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Social-Ecological Transformation for Ecosystem Management: the Development of Adaptive Co-management of a Wetland Landscape in Southern Sweden

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ABSTRACT

We analyze the emergence of an adaptive co-management system for wetland landscape governance in southern Sweden, a process where unconnected management by several actors in the landscape was mobilized, renewed, and reconfigured into ecosystem management within about a decade. Our analysis highlights the social mechanisms behind the transformation toward ecosystem management. The self-organizing process was triggered by perceived threats among members of various local stewardship associations and local government to the area's cultural and ecological values. These threats challenged the development of ecosystem services in the area. We show how one individual, a key leader, played an instrumental role in directing change and transforming governance. The transformation involved three phases: 1) preparing the system for change, 2) seizing a window of opportunity, and 3) building social-ecological resilience of the new desired state. This local policy entrepreneur initiated trust-building dialogue, mobilized social networks with actors across scales, and started processes for coordinating people, information flows and ongoing activities, and for compiling and generating knowledge, understanding, and management practices of ecosystem dynamics. Understanding, collaborative learning, and creating public awareness were part of the process. A comprehensive framework was developed with a shared

vision and goals that presented conservation as development, turned problems into possibilities, and contributed to a shift in perception among key actors regarding the values of the wetland landscape. A window of opportunity at the political level opened, which made it possible to transform the governance system toward a trajectory of ecosystem management. The transformation involved establishing a new municipal organization, the Ecomuseum Kristianstads Vattenrike (EKV). This flexible organization serves as a bridge between local actors and governmental bodies and is essential to the adaptive governance of the wetland landscape. It is also critical in navigating the larger sociopolitical and economic environment for resilience of the new social-ecological system. We conclude that social transformation is essential to move from a less desired trajectory to one where the capacity to manage ecosystems sustainably for human well-being is strengthened. Adaptability among actors is needed to reinforce and sustain the desired social-ecological state and make it resilient to future change and unpredictable events.

KEY WORDS: Adaptability, adaptive co-management, ecosystem management, key individuals, leaders of change, organizational change, resilience, self-organization, social memory, social-ecological systems, transformability.

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INTRODUCTION

Human well-being and progress toward sustainable development are vitally dependent on improved management of the Earth's ecosystems. The focus of the international Millennium Ecosystem Assessment is to strengthen our capacity to manage ecosystems sustainably to ensure continued provision of essential services. This process requires an understanding of not only the ecological system but the integrated social-ecological system (Berkes and Folke 1998).

Social-ecological systems are complex systems, the inherent features of which are change and uncertainty (Gunderson and Holling 2002). To strengthen our capacity to deal with uncertainty and change and to sustain ecosystem services, we must be able to monitor, interpret, and respond to ecosystem feedback (Gadgil et al. 1993, Berkes et al. 2003). Knowledge generation of ecosystem dynamics and the capacity to respond to ecosystem feedback among local resource users and steward associations tend to be integrated with management practices and evolve with the institutional and organizational aspects of management in what we refer to as adaptive co-management systems (Olsson et al. 2004). Adaptive co-management is the combination and operationalization of adaptive management (Holling 1978) and adaptive governance (Dietz et al. 2003).

Adaptive co-management focuses on creating functional feedback loops between social and ecological systems. It relies on collaboration among a diverse set of actors operating at different levels, often in networks, from local users to municipalities to regional and national or supranational organizations. Adaptive co-management systems have been defined as flexible community-based systems of resource management tailored to specific places and situations, supported by, and working with, various organizations at different levels (Folke et al. 2003). Sharing management power and responsibility may involve multiple institutional links among user groups or communities, government agencies, and non-governmental organizations. Hence, adaptive co-management systems build on open institutions and learning (Shannon and Antypas 1997), drawing on a variety of sources of information and knowledge and avoiding set prescriptions of management superimposed on a particular place, situation, or context. Adaptive co-management includes experimentation that provides opportunities to track desired and sustainable trajectories (Carpenter and Gunderson 2001).

We have recently proposed that adaptive co-management of ecosystems has the potential to build resilience in social-ecological systems (Olsson et al. 2004). Social-ecological resilience refers to the capacity of a social-ecological system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks (Walker et al., *in preparation*). The ability to reorganize and renew a desired social-ecological system state following disturbance and change will strongly depend on the influences from states and dynamics at scales above and below. Such cross-scale aspects of resilience are captured in the notion of a panarchy, a set of dynamic systems nested across scales (Gunderson and Holling 2002). Hence, resilience reflects the degree to which a social-ecological system is capable of self-organization (vs. lack of organization, or organization forced by external factors) and the degree to which the system can build and increase the capacity for learning and adaptation (Carpenter et al. 2001).

The capacity to adapt to and shape change is an important component of social-ecological system resilience (Berkes et al. 2003). In a social-ecological system with high adaptability, the actors have the capacity to sustain the system in desired states in response to changing conditions and disturbance events. What sustains the adaptive capacity of social-ecological systems in a world that is constantly changing? Following the work of Berkes and Folke (1998), Tengö and Hammer (2003) identify a bundle of management practices in a small-holder

and Folke (1998), Tengo and Hammer (2003) identify a bundle of management practices in a small-holder Tanzanian agropastoral society as part of adaptive capacity. Colding et al. (2003) summarize practices for coping with environmental variability and disturbance events that seem to confer resilience in social-ecological systems. Trosper (2003) suggests that the potlatch system among Indians on the Northwest Coast of the USA must have been characterized by adaptive capacity as it persisted for two millennia before these tribes had contact with people from the Old World. The characteristics of the system, namely property rights, environmental ethics, rules of earning and holding titles, public accountability, and the reciprocal exchange system, provided all three elements of resilient social-ecological systems as defined above. Folke et al. (2003) identify and expand on four critical factors in complex social-ecological systems that interact across temporal and spatial scales and that seem to be required for dealing with ecosystem dynamics during periods of change and reorganization: learning to live with change and uncertainty, nurturing diversity for reorganization and renewal, combining different types of knowledge for learning, and creating opportunities for self-organization toward social-ecological sustainability.

It is the last factor, in particular, that is the focus of this article and it relates to transformability, a concept under development within the Resilience Alliance (Walker et al., *in preparation*). Transformability is the capacity of a social-ecological system to move to a new configuration defined by new state variables or the old state variables supplemented by new ones. New variables are introduced or allowed to emerge to create untried beginnings from which to evolve a new way of operating when existing ecological, economic, and social structures become untenable (Walker et al., *in preparation*).

Here, we study the emergence of an adaptive co-management system for wetland landscape management in southern Sweden, a process by which the prevailing management system was moved into a new configuration of ecosystem management within about a decade. Coordinated and collaborative ecosystem management at the landscape and catchment level did not exist earlier. Hence, this article focuses on social change processes for establishing ecosystem management (Danter et al. 2000) and, following the work of Berkes and Folke (1998), Berkes et al. (2003), and Gunderson and Holling (2002), on elucidating social mechanisms behind such management or, more specifically, social mechanisms of adaptability and transformability.

The starting point for our analysis was the observation of a policy change by the Municipality of Kristianstad in 1989 that adopted a new approach for managing the wetland ecosystems of the lower Helgeå River catchment, in southern Sweden (Fig. 1). The ecosystems in this area and the social structures and processes behind their management are defined as a social-ecological system (SES) (see Berkes and Folke 2002). The policy change was accompanied by an organizational change with the establishment of a new municipal organization, the Ecomuseum Kristianstads Vattenrike (EKV), which plays a key role in the adaptive co-management of the area's ecosystems. The self-organizing process of untried beginnings created new organizational and institutional arrangements and recombined existing ones to fit context-specific challenges, problems, and needs. The objective of our analysis is to unravel the social mechanisms involved in the transformation toward ecosystem management of the wetland landscape.

