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Sustaining urban ecosystem services with local stewards participation in Stockholm (Sweden)

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Abstract

Urban ecosystems are becoming increasingly important as nodes of interaction between humans and nature. Sustainable management of urban ecosystems is therefore a crucial issue that needs to be analysed. The aim of this paper is to explore if adaptive co-management may be a viable approach for managing ecosystem resilience of a biodiversity-rich urban landscape in Stockholm, called the National Urban Park. Adaptive co-management is an integrative and place-specific approach that focuses on creating functional feedback loops between social and ecological systems. A social-ecological inventory based on multiple forms of qualitative data reveals that there are twenty-four local steward associations linked to ecosystem services, like air filtration, recreation, pollination, seed dispersal, delivered to the

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cityscape of Stockholm. They operate under diverse property-right regimes. Local actor groups in the park also alter biotopes and associated ecosystem services. Their specific management practices sustain diversity of culturally transformed biotopes on a landscape level and seem to be one contributing factor for the rich species diversity currently found in the park. Inclusion of local actors, in the unique cultural landscape in Stockholm, in an integrative co-management programme may strengthen biological-diversity management, reducing overall cost of management and promote joint learning of how to adapt to unpredictability and change. Complementing the local stewards with actor groups active outside the administrative borders of the National Urban Park together with scientists and authorities in an adaptive co-management regime is suggested as a way to sustain the resilience of the National Urban Park as a biodiversity-rich social-ecological system.
Keywords: adaptive co-management; urban biodiversity; urban ecology; local actors; social-ecological system

Introduction

Given the accelerating rate of urbanization worldwide, urban ecosystems are becoming increasingly important as nodes of interaction between humans and nature (Pickett et al. 2001). Urban ecosystems deliver critical ecosystem services with a substantial impact on human well-being (Bolund and Hunhammar 1999). Analysing and identifying components that contribute to the sustainable management of urban ecosystems is therefore a crucial issue for ecologists to address. Which approach is best suited for this purpose, an expert-planned 'protected-area approach' or an adaptive co-management approach (Olsson, Folke and Berkes 2004) including local steward associations (here called local actor groups) involved in natural-resource, biotope and ecosystem management in urban areas? The aim of this paper is to explore if inclusion of local actors in adaptive co-management may be a viable approach for sustaining ecosystem resilience of a biodiversity-rich urban landscape in Stockholm, called the National Urban Park.

Natural-resource management approaches that are based on assumptions of linear cause and effect and 'nature in balance', have on numerous occasions resulted in surprises and irreversible degradation of ecosystems (Holling and Meffe 1996). Leading contemporary ecologists base their assumptions on 'resilient nature' including aspects such as nonlinearity, historical dependency and multiple possible outcomes (e.g. Levin 1998; Peterson, Allen and C.S. 1998; Carpenter et al. 2001; Holling 2001; Folke et al. 2002). Ecosystem resilience is defined as the magnitude of disturbance that a system can experience before it moves into a different state (stability domain) with different controls on structure and function (Holling 1973, 1996). Resilience sustains the capacity of desirable ecosystem states to produce ecosystem services and goods (Costanza et al. 1997; Carpenter et al. 2001). This world view recognizes that it is practically impossible to understand all ecosystem functions; consequently, a sustainable management should be flexible, adaptive and experimental at scales compatible with the scales of critical ecosystem functions (e.g. Holling 1987; Gunderson, Holling and Light 1995). However, studies exclusively within the field of ecology provide limited clues for planning and management of human dominated ecosystems, (Berkes and Folke 1998; Ahern 1999; Opdam, Foppen and Vos 2001) such as urban ecosystems. The intense human influence stresses the importance of analysing interacting social dynamics as well (Barrett et al. 2001; Kinzig 2001; Folke, Colding and Berkes 2003). Ecology has the tools for assessing

ecosystem resilience and suggesting where to intervene in management. However, social science is better equipped for understanding how to develop learning about the system and flexible and resilient governance structures to meet external driving forces. There clearly is a need for integrative approaches, both interdisciplinary within academia and incorporating other knowledge cultures, for a successful management of complex landscapes (e.g. Wu and Hobbs 2002; Tress, Tress and Fry 2005). Adaptive co-management is an integrative approach where focus is on creating functional feedback loops between social and ecological systems. It draws on a variety of sources of information and knowledge from numerous scales, avoiding set prescriptions of management superimposed on a particular place, situation or context (Olsson, Folke and Berkes 2004).

