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Conflict resolution through ecosystem-based management: the case of Swedish moose management

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Abstract: Swedish moose (*Alces alces*) management has over the years transformed from a situation similar to what Hardin (1968) defined as a tragedy of the commons – i.e. where open access and unrestricted demands lead to over-exploitation – into a situation characterized by an abundance of moose. While high numbers of moose are preferred by hunters, they damage forests through grazing, causing conflicts between hunters and forest owners. In an attempt to resolve these disputes, the Swedish government is introducing a new local ecosystem-based management system. This paper analyzes this shift from managing a single resource to the broader perspective of ecosystem management and discusses to what extent it will contribute to conflict resolution. The results suggest that some of the problems highlighted may be solved through the implementation of an ecosystem management system. However, several challenges remain to be tackled, such as how to establish robust partnerships between forest owners and hunters for managing moose on land with a fragmented property rights structure. This can lead to different and conflicting objectives and, consequently, difficulties in reaching collective action.

Keywords: conflict, ecosystem management, moose, social-ecological systems, Sweden

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1. Introduction

Swedish moose (*Alces alces*) management has over the years changed from a situation similar to what Hardin (1968) defined as a tragedy of the commons – i.e. where open access and unrestricted demands lead to over-exploitation – into a situation characterized by an abundance of moose. In fact, research suggests that the total moose population in Sweden has increased to its highest level since the Ice Age (Danell and Bergström 2010). This remarkable turn of events can be traced to a combination of at least two factors: institutional change, which affected the incentives to collective action among forest owners and hunters; and the industrialization of forest management producing food preferable for moose (Wennberg DiGasper 2008; Liberg et al. 2010).

Following these changes, moose hunting has evolved into an important economic and recreational activity in Sweden, with approximately 280,000 hunters participating each year (Gunnarsdotter 2005; Mattsson et al. 2008), while the number of moose shot has increased from 11,318 to 98,360 between 1945 and 2012 (SAHWM 2012). However, the high number of moose causes grazing damage to forests, particularly young pine forests, which leads to reduced growth and timber quality, which in turn leads to lower economic returns. The Swedish Forestry Research Institute has estimated the losses to about 1.3 billion Swedish crowns or ca. €150 000 per year (Glöde et al. 2004; see also Bergström et al. 2010).

In particular, the forestry industry – along with large scale forest owners as well as forest associations representing non-industrial forest owners – and hunters' associations disagree on how to manage the moose and the forests to limit grazing damages. Although the moose population has been reduced by almost 50% during the last two decades, the forestry industry has requested a further 50% reduction to reduce grazing damage to an acceptable level (SOU 2009:54; Liberg et al. 2010).

A number of efforts have been made to manage this collective action problem in order to reduce the adverse effects of the large moose population, efforts such as hunting regulations and the introduction of reimbursement schemes to diminish grazing damage, but without much success (Åkerberg 2005). The poor performance of these top-down measures have forced parliament to initiate new management methods. In the early 1990s, parliament introduced community-based Moose Management Units (MMUs) which are organized on a voluntary basis. These units, comprising forest owners and moose hunters, have the authority to decide

the numbers of moose to be harvested each year within their specific management unit. In 2010, the MMUs covered approximately 11 million hectares or 25% of the hunting grounds in Sweden (Liberg et al. 2010) and proved to be a popular way of organizing moose hunting in Sweden. However, the decentralization of management via the MMUs did not solve the conflicts between forest owners and hunters. According to an official investigation, moose management is still characterized by a collective action problem, i.e. a lack of collaboration or uncoordinated actions resulting in conflicts, where the stakeholders involved seem to lack the incentive to contribute to conflict resolution (SOU 2009:54).

How may we then understand the difficulties to resolve this conflict? On the one hand, the moose is a migratory animal that roams freely over large areas, often 50,000–100,000 hectares, which necessitates management over large geographical regions. Fencing of private properties to exclude moose would be too expensive and not in line with the Right to Public Access in Sweden, a unique right with roots in the early Middle Ages that gives people the right to roam freely in the countryside regardless of who owns the property (EPA 2012). On the other hand, hunting rights are tied to property ownership and the average property size in Sweden is only 45 hectares (Swedish Statistical Yearbook of Forestry 2011). The median sized MMU is approximately 10,000 hectares (Wennberg DiGasper 2008). It is thus reasonable to assume that the collective action problem is at least partly related to the mismatch between social (10,000 ha) and ecological scales (50,000–100,000 ha) (Young 2002; Wennberg DiGasper 2008), a mismatch similar to the concept of the tragedy of the anticommons, arising from fragmented property rights, and where the right of exclusion create coordination problems (Heller 1998; Schlueter 2008; see also Bellantuono 2011).

To deal with this problem, the Swedish government has introduced a new management system. The MMUs, based on self-organisation, will remain the primary management units at the local level; however, starting in 2012, they will be complemented with a new, ecosystem-based moose population unit. The primary tasks of these new units will be to coordinate moose hunting in ecosystem-level "Moose Management Areas (MMAs)," covering about 50,000 hectares in the southern parts and at least 100,000 hectares in the northern parts of Sweden with the aim of finding a better match of the social and ecological scales. These new organisational levels will also play an advisory role to and coordinating moose hunting in the MMUs (Prop 2009/10:239).

