Of forest, snow and lichen: Sámi reindeer herders’ knowledge of winter pastures in northern Sweden

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A B S T R A C T

Over the last few decades, the use of forests both by Sámi reindeer herders and for commercial forestry has been a source of increasing conflict in northern Sweden. Forestry disturbs forest ecosystems and thus damages reindeer pastures, especially those rich in ground lichen, for which reindeer forage during the wintertime by digging through the snow. Despite increased communication between the two groups, the Sámi still feel that their interests are not adequately considered by the commercial forestry sector. This paper presents the results of an interdisciplinary study that comprised semi-directed interviews and participant observations. The objective was to understand the Sámi reindeer herders’ extensive ecological knowledge of winter forest pastures, and the characteristics they observe when managing this resource. The study also analysed specific terminology used by the Sámi herders, to describe, analyse and communicate these properties. These terms, as well as Sámi herder knowledge in general, emphasize the importance of snow cover for reindeer grazing in forest pastures, as well as the effects of forest structure and ground vegetation on variations in snow cover during the winter. Whereas the Western use of the word ‘pasture’ is often associated with a specific plant community, the Sámi herders’ understanding of the word also includes the effect of snow on grazing and for this they use a culturally specific word in their language: guohtun. This term conveys the additional notion of whether it is possible for reindeer to access the pasture under the snow. Sámi herder knowledge and know-how allow them to use the mosaic of forest ecosystems to accommodate variability in snow cover during the wintertime, using different forest areas in response to different grazing conditions. Finally, the authors argue that, in order to promote the balanced, multiple use of boreal forest ecosystems, it is necessary to acknowledge and understand Sámi reindeer herders knowledge and thus to fully integrate their needs and aspirations.

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1. Introduction

This paper examines Sámi herders’ ecological knowledge and their use of forest pastures for reindeer (Rangifer tarandus tarandus L.) grazing during wintertime in northern Sweden. Since 1992, article 8(j) of the Convention on Biological Diversity (www.cbd.int), has emphasized the important role of indigenous ecological knowledge in managing biological diversity. In Sweden, both the social principles of the Forest Stewardship Council (www.fsc-sverige.org) and the objectives of Swedish forest policy (Swedish Forest Agency, 2005) take into consideration the uses of the forest for reindeer husbandry by the Sámi, the indigenous people of northern Fennoscandia. The study of traditional ecological knowledge, the complex arrays of knowledge, know-how, practices and representations that guide human societies in their innumerable interactions with the natural milieu (Nakashima and Roué, 2002), represents an important interdisciplinary field shared by anthropologists, ecologists and geographers, often in conjunction with local communities. This is rooted in ethnoscience, the study of a culture’s system of classification and taxonomy to describe its surrounding environment. Such an approach will be used in this study to clarify the interactions that exist between Sámi reindeer herding and commercial forestry.

Although the Sámi have the right to herd reindeer over the northernmost counties of Sweden, the multiple-uses of the forest resource are a source of conflict between reindeer herders and commercial forestry (Eriksson et al., 1987; Widmark, 2008). During the wintertime, reindeer mainly graze in the forests where they
feed on ground and epiphytic lichens, e.g. Cladonia spp. and Bryoria spp. (Kojola et al., 1995; Storeheier et al., 2002). Forest companies, which own 50% of forest land (Statistical Yearbook of Forestry, 2007), make use of the same land as reindeer herders, since 44% of the northern part of Sweden is covered by productive forest land. Since the 1950s, forestry has become a highly mechanized and organized industry, and today is largely based on clear-cutting and artificial regeneration. Modern forest management severely affects the reindeer’s winter pastures by decreasing the extent of ground lichen both locally, for instance during soil preparation works (Eriksson and Raunio, 1990; Roturier and Bergsten, 2006), and at the wider landscape level (Berg et al., 2008).

