

## Past and Present Winter Feeding of Reindeer in Finland: Herders' Adaptive Learning of Feeding Practices

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**ABSTRACT.** The research examines reindeer feeding practices and herders' learning of them in three herding co-operatives in Finland: Kuukas in the south, Oraniemi in the central area, and Hammastunturi in the north. In the southern and central co-operatives, from the late 19th century until the Second World War (1939–45), trees rich in lichens were cut to provide emergency forage. Harvesting lichens from trees and feeding associated with “tether calving” and “fence calving” have been common in the central and northern co-operatives. In the 1960s and 1970s, poor digging conditions resulted in reindeer losses, and pressure to feed reindeer increased further as forestry practices and overgrazing caused pastures to decline. Large-scale feeding entered daily practice in Kuukas and Oraniemi in the late 1980s and mid-1990s. The increased interaction between humans and reindeer brought about by regular feeding has made the animals tamer. In fact, they have adopted the permanent feeding areas as part of their pasture rotation. In Hammastunturi, herders entice reindeer from one pasture to another by providing supplementary forage. Knowledge about feeding developed in close concert with agriculture, and was transferred from south to north in the 1980s and 1990s. We argue that feeding practices draw on traditional ecological knowledge, which includes old ways of herding cattle. Herders' personal working practices and training are knowledge that is difficult to describe in words and must be learned by experience. Learning to feed reindeer requires not only familiarity with herding in practice (which implies profound knowledge about the animals, their nutrition, digestion, behavior, and handling), but also familiarity with the herding district and co-operation across generations.

**Key words:** reindeer herding, winter feeding, lichen, Finland, boreal forest, interview, local knowledge, learning, anthropology, biology, multidisciplinary

**RÉSUMÉ.** Cette étude porte sur les pratiques alimentaires du renne et sur l'apprentissage qu'en font les bergers au sein de trois coopératives de la Finlande : Kuukas dans le sud, Oraniemi dans la région du centre et Hammastunturi dans le nord. Dans les coopératives du sud et du centre, de la fin du XIX<sup>e</sup> siècle jusqu'à la Seconde Guerre mondiale (1939–1945), on coupait des arbres riches en lichen pour servir de fourrage d'urgence. La récolte du lichen des arbres et l'affouragement lié au «vêlage en laisse» et au «vêlage en enclos» sont courants dans les coopératives du centre et du nord. Dans les années 1960 et 1970, les mauvaises conditions de creusage se sont traduites par la perte de rennes, et la pression exercée pour faire manger les rennes a augmenté au fur et à mesure que les pratiques d'exploitation forestière et le surpâturage ont réduit la taille des pâturages. L'affouragement à grande échelle est devenu monnaie courante au quotidien dans les coopératives de Kuukas et d'Oraniemi vers la fin des années 1980 et le milieu des années 1990. L'interaction accrue entre l'être humain et le renne découlant de l'affouragement régulier a rendu les animaux moins sauvages. Ils ont en fait adopté les aires d'affouragement permanentes dans leur rotation des pâturages. À Hammastunturi, les bergers incitent les rennes à passer d'un pâturage à un autre en leur donnant du fourrage supplémentaire. Les connaissances en matière d'affouragement se sont développées en contact étroit avec l'agriculture, et elles ont été transférées du sud au nord dans les années 1980 et 1990. Nous soutenons que les pratiques d'affouragement s'appuient sur les connaissances écologiques traditionnelles, dont les anciennes méthodes de garde des troupeaux. Les méthodes de travail personnelles des bergers et leur formation sont des connaissances difficiles à décrire avec des mots, car elles doivent plutôt s'acquérir par le biais de l'expérience. Apprendre à nourrir les rennes exige non seulement de se familiariser avec la garde des troupeaux en pratique (qui implique des connaissances poussées des animaux, de leur alimentation, de leur digestion, de leur comportement et de leur manutention), mais aussi de se familiariser avec le territoire de garde et la coopération au fil des générations.

**Mots clés :** garde des rennes, affouragement hivernal, lichen, Finlande, forêt boréale, entrevue, connaissances locales, apprentissage, anthropologie, biologie, multidisciplinaire

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## INTRODUCTION

The development of reindeer herding in Finland can be described in terms of two traditions, western and eastern. The western tradition developed from or in contact with nomadic Sámi herding, which spread from central parts of Scandinavia during the 16th and 17th centuries. In nomadic Sámi herding, Fell Sámi families roamed hundreds of kilometers with their large reindeer herds from summer pastures to winter pastures and back again. They used reindeer mainly as a source of meat and milk. The eastern herding tradition, which originated in the practices used by Forest, Inari, and Skolt Sámi and later by Finnish peasants, differed in many respects from the western practice. Eastern practitioners herded reindeer on a smaller scale and combined herding with other livelihoods, such as hunting, fishing, and farming (Heikkinen, 2006). Forest Sámi used reindeer mainly as draught animals for transport. They did not adopt the yearly nomadic herding cycle or milk reindeer, and their animals grazed freely until the roundups in early winter (Paulaharju, 1927; Itkonen, 1948; Kortessalmi, 1996, 2007; Heikkinen, 2006).

When settlements spread from south to north around the turn of the 19th century, Finnish peasants adopted herding practices from the Forest Sámi. The peasant herders developed innovations and creative solutions in herding (Kortessalmi, 1996, 2007). For example, they began rounding up their reindeer in ready-made cattle alleys and in fenced fields close to the farm, known as “reindeer fields” or “reindeer yards” (*poropelto*). They also invented a device for more effective transportation—the “reindeer sleigh”—and started using longer trains of reindeer than the Sámi had (Kortessalmi, 1996, 2007). When reindeer numbers started to increase in the mid-19th century, so did the importance of reindeer as a source of meat. In the 1960s, the system of slaughter focusing on calves was adopted from cattle farming (Aikio and Helle, 1985).

Intensive herding, in which small herds are controlled by the herder, was practiced in the reindeer-herding area of Finland before the Second World War (Fig. 1). The practice allowed effective use of winter pastures and served pasture rotation, the setting aside of grazed areas for several years to allow lichens to recover. Intensive herding also protected reindeer from predators and prevented animals from escaping into neighboring co-operatives and damaging agricultural fields and stored hay (Helle and Jaakkola, 2008). The main natural winter forage, lichens, was a carefully regulated resource among the herders, as one informant from Hammastunturi noted: “In summer an eye was kept on the places where lichens grew well. When motor bikes were introduced, father forbade us to drive them on the pastures, so that lichens would not be damaged” (Male 1). Intensive herding was replaced with extensive or loose herding in the southern part of the herding area following the disruption caused by the Second World War. Extensive herding is characterized by the free ranging of large herds, which are gathered only for calf marking in summer and roundups in

