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The Stockholm Urban Assessment (SUA-Sweden)

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MILLENNIUM ECOSYSTEM ASSESSMENT
SUB-GLOBAL SUMMARY REPORT
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The Stockholm Urban Assessment (SUA-Sweden)

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Note: There are two Swedish Assessments:

1. Kristianstad Wetlands (KW-Sweden) and
2. The Stockholm Urban Assessment (SUA-Sweden).

These assessments have different research teams and submit two separate summaries.

Report content:

1. Introduction & Conceptual Framework

1.1 Main objectives of the Stockholm Urban Assessment (SUA)

Due to population increase and urban development, the greater metropolitan area of Stockholm displays quite a dramatic loss of ecosystems in recent time. Green areas in several self-governing municipalities have successively become fragmented and isolated. Coupled to other environmental impacts there is an overall trend of biodiversity decline in the area; hence there is a risk that essential ecosystem services gradually are reduced. A development of policies to change this trend is needed. The research of SUA should be viewed in the light of contributing to such a development by drawing on research in ecology and theories of common property systems and complex adaptive systems.

The overall objectives of the Stockholm Urban Assessment (SUA) are to investigate how capacity can be built to better adapt to change and, more specifically, to find effective ways to manage urban ecosystem services. Many of the services fall into the category of 'free-access' services, or 'public goods' (Arrow, 1996). Examples include mobile organisms involved in seed dispersal and pollination that may contribute to maintain a well functioning structure of ecosystems. These *life support functions* (Daily, 1997) have not been assessed, described and communicated previously in the physical planning of the Stockholm region and therefore not seriously taken into consideration. One outcome of this is that life support functions in the long-term may experience "the tragedy of the commons" described by Hardin (1968). This in turn may impinge on the *life-fulfilling functions* (Daily, 1999) that ecosystems provide humans with, such as aesthetic beauty, cultural inspiration, scientific discovery and recreational values.

The aim of the assessment is to provide a background for designing governance systems that better take into account landscape ecological scales in biodiversity management. The current system with 26 self-governing municipalities is poorly equipped for dealing with landscape ecological scales; the outcome is a patchy and uncoordinated biodiversity management system. A useful strategy is to view most ecosystem services as common pool resources (Duit, Colding and Lundberg, *in progress*). This requires a shift of perspective in scale, from local to regional. Viewed at the regional level, landowners whether private, municipal or state, represent key players with a responsibility that transcends their local boundaries of operation and where the urban environment can be considered as a 'common'. Adaptive co-management designs may facilitate such a shift of perspective without changing the basic structure of the political system.

1.2 Theoretical background

In areas experiencing rapid social and environmental transformations, such as the Stockholm County, there is a need to develop a capacity to respond and adapt to change and to develop policy directions that can help build resilience to deal with change. Berkes et al. (2003) refer to such a capacity as *adaptive capacity*. As the theories on common property systems and complex adaptive systems indicates, adaptive capacity of all levels of society is constrained by institutions and the resilience of the natural systems on which they depend (Berkes et al., 2003). Resilience is an important element of how societies adapt to externally imposed change, such as global environmental change and urbanization following population migration. The greater their resilience, the greater is their ability to absorb shocks and perturbations and adapt to change. Conversely, the less resilient the system the greater is the vulnerability of institutions and societies to cope and adapt to change (Adger, 2000). A resilient social-ecological system, which can buffer a great deal of change or disturbance, is synonymous with ecological, economic, and social sustainability (Berkes et al., 2003). Sustainability is here seen as a process, rather than an end product, a dynamic process that requires adaptive capacity for societies to deal with change (Berkes et al., 2003). Sustaining adaptive capacity requires analysis and understanding of feedbacks, and more generally, the dynamics of the interrelations between ecological systems and social systems. It also means learning how to maintain and enhance adaptability, for instance through sustaining social and ecological memory (Folke et al., 2003), and understanding when and where it is possible to intervene in management.

A crucial part of building adaptive capacity is the role of a governance system that can learn from experience and generate knowledge across organizational levels to cope with change. Such a governance system is horizontally linked. Institutions and their linkages, vertically and horizontally across organizational levels and involving local people, scientists and authorities, appear crucial in this regard by promoting information exchange to effectively deal and respond to change and issues that transcend locality (Folke et al., 2003). The simplest kind of cross-scale institutional linkage is the one that connects local-level management with governmental-level management in partnerships, e.g., co-management (Pomeroy and Berkes 1997; Berkes 2000). The sharing of resource management responsibility and authority between users and government agencies has been receiving increased attention all over the world (Jentoft and McCay 1995; Pinkerton 1989; Hanna, 1998). Co-management designs have the potential to lower overall costs of management, most notably costs incurred for describing and monitoring the ecosystem, designing regulations, coordinating users and enforcing regulations (Hanna, 1998; Johannes, 1998). As often recognized, local-level institutions are better able to adjust to feedback dynamics due to that people involved in management of resources and ecosystems may faster detect ecological change (Baland and Platteau 1996; Costanza et al., 1998). Also, the active involvement of citizens through local Agenda 21 activities may be facilitated though co-management designs. Hence, the potential of co-management designs is well worth exploring for urban ecosystem management as well.

Holling (1978) recognized that complex adaptive systems required adaptive management. *Adaptive management* emphasizes learning-by-doing, and takes the view that resource management polices can be treated as “experiments” from which managers can learn (Walters, 1986; Gunderson, 1999). Organizations and institutions can “learn” as individuals do, and hence adaptive management is based on social and institutional learning. Adaptive management differs from the conventional practice of resource management by emphasizing the importance of *feedbacks* from the environment in shaping policy, followed by further systematic experimentation to shape subsequent policy. Thus, the process is iterative, based on feedback learning and leading to self-organization through mutual feedback and entrainment (Colding and Folke, 1997).

Adaptive co-management explicitly recognizes the necessity of combining adaptive management with organizations and institutions across scales (Folke et al., 2003). It may serve as a valuable complement to the standard response of establishing protected areas, which may be quite problematic in political terms. SUA will draw on the valuable co-management lessons of the Kristianstad Wetlands, where co-management successfully is evolving for the benefit of both people and nature!

1.3 The Stockholm County

Stockholm County consists of a total land and water area of 678 500 ha, representing about 2% of the total land area surface of Sweden, and extending about 180 km from north to south (Figure 1).

46% of the land area constitutes forest, 18% agricultural lands, 14% settled areas, and 22% represent other land uses (Statistical Yearbook of Sweden, 1998).

The County 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. There exist 106 densely populated areas (tätorter) in the County that comprise house settlements with at least 200 inhabitants and the distance between houses not larger than 200 meters (www.ab.lst.se). Densely populated areas represent about 10% of the land surface, and 95% of the inhabitants live in those areas. In year 2002, the population in the Stockholm County was 1.849.200 (www.ab.lst.se), i.e., about 21% of the inhabitants of Sweden.

Figure 1. The Stockholm County and densely populated areas. Source: Länstyrelsen i Stockholms län www.ab.lst.se

In a European perspective, the Stockholm region is an area rich of green areas. The structure with settlements along the radial net of transportation and the ten *green wedges* in between, create good conditions for the inhabitants to means of transportation and access to green areas. The green wedges extend from the rural parts of the County towards the central parts of Stockholm city (Figure 2). A large part constitute remnants of former connected biotopes originating from previous land use practices, fragmented by urban expansion during the last 50 years (Lövenhaft, 2002).

Green wedges comprise both *core areas*, of social and ecological significance, and *green links* that link core areas with wedges. Together with large areas for recreation in the region's outskirts, green wedges constitute the nucleus of the green area structure and are considered important in physical regional planning. Within Stockholm County, green areas that cover several self-governing municipalities have successively become fragmented and isolated. During the 1970s and 1980s about 8 and 7 percent of green areas respectively were lost due to urban sprawl. Data indicate that red listed species are declining since the middle of the 1970's. Approximately 50% (a total of 223 red listed species) have disappeared from the most centrally located green areas (Gothnier et al., 1999). However, about two third still exist in the Stockholm County. Many groups of common species also show a sharp drop in abundance, such as amphibians, reptiles and some bird species.