A key feature of reindeer grazing in winter is that reindeer have to dig through the snow to reach the lichen. It is well known that snow density and depth are key factors that influence reindeer grazing (Eriksson, 1976; Pruitt, 1979; Collins and Smith, 1991; Kumpula and Colpaert, 2007; Helle and Kojola, 2008). The effect of forest management on the degree and extent of snow cover is therefore of great importance to Sámi herders, but has not been thoroughly studied because of its complex nature. Several studies have identified the variety and accuracy of Sámi vocabulary with respect to snow and ice quality (Jernsletten, 1997; Ryd, 2007). Nevertheless, an important aspect of this knowledge has been overlooked, namely its dynamic use by Sámi herders for the management of the variable quality of grazing pastures over the winter.

Communications and negotiations between forestry managers and Sámi herders have increased in prominence and importance over recent years (Sandström and Widmark, 2007). The Sámi herders believe, however, that the forestry sector does not adequately consider their interests. Conversely, forest managers often consider herders’ practices and demands to be both difficult to comprehend and to satisfy. For these reasons, it is essential to examine how the Sámi herder’s body of knowledge concerning reindeer herding and their local environment is structured. A principal objective of this study is to improve our understanding, through interviews and participant observation, of Sámi reindeer herders’ ecological knowledge, mainly with regard to grazing conditions and their use of managed forests during the wintertime.

2. Methods

2.1. Study area

The study zone is located in the winter grazing areas of the four herding communities of Tuorpon, Jákjággasska, Sirges and Sörkáitum in the county of Norrbotten, boreal Sweden. The territory of each herding community lies adjacent to its neighbour’s, running north-west to south-east (Fig. 1). All of the herding communities are mountain based, which means that they move with their reindeer from summer pastures located in the Scandinavian mountain range to winter pastures located in the forests, where the reindeer predominantly rely on lichen for forage. Whereas the summer pastures are shared, during the wintertime the herding communities are divided into small groups, composed of siblings or relatives and their reindeer. About 30 winter groups, with herds ranging from 300 to 3000 reindeer, are distributed over the study area during the winter months. The winter grazing areas of the four herding communities extend into the forests both south and north of the city of Jokkmokk. The mixing of different communities’ herds and cooperation between neighbouring herding communities is frequent both during the summer and the wintertime. Jokkmokk represents an important place for Sámi culture in northern Sweden, and a large proportion of its inhabitants are Sámi people and reindeer herders.

Jokkmokk is also known as a pioneering area with respect to instigating dialogue between foresters and reindeer herders. At the beginning of the 1980s, the ‘Jokkmokk’s model’ was known as the first consultation framework, between Sámi herders and forest managers, to address the conflict between reindeer herding and forestry (Gustavsson, 1989). Since 2004, the four mountain herding communities studied have also been involved in the first phase of an innovative project based on participatory management and remote sensing, known as the ‘Land Use Plan for Reindeer Husbandry’ (Sandström et al., 2003).

Most of the study area is covered by managed forests, dominated by Scots pine (Pinus sylvestris L.) and Norway spruce (Picea abies (L.) Karst.). The area lies at an altitude of between 20 and 617 m. a. s. l., along the valley of the Lule River. The mean

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Fig. 1. Location of the study area. The land used for winter pastures by the reindeer herding communities is outlined in dark grey. The borders between reindeer herding communities are indicated by the bold lines.
annual temperature is $-1^\circ$ C, ranging from $-14^\circ$ C in January to $+14^\circ$ C in July. There are approximately 200–225 days of snow per year, with an average maximum depth of 70–90 cm (1961–1990 data, www.smhi.se) with notable variations in snow depth due to differences in elevation within the study area.

2.2. Fieldwork

The fieldwork comprised semi-directed interviews and participant observation. Between March 2008 and March 2009, 22 reindeer herders belonging to the herding communities of Jäkkäsgasska, Sirges, Sörkaitum and Tuuropo were interviewed, often with the help of field maps to support the discussions. Although most of the Sámi herders use the Sámi language as their mother tongue, the interviews were performed in Swedish, in which they are all fluent, with the exception of some Sámi words and expressions that defy easy translation and are culturally specific. The interviews were recorded and then transcribed in full. The topics discussed during the interviews concentrated on the nature and use of winter pastures, herding management approaches, forestry techniques and Sámi relationships with forest companies.