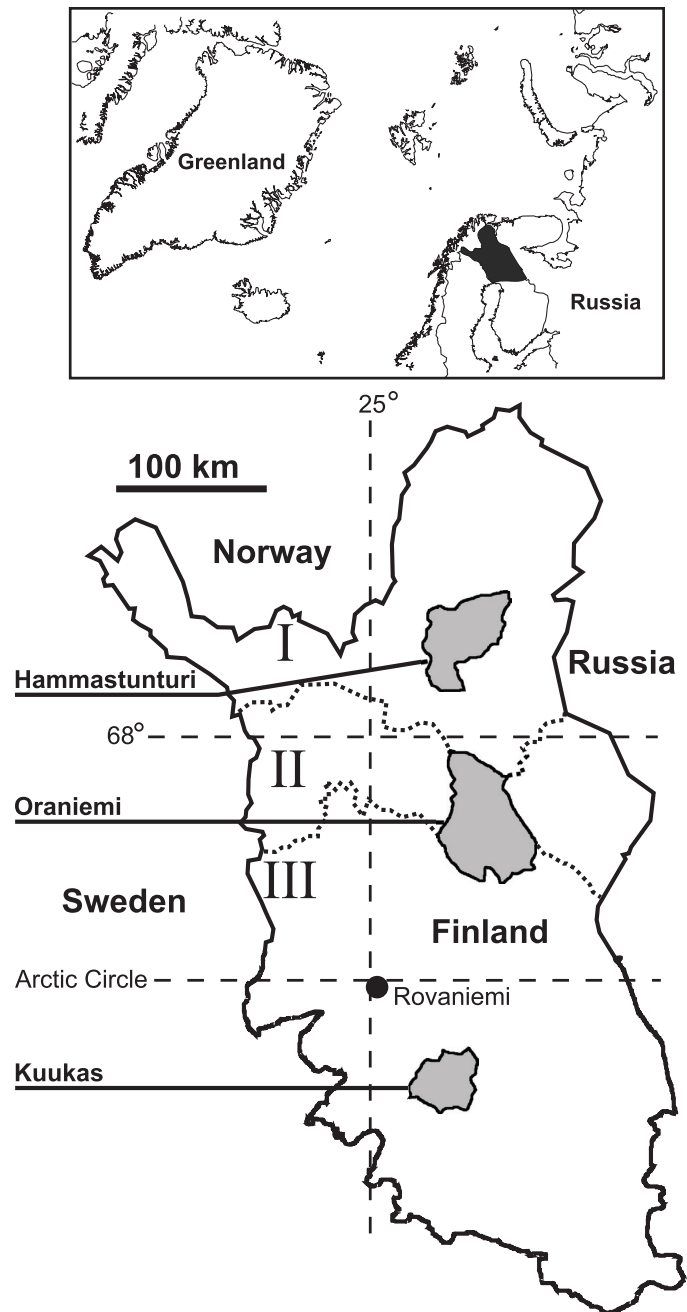


FIG. 1. Reindeer herding area in Finland, showing the forest herding co-operatives of Kuukas, Oraniemi, and Hammastunturi and the borders of the areas known as the Sámi reindeer herding area (I), Special reindeer herding area (II), and Other reindeer herding area (III).

autumn (Helle and Jaakkola, 2008; Vuojala-Magga et al., 2011). In the north, the “snowmobile revolution” sparked a transformation from intensive to extensive herding by the 1960s (Pelto et al., 1968; Müller-Wille, 1975; Helle and Jaakkola, 2008). The mechanization of herding with the introduction of the snowmobile can also be seen as a part of a broader process of modernization in the livelihood. For example, Näkkäläjärvi (2013) has concluded that the introduction of the snowmobile did not significantly change the nature of traditional Sámi herding in the Jaurustunturi area

of Western Lapland; rather, it enabled a nomadic cultural practice to continue under changed societal conditions.

Reindeer herding has experienced fundamental changes since the mid-20th century, including the shift from a subsistence economy to a financial economy and a transition to permanent housing, as well as the introduction of snowmobiles, terrestrial vehicles, and other new technology such as mobile phones and GPS collars (Pelto et al., 1968; Müller-Wille, 1975; Kortessalmi, 2007). Winter pastures have become fragmented and have declined in number and quality for several reasons: Finland's cession of territory to the Soviet Union after the Second World War; the requirements of the forest and energy industries, mining, and agriculture; and the construction of transportation networks. Overgrazing caused by high reindeer densities and inadequate or lacking pasture rotation systems has also greatly contributed to the trend (Forbes et al., 2006; Heikkinen, 2006; Kortessalmi, 2007; Mattila and Mikkola, 2009; Kumpula et al., 2011; Jaakkola et al., 2013). The marked reindeer losses of the 1960s and 1970s were due to poor digging conditions caused by deep snow cover and ground icing or to moldy vegetation (Helle and Saastamoinen, 1979; Kumpula et al., 2000; Vuojala-Magga et al., 2011). The increased energy consumption these conditions required weakened the animals, lowered calf percentages, and ultimately led to animals' perishing (Helle and Kojola, 2008; Vuojala-Magga et al., 2011). Reindeer numbers then peaked in the 1980s as a result of extensive herding, favorable weather and snow conditions (FMI, 2013; RHA, 2013), the adoption of a slaughter system focusing on calves, and antiparasite medication. Moreover, the number of animals slaughtered was reduced, as demand for meat fell, e.g., because of the Chernobyl nuclear power plant accident in 1986 (Heikkinen, 2006; Vuojala-Magga et al., 2011). The large herd at the time led to severe overgrazing of winter pastures, which—together with forest cutting—increased pressure to use feeding (Kortessalmi, 2007).

Winter feeding started in the late 1960s. The practice consists of feeding reindeer with hay, grass silage, pellets, or a combination to prevent losses of animals, to help them achieve or maintain an adequate nutritional status over the winter, and to produce bigger calves for slaughter (Nieminen et al., 1998; Heiskari and Nieminen, 2004; Helle et al., 2007; Turunen et al., 2013). Animals are fed in pens and in the field (e.g., in forests, fells, or other natural pastures). In the southern part of the herding area, feeding pens are common, whereas field feeding is more usual in the central and northern parts. When a reindeer is fed in a pen, it gets all or at least part of its forage from the herder, whereas feeding in the field is based for the most part on natural pastures. Industrial production of pellets started in the 1970s, and pellets were improved in the 1980s (Nieminen et al., 1998). According to the Finnish Food Safety Authority (EVIRA, 2013), the production of mixed reindeer feeds has increased during the past 30 years (Fig. 2). The disadvantages of feeding include increased risk of diseases (Tryland et al., 2001; Aschfalk et al., 2003) and intensified impacts

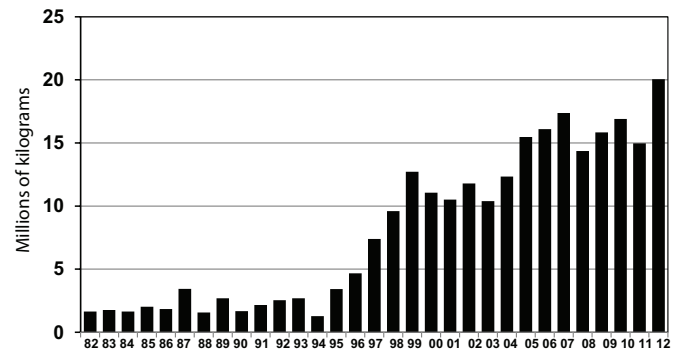


FIG. 2. Production of mixed reindeer feeds (millions of kilograms) in forage plants in Finland, 1982–2012 (EVIRA, 2013).

of grazing and trampling on vegetation and soil (Suominen and Olofsson, 2000; Stark et al., 2010; Kumpula et al., 2011; Turunen et al., 2013). Furthermore, in the southern and central parts of the herding area, the costs of feeding may account for as much as 30% to 50% of herding costs. Where this is the case, the profitability of herding becomes dependent on European Union livestock and arable area subsidies, which have been paid since Finnish accession to the Union in 1995 (Meristö et al., 2004; Rantamäki-Lahtinen, 2008; Nieminen, 2013). Although supplementary feeding involves considerable expense, it is often the only profitable alternative for herders (Rantamäki-Lahtinen, 2008).

This study draws on developmental systems theory (DST), augmented by the concept of learning, as a general framework for constructing the process of change. DST opens up a perspective encompassing multiple context-sensitive causes (Ingold, 2001; Lewontin, 2001; Oyama et al., 2001). Reindeer herding is viewed in terms of the practical engagement of herders, with “practice” referring to both practical mastery of herding skills, such as winter feeding, and the dynamics of the local social systems, such as herding units (e.g., the kin group or village herd) as these are experienced by individual herders (Ingold, 2000; Vuojala-Magga, 2012). Knowing, thinking, and understanding are generated in the practical tasks and work of everyday life. Practice is seamlessly connected to the concept of activity and links individuals to the lived reality (Lave, 1990, 1991; Kozulin, 1996; Lave and Wenger, 1996, 2001). In the context of DST, the concept of learning offers the possibility to analyze the individual herders' learning experiences in feeding reindeer as part of the cumulative shared knowledge of many herders; the concept can also be applied to changes in the behavior of reindeer due to feeding. As Ingold (2000:418) states: “We do not have to think the world in order to live in it, but we do have to live in the world in order to think it.” In the same way, instead of talk about reindeer husbandry, there is talk within herding practice. One focus of our research is thus the learning processes of practitioners in their active engagement with the constituents of their surroundings: this is context-situated learning within the social world of herders and reindeer behavior, or what can be termed “an education of attention” (Gibson,

TABLE 1. Characteristics of the herding co-operatives studied.

