Already adaptive? lessons from a pilot study of management of fish and wildlife

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Abstract

The issue of sustainable management of natural resources is currently in focus in all areas and by many governments in the world. Adaptive management has been suggested as means for sustainable utilization of natural resources and through an increase of social ecological resilience. Adaptive management is based on the assumption of ecosystems as complex systems where the only thing certain is that there will always be surprises. There are two lines of research within the adaptive management approach that if implemented would demand different institutional frameworks. The first line of research view adaptive management as integration of parts and is based on processes of model building ecosystems done in cooperation between scientists and resource managers. Gaps in the "state of the art" biological/ecological knowledge are believed to be filled by conducting experiments in actual ecosystems. The other line of research is based on the assumption that there already are adaptive management systems in place. For example tribes and other user groups monitor ecosystems and adjust management decisions to changes detected and therefore they have been able to build ecological and social resilience, which entails that the system can adjust to changes smoothly and that there are a constant learning process occurring.

The Swedish government has declared its intention to implement adaptive management regarding management of moose and fish but has not specified how this should be accomplished. In this report the adaptive management and its two lines of research are contrasted with conventional resource management. A pilot case study was performed on moose harvesting administrative units and a river administrative organization analyzing whether features of the different management approaches were present and what institutional changes would be required for implementing large scale adaptive management. The study indicated that there are significant signs of adaptive management already in place in Swedish moose and terrestrial fishing units. It is concluded that decentralization of decision-making over moose and terrestrial fish have contributed to changes in management practices which are now more adaptive than during the previous top-down regulations. A value shift from viewing fish only as a food value to viewing fish as a hobby exercised through sport fishing and as a tourist potential has also influenced management practices significantly and led to resource users spending more time and effort in trying to improve and protect fish. Still however forest companies' management practices regarding moose administration resembled conventional resource management to a greater degree than adaptive management. The conclusion follows that the property rights structure strongly influences implementation of adaptive management.

If the Swedish government intend to implement adaptive management, consideration has to be taken to administrative units where there already are adaptive management features in place. Perhaps the goal of the Swedish government should be to strengthened already existing institutions promoting adaptive management practices.

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At the Johannesburg World Summit on Sustainable Development in 2002, a political declaration and an implementation plan for sustainable development was adopted (Regeringens skrivelse 2001/02:173). Sustainability has been defined as using resources in such manner as not to risk future generations' abilities to utilize them (Feeny et al. 1990). One aspect of sustainability is how natural resources such as species with diverse utilization values can be managed as to ensure sustainability. For many people, fishing and hunting are recreational sports with strong appeals. However, moose, for example cause grazing damage on forestry land which decreases the value of the forest. A problem facing many governments therefore is how to manage resources sustainably while ensuring that various actors' interests are taken into consideration. This is perhaps not the easiest task since the interests of diverse actors often conflict.

The Swedish authorities have in several official reports proposed an adaptive management approach in order to ensure sustainable resource use in oceans, terrestrial waters and regarding wildlife (SOU 2003:72; EPA rapport 5301). An international review of Swedish wildlife research suggested that large-scale adaptive management experiments should be performed in order to improve wildlife management (EPA rapport 5179). As a result, the Swedish wildlife and fish management is clearly changing direction as to the way management is performed. What does adaptive management entail? How does this management approach differ from conventional resource management?

The development of new ecological theories and concepts and the apparent limitations of conventional resource management 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 Canadian ecological theorist C. S. Holling (Lee 1993). It was emphasized that ecosystems are complex non-linear systems which entail that the only certainty is uncertainty and that management strategies have to accept this as an integral part

of the ecological system (Folke 2002). In difference, conventional resource management is characterized by the idea of command and control over resources, with the goal to maximize sustainable yields of a resource. Scientists and resource managers need to cooperate in order to establish ecosystem models. These contribute to problem clarification and elimination of unproductive options (Walters 1997). Perhaps the most important result that model building can accomplish is disclosing gaps in the "state of the art" biological and ecological knowledge. The "missing" information can be obtained by implementing large-scale focused experiments in the ecosystems. The experiments lead to increased knowledge of the ecosystem and therefore, also improve the chances for selecting appropriate policies in the future (Walters 1997).

The role of local resource users is debated among scholars. However, it seems as if the foremost concern is that local resource users do not impede implementation of ideas established by scientists and resource managers (Gunderson 1998; Lee 1999). Gunderson has expressed concern regarding stakeholders' lack of technical knowledge and the risk of replacing uncertainties in ecosystems with institutional processes, such as community based management where science is completely ignored (Gunderson 1998). The view of the local resource users as having a passive role is more in line with a top down management structure as is the practice in conventional resource management. Lee claims that "…adaptive management appears to be a "top-down" tool, useful primarily when there is a unitary ruling interest able to choose hypotheses and test them (Lee 1999)".

Another feature of the adaptive management approach is the realization of interconnectedness between ecological and social systems. For example, Walters and Holling realized that if economic systems were not taken into account it could jeopardize "purely" ecological solutions (Walters 1986). The adaptive management approach has been applied successfully in, for example: the Everglades (Gunderson, Holling, and Light 1995), and waterfowl management in USA (Johnson 1999).

However, other researchers have focused on locating adaptive systems that exists where communities have managed to use resources sustainably (Berkes 2003; Berkes 1998; Berkes and Folke 1998). The difference 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, and Folke 1998).

Research focus has been on local resource users and their ability to manage resources sustainably due to, among other things, their ecological knowledge. One important aspect is whether local resource users have managed to build social-ecological resilience by adapting to ecosystem changes. Social-ecological resilience has been defined as;

> 1) the amount of disturbance a system can absorb and still remain within the same state of domain of attraction,
> 2) the degree to which the system is capable of self-organization (versus lack of organization, or organization forced by external factors) and,
> 3) the degree to which the system can build and increase the capacity for learning and adaptation (http://www.resalliance.org/ev.php).

Since there is evidence of existing adaptive management systems it is critical to examine whether this also might be the case in Swedish moose and terrestrial fish management systems. For example, Olsson and Folke (Olsson and Folke 2001) found an adaptive management system managing cray fishing in Lake Racken in southern Sweden. Is it possible that there are adaptive management systems regarding terrestrial fish and wildlife? If local resource users have already established adaptive management systems perhaps the public authorities should support these systems by for example, financial aid or expertise knowledge.