The paper begins with a description of the study site, followed by information on the method design used for identifying ecosystem services delivered from various sites in the park. I will proceed by showing that social-ecological interactions by actors in the park deliver various and specific ecosystem services to the cityscape. Based on this information, I will discuss in what way local actor groups contribute to ecological resilience, and thereby to the flow of desirable ecosystem services. I assert that integration of local actor groups, in this unique cultural landscape in Stockholm, in a broadly conceived adaptive co-management programme, is beneficial for sustaining species diversity, reducing overall cost of management and creation of joint learning how to adapt to unpredictability and change.

Study site

Stockholm County has the largest population concentration in Sweden with about 1.8 million people. The County extends about 180 km from north to south and is one of the most densely populated areas of Sweden with 280 inhabitants per km^2 as compared to 21 inhabitants per km^2 for Sweden in total. Ten green wedges constitute the nucleus of the green structure of the County. The National Urban Park (NUP) is situated within one of them, connecting it to ecosystems on a larger scale, which is crucial for ecological functions within the park (Holling 2001; Folke, Colding and Berkes 2003; Lundberg and Moberg 2003). A threat to the park is that urban development in surrounding areas accelerated dramatically during the 1970s and ’80s (see http://www.ab.lst.se). Figure 1 shows the location of the NUP in focus here. The park covers about 27 km^2 adjacent to the inner city of Stockholm, including about 8 km^2 of open water. The park got legal protection 1995, as the first NUP in the world (Elmqvist et al. 2004).

The millennia-long land-use history (Lundevall 1997; Gustavsson 1998) of the area where the contemporary National Urban Park is located has resulted in a unique cultural landscape that is rich in terms of biodiversity. Few areas of the same size in Sweden show such a high species diversity (Lundevall 1997; Brusewitz 1995). Despite the park being one of the most frequently visited green areas in Sweden and representing only one percent of the region’s area, it hosts approximately 75% of all the species recorded in the region of Uppland. There are more than 1000 species of *Lepidoptera* documented, more than 1200 species of *Coleoptera*, and more than 250 bird species, including many red-listed species (Löfvenhaft 2002b).

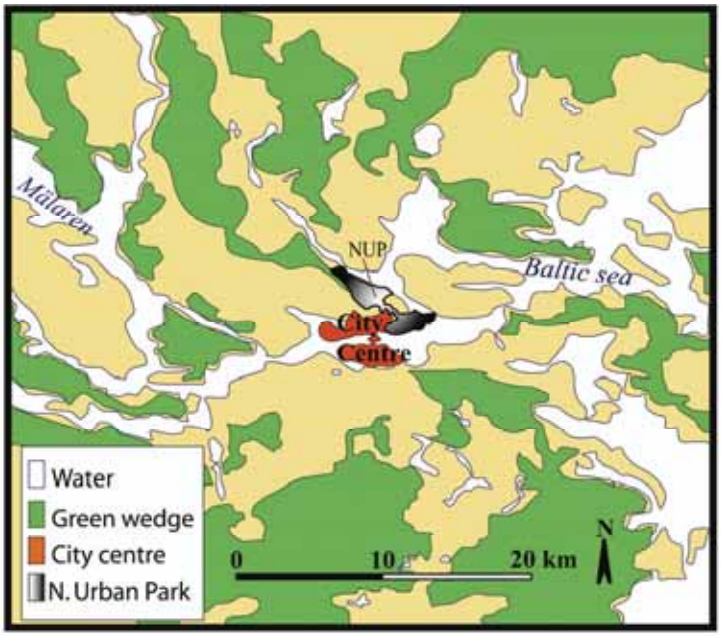

Figure 1. Map of Stockholm area with green wedges and the study site, the National Urban Park (NUP) of Stockholm

