Ancient wild reindeer pitfall trapping systems as indicators for former migration patterns and habitat use in the Dovre region, southern Norway

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Abstract: The distribution of ancient reindeer pitfall trap systems suggests an extensive regional migration of reindeer between seasonal pastures in parts of southern Norway. The migration routes were funnelled by natural barriers across a high, rolling mountain plateau. In the Dovre area, two pitfall trapping systems, totalling at least 1547 individual pitfalls, were identified and measured using a standard procedure and GPS to record location. Migrating reindeer typically cross over valleys between areas of higher ground and reindeer pitfall trap lines are therefore aligned along the valley, individually placed so that their long axis is perpendicular to the direction of the valleys. Pitfall trap systems for moose are also evident in the landscape. In contrast to reindeer, migrating moose mainly follow the line of the valley. Pitfall rows built for moose trapping are therefore placed mainly across the main direction of the valleys, and the individual pitfalls are also larger than those intended for reindeer. Migration and lichen utilization are important factors in reindeer adaption to limited food resources and existence in marginal mountain habitats. The trap systems and their ecological context support the hypothesis of ancient large-scale reindeer migration over the west-east Dovre axis between summer pastures and winter grazing land. This migration has ceased entirely because of increasing traffic on the north-south railway and highway and probably also because of reduced reindeer populations.

Key words: habitat use, *Rangifer tarandus*, trapping systems.

Rangifer, 28 (1): 79 – 87

Introduction

In addition to spears, bows and arrows, and more recently firearms, reindeer have been hunted in a variety of ways down the ages, not least using pitfalls and systems of fences which led the animals into traps, off precipices, or into lakes and rivers (Blehr, 1987). The use of trapping systems for *Rangifer* and other ungulates have been reported from Europe (Selinge, 1974; Mølmen, 1978; Mølmen & Skogland, 1980; Blehr, 1987; Indrelid, 1994; Mikkelsen, 1994; Barth, 1996; Vorren, 1998; Bang-Andersen, 2004; Mathiesen, 2005; Jordhøy, 2007), North America (Ingold, 1980; Gordon, 2004), Greenland (Rosing, 1956; Nellemann, 1969) and Africa (Andersson, 1856; Livingstone, 1857; Hester & Hobler, 1969).

This paper focuses on one mass trapping technique widely used in the mountain valleys of the northern part of the Dovre region in southern Norway (Fig. 1). This includes 4 modern reindeer management districts

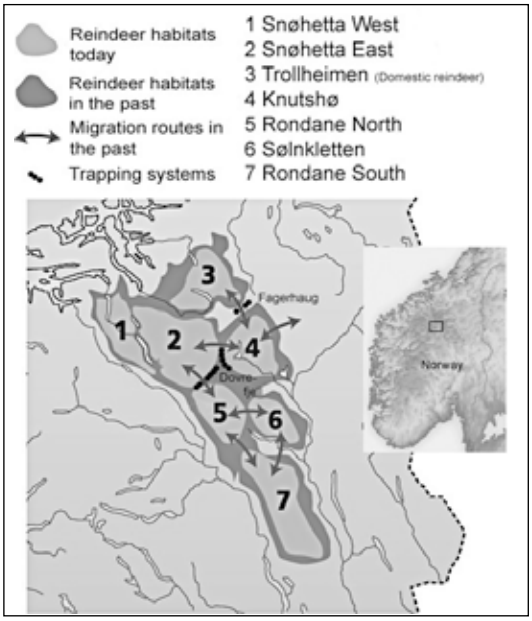

Fig. 1. The reindeer trapping systems at Dovrefjell and Fagerhaug. The former and present extent of suitable habitat, and apparent former migration routes in the Dovre-Rondane reindeer area, are indicated.