Aim:

The aim of this paper is to find out to what extent there already are adaptive management systems in place in the Swedish moose and terrestrial fish management systems. The Swedish authorities' interpretation of the adaptive management approach seems to be influenced mainly by Hollings and his colleagues' definition of the approach and not by Berkes and Folke's line of research of existing adaptive management systems. It is likely that these two interpretations of adaptive management require different institutions therefore it is crucial to be clear as to what kind of system will be more successful when implemented in an already existing institutional framework. Walters and his colleagues' line of research have more similarities to a top down management system while the other line of research requires

a bottom up management system. What are the institutional prerequisites for the adaptive management approach as described by Berkes and his colleagues? The second aim is to generate hypotheses for further research.

This paper is organized in the following way; first, the investigating method will be introduced to be followed by a description of the case studies. The Swedish legal framework will thereafter be described. Central features of the adaptive management approach will be described briefly and the results from the case studies will be introduced. Finally, an analysis and a discussion regarding the results of this study will be presented.

Method:

This paper is based on the findings of a pilot study investigating to what extent adaptive management systems are in place regarding moose and terrestrial fish in Sweden. Three cases has been investigated; *two moose management systems* and one *terrestrial fish management system*. One of the moose management systems is constituted of privately owned land and the other is owned by a forest company. The pilot case studies were chosen in part due to their geographical location. All the cases are situated in Norrbotten County in northern Sweden which is rich in wildlife and fish. Informational interviews were performed with employees at the County Administrative Board in Norrbotten County (CAB) and representatives of various interest organizations. Also, documents pertaining to this area were reviewed. Semi-structured interviews were conducted with representatives of different management systems of fish and moose. A representative of a municipality river council that also is a representative of the river management system for an entire river was interviewed. The *forest company* employs a forest manager for Norrbotten County and seven district managers who are placed throughout the county. The forest manager, one district manager, and a hunting team leader managing hunting on the forest company land were interviewed. The chairman of the *private moose management system* was interviewed, as well.

Case Studies:

The *terrestrial fish management system* manages an entire river. Owners of fishing rights, along the river, have voluntarily transferred their management rights to fishing councils in the municipalities, (the river stretches over four municipalities). There is ca: six to eight people in the municipality fishing councils and these represents villages, forest companies and the municipality. In 2002, a fishery management system for the entire river

was established that it is constituted of two representatives from each of the four municipalities. They decide on, among other things, fishing restrictions.

There are two main management systems for moose in Sweden. The "older" are called Game Management Areas (viltvårdsområden VVO) and the "newer" are called Moose Management Areas (älgskötselområden ÄO). The VVO is regulated in a specific law while the ÄO is loosely regulated. The most significant criteria for establishing an ÄO is that the area is large enough to contain a moose population. The most significant difference is that ÄOs can decide the moose quotas in a hunting season, while the CAB decides the moose allocation to VVOs. Approximately 30-40% of the total moose area in Norrbotten County is constituted by ÄO management systems (interview 8).

The *forest company* administer several ÄOs of various sizes located on their land, which is spread throughout the county. The district manager is in charge of two ÄOs of about 60,000 hectare and 20 hunting teams made up of ca: 160-170 hunters leasing hunting rights.

The *private ÄO* is constituted of privately owned land and is 13,420 hectare. It was established in 1996. Three VVOs have joined to establish the ÄO.

This selection of management systems allows a comparison between different types of resources and diverse property rights structures, which might affect the existence of adaptive management features.

Legal framework:

The Swedish government has in several policy documents made it quite clear that they wish resource users and land owners to take on a bigger responsibility for the management of fish and moose (Prop. 1980/81: 153 & Prop. 1991/92:.9). During the last decades alterations in formal rules have led to devolution of management rights and deregulation of fish and moose policies. Two arguments behind these modifications are high administrative costs associated with a top down structure and the belief that resource users can improve resource management (Prop. 1980/81: 153 & Prop. 1991/92:.9). The change in official policy has increased management rights of property owners.

Property rights refer to the relationship between people in regards to some object. This implies that one person's right includes another person's obligation to respect that right (Ostrom and Schlager 1996). The most basics rights are rights to 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.

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 property right (Ostrom and Schlager 1996). Below in Table 2, the major changes in law regarding property rights of fish and moose are presented.

Table 2. Changes in fish and moose management regulations (adopted after Ostrom and Schlager 1996).

Property Rights				
	Withdrawal, i.e., [The right to fish/hunt]	**Management, i.e.,** [The right to regulate usage patterns]	**Exclusion, i.e.,** [The right to decide – access and how to transfer the right]	**Alienation, i.e.,** [The right to sell or lease out hunting/fishing rights]
Fishing Rights Owner	Yes	Yes, since 1994 (SFS 1994:1716).	Yes, in areas with private fishing rights.	Yes
Anglers	Yes, If they have a fishing permit	No	No	No
Hunting Rights Owner	Yes, if they have a hunting license	Yes, since 1992 when the possibility to register an ÄO was made possible the decision on how many moose to shoot during a hunting season was transferred to landowners. The CAB decides moose allocations to VVOs.	Yes	Yes
Hunters	Yes, If they have a hunting lease and license	No	No	No

While changes in law have increased the management rights of property rights holders, the government still decides the hunting season and grants permission regarding questions, such as, cultivation of fish. In the last ten years, a top down system has been converted into a bottom up system. Local resource users take practically all management decisions and are no longer passive recipients of quotas. According to Ostrom's design principles, one perquisite for resource users to establish institutions is a minimal right to organize (Ostrom 1990). Other researchers have emphasized the necessity of extensive management rights in order for resource users to establish adaptive management systems of natural resources (Olsson, Folke, and Berkes 2003; Olsson, Hahn, and Folke 2003). As Adger puts it; "Promoting resilience means changing, in particular the nature of decision-making to recognize the benefits of autonomy and new forms of governance promoting social goals, self-organization, and the capacity to adapt" (Adger 2003:2). In other words due to the conversion of a top down management system into a bottom up system the institutional prerequisites for adaptive management systems are in place regarding moose and terrestrial fish.