The fieldwork began in March 2008, by establishing the necessary contacts and conducting interviews. The second step was undertaken between June and September 2008, and involved visiting herding communities located in the mountains, assisting at the marking of calves and the slaughter of male reindeer, and visiting winter grazing areas with reindeer during the snow-free season. The last phase was undertaken between January and March 2009, and involved participant observation in the field and through further interviews.

Forest managers from the four forestry companies based in Jokkmokk, as well as representatives from the Regional Board of Forestry, were also interviewed on different occasions during this period in order to improve the analysis and the discussions.

3. Results and discussion

3.1. Sámi knowledge about pastures in managed forest

3.1.1. Tree cover, snow conditions and ice formation

Sámi reindeer herders all agreed on the effects of clear-cutting on winter pastures (see also e.g. Beach, 1981, p. 266; Helle and Jaakkola, 2008). This measure alters the snow cover and is perceived as a serious impediment to reindeer grazing. The herders often compare clear-cut areas with the bare Scandinavian mountain ranges, which must be abandoned during the winter, precisely for this reason, because the snow becomes too hard to be dug by the reindeer. According to the Sámi who we interviewed, the removal of the trees produces the same effect on the forest land.

“When a forest is clear-cut, there is no more protection, the pasture is locked down. The snow locks it in, with snowdrifts, like in the mountains. Even if there is something to graze, the reindeer cannot dig through the snow. The snow is too deep and hard in the clear-cut. (…) Reindeer avoid clear-cut areas until the pines have grown through the snow cover again. (N.-J. Utsi, pers. comm., March 28, 2008)”

According to the academic literature, forest stands always have thinner snow cover than adjacent areas that are clear-cut (Golding and Swanson, 1986; Ottosson-Löfvenius et al., 2003) because the crowns of conifer trees trap the snow leading to a lower accumulation around the trunks (Hardy and Albert, 1995). Forest structure and stem density are determinant factors that affect the depth of snow (Ottosson-Löfvenius et al., 2003). This has been suggested to explain why reindeer prefer grown forests to open areas (Helle et al., 1990; Collins and Smith, 1991).

But far from possessing a static body of knowledge about snow conditions, Sámi herders apply their understanding with great expertise and flexibility as regards changes in the quality of snow cover due to variation in temperature, further snow accumulation or wind factors, which are precisely the causes for snow metamorphosis (Gray and Male, 1981). The Sámi herders also demonstrate a thorough understanding of the effects on snow cover of trees, forest structure and seasonal events, for example, occasional thawing-freezing period. This information has not as yet been documented in an accurate manner.

Sámi herders maintain that when a warmer period occurs, inducing snow to melt from the crowns of trees, the snow drops and packs around the tree stems. In such cases the snow in dense mature forests may become completely hard and packed whereas in sparser stands, the snow is only compacted around the trunk, leaving softer snow between the trees where the reindeer can graze.

“In denser forests, (…) it may rain or the snow may melt, then it becomes ice underneath. In contrast, if the snow drops from only a few large tree crowns, there are “windows” in between where the pasture is still good. (A herder from Sirges, pers. comm., March 20, 2008)”

Older forest stands differ from younger ones because of the size and height of the trees. Sámi herders explain that when clumps of snow fall from the high canopy in older forests, the snow becomes compacted around the trees. As younger trees trap less snow and are only a few meters high, they do not create such a phenomenon.

“The pastures were poor everywhere. (…) One thing that has been good this year is the younger forests, around 1.5 metres high. Here, the pasture was quite good. But in the older forests… a lot of snow fell in the autumn, and at the beginning of January it melted, so all the snow fell down from the tree crowns and became compacted. But in the younger forests, the snow had not attached itself so much to the branches, so it was already on the ground. (A herder from Sirges, pers. comm., March 20, 2008)”

While the fact that young trees trap less snow than larger trees is an advantage for reindeer herders in the case of a thawing-freezing period occurring between the months of January and February, the opposite may be true when an early snow thaw occurs in the autumn, after the first snowfall. In younger forests, most of the snow will reach the ground and melt. When freezing temperatures return, this moisture turns to ice and makes the pasture below inaccessible to the reindeer.