The first section of the article describes the area, its geographical characteristics, and the methods used in the study. The second section describes the development of the EKV and the self-organization process toward an adaptive co-management system, a process that was triggered by perceived threats to the area's social and ecological values among members of various local steward associations and local government. We show how one local individual played a critical role in leading change and transforming governance into an adaptive co-management system. The transformation involved coordinating information and ongoing activities, building knowledge and understanding of ecosystem dynamics, providing leadership in the form of visions and goals, and developing a social network for ecosystem management. The transformation of the previous management system into a trajectory of ecosystem management required seizing a window of opportunity and linking organizations and institutions across scales. The final section discusses how the adaptive co-management approach can create functional feedback loops in social-ecological systems, help track sustainable trajectories, and build social-ecological resilience.

CASE STUDY

The town of Kristianstad is situated in northeast Scania County (*Skåne Län*). The county currently has 1.2 million inhabitants and Kristianstad has 73 000 inhabitants. The town, established in 1614 by the Danish king Christian IV, is the administrative center of the Municipality of Kristianstad. The vast wetlands surrounding the town historically provided a defense for the town. Today, the area provides a variety of ecosystem services, including recreation for people living in and around Kristianstad.

The area chosen for this study, Kristianstads Vattenrike (KV), is defined by hydrological and political borders and includes the Helgeå River catchment area and the coastal regions of Hanö Bay within the Municipality of Kristianstad (see Fig. 1). Kristianstad Vattenrike roughly translates as "the Kristianstad Water Realm," but *rike* also means riches; the double meaning of the title both defines the catchment area and reflects its rich natural values.

KV covers an area of 110 000 ha. The Helgeå River runs through central Kristianstad and drains an area of 4775 km^2. Starting in the forested highlands of Kronobergs County (Fig. 1), it runs through boreal forests on archaic rock for 170 km before reaching the Kristianstad plain and wetlands of KV and eventually the Baltic Sea. The pH level is slightly acidic and humus levels fairly high when it reaches the Kristianstad plain. The sedimentary rock and soils of the Kristianstad plain are calcareous and the pH rises when the Helgeå River reaches these areas due to mixing-in of groundwater and high nutrient levels. The natural hydrological regime of the lower Helgeå River is highly dynamic, with an annual average water fluctuation of 1.4 m in central Kristianstad (-0.2 to +1.2 m a.s.l.) which creates extensive floodplains. Occasionally, usually between December and April, the water level can reach over 2 m a.s.l., e.g., as recorded in 1912, 1917, 1928, 1980, and 2002 (see Municipality of Kristianstad's home page). The water level of the lower Helgeå River system occasionally falls below sea level, which causes saltwater intrusion as far up as Lake Hammarsjön. Most of the tributaries to the lower Helgeå River drain the Linderödsåsen ridge in the western parts of the municipality (Fig. 1).

The wetlands of the lower Helgeå River contain two shallow lakes with a total area of 22 km^2 (summer water levels). The lakes constitute one of a variety of habitats within Kristianstads Vattenrike. Other habitats include large beech forests on the slopes of the Linderödsåsen ridge and wet forests and willow bushes in the lowlands (Fig. 2). Much of the area is agricultural land; the sandy and clay soils around Kristianstad have been and still are important for agricultural production and the area is one of the most productive in Sweden. There are sandy grasslands with unique flora and fauna. The area also holds the largest groundwater reserve in northern Europe. The groundwater aquifer is used for household and industrial purposes and irrigation. Through "leakage" zones, it also provides the wetlands with calcareous water, which creates special biotopes in these zones.

Kristianstad Vattenrike is known for its rich fauna and flora, including rare plant species such as fen ragwort (*Senecio paludosus*) and river water-crowfoot (*Ranunculus fluitans*). It also boasts an array of fauna including 40 [7] fish species, 6 [2] amphibian species, 260 [31] bird species, 11 [4] bat species, and an abundance of insects and mollusks (IUCN red-listed species within parentheses). Some of the area's unique flora and fauna were described by Swedish botanist Carl von Linné on his journey through Scania in 1749 (von Linné 1751) and the natural beauty and outstanding values of the lower Helgeå River have been described by several Swedish authors, including Carl Fries (1958).

The area includes Sweden's largest flooded meadows landscape, used for grazing and haymaking, and many of the unique values of the area are associated with these social-ecological systems and require active management to be sustained. The dynamics of the Helgeå River including its annual flooding, together with the proliferation of grazing and haymaking, are important factors for maintaining these flooded meadows and associated values. The lower demarcation of the flooded meadows is the summer brink of the Helgeå water system and the upper demarcation is appropriate for year-round agriculture. Using flooded meadows for agricultural purposes is an ancient tradition in Sweden and described for the lower Helgeå River by Carl von Linné on his journey through Scania in 1749 (von Linné 1751). Adaptations to the hydrological dynamics of the lower Helgeå River and associated practices have developed over millennia and provide unique cultural–historical and ecological values (Cronert 1991, Wendt-Rasch and Cronert 1996).

Since Kristianstad's establishment in 1614, there has been increasing pressure on the wetlands of the Lower Helgeå River and the values or ecosystem services they provide. Examples of such services are flood control, habitat supply, species biodiversity, and cultural, recreational, and information services. In 1975, in an attempt to secure the values, the 35-km stretch of wetlands along the lower Helgeå River from Torsebro to the Hanö Bay in the Baltic Sea was designated as having international importance by the Convention on Wetlands of International Importance; it became known as the Ramsar Convention Site (RCS) (Fig. 1). The area had already been declared to be of national interest for nature conservation and, parts of it, for cultural heritage, fishing, and recreation. Sweden signed the Ramsar Convention on Wetlands in 1974; the Convention came into force in 1975 and was immediately ratified by Sweden, making the county administration responsible for management of the RCS (see the Ramsar Convention on Wetlands home page). In its official plan from 1975, the Kristianstad County Administrative Board (now Scania County Administrative Board) suggested that almost the whole area, 49 km^2, should become a nature reserve. In 1989, only 3% of the RCS was protected by reserves (Magnusson et al. 1989).

METHODS

The study identifies and investigates the social processes and mechanisms behind the adoption of a flexible and collaborative management of the wetland ecosystems of the lower Helgeå River catchment and the inclusion of the EKV as part of the municipal organization. The study was conducted over a period of 18 months during 2001–2003.

Open-ended, in-depth interviews (Bernard 1994, Kvale 1996) were conducted with four individuals who work

Open-ended, in-depth interviews (Bernard 1994, Kvale 1996) were conducted with four individuals who work within the EKV and have been involved since the beginning in 1989. They were interviewed on several occasions throughout the period. The goal was to capture the interviewees' experiences regarding the development of the EKV and the new management approach. Interviewees were asked to describe events and their own roles and strategies that had relevance for the change. They were also asked to describe the continuing work, strategies, goals, and achievements of the EKV. The interviews helped identify relevant literature that was used to describe the history of the wetland landscape and land-use changes.