However, there is still a difference if you own property or if you lease the right to hunt or fish. In other words, changes in formal rules have only directly affected property owners. Hunters and fishermen leasing rights can not make decisions as to where, how and when to appropriate the resource. There are no significant differences between the two resources fish and moose regarding the legal framework. Therefore eventual differences of the extent of adaptive features, regarding the two types of resources, moose and fish, can not be explained by different formal legal regulations.

Adaptive Management Features:

The focus in this study is on local resource users and to what extent they have succeeded in establishing institutions that are adaptive. Researchers have identified certain adaptive management features in local systems that increase social ecological resilience. In order to decide whether a management system is adaptive the following features have been used; 1) ecosystem management, 2) local ecological knowledge, 3) learning, 4) experiments, 5) monitoring, 6) responses to environmental feedbacks, and 7) cross scale linkages. These features have been defined as critical adaptive management features by established researchers in this field (Berkes 2002; Berkes July 2003; Berkes and Folke 1998; Folke, Colding, and Berkes 2003; Olsson and Folke 2001). In the following sections, a brief description of the factors will be presented.

In difference to conventional resource management adaptive management takes into consideration the entire ecosystem and not only single resources. In a similar fashion *ecosystem management* treats single resources as part of a complex network of processes and functions on different spatial and temporal scales (Olsson and Folke 2001). If, for example, there is a change in the predatory population, this might greatly affect the entire food web and have far reaching consequences which might be difficult or even impossible to predict. Another aspect of ecosystem management is that both slow and fast processes in the system are monitored and taken into consideration. Therefore not only fast processes, such as, species abundance, but also slow properties, such as change in soil or ph levels in water, should be monitored (Olsson and Folke 2001). Thus, if the management systems in the case studies only take into consideration the resource of interest and not any other features of the ecosystem they can not be considered as applying ecosystem management. However, in order for resource users to be able to apply ecosystem management, they need to have substantial knowledge of ecosystem properties.

The importance of *local ecological knowledge* in order to manage ecosystems adaptively is emphasized by these researchers. In difference to local ecological knowledge, traditional ecological knowledge implies a historical and cultural continuity (Olsson and Folke 2001). Due to globalization, local ecological knowledge is not only based on observations of the ecosystem, but also scientific knowledge. These two types of knowledge can be coupled since they complement each other, local knowledge consists of a series of local observations over time, which is difficult to attain with "traditional" science (Folke, Colding, and Berkes 2003). In Olsson and Folke's study of cray fishing in Lake Racken in Sweden, they found a mix of scientific knowledge and local knowledge. The local knowledge was obtained through monitoring at the local level and complemented by scientific sources and governmental agencies (Olsson and Folke 2001). However, in order for ecological knowledge to be accumulated among a group of resource users, institutions promoting learning has to exist (Folke, Colding, and Berkes 2003).

Scholars also stress the importance of enhancing the capacity to *learn*. The social memory of a community is communicated by people occupying different roles such as interpreters (people who explain ecological knowledge to the community), networkers, innovators, implementers, followers and reinforcers (Folke, Colding, and Berkes 2003). Interpreters "…continuously process ecological information into practical knowledge and make it accessible for decision-making" (Folke, Colding, and Berkes 2003). However, there are also certain types of organizational structures that promote learning. For example, decentralized organizations have proven to facilitate learning, since these enhance the possibilities for collective learning (Röling and Jiggins 1998). As can be seen in Figure 1, it in order for learning to result in ecological sound practices and increased ecological knowledge requires certain types of institutions and types of learning, such as, collective learning (Röling and Jiggins 1998).

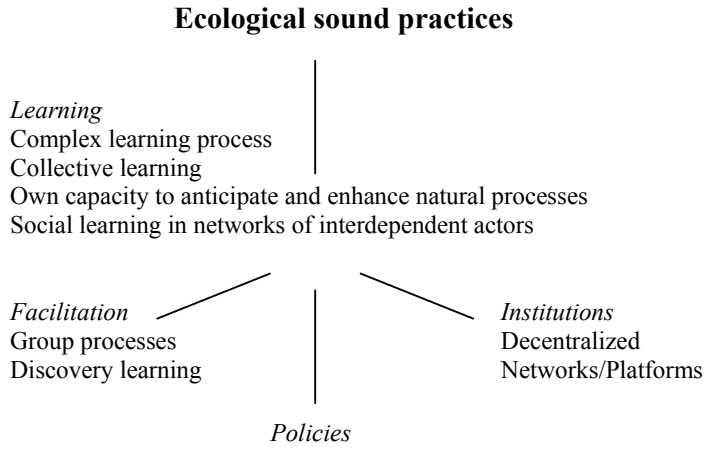

Fig.1. The ecological knowledge system (Röling and Jiggins 1998).

In Figure 1, the importance of learning in groups and how collective learning enhances the understanding of complex ecosystems is illustrated. The environment for learning has to be positive in other words it is important with learning that questions basic assumptions and allows for creativity.

Another important adaptive management feature is for local resource users to *conduct experiments*. "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 practices" (Berkes 1998:358 Gadgil et al., 1993). When local resource users conduct experiments, they ask questions first and then, attempt to answer them by testing their ideas in management practices. However, experiments can not be conducted without some prior observations of ecosystems.

For example, when managing moose and fish it is critical to obtain information regarding population sizes. If there are no ways to find out the population size it becomes impossible to decide how many moose to shoot or how many fish to catch. Hence, *monitoring* of the resource is a crucial aspect in order to be able to manage the resource adaptively. However, in order for new information obtained from monitoring efforts to be implemented, management systems that are able to respond quickly to detected changes are required.

