such as high competition among land uses and the overall high degree of spatial heterogeneity (Pickett et al. 2001, Band et al. 2005).

I found that the more urbanised a municipality was, the fewer and larger were the nature reserves (fig. 3 in **paper I**). A crucial question is then the location of the nature reserves. If fewer and larger, it may be because they are located in the periphery of the city where the competition among land use interests might be weaker. Such scattered localisations may negatively impact both public accessibility and ecological connectivity since the landscape surrounding the areas is commonly highly urbanised, e.g. with physical barriers to access and hostile conditions for certain species.

It was also shown that the urban nature reserves displayed a higher diversity of land covers and a different land cover composition compared to rural ones (**paper I**). The same pattern was found for the objectives used in establishment of the nature reserves – a higher diversity and a different composition (fig. 3 in **paper III**). The high degree of spatial heterogeneity in urban landscapes that results in small scale mosaics of different land uses, probably lays the foundation for the diversity of land covers and objectives for protection. In addition, the pressures from other land use interests probably result in nature conservation that is only tenable on sites with multiple values and therefore the urban nature reserves are generally based on more objectives.

Missing meso-scales

The new understandings of cities as complex and highly dynamic systems indicate that we are clearly in an era of more holistic approaches. Contemporary environmental challenges are often at large scale and hence nature conservation increasingly is approached at larger landscape scales (Ahern 1999, Antrop 2001, Turner 2005, Nassauer 2006, Potschin and Haines-Young 2006b, Lindborg et al. 2008, Selman 2009). Several European directives also exemplify a political awareness in this sense, i.e. the landscape convention (Council of Europe 2000), Natura 2000 network (European Commission 2010) and the framework for water directive (European Commission 2000). These provide important incentives for integrating nature conservation areas into larger contexts. Also urban planning and urban ecology are promoting large-scale approaches as the future for urban green areas in general (Flores

et al. 1998, Selman 2006, Gordon et al. 2009, Lovell and Johnston 2009). This is not just about scaling up measures, but also to embrace the cross-scale interactions that characterise social-ecological systems (Folke et al. 1998, Cash 2000, Young 2002, Cumming 2006, Folke et al. 2007, Galaz et al. 2008). From the perspectives of urban nature conservation areas, this concern relating local measures to neighbouring and regional structures, as well as short term management practices to strategic time frames. In **paper IV** the handling of such cross-scaling challenges were evaluated in practical management and we found that several spatial and temporal scales were recognized, although interactions across scales were seldom recognized. Connections between regional and local spatial scales, as well as between long and short time scales, were missing and we identified these missing connections as “meso-scales” (fig. 2 in **paper IV**).

The lack of spatial and temporal meso-scales can be explained by general urban characteristics as well as case specific factors. The human dominance in urban landscapes effectively hides many ecological patterns and processes (Elmqvist et al. 2008). As an example, a land use division between a nature reserve and a residential area is usually more evident than ecological connections such as a species habitat that stretches over the division or the function of the residential area as an ecological link between the nature reserve and another green area. Since the urban landscape is perceived as hostile by many species, such ecological connections across the urban matrix are highly important (Lundberg and Moberg 2003, Mörtberg et al. 2007, Lindborg et al. 2008, Lundberg et al. 2008). The urban land use divisions are reinforced by a common way of organisation, where responsibilities are divided among sectors with limited incentives for in between connections (c.f. Ernstson et al. 2010). One striking example from **paper IV** was the separation of management of terrestrial and water environments within the same nature conservation area. This is a clear neglect of the hydrological flows where conditions in watershed impact the water courses. In contrast to the centralisation of general Swedish nature conservation, spatial planning and urban nature management are decentralised and performed at the municipal level (box 1). The municipalities have limited incentives for co-operation which is another effective barrier to meso-scale approaches.