Three reasons for the rich levels of biodiversity have previously been proposed, related to past activities in land use and management (Barthel et al. in press). The first two reasons pertain to the long continuity of royal land ownership through times of change in the surrounding areas and to the management tradition of the Oak tree. The third reason is that the landscape holds a high number of biotopes, sometimes referred to as alpha diversity (O'Neill et al. 1988). Löfvenhaft (2002a) found that the park holds 24 different types of biotopes. Because different biotopes provide different habitats and support diverse species compositions, it is generally true that the total number of species in a landscape increases as landscape mosaic richness increases, although this does not account for interior species that are found within more homogeneous less disturbed landscapes (Peters and Goslee 2001). Nevertheless, some of the biotopes found in the NUP have the configuration and size to support populations of interior species, such as the Eurasian jay, several woodpecker species and owls. This indicates that the park includes biotopes that are somewhat resistant to edge effects (Meffe et al. 2002).

Methods

Results presented in this paper are from research carried out in 2003 and 2004. I have made a social-ecological inventory of the National Urban Park of Stockholm based on a previous study where 24 steward associations (actor groups) and their activities where identified (Barthel et al. in press). The inventory of this paper deals with ecosystem services delivered from biotopes managed by these actors. The objective with the inventory is to investigate with multiple forms of data, the role of management by many local actors contributing to the deliverance of desirable ecosystem services and biodiversity values of the park. Their management may sustain heterogeneity in the landscape, and specific ecosystem services may depend on management by a number of local actors. Removing or replacing management

actors from the landscape may therefore transform the landscape and affect the deliverance of ecosystem services and the capacity of ecosystems to sustain them.

This study uses qualitative data with the purpose of illuminating aspects of the complex social-ecological system of the NUP. The definition of social-ecological system used in this paper includes the ecosystem and the social actors involved in governance of the ecosystem. The scale of concern is ecosystem services delivered on a local level for the benefit of the city inhabitants. Global ecosystem services, such as CO_2 sequestering by urban ecosystems (Jansson and Nohrstedt 2001), do not have to be delivered locally for the benefit of city inhabitants in contrast with, for example, locally enjoyed air filtration. Ecosystem services on a micro-scale have not been included, such as predators of micro-pathogens. Hence, the scale of concern here is that which directly benefits, and is perceptible by, inhabitants of the city.

The methodological design used to identify ecosystem services combines four sources of information. The first are field observations at sites managed by local actor groups. These where made during 2003 and 2004. The observations were made mainly during the growing seasons. I focused on vegetation cover, management practises and the surrounding landscape when observing the sites. Secondly, observations were compared with analyses of recently produced biotope maps, such as the work by Stockholms Stadsbyggnadskontor (1997) and Löfvenhaft and Lannek (2002). The third and fourth sources of information consisted of qualitative data (Patton 1980; Bernard 1994; Kvale 1996), including three semi-structured interviews and a telephone survey with 24 respondents. The aim was to derive further information on management practices performed by local actor groups. The semi-structured interviews were conducted with respondents active in the network organization *Alliance of the Ecopark* (see http://www.ekoparken.org/: Opperud 2003-05-28; Schantz 2003-03-22; Waldenström 2003-04-09). The length of the interviews was about one hour and they were carried out in 2003. The fourth source of information was a telephone survey. It was conducted in the spring of 2003 and the respondents were the identified 24 actor groups. The aim of the survey was to get estimates on what kind of management they were performing and where in the landscape they were active. All 24 local steward associations or actor groups responded.

These four sources of information were combined with the literature on ecosystem services (Folke, Holling and Perrings 1996; Baskin and Rorer 1997; Daily et al. 1997; Nabhan and Buchmann 1997; Naylor and Ehrlich 1997; Costanza et al. 1997; Bolund and Hunhammar 1999; Löfvenhaft 2002b). Criteria for classification of ecosystem services delivered by the various sites in the park (see Table 1) were synthesized using these multiple form of data. Based on these criteria the four most characteristic ecosystem services per site were chosen in order to highlight differences between sites in the deliverance of services to the urban landscape, although I recognize that some of the sites deliver all ten identified ecosystem services to some degree. No quantitative estimations of these ecosystem services have been conducted. For instance, no quantitative data on pollinating insects in allotment areas are included in this analysis. Hence, results from a study of this kind are of a tentative standard from a strict natural-science perspective. However, the methodology gives qualitative information on various kinds of ecosystem services that are delivered from biotopes of the park that are managed by local actor groups.

