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Insight, part of a Special Feature on Scale and Cross-scale Dynamics

Enhancing the Fit through Adaptive Co-management: Creating and Maintaining Bridging Functions for Matching Scales in the Kristianstads Vattenrike Biosphere Reserve, Sweden

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ABSTRACT. In this article, we focus on adaptive governance of social–ecological systems (SES) and, more specifically, on social factors that can enhance the fit between governance systems and ecosystems. The challenge lies in matching multilevel governance system, often characterized by fragmented organizational and institutional structures and compartmentalized and sectorized decision-making processes, with ecosystems characterized by complex interactions in time and space. The ability to create the right links, at the right time, around the right issues in multilevel governance systems is crucial for fostering responses that build social–ecological resilience and maintain the capacity of complex and dynamic ecosystems to generate services for human well-being. This is especially true in the face of uncertainty and during periods of abrupt change and reorganization. We draw on our earlier work in the Kristianstads Vattenrike Biosphere Reserve (KVBR), in southern Sweden, to provide new insights on factors that can improve such linking. We focus especially on the bridging function in SES and the factors that constrain bridging in multilevel governance systems, and strategies used to overcome these. We present two features that seem critical for linking organizations dynamically across multiple levels: 1) the role of bridging organizations and 2) the importance of leadership. Bridging organizations and the bridging function can be vulnerable to disturbance, but there are sources of resilience for securing these key structures and functions in SES. These include social mechanisms for combining multiple sources of knowledge, building moral and political support in social networks, and having legal and financial support as part of the adaptive governance structure.

Key Words: *adaptive co-management; adaptive governance; cross-level links; cross-scale interactions; ecosystem management; resilience; social–ecological systems; social networks*

INTRODUCTION

Current approaches for managing ecosystems often fail to match social and ecological structures and processes operating at different spatial and temporal scales (Folke et al. 1998, Berkes and Folke 1998, Carpenter and Gunderson 2001, Berkes et al. 2003). They are often unable to deal with the change and uncertainty inherent in social–ecological systems (SES). The mechanism behind this management failure lies in the attempt to control a few selected ecosystem variables in their efforts to deliver efficiency, reliability, and optimization of ecosystem goods and services (Holling and Meffe 1996). However, stabilizing a set of desirable goods and services can lead to increased vulnerability of the system to unexpected change (Folke et al. 2003, Gunderson and Holling 2002). For example, Wilson (2006) argues that this mismatch of ecological and management scales makes it difficult to address the fine-scale aspects of ocean ecosystems, and leads to fishing rights and strategies that tend to erode the underlying structure of populations and the system itself.

The mismatch between ecological and social dynamics is referred to as the problem of fit (Folke et al. 1998, Young 2002, 2003). A major challenge concerning the problem of fit lies in addressing the governance dimension of ecosystem management and the social factors that enable such management. This includes factors that stimulate the development

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of institutions that respond to environmental feedbacks and that maintain the capacity of ecosystems to generate services for human well-being (Folke et al. 1998). It also includes social factors for monitoring ecosystem change and for generating, accumulating, and transferring ecological knowledge and understanding.

A theoretical framework for analyzing interconnected SES that focuses on resilience and social features that enable ecosystem management is developing (see, e.g., Berkes and Folke 1998, Gunderson et al. 1995, Gunderson and Holling 2002, Berkes et al. 2003). This has triggered a number of studies that focus on various aspects of social–ecological interactions and cross-scale links, such as spatial dynamics (Wilson et al. 1999), vertical institutional links and co-management (Berkes 2002), policy networks (Shannon 1998), institutional redundancy (Low et al. 2003), the role of institutional entrepreneurs (Westley 2002), and networks (Janssen et al. 2006).

Folke et al. (2003) identify four critical factors for SES that interact across temporal and spatial scales that seem to be required for dealing with ecosystems dynamics during periods of rapid change and reorganization: 1) learning to live with change and uncertainty, 2) combining different types of knowledge for learning, 3) creating opportunity for self-organization toward social–ecological resilience, and 4) nurturing sources of resilience for renewal and reorganization. In this article, we focus on the mechanisms for facilitating the interaction between these factors and for improving the capacity for dealing with abrupt change and uncertainty.

The shift from approaching social and ecological systems as two linked but essentially separate systems to approaching them as truly interconnected complex SES has also triggered the emergence of analytical frameworks such as adaptive co-management and adaptive governance The former refers to management systems that are tailored to specific places and situations, and supported by, and working with, various organizations at different levels. Adaptive co-management combines the dynamic learning characteristic of adaptive management (sensu Holling 1978) with the link characteristic of collaborative management (Wollenberg et al. 2000, Gadgil et al. 2000, Ruitenbeek and Cartier 2001, Folke et al. 2003, Borrini-Feyerabend 2004). Although it provides an analytical framework for studying complex social–ecological interactions (Folke et al. 2003, Olsson et al. 2004a, Armitage et al. 2007), there is a need to develop this framework further in order to address the governance dimension of SES and the capacity to deal with uncertainty and change inherent in these systems.