Initially, the interviews were unstructured, but became semi-structured as significant events and key individuals started to be identified, which guided further questions. These semi-structured interviews focused on strategies for creating and developing the EKV and the motivation behind these strategies. During the interviews, other people outside the EKV but important to its development were identified. Telephone interviews were subsequently conducted with a municipal politician identified as important to instituting policy change in 1989, as well as the Kristianstad County Governor who provided initial funding for establishing the EKV.

An extensive review of other information sources was also conducted to complement the interviews. The history of how the EKV developed was found in sources from 1977 to the present, including project proposals, inventories, progress reports, notes, maps, correspondence, Internet sites, and newspaper clippings. These sources were searched continuously during the study to inform subsequent interviews.

We used qualitative evaluation methods in our analysis (Patton 1980, Bernard 1994) to understand the social mechanisms for social-ecological transformations. The analysis is guided by the definition of social conditions for adaptive co-management processes identified by Olsson et al. (2004). In analyzing the history of the development of the EKV organization and the adaptive co-management of the wetland landscape, a pattern emerged. It showed that a key individual or steward (Pinkerton 1998, Berkes and Folke 2002, Westley 2002) was important for developing this new management system. To further understand how the social conditions for ecosystem management were created, we use the theory described by Kingdon (1995) on policy windows and policy entrepreneurs to tease out certain qualities of key stewards that seem essential for transforming social-ecological systems in response to experienced or anticipated crisis.

PREPARING THE SYSTEM FOR CHANGE

The Ramsar Convention on Wetlands provided a framework for protecting the wetland areas from further exploitation and resulted in several conservation plans, policy documents, and protection efforts. However, inventories and observations conducted by individuals of various local steward associations and local government during the 1980s indicated that the natural and cultural values of the lower Helgeå River catchment continued to disappear despite the fact that it had been designated a Ramsar Convention Site. In particular, they observed declining bird populations, eutrophication and overgrowth of lakes, and a decrease in the use of flooded meadows for haymaking and grazing. Even flooded meadows in nature reserves on state-owned land were degrading because of neglect and inadequate management practices (as indicated in Johansson and Cronert 1989). There was growing concern that a crisis was looming, that the RCS status given to the wetlands of the lower Helgeå River was not enough to sustain the natural and cultural values of the area. The problems of implementing and fitting the Ramsar Convention on Wetlands to local contexts have been recognized by Adger and Lutrell (2000).

The EKV was established in 1989 to help the Municipality of Kristianstad manage the ecosystems of the lower Helgeå River catchment (Kristianstads Vattenrike, KV). It is a flexible and dynamic organization, promoting a management within KV that treats humans as part of ecosystems and includes social, economic, and ecological dimensions. The EKV is part of the municipality's organization and reports directly to the municipality board, like a municipality administration. However, it is not an authority and has no power to make or enforce formal rules. It plays a key role as a facilitator and coordinator in local collaboration processes that involve international associations, national, regional, and local authorities, researchers, non-profit associations, and landowners to maintain and restore the natural and cultural values of the area. The EKV is also involved in developing policy, designing projects, resolving conflicts, coordinating and administering conservation and restoration efforts, and developing goals for KV, as well as producing management plans, agreements, follow-up reports, and updates for specific areas.

The EKV has made the wetland landscape area more accessible to the public and has established 13 information sites in the wetlands. More than 150 000 people visit these sites each year. It may be argued that the EKV has established essential conditions for adaptive co-management of wetland ecosystems, which in turn can create functional feedback loops and build resilience in social-ecological systems. In the following sections, we investigate and analyze the processes behind the changes in policy and organization for managing the wetland ecosystems of the lower Helgeå River that took place in 1988–1989.

One individual played a particularly significant role in creating and shaping the organizational change. In response to ecosystem change, he met with other concerned individuals and groups and developed a social network based on trust and dialogue. He compiled existing ecological knowledge and experience found within the network in a project proposal, and linked people and ongoing projects in the area. He also provided overall goals and vision in an ecosystem approach to wetland management and used a window of opportunity to convince political decision-makers of the need for a new organization and improved management of the wetland landscape. This steward coined the term "Kristianstads Vattenrike" (the rich wetlands of Kristianstad) and developed and realized the idea of the EKV, of which he is also the director. In this article, we identify him by his initials, SEM, and start this section by giving a background of this key steward and how he developed the ideas and strategies that were realized in the EKV.

Linking Nature and Culture

Originally trained as a geologist, SEM was employed by the Kristianstads County Museum, first as an assistant and eventually as the curator of the department of natural history. One of his first assignments in 1977 was to host a traveling exhibit on Swedish wetlands arranged by the Swedish National Museum of Natural History and hosted by the Kristianstad County Museum. The exhibit did not include the wetlands of the lower Helgeå River and the Ramsar Convention Site. SEM saw an opportunity to call attention to these wetlands, including their history and ongoing restoration and, therefore, added material to the exhibit. He described the restoration project of Lake Hammarsjön that had started in 1974. He also linked nature and culture in illustrating the history of the wetlands of the lower Helgeå River. He compiled several maps based on general and detailed maps from the military record office and other more recent maps. Together, they represented a period from the 17th century to the present. He distinguished four significant changes over time caused by human activity in the Lower Helgeå River catchment (Magnusson 1981) and illustrated these changes in four maps that were included in the exhibit. The exhibit showed how the wetlands had shrunk over the past three centuries and discussed the social processes that had caused these changes.

SEM was involved in several other exhibits at the County Museum that linked nature and culture. For example, in 1978, the museum marked the 200th anniversary of Swedish botanist Carl von Linné's death. SEM notes that "it was an eye-opener regarding the important connection between natural and cultural history...reading old accounts of someone's travels helps us understand today's landscape, fauna and flora as originating in landscapes of ancient times. Without the landscape history, there can only be poor understanding of how today's landscape functions and why species of different kinds exist where they do." The Linné exhibit gave insights into how the wetlands had historically been used by people and highlighted the fact that many of the biodiversity values described by Linné actually resulted from agricultural practices, making local people cultural stewards of wildlife habitats (Nabhan 1997).

At the County Museum, SEM also worked on an *Utemuseum* (outdoor museum), a term that he coined. The idea behind an outdoor museum is to give visitors on-site information that helps them interpret the landscape around them and increases their interest in and commitment to the values associated with the landscape (Magnusson 1987). An outdoor museum usually consists of panel displays in selected places throughout the landscape that provide information about, for example, the site's geology, ecology, and cultural history. Some outdoor museums include buildings designed and built to fit a specific place and enhance the experience of the area. The County Museum and SEM were involved in the establishment and pilot operation of several outdoor museums around the county during the 1980s.

During his tenure as a curator at the County Museum, SEM gained knowledge and understanding of the history and dynamics of the cultural landscape and how local agricultural practices had for millennia shaped the landscape and ecosystems of the lower Helgeå River, which in turn provided ecological values. He also had an opportunity to develop a range of methods to inform the public of the County Museum's activities and the area's natural and cultural values and increase commitment in maintaining these values. This included close ties with the local media. These methods were eventually applied in the EKV.

Building Local Ecological Knowledge

The 1980s saw a growing public awareness of the disappearing ecological values of the lower Helgeå River's wetland landscape. Increasingly concerned, SEM saw a need to quantify these values and understand changes in the underlying processes that sustain them. He focused on the flooded meadows within the Ramsar Convention Site, as many unique values were associated with these meadows and the site provided a well-defined focus area. Where grazing and haymaking were still practiced within this area, unique values were maintained; where they had been abandoned, values were decreasing.