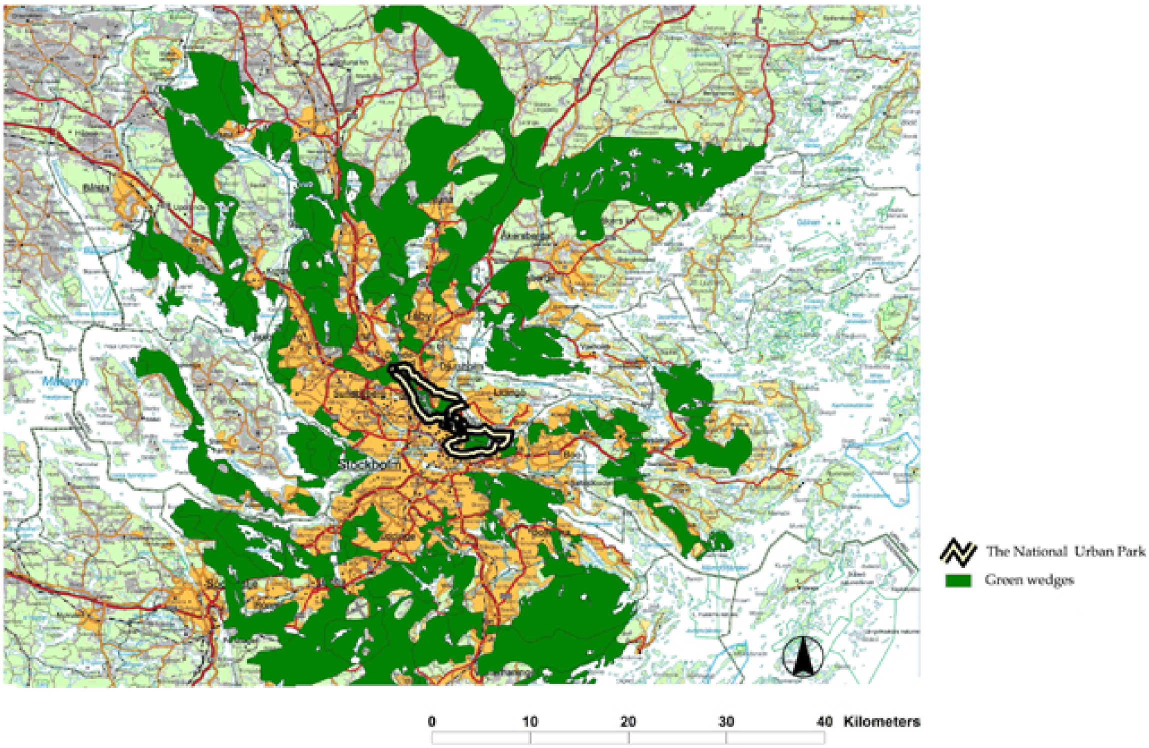

Figure 2. The green wedges of Stockholm County. Source: Colding, Lundberg and Folke (*in progress*).

1.4 SUA study site

Figure 3 presents the SUA study site, covering a circle with a 20 km radius (Figure 3). The 20-km zone represents the greater metropolitan area of Stockholm, where population level is at a peak and the most developed part of the county. The circle's outer fringe areas can be described as an exurban and rural landscape that includes suburbs and edge cities. The circle also includes a major part of the green wedges.
A critical focus in SUA is the analysis of landscape connections between the Stockholm National Urban Park (NUP) and surrounding green patches and ecosystems. The park has over time become more and more isolated with possible loss of biodiversity in the long-term. The study site has therefore its centre in the park, as displayed in Figure 3. The park covers an area of 2700 hectares and is located adjacent to the inner city of Stockholm and forms an important part of the green structure (Lövenhaft, 2002). Three municipalities share the land of the park, which borders four other municipalities. The park extends from the landward end of the Stockholm archipelago, via Djurgården and Haga-Brunnsviken, to the grounds of Ulriksdal palace to the northwest. The large populations of oak (*Quercus robur* and *Q. petrea*) make the park unique in an international perspective. Few areas of the same size in Sweden show such a high diversity as NUP. Of Lepidoptera there are more than 1000 species documented, of Coleoptera more than 1200 species, and more than 250 bird species have been observed here. Among insects there are at least 60 red

listed species, among fungi 32 species and more than 20 red listed species of vascular plants, mammals (bats), amphibians, reptiles and fish species (Gothnier et al., 1999).

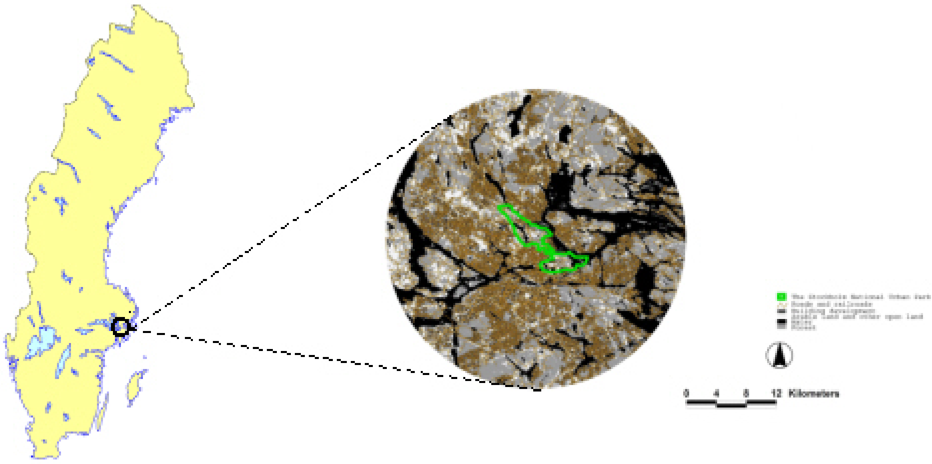

Figure 3. The 20-km circle of the SUA study area. Source: Lundberg et al. (in manuscript).

The National Urban Park (NUP) represents an area of national interest and is since 1995 governed by a specific law in the Environmental Code. The law stipulates that new buildings and new facilities within the area may be developed and other measures taken only if this can be done without intruding on the park landscape or the natural environment and without causing harm on the landscape's natural and cultural values. Despite legal protection urban sprawl has not been mitigated in the park's fringe areas.

The formation of the park owes its establishment due to various pressure groups and NGOs and can be viewed as a local response to loss of green space. Besides biological values, the park holds unique historical and cultural values as well. The Royal Djurgården Adminstation (RDA) is a key manager of NUP active in its care and maintenance.

NUP can be considered a miniature template of drivers and issues related to green area loss in the Stockholm County as a whole. For example, it includes most of the examples of land use investigated in the 20-km study area; it provides a complete array of urban ecosystem services; and it provides organizational and institutional set ups, characteristic of the study area as a whole.

1.5 The SUA analytical framework and research areas

There are two main analytical focal points in SUA, taking place interchangeably. One is the build up of information on the existing institutional and organizational capacity to deal with change. The second focal point has to do with the *support functions* needed for the maintenance of resilient ecosystems. Figure 4 presents the conceptual framework for the analyses undertaken in SUA (methods and tools are dealt with under section 5). As the figure indicates SUA focuses on the ecosystem services that urban green patches provide to users and managers in the study area.