We have earlier argued for adaptive governance as a form of governance suitable for dealing with complex SES and enhancing the fit between institutions and ecosystem dynamics (Olsson et al. 2004b, Folke et al. 2005). Adaptive governance conveys the difficulty of control, the need to proceed in the face of substantial uncertainty, and the importance of dealing with diversity and reconciling conflict among people and groups who differ in values, interests, perspectives, power, and the kinds of information they bring to situations (Dietz et al. 2003). Such governance fosters social coordination that enables self-organization and adaptive co-management of ecosystems. For such governance to be effective, it requires an understanding of both ecosystems and social–ecological interactions.

Governance systems designed to deal with complexity often rely on multilevel arrangements, including local, regional, national, transnational, and global levels, where authority has been reallocated upward, downward, and sideways away from central states (Ostrom 1983, Stoker 1998, Hooghe and Marks 2003, van Kersbergen and van Waarden 2004). This type of governance is dispersed across multiple centers of authority, is "pluricentric" rather than "unicentric," and is characterized by non-hierarchical methods of control. The common property resources research refers to such nested, quasi-autonomous, decision-making units operating at multiple scales as polycentric institutions (e.g., Ostrom 1998, McGinnis 2000, Dietz et al. 2003).

It has been proposed that polycentric structures can address environmental problems at multiple scales and nurture diversity for dynamic responses in the face of rapid change and uncertainty. Simple, large-scale, centralized governance units do not, and cannot, have the variety of response capabilities that complex, polycentric, multilevel governance systems can have (Ostrom 1998). Similarly, Imperial (1999) argues that polycentric governance creates an institutionally rich environment that can "encourage innovation and experimentation by allowing individuals and organizations to explore different ideas about solving [complex] problems."

Such arrangements can enable self-organization and nurture sources of renewal and reorganization after crisis.

However, the governance challenge lies not only in developing multilevel institutions and organizations for multiscale ecosystem management, but also in being in tune with the interplay between periods of incremental change, when things move forward in roughly continuous and predictable ways, and abrupt change, when experience is often insufficient for understanding, consequences of actions are ambiguous, and the future of system dynamics is often uncertain (e.g., Gunderson 1999, Adger et al. 2005). We are particularly interested in avoiding pathways of social–ecological misfits that lead to social traps (e.g., Costanza 1987) and constrained options for societal development and future capacity for adaptations (Gunderson et al. 1995, Gunderson and Holling 2002, Berkes et al. 2003). Understanding how to organize links between relatively autonomous but interdependent actors and actor groups at multiple levels is crucial in this context.

The literature on social capital addresses the linking aspect, or connectedness, and emphasizes the importance of norms and networks for enabling people to act collectively (see, e.g., Woolcock and Narayan 2000, Pretty and Ward 2001). The literature on social capital differentiates between bonding (strong) and bridging (weak) links or ties; networks composed of bridging links to a diverse web of resources can strengthen a community's ability to adapt to change, but networks composed only of local bonding links, which impose constraining social norms and foster group homophily, can reduce adaptability (Newman and Dale 2005). Granovetter (1973) argues that weak ties, i.e. the bridges between different stakeholder groups, may be the most valuable for generating new knowledge and identifying new opportunities, and thus create a macro effect: "those to whom we are weakly tied are more likely to move in circles different from our own and will thus have access to information different from that which we receive." In this paper, we suggest that bridging is a critical function in complex SES for dealing with uncertainty, and for nurturing renewal and reorganization in the face of abrupt change and crisis.

Several studies have looked at the role of social networks in interorganizational collaboration and collective action in relation to natural resource management (see, e.g., Agranoff and McGuire 1999, 2001, Mandell 1999, Carlsson 2000, Mandell and Steelman 2003, Imperial 2005). Although these studies address the linking aspect, there is a need to increase the understanding of the role of networks for dealing with uncertainty and abrupt change in SES (Scheffer et al. 2003, Bodin and Norberg 2005, Janssen et al. 2006). We concur with Westley (2002), who argues that the capacity to deal with the interactive dynamics of social and ecological systems requires learning environments and networks of interacting individuals and organizations at different levels to create the right links, at the right time, around the right issues.

A key argument in this respect is that ecosystem management is an information-intensive endeavor and requires knowledge of complex social–ecological interactions in order to monitor, interpret, and respond to ecosystem feedback at multiple scales (Folke et al. 2003). Because of this complexity, it is difficult if not impossible for one or a few people to possess the range of knowledge needed for ecosystem management (Berkes 2002, Brown 2003, Gadgil et al. 2003, Olsson et al. 2004a, Carlsson and Berkes 2005). Instead, knowledge for dealing with SES dynamics, including uncertainty and abrupt change, is dispersed among individuals and organizations in society. It requires social networks that span multiple levels in order for actors to draw on dispersed sources of information and institutional arrangements that enable integration and mobilization of knowledge at critical times (Imperial 1999, Olsson et al. 2006).