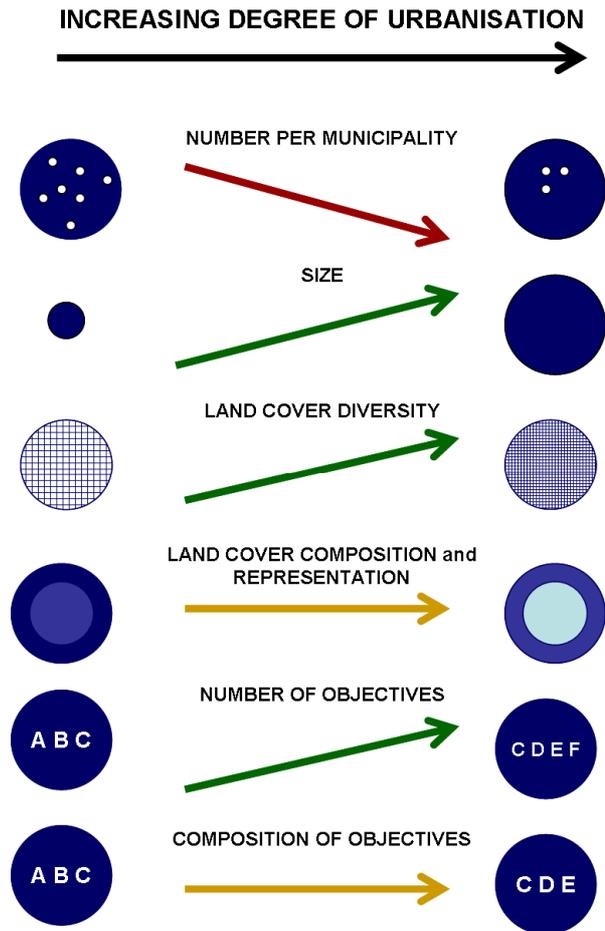


Figure 4. Urbanisation impacts on nature conservation patterns.

With increasing degree of urbanisation the characteristics of nature reserves changed. Green arrows indicate an increase with increasing degree of urbanisation, red arrows a decrease, while yellow arrows indicate qualitative changes, e.g. composition. Based on results from **paper I** and **III**.

Land cover patterns across borders

In **paper IV** issues of multiple scales and cross-scale interactions were addressed from the local perspective of nature conservation areas and the study showed that spatial meso-scales were not recognised. This was further investigated in **paper I** where urbanisation effects on land cover³ within urban nature reserves were analysed, whereas **paper II** examined whether nature reserve establishment impact land use patterns in surrounding landscapes.

In general, increased urbanisation changed nature reserve land cover composition (tab. 1 in **paper I**). For example, the proportions agricultural fields and grasslands increased at the expense of forests and wetlands (tab. 1 in **paper I**). Similar changes were also found in the landscape outside the nature reserves, but to a different degree. As a result the representation of different land covers also changed with increasing degree of urbanisation (fig. 5 in **paper I**). One example is the land cover “grassland” that is generally over-represented⁴ in Swedish nature reserves (tab. 1, fig. 4-5 **paper I**). With urbanisation the share of “grassland” in the landscape generally increased, but to an even larger extent in the urban nature reserves. This meant that the general overrepresentation was enhanced with increasing urbanisation. The results indicated that general prioritisations within Swedish nature conservation also are found in the urban nature reserves (tab.1, fig. 5 in **paper I**). This is intelligible since many Swedish cities are situated in fertile regions with an agricultural land use history and agricultural land is also the first hand choice for urban expansions (Statistics Sweden 2003) and hence this land cover is more threatened than forests

It has been suggested that nature attracts urban development, for example manifested in higher real estate prices near urban nature (Crompton 2005). In addition, large scale studies have shown that the distance of nature conservation areas and cities is decreasing (McDonald et al. 2007, McDonald et al. 2008). But such relationship has not been studied specifically for formally protected urban nature conservation areas. If such relation exists within cities, it implies that urban nature, and especially nature conservation areas, run a higher risk compared to less attractive environments, to become surrounded by built up areas and hence losing ecological connections to other green structures. In contrast, however, **paper II** showed that proximate land cover patterns largely followed the overall urbanisation trend in the municipi-

³ In **paper I** the term “land cover” was used since the original data consisted of satellite images, while **paper II** was based on comprehensive land use maps and therefore the term “land use” was used.