Herding co-operative	Kuukas (southern)	Oraniemi (central)	Hammastunturi (northern)	Reference
Total surface land area (km <sup>2</sup> )	1345	3938	2155	Mattila, 2012
Bedrock	Basal gneiss	Granite	Granulite	Manner and Tervo, 1988
Phytogeographic region	North Ostrobothnia	North Ostrobothnia	Forest Lapland	Kalliola, 1973
Largest permissible number of reindeer	1500	6000	5500	RHA, 2013
Number of reindeer (2011–12)	1521	5433	4342	RHA, 2013
Reindeer/km <sup>2</sup> land area	1.1	1.4	2.8	Mattila, 2012; RHA, 2013
Calf percentage (calves per 100 females at fall roundup, 2011)	58	69	47	RHA, 2013
Number of reindeer killed by traffic in 2012	61	105	86	RHA, 2013
Number of reindeer killed by predators and compensated <sup>1</sup> (2011–12)	4	23	81	RHA, 2013
Number of reindeer owners (2011–12)	64	138	91	RHA, 2013
Terricolous lichen pasture (ha/reindeer)	4.2	6.4	12.2	Kumpula et al., 1997, 2009
Arboreal lichen pasture (ha/reindeer)	11.0	14.2	16.0	Kumpula et al., 1997, 2009
Shrub, deciduous and herb pasture (ha/reindeer)	18.9	20.0	11.9	Kumpula et al., 1997, 2009
Fells/(ha/reindeer)	–	0.2	1.2	Kumpula et al., 2009
Peatland (ha/reindeer)	–	24.4	4.7	Kumpula et al., 2009
Area of infrastructure impact (% of the total land area)	–	12.0	6.7	Kumpula et al., 2009
Mean annual temperature, 1970–2010 (°C)	0.74	-0.52	-0.61	FMI, 2013
Mean January temperature, 1970–2010 (°C)	-11.5	-13.7	-13.0	FMI, 2013
Mean July temperature, 1970–2010 (°C)	15.2	14.6	14.1	FMI, 2013
Mean annual precipitation, 1970–2010 (mm)	605	512	426	FMI, 2013
Thickness of snow cover on 15 March, 1970–2010 (cm)	72	74	65	FMI, 2013
Mean snowmelt date, 1970–2010	7 May	15 May	17 May	FMI, 2013

<sup>1</sup> The state pays compensation to herders or to the herding co-operative for reindeer killed by predators if approved by the local predator assessor.

1979; Lave, 1990, 1991; Lave and Wenger, 1996, 2001; Ingold, 2000, 2001; Ingold and Kurttila, 2000).

This research seeks to characterize the past and present winter feeding practices of reindeer in southern, central, and northern parts of the reindeer herding area in Finland (65°–68° N) (Fig. 1). The herding co-operatives studied—Kuukas, Oraniemi, and Hammastunturi—are referred to as “forest herding co-operatives” because they are located in the northern boreal coniferous forest zone. We have studied the views of 12 herders in order to analyze their knowledge of winter feeding practices, their reasons for feeding reindeer during historical periods, and how they have learned to feed reindeer. The study focuses on the period from the 1960s to 2010.

## METHODS

### Study Sites

These three herding co-operatives—Kuukas, Oraniemi, and Hammastunturi—were selected for this research in cooperation with the Reindeer Herders' Association (RHA) (Fig. 1). They represent, respectively, “typical” co-operatives in the southern, central, and northern parts of the reindeer-herding area in Finland (65°–68° N). The salient characteristics of the co-operatives are presented in Table 1. All three study sites are located in the north boreal coniferous forest zone. Both Kuukas and Oraniemi are in North Ostrobothnia (Perä-Pohjola), which is characterized by Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* L. Karst), and Hammastunturi is in Forest Lapland,

which is characterized by forests dominated by Scots pine and fells (Kalliola, 1973).

Kuukas, the southernmost co-operative, lies in the municipality of Ranua. The traditional herding practices in the cooperative are based on those used by Finnish farmers. The largest number of reindeer permitted is 1500, and reindeer density is approximately 1.1 reindeer per km<sup>2</sup> of land area. Forestry has decreased the amount of winter pasture. Some of the summer pasture mires are used for forestry activities and peat production. During summer, reindeer graze freely in what is known as a mixed or collective herd (*sekatokka*, *yhteistokka*). After the autumn roundup, some reindeer are fed in the forest, but most are herded into feeding pens, where they are kept until spring and then released for calving. Calves are earmarked in summer (Turunen and Vuojala-Magga, 2011; RHA, 2013).

Oraniemi, which lies in the municipalities of Sodankylä, Savukoski, and Pelkosenniemi, is the fifth-largest herding cooperative in Finland. The herding culture in Oraniemi can be seen as a mixture of the southernmost tradition and Sámi traditions. This co-operative has the largest number of reindeer (6000) permitted of the three studied here and a reindeer density of 1.4 animals per km<sup>2</sup>. According to a Finnish government classification initiated in the 1960s, Oraniemi lies in what is known as the “Special reindeer herding area” (Fig. 1), which has a level of protection to secure the reindeer industry (Reindeer Husbandry Act, 1990). The summer and autumn pastures are of good quality, but winter pastures have diminished in size and quality as a result of forestry activities. Herding is characterized by independent herding units such as village herds (*kylätokka*), each of which includes smaller herds (*tokkakunta*) grazing

in their own pasture areas. During winter, most of the reindeer are fed in pens, and the rest are fed in the forest. Herders use both free calving and calving fences. Some calves are earmarked in summer and some in autumn (Turunen and Vuojala-Magga, 2011; RHA, 2013).

Hammastunturi lies in the municipality of Inari and is located in what is known as the “Sámi reindeer herding area,” in which reindeer husbandry has priority (Fig. 1). This means that special attention should be paid to secure this industry against other uses or conflicting interests in issues related to encroachment. For example, the Finnish government must consult the different herding co-operatives in cases of land sales. Most of the herders in the cooperative are Sámi. Herding is based on the *siida* system (a *siida* is an extended family or kin group consisting of economically independent households), which means that family and kinship play a key role in herding practices. The largest reindeer number permitted in Hammastunturi is 5500, and the reindeer density is 2.8 animals per km<sup>2</sup>. Some of the winter pastures are protected, and some are commercial forests. Summer pastures include mires and wetlands of good quality. Small-scale gold mining is common in the region. Winter herding entails the use of forage to move herds from one pasture to another, and in spring, free calving or calving fences are used (Turunen and Vuojala-Magga, 2011; Vuojala-Magga, 2012; Vuojala-Magga et al., 2011; RHA, 2013).

### *Interviews and Field Observations*

We interviewed 12 reindeer herders, or 3% to 5% of the reindeer owners in each of the three co-operatives. The age of the informants (2 females, 10 males) ranged from 40 to 80 years. In Hammastunturi and Oraniemi, herding is a full- or part-time job for the owners, whereas in Kuukas it is a livelihood supplementary to work in agriculture, forestry, or construction or to other sources of income. Most of the herders in Hammastunturi are Sámi, but in Kuukas and Oraniemi the reindeer are owned and managed by Finnish people. The interviews were conducted at the homes of the herders during spring 2009 and 2010 by anthropologist Terhi Vuojala-Magga (a member of the Hammastunturi herding co-operative) and biologist Minna Turunen. The interviews were thematic, enabling discussion of matters that the herders found interesting and important. The most in-depth questions concentrated on the past and present status and practices of winter feeding, reasons for feeding, herders’ learning of feeding practices, and the behavior of reindeer in conjunction with feeding. Herders were asked how their feeding methods and innovations originated and how this knowledge was disseminated from one area to another. They were encouraged to tell stories freely; to describe the ways in which they learn, assimilate and develop new feeding practices, methods, and techniques; and to relate how they have applied their own knowledge to feeding their herds. To gain as long a historical perspective on herding and feeding as possible, we placed a special

focus on analyzing the data of informants who had several decades of herding experience. The interviews were conducted in Finnish, tape-recorded, and transcribed and analyzed by both authors. If clarifications were needed, we consulted the herders.