Various scholars have pointed out that linking different levels and knowledge systems requires an active role of individuals or organizations, e.g., the role of non-governmental organizations (NGOs) as coordinators and facilitators in co-management processes (e.g., Halls et al. 2005). Another example is the role of intermediaries in linking local communities to outside markets (Bebbington 1997, Ribot 2004, Pomeroy et al. 2006). Crona (2006) refers to individuals that link fishers to markets in coastal communities of East Africa as middlemen. As Gonzales and Nigh (2005) point out, such intermediaries are no guarantee for more democratic decision making, but can be part of hierarchical command-and-control structures where policies are implemented in a top-down fashion.

We draw on our earlier empirical studies in Kristianstads Vattenrike Biosphere Reserve (KVBR), Sweden (Olsson et al. 2004b, Hahn et al.

2006, Schultz et al. unpublished) to provide new insights on social factors that can enhance the fit between governance systems and ecosystems. We focus especially on the bridging function in SES and the factors that constrain bridging in multilevel governance systems, and strategies used to overcome these. The article starts with a description of the KVBR and the emergence of an adaptive co-management system. We identify key features that seem critical for linking organizations dynamically across multiple levels, and discuss the role of these in enhancing the fit between governance systems and ecosystems. Our concluding remarks concern sources of resilience for securing key structures and functions in SES in the face of uncertainty and change.

KRISTIANSTADS VATTENRIKE BIOSPHERE RESERVE

Kristianstads Vattenrike Biosphere Reserve is defined by hydrological and political borders, and includes the lower Helgeå River catchment and the coastal regions of Hanö Bay within the Municipality of Kristianstad. In June 2005, the area became a Man and Biosphere (MAB) Reserve. The lowland area has long been appreciated for its cultural and natural values. Aside from having high biodiversity and unique habitats of cultural–historical values, it is one of Sweden's most productive agricultural areas and also contains one of the largest groundwater reserves in northern Europe. The abundance of valuable ecosystem services generated in the area is also reflected in the range of stakeholders representing different interests, from local farmers to international nature conservation organizations (Olsson et al. 2004b, Schultz et al. unpublished).

The Emergence of a New Management Approach

Since 1989, a flexible collaborative approach to the management of the lower Helgeå River catchment has been in use, which promotes a management that treats humans as part of ecosystems and includes social, economic, and ecological dimensions. This shift in management regime had its beginning in the early 1980s. Several individuals, representing different local organizations, observed a continuing decline in natural and cultural values. This was despite the fact that the area was listed in 1975 by the Ramsar Convention on Wetlands of International Importance. In particular, they observed declining bird populations, decreased water quality, and overgrowth of lakes, and a decrease in the use of flooded meadows for haymaking and grazing.

In response to an anticipated crisis, personal links developed among these individuals, and a social network of concerned individuals and organizations started to emerge. This eventually led to the establishment of a municipal organization, the Ecomuseum Kritianstads Vattenrike (now called the Biosphere Office (BO)), and the transformation of the social–ecological system into a trajectory of adaptive co-management. We have earlier identified the director of the BO, Sven-Erik Magnusson (SEM), as instrumental in this process. He provided transformational leadership and seized the window of opportunity to convince municipal politicians of the need for a new management regime for the lower Helgeå River catchment (Olsson et al. 2004b).

Although there was a change in the management regime for the lower Helgeå River catchment in 1989, various environmental projects had been initiated before that. These projects ranged from biological inventories and monitoring programs to habitat restoration projects and improved land-use practices. For example, in the Kristianstad Project, various management practices for reducing nitrogen and phosphorus loads to the Helgeå River were tested. These practices included restoring water courses, establishing dams, protecting riparian zones, and creating artificially flooded meadows. It was a collaborative project involving land owners, the University of Lund, the Municipality of Kristianstad, the Kristianstad County Agricultural Board, Önnestads Agricultural and Horticultural College, and a local branch of the Federation of Swedish Farmers (LRF). Although these projects involved a diversity of actors at multiple organizational levels, their focus was often narrow (Olsson et al. 2004b). Also, the various projects were often unaware of each other.

Some local actors realized that the problems of declining bird populations, abandonment of management practices for cultivating flooded meadows, and decreased water quality and overgrowth of lakes were interrelated and connected. However, the social structures and processes for dealing with the problems were not.

SEM saw the need to deal with this lack of fit, and initiated strategies to match the scale of the problems and manage the area at the landscape level. At the time, SEM was employed by the County Museum, engaged in developing outdoor museums, and he focused on the flooded meadows in the area. He began to link key individuals of different projects (Fig. 1). He used the area's "water" as the common denominator for linking these projects and managed to change the perception among key actors from seeing the wetlands as a problem ("water sick") to seeing it as a valuable resource ("water rich"). This was not just a process of connecting people, it also involved building trust, compiling and generating ecosystem knowledge, defining an area for management, developing a common vision and goals for ecosystem management, and mobilizing broad support for change (Olsson et al. 2004b).