⁴ Overrepresentation means that there is more of that land cover in the nature reserve in comparison to the surrounding landscape.

palities (fig. 3, 5 in **paper II**). The establishments of nature reserves were also found to occur in the aftermath of local urbanisation (fig. 5 in **paper II**). This suggested that the nature conservation process is directed by perceived and articulated threats to certain locally defined values and have limited possibilities to impact the surrounding land uses.

Current Swedish urban nature conservation is based on general ideas of what to protect, and less concerned about what nature is needed in the city in a long term perspective. Both **paper I** and **II** support the picture of urban nature conservation areas as isolated fragments (**paper IV**) of remains from former land uses, e.g. small scale agriculture. The ongoing urbanisation in the proximity of nature reserves is a clear example of this (**paper II**). To sustain the values within these areas there is a need to develop strategies for bridging their borders and recognise and enhance the interaction with the surrounding landscape (**paper V**). These borders are commonly compromises of ecological and social interests, e.g. species habitats and migration routes, land ownerships and political intentions, and seldom fully matching either social or ecological divisions of a landscape (**paper V**). Although artificial, they become powerful and very definite in defining where certain values are found and others are lost. Within these borders the focus is on former or existing values that are perceived as threatened (**paper I, III, V**). Outside there is a forward looking process where urban development planning focuses on meeting future demands of population growth, industrial activities and demographic changes. Such future scenarios for urban nature are largely missing, e.g. prognosis of changes in frequency of visitors, changes in biodiversity or external impacts.

Why urban nature conservation?

The increase in the human population requires an increasingly effective use of land to satisfy human needs. Therefore there is a need of protecting nature in human dominated landscapes (Pimentel and Stachow 1992, Callicott 1999, Reyers et al. 2009). This highlights the questions of what kind of nature is to be protected and why. Traditionally nature conservation is about safeguarding biological values that are threatened, rare or contribute to the representation of biotopes within a regional set of nature conservation areas. Even though certain cities are located at biodiversity hotspot of global importance, much of the urban nature is, from a biological viewpoint, rather trivial and does not fully correspond to the traditional frame for nature valuation. The analyses of the objectives for establishing urban nature reserves in **paper III** aimed at examine the current foundation for urban nature conservation in order to set the stage for a deepened discussion about its purposes in an urban context.

The establishment of Swedish urban nature reserves were found to be commonly based on the objectives “outdoor recreation” and “preservation of biodiversity⁵” (box 1, fig. 3 in **paper III**). The emphasis on social values implied that the nature reserves were not protected from humans, but instead established for human benefits. Once again this pattern corresponded to the strong competition among land uses where multiple values, including social, are needed to achieve broad acceptance of nature conservation decisions. It is regulated by law that urban plans must devote areas for outdoor recreation nearby built up areas (Swedish government 1971) and many of these outdoor recreation areas have later become nature reserves. This means that the nature reserves were founded upon already articulated values. Even if such strategy leads to effective protection of multiple values, it also means that the selection of nature conservation areas is based on other measures than strategic consideration of current social and ecological values and future needs. A positive consequence is that the social focus and multiple values create as strong identity that appeal to the broad public. Such strong identity is a prerequisite for urban nature conservation areas long term sustenance as discussed in **paper V**.

The historical and current social basis of Swedish urban nature protection may potentially be revitalised to sustain and develop human-nature linkages in the urban landscape (**papers IV, V**). However, the recent increase in the objective “preserve biodiversity” for establishing nature conservation areas, paralleled with the decrease in the use of the objective “outdoor recreation” (fig. 4 in **paper III**), indicates a change in urban nature conservation focus. I argue that this is related to nature conservation generally being a reactive process, driven by threats that results in ad hoc solutions to local situations (c.f. Emneborg and Götmark 2000, Margules and Pressey 2000). Such processes are largely in the hands of various stakeholders and partly depending on local power relations (c.f. Ernstson et al. 2008), rather than conscious valuations for strategic large scale prioritisations. The increasing focus on organism biodiversity may also reflect the need for strong arguments to set aside areas in urban contexts, e.g. support from European legislation for certain species.

