Already Adaptive?

- A quantitative study of the presence of adaptive management aspects in local moose management systems

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Abstract

The Swedish authorities have, in several official reports, proposed an adaptive management approach, in order to ensure sustainable resource use in terms of oceans, terrestrial waters and wildlife. Adaptive management emphasizes that ecosystems are complex non-linear systems, in which the only certainty is uncertainty, and that management strategies must accept this as an integral part of the ecological system. Conversely, conventional resource management is characterized by the concept of command and control over resources, with the goal to maximize sustainable yield. Conventional resource management is associated with a top-down management structure, and it is reasonable to assume that fundamental institutional changes are required in order to replace conventional resource management with adaptive management. Changes in Swedish official policy have entailed increased management rights of property owners regarding moose management. In other words, due to the conversion of the top-down management system to a bottom-up system, the formal institutional prerequisites for *local adaptive management systems* presumably are in place regarding moose management.

This is a quantitative study that assesses the extent of adaptive management currently in place within local moose management systems in an industrialized country. It can be assumed that one would be less likely to find adaptive management systems here, due to the fact that resource users are not dependent upon the resource for their livelihood, as opposed to the situation often existing in third world countries. A Moose Management Units (MMU) database has been established that contains variables, such as monitoring methods, goals regarding the size of the moose population, and so on, which can be operationalized as aspects of adaptive management. Since most research within the adaptive management literature consists of case studies, this study provides a complement to the research field.

Results show that there are few aspects of adaptive management currently present in Swedish MMUs. Even though private landowners have extensive management rights, to date, they have not implemented central aspects of adaptive management, such as ecosystem management. The conversion of a top-down system characterized by single species management will not automatically turn into an adaptive management system, even though resource users have gained management rights. The public administration has a paramount role in implementing adaptive management, because it can provide knowledge, share information and advice, and promote learning. The traditional role of the public administration regarding moose management is that of enforcing and monitoring rules. However, since the potential of establishing MMUs has existed, this role has been undermined. It seems that the public administration is inflexible, and that the current organizational structure inhibits the establishment of adaptive management. Therefore, it is critical, prior to decentralization and deregulation, to ensure that the organizational structure of the public administration will promote and not inhibit the implementation of new management systems.

INTRODUCTION

A great deal of research regarding natural resource management has focused on the pros and cons of top-down versus bottom-up management systems, as well as a variety of combinations involving these two 'ideal types' of management (Baland, Platteau et al., 2000; Hanna, 1998; Ostrom, 1990). Due to problems inherent in conventional resource management, adaptive management has been proposed as a more productive system for managing natural resources in a sustainable way (Berkes, 2003; Folke, Carpenter et al., 2002; Gunderson, Holling et al., 1995; Walters, 1997). One central question has been: under what institutional framework will adaptive management systems emerge? Most research regarding this issue has consisted of case studies. Many case studies have been conducted in third-world countries and among indigenous tribes (Berkes, 1998; Berkes & Folke, 1998). Even though case studies have been conducted in the industrialized world, there have been few, if any, quantitative studies regarding the presence versus absence of local adaptive management systems (Hanna, 1998; Olsson & Folke, 2001; Olsson, Hahn et al., 2003).

In 1992, it became possible for landowners in Sweden to establish Moose Management Units (MMU), local management systems which were allotted the sole responsibility for moose management, including the right to decide the size of the local moose population. This management system has become widespread, and MMUs covered approximately 11 million hectares of land in Sweden by the year 2005. Because landowners must hand in a management plan to the County Administrative Boards when they apply to establish an MMU, an opportunity exists to investigate whether these management organizations resemble adaptive management systems, both at a national scale and in an industrialized country. Even though the explicit intention behind decentralization was not that these systems would become adaptive, nonetheless, this provides an opportunity to test the assumption that decentralization leads to management systems that are adaptive.

The current paper begins by describing what the concept of adaptive management entails. This is followed by a depiction of the background behind the establishment of MMUs and, in turn, the Swedish hunting administration. Since MMUs have resulted in changes in property rights, what this has meant is described thereafter. The way in which adaptive management is measured is depicted next. Finally, results and a discussion of those results are presented.

ADAPTIVE MANAGEMENT

The development of new ecological theories and concepts, and the apparent limitations of conventional resource management both have contributed to the emergence of the adaptive management approach. In the mid-1970's, an interdisciplinary team of biologists and system analysts defined the adaptive management approach, and their work was published in 1978 by a Canadian ecological theorist, C. S. Holling (Lee, 1993). It was emphasized that ecosystems are complex non-linear systems, in which the only certainty is uncertainty, and that management strategies must accept this as an integral part of the ecological system (Folke, Carpenter et al., 2002). Conversely, conventional resource management is characterized by the concept of command and control over resources, with the goal of maximizing sustainable yield. The adaptive management process often requires that scientists and resource managers cooperate, in order to establish ecosystem models, because these models are believed to contribute to problem clarification and the elimination of unproductive options. Perhaps the most important result that model building can accomplish is disclosing gaps in 'state of the art' biological and ecological knowledge. The 'missing' information can be obtained by the implementation of large-scale experiments within ecosystems, experiments that generate new knowledge and, therefore, also improve the likelihood for selecting appropriate policies in the future (Walters, 1997).

Another aspect of the adaptive management approach is its emphasis on the interconnectedness between ecological and social systems. For example, if economic systems are not taken into account, this could jeopardize 'purely' ecological solutions (Walters, 1986). The adaptive management approach has been applied successfully in, for example, the Everglades (Gunderson et al.1995), the Columbia River Basin (Lee, 1999), the ground fishery in Tasmania (Lee, 1999), and waterfowl management in the USA (Johnson, 1999).

However, other researchers have chosen another line of research and have focused on adaptive systems where communities have succeeded in managing resources in a sustainable way (Berkes, 1998, 2003; Berkes & Folke, 1998). The difference between these two lines of research has been described in the following way:

> The first [view] involves rethinking resource management science in a world of uncertainty and surprise, using systems approach and adaptive management (Holling 1978; 1986; Walters 1986; Lee 1993). The second involves rethinking resource management social science by focusing on cultural capital (as an integral part of a triad with economic capital and natural capital), and on property-rights system (Berkes and Folke 1994a; 1994b) (Holling, Berkes et al., 1998).

The second line of research has focused at the local level, and on resource users and their ability to manage resources in a sustainable way. The local approach requires considerable effort from local resource users, and these users also need to have management rights to manage the natural resources. One prerequisite for resource users establishing institutions is the right to organize and, if local resource users are to establish adaptive management systems, this also would be the minimum requirement (Ostrom, 1990). This is one of Ostrom's eight design principles for long-lasting common pool resources[1]. Other researchers have emphasized the necessity of extensive management rights, for resource users to establish adaptive management systems (Adger, 2002/2003; Olsson, Hahn et al., 2003). However, devolution of management rights does not automatically mean that local resource systems will become adaptive. Research has disclosed that long-enduring local management systems of common pool resources usually are nested within even larger organizations. Such a polycentric governance system requires that citizens be able to organize multiple governing units. "Each unit exercises considerable independence to make and enforce rules within a circumscribed domain of authority for a specified geographical area" (Ostrom, 2005:283). Emphasis is placed upon the importance of local resource systems in managing resources; however, not without the support of other organizational levels (Folke, Hahn et al., 2005:449). "…[A]utonomous self-organized resource governance systems may be more effective in learning from experimentation than a single central authority" (Ostrom, 2005:281). One reason is that local appropriators have knowledge of the resource and the surrounding environment, and receive feedback from changes in the environment. Another benefit of local resource systems is that the costs for enforcing rules are low. Perhaps the greatest benefit is that, if a local resource system fails, the consequences will not affect as great an area, as if a central agency is unsuccessful with its natural resource management policies (Ostrom, 2005).