A critical adaptive management feature is therefore flexible management systems that quickly can take legitimate decisions and also have the resources to implement these adjustments. However, not only do decisions need to be legitimate, the implementation

process also have to be legitimate, among the resource users. In addition, institutions have to be able to ensure rule compliance (Ostrom 1990). This is the "Achilles heal" for conventional resource management, since resource users often consider decisions illegitimate and it becomes extremely difficult to obtain rule compliance without dramatic monitoring costs (Hanna and Munasinghe 1995). Research indicates that local level systems responds faster to changes in ecosystems than do centralized agencies (Carlsson 2003; Davidson-Hunt and Berkes 2003). However, even if all of the above features exist in local systems, these still might not be successful adaptive systems since certain ecological aspects are better handled by larger units.

Researchers seem to agree as to the importance of *linking local resource systems to other scales* (Berkes 2002; Berkes July 2003; Cash and Moser 2000; Low et al. 2003; Murphree 2000). According to Dolsak and Ostrom, the specific characteristics of the CPR determine how important it is with linkages. If the resource is characterized by the following factors, it may require institutions to be created at different levels. The resource is part of a highly complex ecosystem and the use of the resource results in extensive negative externalities (Dolsak and Ostrom 2003). The presence of larger, overlapping jurisdictions is an important complement to the work of local level systems. Larger units can in general handle issues such as, natural disasters, corruption/inefficiency, provide scientific and technical skills to complement local knowledge and provide conflict resolution arenas for conflicts among parallel units (Low, Ostrom, Simon & Wilson 2003:108). Linkages can be either vertical or horizontal. Vertical linkages are connections on a spatial level and vertical on an organization level (Berkes 2002).

In the following section it will be discussed to what extent the management exhibit adaptive management features. Case studies will be presented according to; ecosystem management, local ecological knowledge, experimenting, learning, monitoring, responses to environmental feedbacks and cross-scale linkages. Have the resource users established institutions exhibiting adaptive features? Is there a difference in adaptive features due to the type of resource being managed? To gain better understanding of the existence of the above factors requires extensive ecological and biological knowledge that can be formulated into questions posed to resource users. However, indications of the features are possible to detect without a comprehensive investigation. The above adaptive features might also be interpreted as the "positive adaptive management cycle" since they are interrelated and interdependent. It is critical that a system exhibits several of the features in order to be defined as an adaptive management system. In Figure 2, the interconnectedness between the

different features is highlighted. Hence, if something is detracted from the "positive adaptive management cycle", such as, the right to take decisions regarding harvesting or monitoring, the cycle is disrupted; therefore the system is not "fully" adaptive. It is necessary with a flow of activities, all of which are interrelated. For example, a crucial aspect of learning is the existence of cross-scale linkages that can ensure information flow between local systems. Another is that local users conduct experiments since these are a way to learn efficiently about ecosystem properties. Another important aspect is it takes time to establish adaptive systems since the cycle has to be repeated continuously. The concept of ecosystem management means that the "positive adaptive management cycle" should be applied not only to one resource, but the whole ecosystem. If the management system shows a lack of one or several of the features in the "positive adaptive management cycle" circle it is not "fully" adaptive.

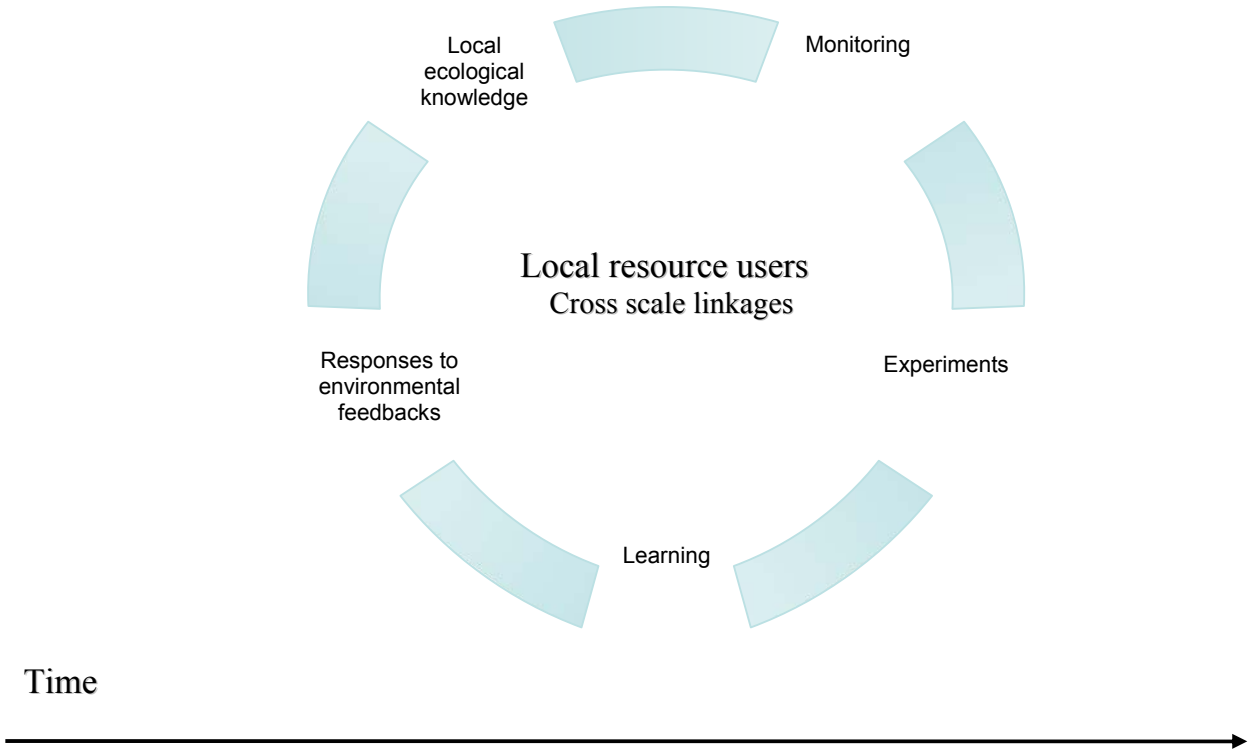

Figure 2. The positive adaptive management cycle.

Results:

In the following sections the results of the findings from the case studies are represented. Since this is a pilot study only indications of the existence of adaptive management features can be claimed and not the exact "amount" of each feature.