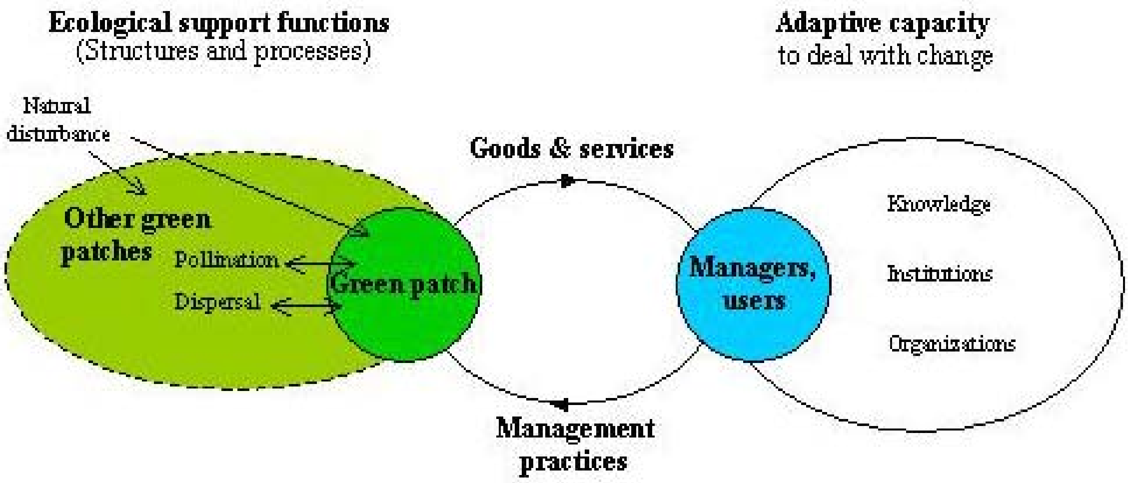

Figure 4. The analytical framework used in SUA.

On the left-hand side are the ecosystems, which may consist of a local green area patch that may be connected or nested within other ecosystems, composing a regional ecosystem in a drainage basin. Several critical processes, such as natural disturbance, dispersal of organisms, and pollination maintain the natural system, here referred to as the *ecological support capacity*. Ecosystems generate various goods (or, provision services), and the regulation and cultural services enjoyed by urban users and managers respectively. Users with management rights may to a various degree manipulate or manage the ecosystems in order to generate desired goods and services.

Users and managers use local institutions that are nested in institutions operating at regional, national and even international levels. Ecological knowledge and understanding of users and managers optimally frame institutions for carrying out sound resource management practices. Organizational bodies and networks may also hold such knowledge, such as NGOs, government agencies, and the scientific community.

In SUA, a selective sample of green patches is currently being assessed. These include allotment gardens, golf courses, the National Urban Park and protected areas. They are completely mapped in the 20-km zone. In addition, random samples of cemeteries, recreational areas, urban city parks and possibly agriculture and forestry will complement the assessment. The research areas in SUA are presented more in detail in sections 1.6-1.10.

1.6 Analysis of management, management practices, and users of urban green space

Following the definition of Ostrom and Schlager (1996) the legible managers of green area patches in SUA include people that hold rights associated with *alienation*, *exclusion* and *management*. Such people or groups hold management rights, i.e. they have “the right to regulate internal use patterns and transform the resource by making improvements" (ibid:131). They directly influence biodiversity through their practices. Practices differ in regards to the management objectives carried out in the SUA-assessed green areas, from farmers growing crops, green keepers managing wetlands on golf courses to biodiversity managers of protected areas. This results in a land use mosaic that provide for unique habitat heterogeneity and a diversity of ecosystem services.

In SUA, users of green space are defined as those people that hold *access* and/or *withdrawal* rights (the right to obtain resource units) to urban green patches (Ostrom and Schlager, 1996). They do not hold management rights. Users include citizens and visitors. Some are organized in associations, such as in bird watching groups or in golf clubs and may become important *pressure groups* that influence political decisions and development of urban green space.

1.6.1 Current status of management in the study area

A study of five different green areas in the Stockholm County reveals that a lot of efforts are put into increasing the amount of knowledge and analysing it in new ways (Borgström, 2003). The managers are in general good at gathering and compiling knowledge, and creating plans, but the implementation is limited and there is almost no monitoring and evaluation of practices. A management without continuous monitoring cannot be evaluated and has no chance of becoming adaptive. Proper indicators, that reflect management success, need to be developed and connected to management objectives and goals. The study also reveals that there is limited ecological modelling - an important link between complex knowledge and effective practice and serving an important role in adaptive management, by which managers can test management alternatives and try to predict the outcomes for deciding how to best achieve certain management goals (Borgström, 2003).

Current management of NUP share certain features of an ecosystem approach, but also display severe deficits. Most of the stakeholders recognise basic ecological functions, like biological diversity, key species, dead wood and nutrient cycling. Disturbance regimes are also partly used to sustain these functions and processes, e.g. thinning and grazing (Barthel et al, in progress). This means recognition of the ecological integrity that is fundamental in developing resilient ecosystems. Another shortfall is that the outcome of some of the management projects is not continuously monitored or evaluated. This makes it difficult to evaluate management projects.

Also, there is little understanding about the role of surrounding ecosystems to the one being managed. Management appears often to be carried out in isolation from other ecosystems being managed in the surroundings (Borgström, 2003). This may be due to a lack of scientific knowledge about the relationship of isolation effects on biodiversity or to institutional and organizational barriers. In this context, the research in SUA related to landscape connections might provide important information to local managers to consider larger scale issues of ecosystem management and to foster a closer collaboration among local managers in a particular area through adaptive co-management designs.

Co-management exists sparsely in the County. For example, a wetland project known as "Tyreså-projektet" within a major system of lakes south of Stockholm aims to co-ordinate the lake management between six municipalities, and to handle up-stream/down-stream problems related to eutrophication (Borgström, 2003).

Also, in NUP the County Administrative Board of Stockholm has the responsibility for the co-ordination of the stakeholders involved in the park in a co-management group. A remarkable number of stewardship and conservation groups that articulate local values of the park participate. However, it seems that there are no formal broad communication procedures and there are numerous conflicting interests that create tensions due to different perceptions and perspectives on urban development (Barthel et al., in progress). Also, there is a limited dialog about practical management among the stakeholders. The lack of an actual co-management process can be exemplified by the missing of important stakeholders for water management of NUP although a main objective is to restore wetlands and to decrease polluted inflow from urban surroundings (Stockholm Stad, 1994). The many watercourses, lakes and rich wetlands, are managed by Stockholm Water Inc. Although the lakes are ecologically connected to the rest of the landscape, the Stockholm Water Inc is not represented in the co-management group (Barthel et al, in progress).

NUP provides a miniature template for the way different groups make use of urban green space, organized in the umbrella organization Alliance of the Ecopark (Förbundet för Ekoparken), consisting of 48 voluntary associations with more than 175.000 members. It was founded 1992 when exploitation plans in the park were made public. In 1995, the alliance held a key role in the process of securing legal protection for the park (Waldenström, 1995).

Furthermore, there are 27 groups of authorized users and 17 groups of entrants (Barthel et al., in progress) involved in conservation issues in NUP. Altogether there are 66 organizations/associations involved, in commission on different governmental levels, from local to global. The distributions of organizations operating over different governmental levels reflect the degree of cross-scale, organizational linkages that exist for the park.

1.7 Analysis of different epistemologies of ecological knowledge behind green area management

Sustainable use of the capacity of ecosystem to generate services is unlikely without improved understanding of ecosystem dynamics. It has been argued that all forms of relevant information should be mustered to increase knowledge for improved ecosystem management, including different systems of knowledge and their combination (Berkes and Folke, 1998). In SUA the focus is on expanding knowledge from structure to function of nature, the incorporation of knowledge of ecological processes and dynamics into institutions, and the increased potential for learning and building social-ecological resilience by making use of and combining different knowledge systems.