Although it is reasonable to assume that the scale mismatch is part of the problem with collective action and probably also part of the solution, studies have suggested that there are a number of other factors associated in particular with the decentralized management system – MMUs, now embedded in the new management system – such as a lack of accountability mechanisms, unequal power relations, and lack of knowledge of the system to be managed that may affect the incentives to cooperate among the key actors (Wennberg DiGasper 2008; Liberg et al. 2010). By identifying collective action problems in relation to MMUs, we thus assume that we can assess to what extent the new management

system is appropriately designed to deal with – or compensate for – the lack of incentives to collaborate among key actors, thus affecting the potential for successful implementation of a new moose management system.

2. Framework for analysis

The analysis of collective action problems related to moose management is based on the conceptual framework on social ecological systems (SES) developed by Elinor Ostrom (2009). The framework consists of four contextual subsystems – resource systems (RS), resource units (RU), governance systems (GS), and actors (A) – which influence patterns of interactions leading to a certain outcome (Figure 1). The outcome in turn feeds back into the context and influences the biophysical conditions and trends (RS and RU), as well as the rules used on different levels (GS), and the actors, which in our case primarily include forest owners and hunters (A) (Ostrom et al. 1994; Ostrom 2005). Each of these contextual elements can be broken down into details depending on the focus of the study. A similar framework, taking into consideration contextual factors, governance arrangements and collective action institutions has been developed by Ratner et al. (2013). The two frameworks focus on a similar set of variables that have been observed and measured shaping the incentives for collective action to manage contested resources cooperatively (Ostrom 2009; Ratner et al. 2013, see also Di Gregorio et al. 2008). These 10 variables, further elaborated on below, offer a structured way to assess the scope for conflict and cooperation with a specific focus on priorities for policy development and institutional reform. "As such, the process of collective analysis and problem-solving can itself become an instrument of social learning" (Ratner et al. 2013, 201) to improve the institutional fit.

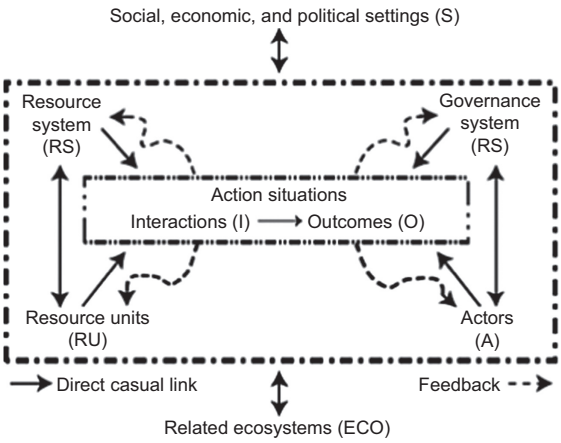

Figure 1: Action Situations Embedded in Broader Social-Ecological Systems (adapted from Ostrom 2007).

The action situations, is where social bargaining on resource use occur, and may take place at many different levels, from the local household to international levels and include a number of different activities. In our case, we are particularly interested in action situations where the key actors (hunters and land owners) meet and negotiate over collective choice rules. The outcome of these negotiations will influence the broader institutional context and contribute to, for example, conflict resolution and the sustainable use of the resources (Ostrom 2005; see also Di Gregorio et al. 2008; Ratner et al. 2013).

2.1 Key variables shaping the incentives for collaboration

Characteristics of both the resource systems (in this case forests and moose populations) and specific resource units (i.e. tree stands/trees and moose populations) are critical context variables that affect the interactions of key actors in our case (Ostrom 2007). The size of the resource system is therefore crucial for the incentives for collaboration. On the one hand, very large areas are often related to high costs of defining boundaries, monitoring of both the resource and its use, while on the other hand very small areas may be too small to be able to adequately manage a migratory resource like moose (Agrawal 2000). It is thus most conducive to benefits and costs to find a match between the scale of management and the scale of the ecological processes or natural resources being managed (Young 2002; see also Agrawal 2001; Ostrom 2005). The productivity of a resource system is also assumed to affect incentives for collaboration. Incentives to collaborate are, for example, expected to be very low if the resource system is characterised by either scarcity (e.g. lack of forest habitats suitable for moose) or the opposite (e.g. a system with an abundance of moose due to very favorable foraging conditions). Users thus need to observe some scarcity or over-abundance before they invest in collaboration to, for example, reduce conflicts between different users due to either an over- or under-harvesting of a resource (Fisher et al. 2012). The predictability of system dynamics is another factor that is supposed to affect the incentives for collaboration since it is easier to build institutional arrangements for the management of resources (Di Gregorio et al. 2008) and thus to estimate the effects of management decisions. This variable can also be an important driver for arranging collaborative institutions on larger scales in order to reduce unpredictability associated with management related to small areas (Young 2006).