“When an early snowmelt happens, a severe one, so there is almost no snow left, then you cannot escape the ice that forms on the ground. The young forests become hard because there is more snow on the ground. (A herder from Sirges, pers. comm., March 05, 2009)”

According to reindeer herders, snow conditions dictate the quality of forest pastures and this may differ significantly between forest stands, varying from one winter to another, and even between two climatic events within one winter.

3.1.2. Understorey vegetation and reindeer pastures

Trees are not the only factors that affect snow conditions in a forest stand. Another aspect of Sámi knowledge, infrequently
studied to date, is the effect of understorey vegetation on snow coverage. Sámi herders state that understorey vegetation determines snow properties for reindeer grazing. They always contrast two main vegetation types: lichen-heath vegetation with its extensive ground lichen cover, and ericaceous dwarf shrub vegetation with mosses and some patches of ground lichen. The Sámi herders differentiate these two categories of vegetation according to the thickness of the humus layer: “thin humus” for the lichen-heath vegetation, and “thick humus” for the dwarf shrub vegetation. Interestingly, these two categories relate well to the Swedish classification of ground vegetation types used by forestry (defined by Hägglund and Lundmark, 1982), which comprises lichen soil types (lichen cover >25%) and moss soil types (lichen cover <25%), respectively. It is well known that lichen-heath vegetation is widely preferred for reindeer grazing during the wintertime, as confirmed by our interviews and by Inga (2007). However, the value of dwarf shrub vegetation, which contains only patches of lichen, has been overlooked by most field observers. Sámi herders relate this value to snow consistency. First, an interesting effect of ericaceous dwarf shrubs, described by Sámi herders, is that they are effective in trapping the snow that falls, increasing its porosity and preventing the hardening of the snow over time.

“Where the lichen is spread within lingonberry and bilberry shrubs, the twigs bear the snow instead of the lichen. If the reindeer breaks the hard upper snow layer, it is softer underneath. (N.-P. Pavval, pers. comm., Aug 28, 2008)”

According to herders, another characteristic of this type of vegetation is that if the first snow thaws in the early winter, then water flows down through the generally thick moss layer, leaving the lichen accessible for the reindeer to graze (see also Ruong, 1964). In contrast, in lichen based heathland the water soaks into the lichen mat, building a crust of ice which freezes, and thus limits its availability as reindeer fodder.

“When it snows or rains during the autumn, the ground becomes wet and this may turn to ice. Where the humus layer is thick, the water goes through. However, with a lichen heath, the water remains. So on such winters, reindeer grazing may be better in forests with thicker humus, even though there is less lichen compared to lichen-heaths, which are locked down due to the ice. (A herder from Sirges, pers. comm., March 20, 2008)”

When the thawing–freezing period occurs in the autumn or early winter, ice crystals may adhere strongly to the ground early in winter, ice crystals may adhere strongly to the ground and, with a mature lichen heath, the nature of the bottom can limit the availability for reindeer grazing.

“When 10 or 20 centimetres of snow fall, and the temperature rises, the snow melts. However, this will freeze again later. In the forests with thicker humus, where there are only patches of lichen 5-6 cm high, the water flows better through the vegetation, and the ice is perhaps only a few centimetres thick. [The reindeer] can still graze the top of the lichen. On the other hand, in a flat lichen-heath, where there is only lichen, if the snow melts and then freezes, the ice covers all the lichen. This is because the lichen is only few centimetres high due to reindeer grazing. So there are no pastures in lichen-heaths anymore (…) and so we have to use forests which hold fewer lichens within their vegetation. (R. Stokke, pers. comm., Aug 30, 2008)”

Paradoxically during unfavourable winters, when an ice crust prevents the reindeer from reaching the lichen, it is thus the pastures that the Sámi herders usually consider to be poorer (i.e., patches of lichen on a moss soil) that provide the best grazing, while the pastures generally perceived to be most valuable (i.e., a continuous lichen mat on lichen soils) are locked under ice and are inaccessible. This explains why Sámi herders, when asked what is the ideal pasture, often answer “it depends”, much to the dismay of foresters. Such variability also explains why Sámi herders always emphasize the need to have access to all the different types of pasture, each of which may be of critical importance depending upon prevailing conditions. Defining the required quality of reindeer pastures therefore depends on many factors, including biological, geographical and climatic variables (Kitti et al., 2006). For Sámi reindeer herders the quality of grazing pasture is defined by many interacting factors, however, in the end it is related to the availability of the resource.