Only a fraction of the dynamics of ecosystems is likely to have been subject of careful observations within the framework of formal science. A large proportion would be part of the experience of the people living, observing and using the systems in a variety of contexts (c.f. Olsson and Folke, 2001; Carlsson, 2003; Tengö and Hammer, 2003; Gadgil et al., 2003; Colding, Elmqvist and Olsson, 2003). Monitoring change is key to increase the ability to respond to change and shape institutions and management practices. Gadgil et al. (2003) argue that such "experiential” knowledge in societies may play an important role in the understanding of the behavior of ecological systems, particularly in situations of crisis and reorganization. Such practical working knowledge may be a valuable complement to scientific "experimental" knowledge in addressing the dynamics of complex adaptive ecosystems and their management (Johannes, 1998; Levin, 1999).

A primary goal of SUA is to facilitate an adaptive learning process for managing ecosystems. The origins and types of knowledge differ among different managers in the study area. For example, knowledge among agriculturalists differs from knowledge held by green keepers of golf courses and allotment garden holders. While both scientific knowledge and local ecological knowledge constitute such knowledge their integration may improve the potential for improved ecosystem management. In SUA the adaptive learning process are oriented towards fulfilling the dual objectives of 1) combining scientific and local ecological knowledge for strengthening critical ecological support functions, and 2) to provide diachronic information on ecosystem change. One example pertaining to the first objective is the plan for collaborative work among representatives of the Swedish Golf Association, The Stockholm Society for Nature Conservation and scientists of SUA for improved golf course management. Another is the plan of a bird watching group to monitor key bird populations of NUP – a collaborative effort among RDA, local bird watching associations and SUA scientists.

One example pertaining to the latter objective would be the provision and storage of information for terrestrial ecosystem monitoring (e.g. indicators) among participants in future adaptive co-management designs. Such information may provide for *social memory*, a key ingredient for successful adaptation to change (Folke et al, 2003). Social memory is the arena in which captured experience with change is actualized through community debate and decision-making processes into appropriate strategies for dealing with ongoing change (McIntosh, 2000). Social memory embeds historical and cultural observations (McIntosh, Tainter and McIntosh, 2000), such as mistakes and crisis that a society has experienced and therefore plays an essential role for increasing adaptive capacity.

1.8 Analysis of the role and dynamics of institutions

The field of common property examines the linkages between resource management and social organization, analyzing how institutions and property-rights systems deal with the dilemma of the "tragedy of the commons" (McCay and Acheson, 1987; Berkes, 1989; Bromley, 1992; Ostrom et al., 1999). Institutions are here defined as "humanly devised constraints that structure human interaction... made up of formal constraints (rules, laws, constitutions), informal constraints (norms of behaviour, conventions and self-imposed codes of conduct), and their enforcement characteristics" (North, 1994). Institutions are the set of rules actually used or the working rules or rules-in-use (Ostrom, 1992). But they are also socially constructed, with normative and cognitive dimensions (Jentoft, McCay and Wilson, 1998), particularly relevant in dealing with the nature and legitimacy of different kinds of knowledge.

The research related to institutions in SUA includes analysis of property rights, and formal and informal institutions governing land use. Land use is primarily related to different forms of property rights, with the state, individual municipalities and private landowners holding land. In general, in the more central parts of the county, individual municipalities tend to own most of the land, while state and private holdings are dominant in the more peripheral parts. However, it appears that a particular set of property rights have withstood urbanization pressure better than others in recent years, in particular former royal land holdings, military fields, and entailed estates (fideikommiss) (Colding, Lundber and Folke, in progress). They include large green areas and constitute important parts of the Stockholm green wedges. Why and how these areas have been maintained may provide insights on the role of juridical aspects as well as incidental forms of nature conservation.

A number of *formal institutions* determine how green areas are used, managed and maintained and influence local management practices. The Environmental Code (EC), and the Planning and Building Act (PBA) - represent the two most important legal measures regulating biodiversity management. The EC contains overall regulations as to how public interests are taken into account when government authorities and municipalities deal with cases of conflicting interests concerning the use of natural resources (Svensk Författningssamling 1998). The PBA governs spatial planning and states that each municipality shall draw up an up-to-date Municipal Comprehensive Plan (MCP). The plan indicates where development is suitable. Such plans reflect future trends of land use in the study area and constitute an important tool in the analysis of trends and conditions. Furthermore, several international conventions influence biodiversity management, such as the Convention on Biological Diversity (CBD) and The European Union network, Natura 2000. Together with a number of alternative forms of protected areas, the formal institutional context dominates biodiversity management in the study area. However, it appears as if many formal institutions lack flexibility to adapt to an ecosystem approach, reflected in that management are rigid and often work in isolation (Borgström, 2003). For example, the formal institutions of self-dependent national parks/nature reserves and World heritage sites very much create a patchwork quilt of ecosystems, not matching critical ecosystem interactions and dynamics (ibid). Also, the current system of self-governing municipalities unintentionally promotes independent management of green areas, missing the important aspects of landscape connectivity in biodiversity management (Colding, Lundberg and Folke, in progress).

A relevant objective of SUA is to analyze how local institutions, of which many are informal, can take on new roles and responsibilities related to ecosystem management, which can and which cannot– and why. Such information is essential in order to design a governance system that can learn from experience and generate knowledge across organizational levels to cope with change.

1.9 Analysis of social organizations and networks in relation to urban green space

There exist many examples from Stockholm about how pressure groups through their networks have preserved areas in danger of becoming exploited. The formal establishment of NUP as an area of national interest is very much a result of such pressure groups. These groups provide good examples of self-organization that arise and ‘kick in’ when crisis occurs or for mitigating crisis. When there is a crisis, space is created for renewal, reorganization and novelty (Folke et al., 2003). The crises may be changes in property rights, acidification, resource failures, rigid paradigms of resource management, new legislation or governmental policies that do not take into account local contexts (Folke et al, 2003). The combination of user groups related to social memory, their diversity, overlapping functions, and their redundancy may provide resilience for reorganization, novelty, and thereby enhances adaptive capacity in the face of disturbance and crisis (ibid). But their combination may also cause barriers, collision and erosion of memory, as may be the case when different cultural value systems, worldviews and discrepancies in conceptualisation are brought together and interact (Tengö and Hammer, 2003), or when the cultural dynamics created by the policies of those in power during earlier periods may inhibit development of the ability to respond to disturbance and surprise through building resilience (Trosper, 2003; Gunderson, Holling and Light, 1995). A number of distinct, but often overlapping, roles exist regarding social memory in social-ecological systems (Folke et al., 2003) and analyses of organizations active in the study area will be conducted along this line.

1.10 Analysis of ecological support functions and provision of terrestrial ecosystem indicators

The left side of Figure 4 summarizes the part of the assessment related to the *ecological support functions* necessary to maintain resilience in the urban green area mosaic. A crucial part of SUA is to study the life support processes (e.g. pollination and seed dispersal) necessary for the provision of ecosystem goods (or ‘provisioning services’) and life-fulfilling functions (or, ‘cultural services’) that include recreation, aesthetic beauty and cultural, intellectual, and spiritual values.

Based on a land use mapping, SUA will make gap analysis studies to increase understanding about the dispersal capacity of critical organisms in the study area. In particular the dispersal capacity of keystone species and mobile link organisms of NUP and surrounding green areas are being analyzed (Colding, Lundberg and Folke, in progress). It is anticipated that key-structuring organisms (keystones and mobile link organisms) in NUP and the 20-km circular zone lose important habitats required for their survival due to loss of ecosystems. In SUA we consider these groups of species as indicators or symbols that can be used for monitoring ecosystem dynamics (e.g. bird migration) that may be used to guide human actions. Such knowledge may to some extent be produced or it may be vested in groups as in the form of social memory. In the Stockholm County there are more general indicators presently used concerning water management relative to terrestrial management (Borgström, 2003).