The characteristics of the resource systems per se and its value also affect the incentives for collaboration. It is, for example, more difficult and costly to observe and manage migratory resource units, such as wildlife (in our case, moose). However, as mentioned above, it is at the same time necessary to be able to match the management system with the system to be managed (Young 2006), which in turn is related to the characteristics of the actors and in particular the numbers of actors involved. The more users and fragmented property rights in the system, the more difficult it is assumed to be to get people together and to reach agreements

on changes. However, if the task is to manage a moose population that roams over large areas, it may also be possible to mobilize larger groups of hunters and landowners to actually be able to influence the development of the population as a whole and not only small parts of it. According to Ostrom, size is thus always relevant, "but its effect on self-organization depends on other SES variables and the types of management tasks envisioned" (Ostrom 2009, 420). Prior experience of organization is likewise assumed to facilitate collective action as well as shared norms, in particular, norms of reciprocity and trust since these may affect the level of transaction costs (Zachrisson 2009; Widmark and Sandström 2012) and costs of monitoring (Baland and Platteau 2000). It is also necessary that users, at least to some extent, share knowledge of the resource units and resource system to avoid conflicts over fundamental components of the system. Understanding how the moose affects forests and wider biodiversity concerns through grazing and vice-versa is, for example, fundamental to be able to find a balance between two major interests related to moose management (Sandström 2012). Incentives to collaborate are also assumed to increase relative to the importance of the resource to the users. Previous research has, for example, shown a strong correlation between successful cases of collaboration and to what extent users are dependent on the resource system for economic or sustainability reasons (Ostrom 2005). Number of actors, shared norms, knowledge, and importance of the resource are thus variables assumed to affect the cost of organizing and maintaining collaboration (Berkes and Folke 1998).

Finally, from an institutional perspective, the governance system (GS) provides a set of rules defining who gets what, where, when, and how in a society. The governance system thus includes mechanisms of representation in decision-making, distribution of power, and mechanisms of accountability (Agrawal and Ribot 1999; Lemos and Agrawal 2006), as well as rules specifying what is permitted or prohibited. Among these nested types of rules (operational rules govern day-to-day decisions, collective choice rules affect how operational rules are to be changed, and constitutional choice rules regulates the collective choice rules) collective-choice arrangements are assumed to be the most conducive to collective action, to the extent that actors who have a long-term stake in the resource are also represented in these arrangements (Ostrom 2005; Ratner et al. 2013), and have the power to influence decisions and the distribution of benefits and costs in the system (Agrawal and Ribot 1999; Lemos and Agrawal 2006; Sandström et al. 2009; Zachrisson 2009).

Application of the SES framework requires detailed information about the resource system, resource units, the governance system in place, actors, and the usage of the system. To find this information and identify factors or variables that fuel long-enduring conflicts, and ways in which problems can be tackled by either adjusting existing institutions or creating new ones to bridge gaps in the prevailing system, we focused on the 10 variables that are assumed to affect, negatively or positively, incentives to collaborate in the management of moose and forests (Ostrom 2005; Ratner et al. 2013) (see Table 1, in italics).

Table 1: Variables (italics) affecting collaboration (adapted from Ostrom 2007, 2009).

Resource systems (RS)	Governance systems (GS)
RS1 – Sector (e.g. water, forest, pasture)	GS1 – Government organizations
RS2 – Clarity of system boundaries	GS2 – Non-government organizations
RS3 – Size of resource system	GS3 – Network structure
RS4 – Human constructed facilities	GS4 – Property rights system
RS5 – Productivity of system	GS5 – Operational rules
RS6 – Equilibrium properties	*GS6 – Collective choice rules*
RS7 – Predictability of system dynamics	GS7 – Constitutional rules
RS8 – Storage characteristics	GS8 – Monitoring and sanctioning processes
RS9 – Location	
Resource units (RU)	**Actors (A)**
RU1 – Resource unit mobility	*A1 – Number of users*
RU2 – Growth and replacement rate	A2 – Socioeconomic attributes of the users
RU3 – Interaction among resource units	A3 – History of use
RU4 – Economic value	A4 – Location
RU5 – Size	*A5 – Leadership/entrepreneurship*
RU6 – Distinctive markings	*A6 – Norms/social capital*
RU7 – Spatial and temporal distribution	*A7 – Knowledge of SES/mental models*
	A8 – Dependency on resource
	A9 – Technology used

Outcomes can be evaluated using a number of criteria according to the particular focus of analysis. Since we are particularly interested in the incentives for collective action and their impact on sustainable institutions, we have chosen to focus on the following three factors, which often are considered crucial for long-enduring collaborative governance arrangements: *efficiency* in terms of goal fulfilment; *equity* in terms of power sharing and thus a guarantee of a fair distribution of costs and benefits from resource use; and finally *accountability mechanisms* to guarantee responsibility, internally as well as in relation to actors that are represented (Agrawal and Ribot 1999; Adger et al. 2005; Lemos and Agrawal 2006; Sandström 2009; Zachrisson 2009; see also Ratner et al. 2013). This analysis may lead to insights about not only how the current and new institutional arrangements restrict or enable desirable outcomes (in this case, collective action), but also how to better match social and ecological scales.