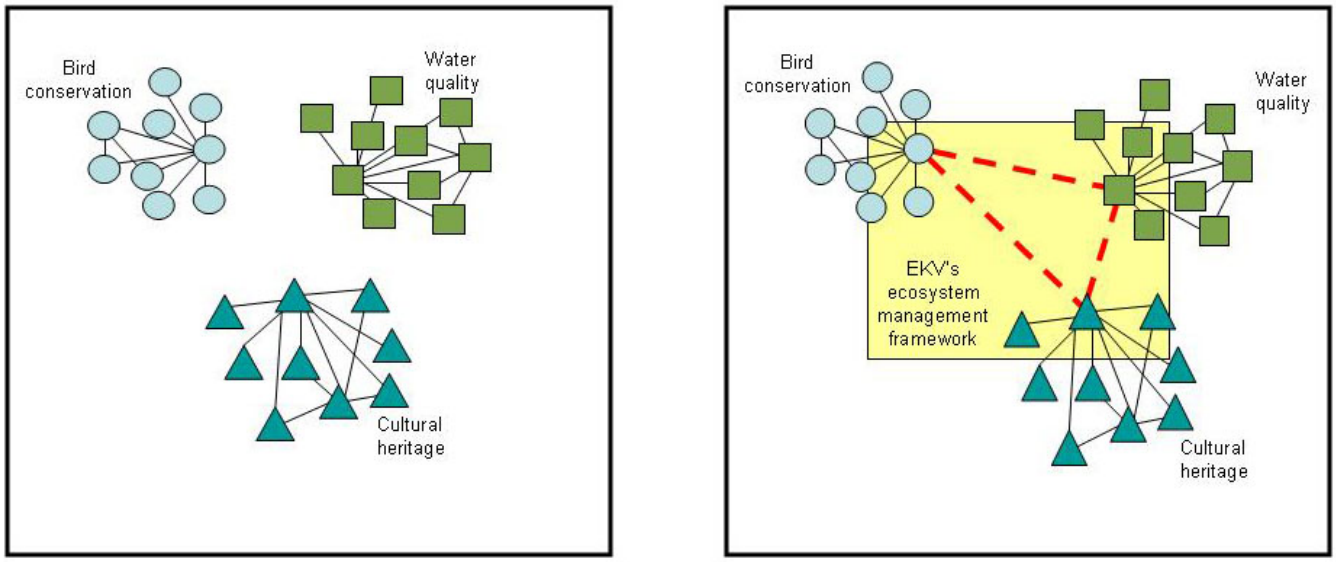
SEM assembled a broad base of support for the new management regime and the establishment of the BO among members of several organizations at different levels. Apart from the participants in the Kristianstad Project mentioned earlier, these supporters represented the Nature Conservation organization (SNF), the Bird Society of Northeastern Scania, the County Administrative Board, WWF Sweden, Kristianstads University College, the Swedish National Museum of Natural History, and a national research council (FRN). These individuals became the nodes of an emerging policy network, and their support was important to convince the executive board of the Municipality of Kristianstad to adopt the new management approach. Supported by the policy network, SEM approached a local top politician of the Executive Board of the Municipality of Kristianstad with a policy proposal containing a new management strategy for the lower Helgeå River catchment. This was at a time when the Executive Board of the Municipality was searching for a new identity for the City of Kristianstad, which opened a window of opportunity for change. This was certainly a critical link at a critical time and, in the words of SEM, "had we not taken the chance then, we would still be knocking on the door" (Olsson et al. 2004b). The perception shift to "water-rich" that took place in 1989 among policy makers can be seen as a perceptional regime shift, and it gave the political momentum needed to institutionalize the new management approach.

Adaptive Co-management of Kristianstads Vattenrike Biosphere Reserve

A unique feature in the management of the KVBR is the organizational arrangement that has developed for dealing with problems at different scales. The adaptive co-management of the KVBR relies on a social network of actors of which the BO is the key node (Hahn et al. 2006). The BO has a staff of five people and is part of the municipality's organization; it reports directly to the municipality board, like a municipality administration. However, it is not an authority and has no power to make or enforce rules. It relies on several funding sources, including the Municipality of Kristianstad, the County Administrative Board, and the Swedish Environmental Protection Agency. It plays a key role as a facilitator and coordinator in the collaborative processes to maintain the ecosystem services of the area. These processes involve international associations, national, regional, and local authorities, corporations, researchers, non-profit associations, and land owners. The BO is also involved in developing policy, designing projects, resolving conflicts, coordinating and administering conservation and restoration efforts, and developing goals for the KVBR, as well as producing management plans, agreements, follow-up reports, and updates for specific areas (Olsson et al. 2004b, Hahn et al. 2006).