The articulation of threats and the use of such articulations are crucial processes. What is perceived as a threat is dependent on knowledge, and in turn, the awareness and perception of a threat give incentives for generation of new knowledge. For example, since 1990s the biodiversity loss has been recognised globally (UNEP 1992), and thereby off set an increase in research and policy development to handle this identified challenge. The issue of biodiversity then enters a positive feedback loop where more knowledge

⁵ This objective concerns biodiversity at organism group level, e.g. birds, plants and fungi.

leads to better articulated challenges and stronger incentives for further investigations. These feedback loops might lead to a neglect of values that need to be safeguarded, but is not currently perceived as threatened. This is in the findings exemplified by the recent decrease in the use of “outdoor recreation” for establishing urban nature reserves. Today there is a limited awareness of these kinds of political drivers and normative foundations in nature conservation policies and research (Stenseke 2009, Maris and Bechet 2010, Stenseke 2010). This is especially important in human dominated environments where the value of nature is largely indirect.

Future urban nature conservation

This thesis showed that there is a certain urban nature conservation signature. It is expressed physically in the urban landscapes (**paper I-II**), as well as conceptually in planning and management of nature conservation areas (**paper III-IV**). The revealed pattern is likely a reflection of the urban landscape characters, rather than a conscious adaptation to the urban context. Crucial for future urban nature conservation is the current limited recognition of the urban matrix where the nature conservation areas are becoming isolated islands. To uphold their functions and values, these islands will need increasingly intensive and costly management. This is a vulnerable trajectory where the nature conservation areas are passive receivers of urban dynamics, instead of being active elements of importance for the whole urban system (**paper V**).

The lack of social and ecological linkages between nature conservation areas and urban landscape might decrease the public support for conservation and cause degradation of biodiversity and hence impact the flows of ecosystem services. Therefore there is a need for urban planning to seek social-ecological synergies, address the challenges of urban nature dynamics, and to integrate local and informal means of urban nature management (**paper V**). In this context I propose an alternative urban nature conservation model where urban nature, including conservation areas, is perceived, planned and managed as valuable and integrated parts of the urban landscape. Three components constitute this model: i) active planning and management of multiple ecosystem services, ii) cross-scale strategies and focus on border zones and iii) proactive approaches. Below I discuss ways of adapting the current nature conservation framework to the urban context by recognising these three components.

Multifunctional urban nature

The view of urban nature as a social-ecological feature (Powell et al. 2002) opens up for many more possible objectives than a more traditional nature conservation approach. In this thesis it was found that urban nature conservation areas are based on multiple objectives. This is a challenge in practical management, but given the current shortage of and continued decrease in

urban nature, I argue that multiple values are necessary and should be actively enhanced and created. A widely discussed concept in this context is *multifunctional landscapes* (Brandt & Vejre 2003; Helming & Wiggering 2003; Naveh 2001; Selman 2009). There are three ways to multi-functionality: i) a spatial combination of patches with different land uses, ii) multiple functions in one patch but at different times and iii) multiple functions at the same patch and at the same time (Brandt and Vejre 2004). These are depending on the scale of the approach, and could be applied at both local, landscape and regional levels of cities. Using multi-functionality is a way of describing cities beyond social and ecological divisions (Pickett and Cadenasso 2008) and a potentially useful framework for reformulating the role of nature conservation areas in urban landscapes.