In addition to examining the relevant literature and interviews, this study draws on the authors’ long-term participation in daily herding work and field observations. In this respect, the research follows the principles of empiricism, which emphasize that knowledge and understanding come primarily from lived experiences based on everyday life and work—in this case, work within the herding community (James, 1976; Jackson, 1989; Rosaldo, 1989). Anthropologist T. Vuojala-Magga, who lives in the village of Kuttura in Hammastunturi, has made field observations for more than 10 years on herding and feeding in the forest, gathering and rounding up reindeer, free and fence calving, and calf earmarking. Both authors also made detailed field observations and had discussions with the herders during the period 2008–10, as part of the project “Reindeer forage and supplementary feeding in changing climate,” which studied not only past and present feeding practices but also the ecological effects of winter feeding on soil and vegetation (Turunen and Vuojala-Magga, 2011; Turunen et al., 2013).

### *Statistics*

The study uses statistics from the Reindeer Herders’ Association (RHA, 2013), the Finnish Meteorological Institute (FMI, 2013), and the Finnish Food Safety Authority (EVIRA, 2013). In addition to number of reindeer, we have used calf percentage (number of calves per 100 females as calculated in the autumn roundup). This figure is a good indicator of herd productivity and status since more than 75% of reindeer slaughtered are calves (RHA, 2013).

## FEEDING IN INTENSIVE HERDING

### *Early Practices*

The earliest winter feeding practices developed in association with the intensive herding practiced by Forest Sámi (Kortesalmi, 1996, 2007). Before the 18th century, the number of reindeer owned by households was small, and reindeer were used as decoy animals in deer hunting or as work animals, or were raised for slaughter. In summer, most reindeer grazed free; some were used in autumn in hunting and in late winter for transporting goods and people. Domestic reindeer were used alongside or instead of horses for the conveyance of people and goods such as firewood, hay, and grain from cultivated fields, as well as for the long-distance transportation (for a fee) of priests and government officials (Kortesalmi, 2007). The most active herders collected lichens in autumn when the ground was still unfrozen and gathered them into piles and patties, which were

TABLE 2. Winter feeding and herding practices in the Kuukas (southern), Oraniemi (central), and Hammastunturi (northern) forest herding co-operatives of Finland in 1850, 1900, and 1960–2010. Intensity of activity is estimated on the basis of interviews and earlier studies as (●) high (> 50% of reindeer), (○) low (< 50% of reindeer), or (–) no activity (ca. 0% of reindeer).

Co-operative	Feeding practice	1850	1900	1960	1970	1980	1990	2000	2010	Informant	Reference
Kuukas (southern)	Tree cuttings	●	●	○	–	–	–	–	–	Males 2, 9	Helle, 1982; Kortessalmi, 1996; Ruuttula-Vasari, 2004
	Pulling down lichens	●	●	●	○	–	–	–	–	Males 2, 9	Ruuttula-Vasari, 2004
	Tether calving	○	○	–	–	–	–	–	–	Males 2, 9	Kortessalmi, 1998; Hannula, 2000
	Calving fences	–	–	–	–	–	–	–	–	Males 2, 9	Nieminen and Autto, 1989
	Free calving	●	●	●	●	●	●	●	●	Males 2, 9	Nieminen and Autto, 1989
	Field feeding	–	–	–	●	●	●	●	●	Males 2, 9	Helle and Saastamoinen, 1979
	Feeding pens	–	–	–	●	●	●	●	●	Males 2, 9	Helle and Saastamoinen, 1979; Nieminen and Autto, 1989
Oraniemi (central)	Tree cuttings	●	●	○	–	–	–	–	–	Males 3–6	Ruuttula-Vasari, 2004
	Pulling down lichens	●	●	●	–	–	–	–	–	Males 3–6	Ruuttula-Vasari, 2004
	Tether calving	●	●	●	–	–	–	–	–	Males 3–6	Hannula, 2000
	Calving fences	–	–	–	●	●	●	●	●	Males 3–6	Hannula, 2000
	Free calving	●	●	●	●	●	●	●	●	Males 3–6	
	Field feeding	–	–	–	●	●	●	●	●	Males 3–6	Helle and Saastamoinen, 1979; Nieminen and Autto, 1989
	Feeding pens	–	–	–	●	●	●	●	●	Males 3–6	Helle and Saastamoinen, 1979; Nieminen and Autto, 1989
Hammastunturi (northern)	Tree cuttings	○	○	○	–	–	–	–	–	Males 1, 7, 8, Females 1, 2	Ruuttula-Vasari, 2004; Helle and Jaakkola, 2008
	Pulling down lichens	●	●	●	○	–	–	–	–	Males 1, 7, 8, Females 1, 2	Itkonen, 1948; Helle and Jaakkola, 2008
	Tether calving	●	●	●	–	–	–	–	–	Males 1, 7, 8, Females 1, 2	Hannula, 2000
	Calving fences	–	–	–	●	●	●	●	●	Males 1, 7, 8, Female 1	Nieminen and Autto, 1989; Hannula, 2000; Helle and Jaakkola, 2008; Vuojala-Magga et al., 2011
	Free calving	●	●	●	●	●	●	●	●	Males 1, 7, 8, Females 1, 2	
	Field feeding <sup>1</sup>	–	–	–	–	●	●	●	●	Males 1, 7, 8, Female 1	Helle and Saastamoinen, 1979; Helle and Jaakkola, 2008; Vuojala-Magga et al., 2011
	Feeding pens	–	–	–	–	–	–	–	–	Males 1, 7, 8, Female 1	Helle and Saastamoinen, 1979; Nieminen and Autto, 1989

<sup>1</sup> In Hammastunturi, field feeding includes herding with hay.

hauled home in winter to feed to the reindeer trained to transport people (Itkonen, 1948; Kortessalmi, 1996, 2007). Draught reindeer received extra portions of food: in addition to lichens, they were fed dried hay and leaves from bundled tree branches (*Betula* sp., *Salix* sp., *Populus* sp., and *Sorbus* sp.) and water horsetails (*Equisetum fluviatile*) harvested from lakes and rivers. Bread was important in luring reindeer from the forest, and once an animal became accustomed to eating bread (“a bread reindeer”) herders could get close enough to catch it. Herders skied around in the forest to attract the rest of the reindeer and in that way were able to gather them at the roundup sites in autumn (Itkonen, 1948; Kortessalmi, 1998, 2007). During difficult winters, herders pulled lichens off trees, cut down trees rich in lichens, and broke the hard snow cover with shovels to make digging easier for reindeer (Itkonen, 1948; Helle and Jaakkola, 2008) (Table 2).

Winter feeding has developed in close concert with small-scale agriculture. Most of the herders in Kuukas and Oraniemi have had meadows of their own, cultivated hay

fields, or both, and there is a long tradition among them of making and storing forage for cattle and domestic reindeer (Hiltunen, 1990; Kortessalmi, 1998, 2007). Even the northernmost Sámi combined reindeer herding with small-scale cattle farming from the late 18th century through the 1960s (Itkonen, 1948; Kortessalmi, 2007). In Kuukas, small-scale feeding based on forage collected from natural pastures or from hay or grain fields has been used since the winter of 1968–69 as a form of emergency feeding during difficult snow and weather conditions and when pastures are moldy (see also Helle and Saastamoinen, 1979; Hiltunen, 1990; Helle and Jaakkola, 2008). When forage (such as hay or leaves) was gathered for cattle for winter, it was collected for reindeer as well. The manager of the Kuukas co-operative (Male 2) recalled:

Even for the cows there was nothing more than a fistful of oat or barley; there were no minerals or medical substances. Farm animals were fed first, and reindeer after them; using trial and error, we tried all kinds [of

feeds]. We then started to get concentrated feeds for cattle, and that is when we started to try them out with reindeer, too; this is how there was a connection to agriculture.

The gradual extension of winter feeding from south to north was influenced by the Field Reservation Scheme, enacted in 1969. Under this system, the state paid farmers to leave fields uncultivated in the interest of reducing overproduction in the dairy sector. However, farmers were still allowed to feed the hay growing on these fields to reindeer. As a result, what used to be meadows and hay fields in the reindeer herding area have come to be used almost entirely for reindeer herding (Helle and Saastamoinen, 1979; Helle and Jaakkola, 2008).