Table 1. Criteria for classification of ecosystem services delivered from the National Urban Park

Criteria	Ecosystem service
Green space open to and enjoyed by the public	Recreation/cultural values
Important feeding areas and habitats for mobile links, such as birds	Seed dispersal
Important feeding areas for pollinators	Pollination
Street trees, lawns or urban forests close to noisy areas	Noise reduction
Areas described as important habitats for red-listed species	Genetic library maintenance
Habitat for predators of pests, such as insectivorous birds	Insect-pest regulation
Permeable surfaces like lawns etc	Surface-water drainage
In-city vegetation/street trees, vegetation close to buildings, water bodies	Regulation of microclimate
Street trees, lawns or urban forests close to sources of pollution	Air filtration
Wetlands	Nutrient retention

Results

In this section I present results of an analysis of the different steward associations, here called actor groups, involved in management of the park in relation to various ecosystem services that they are engaged with. Ten potential ecosystem services are delivered from various sites in the park to the cityscape. These sites can be viewed as culturally transformed biotopes according to demands of their managers (Antrop 2005). These biotopes are managed by 24 different actor groups, with diverse property rights to the natural resources of the park. This shows that not only owners are active in managing the urban landscape, but also proprietors and claimants affect ecosystem dynamics on a local scale.

Royal Djurgården Administration *(KDF)* is one of the key management actors in the National Urban Park in Stockholm. It deals with property rights associated with proprietors (see Table 2), and manages about 80% of the park area. Their management objective is to preserve biological diversity with high priority placed on conservation of endangered species. It manages sections of the park next to the built-up environment of the city, including large lawns, wetlands and old forests. Land in the park is overwhelmingly state-owned. The seven owners of the park, presented in Table 2, are responsible for management of the remaining about 20% of the area. All in all, there are 24 actors with management rights that are active in the park. In Table 2 they are presented in accordance with the findings of Ostrom and Schlager (1996) concerning the different operational levels of property rights that can be held by individuals or groups relative to the natural-resource base.

Table 2. Urban steward associations and organizations (actors) active in management in the National Urban Park. The actors are classified by property rights to the natural-resource base

Actors: Organizations and associations	**No**	**Property-rights regime**	**Operational level of property rights to the natural-resource base**
World Wildlife Foundation (WWF), The Swedish Society for Nature Conservation, Patrullen Utter, Bergshamra för alla, Stockholms Ornitologiska förening	5	Claimants	The right of management for regulating internal use patterns and transform the resource by making improvements
Stockholm Water Inc., Royal Djurgården admin., Botanic Garden of Bergius, Garden of Rosendal, The 4H Farm of Stora skuggan, Allotment areas of Söderbrunn; Kvarnvreten; Ulriksdal; Frescati; Bergshamra and Stora skuggan., Out door museum of Skansen	12	Proprietors	Management rights, and the additional right to determine who will have an access right and how that right may be transferred
National Property Board, Swedish National Road Administration, Vasakronan, Akademiska hus, Municipalities of Stockholm; Solna and Lidingö	7	Owners	All the rights that Claimants and Proprietors hold and the additional right to sell or lease property

Table 3. Potential local ecosystem services delivered by the cultural landscape of the National Urban Park. These services are classified by the number of urban actor groups that affect their deliverance

Potential local ecosystem services	**Number of actor groups that affect each ecosystem service**			
	Owners	**Proprietors**	**Claimants**	**Total**
Recreation/cultural values	4	6	5	15
Seed dispersal	1	9	4	14
Pollination	0	10	2	12
Noise reduction	5	6	0	11
Genetic-library maintenance	2	4	5	11
Insect-pest regulation	1	7	1	9
Surface-water drainage	3	2	0	5
Regulation of microclimate	3	2	0	5
Air filtration	5	0	0	5
Nutrient retention	0	2	2	4