Still, the qualitative questions of what functions and for whom, need to be addressed. Urban nature must become recognised by its social-ecological origin and importance for citizens and such view implicates an anthropocentric value base. The concept of ecosystem services is in this sense highly relevant since it aims at linking ecosystem functions to human needs and values (Daily 1997, Millennium Ecosystem Assessment 2005, Haines-Young 2009). Therefore I suggest that the multifunctional urban landscape may be described in terms current and future needs of ecosystem services as well as capacity to provide these services (c.f. Barthel 2006, Andersson et al. 2007, Ernstson et al. 2010). Crucial questions are: What ecosystem services are needed now and in the future? Where and at what scale are they needed?, and What kind of urban nature and biodiversity can provide such ecosystem services? Applying these questions in urban nature conservation may change both the landscape configuration and conservation prioritisations (c.f. Brooks et al. 2006, Chan et al. 2006, Armsworth et al. 2007). An area can for example become protected because of its potential for future local food production, for mitigation of floods due to climate change or because of its importance as an ecological link between core areas at the landscape scale.

Intermediate zones

In an urban setting the promoted large scale approaches means bridging the many divisions and borders throughout the landscape. Conservation areas must be linked to other formal as well as informally managed urban green areas and also to the built up areas. Currently urban planning and nature conservation are least interested in the outskirts, near the borders of their authority. However, this is a crucial spatial zone, where physical and conceptual integration may take place. I call these sites *intermediate urban zones* that potentially enhance ecological connectivity between urban nature at different scales (Lovell and Johnston 2009). Furthermore, these zones have the potential to be easily accessible entrances where human activities

are less restricted compared to inside the nature conservation areas. In these locations the co-existence of several ecosystem services can be powerful connectors between the citizens and urban nature. Community gardens, cemeteries, golf courses and other semi-intensive urban land uses are examples of existing important intermediates that need to be highlighted and multiplied. Due to their location, they are likely the areas most prone to urban exploitation, and therefore probably need some kind of formal agreement to be sustained. Such zones may also become starting points for meso-scale organisation of planning and management of the urban landscape. Because they are neither conservation areas nor urban areas they can attract a broad range of different stakeholders to the same table. This is an arena with potential for extended co-ordination of planning and managing the cities at the scale of neighborhoods (c.f. Ernstson et al. 2010).

There are two main challenges posed by the suggested model of cross-scaling multifunctional urban landscapes. First the importance of identity and constituency of urban nature conservation areas. If an area is optimised for providing multiple ecosystem services it risks becoming fuzzy. Such unclear identity might be detrimental to the areas longevity in the urban landscape (**paper V**). Second, the incompatibility between certain ecosystem services may cause conflicts of interests and degradation of the ecosystem (e.g. Kremen 2005, Bennett et al. 2009, Raudsepp-Hearne et al. 2010). This emphasise the need for multi-functionality at several scales, where competing ecosystem services can be provided at different places in the landscape.

Beyond threats

Currently urban nature conservation is directed by recent or ongoing urban development possessing threats to existing or former values. This reactive approach offers limited space for strategic planning and leads to increased vulnerability and difficulties in achieving common goals such as sustainable cities. There is a need for visions that goes beyond size of areas, representation of biotopes and saving from urban development.

In most cities urban nature is decreasing with consequences such as decreasing accessibility for citizens and ecological connectedness, and conflicts of interests in the remaining areas. If there is a similar shortage in housing or infrastructure, it becomes a political prioritisation and strategic programs for development are often created. A similar strategy would be useful in the case of urban nature, where the forecasted decreases could be met by strategies for how to increase the urban nature. This is not just about greening the built up elements such as roofs, walls and roadsides, but also actually creating large areas of urban nature. Currently there is a strong trend in Europe to build on former industrial sites, railways and harbours. In many cases these

sites are nearly zero in nature. However, these areas do not necessarily need to be densely built as is currently the case. Development projects can instead be viewed as opportunities where interest and investments are focused to a particular site contributing to the overall green structure in urban landscapes.

Concluding remarks

This thesis describes the global challenges of urbanisation and biodiversity loss and more specifically it examines the interface between nature conservation and urban development at the landscape scale. The overall question was: Is formal means of protection of nature a successful tool for safeguarding ecosystem services provided by urban nature? My answer is: Probably not, at least not in a long-term perspective.