3. Methods

Kronoberg County in southern Sweden may be identified as a critical case in Swedish moose management and thus an appropriate area to study in order to identify problems and opportunities relating to collective action in Swedish moose management systems. According to the critical case study method, a single case can be selected for analysis provided it has strategic importance in relation to the general problem addressed, i.e. if it is valid for this case, it is

valid for all (or many) cases (Yin 1994; Flyvbjerg 2011). Kronoberg County is an appropriate case study area for several reasons. Kronoberg is, like large parts of Sweden, a forested county with extensive moose hunting and also identified grazing damages. There have however been extensive changes in the ecosystem in Kronoberg, partly as a result of severe storms. These have wiped out large areas of mature forests, creating excellent conditions for moose, which feed on young deciduous and coniferous trees (Gustafsson 2009). Forest owners as well as hunters thus need to be able to manage a rapidly increasing number of moose. However, as mentioned above, collective action may be hampered due to the number of users and a highly diversified ownership structure. The average size of individual properties in Kronoberg is 51 hectares; hence the ownership structure is, as in Sweden in general, very fragmented, and timber production might not necessarily be the main reason for ownership (Swedish Statistical Yearbook of Forestry 2011). As a result, there is a significant need for cooperation while, at the same time, an imminent risk of collective action difficulties in achieving a match of social-ecological scales, since this requires cooperation among many forest owners and hunters to achieve moose management units of an appropriate scale. We can thus assume, therefore, that the problems we identify here are also valid in the rest of the country.

To gather data for the chosen case study area, both desktop studies and interviews with relevant actors were conducted. Our analysis started with a scoping phase, where issues such as quantitative information on indicators such as moose populations, forest conditions, property rights, and land use in the county was collected. We then examined policies and documents, including bills and management plans to assess formal institutional arrangements, as well as those describing the management process. These data provided the foundation for developing an interview manual. Semi-structured telephone interviews were conducted in March and April 2010 with actors in the selected case study area to gain insights into the collective choice arrangements (GS6). Telephone interviews were carried out with a representative sample of the presidents or contact persons of 20 of the 50 MMUs in the county. In addition, nine interviews were conducted with landowners of various categories present in the county (Wennberg DiGasper and Sandström 2010).

4. Results

Approximately 50% of Sweden's land area (28 million hectares) is covered by forests, making Sweden one of the most heavily forested countries in the boreal region in terms of forest area per person. By 1900, Sweden held a leading position in the international timber market, and since then forests and the forestry industry have been among the most important sources of Sweden's wealth (Swedish Statistical Yearbook of Forestry 2011).

Forests cover most (76%, or 644,000 hectares) of Kronoberg County. Forestry production potential is high, and the annual harvest, mainly through clear cuts,

in the county is worth, after industrial processing, 9 billion SEK (Länsstyrelsen Kronobergs 2011). More than 80% of the forest area is owned by non-industrial private forest owners (higher than the national average proportion, which is ca. 50%, for Sweden). As a consequence, forests in Kronoberg are divided into more than 11,000 property units, owned by nearly 14,000 people. Most of these owners, 64%, live close to their forest (Länsstyrelsen Kronobergs 2011). As in Sweden in general, the forest is thus of great concern to many inhabitants in Kronoberg.

The moose, a species spread all over Sweden and often called the king of the Swedish forests, is considered the most valuable game species in Sweden. As mentioned above, about 280,000 hunters harvest around 100,000 moose annually. If we assume an average carcass weight of 130 kg (Sylvén 2003), the moose harvest in 2011 involved 13 million kg of moose meat, which is around 10% of the Swedish production of cattle meat in 2011 (Swedish Meat Statistics 2012). Moose harvesting, which is of great cultural and recreational value, is thus also of great economic value, particularly to hunters and their families (Mattsson et al. 2008; Ericsson and Sandström 2005). In Kronoberg, 3191 moose were harvested in 2011 by 8441 registered hunters (Länsstyrelsen Kronoberg 2013). As with the forest, the moose is thus also of great importance to many inhabitants in Kronoberg.

However, moose, which have a relatively low-nutrient diet, must consume 15–20 kg of food [coniferous tree shoots, in particular pine, in the winter and deciduous shoots and leaves, aquatic vegetation, and shrubs in the summer (Bergström et al. 1997)] to meet their daily needs, which is why, with high population densities, it may have adverse socio-economic effects, such as damage to commercial forests from grazing. It can also have a negative impact on society on an aggregated economic level since the forest industry is important (SOU 2009, 54). In addition, grazing may have indirect effects on biodiversity (Mathisen 2011). The conflict thus concerns two valuable natural resources, and our interviews show that, depending on whether one is a forest owner or a hunter, an individual may value the resources quite differently.