Owners and key actors, such as Royal Djurgården Administration, are responsible for maintaining biological values in the park. However, not only owners are affecting the flow of ecosystem services (see Table 3). Out of all actors in Table 2, eleven

proprietors (Stockholm Water Inc. excluded) and three claimants (WWF and The Swedish Society for Nature Conservation excluded) are locally evolved interest groups (Barthel et al. in press). These locally evolved proprietors and claimants also contribute to shaping the landscape and therefore affecting ecosystem dynamics and the flow of ecosystem services.

Local actor groups impose redundant management practises in the park since the vast majority of them manage relatively small sites. All of them actively affect their surroundings by specific management practices into what I refer to as culturally shaped biotopes. On a landscape scale their active management results in a heterogeneous landscape and the various biotopes deliver specific ecosystem services.

An example of a locally evolved actor group is allotment associations (see Table 2). Allotment associations have the property rights that are associated with proprietors, since they rent land from owners, commonly on a 25-year basis. They occupy rather small sites in the landscape, and these are transformed by specific management practices. The four most characteristic ecosystem services delivered from social-ecological interactions taking place in allotment gardens are pollination, seed dispersal, insect-pest regulation and noise reduction. These associations often cultivate organically, making these biotopes good habitats or feeding grounds for mobile link species and natural predators of pests. Moreover, a prolonged flowering season makes them important feeding grounds for pollinators. Allotment gardens are often situated close to busy roads, and thus their trees and vegetation function as noise reducers.

There are six allotments in the park, hence these six actor groups affect the flow of pollination, seed dispersal, insect-pest regulation, and noise-reduction services in this urban landscape. Each ecosystem service is affected by several actor groups with different ownership (see Table 3). In the following section I will discuss the results and the importance of including the neglected group of local actors when analysing natural-resource systems.

Discussion

Active management by many local actors may play an important role in sustaining the flow of desirable ecosystem services in this cultural urban landscape. Recreation and cultural values is the ecosystem service that is associated with the highest number of actor groups in the National Urban Park in Stockholm (see Table 3). It is a highly appreciated service by the inhabitants of the city as it is estimated that 15 million people visit the park annually (Waldenström 1995; Stadsbyggnads Kontor 1997). Owners and key actor groups such as Royal Djurgården Administration, which manages large sections of the park, are linked to this service. Included in providing this service are some of the local actor groups, as they also enhance their surroundings for public recreational enjoyment. Seed dispersal, pollination and insect-pest regulation are ecosystem services that are overwhelmingly linked to management practices performed by local actor groups (see Table 3). These services have cross-scale linkages within the larger ecosystem and people outside the source areas are probably benefiting from these. Only four actor groups are engaged with nutrient retention in the park and none of them are owners (see Table 3). Since the biotopes from which these services flow are culturally shaped, the deliverance of the services is reliant on active management by a number of local actors.

Many of the local actor groups impose redundant management practices in the landscape. They are active on relatively small sites in the park situated within larger

sections that are managed by owners or key actors. Some of them aim at enhancing habitats for particular species and act on very limited spatial scales. Others are active on larger spatial scales. Taken together they sustain alpha diversity on a landscape level by transforming the respective sites into specific biotopes. Alpha diversity of biotopes has been estimated as one major cause for the species richness of the park (Gothnier, Hjort and Östergård 1999; Löfvenhaft 2002a). Removing or replacing management actors from the landscape may transform the landscape and challenge species-richness and deliverance of linked ecosystem services. Biodiversity assessments in the contemporary 'protected-area approach' of the park miss this important aspect.