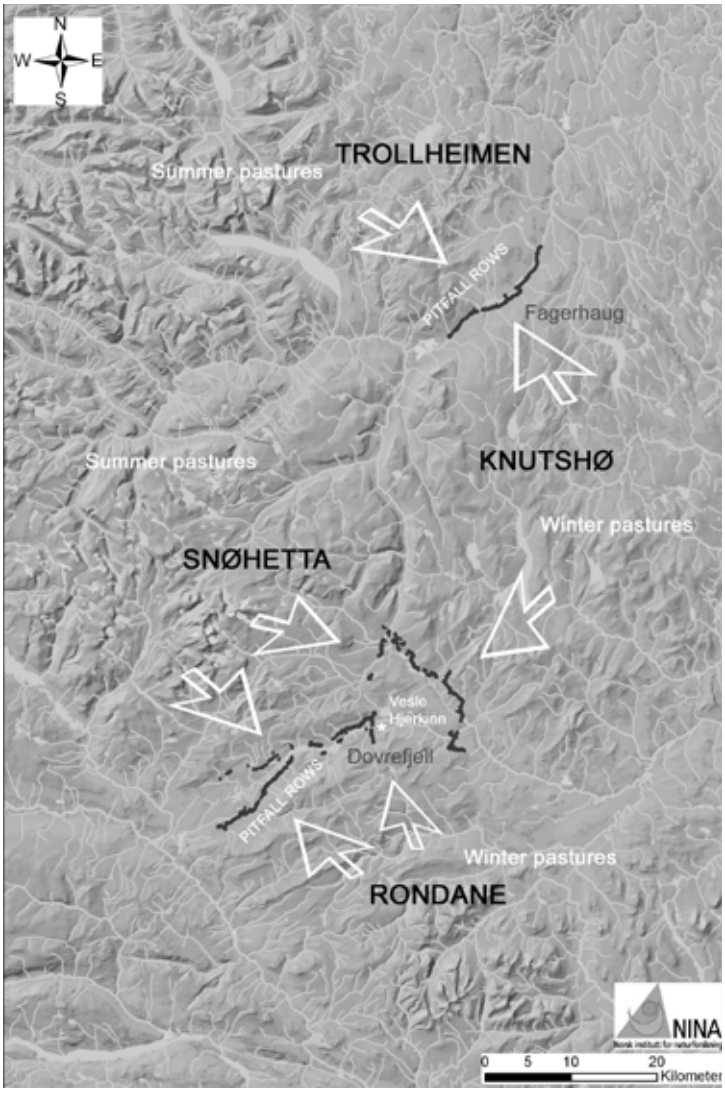

Fig. 2. The trapping systems at Fagerhaug and Dovrefjell, and apparent former reindeer migration routes between summer - and winter pastures.

(Table 1). In addition to traps described as indicators for former reindeer migrations, this paper also focuses on the underlying ecological factors which triggered former reindeer movements.

Study area and material

Previous studies have reported the locations of pitfalls in Dovrefjell and Fagerhaug (Mølmen & Skogland, 1980). The Dovrefjell system comprises several groups of pitfalls along the hillsides, while the Fagerhaug system is a single continuous row of pitfalls (Fig. 2). The average amount of precipitation at Dovrefjell is 700 mm/year; at Fagerhaug 500 mm/year.

Precipitation increases to the oceanic west, and decreases to the continental east. The western ranges are accordingly snow-rich and winter forage far more limited. The landscape features consist of varied and undulating mountain formations. Sparse, alpine birch forests interspersed with open heathery areas, are the main vegetation elements within the study area at Dovrefjell. Pinewood with heather on the forest floor dominates the study area at Fagerhaug.

We conducted surveys on foot by walking systematically east-west and north-south using an approximate 100 m x 100 m grid, to identify as much as possible of the two major trapping systems at Dovrefjell and Fagerhaug (Fig. 1, 2). Many pitfalls were overgrown and hence difficult to discover. Individual pitfalls were mapped using GPS, and a standard procedure was used to record relevant parameters including pitfall type, their direction, dimension, detailed topographical location, condition, terrain type and incline, degree and vulnerability to influence by man etc.). The data were subsequently transferred to land-use maps (1:5000) and digital 3-dimen-

sional terrain models, using the ArcView data-program (Jordhøy *et al.*, 2005).