In 1986, the Municipality of Kristianstad initiated a cultural heritage program (*kulturminnesvårdsprogrammet*) that

was completed in 1989. This program included inventories of buildings, archeological sites, and the cultural landscape. SEM was responsible for the part of the program dealing with the cultural landscape, which aimed at identifying areas for protection. This included an inventory of meadows and pastures, funded by the Municipality of Kristianstad and conducted by SEM and the Kristianstads County Museum. As many of the natural values of the area were linked to human use, SEM saw an opportunity to combine the two. A criterion for selecting areas to investigate was historical continuity of land use; again, compilations of several maps were used to identify these target areas. The inventory included a range of habitats within the municipality's jurisdiction and identified several areas with unique flora. However, relatively few of them were within the Ramsar Convention Site and information about the flooded meadows described their values but not what sustained them. Therefore, in 1989, SEM used the experience from his work at the County Museum to design a special inventory of the flooded meadows and their cultivation status. A member of the Bird Society of Northeastern Scania (BSNES), who later became deeply involved in the EKV, helped design this inventory (see below). It was termed "mapping of land-use practices" (*markhävdkartering*), intentionally avoiding conventional terminology associated with ecological inventories and instead using the language of cultural geographers. The inclusion of an inventory of the cultural landscape in the cultural heritage program made it financially possible for SEM to produce an inventory that combined natural and cultural aspects and illustrated how ecological values such as biodiversity are linked to the quality of the agricultural practices used for cultivating the flooded meadows.

At the same time, in the mid to late 1980s, SEM met several members of the BSNES, who had observed declining waterfowl populations in the area, especially in species associated with flooded meadows (Johansson and Cronert 1989). BSNES members have produced continuous inventories of birds since the 1950s (e.g., Bengtsson 1963) and recorded declining waterfowl populations in Lake Hammarsjön and Lake Araslövssjön. The earlier inventories linked the decline to "active threats" such as the disappearance of wetlands by active lowering of water levels, building of embankments and landfills, as well as draining and dredging. Later inventories, some produced in cooperation with the County Administrative Board, linked declining waterfowl populations to the more passive threat posed by the decreasing use of flooded meadows for grazing and haymaking (Neideman 1979, Helldén 1984, Adolfsson et al. 1985, Johansson and Cronert 1989).

Members of the BSNES also recognized that nationally protected areas of flooded meadows needed improved management practices to prevent them from becoming overgrown (Johansson and Cronert 1989). Officials at the national and county levels responsible for managing flooded meadows within nature reserves on state-owned land were proactively approached by the BSNES. Representatives from the County Administrative Board, responsible for producing a management plan of these areas, and the National Forestry Board, responsible for management practices, were brought out to the reserve (*Håslövs Ängar*), where BSNES members convinced them that mere protection of the flooded meadows would be insufficient to maintain healthy bird populations. This elicited an almost immediate response and improved management practices. The BSNES also proposed that parts of the RCS be made into a national park, but this idea did not enter the political process and become realized.

In this way, SEM and the members of the BSNES joined forces, pooling their experience and knowledge. In 1986, in their inventory of breeding birds at Lake Hammarsjön, Johansson and Cronert (1989) conducted a mapping of land-use practices similar to the one that SEM wanted to produce for the RCS. This provided an opportunity to link the cultural history and continuous use of the wetlands for grazing and haymaking to the ecological qualities for maintaining a rich bird fauna.

The mapping of land-use practices within the RCS that was completed in 1989 (Magnusson et al. 1989) provided information about flooded meadows and their geographical position and size, and whether or not they were used for grazing, haymaking, or both. This included indications of whether the areas were strongly or weakly grazed, when the grass was cut, and whether or not haymaking was followed by grazing. The maps also indicated areas where the land was no longer exploited, and where the flooded meadows were becoming overgrown. The mapping revealed that the area still boasted 1200 ha of flooded meadows used for grazing (800 ha) and haymaking (400 ha, including some with post-harvest grazing), which is unique in the northwestern European context. It helped define and prioritize areas for improving land-use practices and estimate the funding needed to maintain and develop these practices, and identified habitats for unique flora and fauna.

SEM offered the following reflection on investigations and policy documents for managing wetland ecosystems: "The mapping of local land-use practices generated knowledge that was necessary for producing a detailed policy plan and taking action for improving management practices of flooded meadows of the lower Helgeå River. This is something that national efforts often fail to do because their findings are too general, like the inventory of flooded meadows by Larsson [1972]. Such reports also tend to end up far from the local context, unavailable for local action. Our mapping project is not instead of such efforts but rather is complementary and linked to them."

National reports and inventories and scientific articles (for example Larsson 1969, Larsson 1972, Pehrsson 1979, Alexandersson et al. 1986) influenced and informed the mapping of land-use practices (Magnusson et al. 1989), illustrating how such "coarse-grained" information can guide local efforts to produce "fine-grained" context

illustrating how such "coarse-grained" information can guide local efforts to produce "fine-grained," context-specific knowledge. This combining of different sources of knowledge in the local context to improve practices for ecosystem management is a strategy used in the ongoing work of the EKV.

The idea for the creation of the EKV was born during the cultural heritage program. Encouraged by the inventories and inspired by other ecomuseums in Europe, such as the French *Musée Camarguais,* SEM decided to establish an ecomuseum on the lower Helgeå River. Aside from the region's natural and cultural values, which made it a potential tourist attraction, the museum could be easily accessed: Kristianstad is in the middle of the wetlands, a 5-minute walk from the city center (Fig. 3).

Providing a Vision and Developing Social Networks

SEM was aware of the diversity of actors at different organizational levels involved in ongoing activities in the area, such as inventories and monitoring programs, restoration projects, and improved land-use and management practices, although they were often not aware of each other. He argues that "it was important to gather [these] activities in one concept. The concept that I thought could be appropriate was Kristianstads Vattenrike." The area's "water" became the common denominator linking the projects.

The first thing SEM did was garner support for the EKV by focusing on "strong individuals in key organizations." This focus on establishing a close relationship and trust with key individuals was to become an important strategy for the EKV (S-E. Magnusson, H. Cronert, and K. Magntorn. *Lokal samverkan i Kristianstads Vattenrike* [Local collaboration in Kristianstads Vattenrike], *unpublished EKV report*; Hahn et al., *in preparation*). His initial contacts who supported the EKV project and were willing to collaborate in some form included:

- a researcher at the University of Lund who was interested in linking a research project on nutrient loads from agriculture around Kristianstad and their effects on the Hanö Bay to the EKV;
- an official at the World Wildlife Foundation (WWF) Sweden interested in the project's nature conservation aspects;
- the rector and a senior lecturer at the Kristianstad University interested in the EKV's focus on research, education, and pedagogy;
- an hotel director and former president of the Kristianstad Tourism Board intrigued by the EKV's potential to attract tourists; and
- the director of the National Museum of Natural History who was interested in the ecomuseum.

These individuals represented the main overarching goals in a vision for the future development of KV identified by the EKV: environmental protection, nature conservation, tourism, pedagogy, and education, and the creation of an outdoor museum (Fig. 4). These focus areas formed the structure of the EKV when it was established in 1989 (cultural history was added after the inception). By early 1988, the term EKV, Ecomuseum Kristianstads Vattenrike, had already come to represent not just an outdoor museum project but also an organization working to initiate, improve, and build upon ecosystem management of the catchment of the lower Helgeå River. However, the name has been retained.