This is part of a larger discussion on the capability of the current nature conservation policies that are dominated by set aside areas, to meet the contemporary challenges (Bishop et al. 1995, Selman 2009). I argue for the continued need of nature conservation areas in the urban landscape. First, because as long as the different interest of land use in a city is unbalanced in decision making, strong tools are necessary to sustain urban nature and functional ecosystem that provides ecosystem services. Second, because the current renewal of general nature conservation policies needs the urban landscape as a testing ground since the anthropogenic challenges are especially pronounced here.

By studying Swedish urban nature conservation I identified certain patterns that emerge when nature conservation is implemented. Such patterns are also likely to be found in cities outside Sweden, suggesting that these findings are useful in the current general renewal of nature conservation policies. I found urban nature conservation to be a very local business, where nature conservation areas are established in the aftermath of local urbanisation, and managed largely in isolation from the surrounding landscape. This gives limited availability for creation of multi-functional urban landscapes where built up areas and nature conservation areas are integrated. In my experience urban nature is commonly viewed as a victim of urban development, which is unfortunate as both are crucial elements of urban sustainable development. An unconscious continuation along this trajectory will most likely diminish the potential of future provision of local ecosystem services.

The future challenge is to transform the current reactive, defensive and isolated urban nature conservation, to include active planning and management of multiple ecosystem services as well as strategies for cross-scaling and a

clearer focus on intermediate zones. With urban lifestyles dominating the world there is an increasing interest to define and create the “good city” in policy, research and practice. There is no question that if ever achievable, the city in it self display a high concentration of windows of opportunities. The key question is rather how to take advantage of that potential.

Sammanfattning på svenska

Vi människor behöver natur. Inte bara i storslagna nationalparker långt bort, utan nära där vi bor och arbetar. Stadsnaturen kan minska lokala miljöproblem som luftföroreningar, ge oss platser för lek, lärande, motion och avkoppling, och också bidra positivt till vår hälsa. Sådana tjänster som vi får från naturen kallas ekosystemtjänster. Många av de lokala ekosystemtjänster som stadsnaturen bidrar med är viktiga för en hållbar stadsutveckling. Eftersom många städer ligger i områden med hög biologisk mångfald, t.ex. flodmynningar, är stadsnaturen även en viktig del i arbetet för att stoppa den världsomfattande förlusten av biologisk mångfald.

Samtidigt som stadsnaturen är en tillgång konkurrerar den med andra markanvändningsintressen. I många städer minskar andelen natur, till förmån för bebyggelse och infrastruktur när städerna växer. Urbanisering leder därför till att allt fler stadbor har allt mindre natur att tillgå och därmed utarmas stadsnaturens möjlighet att tillhandahålla ekosystemtjänster. På många håll inrättar man därför skyddade naturområden i städer. Till exempel fick länsstyrelserna i Stockholm, Göteborg och Malmö 2002 i uppdrag av regeringen att ta fram program för hur man planerade att skydda den tätortsnära naturen. I Stockholm innehöll programmet förslag om inrättande av 71 nya naturreservat till och med 2013. Dessa naturskyddade områden ska tjäna många både ekologiska och sociala syften, t.ex. upprätthålla biologisk mångfald och tillhandahålla miljöer för friluftsliv och annan naturkontakt. Samtidigt använder man naturvårdsverktyg som utvecklats i landskap som skiljer sig mycket från städernas miljöer. I städerna finns dessutom ett annat verktyg, fysisk planering, som styr hur marken ska användas. I det stadslandskap som nu växer fram möts naturvården och den fysiska planeringen – två lagstiftade institutionella verktyg med lång historia. Den här avhandlingen syftar till att undersöka det här mötet mellan naturskydd och bebyggelse och diskutera de naturskyddade områdenas framtida roll för ett hållbart stadslandskap.