[1] The others are: clearly defined boundaries; congruence between appropriation and provision rules and local conditions; collective choice arrangements; monitoring; graduated sanctions; conflict resolution mechanism; and nested enterprises (Ostrom, 1990). Common pool resources are goods with characteristics that make it difficult to exclude potential appropriators. Moreover, where joint use also indicates subtract-ability, that is, when one person deducts units from the resource, these resources adversely affect the ability of others to use that same resource.

A major focus has been on traditional societies and how these have managed to build social-ecological resilience.

> Traditional systems parallel adaptive management in their reliance on learning-by-doing, and the use of feedback from the environment to provide corrections for management practice. They differ from science-based systems generally by the absence of testable hypotheses and generalizable theories, and the integration of moral and religious belief systems with management (Gadgil et al. in Holling, Berkes et al., 1998)

Since many traditional societies have managed to adapt to an ever-changing environment, the proponents of the local adaptive management approach argue that it is possible to gain insight into what contributes to resilience-building in both social and ecological systems. Certain management practices, based on ecological knowledge, have been identified to increase resilience. Some of these management practices are the monitoring of changes in ecosystem and in resource abundance; total protection of certain species; the protection of specific habitats; temporal restrictions of harvest; integrated species management; and resource rotation. Some social mechanisms behind management practices increasing resilience are the accumulation and transmission of ecological knowledge; cross-scale institutions; and mechanisms for cultural internalization (Folke, Pritchard et al., 1998:418).

The most significant institutional prerequisite for local adaptive management is that the local resource users should have an opportunity to actually manage natural resources. "Promoting resilience means changing, in particular the nature of decision-making to recognize the benefits of autonomy and new forms of governance in promoting social goals, self-organization, and the capacity to adapt" (Adger, 2002/2003:2). To facilitate the development of local resource systems, it is necessary to establish rules allowing for this to take place. One problem with the local approach could be that people are not motivated to engage in natural resource management. Private ownership of property might provide incentive to engage in the management of natural resources. However, if there is no interest among local resource users to manage ecosystems adaptively, the whole principle collapses. Another important aspect is that the system must include more than only a few resource users. As Adger states:

> [it] is important to note that, because of its institutional context, social resilience is defined at the community level rather than being a phenomenon pertaining to individuals. Hence, it is related to the social capital of societies and communities" (Adger, 2000:349).

How many people in a community need to be engaged in the management of the ecosystem and have ecological knowledge, in order for the *community* to be socially resilient? This should be of particular importance in industrialized countries, wherein resource users often do not depend upon the resources for their livelihood or live in close proximity to the ecosystems. It, therefore, is reasonable to assume that there often might be too few resource users who are engaged in the management of natural resources.

In the next section, the reasons for establishing MMUs are described.

BACKGROUND ON THE ESTABLISHMENT OF THE MMU

The Swedish moose management system had, until the early 1980's, been characterized by growing cooperation among landowners and efforts to increase the historically-weak moose population. However, in the late 1970's and early 1980's, Sweden experienced the largest moose population recorded in history. Despite increased shooting, the moose population continued to grow. The shooting numbers increased from 50,000 in 1975 to over 150,000 annually in the early 1980's (SOU 1990:60:26-28). The main reason for the unprecedented increase in the moose population was changes in the moose management system, which included licensed hunting and altered hunting practices. For example, the percentage of calves shot increased, in order to save productive cows and raise the productivity of the moose population (SOU 1990:60:26). Another reason for the increased moose population was changes in forest production such as increased clear-cut forests (SOU 1990:60:26).

The centralized and detail-regulated moose administration system was costly. Consequently, the government decided that the Environmental Protection Agency (EPA) should suggest ways to change routines and decision-making procedures regarding moose management (Prop. 1986/87:58.41 & Prop. 1991/92: 9). It was argued that the grazing reimbursement system lacked incentives for active preventative actions; in particular, for increased shooting (SOU 1990: 60:40). However, this problem also was connected to the limitations of a highly-centralized, top-down system in the management of natural resources. One reason for decentralization of the moose management system was that it was considered critical to adjust the moose population to suit local conditions, such as the productivity of the land and the extent of grazing damage. Also, goals concerning the density of the moose population at the local level had to become more flexible, according to the government (Prop. 1991:92: 9:16).

Due to problems associated with the large moose populations, two measures were suggested in a government bill passed in the early 1990's. One was the abolishment of the grazing damage reimbursement system in 1995. This, of course, accentuated the importance of keeping moose populations down (Prop. 1991/92: 9). However, the most important change was the establishment of new moose management systems, called Moose Management Units (MMU; älgskötselområde) in 1992. It was emphasized strongly that, with the system already in existence at the time, landowners had a difficult time ensuring that their interests were taken into account. Inadequate knowledge of the moose population, irresponsibility, and poor cooperation between landowners and hunters also were stated to be reasons for the excessively large moose population (Prop. 1991/2: 9:1-24).

THE SWEDISH HUNTING ADMINISTRATION

At the national level, the Environmental Protection Agency (EPA) is the supervising public authority and issues directives and general advice on the management of wildlife. The County Administrative Board (CAB) plays a significant role in implementing wildlife policy. The CAB grants permission for many matters concerning hunting and wildlife care. It decides on the establishment of Wildlife Management Areas (WMA, sw viltvårdsområden) and MMUs, and also grants hunting permits (Prop. 2000/01:73:73). There is a consultative administrative unit, called the Wildlife Management Board (WMB, sw viltvårdsnämnden) in each county, wherein diverse interests are given an opportunity to offer their views and provide expert knowledge prior to major decisions by the CAB (Fransson, 2003:27). The WMBs are regulated by law, whereby the main assignments and organizational structure are stipulated. The WMBs are comprised of hunting organizations, forestry and agricultural and nature interest organizations (SFS 1987:905 46§) and they address issues of overreaching and principal nature (NFS 2002:19 29§ p.2). Local forums that are voluntary are comprised of hunter representatives and larger landowners, such as forest companies, that, among other things, leave suggestions on moose hunting quotas to the WMB which, in turn, advises the CAB. However, the establishment of local forums is not mandated, but based purely on a voluntary basis, and the Swedish

Association for Hunting and Wildlife Management (SAHWM)[2] organizes the local forums (Fransson, 2003)[3].