1.10.1 Mobile links

Mobile links (Lundberg and Moberg, 2003) could become a useful tool for monitoring ecosystem dynamics. They provide a multitude of different functions, such as translocation of nutrients, seed dispersal, and pollination, sharing only the ability to travel between areas, either passively or actively. Mobile links are inextricably involved in the spatial dynamics within and between systems, and their presence is necessary for the function of a landscape. The role of mobile links is perhaps most apparent for regeneration following disturbance, when they provide ecological memory by linking the disturbed site to undisturbed source areas (Nyström and Folke, 2001; Elmqvist et al., 2001). Surveying mobile links of interest is one way of remaining up to date with the spatial dynamics, especially if combined with remote sensing. Changes in the diversity of mobile links can alter the rate, timing, duration, magnitude, spatial extent, quality, and frequency of their linking functions, thereby altering ecosystem dynamics and development (Lundberg and Moberg, 2003). Changes in the living conditions for mobile links in one area may lead to unexpected cascading effects in habitats far from this area. Current recommendations for biodiversity conservation focus on the need to conserve dynamic, multiscale ecological patters and processes that sustain the full complement of biota and their supporting natural systems (Poiani et al., 2000).

The study of Eurasian Jays, *Garrulus glandarius,* in an urban landscape (Lundberg et al. ms) reflects the potential of a process-oriented approach to biodiversity management in dynamic landscapes (cf. Bengtsson et al., 2003) and biodiversity conservation efforts should include the involvement of the role of mobile link species as well as other functional groups essential for ecosystem resilience. The natural regeneration capacity of the oak dominated landscape of the National Urban Park of Stockholm seems to be strongly dependent on the functional role of Jays in acorn dispersal and regeneration over large scales. Results from studies in SUA indicate that acorn predation is substantial in the NUP and that successful oak regeneration in the dynamic urban landscape seems to depend on the cashing of acorn by Jays. Furthermore, Jays move in the urban landscape and contribute to the dispersal of acorn into different urban ecosystems. Results from Lundberg et al. (in manuscript) indicate that Jays depend on territories with coniferous trees to breed successfully. Hence, coniferous tree stands within and in surrounding habitats of NUP are critical, but are a limited resource in the park itself. There is a large knowledge gap about animal movement between the park and surrounding green areas, a gap covered by studies in SUA.

1.10.2 Functional groups: pollinators

A functional group is defined as a set of species that performs similar but not identical ecological roles. As mentioned earlier mobile link species are examples of functional groups providing a multitude of different functions, they can be *resource linkers, genetic linkers, process linkers*, all those are functions that has to do with connecting habitats in space and time (Lundberg and Moberg, 2003). However there are other important functional groups performing ecosystem services essential for ecosystem resilience and for human beings e. g. decomposers and pollinators.

Pollinators can serve as genetic linkers by moving genetic material from one habitat to another (Lundberg and Moberg, 2003), but they play other important roles as well. They are essential for a successful reproduction of many plants, thus supposedly important also for other species depending on those plants, which means that the loss of pollinators from a biotic community is critical and may not be easily reversible (Allen-Wardell et al., 1998). Therefore the preservation of the function pollination is important. Bengtsson et al (2003) argue that a sustainable ecosystem - a system that remains functional - should contain functional groups with a large number of substitutable insurance species.

Furthermore, pollinators are a functional group providing ecosystem services of economical and recreational relevance for human beings for example by pollinating agricultural crops, orchards and backyard gardens (Allen-Wardell et al., 1998; Buchman and Nabhan, 1996). Pollinator declines may affect both total harvest and harvest quality (Allen-Wardell et al., 1998). A major threat to pollinators is the fragmentation and loss of suitable habitats. Although its effect on native pollinators are not completely understood, habitat fragmentation may reduce pollinator populations due to loss of nesting habitats for example (Buchman and Nabhan, 1996). Among others, urbanization is one of the human activities causing habitat loss (McKinney, 2002). In an ongoing project pollinators mainly bumblebees, solitary bees and hover flies are studied along an urban-rural gradient from Stockholm city towards Uppsala (Ahrné, in progress). The objectives are to examine changes in species diversity along the gradient, and to identify the spatial scales on which pollinators move and to relate this knowledge to the scales on which green areas in Stockholm are currently managed. The first studies performed during the summer 2003 focused on species diversity of bumble bees and other pollinators on flower rich sites, in this case allotments, situated along the urban-rural gradient (Ahrné, in progress).

2. Ecosystem Services and Human Well-Being

The ecosystem services dealt with in SUA are selected based on the high rate of ecosystem loss and fragmentation within the study area. For example, the National Urban Park of Stockholm has become increasingly isolated from surrounding ecosystems that in turn are becoming fragmented and isolated. Figure 5 presents a typology for the ecosystem services assessed in SUA. All types of human use of the natural environment require space, such as habitation, cultivation, industry and engineering, transportation, recreation and nature protection. All these functions of space occupancy can be considered *carrier functions* (de Groot, 1992:69; Colding, Lundberg and Folke, in progress). Figure 5 displays five major carrier functions that are of interest in SUA, i.e. terrestrial green area patches where primary production occurs. Examples of green patches analyzed are marked in bold in Figure 5.

The first carrier function in the typology is production, i.e. lands occupied for the production of various goods, where the major management objectives are economic to produce various ecosystem goods, such as foods or other products. In most countries of the world, production patches are poor in terms of biodiversity, and many contribute to pollution of land and water.

The second group in the typology is nature protection. In most cases a number of different types of protected areas serve this function. Management objectives for such areas are geared at nature conservation and ecological restoration. From an institutional point of view, protected areas are legally set aside. Hence, they can be considered as formally protected. In Sweden, most protected areas allow human access and can be used by citizens for recreational purposes, and may even allow for various uses, such as mushroom and berry picking.

The third group in the typology, habitation patches, include green area patches related to human habitation. In many countries habitation often include private gardens (homegardens) and neighbourhood parks. In the study area, a great part of the green area structure is composed of home gardens. Such green area patches are managed, or tended, mainly for aesthetic reasons, and providing for recreation. Often such lands are privately owned excluding use of such areas to other humans.

The fourth group in the typology, recreation areas, include patches that mainly serve recreational purposes. Most such areas allow for public access, although some may be restricted to a particular association. However, their degree of access is higher than both production and habitation patches. Some of these green patches are managed by local managers using local level institutions and based on local ecological knowledge and practices.

The fifth category contains miscellaneous green area patches, which do not fit into the previous four carrier functions. Examples include cemeteries and university campuses. Such areas often have important cultural and historical connections by providing a “sense of place” to humans.

Taken together, the different carrier functions contribute in generating a diverse set of ecosystem services in the urban landscape. In SUA, the assessment focus is on the *mediation process* of such goods and services, i.e. the “management, institutions, and ecological knowledge-complex” depicted in Figure 5, and in detail described in sections 1.5-1.10.

We have briefly discussed issues of access to these services by the urban population, an aspect further explored in the studies. Other aspects, such as the distinction between direct ecosystem services and indirect services generated by the various carrier functions will also be dealt with. For example, green areas generate specific services to their users and managers; however, they also provide a number of ecosystem services enjoyed by all the inhabitants in the study area. Such services are non-extractive and can be considered a ‘common’ to the inhabitants of the area. Ten such indirect ecosystem services can be identified in the SUA study area, including air filtration; regulation of micro climate; noise reduction; surface water drainage (Bolund and Hunhammar, 1999); recreational and cultural values; nutrient retention; genetic library (Daily, 1997); pollination (Nabham and Buchmann, 1997); seed dispersal (Naylor and Ehrlich, 1997; Baskin, 1997); insect pest regulation (Folke et al., 1996). For example, Jansson and Nohrstedt (2001) found that about 40% of the CO_2 generated by traffic and about 17% of total anthropogenic CO_2 can potentially be accumulated by the green area structure in Stockholm County.