#### Lichen Tree Cuttings

According to the interviewees in Kuukas and Oraniemi (Males 2–5), reindeer owners helped reindeer by cutting trees rich in arboreal lichens (*Bryoria* spp., *Alectoria* spp., *Usnea* spp.) when the digging conditions for terricolous lichens (*Cladonia* sp., *Cladina* sp.) were the most difficult, or when the pastures were poor in lichens because of high reindeer numbers (Itkonen, 1948; Alaruikka, 1964; Ruuttula-Vasari, 2004; Kortessalmi, 2007) (Table 2). Tree cuttings, or “reindeer cuttings” (*porokaski*, *luppokaski*, *luppohakkuut*), were used to feed reindeer, as well as to control them and herd them from one place to another, providing protection from predators in the process. Lichen tree cutting was most common from the late 19th century until the Second World War (Itkonen, 1948; Alaruikka, 1964; Ruuttula-Vasari, 2004; Kortessalmi, 2007). In the southern part of the herding area, large numbers of trees were cut down in one place (Fig. 3). For example, it was calculated that in Kuukas, 60 to 100 spruce trees per winter were felled for each reindeer in 1880, which means that 120 000 to 300 000 trees were cut in an area of 2400 to 6000 ha in a single winter (Helle, 1982). As a herder from Kuukas (Male 2) recalled, “Half a dozen men were cutting down lichen-rich spruces for the herd each day—whatever could be felled at breast height with an axe—...[providing] *karve*, *naava*, *luppo* [different species of arboreal lichens] by which reindeer were fed.”

Until the end of the 19th century, lichen tree cutting in Kuukas was connected to the slash-and-burn cultivation of spruce forest (*huuhtaviljely*), a practice that had come to the area from southeastern Finland. After reindeer had eaten the lichens from the spruce trees, either the felled trees and their tall stumps were left in place (Fig. 3a), or the area was drained, burnt, and sown with rye (Aikio and Helle, 1985; Hiltunen, 1990; Aarnio, 2001; Kauppi, 2003). Slash-and-burn cultivation wasted extensive areas of spruce forests, because the same area could be cultivated only once in a period of 40 or 50 years (Hiltunen, 1990). The destruction of forest by slash-and-burn cultivation and lichen tree cutting, as well as reindeer grazing, trampling, and peeling of



FIG. 3 (a) Lichen tree cuttings, photographed in summer 1911, in Posio, Finland. Photo: Olli Heikinheimo (Lusto, collection of Yrjö Ilvessalo). (b) Reindeer feeding on arboreal lichens in a cutting area. Photo: Forestry Museum of Lapland. (c) Winter feeding of reindeer in a feeding pen in Kuukas, northern Finland. A device for distributing food pellets has been attached to the back of the snowmobile. Photo: Minna Turunen.

their antlers on tree saplings, caused the earliest disputes between Forestry Board officials and peasant herders; these disputes began in the 1850s, as new demand for spruce saw logs and pulpwood increased their value. In response to this development, lichen tree cutting was regulated (Hiltunen,

1990; Ruuttula-Vasari, 2004), as reflected in a contract between parties engaged in forestry and in reindeer herding signed in Kuukas on 10 January 1911: “Reindeer owners must only cut dry, stunted, and thin trees (diameter less than 8 cm) from the pine- and spruce-dominant mires, must leave stumps no higher than 50 cm, and must trim felled trees” (Turunen and Vuojala-Magga, 2011). Lichen tree cutting gradually ceased, first in the south because of regulations, and throughout the region from the 1950s onwards because of commercial cutting, which left residue that attracted reindeer and provided them with a short-term source of lichens (Alaruikka, 1964; Ruuttula-Vasari, 2004) (Fig. 3b).

Lichen tree cutting was common among the Sámi herders in northern Sweden (Berg, 2010; Berg et al., 2011), but not among herders in Finland; in Hammastunturi, for example, arboreal lichens were pulled from trees using long rods. The informants from Hammastunturi (Males 1, 7, 8, Female 1) described how such rods (*lupokepit*), later equipped with a hinged blade, were used to cut off dead lower branches rich in arboreal lichens for the herd. Reindeer could hear the sound of an axe or a rod, and when snow conditions were difficult, they came to the feeding grounds from distances of several kilometers (Males 1, 7, Female 1). Harvesting lichens from trees was a common practice throughout the reindeer herding area (Itkonen, 1948; Helle and Jaakkola, 2008; Jaakkola et al., 2013).

#### *Feeding in Connection with Calving*

Tether calving was a widespread practice in Oraniemi and Hammastunturi (but not in Kuukas) until the beginning of the 20th century, and it continued in northeastern Finland until the 1960s (Hannula, 2000) (Table 2). In tether calving, pregnant reindeer were tied with a cord to a tree or a small log from April to the end of May. The reindeer were moved to a new lichen pasture with fresh snow two to four times each day until the birth of their calves, which were then earmarked. Tether calving ceased in the late 1960s because of forestry activity and the start of extensive and loose herding, which were brought about by the increased reindeer numbers after the war and the introduction of snowmobiles (Hannula, 2000; Helle and Jaakkola, 2008; Vuojala-Magga, 2010; Vuojala-Magga et al., 2011).

The use of calving fences on natural pastures in combination with feeding was developed in the 1970s from tether calving (Hannula, 2000) (Table 2). The calving fences used in Hammastunturi and Oraniemi most often cover an area of 15 to 25 ha and are located in dense spruce forests close to an open mire or body of water. Reindeer are separated into fenced pens in late winter just before the herd would spread out on crusted snow in search of arboreal lichens. In Hammastunturi, pregnant hinds are separated into sections of their own in the fenced area from March-April until the end of May, and one-year-old calves are also separated into sections of their own to ensure their well-being. Use of calving fences facilitates the earmarking of newborn

calves, as well as the feeding of pregnant hinds and their protection from predators (Anneberg, 2010). Calving fences have been less used in Kuukas, where free calving and summer earmarking are more common. In Hammastunturi, some of the siidas have earmarked calves within 24 hours of calving and let hinds with a calf free, but others have earmarked calves at the roundup in June. Herders used calving fences extensively in the mid-1990s because late snowmelts caused many newborn calves to perish on snow or in water holes (Vuojala-Magga et al., 2011; Vuojala-Magga, 2012). The interviewees for this study (Males 1, 3–7, Female 1) indicated that herders’ decisions to use calving fences rather than free calving have been based not only on snow conditions, but also on recent forestry cutting and predator densities.

## WINTER FEEDING IN EXTENSIVE HERDING

### *Reasons for Feeding*

In all three co-operatives studied, supplementary feeding of reindeer began in response to decreased availability of winter forage. Lichen-dominated winter pastures had become fragmented and declined in number and quality, mainly as a result of forestry industry activities. These changes in the landscape of winter pastures, combined with simultaneous high reindeer densities, intensified the grazing pressure on the remaining pastures (Jaakkola et al., 2013). In addition, lacking or incomplete seasonal pasture rotation systems have increased summertime grazing and trampling on winter pastures, which has led to overgrazing even in co-operatives with low reindeer densities (Kumpula et al., 2011). Since reindeer numbers are higher than winter pastures can sustain, herders have to supplement the animals’ diet with hay and pellets.

After the Second World War, the value of forests rose quickly, as the reparations that Finland had to make were paid partly by logging state forests (Heikkinen, 2006). After the 1950s, selective cutting was replaced by clear-cutting (all trees removed in a single harvest), followed by prescribed burning or scarification (topsoil turned over to expose mineral soil). Forestry activity has reduced both terricolous and arboreal lichens, and access of reindeer to pastures has been hampered as a result of tree cutting, site preparation, fertilization, and logging residues, as well as forest fragmentation caused by roads and ditches (Pruitt, 1979; Berg et al., 2008; Kivinen et al., 2010; Jaakkola et al., 2013). For example, in Kuukas the mean coverage of reindeer lichens in sub-xeric heath forests was 5.0% in the period 1976–77 but only 0.6% in the years 2002–04 (Mattila, 2006). In Oraniemi, the coverage decreased from 16.6% to 3.0% in the same period (Mattila, 2006). Logging changes the structure of forests, which in turn affects the amount of light and moisture available to lichens. Clear-cutting also increases snow density, which can further deteriorate digging conditions (Pruitt, 1979). The only nature



reserves in the region whose old-growth forests have not been used by the forestry industry are the Hammastunturi Wilderness Area (1825 km<sup>2</sup>) in Hammastunturi and the Natura 2000 sites of Koitelainen (4 km<sup>2</sup>) in Oraniemi and Litokaira (3 km<sup>2</sup>) in Kuukas.