In principle, all moose hunting is done through licenses, which means that moose quotas are allocated to persons with hunting rights. The CABs decide what areas can be registered as licensed areas, under the condition that the area is large enough to shoot one mature moose per year, and still ensure the subsistence of the species[4]. There are two formal organizations for coordinating moose hunting among landowners in Sweden, one is the WMA and the other is the MMUs. The most significant difference between the WMA and MMU is that MMUs can decide how many moose to shoot during hunting season, whereas the CAB decides moose allocation to the WMAs. The MMU is an entirely voluntary organization, in contrast to WMAs that might subject landowners to enforced enrolment. The argument for establishing MMUs was to decrease detailed regulation and to transfer responsibility to landowners and hunters to manage moose populations (Prop 91/92:9:16). However, some WMAs might have been large enough to form an MMU; and, in other instances, a WMA might have joined with other license areas to establish a MMU. The WMA is regulated by a special law, wherein there are stipulations as to the rights and obligations of the WMA association. The WMA association, for example, is entitled to make decisions regarding the organization of hunts, for example, whether everyone has to hunt together. Decisions made by the association can be appealed at the CABs (Prop. 1999/2000:73). On the other hand, MMUs are very loosely regulated, and the only sanction mechanism available for the CABs is to deregister an MMU.

PROPERTY RIGHTS

Since the publication of Hardin's article, "The Tragedy of the Commons", considerable research has been conducted on the effects of diverse property rights regimes over natural resources (Hardin, 1968; Libecap, 1993; Ostrom, 1990; Ostrom & Schlager, 1996). Hardin mistook the commons for open access, but he highlighted the difficulties inherent in achieving collective rationality among a group of rational resource users without any rules (Hardin, 1968). Later research has proven that commons have rules restricting access and usage of a resource (Ostrom, 1990). When analyzing common-pool resources, four ideal and analytic

[2] SAHWM is Sweden's largest interest organization of hunters, and was established in 1830.

[3] The SAHWM was delegated the authority to manage wildlife care in Sweden through parliamentary decisions in 1938 and 1951 (Fransson, 2003:8).

[4] However, one moose calf per year can be shot, if the area is of at least 20 hectares (SFS 1987:259 §33).

categories frequently are used: open access (unrestricted usage); state property (held by a government that decides on access and use limitations); communal property (property held by a community, whose members have equal rights of access and use); and private property. Private property provides individuals with the right to exclude other users and to regulate the use of resources, and these rights generally are recognized and enforced by the state. Ownership also usually is transferable and exclusive (Feeny, Berkes et al., 1990). All types of regimes are restricted in the use of resources, except open access. In Table 1, a comparison of the four ideal categories, with respect to specific owner rights and duties, is depicted.

Table 1. Types of Property-Rights Regimes with Owners, Rights and Duties (Source: Hanna, Folke et al., 1996:5).

Regime type	*Owner*	*Owner rights*	*Owner duties*
Private property	Individual	Socially acceptable uses, control of access	Avoidance of socially unacceptable uses
Common property	Collective	Exclusion of nonowners	Maintenance; constrain rates of use
State property	Citizens	Determine rules	Maintain social objectives
Open access (nonproperty)	None	Capture	None

Research has revealed that none of these systems is best at ensuring sustainability, besides the fact that open access often leads to resource degradation (Berkes, 1996:88). However, these categories are too 'general' to really be of help when analyzing specific property rights, because these are much more complex. For example, property rights regimes affecting the Sámi in Sweden are all of the above, in some form or other. Sámi village territory functions as a communal property with regards to reindeer grazing; the village implements rules; however, these rules cannot be socially unacceptable, such as overgrazing resulting in degradation of the sensitive tundra. The State owns the land, while the Sámi have user-rights that include not only grazing rights, but also hunting and fishing rights. In addition, individuals own the reindeers (Wennberg-DiGasper, 2003). A similar level of complexity applies to the Swedish MMUs. In Table 2, a breakdown of what property rights contain is depicted.

Table 2. Bundles of Rights Associated with Position (Source: Ostrom, 2003).

	Full owner	Proprietor	Authorized claimant	Authorized user	Authorized entrant
Access, i.e., [The right to enter property]	X	X	X	X	X
Withdrawal, i.e., [The right hunt]	X	X	X	X	
Management, i.e., [The right to regulate usage patterns]	X	X	X		
Exclusion, i.e., [The right to decide – access and how to transfer the right]	X	X			
Alienation, i.e., [The right to sell or lease Management rights and/or exclusion rights]	X				

Property rights refer to the relationship between people with respect to some object. This implies that one person's right includes another person's obligation to respect that right (Ostrom & Schlager, 1996). The most basic rights are rights to the access and withdrawal of resources. Management rights are defined as the right to organize usage patterns; this includes where, how and when appropriation of a resource can take place. To have management rights also means that it is possible to make decisions regarding improvements in the resource. *Exclusion* implies that the person holding the right can decide who will have access, while *alienation* is defined as the right to sell or lease out the management rights and/or exclusion rights (Ostrom, 2003). These rights either can be held individually or by collectivities. The significant difference between access and withdrawal rights versus management rights, exclusion rights, and alienation rights is that the last three entail the property rights holder being able to make decisions about future rights. In other words, in order to provide incentives for resource users to invest in resource management, it is critical that they have at least management and exclusion rights (Ostrom & Schlager, 1996).

Researchers have emphasized the necessity of extensive management rights, in order for resource users to implement adaptive management systems. The potential to establish MMUs has granted landowners management rights. "Systems of property rights and rules defined, implemented and monitored, and enforced by resource users are likely to perform better than systems of property rights and rules defined, implemented and enforced by an external authority" (Ostrom & Schlager, 1996:146). Reasons that resource users should be more successful than external authorities in defining, implementing, monitoring and enforcing rules include their knowledge of the physical environment, due to daily harvesting activities; the rules matching the social and cultural environment; and the lower costs of monitoring and enforcing rules (Ostrom & Schlager, 1996).

Also, without MMUs, private property rights are restricted through '*allemansrätten*' (everyman's right), which permits public access to private property, a right that also includes the right to pick berries and mushrooms[5]. Every person, thus, is an *authorized entrant* on private property in Sweden. The 'everyman's right' causes conflict between hunting interests and outdoor life interests. The Outdoor Life interest organization has stated that hunting interests have been prioritized, and that outdoor life primarily has been considered to be a disturbance and less important than hunting (Prop. 1986/87: 58:136).

Hunters leasing hunting rights can be characterized as *authorized users,* since their withdrawal rights are specified, they cannot make decisions on management issues, and they have no exclusion or alienation rights. Like everyone else who hunts, hunters who lease hunting rights are restricted by a number of formal rules, such as the hunting period, hunting license requirements, and so on.

The potential to establish MMUs resulted in increased management rights for landowners, since they now could decide how many moose to shoot. The importance of deciding the number of moose to shoot is related to the significant impact that hunting has on the moose population. Approximately 1/3 of the moose population is decimated during a single hunting season. This illustrates the extreme importance of management rights, specifically the right to decide the number of moose to shoot. It is impossible to control a small-game population in this same manner, because the impact of hunting is so much smaller (SOU 1990:60:27).

METHODS

The general criteria for establishing an MMU is that the area must be large enough to contain its own moose population. If landowners want to establish an MMU, they must formulate a management plan that has to be approved by the County Administrative Board (CAB) (1987:

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[5] Allemansrätten is regulated by Swedish constitutional law and entails the public right to access private property (RF 2:18).