With the support of these five individuals in hand, SEM prepared the first proposal to charter the EKV in late 1988. The purpose of creating the EKV, according to the proposal, was to:

- address links between humans and nature;
- highlight the connection of the wetlands to the surrounding landscape and the sea;
- inform the public about ongoing activities; and
- increase the understanding and appreciation of the values of the area.

This proposal was aimed at the municipality, the County Administrative Board, and several other potential collaborators and financial backers. The proposal covered social, economic, and ecological aspects for managing the wetland landscape. SEM used these in one-on-one encounters, focusing on specific parts of the proposal that might interest the person in question. The proposal also included information on values, threats, and potential of the wetland area. It pointed out the important role of the EKV in conflict resolution, coordinating activities, information sharing, and developing overall goals for managing the wetland ecosystems. SEM notes that "some of these were new strategies that had not yet been tried." In the proposal, it was also argued that there was enough existing knowledge among local actors to enable immediate action to start the project.

As described above, SEM led the process of organizing change and by late 1988–early 1989, SEM had assembled a broad base of support for the EKV from several key individuals within various key organizations at different levels in society. These supporters included representatives from local groups such as environmental organizations, the

Bird Society of Northeastern Scania, and farmers' associations. It also included other actors such as the municipality, the County Administrative Board, WWF Sweden, the National Museum of Natural History, and a national research council (FRN). These individuals became the nodes of an emerging social network. This network is an important factor for the organizational flexibility and dynamics for managing the ecosystems of KV today (Hahn et al., *in preparation*).

ESTABLISHING THE EKV—USING A WINDOW OF OPPORTUNITY

A crucial meeting occurred in October 1988 between SEM and a senior municipal politician who was presented with the EKV idea. The politician was enthusiastic about the holistic approach and the suggested name "Kristianstads Vattenrike." The politician notes that "SEM presented the area in a different way than anyone had done before and I became aware of the values. Many considered the wetlands as a problem....SEM presented a nature conservancy plan that didn't close the area but opened it up and made it accessible for the public". He continues, "I was impressed by the way SEM marketed the idea and the broad support he had. He managed to engage and involve several important groups in the project, even farmers."

The politician in turn convinced the chair of the municipal executive board to support it. These two individuals were instrumental in implementing the EKV; according to SEM, "these were the only two at the municipality that were able to get the stone rolling at the time." They were convinced that the issue of improved management of the wetlands of the lower Helgeå River was pressing. According to SEM, "they realized that the values of these areas were threatened and that the wetland ecosystems could serve humans by providing both recreational opportunities and nitrogen reduction." It provided a *window of opportunity* to establish the EKV and realize the idea of a flexible and collaborative management of the ecosystems of KV (Fig. 5). A press release (February 1989) was used to anchor the idea of the EKV with the general public and to show the broad support for the project.

In March 1989, the Municipality of Kristianstad assumed responsibility for running the Kristianstads Vattenrike project and granted funding for a small group of people to develop the EKV idea further. SEM was appointed project leader and tasked with identifying a suitable location and budget for a wetland center, which was part of the original idea (the center was never realized due to financial constraints). At this point, SEM and the EKV project were still associated with the County Museum. However, as indicated in interviews with both SEM and the municipal politician, the idea did not have support from the museum board, which led to SEM and a colleague (an exhibition designer) resigning from the County Museum in August 1989. However, the Municipal Executive Board was in favor of the EKV project and its vision, and SEM and his colleague from the County Museum became part of the municipality organization, where they started to work September 1, 1989. The municipality established an EKV office that still functions as a meeting place and workshop for building material for wetland exhibitions. In hindsight, SEM argues that "becoming part of the municipality organization was better for the EKV project as the municipality is a major landowner in the [KV] area. The County Museum neither owns land nor has the broad competencies or economic resources important for implementing a project like the EKV that a municipality can provide."

The initial funding for the EKV depended on the willingness of actors to contribute to the process. Different parts of the EKV project appealed to different sponsors and all sponsors made their support conditional on broader participation by other sponsors. Sponsors and other collaborators were approached individually and were given presentations on whichever aspect of the project was deemed to be appealing to them and their specific interests. This is also linked to the trust-building process and the focus on "strong individuals in key organizations" mentioned above. For example, the municipality was interested in "putting Kristianstad on the map," strengthening Kristianstad's image and sense of identity. The County Administrative Board was interested in nature conservation and regional development aspects. The municipal politician we interviewed noted that "Kristianstad was relatively unknown except for its military base but we did not think that this was appropriate....We needed something else." The WWF was interested in supporting biodiversity within the flooded meadows. SEM argues that "the key was to avoid a one-size-fits-all proposal that would be so neutral that nobody would be interested. Instead I had to approach each person and identify what their specific needs and interests might be and emphasize the parts of the [EKV] project proposal that they could identify with and find of interest."

SEM established an agreement that the municipality would hire a person to start an EKV project on restoring flooded meadows as part of the EKV if the County Administrative Board would contribute and fund an adviser/administrator for a year. The funding from the County Administrative Board was provided by the sitting County Governor who notes that "we thought it was a good idea to use the environment and tourism to put Kristianstad on the map....we used a regional development fund to finance the project." However, although this financed the EKV's administration, there was still no funding for such activities as fencing and clearing. The WWF, which formed part of the emerging network, was willing to fund the remaining part of the project on the condition that the municipality and the County Administrative Board funded the administration.

BUILDING RESILIENCE OF THE DESIRED STATE AFTER INCEPTION

Since its inception, the work of the EKV has developed into a flexible collaborative approach for managing the ecosystems of KV. It includes actors at several levels in society, from local to international (Table 1). We have described elsewhere some conditions that can facilitate the emergence of adaptive co-management arrangements (Olsson et al. 2004) and showed how these conditions are important for building resilience in the social-ecological system. These include leadership and trust, enabling legislation that creates social space for ecosystem management, funding for response to environmental change and for remedial action, monitoring and responding to environmental feedback, facilitating information flow through social networks, combining various sources of information and knowledge, understanding, and establishing arenas for collaborative learning of ecosystem management. The new management of wetland ecosystems seems to meet these conditions and the process is characterized by turning problems into possibilities. In the following section we describe how these conditions are reflected in the KV case study. In Table 2 we identify three sets of essential social-ecological processes and the underlying strategies that were used to create those conditions. We argue that these processes and strategies are essential in building resilience of the new stability domain or desired trajectory.

The EKV, together with other actors, operates within existing polycentric governance structures (in the sense of McGinnis 2000) involving different levels of society. Hence, development of the adaptive co-management system did not involve the creation of new institutions but rather a reorganization within existing institutional frameworks. This reorganization was guided by a shared vision and involved connecting and coordinating ongoing activities. This means that the change in behavior observed among actors in the area was not due to enforcing rules and regulations but creating incentives for individual action and involvement. Incorporating the EKV as an organization within the Municipality of Kristianstad created space for self-organization and development of social networks across scales for ecosystem management. The legitimacy of municipal support made it possible to coordinate information and start collaborative processes that we argue are necessary for ecosystem management, yet allowed the EKV to maintain the flexibility of a semiautonomous organization.