“A pine-heath was clear-cut 15 years ago, and is now a young forest with a lot of lichen on the ground. There is a mature forest located next to it, with more diverse vegetation; bilberry, lingonberry and only a few spots of lichen. In a normal winter, the reindeer graze in the younger forest, where the lichen coverage is continuous, even if the lichen is very short. But if the snow freezes to ice in the younger forest but not in the mature forest, then the reindeer will graze in the mature forest where there are only spots of lichen. That’s why we need different types of forest. That’s why we want to take care of the last lichen-rich pine forests that we have because the snow conditions are never the same from year to year. (L.-E. Nutti, pers. comm., Sept 02, 2008)”

3.2. Guohtun, a pasture that can disappear

3.2.1. “Guohtun is more than just food”

As described in the previous section, reindeer herders are very knowledgeable about the way snow cover can vary in forest stands and influence the access to ground reindeer lichen. One herder characterized, in a very clear manner, how inextricably snow and ice are linked to the availability of reindeer lichen:

“The reindeer grazes differently depending on the nature of the snow, the nature of the bottom. … [that is] the place where the snow or the ice meets the ground. One can generally say that if you take three factors; how much lichen there is on the ground, how is the bottom, and then how much snow is present, and if two of them are acceptable, it can work. For example, if the lichen is high, there is little snow and maybe ice [in the bottom], then one is bad, but perhaps the lichen protrudes above the ice. [On the other hand], if the lichen is very short at a place, but the bottom is very good and there is little snow, then maybe the lichen is bad but the reindeer can still graze there. In a way, it is a real science. (M.-P. Astot, pers. comm., Aug 31, 2008)”

Such reasoning is often understated and implicit. Indeed, it was noted during the interviews, that the Sámi herders associate the Swedish word bete, strictly meaning ‘grazing’ or ‘pasture’ with a wide range of different meanings. In this context, the word bete could relate to ground lichens, pastures in general, snow conditions or a combination of these factors. This diversity of meanings can only be understood by analysing the Sámi language, where the complex term guohtun is translated bete in Swedish meaning ‘pasture’ (Ruong, 1964; Nielsen and Nesheim, 1979 [1932–1962]; Svonni, 1990). When asked to
clarify the meaning of guohtun, the herders gave the following definitions:

“Guohtun is more than just the food, it is the whole actually: how the reindeer can get their food. It means that what is above the lichen is also included in it, everything that influences the food itself. (P.-J. Parffa, pers. comm., Feb 05, 2009)”

“Guohtun means, in fact, that the reindeer get the food. Therefore it includes the snow conditions, snow depth, the ground, what is on the ground, if there is lichen; the idea is that reindeer can get their food: guohtot. The reindeer guohtot: the reindeer eat, the reindeer... graze. (G. Kuhmunen, pers. comm., July 30, 2008)”

The herders’ definitions of guohtun relate to the accessibility of pastures for reindeer grazing. Consequently, in the winter, the meaning of the word guohtun encompasses both the snow conditions and the lichen. In Ryd’s published glossary on snow (Ryd, 2007, p. 213), guohtun is translated as “good pasture under the snow”. This is not strictly correct as it distinguishes the snow from the pasture below, and implies that a pasture could be good once and for all, overshadowing completely the problem of access. Nielsen and Nesheim’s definition of the word guohtun allusively incorporates the wider meaning: “(a) grazing, feeding: (b) pasturage, food; also used of the possibility of the reindeer finding reindeer moss under the snow” (sic) (Nielsen and Nesheim, 1979 [1932–1962], II p. 232).

As can be seen, guohtun is not easy to translate into another language as it encompasses several levels of meaning. When the Sámi talk in Swedish (for instance when talking to forest managers), the reindeer herders are obliged to use the word bete (pasture) as a translation for guohtun, which in a Western context has only a restricted meaning, i.e., plant communities suitable for grazing. This greatly impoverishes the original multi-layered Sámi meaning of guohtun.