905 §3). The moose management plan should contain the long-term goals for management of the moose population, as well as measures intended to restrict damages by moose on farm lands, forests, and traffic. The plan also should contain information about the grazing situation, the size of the moose population (winter population and an estimate of migratory moose), and the number of animals shot per year. According to EPA directives, the CABs should revise the MMU management plans and take measures if necessary, like deregistering MMUs (NFS 2002: 19).

For the purposes of this study, all the MMU plans in Sweden were collected and the information they contained entered into a database. The database contains 637 MMU plans from twenty counties[6] (approximately 20 MMU plans were missing). In Sweden's twenty counties that contain moose populations, the number of MMUs per county varied between 4 and 89. The MMUs extended over approximately 10, 8 million hectares of land and the size of the MMUs varied from 1,371 hectares to 247,000 hectares (the median size is 10,061 hectares).

Since 1992, it has been possible to establish MMUs and, according to the Environmental Protection Agency's (EPA) guidelines, MMU management plans should be revised every third year (NFS:2002:19); however, compliance with this seems to have differed between counties. Only one copy of the moose management plan was collected for each MMU, even though some MMUs have submitted several versions over the years. It is not known whether each MMU plan was the first or a revised version. The SAHWM had formulated a template for the moose management plan to be handed in to the CAB at the time of MMU establishment. However, this template has changed somewhat over the years and, therefore, the MMU plans differed in the information available. In addition, some MMUs had created their own MMU management plan version.

CAN SWEDISH MMUs BE CHARACTERIZED AS LOCAL ADAPTIVE MANAGEMENT SYSTEMS?

In this section, the concept of local adaptive management will be operationalized, in order to examine to what extent adaptive management aspects are prevalent in Swedish MMUs. Generally, adaptive management entails that the management system is able to respond to changes in ecosystems independently, whether these changes are caused by people or due to non-anthropogenic causes. In order for a management system to be adaptive, managers must

[6] In Gotland county, there is no moose population.

accept the unpredictability of ecosystems and apply an experimental approach to learn more about these systems. One critical component, therefore, is managers establishing management systems that deal with the intrinsic unpredictability of ecosystems. Five different criteria will be utilized in order to evaluate whether MMUs can be considered adaptive management systems. These are: 1) the degree of success; 2) the degree of ecosystem management; 3) the degree and methods by which monitoring is conducted; 4) the number of MMU activities; and 5) the degree of cross-scale linkages. These different measurements have been developed from concepts derived from the adaptive management literature.

Degree of Success:

Adaptive management is grounded in the realization of the interconnectedness between ecological and social systems, and emphasises how essential it is to take social and economic factors into consideration when establishing natural resource management systems. In other words, adaptive management *does not promote conservation per se,* but rather the utilization of natural resources in a sustainable way, ensuring that no loss of resilience takes place. A management system of natural resources can be considered adaptive if the actors' desired goals regarding the resource are met (such as the size of the moose population). In order to avoid loss of resilience, it is essential to ensure biological diversity of tree species, such as aspen, ash, and sallow, and not only economically valuable tree species.

One indicator of whether the moose management system is adaptive, therefore, is if the resource users have been successful in reaching their goal with respect to the size and composition of the moose population, within acceptable biological levels. This will be measured by examining goal fulfilment in relation to the reported composition of the moose population, and the amount of grazing damage. Another goal often set by actors is that the moose population does not contain too few bulls. Since it is very popular to shoot mature bulls, this is perhaps not such an easy goal to achieve. Nonetheless, this should provide an answer as to what extent MMUs have been successful in reaching their preferred moose population size and composition.

Ecosystem management:

Ecosystem management involves a holistic view of the environment and, therefore, it is critical that the resource users not only monitor the moose population, but also other ecosystem properties. For example, do the resource users actually perform a local grazing damage inventory? This would be an indication that they also pay attention to other aspects of the ecosystem. Another aspect that this study will examine is whether notes have been drafted in the MMU plan about grazing damage to different tree species. Noting the degree of grazing damage to various tree species would indicate that the MMUs are paying attention to other variables in the ecosystem, besides the moose population. However, one also can respond to ecosystem feedback via wildlife care efforts, like improving grazing conditions by the clearing of forests, the feeding of wildlife, or the establishment of wetlands. To summarize, this study's indicator of ecosystem management contains the following variables: utilization of a local grazing damage inventory method; observations of grazing damage to different tree species; and performed wild care efforts.

Monitoring:

As mentioned previously, one important aspect of natural resource management is the monitoring of wildlife populations. Therefore, it is important to examine to what extent MMUs have utilized monitoring methods. All monitoring methods have their strengths and weaknesses, and it is likely that reliability increases if local resource users utilize more than one monitoring method. Therefore, not only whether MMUs use monitoring methods will be examined, but also whether they combine different methods.

Activities:

Another indicator of importance is the number of activities within the MMUs. For example, do the resource users perform several monitoring methods, or do they have a goal concerning the size of the moose population? Even though this is not an exact indicator of adaptability, this measure will give an indication of activity level and, therefore, also whether the MMUs perform central activities related to adaptive management.

Cross-scale linkages:

It is critical that the local resource systems are not isolated, but are linked both vertically and horizontally. The CABs' routines regarding MMU plans will be treated as an indicator of a horizontal linkage. Local forums can function as vertical linkages among MMUs; therefore, prior studies of these will be examined in order to determine their performance.

RESULTS: TO WHAT EXTENT ARE SWEDISH MMUs ADAPTIVE?

In this section, the question as to what extent the Swedish MMUs are adaptive will be answered empirically. This will be accomplished by measuring the five criteria listed and described in the previous section.

Degree of success:

The first criterion contains three variables, 1) the goal fulfilment regarding the number of moose per 1000 hectares; 2) the percentages of bulls in the moose population; and 3) the amount of grazing damage. In Table 3, the numbers of MMUs that have reached their goal regarding the size of the moose population in the winter population are presented. If MMUs have succeeded in satisfying their moose population goal within the range of 85%-115% (100% is exact goal fulfilment), they are considered adaptive. However, if MMUs are outside this range, they are not considered adaptive[7]. It should be noted that some MMUs may have not had time to reach this goal, because they had been established within the last few years. If the version reviewed was the first version of the plan that was collected, the MMUs would not be expected to have had time to meet their targets. However, most MMUs would have been established several years ago and, therefore, should have had time to affect their moose population. It is essential to keep in mind that the feeding capacity of the lands differs significantly, and also that certain areas harbour other animals, such as deer, competing for food. Therefore, there is no 'correct' number of moose per 1000 hectares. Moreover, this means that it is difficult to control whether MMUs have 'realistic' moose population goals. However, due to the review of MMU management plans by interest organizations and the CABs, it is likely that the goals concerning the size of the moose population are not entirely unrealistic.

Table 3. Goal fulfilment of MMUs regarding number of moose/1000 hectares.

Monitoring Method	Goal fulfilment	Percentage
All MMUs	MMUs that have not reached their goal as to the number of moose/ 1000 hectares*	47 %
	MMUs that have reached their goal as to the	53 %

[7] Approximately 15% of all the MMUs were found to be below 85% and approximately 33% above 115%. In other words, most of the MMUs that have not been successful in reaching their goal regarding moose population size had more moose per 1000 hectares than initially intended.