The sharing of resource management responsibility and authority between users and government agencies has been receiving increasing attention globally (Jentoft and McCay 1995; Pinkerton 1998; Hanna 1998). Inclusion of local actor groups in adaptive co-management may also be a viable approach for sustaining ecosystem resilience of the NUP. First of all, the 24 local actor groups described in the Results section belong to a kind of actor groups that often use management practices that are determined by locally evolved informal institutions and local ecological knowledge, and have often been a neglected group when analysing natural-resource management systems (Olsson and Folke 2001). Hence, since their management may sustain alpha diversity of biotopes and flow of ecosystem services, this group should be included when analysing ecosystem management of the park.

Secondly, since adaptive co-management is an integrative approach it promotes learning and creation of functional feedback loops between social and ecological dynamics (Olsson, Folke and Berkes 2004). Contemporary societal challenges that where not perceived when the separate academic disciplines where formed, demand novel understanding. An example of such a challenge is sustainable management of complex social-ecological systems (Berkes, Colding and Folke 2003). No single institution or knowledge culture will ever understand the whole issue of sustainable management, since it includes understanding of ecosystem dynamics as well as of social dynamics such as human behaviour, institutions and governance structures. Combining information from various disciplines within academia, in a transdisciplinary approach, creates novel knowledge (Tress, Tress and Fry 2005), which may enhance the understanding of complex issues. A previous obstacle for this has been a lack of theory (Moss 2000; Fry 2001).

A wider integrative approach that also includes stakeholders adds experiential knowledge and promotes joint information exchange in learning about how actions by different actors influence the ecosystem (Ahern 1999; Ashby 2003). This may diversify mental monocultures and challenge accepted wisdom (Ashby 2003), and those are major challenges for adaptive co-management approaches. Actors involved in management of resources who understand ecological functions on one scale of the system do not necessarily have a sound understanding of what is going on on another scale (Ashby 2003). Still, for creating functional social-ecological feedback loops, ecosystem monitoring, evaluation and response have to be performed at various scales (Berkes and Folke 1998; Olsson, Folke and Berkes 2004). It has been claimed that local-level institutions are better able to adjust to feedback dynamics due to the fact that people involved in management of resources and ecosystems may detect ecological change more rapidly and adapt management practices accordingly (cf. Berkes 2004). Informal management institutions including norms and property rights that guide local management behaviour often have evolved over time scales longer than individual human lifetimes. Therefore, locally evolved institutions may content a

'memory' of past local ecological crises and social responses. Therefore they might fit better to unperceived long-scale local ecological processes or rare ecological events, such as pest outbreaks or fire, and this would make them function as 'ballast' to short-term experimental learning (Holling 1978; Walters 1997; Gunderson, Holling and Light 1995; Ostrom and Schlager 1996; Berkes and Folke 1998). Hence, integration of local actor groups adds fine-tuned place-specific ecological knowledge of ecosystem functioning on local scales (Olsson and Folke 2001).

A third reason for integrating local actor groups in adaptive co-management of the NUP, is that integration of local management actors may also lower overall costs of management, most notably costs incurred for describing and monitoring the ecosystem, designing regulations, coordinating users and enforcing regulations (Colding and Folke 2001; Hanna 1998; Johannes 1998). Ecosystem monitoring might be costly, and adaptive management projects have failed because of this (Meffe et al. 2002). Hence, there is a need to search for cost-effective solutions. People in the organizations presented in Table 2 often have genuine interests and aspirations since they have been active in the area for decades. For instance, the park owes its legal protection to several of the actors presented here, and this effort can be viewed as a response to local concerns about loss of green areas (Waldenström 1995). Moreover, the time spent in the locale is on a voluntary basis, which would make monitoring of ecosystem change on a local level highly cost-effective.

However, the park is nested within a larger ecosystem, and it is therefore not enough to focus just on the local scale for maintaining resilience. Löfvenhaft (2004) has shown that over the last 50 years former connected habitats in and bordering the NUP have been fragmented and that negative effects on amphibian populations are evident, and that this degradation has been coupled to a time lag of several decades. Green areas of other cities that have become disconnected from the wider environment tend to lose biodiversity and erode (Recher and Serventy 1991; Drayton and Primack 1996). Hence, it seems that protecting green areas in isolation will not sustain the capacity of ecosystems to generate services (Gilbert 1980; Bennet 1987; Merriam 1991; Steffan-Dewenter and Tscharntke 1999; Debinski and Holt 2000).