Our informants (Males 1–8, Females 1–2) indicated that feeding was an acute response to difficult winters with ground icing and deep snow, often combined with moldy vegetation (Kumpula et al., 2000). These conditions led to severe reindeer losses in the periods 1968–69, 1972–77, and 1995–97 (Fig. 4a, b) (see also Helle and Saastamoinen, 1979; Hiltunen, 1990; Helle and Jaakkola, 2008). The calf percentage was at its lowest in Kuukas in 1975 (32%; no data available for 1968–69) and in Oraniemi in 1973 (15%) (RHA, 2013) (Fig. 4b). In Hammastunturi, it has ranged from 6% to 75% since the mid 1960s, reaching its lowest in 1973 (6%) and 1974 (18%) (Fig. 4b). An ice cover that forms over the soil and vegetation is the worst situation for pregnant hinds and calves less than one year old, since it often restricts the availability of forage for the whole winter. This shortage not only decreases calf percentages, but also increases the winter mortality of older reindeer. The situation in Kuukas in the winter of 1968–69 was very difficult, as one informant noted:

On 5 October 1968 deep snow covered soil which was already wet due to autumn rains, after which the lichens and lattermath became moldy. When the reindeer did not find anything to eat on the ground, they were forced to feed on lichens on the tree branches, which became inedible due to icy drizzle. Due to moldy ground vegetation and frozen lichens on trees, the amount of forage was inadequate, and the herds dispersed very badly, which hampered gathering the animals and driving them home for feeding (*piharuokinta*). The Kuukas co-operative could not afford emergency feeding or herding salaries, and reindeer owners took hay to forest reindeer at their own expense and without salary. Reindeer owners took reindeer home and, apparently due to the reindeer losses experienced in the winter of 1968–1969, learned how to provide for the well-being of their herds with pen feeding even during normal winters.

(Hiltunen, 1990:295)

The winter of 1996–97 was also a very difficult one, and in Oraniemi it became a decisive year for starting large-scale pen feeding (Males 3–6). That particular herding year coincided with the production of mixed reindeer feeds in Finland, which increased very rapidly thereafter (EVIRA, 2013) (Fig. 2).

#### Feeding in Recent Decades

Our interviews indicate that the herders acquire winter forage through their own or co-operative-level production, contract cultivation, or purchases from outside

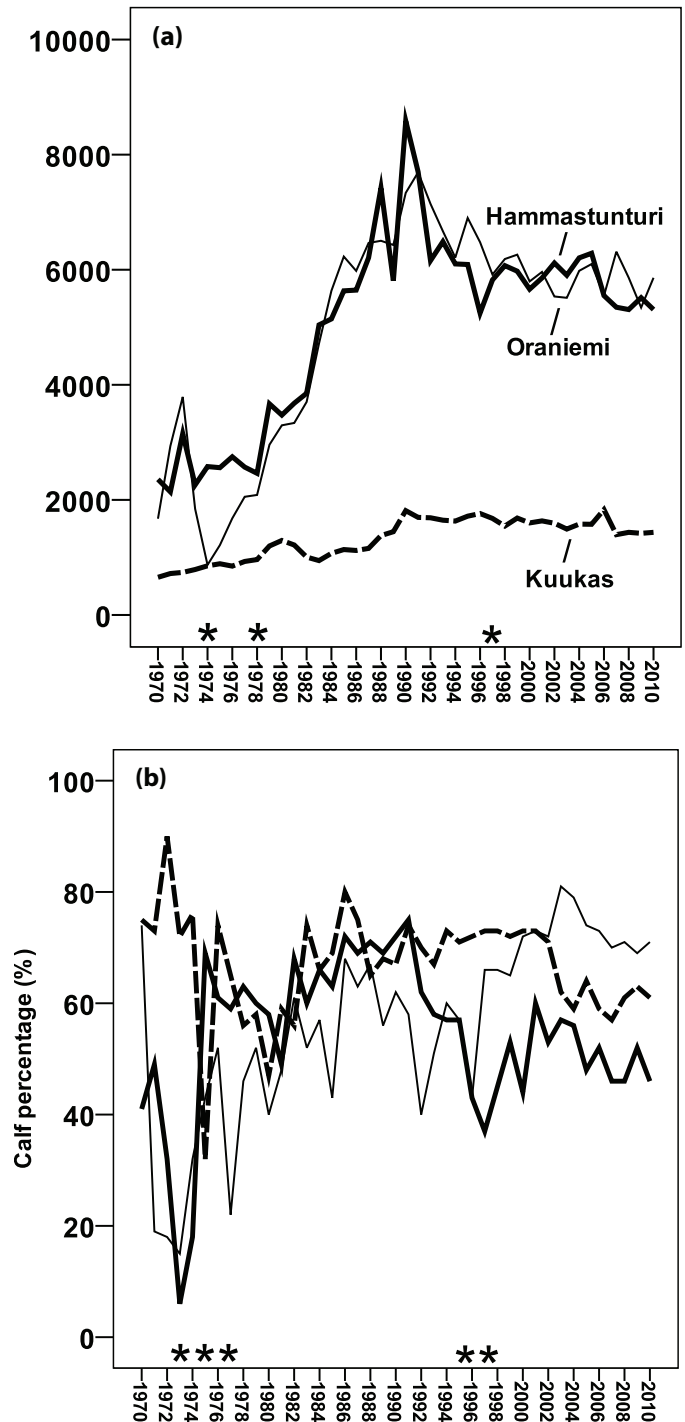


FIG. 4. (a) Reindeer numbers and (b) calf percentages (calves per 100 females) in Kuukas, Oraniemi, and Hammastunturi, 1970–2011 (RHA, 2013). Stars indicate the years of reindeer losses identified by the informants.

sources (Males 1–8, Female 1). In Kuukas and Oraniemi, the fact that the herders have had their own or rented land, machines, and forage production for cattle has facilitated the development of feeding. After the autumn roundup, 80%–90% of the reindeer, called “pen reindeer,” are herded into feeding pens (Fig. 3c) and the rest, the “forest reindeer,” are fed in the field. Mainly because of regular winter feeding and a relatively low predator density (Table 1),

the calf percentage during 1990–2000 was some 68% in Kuukas and 65% in Oraniemi (RHA, 2013) (Fig. 4b). The duration of the feeding period in the pens depends on the annual conditions: in winters with thin snow and no ground icing, reindeer stay in the pen for only two or three months, whereas in winters with a thick snow cover, ground icing, or both, they stay there for four or five months. In May–June, the reindeer give birth either free (Kuukas) or inside the calving fence (Oraniemi). The ratio of pen feeding to field feeding and the extent of labor used in forage production vary from family to family and winter to winter. The hierarchy of the herd is taken into account: in Oraniemi, for example, pens are divided into sections that enable feeding according to the age, sex, and fitness of the reindeer and the date when they were placed in the pen (Male 3). Particularly weak reindeer (*rautsi*) are fed with lichens, which are bought from travelling dealers or brought by the herders themselves from Ostrobothnia.

In Kuukas and Oraniemi, reindeer have adopted the permanent feeding areas as part of their pasture rotation. With annual feeding now in use for decades, it is the reindeer rather than the herders who “decide” when the animals start finding their way to the pens. When the availability of natural forage declines in early winter because of a thick snow cover or ground icing, reindeer spontaneously start moving into the pens. As one herder said: “Reindeer start gathering themselves” (Males 2, 3). The reindeer are so used to pen feeding that if the “pen reindeer” of the previous year are brought to the feeding pen by truck, the herder sees very quickly that “they settle down in the pen like they would at a familiar and safe place at home” (Male 2). In late winter, when snow has a crust on it (*sevää*) or “you can smell the ground” (Male 1), reindeer become restless and are released into the forest to feed on arboreal lichens.