N = 417	number of moose/1000 hectares**	
MMUs that have utilized both airplane inventory and ÄlgObs N = 94	MMUs that have not reached their goal as to the number of moose/ 1000 hectares*	70 %
	MMUs that have reached their goal as to the number of moose/1000 hectares **	30 %
MMUs that have utilized either airplane inventory or ÄlgObs N = 311	MMUs that have not reached their goal as to the number of moose/ 1000 hectares*	49 %
	MMUs that have reached their goal as to the number of moose per 1000 hectares **	51 %

*outside the range 85%-115% (100% is exact goal fulfilment)
**within the range 85%-115% (100% is exact goal fulfilment)

The overall success in establishing an appropriate moose population was 53%. However, in order to ensure the reliability of the numbers stated, it is critical that MMUs utilize reliable monitoring methods[8]. In total, 94 MMUs have been utilizing both airplane inventory and ÄlgObs. If the MMU has utilized both methods, as compared to one method alone, data reliability should be relatively high. Interestingly, in counties in which both methods have been used, goal fulfilment appears to be less frequent, 30% versus 51% for those counties only using one monitoring method. That almost half of the MMUs have failed to achieve their population goals is disturbing; but even more daunting is the fact that only 30% appear to be successful when more reliable monitoring is conducted.

The second variable that is part of our degree of success measure involves the composition of the moose population. If the percentages of bulls in the moose population are within the range of 31-71%, this is considered to be an indication of adaptiveness. In Table 4, the percentages of bulls in the moose population are presented.

Table 4. Percentages of bulls in moose populations.

Monitoring Method	Bulls in the moose population	Percentages

[8]The wildlife biologist, Göran Ericsson, claims that for data on the number of moose per 1000 hectares to have any reliability, MMUs should have utilized both ÄlgObs and airplane inventory methods, Umeå 15-09-05.

All MMUs N = 404	MMUs with too few bulls in the population	86 %
	MMUs with an acceptable number of bulls in the population	14 %
MMUs that have utilized both airplane inventory and ÄlgObs N = 100	MMUs with too few bulls in the population	83 %
	MMUs with an acceptable number of bulls in the population	17 %
MMUs that have utilized either airplane inventory or ÄlgObs N = 313	MMUs with too few bulls in the population	86 %
	MMUs with an acceptable number of bulls in the population	14 %

Many hunters want to shoot older bulls with large horns. Table 4 shows that 86% of the MMUs have less than 30% bulls in the moose population. One possible explanation is that the actors within the MMUs have not had enough time to adjust their shooting practices since the establishment of the MMU. It is likely that it takes time to establish resource management systems that are adaptive, since adaptive management entails that resource users conduct experiments and continuously increase their knowledge of the ecosystem. In many of the MMU management plans, one of the goals was to increase the percentage of bulls. A probable explanation is that, in MMUs of approximately 60,000 hectares, 30% of the bulls will be shared with neighbouring areas[9] (Ericsson & Wallin, 1995). In other words, because only 28 MMUs are larger than 60,000 hectares (MMU database), the majority of MMUs share bulls. The median sized MMU is about 10,000 hectares (MMU database), meaning that the median-sized MMUs share about 40-60% of their bulls with neighbours, depending upon where in the country the MMU is situated (Ericsson & Wallin, 1995). In this case, irrespective of the monitoring methods used, there is no significant difference in results.

It is reasonable, therefore, to conclude that MMUs, in general, fail to ensure their desired composition of the moose population. The most probable explanation is that the MMUs are too small for the actors to make decisions on how many bulls to shoot. Perhaps the only way for MMUs to achieve this second goal, with the current organizational structure, is for MMUs

[9] It has been noted that, in MMUs of 60,000 hectares, approximately 30% of the bulls will be shared with neighbors, under the presumption that the average size of a moose 'habitat' is 1500 hectares. The habitat of moose varies from 500 hectares to 3000 hectares, depending upon the sex of the animal (bulls have habitats twice as big as cows) and what part of the country it is. In northern Sweden, the moose migrate between summer and winter feeding grounds (Ericsson & Wallin, 1995).

to increase their degree of cooperation with other hunting organizations. Both horizontal and vertical linkages may be needed to decrease the negative external effects of harvesting. Since moose are very mobile and the shooting of bulls results in negative externalities, it is crucial that such linkages exchange information and make collective decisions about the shooting practices of moose.

The third variable that was part of our measure of degree of goal fulfilment was the amount of grazing damages. In the MMU management plans, the resource managers could note down whether they considered the grazing damage to be “insignificant”, “acceptable”, or “significant”.

Table 5. The amount of grazing damages in MMUs.

MMUs with significant grazing damages	28 %
MMUs with insignificant or acceptable grazing damages	72 %

N = 546

Table 5 demonstrates that a majority of the MMUs consider the amount of grazing damage insignificant or acceptable, but still 28% felt that grazing damage has been significant. This is a disturbing result, considering the effects grazing damage has not only on the value of the forest but also on biological diversity.

In order to generate an overall estimate of the general degree of goal fulfilment, the success in terms of percentage of bulls and amount of grazing damage were added.

Table 6. Degree of Success

No success Score=0	22 %
Low degree of success Score=1	45 %
Some degree of success Score=2	31 %
High degree of success Score=3	2 %

N = 589

Table 6 indicates that 33% of the MMUs have had at least some degree of success reaching their goals, while 67% of the MMUs have had no to little success.

Ecosystem Management:

A significant difference between adaptive management and conventional resource management is that single species management is replaced by ecosystem management. Ecological research has disclosed the importance of monitoring slow variables in ecosystems, since these are principal in the functioning of ecosystems. In order to estimate the degree of ecosystem management, an ecosystem index composed of three variables was created. These variables were: utilization of a local grazing damage inventory method, wild care efforts, and estimation of grazing damages on different tree species. First each of the variables will be presented separately, followed by a broader picture in the form of an ecosystem management index. In Table 7, the percentages of MMUs that utilize a local grazing inventory method are provided.

Table 7. The percentages of MMUs that utilized a local grazing damage inventory method.

MMUs using a local grazing damage inventory method	23 %
MMUs not using a local grazing inventory method	77 %

N = 618

One efficient way to ensure biological diversity and to control the extent of grazing damage to various tree species would be for local resource users to employ a local grazing damage inventory method[10]. Biologists have developed different versions of local grazing damage inventory methods, and the latest version is called Local Äbin. Detailed instructions on how to use this method is available on the NBF website. One scientist who had developed the method stated that it was easy to use[11]. The Chairman of the MMU claimed that he had tried to use it, but found it difficult (interview 2). This might be an example of difficulties in transferring inventory methods to local resource users.

The second variable that is believed to reflect ecosystem management is wild care efforts conducted by local resource users. In Table 8, wild care efforts performed by actors in the MMUs are presented.

[10] National surveys on the amount of grazing damage have been conducted by the National Board of Forestry (NBF), called Äbin. However, these surveys only cover larger geographical areas and are not detailed enough to use on the relatively small MMUs.