Results and discussion

The main type of pitfall found in the two investigated systems now appears in the landscape as partly overgrown holes in the ground, usually with a visible oval ring mound around the hole (Figs. 3, 4). These are quite different from the conspicuous, stone bricked pitfalls also found in the area, which mainly occur singly and in small groups higher up in open mountain areas (Fig. 4). A total of 1547 pitfalls were recorded in the period 2001-2007; 1222 in the Dovrefjell system and 325 in the Fagerhaug system. There were only 12 stone bricked pitfalls in these two systems, all in the Dovrefjell system. Conditions on the ground and available construction materials appear to have been important factors influencing these different methods of construction. The study area surface geology is mainly gravels, with little stone available.

Table 1. Total area (km²), approximately population size (winter) and percentage distribution of seasonal pastures in four reindeer districts in the Dovre region (Rekdal, 1995; Fremstad, 1997; Gaare *et al.*, 2001). *1*: **Winter pastures** - trailing Azalea heath and three-leaved rush heath *(i.e. Loiseleurio-Diapensietum, Cetrarietum nivalis,* and *Juncion trifidi). 2*: **Spring/early summer pastures** - bilbery heath, mat-grass heath, dwarf birch heath *(i.e. Phyllodoco-Vaccinetum myrtillii, Nardetum chionophilum/Descampsio-Anthoxanthion,* and *Hylocomio splendentis-Betuletum nanae). 3*: **Summer pastures** - three-leaved rush heath whitout lichens, willow scrub, meadow snow patch *(i.e. Chiono-Juncetum trifidi, Rumici-Salicetum lapponae/Salicetum ulmariosum alpicolum, Salicetum deschampsietum,* and *Ranunculo acris Anthoxanthion/ Ranunculo-Poietum alpinae). 4*: **Autumn/fall pastures** - dwarf willow snow patch *(Cassiopo-Salicetum herbaceae)*, rich and poor bryophyte snow patches belonging to the order *Salicetalia herbaceae*, rich or poor fens belonging to the orders *Scheuchzerietalia palustris* and *Caricetalia nigrae. 5*: **High mountain areas, scree, glaciers, lakes etc.**

Reindeer area	*Area km²*	*Population size*	*1*	*2*	*3*	*4*	*5*
Snøhetta East and West	3400	2100	17	21	6	11	44
Trollheimen*	2200	1600*	13	32	8	22	25
Rondane North	1200	1500	33	17	10	7	33
Knutshø	1700	1400	41	26	7	18	9

* Domestic reindeer herd.

A large proportion of the main pitfall type that was found in the two systems were excavated/built in moraines/areas with moraine soil (Figs. 3, 4). Wood (birch and pine) was used in the pitfall wall-constructions (Amundsen *et al.*, 2007). A wood fragment from a pitfall located in the south of the Dovrefjell