Ecosystem management:

The *terrestrial fish management system* that has been investigated manages almost an entire river which can be classified as one ecosystem. The managers applied a holistic view of the ecosystem. However, the river representative also stated that they were aware of their limited knowledge of the ecosystem but were continuously learning. For example, they considered various factors such as, spawning habitats and the presence of predators. The chairman also discussed the effects the coastal fishing had on the fish populations in the river.

The *private ÄO* considered factors such as grazing damage, however, not from an ecological point of view, rather from a forest industry perspective. The chairman showed awareness of the interconnectedness between moose and the forest, as well as, of the fact that certain tree species were almost extinct due to moose grazing damages. However, they did not monitor slow processes in the ecosystem only species abundance and can, therefore, not be considered as applying ecosystem management.

The district managers at the *forest company* are in charge of both forestry aspects and wildlife. Consideration is taken to factors such as rare biotopes however this is required by the public authorities. They monitored only the moose populations, but not slow processes and cannot be considered to apply ecosystem management.

To summarize, the pilot study indicates that the *river management system* applies ecosystem management, but not the *forest company* and the *private ÄO*. Perhaps this result can be explained by the fact that grazing damages is most relevant to the forest interests and there are no other obvious processes affecting the moose population. In addition the river management system was trying to restore the trout population in the river and therefore paid more attention to other variables in the ecosystem, such as, spawning habitats.

Local ecological knowledge:

The chairman, forest manager, district manager and the river representative were aware of the effect ecological principles such as, place (local factors such as climate and its effect on the ecosystem), species (functional role of species in the ecosystem), and disturbances (factors affecting the ecosystem) (Olsson and Folke 2001).

The river representative had knowledge about the importance of trout spawning areas. He also knew how to create these and mentioned problems with deciding where to place habitats due to the low water levels, thereby inhibiting them to judge where streams flow during normal water levels. When deciding on fishing restrictions they follow the National Board of Fishery (NBF) recommendations on minimum sizes of fish allowed to be caught in order to ensure that highly productive fish are not over fished. The ecological knowledge that the river representative had was a combination of observations of the ecosystem and knowledge attained from governmental and scientific sources. The river representative showed how the interaction between his observations and knowledge from other sources increased his level of ecological knowledge, this was an ongoing process.

The chairman of the *private ÄO* kept up with scientific research relating to moose migrations and discussed the problems of concentration of moose to specific areas. He stated that when counting calve is based on experiences of how they wander and how far. He also mentioned problems with moose grazing and said that from his own experience, many times grazing damage seemed worse at first sight, however closer inspection revealed the damages were not as bad, and this in part could be explained by the fact that moose return to graze on the same tree. The chairman seemed to be very observant of the ecosystem and also questioned what he saw with his own eyes and tried to find explanations to this by talking to other people or by consulting scientific sources.

Different disturbances and the effects these have on the ecosystem were discussed by the forest manager and the district manager at the *forest company*, such as, there were less forest clearings these days and therefore the overall food supply for moose had declined. They also were aware of the biological functions of the moose. For example, both the chairman and the forest manager knew that cows are more productive at a later age and they also had made efforts at trying to calculate the productivity of the moose populations. The district manager spent the entire period of bare ground out in the forest since he marked off areas for forest clearing and also had to evaluate whether there were rare biotopes or ancient remains that needed to be protected.

However, according to the hunting team leader at the *forest company*, only a couple of the hunters in his hunting team spent more than a week in the hunting area and can, therefore, not have ecological knowledge from first hand observations. However he also stated that some hunting teams were more engaged and spent more time out in the forests and therefore might also have "more" local ecological knowledge. However due to the limitations of this pilot study this was not possible to include. In addition, the hunting team leader said that they did not attend any study circles and the only source of information they utilized was the Swedish Hunting Association's[1] (Svenska jägareförbundet, SHA) magazine.

Thus, while the relative extent of their knowledge is not estimated in this study all of the interviewed actors had local ecological knowledge. They had acquired their knowledge from both, first hand observations gained from spending significant time in the ecosystems, and from scientific and governmental sources. To summarize, the study indicates that local ecological knowledge among resource users is more prevalent in the *river management system* and the *private ÄO* than among hunters hunting on *forest company* land.

Experiments:

The *river management system* conducts experiments. There had been a five year fishing project in order to find out the size of the grayling population. This project was initiated by a local fly-fishing club and conducted in cooperation with the Swedish Agricultural University in Umeå and the National Board of Fishery (NBF). The five-year fishing project was also an experiment since two stretches of the river were selected. In one stretch, catch and release fishing took place, while the other stretch of the river was closed off from fishing. The intent behind this experiment was to find out the effect catch and release fishing had on the fish population.

The *private ÄO* also conducts experiments. For example, they noticed a higher percentage of bull calves shot than cow calves. After discussing this issue, they concluded that they usually shot the first calf they spotted, in other words, the calf in closest proximity to the cow. They knew that bull calves of milk cows usually came after the cow calf, so they decided to start shooting the second moose calf they spotted. The result was a decrease in the number of shot bull calves. In other words, they formulated a hypothesis and tested it in an experiment and received results that seemed to confirm their hypotheses. In response to their findings, they changed their harvest strategy.

[1] The Swedish Hunting Association is the largest interest organization of hunters in Sweden.

The *forest company* did not conduct any experiments.

To summarize, the study indicates that resource users in the *fish management system* and *private ÄO* conducts experiments, while this does not take place among resource users on *forest company* land.

Learning:

The river representative and the chairman both acted as key stewards since they continuously were learning about ecosystem properties and conveyed this information to other hunters respectively fishermen. The *river management system* and the *private ÄO* definitely applied discovery learning and learned collectively, this is stated to increase abilities of resource users to anticipate and enhance natural processes (Röling and Jiggins 1998).

None of the active in the *river management system* had any formal educational background in biology or ecology. However, they relied on governmental and scientific sources to gain new information. They were learning collectively, since they regularly met at meetings and when coordinating for example restoration of spawning habitats. They also applied discovery learning since they formulated questions about ecosystem properties and attempted to answer these by projects. The river representative continuously asked questions relating to the status of the ecosystem. For example, they had been confounded by some of the results gained from the fishing project and speculated as to possible explanations however he said that they were going to consult experts at the NBF in order to find out whether they could provide some answers. According to the river representative those fishermen engaged in the management of fish were constantly seeking new knowledge so the challenge was to transfer knowledge to those resource users who did not have the same level of interest.