The distinction between these two key stakeholders may, however, be somewhat illusory. The primary institution guiding hunting in Sweden is land ownership (SFS 1987:259 §10), which means that anyone who owns land, irrespective of the property size, has the right to hunt on it, provided that they follow national hunting regulations. Since many landowners do not hunt themselves, the forest owners may choose to lease out the right to hunt, the result of which means that approximately 50% of the hunters in Sweden, and even a larger share in Kronoberg, are also forest owners, while the rest lease hunting ground. Studies and our interviews also show that the ownership interests vary between large and small estate owners. For example, the larger estates are more likely to be economically dependent on forest resources in terms of timber production (Nordlund and Westin 2011). And the leasing out of hunting rights nowhere generates income equivalent to timber harvesting and is thus not an alternative but rather a complement to timber harvesting and a necessary activity if owners are to somehow control game populations on their land. There is thus a variation in dependence on the resource,

which it is assumed influences the incentives to collaborate and contributes to the conflicts primarily between forest-owning non-hunters and non-forest-owning hunters, with forest-owning hunters as an in-between group. The divergent interests become particularly apparent if we also include the forest companies, which also have a strong economic interest in forests, owning about 25% of the forests and providing a number of jobs within the forestry sector. These forest owners and the hunters are organized separately and are recognized as strong lobbying organizations at the national, the regional, and (particularly in the case of the hunters) the local level (Wennberg DiGasper 2008).

In relation to the difficulties predicting the development of moose populations, conflicts between key stakeholders have escalated. Moose population density has thus fluctuated over the years, with a peak in the early 1980s in Sweden as well as in Kronoberg County. The consequence of this peak is now clearly visible in the landscape. Due to the abundance of moose, many landowners chose to plant spruce instead of pine in order to avoid future grazing damage; between 1984 and 2006, coverage of pine aged 0–10 years decreased from 24,000 to 9000 hectares, while coverage of spruce aged 0–10 years increased from 30,000 to 57,000 hectares (see Figure 2). The number of moose was however significantly reduced in the county primarily due to hunting, but also due to a lower degree of forage productivity – i.e. a lack of food (Wennberg DiGasper and Sandström 2010).

The county has, however, been severely struck by storms recently: Hurricane Gudrun in 2005 and Storm Per in 2007, in which about 250 million trees were felled, almost equivalent to the normal annual harvest in Sweden. The spruce forests were the most severely affected and the Swedish Forest Agency estimates the cost of forest damage to have been about €2.1 billion (Gustafsson 2009). The storms caused large-scale destruction, partly because of vulnerability due to the structure and species composition of the forests, which included very high

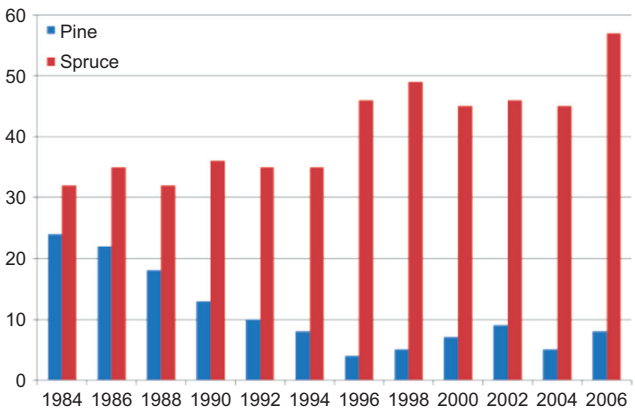

Figure 2: Thousands of hectares dominated by pine and by spruce between 0 and 10 years old from 1984 to 2006 in Kronoberg County (Swedish National Forest Inventory 2010).

proportions of spruce-dominated or pure spruce stands with shallow root systems (Hanpää et al. 2005). Although spruce is the naturally dominant tree species in Kronoberg, reforestation with spruce at the expense of pine (due in large part to the risk of moose grazing on pine stands) has progressively increased its proportion in the county. Since the storms created large open areas, which are now covered by a deciduous shrub layer of varying density, the forage productivity will increase which will benefit the moose population as deciduous shrubs are an important food source. In some of the monitored areas in Kronoberg, the number of moose is calculated to be about 7 animals per thousand hectares (Swedish Forest Agency 2013), which is about 5 too many, according to goals set by the Swedish forestry industry. The abundance of moose will, if no management measures are taken, probably continue to reduce forest owners' incentives to plant pines instead of spruce (Swedish Forest Agency 2013).

4.1 Actors and collective choice arrangements

As mentioned above, MMUs were introduced in 1993 as the primary collective choice arrangement. The MMUs are supposed to cover areas sufficiently large (about 10,000–15,000 hectares) to allow at least 25 moose to be harvested annually. In contrast to other hunting areas, hunting within an MMU does not require a license; instead, hunters and landowners decide moose management measures, including how many moose should be harvested in the area. This requires collective action through consultation between forest owners and hunters, and the establishment of a management plan (1987: 905 §3). The plan should describe the short- and long-term objectives for moose population development, specify actions to be taken to limit grazing damage to forests and crops, and the risk of traffic accidents caused by moose. When finalized, the plan is approved by the county (Prop 1991/92:9).

Within MMUs, the landowners and hunters are thus free to decide the conditions for collaboration (Prop 2009/10:239). According to our theoretical framework this should, by offering strong incentives for collective action, contribute to robust governance of moose populations. However, when analyzing the MMUs in Kronoberg, we found that these do not outweigh the fact that key actors value the resources differently, that access to power varies, and that knowledge of the resources is limited. As we will see below, this affects the outcome in terms of lack of efficiency, equity, and accountability mechanisms.