There are three distinct forms of organizations that have emerged for managing the area: the consultancy group, the theme groups, and the "adhocracy" groups. The consultancy group has 30 members who represent a variety of interests in the area, including the BO. The members usually meet three times a year, and the organization provides a forum for information and discussion. It also gives recommendations and advises the municipal executive board on land-use plans. The group operates at the scale of the KVBR and was formed to mitigate conflict, produce mechanisms for conflict management, identify common interests, and discuss differences of opinion in a constructive way. The purpose in forming the group in the early 1990s was to gather representatives involved in water-related activities and projects, and who had not met earlier in a common forum (Olsson et al. 2004b). The only time they had been in contact with each other before was during a conflict over the letters page of the local newspapers. The idea was to bring people together when there was no conflict and to build trust among the representatives

Fig. 1. The idea behind the adaptive co-management system in the KVBR is to link clusters in order to address complex interactions in the landscape. The lefthand figure shows the KVBR before1989. Each cluster involves multiple levels, but was often narrow in focus. In the righthand figure, SEM provided leadership in the form of a vision and goals as part of a comprehensive framework (narrative)—a direction in which SEM can make sense of a range of information in the context and framework of the BO (at the time called the Ecomuseum Kristianstads Vattenrike, EKV) framework. Policy networks develop to connect institutions and organizations, and to facilitate information flows, identify knowledge gaps, and create nodes of expertise of significance for ecosystem management. The red dotted line indicates new connections between nodes of different networks. These connections help match the different scales in the landscape (e.g., cultivation practices, overgrowth, birds in the flooded meadow project).



(essential to the success of the collaboration process), identify common interests, and discuss differences of opinion in a constructive way.

The theme groups are collective efforts formed to work with a specific theme within the KVBR. There are currently ten such themes, including sandy grasslands, flooded meadows, groundwater, and coastal sand dunes. Although the initial work in 1989 focused primarily on flooded meadows, the BO has broadened the scope of management and initiated new themes in the landscape to address a broader set of issues related to ecosystems processes across temporal and spatial scales. This way, management expands from individual actors, to a group of actors, to multiple-actor processes. Organizational and institutional structures evolve as a response to deal with the broader set of environmental issues. Knowledge of ecosystem dynamics develops as a collaborative effort, and becomes part of the organizational and institutional structures. Social networks develop that connect institutions and organizations across levels and scales. These networks facilitate information flows, identify knowledge gaps, and create nodes of expertise of significance for ecosystem management.

Adhocracy groups refer to organizations that emerge in response to a surprise, exist as long as the particular problem persists, and subsequently dissolve (Hahn et al. 2006). This pulse relies on a dormant or latent set of connections in a social network of actors involved in the management of the KVBR. These connections have developed around the BO over the years and can be seen as "sleeping links" that are triggered by exogenous

events, such as the arrival of migrating cranes or extreme floods. These links connect actors within and across organizational levels at critical times, and help tune social and ecological dynamics by monitoring, combining knowledge, developing management practices, and responding to environmental change and impending conflicts.

For example, the wetlands around the City of Kristianstad are important resting sites for migrating cranes. In the spring, the arrival of the cranes often coincides with the farmers' spring tillage, and the cranes often damage the crops, especially potatoes. In the late 1990s, the crane population increased in the area, and there was growing discontent among local farmers. To forestall the conflict and collaboratively seek solutions, the BO (at the time called the Ecomuseum Kristianstads Vattenrike) initiated and facilitated the formation of the "crane group" of local actors. In December 1997, they arranged a meeting where farmers from Lake Hornborgarsjön presented their experiences to a group of actors, including three farmers, from the Kristianstad area. This lake is one of the most popular bird-watching places in Sweden, and the people there have learned how cranes and farmers can coexist and how to minimize crop damage. Strategies for Kristianstad were discussed and the Crane Group was formed at this meeting. Since then, the crane group in the KVBR has collaboratively sought solutions to the problem and engaged in various activities to gain new knowledge. The group monitors the cranes and has produced a list of recommendations for farmers if cranes land on their fields. They have appointed a contact person who can provide devices to frighten cranes, and who can assess damage. The crane group has prevented escalation of the conflict by reducing impacts on crops while at the same time enhancing the value for bird-watching tourists (Hahn et al. 2006).

In Table 1, we use the insights from Yaffee et al. (1997) on factors that constrain bridging and list strategies used in the KVBR to deal with and overcome these factors.

LINKING ORGANIZATIONS ACROSS LEVELS TO ENHANCE THE FIT BETWEEN ECOSYSTEMS AND GOVERNANCE SYSTEMS

The organizational design in the KVBR has evolved to deal with social and ecological problems at different scales. The adhocracy and theme groups, in particular, have internal organizational dynamics that nurture sources for renewal and reorganization for dealing with uncertainty and abrupt change. The ability to create the right links, at the right time, around the right issues in the multilevel system enhances the fit between the governance system and the ecosystem. We have shown here that the bridging function is crucial in this context.