[11] Conversation with wildlife biologist, Roger Bergström, Umeå, 15-09-05.

Table 8. Wild care efforts performed by MMUs.

Clearing of forest	16 %
Wildlife feeding	7 %
Other wild care efforts	16 %

N = 557

Table 8 shows that it is not very common that the MMUs perform wild care efforts. An investigation into the attitudes of Swedish hunters towards performing wild care efforts has disclosed that 73% believe their wild care efforts are meaningful. Approximately 15% of the hunters did not perform the degree of wild care efforts that they wished, because of long distances to hunting grounds; and approximately 10% of the hunters did not perform wild care efforts, because they were dissatisfied with the short hunting leases available at their hunting grounds (SOU 1997: 91:237).

A third variable that is believed to reflect ecosystem management is whether grazing damage on more than just economically-valuable tree species, such as pine, is noted down in the MMU management plans. If there are estimates of grazing damage on more than three tree species, this would indicate that ecosystem management is being applied. If resource users utilize a local grazing damage inventory method and note down damages on different tree species, this would indicate a more holistic view of the ecosystems and perhaps contribute to efforts taken in order to ensure that biodiversity is not threatened

Table 9. Estimation of grazing damage on different tree species.

No notes on grazing damage in MMU plans	31 %
Notes on grazing damage on one to two tree species in MMU plans	37 %
Notes on grazing damage on three or more tree species in MMU plans	32 %

N = 637

Table 9 shows that 32% of the MMUs reported grazing damage on more than three tree species. On the other hand, 31% had not noted grazing damage on specific tree species at all. This result might, in part, be explained by the different MMU templates established by the SAHWM. Not all of MMU management plan versions have specific places for writing down grazing damage on more than pine and birch.

In Table 10, the three variables have been compiled in order to indicate the overall degree of ecosystem management in Swedish MMUs. The index is comprised of the three variables already described in this section; utilization of a local grazing damage inventory method, wild care efforts, and estimation of grazing damages on different tree species. However, the score range is 0-5, because actors can perform three different kinds of wild care efforts.

Table 10. Degree of Ecosystem Management in Swedish MMUs.

Score	%
0	51 %
1-2	42 %
3-5	7 %

N = 637

Table 10 indicates that half of the Swedish MMUs do not apply any meaningful ecosystem perspective on the management of the moose population. Only 7 % have a high degree of ecosystem management. This should be of concern, especially considering how important it is, according to adaptive management theories, that local resource users consider the entire ecosystem, and not just a single species.

Monitoring:

As mentioned previously, one important aspect of adaptive management is that of monitoring resource abundance. Monitoring of a resource is essential in order to take management decisions, such as how many moose to shoot. Because all monitoring methods have their strengths and weaknesses, reliability increases if a MMU utilizes more than one method. Therefore, both the type and number of monitoring methods utilized by MMUs will be examined. The utilization of monitoring methods within Swedish MMUs is presented in Table 11.

Table 11. Monitoring methods utilized by the MMUs.

ÄlgObs inventory	54 %
Airplane inventory	26 %
Winter inventory	2 %
Dropping inventory	5 %

N = 637

The most commonly used monitoring method is ÄlgObs, which is not surprising, because this method is coordinated, at the national level, by SAHWM and has existed since 1985 (Ericsson & Wallin, 1998). However, somewhat surprising is that as many as 26 % of the MMUs actually have, at some point, utilized airplane inventory, a method that is fairly expensive. However, due to the attained management rights, perhaps landowners now consider it worth spending the money for this. However, it is likely that larger forest companies are the most willing to invest in this monitoring method. When asked about this, one forest manager stated that the forest company utilized airplane inventory methods when it first established their MMUs, in order to obtain reliable estimates on the size of the moose population (Interview 1). As can be seen from Table 11, the winter inventory method and the dropping method rarely are utilized.

Complementing monitoring methods should be more reliable than any single method used alone. In Table 12, the number of moose monitoring methods utilized by different MMUs is indicated.

Table 12. The number of moose monitoring methods utilized by MMUs.

No monitoring methods	26 %
One monitoring method	49 %
Two monitoring methods	23 %
Three monitoring methods	2 %

N = 543

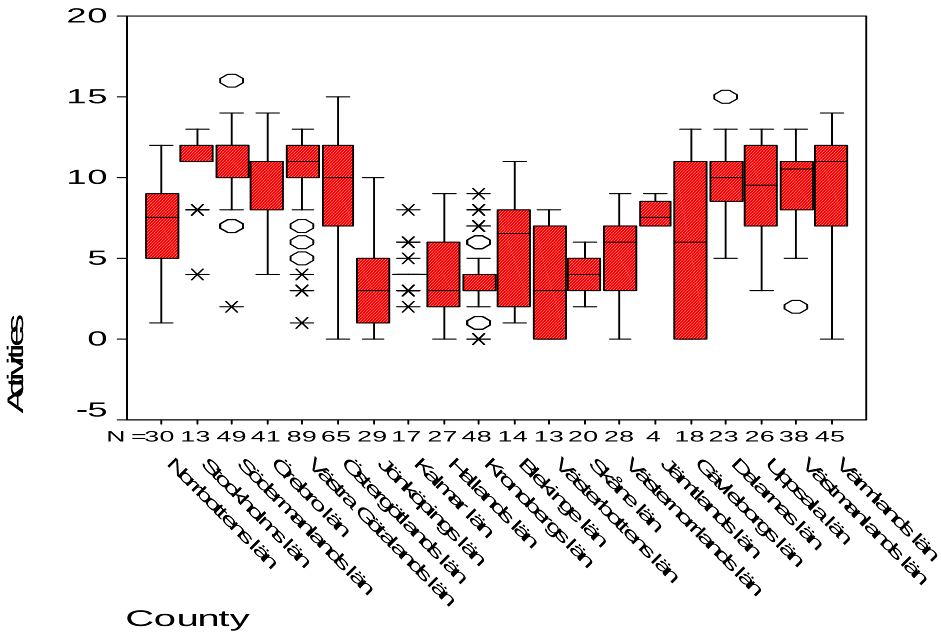
One in four MMUs do not utilize any monitoring method. Admittedly, some of the MMU management plans lack this information. Roughly half of the MMUs use one monitoring method, 23 % utilize two monitoring methods, and only 2% utilize three.

Activities:
As mentioned previously, the number of activities an MMU performs can be considered one aspect of adaptive management. The total number of variables in the activity index is 20. None of the actors within the MMUs performed more than sixteen activities; this was not unexpected, since it is unreasonable to think that any given MMU would, for example, engage in all monitoring methods. In 100 of the MMU plans, local resource users claimed to perform eleven activities. However, many of the MMU plans lacked all the necessary information, suggesting that the estimate of the number of activities performed by local resource users in Swedish MMUs may be low.

Cross-Scale Linkages:

It also is crucial to investigate whether there are differences between counties. One issue is whether the number of activities differs between counties; if this is the case, perhaps the procedural practices of the CABs should be examined. In addition, CABs have an important role to play, since they can provide essential horizontal linkages, which are important according to adaptive management theories. In Figure 1, the number of activities in different counties is illustrated by means of a box plot.[12]

[12] The box illustrates a variable's inter-quartile range and contains 50% of the cases. The line across the box indicates the median value. The whiskers protruding from the box go out to the variable's smallest and largest value. Outliers are indicated by circles. These are variables with scores much higher or lower than the remainder of the sample.