The herders unanimously emphasized that “pen reindeer” are clearly tamer than “forest reindeer,” which have not learned to use the pens (Males 2–6). Some herders are worried about the increased tameness of reindeer that results from feeding:

It is good if reindeer are not too tame; tame reindeer can face many deaths. If an animal is a little wilder, it will not be caught so easily by large predators or poachers. A timid/less tame/shy reindeer is easier to herd using helicopters and ATVs. A tame reindeer is more work to move: it does not run; it comes back and stands under the spruces. If the herd is a little more timid, it starts running properly and moves along better. (Male 4)

In Hammastunturi, mainly because the few and weakly productive hay fields were at long distances, no special feeds were given to reindeer even during the most difficult winters. Even the idea of spending money for feeding reindeer was strange as late as the 1990s. “We knew that reindeer also eat concentrated feeds [pellets], but we did not know how to get them, since they had to be bought” (Male 1). Our interviews indicate that instead of using

feeding pens, most of the herders in Hammastunturi are returning to “the old system,” in which reindeer are herded from one pasture to another. They have modified this practice, however, in that they use supplementary forage in moving the animals and move them in more limited areas than previously. Winter herding in Hammastunturi thus includes “herding with hay” and, in April–May, either free calving or the use of a calving fence. Herders have noticed that the reindeer kept in calving fences are more docile (*hiljainen*) than “forest reindeer,” which calve free (Males 1, 7, 8, Female 1). In the 2000s the calf percentage in Hammastunturi has ranged from 44% to 60% (Fig. 4b). Mainly because of high density of predators (Table 1) and use of low-intensity winter feeding only, the figure has not greatly improved (Vuojala-Magga et al., 2011; Vuojala-Magga, 2012; RHA, 2013).

#### HOW HAVE HERDERS LEARNED FEEDING?

The years of reindeer losses at the end of the 1960s and the beginning of the 1970s stimulated the development of feeding, and the decreasing quality and number of winter pastures increased pressure to adopt the practice more extensively. Herders were forced to learn and adopt new feeding practices and methods. Their experiential and context-situated knowledge of feeding practices has developed in their everyday work. They have learned to feed reindeer through trial and error, which means that during the first years, emergency feeding was only partially successful. A herder from Oraniemi (Male 3) described the process as follows:

Feeding is learning all the time; it takes years to learn to feed reindeer in the forest and also in the feeding pen. One has to pay one’s dues: in the beginning, reindeer also died. Reindeer in varying conditions have to be put into different sections [of the pen], not all mixed—calves separately, weak animals and bucks separately. In this way it is easier to control the system, and there are not so many losses. Many [herders] put mixed herds in the pens. They tried to feed them, but they could not make hay themselves. Reindeer died; now fewer animals die in the pens.

This type of learning by doing is strictly context-situated: the condition and behavior of the animals from well-being to starvation is the context observed and analyzed by the herders every day. By using this knowledge, they have been able to learn and make correct decisions. They had two basic lessons to learn compared to cattle farming. First, the feeding of a weak reindeer has to be started gradually, with small quantities of palatable forage, preferably lichens, to allow the animal’s liver and rumen ecology to adapt to larger amounts of lichens and other feedstuffs; a sudden change in diet can cause digestive problems (Soveri, 1995; Nieminen et al., 1998; Nilsson, 2003). Second, the social

structure of the herd (a dominance-ranked hierarchy) has to be taken into consideration, because animals lower in the hierarchy may be prevented from eating by those in a dominant position if there is not enough feed or enough space in the feeding area (Nilsson, 2003).

In the learning process, the younger generation of herders—especially in the south—started to use feeding practices that their fathers had found to be sound, yet new practices and innovations arose through a method that might be termed “work teaching the worker.” As one herder from Kuukas said: “Knowledge may have been transferred also from son to father” (Male 2). In the case of practical and context-situated learning, it seems that the second-generation herders who are feeding reindeer in pens have better possibilities in the case of feeding practices, mainly because the basic mistakes have already been made by the first generation. As the learning process proceeds from one generation to another, after learning the basics of feeding, more resources become available for innovations and the fine-tuning of methods and techniques. The contribution of each generation thus occurs through *enskilment* and an education of attention (Ingold, 2001).

The inherent desire of humans to try to find better means to save time and lessen their workload has always prompted innovativeness; as one herder noted with humor, “a lazy person searches for easy solutions” (Male 1). Feeding reindeer can be time-consuming and often it has to be done by one person. Innovativeness has thus taken the form of technical know-how, which has been determined by practicality. Technical innovations, including devices for making and distributing pellets (Fig. 3c), cutting whole bales of hay, and distributing grass silage, have been introduced all around the herding area. A herder from Oraniemi (Male 3) described his daily feeding routines in the following way:

[I have] a forage feeder in the back of the snowmobile. Pellets are released into the feeder container from a silo, and a flap opens so that pellets flow down onto the snow; you do not need to use a dipper or bucket. Spreading [the pellets] like this is fast .... all [reindeer] will get some for sure; the pellets do not end up in one pile within a short distance... [In the case of hay], with the whole-bale system the weakest [reindeer] will get the least; this is why it is worth spreading hay so that all [reindeer] will get some, having loose hay in between the piles so that even the weakest [reindeer] will get some.

The knowledge of winter feeding practices was partly transferred orally (e.g., via personal experiences and second-hand stories) from south to north in the 1980s and 1990s. Innovations emerge in the discussions between the herders, their own observations, personal actions, and training during daily herding work (Polanyi, 1966; Polanyi and Prosch, 1975; Tsoukas, 2003; Vuojala-Magga, 2009, 2010). Our informants emphasized that the herders in the northern co-operatives have always been interested in knowing

the reasons for the good fitness and stable calf production of the southern herds despite the difficult winters. The practices and innovations in the south, which have developed in association with animal husbandry, have thus spread north either with knowledge from other herders, that is, an account of “how he or she has managed the difficult years” (Males 1, 7, 8, Female 1), or by applying old feeding practices in a new way. The interviews indicate that none of the new feeding practices have been adopted as such, because each herding co-operative—and even the individual herding units within a co-operative—has a special pasture type, microclimate, topography, herding practices, and pasture rotation, and these have ultimately determined the particular way in which herders, through trial and error, have learned to act.

## DISCUSSION

The winter feeding practices in the herding co-operatives studied in northern Finland have developed in association with intensive herding practices. Because the herds kept by Forest and Inari Sámi and Finnish peasants were smaller than those of Fell Sámi (Itkonen, 1948; Kortessalmi, 2007), small-scale feeding in the vicinity of settlements supported close contact between the herder and the reindeer throughout the year (Vuojala-Magga, 2010; Vuojala-Magga et al., 2011). Herders were very familiar with the circadian rhythm of reindeer, with the animals' feeding and lying times, and followed that schedule. Herding required a great deal of labor and time, because moving the herd from one pasture to another was done on foot or on skis (Itkonen, 1948). In southern herding co-operatives, intensive herding changed to free grazing during the Second World War, when the herds were reduced in size and essentially unmanaged for years (Helle and Jaakkola, 2008). The earlier close relationship between reindeer and herder was broken. Keeping reindeer alive during difficult winters by herding them with lichen tree cuttings and pulling lichens from the trees was less feasible after the war, because the land was fragmented and urbanized, and intensive forestry and agriculture had increased (Heikkinen, 2006; Kortessalmi, 2007; Helle and Jaakkola, 2008; Vuojala-Magga et al., 2011). In northern co-operatives, extensive herding replaced intensive herding with the introduction of snowmobiles, by the 1960s at the latest. Tight control over the herd became unnecessary, because herds could be gathered together in a short time with less labor. The reindeer became less tame as the herds grew larger and the main focus was transferred from their use as draught animals to meat production (Pelto et al., 1968; Müller-Wille, 1975; Helle and Jaakkola, 2008).