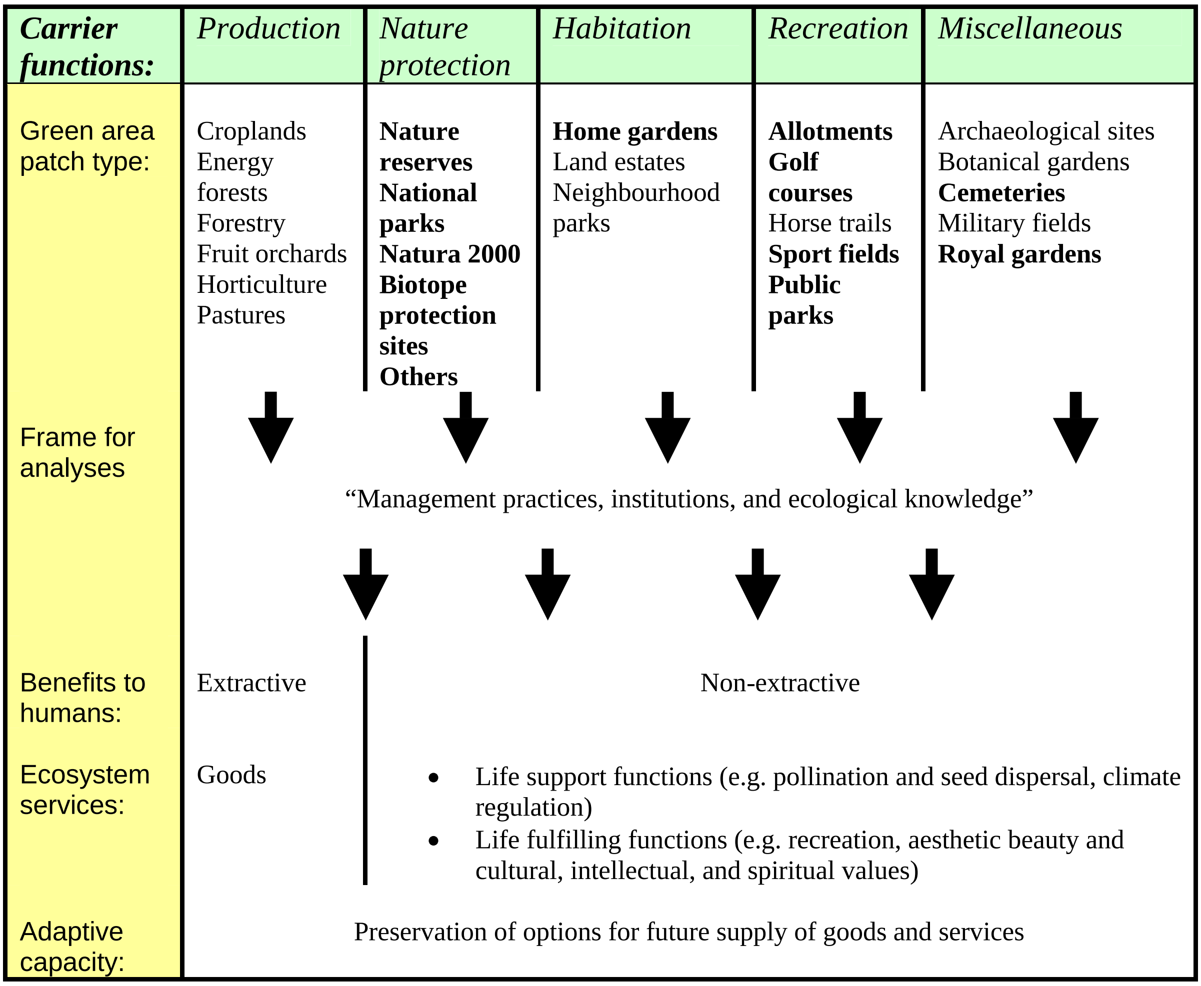

Figure 5. Typology for the assessment of ecosystem services in SUA. Bold text indicates currently assessed green patches in SUA. Source: Colding, Lundberg and Folke (*in progress*).

As is also depicted in Figure 5, SUA focuses on the life-support functions that are a prerequisite for many life-fulfilling functions. The studying of mediation processes has the main objective to understand how adaptive capacity can be improved to shape change in such a way that options for the future supply of goods and services are preserved.

2.1 Recreation – an important ecosystem service in NUP

There exist numerous studies demonstrating a close correlation among the existence of green areas, good air quality, and human health. Recreation is important for human well being, demonstrated in research. Studies within the Stockholm region demonstrate a great demand and need of sites for recreation among the inhabitants. It is estimated that the NUP has 15 million visitors per year, many of which visit the park for recreation purposes (Stockholms Stadsbyggnadskontor, 1999). More than 90

% of the urban population in Stockholm visit the city's green areas at least once a year, 45 % visit every week, and 17 % more than three times a week (Wirén, 2002)

Recreation promotes physical exercise and mental well-being. Loss of biodiversity may lead to substitute inputs (insecticides and pesticides), which may have negative impact on human health by contaminating ground water, and the accumulation of toxins in plants and animals consumed by humans. Urban citizens also need close access to green areas in order to come into contact with nature. This pedagogic function is emphasized in the national school plan for Sweden (Lgr 80) and is also a condition for the completion of several head subjects related to natural science teaching. Several so called, nature schools (naturskolor), already exist in the study area – a reflection of such educational aspects.

3. Multi-Scale Approach

Scale is important in dealing with complex systems. A complex system is one in which many subsystems can be discerned. Many complex systems are hierarchic – each subsystem is nested in a larger subsystem, and so on (Allen and Starr, 1982). For example, an urban green patch may be considered an ecosystem, but it is part of a larger green area structure that can also be regarded an ecosystem. Similarly, institutions may be considered hierarchically, as a nested set of systems from the local-level, through regional and national, to the international. Phenomena at each level of the scale tend to have their own emergent properties, and different levels may be coupled through feedback relationships (Gunderson and Holling, 2001). Therefore, complex systems should be analysed or managed simultaneously at different scales. The multi-scale approach has explicitly been described in sections 1.5-1.10 of this report. Here some additional points related to scale are summarized.

The primary scales at which SUA is being undertaken is *the local to regional scales* with both ecological and social cross-scale interactions As earlier described, current green area management are local in character but needs to be managed at the regional scale. Formal institutions often do not match ecosystem dynamics at the wider ecosystem scale. They are too rigid and often self-depended. There is lack of good terrestrial indicators to monitor ecosystem dynamics and change. Individual self-governing municipalities, responsible for a diverse public interest are engaged in compromising within a limited financial framework, which makes it difficult for them to develop an ecosystem management approach. To 'over-bridge' these gaps in scale, the SUA proposes a system based on cross-scale institutional linkage, e.g., the establishment of adaptive co-management designs for improved ecosystem management. Local managers and users will be involved in these designs. Stakeholder participation in adaptive co-management designs is scale-independent in the sense of being scale-integrative since many may work at local, regional and national levels. Local institutions may hence take on new roles and responsibilities related to ecosystem management.

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4. Bridging Epistemologies

All available knowledge systems are assessed in SUA, including local knowledge and management practices, knowledge among stakeholders at various scales, existing field inventories, and scientific knowledge. This area has been extensively covered in section 1.7 of this report. The aim is to expand the range of information and approaches for improving ecosystem management.

The whole assessment draws on a diversity of sources of knowledge about biodiversity, ecosystem services and dynamics. The steps taken are flexible depending on the situation and the issues to be assessed.

5. Assessment Process

The frameworks for this assessment have been extensively dealt with in sections 1.5-1.10 and 2 of this report. The methods and tools used in SUA include GIS assessments, gap analysis and modeling; statistical trends; inventories of key stakeholder groups with accompanying interviews. Key supplemental sources include a physical regional development plan by the County Council (RUFS 2001), and a new government program of reserves coordinated by the County Administrative Board.

Stakeholders are being selected based on a sample of land uses that are commonly found in urban areas, and are involved through active integration in some studies. In others, stakeholder organizations support the assessment and contribute with data and input. SUA plan to perform workshops with stakeholders involved in ecosystem management in the region. These include local managers and users, NGOs and official planners and authorities.