Guohtun can be considered to be what authors in the sphere of ethnoscience have called a complex category (Friedberg, 1999). In Sámi, guohtun does not relate solely to a plant community. It relates above all, to the accessibility of the plant community to the reindeer given the prevailing snow and ice conditions at different locations and at specific moments in time. It is, therefore, a term that incorporates not only space, but time (Fig. 2). A third level of understanding could also be added, that of reindeer behaviour. It was reported during this study that reindeer do not always graze as expected, even when the lichen is present in a forest stand under snow that is suitable for digging. In the light of these facts, it is important to understand that, when snow conditions or other factors prevent the reindeer from grazing, for example, the residual of clear-cutting activities or the tracks of scarification, etc., the reindeer lichen as pasture, or more precisely the guohtun, disappears for the Sámi herders as a viable resource.

3.2.2. Variability of the guohtun in time and space

The availability of pastures varies over time. During the winter, temperature variations, thawing–freezing periods and snow accumulation, can constantly change the snow cover, and thus the potential for reindeer to graze at a certain place. In the worst case scenario, Sámi herders say that a guohtun can be “destroyed”, because they know from their extensive experience that the reindeer will not be able to graze a specific pasture any longer. Ice encasement of the vegetation can happen after only a few days of mild weather with rain falling on snow (Putkonen and Roe, 2003). For instance, it occurred during the last week of December 2007 (which was a catastrophic winter for reindeer husbandry in the study area), a sudden period of warmer weather, with rain and temperatures above 0°C, ruined perfectly good grazing pastures.

“The mild period arrived suddenly, and in one week the temperature was +10°C. Most of the snow melted and then froze again, and the ground was covered in ice. Only two weeks before we thought the guohtun would be good, and now it was completely inaccessible, locked away under the ice. (R. Stokke, pers. comm., Aug 30, 2008)”

Milder weather can occur with less dramatic consequences, depending upon the forest structure. In some circumstances, it can even improve grazing conditions for the reindeer. For instance, herders say that pastures that were previously inaccessible due to a dense layer of snow from snow fall earlier in the winter, called ceavvi, can become available at a later date when the warmth emanating from the ground softens the snow from below (see also Ryd, 2007, p. 83).

The availability of pastures also varies in a spatial context. Reindeer herders know that under good snow conditions, which is often the case at the beginning of winter, the entire grazing area is potentially available for reindeer grazing. When the snow cover becomes deeper, however, the availability of the pastures and the grazing area decrease.

“If the [snow conditions] are good, the reindeer graze everywhere, even in poor forests. (…) They can graze in places other than in lichen-rich pine heaths; in mires, thickets and on lakeshores, before they turn to lichen pastures. (…) But during the wintertime, in January, February and March, before the snow becomes too hard, the best pastures are the lichen ones. (L.-E. Nutti, pers. comm., Sept 02, 2008)”

As described earlier, the guohtun depends on the vegetation cover and forest structure. Variations in snow accumulation and temperature can damage grazing areas locally. Consequently, the area available for grazing, and thus the area needed for a winter group, varies from year to year.

“We can only use the land that is possible to use. We cannot graze everywhere, partly because of the clear-cuts and because of the changing snow conditions. (…) We do not have a large winter grazing area. That’s what people believe who don’t actually know about reindeer herding... but it is not true. One should look at the pasture area, and they shrink [as the winter season progresses]. (…) Some years the guohtun can be scattered, and then we need more land because the reindeer...
have to walk around. Reindeer walk a lot, grazing at the same time… they are not like other animals that stay in one place. (A herder from Sirges, pers. comm., Aug 28, 2008)"

The availability of suitable pasture for reindeer grazing is never constant, and is driven by variations in tree cover, understory vegetation and snow conditions. Thus, the variability of the guohtun occurs both on a temporal and spatial basis. This constitutes one of the main challenges faced by reindeer herders during wintertime.

3.2.3. Reindeer grazing and trampling snow: impacts on the guohtun

Another important factor that diminishes winter grazing possibilities through time and space are the reindeer themselves. They affect the prevailing snow conditions by their grazing activities. In the Sámi language, ciegar is a “snowfield which has been trampled and dug up by reindeer” (Nielsen and Nesheim, 1979 [1932–1962], III p. 178). A pasture trampled by grazing reindeer becomes useless as the snow is too compacted and dense to allow the reindeer themselves to dig and forage.