In the *private ÄO*, hunters continuously discussed everything from monitoring methods, harvesting strategies, and grazing pressure in different settings, such as, by the fireplace, at VVO meetings, at ÄO council meetings or in local forums (lokala samråd) where the chairman participated. They also arranged study circles during the winter months on subjects such as wildlife. One example of how the chairman acted as a key steward was that he had established a database containing information on the number of moose shot, the location of the shooting, the person shooting and so on. This database was used to show different future scenarios of the moose population depending on the harvest strategy. Hunters had expressed surprise when they, four years ago, were able to shoot several large bulls (every hunters dream is to shoot the big bull with antlers) and wondered where those bulls

had come from. The shooting statistics revealed that they had decreased the percentage of bulls shot from 75% to 50-60%, and the chairman stated that this decrease had entailed a larger population of mature bulls. Since the hunters had gained extensive management rights through the establishment of the ÄO more hunters were interested in learning and they also applied a longer time horizon when planning their harvesting strategy according to the chairman.

The hunters leasing rights from the *forest company* are excluded from the learning process, since they do not take decisions on monitoring or harvesting strategies. Therefore they are in no position to actually learn about ecosystems by altering management practices in responses to changes in the ecosystem. In addition, no collective learning took place since the hunters spend very little time together and they did not participate in any other forums.

To summarize, the study indicates that learning takes place to a higher degree in the *river management system* and *the private ÄO* than among resource users at the *forest company.*

Monitoring:

The *river management system* made efforts at establishing monitoring methods of fish population however to date their monitoring efforts were not conducted in a systematic fashion. However, it is important to keep in mind that their focus was on restoring the trout population and that they had started monitoring the grayling population.

The *private ÄO* used, in addition to Älgobs[2] , two other monitoring methods, counting of "real" calves and winter tracking of moose. Älgobs is a monitoring method with significant problems and is considered more appropriate for spotting trends in a hunting district. A local hunter had established the calf counting method and according to the chairman, they had refined the winter tracking method.

The *forest company* relied mainly on Älgobs, Äbin[3], and at times helicopter counting of moose populations. Helicopter monitoring was not used often, due to the high costs. The forest manager stated that there should be a small number of people monitoring in order to ensure high reliability and claimed that what they needed was better monitoring

[2] Älgobs is a national moose monitoring method administered by the Swedish Hunting Association (Svenska Jägareförbundet). Hunters in Sweden note down the number of moose they spot in one week during the hunting season.
[3] Äbin is a method for estimating grazing damages caused by moose and is conducted by the National Board of Forestry (Skogsvårdsstyrelsen).

methods. The district manager stated that the most reliable monitoring method was helicopter counting of moose, that there were severe limits to the winter tracking method and that the calf counting only revealed the yearly productivity. The hunting leaders had difficulties in mobilizing hunters to monitor and this resulted in more or less guesswork regarding the population status according to the district manager. The hunting team leader stated that when they lost their ability to lease land they felt insecure as to their rights to continue hunting and therefore, lost their initiative to invest time and money in moose management. About ten years ago, the forest company changed land leases into hunting licenses, which, among other things, has entailed that hunters no longer can invite friends to hunt. The reason behind this change was the forest company felt it was easier to terminate hunting leases than property leases.

To summarize, in both the *river management system* and *private moose management system*, the local resource users themselves were taking an active part in establishing monitoring methods. However at the *forest company* the company employees were in charge of this. The forest manager and the district manager seemed to want to utilize monitoring methods they could be in control over and did not want to rely on the hunters too much. In difference, hunters in the private ÄO were showing great creativity in developing and refining their monitoring methods. In addition the hunters in the private ÄO spent significant time on monitoring the moose population while this appeared to be something that neither the hunting team leader nor the employees at the forest company desired.

Responses to environmental feedback:

The *river management system* had, as of yet, not adopted systematic monitoring of fish populations. However, they were working hard at trying to accomplish this. One difference regarding estimating fish populations in comparison to moose populations is the absence of "national" monitoring methods, such as, Äbin or Älgobs. This, of course, requires a great deal of effort from the active fishermen in establishing inexpensive and efficient monitoring methods. The lack of systematic monitoring makes it difficult to respond accurately to changes in the ecosystem. However it is also important to keep in mind that their foremost priority was to cultivate wild trout and restore these to the river. In addition they made efforts at increasing the grayling population.

The *private ÄO* shows flexibility in adjusting the number of moose to be shot. One example was, when the hunters in the beginning of a hunting season noticed fewer moose than expected. They reviewed the winter tracking numbers which showed a decline

in the moose population. They therefore decided to decrease the moose quota. There were no problems gaining consensus regarding decisions on moose quotas between the VVO's and communication seemed to function very smoothly. The organization was highly decentralized and they had low monitoring costs, which led to fast responses to changes in the moose population.

The organizational structure of the hunting of moose in the *forest company* is similar to conventional resource management. The employees at the forest company have taken over the role of the public resource manager, in that, they decide monitoring methods and assign quotas to the hunting teams. This organizational structure prevents resource users from establishing new monitoring methods based on their observations. The district manager expressed distrust towards the reliability of alternative monitoring methods, unless they were clearly defined and did not require too much effort from the hunters. The infrequent contacts between the district manager and the hunters inhibit fast responses to detected changes in the ecosystem as is possible for the hunters in the *private ÄO*.

To summarize, the study indicates that the *river management system* needs to develop more efficient monitoring methods to be able to respond to changes in the ecosystem. The *private ÄO* showed great flexibility in responding to changes in the ecosystem while the *forest company's* organizational structure inhibited prompt responses. The fact that the hunters in the private ÄO responded to their observations of the ecosystem by consulting their monitoring results shows the interaction between observations and how these lead to new management practices.

Cross-scale linkages:

The *river management system* is an example of a formalized vertical linkage, since the four municipalities have decided to cooperate in the management of the river. The terrestrial fishing in the county of Norrbotten is basically left to its own. The CAB provides cost free advice on fish biological questions if asked. However, the river management system had not been in contact with them at all. They have cooperated with the NBF regarding expertise knowledge and applied for project funding.