4.1.1. Efficiency

Due to strong property ownership rights in Sweden, the government cannot force landowners to manage moose collaboratively. However, the incentives to collaborate within MMUs are quite strong, since there are more opportunities to hunt adult animals within them than elsewhere, and the harvest goals are set by the landowners and hunters, while the County decides harvesting targets on other hunting grounds (Prop 1991/92:9). According to the legislation, it is up to the

landowners to determine, either by themselves or through contractual agreements with hunters leasing the hunting grounds, how hunting is organized and to what extent management goals are reached (Prop 1991/92:9).

Opinions were divided among our respondents concerning the efficiency of MMUs, i.e. how well they consider the MMUs to deliver output in terms of goal fulfillment. In general, the respondents valued the possibilities of being able to take part in the management process, to be able to influence the hunt in terms of numbers of moose harvested, etc. In addition, the ability to establish collaboration between the key stakeholders was also highlighted as one of the advantages with MMUs. This is also consistent with the motives behind establishing MMUs, the desire for self-determination, a belief that local-level management is better than regionally based management, which at the time of legislation was the only alternative to MMUs, and finally the ability to either increase the proportion of moose or reduce the same if needed (Wennberg DiGasper and Sandström 2010).

However, the interviewed forest owners also claimed that many of the MMUs rarely meet settled management objectives and that there is a general lack of knowledge among landowners and hunters. In both cases, this was related to inadequate monitoring of moose populations and the lack of quality of the moose management plans which contain vague or even contradictory management objectives. However, attitudes on this issue clearly differed between forest owners with a primary interest in forestry and forest owners with a primary interest in hunting along with those forest owners owning spruce forests who are thus not affected by grazing damages. As illustrated in the citation below, the fact that some forest owners argued for an increase of the moose population was very frustrating for the forest owners who were actually affected by grazing.

> "...Hunters are so strong and there are many landowners who don't give a damn what it looks like in the forest as long as they can shoot their moose and then the risk is that it will be just like it was in ... (name of MMU) that ... there sat the landowners on the board and it was probably a majority who were forest owners, but they had only spruce in their area and they thought of course they should increase the number of moose..." (Interview with forest owner in Kronoberg).

The above quote is from a forest owner who, after Hurricane Gudrun, saw an opportunity to improve the quality of forest management by diversifying tree species on his land. One of the goals for this forest owner, who was economically dependent on his forest, was to increase biodiversity; he had therefore planted both broadleaved and pine after the storm, but was hit hard by grazing. This forest owner was fairly representative in our sample of forest owners in Kronoberg. He was not the only one participating in our study who complained about the efficiency of the MMUs in terms of their inability to find compromises between different interest and the lack of achievement of various goals, particularly the reduction of grazing damage.

4.1.2. Equity

The lack of efficiency can, to some extent, be related to the lack of equity. Several of the interviewed forest owners, for example, claimed that due to the dominance of hunting interests, it was very difficult to voice their opinions at the annual meetings and even more difficult to gain support for an increased moose cull in order to reduce grazing damage. The strong representation of hunters can, as mentioned above, be explained by the fact that many landowners hunt themselves and value hunting highly or lease out their land and delegate the right to representation in the MMUs to hunters. Forest owners with little or no interest in hunting but strong economic interests in their forest are, thus, often underrepresented at the meetings. Sometimes they might even be without representation since the forest land is leased out to a group of hunters:

> "Our ability to have influence is dependent on hunters actually doing as we like, or believing in our arguments...because they are the ones who have the power...we have no right to vote in MMUs and although we have a different opinion they may vote contrary to our will and then it is just to accept it then... and, oh yes, it happens..." (interview with forest manager at a forest company).

Many of the interviewed forest owners affirm similar situations in their respective MMUs. A forest owner who disagrees with the management goals may of course choose to leave the MMU and remove his or her land. However, since the MMUs in Kronoberg cover such a large proportion of the county, in addition to the fact that moose roam over large areas, the forest owners would still be affected by the decisions taken in the surrounding MMUs. Our interviews indicate that the power in the MMUs is unevenly distributed between the actors involved. Those who consider themselves to be negatively affected by the decisions have a limited ability to modify the harvesting goals. Many forest owners thus consider the abundance of moose a major source of lost revenue due to an uneven distribution of costs and benefits related to the hunt. The interviews also show that the actors involved do not have access to any conflict resolution mechanisms to resolve this type of conflict. Exit is the only tool that dissatisfied members, such as forest owners of the MMUs, can use, and it will not solve the problem *per se*.

4.1.3. Mechanisms of accountability

An analysis of management plans – and this was confirmed through the interviews – shows that decisions are not always based on appropriate census or monitoring methods. Instead, they are based on rather vague estimates of the moose population and grazing damage. Our interviews also show that a large moose population does not adversely affect hunters, while it is relatively easy to cut down on shooting if one fears that the moose population is decreasing. As a result, there is a lack of incentive for hunters to dedicate time and effort to monitor the moose population or grazing damage. Due to the consequent lack of information, forest owners have difficulties arguing for reductions in the moose population. In reply to the question as to why the MMUs very rarely used scientifically based monitoring methods, our

respondents cited the financial costs and time commitments that would be required from members of the MMUs. Some of our respondents also revealed that many members of the MMUs did not trust the results of scientifically based methods and that many of the hunting teams had developed their own local inventory methods. Although the value of local knowledge should not be underestimated, this type of data is often difficult to collect on a large scale, especially something like the size of moose populations since it is a migratory species. The lack of knowledge – not only about the size of moose populations but also of how moose roam in the landscape – makes it difficult to hold any decision-makers responsible for financial losses due to grazing damage.