N = 637

Figure 1. The number of activities in counties.

Figure 1 show that, not only are there differences in the number of activities performed by MMUs in different counties, there also are significant differences between MMUs in the same county. The significant differences among counties perhaps could be explained by CAB administrative routines regarding MMU management plans; for example, how often CABs revise MMU management plans and whether these are reviewed by special interest organizations. If MMU management plans are revised and critiqued regularly, perhaps there is more effort by resource users to conduct monitoring, record grazing damage on different tree species, and so forth.

Another issue is whether CABs have the personnel capacity to develop improved management strategies within MMUs. Document analysis revealed that some CABs believed that the function of MMUs already had been met by licensing procedures, and this perhaps led some to be unwilling to spend resources on a new moose management organization. None of the CABs had computerized MMU management plans, and this made it extremely difficult to access an overview of the activities performed by MMUs, or how management strategies could be improved at the county level.

The lack of any systematic treatment of MMU management plans might be due to the legal power of the CABs. There are no other forms of sanction that CABs can take against MMUs, other than to deregister a MMU if it is not working well; and this, of course, is a drastic solution. In addition, if a CAB decides to deregister an MMU, the affected landowners once again might apply to establish a new MMU, or the CAB would have to register the area into other licensing units. In addition, there are no formal rules regarding the content of MMU management plans, only the previously-mentioned EPA 'advice' (NFS 2002:19).

Figure 1 shows that, in certain counties, like Stockholm, Södermanland, and Västra Götaland, the median number of activities is high, and most MMUs within these counties perform about the same number of activities (as illustrated by the small boxes). In contrast, the MMUs in Gävleborg County have a fairly low level of median activity, while the distribution is large (indicated by a large box). Overall it is safe to conclude that the current horizontal linkages are not consistent with polycentric governance.

Local forums:

Another aspect of adaptive management is whether there are vertical linkages between local resource systems. An example of a vertical linkage is an MMU participating in local forums. The interviewed forestry manager stated that the forest company had not been invited to local forums by the SAHWM district in Norrbotten County. However, he believed that it is necessary to participate in local forums to coordinate moose hunting over larger geographical areas (interview 1). SAHWM organizes these local forums, and this is another example of the problems that can arise when a special interest organization has a central role in public administration. The forestry manager did claim that the central SAHWM had welcomed everyone to the local forums (interview 1). Active participation in the local forums might lead to a 'spill-over effect' of management strategies within counties; but no national evaluation of local forums has been conducted. Landowners and hunting interest organizations conducted an overview of local forums, and concluded that they lack formal procedures, including meeting summons, adequate documentation and appropriate representation. In addition, the increase in the number of MMUs was believed to undermine local forums. Despite EPA directives that the Wildlife Management Boards should follow up on local forums, they have not reacted to the declining importance of local forums (Fransson, 2003). Vertical linkages, as expressed through local forums, have declined in importance since the establishment of MMUs.

Overall Adaptability of Swedish MMUs

As can be seen in Table 13, the overall degree of adaptive aspects of Swedish MMUs appears to be low.

Table 13. Overall degree of adaptive aspects of Swedish MMUs.

Adaptive Management Criteria	***Comment***
Degree of Success	67 % of MMUs has low or no degree of success in reaching their goal regarding the size of the moose population within acceptable biological and ecological levels
Ecosystem Management	51 % of MMUs do not apply ecosystem management
Monitoring	26 % of MMUs do not utilize any monitoring methods
Activities	The most common number of activities undertaken by local actors within MMUs was eleven (i.e., about half of the theoretically possible activities).
Cross-scale linkages	MMU plans differed significantly in quality, both within and between counties CABs have not computerized MMU plans The local forums had declined in importance since the establishment of MMUs

The degree of goal fulfilment is low, and this is a serious problem given that many MMUs consider their moose populations to be too large and their grazing damage to be too great. The percentage of bulls was too low, with only 15 % of the MMUs having more than 30% bulls in their moose population. Although the sharing of bulls between MMUs may explain this, to a large extent, this all could be alleviated by greater cooperation between MMUs and other hunting organizations through local forums. Unfortunately, local forums largely seem to have been undermined by the establishment of MMUs.

Ecosystem management is practiced only by half of the MMUs. The focus still is on single-species management, consistent with conventional resource management. One way to ensure that biodiversity is not threatened by moose grazing would be for resource users to utilize local grazing inventory methods; however, only 23 % of the MMUs did this. This might be explained by the single-minded focus of both forest industry representatives and hunters.

Presumably, neither group has a true interest in any holistic view of the ecosystem, since their primary interests are economically-valuable tree species and ensuring adequate hunting opportunities, respectively.

One in four MMUs do not appear to utilize any monitoring methods for moose, though, admittedly, this number may be artificially low because many MMU plans lacked all the necessary information. Of the various monitoring methods available, ÄlgObs seems to enjoy the greatest level of success, because it is conducted during harvesting and many MMUs utilize this method. Traditional monitoring methods usually have been low-cost and rapidly-conducted in connection with harvesting (Moller, Berkes et al., 2004). ÄlgObs is conducted during harvesting and is easy to utilize, since hunters only note down the number of moose they spot. Conversely, monitoring methods like counting droppings entails much more effort, because resource users need to mark areas on a map and, thereafter, only count droppings in these areas. This is time consuming and not conducted during harvesting; thus, it is unlikely that this method is going to be widespread, even though it is inexpensive. Perhaps scientists could take this into consideration and develop monitoring methods that resemble practices already utilized in traditional societies (Gadgil, Berkes et al., 1993). The relative reliability of such practices might be lower; nonetheless, they may serve to increase local ecosystem awareness.

The traditional roles of CABs regarding moose management are those of enforcing and monitoring rules; however, since the evolution of MMUs, this role has been undermined. It seems that CABs are inflexible and that the current organizational structure inhibits the establishment of adaptive management. This study indicates that the administrative routines at CABs differ regarding their treatment of MMU plans.

The results indicate that there are rather few aspects of adaptive management present in Swedish MMUs. In the case of Swedish MMUs, it appears that many aspects of conventional resource management, like focusing on a single species, still are prevalent.

DISCUSSION

Overall, MMUs seem to lack an ecosystem perspective and their focus is on single-species management. With the decentralization and deregulation of the moose management system, it is vital that public interests are taken into account when management decisions are made. Landowners have an obligation to ensure that natural resources are not used in socially unacceptable ways. Therefore, increased management rights also should entail responsibility to protect other aspects of the ecosystem, besides the moose population; for example, by ensuring that biodiversity is not threatened, due to excessive grazing damage on different tree species. However, in the current system, there are no guarantees that landowners apply a holistic view of ecosystems, particularly with respect to decisions on moose populations; though this might be improved by informative efforts regarding the importance of maintaining biodiversity or by implementing formal rules. This lack of an ecosystem perspective is serious, both with respect to maintaining biodiversity and ecosystem resilience. A focus upon only commercially-valuable tree species and moose cannot be deemed 'using natural resources in a sustainable way' and, consequently, cannot be socially acceptable. There is minimal participation by stakeholders, such as environmental organizations, that would highlight these different vital aspects of ecosystems.