Results of the local studies within the study area will provide input and data for physical planners and authorities involved in regional development planning. SUA will develop workshops and seminars in which results and findings are presented. Results will also be communicated through scientific publications in international and national journals, and communicated and discussed in relation to cross scale issues addressed in the Resilience Alliance. Research will be transformed to a broader public in collaboration with Albaeco (see http://www.albaeco.com/english/index). Already, media have reported on the assessment and even King Carl XVI Gustaf is informed.

6. Drivers of Ecosystem Change

In SUA, direct drivers are defined as the proximate causes for loss of ecosystem services, e.g. tangible, visible, and measurable effects of biodiversity loss, such as green area loss and species decline. Main indirect drivers are defined as those that most strongly influence and trigger the direct drivers. As described earlier *the main direct drivers* analyzed in SUA are green area loss that in turn lead to species decline and loss. The loss of ecosystems may lead to the loss of aesthetic, recreational, and cultural values that in turn may lead to reduced human health and well being. The main drivers in SUA are identified through comparisons of GIS assessments and maps of temporal change of green area coverage, backed up with statistical data; species inventories; and field data collection.

The *main indirect driver* leading to green area loss is population growth with its associated phenomena of urban sprawl that leads to change in land use. Also, economic growth visions coupled to institutional mismatches for ecosystem management, and a lack of understanding of ecological support functions can be regarded as indirect drivers behind green area loss. Indirect drivers are identified through regional statistics, physical development plans, and assessments of local stakeholders. These drivers are further described below.

6.1 Population increase

Throughout the 1900's, human population growth, consumption patterns and changes in life style have increased pressure on the natural environment. During the 1990's, there was an annual population increase of about 18.000 persons, a trend predicted to be steady during the period 2000-2010. It is estimated that about 2 million inhabitants will live in the county year 2010 (www.ab.lst.se). Year 2002, the population in the area was 1.849.200 (www.ab.lst.se).

New buildings and infrastructure development have not accounted for the increase in population. An additional 6000 to 10 000 flats per year is required to meet the demands of the increasing population (Office of Regional Planning and Urban Transportation, 2000). Despite a temporal economic recession in the region, and a recent decrease in the rate of population growth, future housing and infrastructure development will impose more pressure on green areas (Länsstyrelsen i Stockholms län, 2003).

Besides green area loss, several other environmental effects are associated with population growth in the region. They include *acidification* due to airborne pollution; increased *nitrogen eutrophication* in forestlands, lakes and other watercourses; clear signs of eutrophication from phosphorus and nitrogen in the Stockholm archipelago; a decrease in the area of *cultivated lands* due to building and infrastructure development; the drainage of open cultivated lands dominated by covered arable lands; and a decrease of *wetland areas* due to cultivation and settlements (http://www.ab.lst.se).

6.2 The lack of regional planning of the green structure

The green structure in the study area is spread out over several municipalities and includes land, water and parts of settlements. Due to the system of self-governing municipalities, actions taken by one municipality affects adjacent municipalities' use of the green structure. Exploitation pressure of one municipality may sometimes be so high that well-considered decisions of planning cannot be taken by one municipality alone. Thus, there is an expressed need for inter-municipal coordination to reach the goals of sustainable development for the region (Länsstyrelsen i Stockholms län, 2003).

Furthermore, many municipalities are against approving plans of protected areas within their own borders due to that they consider them a too strong legal measure that exclude future alternatives for land use (Länsstyrelsen i Stockholms län, 2003). Hence, in SUA, adaptive co-management designs may become a useful catalyst in a process towards a regional approach of ecosystem management.

7. Conditions & Trends

Conditions and trends in SUA are presently assessed through a number of means. Comparisons of GIS assessments and maps of temporal change in green area coverage; statistical records; official local and regional species inventories; field data collection; regional development plans; and interviews with local stakeholders and key individuals represent examples of such means. Below some information about conditions and trends in the study area is presented.

7.1 International competitiveness, economic growth and the regional development plan

Sweden, as most of the Western industrial nations, has witnessed a period of economic recession in recent years, most prominent so in the sector related to IT- and telecommunications. Population growth in the Stockholm County has decreased with a net increase of approximately 11.500 inhabitants year 2002. It is estimated that for year 2003 the population increase will be about 10.000 inhabitants (Stockholmsregionen, 2003). This is partly related to loss of job opportunities, but also to a shortage in housing.

Physical regional planning was in the later part of the 1990s geared at maintaining economic growth in the region. The Regional Development Plan for the County of Stockholm (Office of Regional Planning and Urban Transportation, 2000), focusing on the physical planning for the next 30 years, was developed within a period of rapid economic growth, following the stagnation that characterized the early 1990s (for a closer description of this plan, see: http://www.stockholmsregionen2030.nu/). The time the plan was developed can be characterized as a time of "renaissance within business and industry, the rate of economic growth is high and the population is increasing by nearly 20 000 people per year" (ibid). A main goal of the plan was to make the Stockholm region one of the world's leading development areas and to promote international competitiveness, high and equal living conditions, and a long-term sustainable environment. This should be reached based on five regional strategies adopted by the County Council year 2000. The strategies include economic development; education and research; co-operation in the Baltic region; public transport and accessibility, and housing development (ibid).

The natural environment is sparsely accounted for in the plan. Green areas are deemed important for providing recreation and for biological diversity. The goal is for all parts of the region to have good access to high-quality green areas and to "conserve and develop the green structure in the region" (ibid: 23). Another important goal of the regional development plan is for the Stockholm region, which is closely monocentric, to develop into a more polycentric settlement structure (Regioplane- och trafikkontoret, 2003). Besides the central regional core, development of seven outer cores should be stimulated.

The current trend of the slowing population growth is continuing. In fact, population increase in recent years has been lower than the lowest scenario estimate of the regional development plan. The high prices on apartments and houses, the traffic situation and improved train communications to other regions are some factors that drive this trend. Also, qualified workers are moving to regions where economic growth is higher, such as Skåne and Göteborg. Hence, currently the "economic growth vision" of the region's physical planners is not going in the right direction. How this situation will affect future development is too early to determine.

8. Responses

Below are described some key responses for mitigating green area loss and species decline within the SUA study area. Responses are several, including international and national responses, to those of a more regional and local character.

8.1 International conventions

Several international conventions form the basis for Swedish policies on biodiversity, the most influential being the Convention on Biological Diversity (CBD) and The European Union network, Natura 2000. In response to article 6 of the Convention on Biodiversity ("develop national strategies, plans or programmes"), the Swedish Parliament established 15 *environmental quality objectives* in 1999 to guide Sweden towards a sustainable society (for a closer description, see http://www.internat.naturvardsverket.se/). The Swedish strategy to achieve the environmental target is based on shared responsibility between industry and society. It is the duty of the authorities to be good advisors and to contribute with information of legislation relating to the natural environment. Several objectives have a direct bearing on green area management and conservation, and some are related to various *ecosystem services* produced by ecosystems, such as reduction of climate impact, clean air, reduced eutrophication, flourishing lakes and streams, and the objective of thriving wetlands.

8.2 Formal institutions and protected areas

The proclamation of nature reserves and national parks has been the cornerstone in the preservation of species and ecosystems in Sweden. It is indicative that out of the total land and water surface area of Stockholm County (678 500 ha) about 13 percent represent protected areas (Statistical Yearbook of Sweden, 2002).