In general, our interviews show that the moose management system lacks mechanisms for accountability except when too many moose are harvested. Most of the hunting teams and MMUs have developed some kind of graduated sanctions regarding the overhunting of moose. If hunters shoot too many moose or moose of the wrong sex and thus deviate from goals set in the management plan, they have to either pay a fine or relinquish the meat or trophy. Breaking such rules is also considered a breach of social norms and can be embarrassing for the offender. Hence, compliance with these rules is very high, according to our respondents. However, our interviews demonstrate that the sanctioning system applies only to the management goals relating to the moose population, and not to the goals associated with forests and grazing damage. There are no accountability mechanisms for MMUs that do not fulfill management goals in terms of not shooting all the moose targeted or reducing grazing damage. If the goals are not fulfilled, it is the individual landowners that are negatively affected since they have to bear the costs of reductions in wood production and timber quality. If the grazing damages are very extensive, the landowner might even be forced to re-plant a whole area in accordance with the Forestry Act (SFS 1987:259). The lack of accountability mechanisms means that there are very few ways – if any – of holding the board or representatives at the annual meeting of the MMU responsible for any decisions made resulting in grazing damages.

Our interviews also show that many of the respondents, in particular forest owners, lack incentives to engage in the MMUs because these organizational units are considered too small in relation to the moose population they are supposed to manage. With this governance gap, it is impossible to take the ecological boundaries of the system into consideration. Even if they were able to make the actors within their specific MMU accountable for the decisions made, it would be very difficult for them to convince other MMUs to introduce similar accountability measures. Our respondents largely confirm the problems associated with the mismatch of scales, which have created a gap in the governance structure of moose and the forests (see also Wennberg DiGasper 2008; SOU 2009).

The pattern that has emerged from our interviews demonstrates that the interaction between forest owners and hunters at the local level within the MMUs

suffers from a number of shortcomings, which may explain the conflicting outcomes. Although institutional change and innovation of the MMUs have been and still are under discussion in terms of reform of statutes to guarantee the influence of forest owners, this would not solve the problem of scale. We may thus assume that their capacity to adaptively handle extreme events such as major perturbations of the ecosystem – e.g. Hurricane Gudrun – is limited, which may affect the possibilities of keeping or lowering moose populations to avoid increasing levels of grazing damages.

5. From single-species to ecosystem-based management

The interaction among key stakeholders within MMUs can be characterised as a multiple-use conflict, based on the different economic and social values of the actors concerned, which has a negative effect on the ecological system in terms of both forest regeneration and biodiversity (Sandström et al. 2011). The prevalence of what many forest owners would term "under-hunting" of moose causes financial loss due to extensive grazing, not only for many forest owners, but also for Swedish society at large because of the economic importance of the forestry sector in Sweden. The mismatch of ecological and social scales arises because moose is a species that roams over large areas and the institutional and organizational patchwork of property units exacerbates this problem and makes it difficult to govern. The expectations are, thus, high among both hunters and the forestry industry that the new moose management system will help resolve these conflicts.

The new management system is a goal- and policy-driven approach applied within a geographic framework defined by ecological boundaries that recognizes the interaction between moose and its food. With the introduction of a new management level, MMAs, the intention is to close the governance gap between the local and regional levels to improve the ability of the actors involved to handle an entire moose population (Prop 2009/10:239). Although there may be some trade-offs between ecosystem boundaries and the established administrative structure, especially in terms of cost-effectiveness, the new ecosystem-based MMAs should have the potential to bridge the identified organizational and institutional fragmentation and, thus, better match social and economic scales.

However, the problems identified in our study are not only related to the social and ecological mismatch, but also to shortcomings associated with efficiency, equity, and mechanisms of accountability. The new management system, thus, needs to be designed to overcome these problems as well. Our analysis of the new regulations indicates that the extent to which the government and responsible authorities have addressed the identified shortcomings is unclear.

The primary task of the MMAs is to coordinate moose hunting at the ecosystem level, i.e. across areas of about 50,000 hectares in the southern parts and at least 100,000 hectares in the northern parts of Sweden (NFS 2011:7). Another defined task for the new management level is to produce necessary inventory data in order

to manage the moose population effectively. The basic idea is that the MMAs will contribute with ecosystem-based knowledge, which will provide the foundations for management decisions at the local level, information that is currently missing. This will, in turn, provide an opportunity to make actors accountable for their decisions.

To ensure equal representation, forest owners and hunters are guaranteed an equal numbers of seats on the board of the MMAs (three each). However, to compensate for the uneven power balance at the local level and take into account the fact that the forest owners provide the hunting grounds, the forest owners have a deciding vote; hence, in practice, the forest owners have four votes while the hunters only have three.