Avhandlingen baseras på fem artiklar som utifrån olika teoretiska perspektiv, i olika skalor, och med både kvantitativa och kvalitativa metoder analyserar naturskydd i staden. Södra Sverige användes som fallstudieområde och det motiveras av en lång historik av både stadsplanering och naturvård. I artikel I och III studeras hur olika egenskaper hos naturreservat förändras med

landskapets grad av urbanisering, t.ex. storlek, sammansättning av markslag och syften för avsättning. I dessa analyser användes ett dataset med alla 1869 naturreservat i södra Sverige. I artikel II valdes 16 naturreservat i de tio största städerna ut och markanvändningen i området kring naturreservaten analyserades över tid. Som underlag för analyserna användes översiktliga markanvändningskartor från 1950-2009. Artikel IV utgick ifrån den lokala skalan och analyserade hur man inom förvaltning av naturskyddade områden tar hänsyn till olika skalor i tid och rum. Detta undersöktes genom textanalyser av förvaltningsdokument och intervjuer med förvaltare i fem olika naturområden i Stockholms län. Artikel V redovisar ett tvärvetenskapligt projekt där forskare inom arkitektur och systemekologi undersökt hur man kan överbygga gapet mellan natur och stad inom stadsplaneringen. Arbetet utgjordes av en följd av workshops i olika konstellationer med både andra forskare och praktiker inom stadsplanering, och fokuserades kring en fallstudie av ett regionalt utsnitt av Stockholms grönstruktur med omkringliggande bebyggelse.

Studierna visar att naturskydd i städer skiljer sig från naturskydd i andra landskap. Till exempel är naturreservaten något större, färre per kommun, baserade på fler och andra syften för avsättning och omfattar en större mångfald av markslag. Detta är troligen inte någon medveten strategi inom naturvården utan snarare en konsekvens av det omgivande landskapet. Studierna påvisar också en fysisk och konceptuell isolering av de naturskyddade områdena som ytrar sig i förvaltningens begränsade beaktande av andra skalor än den lokala och kortsiktiga, samt i att stadsutvecklingen pågår opåverkad ända fram till områdenas gräns. Samtidigt är alla stadens delar, inklusive de naturskyddade områden, ömsesidigt beroende av varandra, både socialt och ekologiskt. Gränsen mellan naturskyddade områden och staden i övrigt är också en skiljelinje mellan framåtblickande stadsplanering och bakåtblickande naturvård. En fortsatt urbanisering riskerar att leda till ett framtida stadslandskap där stadsnaturen finns i isolerade öar där det krävs omfattande skötsel för att upprätthålla deras värden. Om man inte tar hänsyn till dessa områdens ekologiska och sociala samspel med det omgivande landskapet riskeras deras potential att tillhandahålla ekosystemtjänster.

För att ta tillvara och utveckla stadsnaturens potential för en hållbar utveckling behövs nya modeller inom stadsplaneringen i stort, samt en anpassning av naturvården till stadslandskapet. För att kunna integrera naturvård och naturskyddade områden i stadsplaneringen behövs strategier som aktivt förstärker och skapar social-ekologiska synergier, möjliggör stadsnaturens dynamik och flexibilitet över tid, och som omfattar lokala och informella sätt att förvalta stadsnaturen. Tre komponenter är centrala för att naturvården ska kunna anpassas till stadslandskapet och också integreras i stadsplaneringen, i) en aktiv planering och förvaltning av en mångfald av

ekosystemtjänster, ii) strategier som omfattar flera olika skalor och fokuserar på gränsområdena i stadslandskapet och iii) proaktivitet och framtidsvisioner. Naturskyddade områden är av stor betydelse för en hållbar stadsutveckling, men det krävs att dessa utformas till att bli funktionella delar av stadslandskapet. Centrala frågor är därför vilken natur som ska skyddas, för vem och var? Städer kan tyckas vara naturens motsats, men samtidigt är det människans vanligaste livsmiljö och om någonstans så finns här den kreativitet och mångfald som behövs för att utveckla en naturvård som bidrar till en hållbar utveckling.

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