The main financial contributors when the EKV was initiated were the Municipality of Kristianstad, the County Administrative Board, World Wildlife Foundation Sweden, and the National Cultural Advisory Board (*Statens Kulturråd*). Their support provided fertile ground for the self-organization process and the organizational change. It also made the EKV vulnerable to external factors that affect funding, such as a new chair of the Municipality Executive Board, as the EKV is dependent on their support. The municipal politician interviewed in this study was chair from the mid 1990s until 2002 and has continued to support the EKV. To ensure the continuation of the EKV and their work, the politician has, as he puts it, "convinced my successor of the importance of the EKV." In order to stabilize the system, one of SEM's strategies has been to encourage local actors to tailor the production of inventories and other material planned within their own organizations such that it may be used as an input to the EKV analyses. This allows the EKV to benefit from a diversity of existing funding sources.

The activities in the different sections of the EKV are project based and framed by the availability of a regular funding stream. Since the start in 1989, the sections have been more or less active, depending on focus, available funding, and availability of a suitable person to manage the issue. SEM argues that "this provides flexibility and opportunities to test new ideas and projects, but it also put pressure on us to constantly hunt for money." Such opportunities provide the basis for self-organization and the capacity for learning and adaptation.

The EKV has been involved in numerous inventories since its inception. These inventories are part of generating new ecological knowledge for the local collaboration process. It is also part of the follow-up and progress of various projects. The mapping of flooded meadows in 1989 provided information necessary for quantifying ecosystem change and demonstrating the imminent ecological crisis. This information was also crucial for responding to ecosystem change, particularly by preventing wetland ecosystems from entering undesired states. The response to the threat of the flooded meadows becoming overgrown was to create social structures and processes to secure their continued cultivation. This was also important for enhancing the declining bird populations that depend on flooded meadows. A mapping of land-use practices conducted in 1996 revealed that the area of flooded meadows used for haymaking and grazing had increased from 1200 to 1400 ha since 1989 (Wendt-Rasch and Cronert 1996). Also, a higher proportion of well cultivated areas was found. Other inventories concern reserves (Wallensten and Cronert 2000, Svensson 2002). By 1991, 170 ha within the Ramsar Convention Site were protected in nature reserves (Cronert 1991) and by 2002 this figure had grown to 480 ha (from the Ecomuseum Kristianstads Vattenrike home page). An inventory of bird populations of flooded meadows within KV in 1997 (Cronert and Lindblad 1998) indicated that several European bird species, some of which were threatened, had increased their population since the EKV was established in 1989. These inventories are initiated and designed by the EKV, often in collaboration with the WWF, the County Administrative Board, the Municipality of Kristianstad, bird societies, and the Swedish EPA. Often, scientists or consultants are hired to conduct these inventories. In the

case of increased nutrient loads to the Hanö Bay and increased levels of nitrates in the groundwater, the response was to reduce nitrogen by experimenting with various ways of using wetlands as filters. The results from the monitoring, inventories, and mapping are communicated to a variety of actors, including the general public, using the outdoor museum sites, local and regional media, and the Internet as important tools. In this way, the EKV continuously conducts inventories to increase ecological knowledge in order to fine-tune management practices and associated institutional and organizational structures to the ecosystem dynamics. Creating such feedback loops is a prerequisite for managing complex systems sustainably (Levin 1999).

The EKV maintains a close collaborative relationship with the farmers, making use of their knowledge and understanding of agricultural practices that have often been developed and passed on from generation to generation. An example is the adjustment of grazing pressure on flooded meadows in relation to biodiversity. If the ground is only grazed by cattle, it takes on a tussocky surface; if it is grazed by horses, it develops a smooth, even surface (or, instead of horse grazing, the flooded meadows can be mowed to achieve the same result). Some bird species are dependent on a mixture of the two types of surfaces. The use of horses is returning in the landscape after declining up until the 1970s (Larsson 1972, Helldén 1984). The EKV uses inventories (e.g., von Proschwitz 2001, Ljungberg 1995) to increase farmers' awareness of the unique values of their land in a larger context. The inventories and the farmers' knowledge are important for continuously "fine-tuning" management practices as part of the learning process to achieve goals.

The Ecomuseum Kristianstads Vattenrike has demonstrated an ability to respond to environmental feedback and to develop new knowledge and understanding about ecosystem management needs. Although the initial work of the EKV was concentrated on flooded meadows, it has gradually expanded its management focus and has initiated new projects. Examples of such projects include reintroducing the white stork (*Ciconia ciconia*) and the European catfish (*Silurus glanis*), dealing with the problem of increasing numbers of cranes (*Grus grus*) and geese (*Anser anser*) and the damage they cause to standing crops, protecting and restoring tributaries of the Helgeå River, and managing floods. As these projects include international associations, national, regional and local authorities, researchers, non-profit associations, and landowners, the network of collaborators has also expanded.

The EKV is currently broadening its response to change in ecosystems outside the Ramsar Convention Site (RCS). Although KV is a well-defined area (see Fig. 1) there is confusion between the KV area (the catchment of the lower Helgeå River) and the RCS. Many of the EKV activities have focused on areas within the RCS as it is a well-defined area for which it has been easier to obtain project funding. It has been more difficult for the EKV to implement projects outside of the RCS wetlands, although project leaders have identified a need to focus on links between the wetlands and the surrounding landscape. The KV is in the final stages of becoming a Man and Biosphere (MAB) reserve/area; currently, it is wrestling with the zoning issues. SEM believes that making KV a MAB area will help expand the focus of activities to the surrounding areas, including the sandy grasslands (also referred to as xeric calcareous grasslands), an ecosystem that, from a European perspective, is even more unique than the flooded meadows. Within the MAB area it will be possible to connect landscape elements that are linked through ecological and hydrological processes and that have been historically and culturally linked through agricultural practices, such as the flooded meadows of the Helgeå River and the outlying grazing areas (*enefälad*) on the Linderödsåsen ridge (Magnusson 1995).

The capacity to address the range of issues involved with ecosystem management is dispersed over a range of actors at different levels in society. Therefore, rather than trying to develop expertise in all issue areas himself, SEM developed social networks to coordinate activities and exchange information about managing the wetland ecosystems of the lower Helgeå River catchment. Knowledge is mobilized through the networks and complements and refines local practices for ecosystem management. The network was first developed to assist with the mapping of land-use practices in order to show ecosystem change. It was subsequently expanded to establish the EKV and the knowledge that exists within the network was used to change municipal policy for managing the wetland landscape. The social network also helps mobilize funding at critical times. It connects institutions and organizations across scales and has continued to develop in response to new problems and challenges emerging in KV. Members facilitate information flows, identify knowledge gaps, and create nodes of expertise of significance for ecosystem management.

SEM played a key role in combining several sources of information and knowledge systems in a local context. At the County Museum, SEM combined information and knowledge of ecology, geology, and cultural history of the landscape used in exhibitions and outdoor museums to help people interpret the landscape around them. In mapping the flooded meadows used for grazing and haymaking, SEM combined his own local, fine-grained knowledge and experience and that of the BSNES with more general, coarse-grained information, such as scientific articles, EPA reports, and other writings on the management of flooded meadows for bird fauna. In the project proposals, SEM compiled and combined information from ongoing projects in the area. All these steps were necessary to address the complex social-ecological interactions of the lower Helgeå River catchment.

SEM plays a key role in compiling knowledge and information from various sources and interpreting and making

sense of it. He interpreted ecosystem changes and created a meaningful order that was captured in the project proposals used as a call for action. SEM provided skills and leadership, which are essential components in the sense-making process for the management of complex social-ecological systems (Westley 2002). With a clear vision, compelling arguments, and good relations with actors, he mobilized several interest groups including landowners to start a self-organizing process toward adaptive co-management of the wetland ecosystems. SEM's leadership is not one of controlling and forcing actors to change behavior, but rather one of inspiring and encouraging them, creating incentives for individual action and involvement.