“A ciegar, it is trampled. It is useless, everybody knows what it means, and nobody goes there. Sometimes, this occurs when reindeer have been grazing out of control, and the area is then covered by snow. It looks nice and beautiful, but it is useless, we cannot use it. Reindeer have grazed and trampled so that the snow becomes too compacted, such as even a blade cannot go through it. (L. Pittsa, pers. comm., March 25, 2008)"

When an area has been grazed and trampled, the reindeer cannot use it anymore. The Sámi herders state that the reindeer do not return to a ciegar in the same year, the snow being too difficult to dig through and the bottom being too frozen to make it suitable for further grazing. As a consequence, the reindeer have to leave the ciegar and find a new oppas.

“An oppas is pristine snow. This is what we need for the reindeer to graze in the snow. If you touch it, it freezes. (…) Reindeer graze step by step. When they have grazed and trampled an area, destroying the snow, they move on to a new place that has not yet been grazed. That is why we are totally dependent on the snow remaining intact. (N.-J. Utsi, pers. comm., March 28, 2008)"

Oppas has been defined as an “untouched, untrodden, covering of snow” (Nielsen and Nesheim, 1979 [1932–1962], III p. 178). Thus, during the wintertime, reindeers move from oppas to oppas, leaving ciegar behind them.

Organized into smaller winter groups, the herders must manage their reindeer within a limited territory. As the winter progresses, more ciegar are created and more grazing lands disappear because of climatic events, thus constantly diminishing the guohtun for reindeer. In order to ensure viable pastures for their herds for the whole of the winter period, Sámi herders from each winter group plan for the temporal and spatial vagaries of the guohtun, throughout their territory.

3.3. Herders’ strategic use of forest types to ensure adequate winter pasture

Sámi are knowledgeable about the use of pastures in particular forest types and the times when these pastures are available during the winter. Accordingly, the decision to use pastures at any one time during the winter depends on the types of forest that the reindeer are able to graze. Reindeer have access to pastures, the guohtun, when spatial and temporal scales match, i.e. “good” snow or ice conditions coincide with the presence of reindeer lichen. The term ‘matching’ is also used in herbivore ecology, and denotes that the amount of time a grazer spends in a feeding area is proportional to the quality and the quantity of the forage in the area (Senft et al., 1987). As Fernandez-Gimenez (2000) highlighted with respect to cattle in Mongolia, herders play a key role in determining the foraging pattern. In the same way, the Sámi reindeer herders use their knowledge of the differences between the various forest stands and their influence on snow conditions, to “steer” the grazing of the reindeer throughout the winter period. This knowledge allows the herders to plan and respond to most of the events that they are likely to encounter during the winter.

For example, areas that accumulate more snow during winter, like the hills and highlands, are preferred at the start of winter, when their snow cover is thinner (Kumpula and Colpaert, 2007; Helle and Jaakkola, 2008). The herders draw upon their experience to use these pastures first, as they will become inaccessible later due to the accumulation of snow. In the study area, Sámi herders generally use the pastures at higher elevation first, allowing the reindeer to graze further down the valley of the Lule River at a later date. Nowadays, this traditional pasture management approach has become difficult to apply because of conflicting activities, such as the harvesting of forests (Kumpula and Colpaert, 2007) or the construction of water reservoirs that have flooded the valley bottoms (Kitti et al., 2006).

“In the wintertime, the area where we can be with our reindeer is limited, and we have to steer them. Most often, it is the snow that makes us move and decide how to use the land. In the old world, we used to use the hills first, in the autumn, before the snow was too deep and then, we used to go down into the valleys. (…) But this has become difficult nowadays, and we have to use the lower lands earlier because of commercial forestry and other encroachment. The land shrinks for us and we no longer have sufficient land to alternate anymore… (A herder from Sirges, pers. comm., Aug 28, 2008)"

Sámi herders can also use their knowledge to forecast changes in the guohtun and to adapt the herding of their reindeer accordingly. A Sámi herder, recounting the situation at the beginning of the winter in 2008, explained that they had predicted that their reindeer would stop digging the snow for ground lichens sooner or later, and would move on of their own accord, to an adjacent forest with epiphytic lichen. This last move was seen as being in the correct direction, towards a pre-planned reindeer gathering place. The link between the two pasture sites was foreseen and planned by the Sámi, in order to maintain control over the reindeer herd by anticipating both the snow conditions and the behaviour of reindeer.