We have identified two features that seem critical for linking organizations dynamically across multiple levels: bridging organizations and leadership. In the following sections, we discuss the role of bridging organizations and leadership for increasing flexibility and adaptability and contributing to scale-matching and resilience-building in SES.

Bridging Organizations and Social Memory

The BO is an example of an organization that bridges local actors and communities with other organizational levels (Olsson et al. 2004b). We refer to these as "bridging organizations." Guston (1999) and Cash and Moser (2000) describe "boundary organizations," which can provide an array of important functions for linking researchers and decision makers. Although similar in some aspects, bridging organizations have a broader scope than boundary organizations, and address resilience in SES. Bridging organizations, like the BO, provide an arena for trust building, sense making, learning, vertical and horizontal collaboration, and conflict resolution (Hahn et al. 2006). Furthermore, they can increase the potential to redirect external forces into opportunities, serve as catalysts and facilitators between different levels of governance, and bring in resources, knowledge, and other incentives for ecosystem management (Folke et al. 2005). Bridging organizations can create the space for institutional innovations and the capacity to deal with abrupt change and surprise.

As we have shown in this article, social networks are important for dealing with abrupt change in SES, but networks are themselves vulnerable to change and can be destabilized, which in turn can affect their ability to respond to ecosystem feedback and to secure the capacity of ecosystems to produce essential services for human well-being. Such destabilizing factors include changes in the composition of network actors, the presence of unresolved tensions and conflict, weak and

Table 1. Factors that constrain bridging, and strategies that are used in the KVBR to deal with and overcome these factors.

Factors that constrain bridging (from Yaffee et al. 1997)		Strategies for dealing with constraining factors in the Kristianstads Vattenrike Biosphere Reserve (KVBR)
Situational factors	Power imbalances	Using a landscape perspective and ecosystem approach to help actors perceive their interdependencies and understand the need to work together to produce solutions to problems.
		Providing participants with joint ownership of processes and outcomes—participants are directly and jointly responsible for making and implementing the decisions that are reached.
	Lack of communication, chemistry, or trust	Organizing interactions among actors to develop personal relationships and build trust.
		Facilitating face-to-face communication and dialog among actors.
		Providing opportunity for continuous interaction among actors.
	Technical and scientific issues	Sense making to facilitate the sharing of information.
		Engaging actors in monitoring and conducting inventories.
		Acknowledging and integrating different types of knowledge.
	Public opposition	Creating public awareness of problems and a sense of urgency by communicating about critical issues and potential crises.
	Fundamental differences that separate the stakeholders	Envisioning the future together with actors.
		Identifying common problems and goals.
		Using the KVBR to develop a sense of place and identity among actors.
Process-related factors	Lack of focus on process	Using an adaptive co-management approach, a collaborative process that continuously evaluates and responds to the effects of management actions and incorporates lessons learned in a new set of strategies to improve management.
	Lack of process management or interpersonal skills	Providing leadership and focusing on social factors that enable ecosystem management.
		Initiating, coordinating, and sustaining social networks of key actors.
		Making sense of and guiding the management process.
	Resistance to collaborative management styles	Starting small, producing small early successes.
		Initiating projects and selecting problems that can be turned into possibilities for trust building and partnerships.
		Convening actors to participate in collaborative processes.
		Structuring incentives for actions.
		Assessing actors' potential for advancing their self-interest through collaboration.

(con'd)

	Difficulty securing the involvement of all stakeholders	Defining the problem together with actors.
		Encouraging and facilitating information sharing among actors.
		Synthesizing and mobilizing multiple sources of knowledge for ecosystem management.
Societal context	Cultural norms	Facilitating norm-building around the new management approach.
		Using different pedagogical tools for communicating the links between ecosystem health and human well-being.
	Stereotypes and intergroup attitudes	Focusing on individuals of actor groups that can help change attitudes of people within their own groups.
		Challenging actors' mental models and frames of reference.
	Polarization arising from traditional process	Initiating a collaborative process of problem solving and decision making.
		Identifying and activating key individuals of actor groups necessary for tackling a particular problem.
	Opposition by public interest groups	Participating in international programs like UNESCO's Man and the Biosphere program and scientific assessments like the Millennium Assessment to strengthen and build public support for the adaptive co-management approach and the KVBR.
		Using the media to communicate progress and global relevance of the work in the KVBR to build public support and change people's attitudes.
	Politics	Continuous dialog with all major political parties, including the ones not currently in power, at all levels to build support for the adaptive co-management approach and the KVBR.
		Building political support for legitimacy of the adaptive co-management approach.
Institutional context	Conflicting agency goals and missions	Encouraging agencies to participate to produce superordinate goals at the landscape level.
		Providing processes to overcome sectoral approaches to managing ecosystems and landscape.
	Organizational norms and culture	Bringing actors together in problem-driven projects to change organizational norms and cultures.
		Offering the Man and the Biosphere program as a new arena for interactions.
	Lack of top level support for collaboration	Influencing decision makers and politicians at higher levels to maintain governance structures that allow for adaptive co-management of the KVBR.
	Resource constr-aints	Maintaining diverse funding sources; not depending on only one source.
		Including financers in the policy networks of the KVBR.
	Government pol-icies and procedures	Using the KVBR as an arena where new processes can be used to overcome restraining government policies and procedures.
		Relying on governance networks for adaptive co-management. Incorporating government agencies, with access to legal and financial support schemes, into the policy network.