One vertical linkage regarding the moose administration is through established local forums. These are compromised of hunter representatives and larger landowners, such as forest companies, that, among other things, leave suggestions on moose hunting quotas to the Wild Care Committees (viltvårdsnämnd) which, in turn, advises the CAB. The Wild Care Committees are regulated in law, where the organizational structure and the main

assignments are stipulated (Fransson 2003). Both the chairman of the *private ÄO* and the forest manager at the *forest company* considered it extremely decisive to participate in the local forums, in order to coordinate hunting in a district. They both claimed this gave a better overview of the status of the moose population in the hunting district. This is an example of scaling up ecological information. The moose population estimates in the ÄO are scaled up to the hunting district level. This kind of information exchange is critical when there are local systems, since it allows for a "bigger" picture of the situation (Murphree 2000; Wilson et al. 1999).

The chairman of the *private ÄO* also said that their way of monitoring the moose population by counting calves had been adopted by other ÄOs through the local forum. This is an example of how innovations in a local system can be spread through a vertical linkage to other local systems (Pinkerton 1999).

The hunting team leader stated that the only contact their team had with the district manager was at the yearly meeting with all the hunting teams and the district manager.

There are also horizontal linkages between the moose management systems and the public authorities. There are fairly regular contacts with the CAB since each ÄO has to hand in a management plan stating the moose quota. However the ÄO is at liberty to change the shooting numbers by as much as -/+ 20%. The plans need to be revised every few years and alterations in the area or in the shooting numbers have to be reported to the CAB.

To summarize, the study indicates that, in contrast to the other cases at the *forest company*, it is not the resource users who are involved in any cross-scale linkages, only employees. As opposed to the representatives of the other two management systems, the *forest company* does not have any obligations to convey information to the resource users. According to the hunting team leader they did not have any contact with other organizations. Therefore, this management system does not display cross-scale linkages, even though information regarding the moose population is linked both vertically and horizontally.

Summary of results:

In Table 2, the findings in terms of adaptive management features found in each of the cases are summarized.

Table 2. Adaptive management features found in case studies

	Local Ecological knowledge	Ecosystem Management	Learning	Experiments	Monitoring	Responses to environmental feedbacks	Cross-scale linkages
River organization	Yes	Yes	Yes	Yes	Yes	No	Yes
Private ÄO	Yes	No	Yes	Yes	Yes	Yes	Yes
Forest company ÄO	Yes	No	No	No	No	No	No

As is apparent in Table 2, there are clearly more adaptive management features prevalent in the *river management system* and the *private ÄO* than in the *forest company ÄOs*. The forest company excludes resource users and this, in practice, entails that their management practices are not adaptive as the concept is understood with reference to the adaptive management theoretical framework. The *private ÄO* illustrates the theoretical ideas of a well functioning local system exhibiting adaptive features. This also applies to the *river management system*. For example, they conduct experiments, monitor and refine their methods, and continuously learn more about the ecosystem. In other words they exhibit many features of the "positive adaptive management cycle" which are believed to be interrelated and interdependent. One difficulty is how to estimate the relative extent of resource users' ecological knowledge and how it is related to other features of the "positive adaptive management cycle". It can be assumed that almost all resource users have some local ecological knowledge, but also how "old" the system is has to be taken into consideration. If for example, an ÄO is newly established it requires time before resource users gain local ecological knowledge from monitoring, experiments and collective learning.

Another important aspect is the "positive adaptive management cycle" has to include more than just 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 is a challenging research question very relevant to

the adaptive management approach. This aspect is critical since a system depending on a few key persons can not be classified as socially resilient however the difficult question is to define when the social system can be considered resilient. This issue is pertinent when resource users do not depend on the resource for their livelihood. Local resource systems, in for example, in developing countries, or of a historical continuity, should have a greater potential to engage more than a few key persons in the management of the ecosystems in difference, to resource systems, where the resource use is more or less a "hobby". The chairman of the private ÄO seemed to play a key role in establishing an adaptive management system however he said that the general interest for management issues had increased among the hunters due to the establishment of the ÄO. He also stated that he believed there were persons ready to take on his role if he decided to "step down".

Analysis:

Clearly, there are adaptive management systems in place regarding both terrestrial fish and moose. One aspect to keep in mind is the time it takes for adaptive systems to be established. The cycle has to be repeated continuously in order to contribute to increased local ecological knowledge. For example, the hunters in the private ÄO established the ÄO in 1994 and gained increased management rights. So, the question of interest is how adaptive can a management system become in 10 years? As mentioned previously the Swedish government has devolved management rights and deregulated moose and fish management policies however this has not been accompanied with a restructuring of the public authorities responsible for moose and fish management. For example, the river management system was loosely linked to the public authorities and the linkages were created on the initiative of the river management system and not the official authorities. In other words there is a lot the government could do to facilitate local resource systems that have gained increased management rights to become more adaptive, such as, provide scientific information and provide conflict arenas. The fish biologist at the interest organization stated that financial aid and information was needed in order for more people to become engaged in the management of terrestrial fish but that there already was a great interest and willingness to spend time on fish management.

Why are there differences in the presence of adaptive features between the three management systems? The legal framework for the management rights of fish respectively moose was similar for property rights owner and persons leasing rights to use the resources. Perhaps the difference can be explained by the major interests of the property rights owners and eventual conflicts between property owners and resource users.

Conflicts:

There is a great conflict of interests regarding the size of the moose population between the forest industry and the hunters and it is severe since neither of the parties has to bear the entire cost for their stands (interview 7). This is particularly true for hunters leasing rights since they do not have to bear any of the economical losses associated with large moose populations as landowners do. The landowners, on the other hand, do not have any incentives to keep moose populations since it is a significant this has entailed a shift in power between hunters and forest companies. financial lost. Since property holders have gained increased management rights over moose,

The *forest company's* influence over the moose population has increased during the last decades, first, through the establishment of local forums and secondly, by the possibility to establish ÄOs. The CAB considers the local forums to have been successfully administered at low costs by the SHA in Norrbotten County (Länsstyrelsen 2003a:7-8). The SHA in Norrbotten County is negative to this reform and have not invited forest companies to all local forums according to the forest manager. The need to coordinate and increase the representation of the landowners was argued in the bill promoting the formation of local forums (Prop. 1986/87). In addition, the establishment of ÄOs has meant that the forest companies can decide moose quotas during a hunting season.