The geographic area defined as Kristianstads Vattenrike provides the arena for collaboration where different interests are represented. SEM states "collaboration is a necessary process to reach the goals set for KV and to achieve sustainable results." SEM believes that " *not* being an authority is a prerequisite for gaining enough trust among local actors to lead local collaboration processes." However, there have been proposals to make the EKV into a municipal administration rather than a municipal organization which could destabilize the system.

The structure of the EKV was based on SEM's conviction that the complexity of the issues of managing the wetland ecosystems of the lower Helgeå River required a coordinated effort involving a range of actors at different levels in society and representing a variety of interests. Depending on the type of problem arising in Kristianstads Vattenrike, various affected actors are gathered by the EKV to be part of the process of solving the problem. The EKV acts as a facilitator and coordinator in such an event. The actors are part of the planning, implementing, monitoring, and evaluating phases of the learning process, and management practices emerge and are revised through this process. Regular meetings of a reference group established at the beginning of the 1990s within the nature conservancy section of the EKV are meant to forestall conflict and in this way produce mechanisms for conflict management. This group included individuals representing various organizations and interests from the local and regional levels. SEM says that "the purpose was to gather representatives involved in activities that had links to the water of the Kristianstads Vattenrike and who had not met earlier in a common forum. Before, often the only time they were in contact with each other was during a conflict arising on the letters page of the local newspapers." He notes that the EKV led the process of "identifying common interests and discussing differences of opinion in a constructive way." This also built trust among the representatives, essential to the success of the collaboration process. As SEM argues, "to start discussing collaboration during a conflict situation is not a good strategy." Formal agreements and action programs emerge from these collaborative processes. These in turn lead to a change in behavior and practices in order to improve management of wetland ecosystems. This has been referred to as "open institutions" (Shannon and Antypas 1997). SEM argues that "this is a faster and more long-lasting way to achieve our goals than making authorities develop rules that force people to change their behavior." This way, the EKV plays a key role in a process of turning problems into possibilities to continuously build capacity for ecosystem management.

SOCIAL-ECOLOGICAL TRANSFORMATION

The new management system seems to meet the conditions defined by Olsson et al. (2004) for the development of adaptive co-management of ecosystems. This article shows how a social-ecological transformation "created" those conditions. The transformation that changed the management of the lower Helgeå River catchment involved three phases: 1) preparing the system for change, 2) using a window of opportunity, and 3) building resilience of the desired state after inception of the EKV.

As Fig. 6 shows, the first phase of the transformation included:

- building ecological knowledge;
- developing social networks; and
- providing vision and goals in a comprehensive framework.

The process of preparing and communicating the proposal served to build a broad support for organizational change among a range of actors at different levels in society. At the same time, it also helped link people, developing social networks important for mobilizing knowledge at critical times. Several of the resilience-building strategies used in the ongoing work of the EKV since its inception (Table 2) were developed during the preparation phase.

Phases 1 (the preparation) and 2 (the window of opportunity) of the transformation can be analyzed using insights from the policy change literature. Key stewards such as SEM have been referred to as "policy entrepreneurs" (e.g., Shannon 1991, Kingdon 1995). Kingdon (1995) identifies key roles for the policy entrepreneur in combining three streams: policy proposals, problem perception, and political momentum to achieve policy change.

The proposal was used to increase problem perception among a wider array of people and organizations at

The proposal was used to increase problem perception among a wider array of people and organizations at different levels in society. This made people aware not only of the ecological problems and values in the area but also of the lack of coordination of ongoing activities. Broad support was important for securing funding for the project, as the commitment of each sponsor was contingent on the commitment of others. The proposals and the engagement and support of a wide range of individuals and organizations at an early stage in the development of the EKV idea helped gain political momentum when the policy window opened.

The policy change by the Municipality of Kristianstad to adopt a flexible and collaborative approach for managing the catchment was accompanied by organizational change with the inclusion of the EKV into the municipality's organization. Support from the municipal executive board was absolutely necessary for the establishment of the EKV and the adoption of an adaptive co-management approach. SEM believes that the window of opportunity was only open during a very short period in the late 1980s; "if we had not taken the chance then, we would still be knocking on the door today." By emphasizing the values of the area and the threats to these values, SEM convinced key politicians that the issue of managing the wetlands of KV was pressing. Such a shift in value system resembles an event that Kingdon (1995) refers to as a problem-driven window opener. According to Kingdon (1995), two things may open a policy window: either decision makers become convinced that a problem is pressing and seek a policy (problem-driven window), or they adopt a theme for their administration and look for problems that may justify change and proposals that are along the theme (political-driven window). Kingdon (1995) states that "the [policy] window opens because of some factor beyond the realm of the individual entrepreneur, but the individual takes advantage of the opportunity ... [policy entrepreneurs] develop their proposals and then wait for problems to come along to which they can attach their solutions or for a development in the political stream like a change of administration that makes their proposals more likely to be adopted."

We have identified four circumstances that were helpful in opening such a window of opportunity and placing the management of KV on the municipal political agenda:

- Local politicians were keen to find a profile for the municipality, "to put Kristianstad on the map."
- The politician interviewed in this study had, like SEM, been working at the County Museum in 1975–1976. Through his contact there, he knew of SEM as a reputable entrepreneur.
- The proposed ecomuseum was a novel device with good potential for local recreation and eco-tourism.
- Environmental questions had been particularly emphasized during the national Swedish election in September 1988. No other question had received as much attention in Sweden, with 46% of the population stressing environmental issues as the most important political issue (Bennulf 1994).

One-on-one dialogue with individuals representing various organizations has been mentioned earlier as one of SEM's strategies to secure the participation of collaborators (Fig. 7). Such dialogues with municipal politicians may also have been important in helping SEM identify the policy window.

SEM took advantage of the policy window to push the EKV project proposal. The proposal contained a compilation of knowledge to convince decision-makers of the need for improved management of the wetland landscape. It was based on a systems approach, addressing complex interactions across spatial and temporal scale in social-ecological systems. This proposal was the basis for the municipality's policy change. The development process of the proposal, with its vision for the future, has similarities to scenario-building processes (Bennett et al. 2003).

Although SEM played a key role through all the phases of the transformation, he did not act alone. However, he provided leadership and led the transformation. Key stewards like SEM often initiate key processes that are required in ecosystem management (see, e.g., Pinkerton 1998, Westley 2002). Individual actors serve as key players in institution building and organizational change in relation to ecosystem dynamics and facilitate horizontal and vertical links in the adaptive co-management process (Folke et al. 2003, Olsson et al. 2004). SEM's work in linking people and activities formed part of the strategy to create social networks drawing on several sources of knowledge, solve complex problems, and stimulate engagement in adaptive co-management of the wetland landscape. The proposals and the trust-building process were important for mobilizing people in these networks and creating vertical and horizontal links. In such a way, key stewards within social networks can establish functional links within and between organizational levels in times of change and facilitate the flow of information and knowledge applied in the local ecosystem management context. Others have also emphasized the importance of social networks in ecosystem management and for dealing with uncertainty and change (e.g., Shannon 1998, Wilson 2002).