“We didn’t really know how the guohtun was, but we hoped that it would hold as long as possible. (…) And we knew that if [the grazing conditions] deteriorated, if [the reindeer] stopped grazing, there was a small forest with epiphytic lichen to the west, which would maintain them. If they started to leave the pasture, they would go there. So we had like a trap to retain them to give us the time to gather them. (P.-J. Parffa, pers. comm., March 26, 2008)"

Many other examples could be presented here, all of which demonstrate how Sámi herders anticipate changes in snow conditions, or assess the quality of a specific forest stand, depending on prevailing conditions. However, these two examples indicate that, far from being a land of uniform snow and pasture quality, the boreal forest for the Sámi reindeer herders is a complex mosaic of grazing areas, with many different properties that their extensive knowledge and local expertise bring to light.
To add a further layer of complexity, it should be noted that these characteristics are dynamic and are used differently according to the situation, for example the size of the herd, the snow conditions, or the progression of the winter. As expressed by one herder: “There is lichen-health and lichen-health!” The Sámi herders’ understanding of the variability of different forest stands and their great ability to adapt reindeer management in response to these factors is not easy to communicate to outsiders who do not know about reindeer husbandry. Herders use their elaborate knowledge of forest pastures to interpret and respond to feedback from their environment, to manage the reindeer herds in the most appropriate manner against a modern landscape under increasing development pressure. The differences in snow conditions that can occur between forest stands provide Sámi herders with a way to manage for the snow variations. The development of commercial forestry management in the second half of the 20th century has dramatically transformed the boreal forest landscape. Forest structure has shifted towards a more uniform forest landscape with removal of certain forest types, e.g. old-growth forests (Östlund et al., 1997). For reindeer herders, this has resulted in a reduction in the number of alternative pastures available to ensure survival under different snow conditions during winter.

4. Conclusion

Sámi reindeer herders are dependent on the boreal forest as an important resource for their reindeer and they use its natural diversity to manage their herds. The knowledge and know-how of Sámi reindeer herders allows them to adapt to variations in grazing conditions. It is not limited to the description and characterization of snow and ice properties but involves a dynamic understanding of the effects of the trees and understory vegetation on snow cover and the ability to foresee how these factors may vary as the winter progresses. Many of the factors affecting reindeer herding, such as ground vegetation and tree cover, are directly or indirectly driven by forestry (Fig. 2). To our knowledge very few research have been carried out on the effects of snow and ice metamorphosis on dwarf shrubs and ground lichen and vice versa (Bjerke, 2009; Temmervik et al., 2009). It could be important for both reindeer husbandry and forestry if research was developed on this topic. On the one hand, it would be of great interest to develop further classification of different forest types, not only according to their vegetation, as is currently the case in commercial forestry, but also by considering the effects of forest management on snow conditions. This is because snow conditions are as least as important for reindeer grazing as the presence of reindeer lichen. As expressed by the Sámi word guohutn, it is essential for forest managers to understand that each silvicultural measure that modifies the snow cover will also affect reindeer grazing potential. On the other hand, new forest management techniques should be tested, such as partial harvesting systems (Steent et al., 2007), to guarantee a diversity of forest types and thus a diversity of snow cover types. This diversity has been decreased by commercial forestry during the 20th century (Östlund et al., 1997). It is essential for reindeer herding, however, as Sámi herders depend upon it to ensure that the reindeer have access in one location or another.

Nowadays, the multiple-use of the boreal forest is completely subordinate to the forest companies and owners’ management of the forest resource. Sámi herders have already made considerable efforts to understand forest managers’ practices and knowledge. In order to achieve equitable use of the forest and decrease the potential for conflict between Sámi reindeer herders and commercial forestry, it is necessary that practitioners of the latter take the same effort to understand and acknowledge the Sámi herders’ extensive knowledge system.

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