Both the forest manager and the district managers wanted control over monitoring methods, although they were not opposed to assistance from hunters. Since the decisions on moose quotas are based on results from monitoring efforts, this is one way to ensure control over allocation decisions. Forest companies wish to protect their assets, which are the forest and have gained extended rights to do so. Therefore it is unlikely they will relinquish this power voluntarily. In addition, the abolishment of land leases also increased the forest company's control over moose management at the cost of general dissatisfaction of the hunters. However, the situation differs in the *private ÄO*.

The chairman stated that the greatest benefit with the ÄO (älgskötselområde, moose management area) was that decisions were made by hunters and not the CAB. Even though the three VVOs (viltvårdsområden, game management area) have established an ÄO, this has not entailed a transfer of management rights to the ÄO council, since it only has administrative assignments. The individual property holders of the ÄO own various sized properties, the chairman stated that there were divergent views as to how many moose should be kept on their common property. The landowners with larger properties have a greater forestry interest compared to landowners with smaller properties. He said that it never turned

into an open conflict since they discussed this issue frequently. In difference to the conflict of interests between hunters leasing rights from the forest company this conflict is not severe, since the people that make decisions have to bear the costs and usually have an interest in both hunting and forestry. The conflict that exists between property owners can be handled efficiently due to the direct communication between the actors and their desire to cooperate.

There are no conflicts of interests between resource users and property rights holders in the *river management system* since healthy fish populations does not cause anyone any financial losses, rather there is a potential for future incomes in form of tourism.

The pilot study indicates that when a conflict is present between resource users and property holders it inhibits the establishment of adaptive management systems. Due to the interest of the *forest company* to control monitoring methods and harvesting strategies, it becomes impossible for resource users to establish a "positive adaptive management cycle" of monitoring, experimenting, responding to changes and refining monitoring methods while simultaneously learn more about the ecosystem properties. This show, the complexity in establishing appropriate institutional framework since not only property rights are of importance, but also the main interests of the actors be it forestry or something else.

Discussion:

During the last decades the Swedish authorities have taken steps towards reconstructing a top down system to a bottom up system where local resource users and property owners are expected to take responsibility for moose and fish management (Prop. 1980/81: 153 & Prop. 1991/92:.9). These measures have entailed increased management rights and deregulation of fish and moose policies. A prerequisite for local adaptive systems is extensive management rights in order for local resource users to be able to establish adaptive institutions.

Ostrom asserts that ideal conditions for successful governance of CPR's are diminishing (Dietz, Ostrom, and Stern 2003), however, perhaps an increased interest in a certain resources might mitigate this trend. As this study indicates, fishermen seem willing to spend time and effort at establishing institutions that are adaptive in order to ensure sustainable resource use. The river representative and the fish biologists at the municipality and the interest organization stated that a new generation had a fundamentally different view of fish as a resource (interview 5 & 6). The respondents argued that the older generation views fish in terms of a food product, while the newer generation, in part, values it as a hobby exercised through sport fishing, but also as a tourist potential. This possible shift in value among resource users can affect the management of the resource significantly, even though there are no changes in formal rules. The river representative stated that the younger generation was willing to spend much more time and effort in trying to ensure sustainable use of the resource. The fish biologist at the interest organization said that many of the fishermen had extensive biological knowledge and had had jobs relating to this field for example as fishing guides (Interview 6). The high level of engagement is demonstrated by the actions taken by the sports fishermen whether engaged in the or in sport fishing clubs. Regarding the restoration of healthy fish populations or ensuring healthy ecosystems in streams and lakes there is no immediate conflict of interest, as is the case with moose. Perhaps one can expect adaptive systems, when there is a great interest for the resource and no conflicts of interests.

However, it is important to keep in mind that it takes time to create adaptive institutions and these can not be expected to come into place overnight. An interesting research question is what institutional prerequisites are necessary in order for local systems to become more adaptive? What makes resource users take collective action to establish adaptive institutions in particular, when they are not dependent on the resource for their livelihood? "Resource users will devise new institutions for managing that resource or change existing rules governing its use when the perceived benefits of the change in rules

exceed the costs associated with creating rules and with the change of the resource use pattern" (Dolsak and Ostrom 2003).

If, as this study indicates, property rights and conflicts of interests are decisive factors, these need to be taken into account when policies are proposed in order to implement adaptive management. Property rights determine the room local resource users have in managing resources. Therefore, it is important to investigate the property rights structure in detail. However, even this is not sufficient, since conflicts of interests can reinforce or deter local resource users' attempts to establish adaptive institutions. As became prevalent in the pilot case study, the hunters leasing rights will probably not gain management rights since the forest company will protect their assets and this includes control over management decisions. No matter how much sense a management approach makes, such as adaptive management, the conditions for it have to be analyzed. As Dolsak and Ostrom point out, existing institutions can be made more efficient, however new management systems will never be implemented in a vacuum (Dolsak and Ostrom 2003).

Is the adaptive management approach as suggested by Holling, Gunderson, Carpenter and Lee, among others, more appropriate for management systems that exhibit top down features, and are unlikely to change due to the interests of, for example, the property rights holder? Could large-scale adaptive experiments regarding issues such as monitoring methods be utilized to enhance the adaptive capacities of top down management systems? Perhaps authorities, such as, the Swedish, should find out if there are local adaptive systems on a larger scale and, if so, support these financially and by expertise knowledge. However, authorities might also consider developing monitoring and harvesting strategies by conducting large scale adaptive experiments and convey this information to management systems exhibiting top down features in order to increase their adaptivness.

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6. Informational telephone interview with a fish biologist at an interest organization 03-10-03
7. Informational telephone interview with a representative of a hunting interest organization 03-10-03
8. Informational telephone interview with a CAB employee 03-10-03