(con'd)

Differing decision-making authority among participants	Assisting actors in navigating formal institutions.
	Providing participants with joint ownership of processes and outcomes—participants are directly and jointly responsible for making and implementing the decisions that are reached.
Inadequate opportunities for interaction	Providing arenas and opportunity for actors to meet face to face.
	Managing social networks and creating multiple ties at multiple levels.

ineffective leadership, frustration over the lack of visible results, and external events that disturb the policy process (Sorenson and Torfing 2005). Bridging organizations can provide strategies for managing social networks in order to deal with uncertainty (in the sense of Koppenjan and Klijn 2004).

Bridging organizations, like the one in the KVBR, seem to play a central role in stimulating, facilitating, and sustaining adaptive co-management and adaptive governance (Folke et al. 2005), including the emergence of governance networks (sensu Hajer and Wagenaar 2003, Sorenson and Torfing 2004) for dealing with uncertainty and change in SES. They can have a key role in collective learning processes (sensu Lee 1993) that builds experience with ecosystem change and evolves as a part of a social memory. Such a process of social learning is linked to the ability of management to respond to environmental feedback and direct the coupled SES into sustainable trajectories (Berkes et al. 2003). Bridging organizations, therefore, are essential in fostering sources of resilience in SES.

Accumulation of social–ecological understanding and experience in a "social memory"—the arena in which captured experience with change and successful adaptations embedded in a deeper level of values is actualized through community debate and decision-making processes into appropriate strategies for dealing with ongoing change (McIntosh 2000)—seems critical for dealing with change. Furthermore, social networks can serve to store social memories for ecosystem management, memories that can be revived and revitalized in the regeneration and reorganization phase following change (Folke et al. 2003). In the KVBR, the BO manages networks of local steward groups to mobilize knowledge and social memory, which in turn help deal with uncertainty and shape change (Folke et al. 2003, 2005). The different networks and the numerous links that can be activated when needed contribute to the robustness of the SES, and therefore, are sources of social–ecological resilience. They constitute the social memory (sensu Macintosh 2000) that can be mobilized at critical times and increase response options to deal with uncertainty and change.

There is a need to understand the governance attributes that support and build social memory, and hence resilience, in the face of disturbance.

Relationships between state and local actors are also addressed in the literature on social capital (Adger 2003) and, more specifically, that on synergies. Evans (1996) links public–private synergies to building the social capital important for economic development. He argues that social capital is often built in the intermediate organizations and informal policy networks, in the interstices between state and society. Ostrom (1996) explores the constructability of such synergies between governments and groups of engaged citizens. An important research question is under which conditions such synergistic relations can most easily be constructed.

Leadership and Actor Groups

The other key mechanism for maintaining the bridging function and adaptability, and for enhancing fit, is leadership, which can come in different forms. For example, key individuals can provide visions of ecosystem management and sustainable development that frame self-organizing processes (Agranoff and McGuire 2001, Westley 2002). Key stewards are important in establishing functional links within and between organizational levels, and therefore, facilitating the flow of

information and knowledge from multiple sources to be applied in the local context of ecosystem management. Social networks often emerge as self-organizing processes (i.e., not implemented by external pressure) involving key persons who share some common interests, although they represent different stakeholder groups (McCay 2002) Leadership has been shown to be of great significance for public network management. Network leadership and guidance is very different from the command and control of hierarchical management (Agranoff and McGuire 2001). It requires steering to hold the network together (Bardach 1998), and balancing social forces and interests that enable self-organization (Kooiman 1993). However, SES that rely on one or a few key stewards performing a particular key function might be vulnerable to change, as exemplified by Peterson (2002) in the case of long-leaf pine forest ecosystems in Florida.

The strength of networks depends on the ability of the key people to exchange information with other stakeholders, identify common interests, and gather support for such interests (e.g., ecosystem management) within their own organization or stakeholder group. Bardach (1998) describes how leaders play different roles in systems of strategic interaction, which include eliciting common goals, creating an atmosphere of trust, brokering organizational and individual contributions, and deploying energies in accordance with some strategic plan. Organizations that do not appear to have much in common may develop crucial links thanks to these key people, who form the nodes of different, loosely connected, networks.