Westley (2002) argues that the capacity to deal with the interactive dynamics of social and ecological systems requires the entire network of interacting individuals and organizations at different levels to create the right links, at the right time, around the right issues. SEM used the window of opportunity to push through the social networks and actions prepared in Phase 1 and establish the EKV, which enabled the creation of cross-scale links. In this way, the transformation to a completely new approach to landscape management was initiated in the region.

This new management involves practices that seem to build resilience of the social-ecological system through adaptive co-management. Some of these practices are summarized in Table 2 and further analyzed in Hahn et al. (*in preparation*). The social arrangements for managing the wetland landscape that emerged in Kristianstads Vattenrike after the window of opportunity opened can be referred to as policy communities. A policy community has been defined as "a diverse network of public and private organizations generally associated with the formation and implementation of policy in a given resource area....Policy communities are interactive networks of alliances around common interests" (Shannon 1998). The policy communities of Kristianstad Vattenrike are framed in local ecosystem contexts; they recognize site-specific environmental and social conditions and link local, regional, and national levels. Haas (1992) referred to such multi-level arrangements that link institutional and organizational structures across scales as "epistemic communities" and gives an example of a group of scientists, government experts, and NGO representatives that enabled the Mediterranean Action Plan. Policy communities often have no formal power sharing but rather operate within an existing institutional framework in polycentric governance structures, which implies that there are no formal rules that force actors to collaborate. However, it seems that, in the case presented here, institutional arrangements such as formal agreements between parties can emerge from the collaborative processes. It is an example of open institutions (Shannon and Antypas 1997), with the potential to provide flexibility and build adaptive capacity through social learning (Folke et al. 2003).

This case also supports the argument of Olsson et al. (2004) that it is difficult for one person to have all relevant knowledge for ecosystem management. Instead of attempting to provide all the necessary knowledge, SEM and the staff at the EKV play an important role in making sense of and managing knowledge, synthesizing a variety of information into what Waltner-Toews et al. (2003) refers to as a coherent collective narrative. SEM is also responsible for the strategies used to form and operate the EKV. These involve press and public relations, marketing, and maintaining a dialogue with key actors, including the media, to identify interests, build trust, facilitate collaboration, and forestall conflict.

Ecosystem management requires a multi-scale approach. The problem of the mismatch of scales between social and ecological structures and processes has been addressed by Lee (1993a) and has been referred to as a problem of fit by Folke et al. (1998). In the case presented here, scale-matching involved defining an area for ecosystem management, coordinating information flow, and initiating collaborative processes. SEM and the EKV are important in the process of expanding management structures to meet new challenges of matching social and ecological dynamics. Such expansion is needed when prevailing management structures become insufficient to address functional links in the landscape, for example between sandy grasslands and flooded meadows. The first step in this process was the creation of the EKV. The next step will be the establishment of a MAB area, which could provide an opportunity to address social-ecological dynamics at other scales. The preparation for implementing a MAB area started in 1989 and has been a continuous process of knowledge accumulation through thorough inventories in collaborative processes. These steps are examples of how knowledge generation of ecosystem dynamics is explicitly integrated and evolves with the institutional and organizational structures and processes of ecosystem management.

CONCLUSION

We have shown how adaptive co-management has emerged through self-organization processes, initiated by key stewards, to fit context-specific problems and needs. The perception of a crisis in the resource triggered action, a key steward provided leadership, vision, and trust and developed and mobilized social networks, a brief social and political window of opportunity opened at a critical time, and broad support was created for a new management approach among a range of actors at different levels in society.

The key steward organized information in a comprehensible framework with vision and goals, which contributed to the shift in perception among key actors of the values of the wetland landscape. The contact with a local top politician provided a cross-scale link at a critical time and the new perception and values were incorporated into the ongoing work of the Municipality of Kristianstad. It allowed the creation of the EKV and the development of an adaptive co-management approach to the wetland landscape.

The system transformed into a new configuration, a new stability landscape. The capacity to create such a new stability landscape is known as transformability (Walker et al., *in preparation*). New variables are introduced and allowed to cascade through and transform a social-ecological system at several levels, referred to as a "revolt" connection between different scales (Gunderson and Holling 2002, Berkes et al. 2003).

As stated in the introduction, transformability can be understood as the capacity to initiate social transformation that moves away from unsustainable and undesired trajectories, toward new social-ecological trajectories that strengthen and enhance management of desired ecosystem states and associated values. The self-organizing process that followed the rapid transformation in 1988–1989 developed into an adaptive co-management system

with numerous social links across scales. The knowledge generation, creating functional feedback loops, social network building, and collaborative learning processes initiated by the key steward helped build resilience of the new social-ecological stability landscape.

The study illustrates that social and ecological systems are linked, which implies that losing key structuring social variables could affect the ecosystem state as much as losing key structuring ecological variables (Bodin and Norberg, *in preparation*). Hence, the erosion or loss of a key social variable such as trust (e.g., Shannon 1998, Pretty and Ward 2001) not only jeopardizes collaboration processes (Baland and Platteau 1996) but also the ability to develop desired ecosystem states and to store and enhance adaptive and transformative capacity. Systems that rely on one or a few key stewards may be vulnerable to change (Olsson and Folke 2001). This is exemplified by Peterson (2002a) who describes the management of the long-leaf pine forest in Florida and how the desired state or the stability domain of the forest is maintained by fire as a main structuring variable. Fire frequency has decreased in the area and long-leaf pine forest ecosystems, therefore, risk entering into other less desired ecosystem states (Peterson 2002b). The forest is located within a military base and an U.S. Air Force general had become a key steward for maintaining the forest through active burning. When the general left his position, a new general who did not share the knowledge of his predecessor replaced him. However, some of the personnel who had taken an active part in ecosystem management had developed an organized knowledge of long-leaf pine forests. They also used a scientist's model of forest dynamics (Hardesty et al. 2000) to successfully convince the new general of the importance of fire management for maintaining the desired stability domain of a long-leaf pine forest ecosystem. This example shows how structures and processes can provide a social memory (McIntosh 2000) of ecosystem management that sustains adaptive capacity in times of change, and that may provide the seeds for transformability.

The development of the adaptive co-management system of Kristianstads Vattenrike was probably most vulnerable during the initial phase of its existence, when the transformation into another configuration of the social-ecological system took place. If the key steward had moved or for some other reason disappeared at this point, the direction of management would have been highly uncertain and the transformation might have taken other pathways. However, the change of policy by the Municipality of Kristianstad initiated social learning (Lee 1993b) and collective action for ecosystem management. In this process, knowledge of ecosystem dynamics developed as a collaborative effort and became part of the flexible organizational and institutional structures of the adaptive co-management system. Such structures include the organization of the EKV and the wider social networks of individuals and organizations that have participated in various projects over the years.

Over time, the ability to deal with change and uncertainty seems to have improved (Hahn et al., *in preparation*), which increases the capacity to deal with future change (Folke et al. 2003). In this way, one may speculate that the development of the adaptive co-management system in Kristianstad, following its initiation about 15 years ago, has reached a state of social-ecological resilience. It may have become robust enough to absorb changes that previously would have threatened its existence.

We suggest that the existence of social mechanisms for transformability, such as those identified in this article, is essential to move away from a less desired trajectory toward a social-ecological one with the capacity to manage ecosystems sustainably for human well-being. Adaptability will be needed to strengthen and sustain such a desired state and make it resilient to future change and unpredictable events.

RESPONSES TO THIS ARTICLE

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