At first glance, the new regulations seem to have taken into consideration the problems of equity and distorted power balance. However, as shown in Table 2, the new governance system, which stretches over multiple levels, from the local to the national, comprises two more or less separate sectors. One is a formally regulated system covering the national, regional, and ecosystem levels with the tasks of setting overarching goals and providing the local tier with knowledge. The other is based on voluntary organizations consisting of MMUs and hunting teams with the specific tasks of setting and implementing management goals at the local level. Although the government proposition points out the need for access to appropriate instruments to achieve the objectives of the new management system, the objectives set at the different management levels divide the governance system between formal and voluntary sectors, which may potentially cause problems. This means that there is few, if any, accountability or sanctioning measures to force the MMUs or the hunting teams to comply with goals set at the ecosystem level or above. The two sectors in the management system are supposed to interact on a more or less voluntary basis. The MMAs should, according to the governmental proposition, "through dialogue with landowners, hunters, and authorities encourage the implementation of inventories that could form the basis of the management within the management area" (Prop 2009/10:239 p. 27 authors' translation).

The primary reason why the MMUs are a voluntary form of cooperation is based on strong ownership rights in Sweden. As a result, forest owners cannot be forced to cooperate. Moose management is based on the willingness of the key

Table 2: The multi-level governance structure of the new management system in Sweden.

Level/organisation	Formal organisation of moose management	Voluntary organisation of moose management
National	Swedish EPA	
Regional	County Administrative Board, including WMD	
Ecosystem	MMAs	
Local		MMUs
Hunting		Hunting teams

actors to define common goals and to comply with these goals. Furthermore, the MMAs will, at least formally, be dominated by forest owners, while the MMUs will still be dominated by hunters. Success of the new management system requires the establishment of a relationship built on trust, not enforcement. In practice, the deciding vote of the forest owners at the MMA meetings will consequently not be very valuable if these decisions are not implemented by the MMUs.

This situation is characterized by a fragmented ownership structure, in which diverse owners have different and potentially conflicting objectives. Such fragmented management structures are not uncommon, but the resulting complications are often underestimated when an ecosystem-based management is to be implemented (Vatn 2007). Although some of the management problems highlighted in this study will probably be solved by the introduction of an ecosystem-based approach to moose management, several challenges remain to be overcome, particularly the identification of ways to establish robust partnerships between forest owners and hunters across scales and between levels. To some extent, we may expect the introduction of an ecosystem approach to remedy some of the problems identified by the social-ecological system of moose management in Sweden; however, the ecosystem approach in its current form is not designed to solve all problems related to the lack of efficiency, equity, or accountability.

However, as this study has shown, the distinction between hunters and forest owners is not that clear cut; in between these two extreme views are a group of forest-owning hunters, who could possibly play a mediating role between forest-owning non-hunters and non-forest-owning hunters, bridging vested interests at different levels (Marshall 2008; see also Ezebilo et al. 2012) through institutional innovation and change at both the level of MMUs and MMAs.

6. Conclusions

Ecosystem-based management is now widely accepted as the standard strategy for delivering sustainable land and marine ecosystem services. Compared to traditional single-species management, an ecosystem-based or holistic approach is assumed to be more suitable for adaptively managing the inherent complexity and diversity of an SES (Ostrom 2011). The Swedish government has recently decided to introduce local ecosystem-based management as a tool to manage moose sustainably in relation to forest resources. A simultaneous aim is to resolve the long-term conflict between landowners and hunters. Our analysis of the old single-species management and the new ecosystem approach from the perspective of governance of SESes (Ostrom 2007) has revealed that some of the identified problems will probably be solved through this shift of management styles. One of these problems is the current mismatch between the ecological and social scales, which will be dealt with by introducing a new management level, the MMAs. With this new institutional level, it will also be possible to collect monitoring data and then spread this into the management system at several levels.

However, some problems not addressed risk being transferred from the current system to the future one, thus affecting the potential for successful implementation of the new management system. One problem that often seems to be underestimated when governments attempt to implement ecosystem-based management regimes on land-based ecosystems (rather than marine systems) is the existence of complex property rights systems and the variation of interests related to this fragmentation. This risk constraining the required collaboration among actors and stakeholders involved in the management of SESes, thus resembling a tragedy of the anti-commons i.e. a coordination breakdown among numerous land owners making it difficult to achieve a socially desirable outcome. In addition, the reform does not address the conflict of interests in terms of the establishment of strong incentives for collective action between forest owners and hunters, which is why we assume that the conflict – at least to some extent – will persist, thus undermining the implementation of EBM. The robustness of both the old and new moose management systems is strongly dependent on voluntary efforts to establish collective action and bonds between landowners and hunters. As a result, methods that increase the possibilities of collective action between landowners and hunters must be developed. These methods must take into consideration the fact that decisions regarding forest management are implemented at the forest estate level but sustainable moose management depends on the spatial and temporal interaction of the forest on a larger scale. In this case, it seems as if forest-owning hunters sharing the values of both forest-owning non-hunters and non-forest-owning hunters could play a mediating role between these two extreme viewpoints and help establish nested community-based governance arrangements at both the hunter-dominated local level and the forest-owner dominated ecosystem level.

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