For example, Bebbington (1997) identifies brokers as key stewards in sustainable agriculture intensification in the Andes, including their role in coordinating social networks in the management process. In all the cases of sustainable intensification, outsiders have played a key role in bringing in new ideas, but more importantly, they have brought in networks of contacts. These "brokers" had different backgrounds, including a priest, a university professor, European volunteers, and funding agencies. The connections they brought with them helped the members of the local communities gain access to non-local institutions and resources, including NGOs with technical assistance and financial resources, sources of technology, donors, and alternative trading networks. These networks spread across national and international boundaries in ways that would have been hard for the locals to achieve on their own.

Bridging different networks and creating opportunities for new interactions is important for dealing with uncertainty and change, and is a critical factor for learning and nurturing integrated adaptive responses to change (Stubbs and Lemon 2001). Tompkins et al. (2002) show how linking networks of dependence and exchange helps facilitate integrated and inclusive coastal management in Trinidad and Tobago. In the Kristianstad case, the BO staff play the role of brokers in developing networks, merging existing networks, and bringing in outside networks for ecosystem management. For example, in initiating the crane group, the staff at the BO acted as brokers in establishing a contact with farmers from another area, which was a strategy to prevent a conflict situation that would stifle the collaboration process. Instead, the BO strategy fostered trust building and sense making at a critical time, and provided a smoother start. Thus, brokers can create cross-scale links at critical times and draw on external sources of information and knowledge, such as scientists and practitioners, to deal with abrupt change and crisis.

In addition to leaders, we have previously identified other essential actors and actor groups that serve social mechanisms in adaptive co-management networks: knowledge carriers, knowledge generators, stewards, and sense makers (Folke et al. 2005). Folke et al. (2003), based on several case studies, identified the following actor groups; knowledge retainers, interpreters, facilitators, visionaries, inspirers, innovators, experimenters, followers, and reinforcers. In the coastal communities of East Africa, actor groups such as beach recorders of fish catches and middlemen who link fishers to markets are of major significance in shaping exploitation patterns of coastal and marine ecosystems, thereby influencing the capacity of these SES to generate and sustain ecosystem services (de la Torre Castro 2006, Crona 2006). Holling and Chambers (1973), in their analyses of social roles in resource management workshops, stressed the importance of also including individuals with opposite views who oppose and criticize. The different roles that actor groups can play are important components of social networks and essential for enhancing the fit between governance systems and ecosystems, and for building resilience in SES. This is a research area that is still in its infancy and requires more attention in the future.

CONCLUSION

The empirical work and analyses of the emergence of governance networks has provided insights in relation to bridging organizations and their role in enhancing the fit in SES. In the KVBR, networks were formed at the regional level that cut across several levels, from local to transnational, to produce a new form of multilevel, adaptive governance that enables ecosystem management.

Bridging organizations play a crucial role in the dynamic relationship between key individuals, social memory, and resilience. They coordinate the interactions among a range of actors at different levels of society and nodes of expertise and a diversity of experiences and ideas for solving new problems. The governance networks of the KVBR constitute multilevel arrangements that are particularly appropriate for solving problems of complex adaptive systems because there is experimentation, knowledge generation, and learning going on in each of the nodes. It seems like such experimentation, in combination with the bridging function, may nurture sources for renewal and reorganization and increase the capacity to deal with uncertainty and abrupt change in SES.

Social networks can serve to store social memory for ecosystem management, a memory that can be revived and revitalized in the reorganization phase following change. The bridging function is crucial in this context. There is a need to investigate further the role of social networks and their cross-scale links in creating flexibility and in providing response options in times of social–ecological change. We also need to understand in what ways such cross-scale dynamics can widen desirable social–ecological stability domains and make systems more robust to change and surprises. We have shown that, in the KVBR, the bridging function is especially important for mobilizing a loosely connected network of actors who represent various interests and knowledge at critical times.

Bridging organizations and the bridging function can, however, be vulnerable to disturbance, but there are sources of resilience for securing these key structures and functions in SES. These include: 1) social mechanisms for combining multiple sources of knowledge, 2) building moral and political support in social networks, and 3) having legal and financial support as part of the adaptive governance structure.

An important lesson is that it is not enough to create arenas for dialog and collaboration, nor is it enough to develop networks to deal with issues at a landscape level. There is a need to understand and actively manage the underlying social structures and processes for ecosystem management (Folke et al. 2007) A challenge in such governance systems is to support social mechanisms and enable institutional arrangements for accessing and combining knowledge to respond to ecosystem feedbacks at critical times. However comprehensive the combined knowledge might be, there is always an element of surprise when dealing with complex social–ecological dynamics. Therefore, bridging different actor groups in networks and creating opportunities for new interactions are important when dealing with uncertainty and change, and are critical factors for learning and nurturing integrated adaptive responses to change.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol12/iss1/art28/responses/

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