Currently, urban development in surrounding green space of the park has accelerated dramatically. Hence, the rich biodiversity and flow of ecosystem services that characterize the contemporary NUP may be jeopardized in the near future by such fast-changing variables as population increase and urban sprawl. Consequently, there is a need to develop social capacity to respond and adapt to these changes and to develop policy directions that shape change.

A resilient social-ecological system that can buffer a great deal of disturbance, is supportive of ecological, economic and social sustainability, and can be seen as a dynamic process that requires adaptive capacity for societies to respond to change (Berkes, Colding and Folke 2003). Building adaptive capacity requires analysis and understanding of feedbacks and, more generally, the dynamics of the interrelations between ecological systems and social systems, and an understanding of when and where it is possible to intervene and coordinate in management (Folke, Colding and Berkes 2003).

Concluding remarks

This paper combines understanding developed in ecology with analysis of the governance system, inspired by insights in anthropology, political science and participatory research. It is part of the emerging integrative science of social-ecological systems and resilience (see e.g. http://www.ecologyandsociety.org). The analysis illustrates that active management by a considerable number of local actor groups seems to sustain rich levels of alpha biodiversity and desired ecosystem services of the National Urban Park in Stockholm. Many local actor groups impose redundant management practices in the landscape, which seem to contribute to and support habitats for various species in the area. Some actor groups are active on relative small spatial scales, others on large sections of the park. Their management is often guided by locally evolved informal institutions, with a memory of past functional feedback loops within the social-ecological system. These processes have resulted in various culturally shaped biotopes that deliver specific ecosystem services. Alpha diversity of biotopes has been estimated as one contributing cause for the rich species diversity found in the NUP. Hence, management by local actor groups seems to have a positive effect on species diversity in this landscape. This important aspect has not been included in recent contemporary biodiversity assessments of the park.

This discovery illustrates the significance of integrative approaches that transbound the natural and social sciences (McMichael, Butler and Folke 2003). An integrative approach such as adaptive co-management may well be a viable approach for sustainable management of the NUP. Creating sustainable management for this urban landscape requires adaptive capacity within the governance system to respond to change. Adaptive capacity builds on understanding of social-ecological feedback loops on multiple scales of the system and their interactions across scales (Berkes, Colding and Folke 2003). Understanding develops when monitoring, evaluation and response are performed on various scales of the social-ecological system. Transdisciplinary science, including social science and natural science, creates novel understanding of interrelations between ecological dynamics and social dynamics. Integration of local knowledge cultures outside academia adds qualitative place-based specific ecological knowledge of small scales to the system and contributes to describing and monitoring biotopes. An integrative approach incorporating actors across organizational levels is a promising way to effectively develop understanding of feedback loops on multiple scales.

Recognition and inclusion of local actor groups in the management of the cultural landscape of Stockholm, in integrative adaptive co-management programmes, has the potential to increase the likelihood of sustaining species diversity, reducing overall cost of management and promote joint learning of how to adapt to unpredictability and change. Such programmes need to account for surrounding ecosystems as well and would also require participation among local actor groups active in managing surrounding ecosystems.

Policies that promote urban sprawl need to account for urban ecosystem dynamics, because urban ecosystems contribute to urban wellbeing. Setting aside green areas will not suffice. Urban ecosystems are cultural landscapes that need to be managed continuously. Local actor groups can play a significant and cost-effective role in such management. Implementing their knowledge and capacity to respond to functional ecosystem feedback into adaptive management schemes will require breaking down of current mental models and accepted wisdoms about how to manage urban areas.

Acknowledgements

I thank Jack Ahern, University of Massachusetts, as well as Bärbel Tress and Gunther Tress, Wageningen University, for constructive comments on the manuscript. I also thank all the participants of the PhD course; I really enjoyed your company during that week in June! Thanks to Jakob Lundberg for the map and Sara Borgkvist and John N. Parker for comments on the text. Many thanks to my supervisor Carl Folke. The Swedish research council Formas provided financial support for the work.

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