In accordance with Swedish law the preservation of green areas can take two approaches. One is that such areas are pointed out in the *Municipal Comprehensive Plan (MCP)* of individual municipalities as areas worthy of protection. However, their legal status is weak. Comprehensive plans are not legally binding; rather they represent important signals for planning authorities and in cases of inquiries of decisions. The other approach is the preservation of green areas through legislative measures. It is stipulated in the *Swedish Environmental Code (EC)* that areas of value for nature conservation, culture and recreation shall be protected as far as possible, especially so within and close to urban areas. Areas of *national interest* and *Natura 2000* sites constitute examples of areas that receive extensive protection in legislation. It is the responsibility of the County Administrative Board that such areas are accounted for in MCPs. Areas of national interest may include both preservation interests (nature, culture and recreational needs) and use interests, such as the building of roads, railways and ports. It is also the responsibility of the County Administrative Board to make sure that coordination occurs among the 26 different municipalities in the Stockholm County concerning appropriation of green areas. Hence, the board has an important role in making sure that MCPs are carried out in accordance with national policies.

Either the County Administrative Board or an individual municipality (since 1986) may decide on *establishing nature or culture reserves*. The deciding body is financially responsible for their protection and management. The state finances its own reserves through means of the Swedish Environmental Protection Agency (SEPA), for example payments to individual landowners. However, it is often the case that other actors, such a municipality or a foundation, such as the Archipelago Foundation (Skärgårdsstiftelsen) finances management on lands it owns.

TABLE 1. Protected landforms in Stockholm County
(Source: Colding, Lundberg and Folke, in progress).

Protected landforms
Natura 2000 habitats
Natura 2000 bird sites
National parks
Nature reserves
National Urban Park
Woodland Key Habitats
Animal protection sites
National interests for nature conservation
National interests for recreation
Landscape protection sites
Biotope sites
Nature conservation contracts

As a rule, the municipalities finance payments and management of locally set reserves, although there exist possibilities for co-financing from the state. Each reserve has its own body of regulations depending on the purpose of the reserve. Reserves are in general harder to abrogate than areas worthy of protection indicated in the detail plan of individual municipalities.

Besides reserves, the Swedish Environmental Protection Agency (SEPA) proposes areas to become *national parks*, ultimately decided on by the Swedish Parliament. SEPA also declares areas of national interest for natural preservation and recreation and which fall under the regulations of the Environmental Code, for example Natura 2000 sites (of which many already are reserves). Table 1 presents the different kinds of formally protected landforms that exist in the study area.

8.3 Local public response

The ways that local stakeholders, the public and other interest groups may interact with a top-down formal framework and hence influence biodiversity policies are several. One is through democratic elections at national, regional and local levels held every four years. Alternatively, interest groups may put pressure on authorities through lobbying activities, for example in protecting areas worthy of preservation. As already mentioned, NUP is a product of such a response. Also, influential groups like the Swedish Society for Nature Conservation, and other concerned parties with rights to fill out complaints may do so to the County Administrative Board, for example regarding decisions taken by a municipality on development schemes. Interest groups may also raise public awareness through debates, letters to the press and media. In this way, and others, both proactive and reactive means exist for local actors to influence biodiversity policies.

8.4 Potential adaptive co-management response

Local stakeholders may also influence biodiversity management through their own land use and management practices. This perspective has received surprisingly little attention from physical planners in the area. A major aim of SUA is to evaluate the prospects of introducing arenas of adaptive *co-management* to supplement the current management paradigm. Such arenas may be especially useful to establish around non-protected green areas managed by local stakeholders that promote ecological support functions, and in areas where protected areas exist where locally managed green space may function as buffer zones. Also, the may be useful for management of weak links that connect larger green areas.

9. Scenarios

9.1 The new government directive for the protection of urban green areas

In the summer of 2002, the Swedish government appointed the County Administrative Boards of Stockholm, Västra Götaland and Skåne, each to develop a regional program for the protection of urban ecosystems in recognition of their increased fragmentation in these settings (Länsstyrelsen i Stockholms Län, 2003). In the directives of the program, the work with the plan should be actively carried out and coordinated by the County Administrative Boards in cooperation with local municipalities and be based on existing knowledge.

The scenario of the Stockholm Urban Assessment (SUA) represents an analysis of the potential outcomes of a program for the establishment of 73 new reserves in the Stockholm region. The municipalities have not yet politically decided on the program, which is presently circulated for considerations (remittance) of which SUA is one remittance part. If the program is implemented in full, an additional 20 000 hectares of lands will be protected in the region or about 17 percent of the land surface area. Hence, the program holds promising effects for mitigating the increasing loss of urban green areas and strengthens the ecosystem services generated by the National Urban Park (NUP) and other larger green areas. However, the new program may have some adverse effects on local stakeholders active in the use and management of non-protected urban green space. The SUA scenario analysis will address the following broad questions:

1. What are the consequences of the new program for a selected number of critical organisms in the SUA study area?
2. What social-ecological consequences may the new program have for local stakeholders active in the management and use of urban green space?

An important part of The SUA scenario analysis is to relate the new reserves of the program to information about the movement patterns of mobile links and keystone species of NUP and surroundings, and to examine in *what ways* and to *what extent* the new reserves may support these populations.

An assumption made in SUA is that a number of different habitat types in human-dominated landscapes may support biodiversity conservation, although they are not recognized in having this capacity. Taken together, the different land uses contribute in generating a diverse set of ecosystem services in the urban landscape that contribute to build social-ecological resilience. The SUA scenario analysis will assess what consequences the new program may have for local stakeholders active in the management and use of urban green space. A *hypothesis* is that lands set aside as reserves may contribute to the increase of land prices of available land, leading to that land tenants no longer can afford holding land. Thus, the new program needs to consider negative side effects associated with it.

The aims of the SUA scenario analysis are to:

- Contribute with new information to physical planners, decision-makers and researchers active in regional and local planning
- Provide relevant hypotheses for research in the region
- Analyze the views of local stakeholders' response to the program
- Develop and provide complementary approaches to protected area management.
- Provide insights in the field of urban ecology

10. Summary of the Stockholm Urban Assessment (SUA)

Stockholm County has the largest population concentration in Sweden with more than 1.8 million people and is projected to grow to 2.4 million people within 30 years. Due to population increase and urban development, the region displays a quite dramatic loss of ecosystems, with a loss of both common and red listed species. The overall objectives of the Stockholm Urban Assessment (SUA) is to investigate how adaptive capacity can be built to better adapt to change and, more specifically, to find effective ways to manage urban ecosystem services. SUA covers the greater metropolitan area of Stockholm and has as its centre the Stockholm National Urban Park (NUP), a 2700 ha woodland area located adjacent to the inner city of Stockholm. Despite legal protection of the park in 1995, there has been a continuous pressure on the park's fringe areas due to urban sprawl. The future management of the park needs to be expanded to also consider ecosystems and social systems outside the park.

SUA focuses on the provision of ecosystem services and the support functions provided by green areas. The role of local users, their management practices, institutional arrangements, and local ecological knowledge in the use and management of unprotected green areas is investigated. Recreation represents an important ecosystem service generated by urban green areas and it is estimated that NUP has 15 million visitors per year and that 97% of the urban population in Stockholm visit one of the urban green areas once a year, and that 47% will make visits every week.

The main direct drivers analyzed in SUA are green area loss, that lead to loss of aesthetic, recreational, and cultural values that in turn may lead to reduced human health and well being. The main indirect driver leading to green area loss is population growth with the associated urban sprawl, drivers that are reinforced by economic growth visions coupled to institutional mismatches for ecosystem management, and a lack of understanding of ecological support functions.

The common response to mitigate the effects of green area and biodiversity loss has been ratification of conventions and development of new governmental policies, including establishment of nature reserves and national parks. Local public response also exists through interest groups that put pressure on authorities. Local stakeholders may also influence biodiversity management through their own land use and management practices. Linked to NUP alone there are some 45 non-governmental organizations representing 175.000 members that are loosely involved in green area management.

A major aim of SUA is to evaluate the prospects of introducing arenas of adaptive co-management to supplement the current management paradigm. Such arenas may be especially useful to establish around unprotected green areas managed by local stakeholders that promote ecological support functions. Co-management may also be useful in areas where protected areas exist and where locally managed green space may function as buffer zones and for management of weak links that connect larger green areas.

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