The strong increase in daily winter feeding since 1980 has brought back elements of intensive herding to the extensive herding practice that prevailed earlier. In intensive herding, animals are habituated to a human presence (Baskin and Hjalten, 2001) by the greater extent of interaction between reindeer and herder, whereas in extensive

herding, this interaction and habituation are less regular. In addition to the size and structure of the herds and the herding practice chosen (e.g., extensive vs. intensive; loose vs. tight herding), reindeer–human interaction is affected by feeding-related factors such as the frequency and regularity of feeding, length of the feeding period, and density of reindeer in the pen or calving fence. In old intensive herding, feeding systems were safer because reindeer relied mostly on natural winter pastures, and humans only assisted in feeding. The present feeding system, however, is more vulnerable, because the reduction in the number and quality of winter pastures has made reindeer more dependent on herders. A herder has greater responsibility, particularly for “pen reindeer,” which most often rely completely on the forage given them by humans during the winter feeding period. Because of these facts and the increased interaction between human and reindeer, the present herding system in northern Finland could be described as a combination of extensive and intensive practices (e.g., Helle and Jaakkola, 2008; Vuojala-Magga et al., 2011).

The interviews show that the daily contact between reindeer and humans during regular winter feeding for two to five months per year has changed the behavior of animals fed in pens. Traces of the old intensive herding can be seen in both the behavior of animals and the techniques used by herders. Today it is easy to herd reindeer into feeding pens in the southern and central co-operatives: the animals come to the pens in early winter when the availability of lichens decreases, just as the reindeer of Inari Sámi herders came to the houses of their owners at one time (Female 2). Reindeer have taken the permanent feeding places as a part of their annual pasture rotation, because they have learned the taste of pellets, which the herders interviewed thought was the greatest attraction for the animals in moving into the pen. According to the concept of affordance put forward by Gibson (1979), reindeer apparently learn to come to the feeding places because they know where the easy food is. Supplementary forage is an affordance offered to reindeer in much the same way as mosquito smokes on the fells were earlier (*porosavu, suitsu*) (Itkonen, 1948). The behavior of reindeer facilitates herders' work: old female reindeer, which have used the same routes to the pen for many winters, come first, and younger reindeer follow after them. The fact that reindeer themselves adjust the duration of feeding also means that they are in relatively good condition when they arrive at the pen. Therefore, special feeding can be targeted to weak or sick reindeer found in the forest, which are first fed an exclusively lichen-based diet (Soveri, 1995; Nilsson, 2003).

Our study shows that daily winter feeding and contacts between reindeer and humans in the southern and central co-operatives have in fact divided the reindeer into two sub-populations: herders talk about “pen reindeer” and “forest reindeer,” and these two groups differ in appearance and behavior. During the difficult winters, pen reindeer are in better shape, heavier, and have a rounded back due to the higher proportion of meat and fat on them that results from

frequent and regular feeding in the pen. Forest reindeer, on the other hand, might be in worse condition, lighter, and have a clearly visible spine. The herders' knowledge corresponds to earlier research findings that feeding pregnant reindeer with pellets increased both their body weight and the weight of their calves compared to free-grazing and lichen-fed reindeer (Säkkinen et al., 1999). Pen reindeer are also habituated to humans and more docile than forest reindeer. Looking at the bodies and vigilance behavior of the animals, an experienced herder can distinguish in the forest whether a reindeer has been fed in a pen, in the field, or on natural pastures. While the vigilance behavior of reindeer is affected by genetic factors and breeding, predator or hunting pressure, group size, and the presence of newborn calves, it is also greatly affected by the frequency of human contact such as that which occurs in feeding (Baskin and Hjalten, 2001; Reimers and Svela, 2001).

The informants pointed out that feeding has changed the behavior of reindeer so that when they are fed regularly by herders on a snowmobile track, or even by hand, they become habituated to a human presence. Reindeer that become too tame or habituated may complicate herding work: they become difficult to gather and move to the roundup sites because they are no longer afraid of the vehicles used by herders. These reindeer are mostly old, experienced females (“crooked” reindeer) or trained, castrated males (sledge reindeer), which can hide and do not join the herd at all. On the other hand, reindeer that are used to feeding follow supplementary forage and head to the roundup fences, and thus get other reindeer to follow them (Vuojala-Magga, 2011). It is also possible that tame reindeer may be more susceptible to traffic accidents than wild ones, because they tend to stay on the roads for longer periods of time. The number of reindeer killed annually by traffic has been approximately 1%–2% of the population. It was highest (ca. 5000 reindeer) at the end of the 1980s and in the early 1990s, when the total population was at its highest (Kemppainen et al., 2003), and some 4000 reindeer were killed annually during the period 2005–11 (Nieminen, 2012). The number of reindeer accidents peaks in November–December, because reindeer favor open highways over deep and soft snow and eat road salt and because darkness and icy roads make driving conditions difficult. Accident prevention has involved clearing roadsides, erecting fencing and warning signs, and putting out licking stones, as well as using repellent devices, reflectors, and navigation systems (Kemppainen et al., 2003; Nieminen, 2012).

The transition from lichen tree cuttings and pulling lichens from trees to large-scale feeding in the field and in pens has not been fast or painless for the herders, since one of the conditions governing the economic profitability of herding is indisputably that the reindeer should rely on natural forage in winter (Kortessalmi, 1998). Our interviews indicate that this transition has been based on the combined knowledge of herders from both reindeer herding and animal husbandry. Since each form of feeding and practice is based on context-situated practical knowledge, it means

that for the most part, verbal information cannot be applied by those who lack the basic skills of working with the animals and understanding their behavior. Most of the herders in Kuukas and Oraniemi had basic feeding skills, as they had their own forage production for cattle and domestic reindeer. Many feeding and treatment methods thus originate from animal husbandry. For example, a “tympanic reindeer” (*paljehtunut, ilmavatsainen, lunkkumaha*)—a sick reindeer that cannot eructate because of a foamy rumen (Antti Oksanen, pers. comm. 2013)—was treated much like a cow in extreme situations. It was given motor oil (in the old days) or cooking oil (today) and kept up walking or walking even on its back legs by holding its stomach as a form of first aid (Males 1, 7, 8, Female 1). For herders, learning to feed reindeer is comparable to learning to herd reindeer, but it does not involve just simple learning or knowledge transfer; instead it requires fundamental knowledge about reindeer (e.g., nutrition, digestion, and behavior during feeding), handling reindeer, and the characteristics of the herding district, as well as good and active cooperation across generations. The learning and knowledge transfer of herders can be described with the term “tacit knowledge”; that is, learning cannot be understood without “knowing the object and the process of doing,” which means being familiar with reindeer herding in practice (Polanyi, 1966). Personal doing and training are knowledge that cannot always be easily described in words.

Context-situated learning here means that each new situation in this process is evaluated where it occurs. Although herders’ knowledge is personal, the new practices adopted are negotiated and transferred in a direct and dynamic relationship with others in the herding communities where this knowledge will be meaningful. In this co-operation, knowledge is accumulated and exchanged in an increasingly meaningful manner (Nonaka and Takeuchi, 1995). Without a doubt, the elderly generation of herders has related its memories of feeding and treatment practices in cattle farming (see Lave, 1990, 1991; Lave and Wenger, 1996, 2001). Winter feeding of reindeer is thus based on traditional ecological knowledge (TEK) (Berkes, 1999), which according to developmental systems theory is not static, because the cumulative body of knowledge is modified as part of societal and environmental changes.

## CONCLUSIONS

Our study shows that the winter feeding practices of the three focal herding co-operatives have developed in association with intensive herding practices. Regular and frequent winter feeding and contact with humans have brought elements of intensive herding back to what was an extensive herding system. Feeding has changed the behavior of reindeer so that they have included permanent feeding areas as a part of their pasture rotation. Feeding has tamed reindeer and habituated them to humans. In this article we have argued that reindeer feeding is based on traditional

knowledge that includes old ways of caring for cattle and that innovations and learning to feed reindeer arise from context-situated knowledge. Herders have learned the feeding methods they use in their daily work mainly through trial and error. Although they have gained new knowledge through their observations and discussions with other herders, each has had to reconcile the feeding methods with his or her herding circumstances, that is, pasture types, topography, microclimate, and current herding practices.

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