The wildlife management organizational structure perhaps also can explain the apparent lack of administrative routines and management strategies within MMUs. For example, the SAHWM provides MMU plan templates, organizes local forums, and is in charge of hunting education and the treatment of ÄlgObs. In other words, the fragmentation of the organizational structure inhibits any broad overview as to what actions to take to improve moose management in MMUs. This division of wildlife administrative assignments, between the CABs and the SAHWM, dictates extensive cooperation, if adaptive management is to be implemented.

This study indicates that extensive management rights are not a guarantee that local resource users will invest time in the management of natural resources, or apply a holistic view of the ecosystem. The conversion of a top-down system, characterized by single-species management and monitoring methods developed by scientists, will not automatically turn into an adaptive management system, even though resource users have gained management rights.

REFERENCES

Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography, 24*(3), 347-364.

Adger, W. N. (2002/2003). Building Resilience to Promote Sustainability. An Agenda for Coping with Globalisation and Promoting Justice. *HIDP Newsletter, 2002/2003,* 1-3.

Baland, J.-M., Platteau, J.-P., & Oxford University Press. (2000). *Halting Degradation of Natural Resources Is There a Role for Rural Communities?* Oxford: Oxford University Press.

Berkes, F. (1996). Social Systems, Ecological Systems, and Property Rights. In S. Hanna, C. Folke & K.-G. Mäler (Eds.), *Rights to Nature* (pp. 87-111). Washington, D.C.: Island Press.

Berkes, F. (1998). Indigenous knowledge and resource management systems. In F. Berkes & C. Folke (Eds.), *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience* (pp. 95-128). Cambridge: Cambridge University Press.

Berkes, F. (2003). Introduction. In F. Berkes, J. Colding & C. Folke (Eds.), *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change* (pp. 1-31). Cambridge: Cambridge University Press.

Berkes, F., & Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. In F. Berkes & C. Folke (Eds.), *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience* (pp. 1-27). Cambridge: Cambridge University Press.

Ericsson, G., & Wallin, K. (1995). Egna älgar - och andras. *Svensk Jakt, 3,* 36-39.

Ericsson, G., & Wallin, K. (1998). Räkna älg en viktig uppgift. *Svensk Jakt, 10,* 100-101.

Feeny, D., Berkes, F., McCay, B. J., & Acheson, J. M. (1990). The Tragedy of the Commons: Twenty-Two Years Later. *Human Ecology, 18*(1), 1-17.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., Walker, B., et al. (2002). *Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformation*. Stockholm: Edita Nordstedts Tryckeri AB.

Folke, C., Pritchard, L., & Berkes, F. (1998). The Problem of Fit between Ecosystems and Institutions. *IHDP Working Paper, 2*.

Fransson, J. (2003). *Viltförvaltning - precisering av Svenska Jägareförbundets allmänna uppdrag*: Jo 2003/220.

Gadgil, M., Berkes, F., & Folke, C. (1993). Indigenous Knowledge for Biodiversity Conservation. *Ambio, 22*(2-3), 151-156.

Gunderson, L. H., Holling, C. S., & Light, S. S. (1995). *Barriers and bridges to the renewal of ecosystems and institutions*. New York, NY.: Columbia University Press.

Hanna, S. (1998). Managing for human and ecological context in the Maine soft shell clam fishery. In F. Berkes & C. Folke (Eds.), *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience* (pp. 190-213). Cambridge: Cambridge University Press.

Hanna, S. S., Folke, C., & Mäler, K.-G. (1996). Property Rights and the Natural Environment. In S. S. Hanna, C. Folke & K.-G. Mäler (Eds.), *Rights to nature : ecological, economic, cultural, and political principles of institutions for the environment* (pp. 1-10). Washington, D.C.: Island Press.

Hardin, G. (1968). The Tragedy of the Commons. *Science, 162,* 1243-1248.

Holling, C. S., Berkes, F., & Folke, C. (1998). Science, sustainability and resource management. In F. Berkes & C. Folke (Eds.), *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience* (pp. 342-390). Cambridge: Cambridge University Press.

Johnson, F. (1999). *Expectation and Surprise in the Adaptive Management of Waterfowl Harvests.* Paper presented at the Adaptive Management Forum: Linking Management and Science to Achieve Ecological Sustainability. Proceedings of the 1998 Provincial Science Forum., Ontario.

Lee, K. (1993). *Compass and Gyroscope. Integrating Science and Politics for the Environment*. Washington: Island Press.

Lee, K. (1999). Apprising Adaptive Management. *Conservation Ecology [online], 3*(2).

Libecap, G. D. (1993). *Contracting for Property Rights* (New ed.). Cambridge: Cambridge University Press.

Moller, H., Berkes, F., Lyver, P. O., & Kislalioglu, M. (2004). Combining science and traditional ecological knowledge: monitoring populations for co-management. *Ecology and Society, 9(3): 2*.

Olsson, P., & Folke, C. (2001). Local ecological knowledge and institutional dynamics for ecosystem management: A study of Lake Racken Watershed, Sweden. *Ecosystems, 4*(2), 85-104.

Olsson, P., Hahn, T., & Folke, C. (2003). Social-Ecological Transformations for Ecosystem Management: The Development of Adaptive Co-management of a Wetland Landscape in Southern Sweden. In *Building Capacity for Resilience in Social-Ecological Systems*. Stockholm: Stockholm University.

Ostrom, E. (1990). *Governing the commons: the evolution of institutions for collective action*. Cambridge: Cambridge University Press.

Ostrom, E. (2003). How types of goods and property rights jointly affect collective action. *Journal of Theoretical Politics, 15*(3), 239-270.

Ostrom, E., & Schlager, E. (1996). The Formation of Property Rights. In S. Hanna, C. Folke & K.-G. Mäler (Eds.), *Rights to Nature Ecological, Economic, Cultural, and Political Principles of Institutions for the Environment* (pp. 127-157). Washington, D.C.: Island Press.

Walters, C. (1986). *Adaptive Management of Natural Resources*. New York: MacMillan Publishing Company.

Walters, C. (1997). Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology [online], 1*(2).

Wennberg-DiGasper, S. (2003). *Management of wildlife in Laponia.* Luleå: Luleå tekniska universitet.

Public Sources

SFS (1987:259) Jaktlag

SFS (1987:905) Jaktförordning

SFS (2000:592) om viltvårdsområden

Prop. 1991/92:9 om jakt och viltvård

Prop. 1986/87:58 Om jaktlag, m.m.

Prop. 1999/2000: 73 Jaktens villkor

SOU 1990: 60 Skada av vilt – Betänkande av utredningen om ersättning vid vissa viltskador

SOU 1997:91 Jaktens villkor – en utredning om vissa jaktfrågor

NFS 2002:19 Naturvårdsverkets föreskrifter om Allmänna råd om administration av jakt efter älg, kronhjort och stora rovdjur m.m.

Interviews:

1. Interview with a forest company's forest manager 06-10-03

2. Interview with a chairman of a MCA 09-10-03