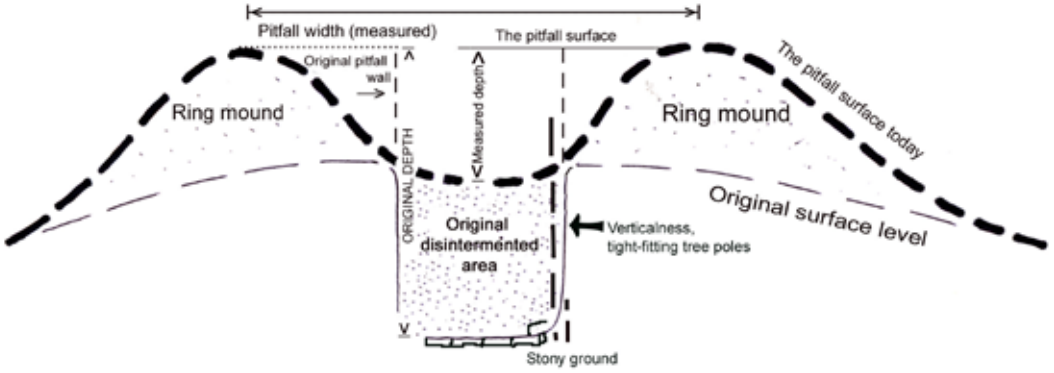

Fig. 3. Original and present shape displayed in a schematic cut of a pitfall. Models of the current surface shape of pitfall remains indicating how measurements were taken (Jordhøy, 2005).

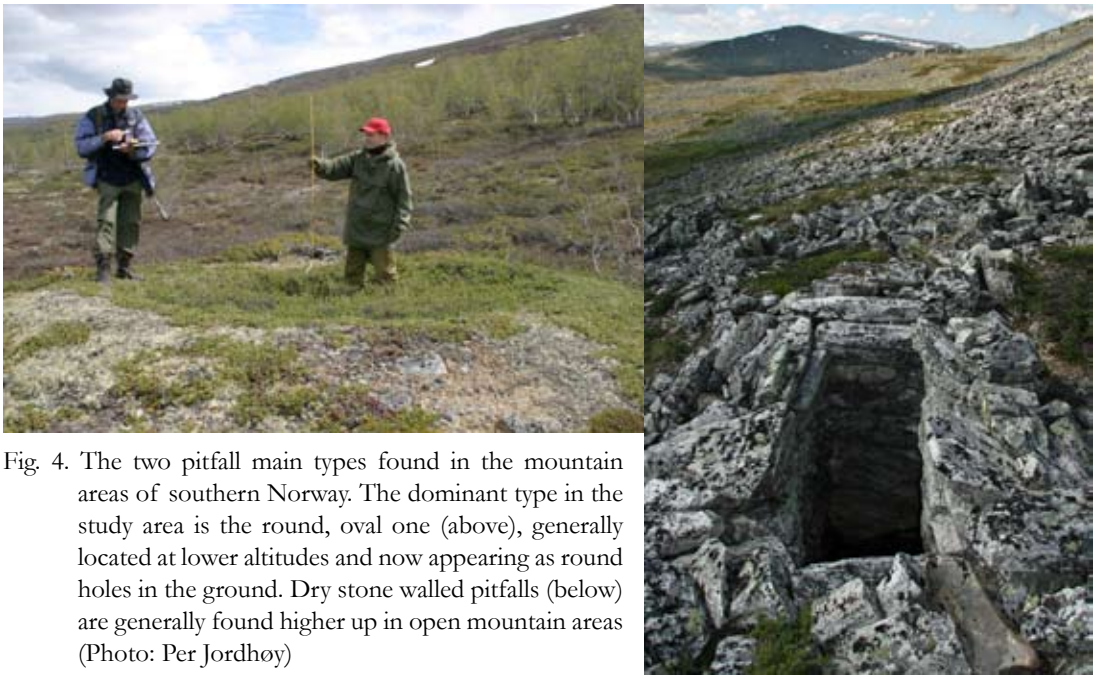

Fig. 4. The two pitfall main types found in the mountain areas of southern Norway. The dominant type in the study area is the round, oval one (above), generally located at lower altitudes and now appearing as round holes in the ground. Dry stone walled pitfalls (below) are generally found higher up in open mountain areas (Photo: Per Jordhøy)

system, as well as ^{14}C datings from the same area from similar trapping systems and from settlements (Barth, 1996; Weber *et al.*, 2007), indicate that the large-scale pitfall systems and funnel-shaped traps were mainly in use in the Viking Period and early Middle Ages (Jordhøy, 2005). The Dovrefjell system (900-1000 m a.s.l.) appears in groups of pitfall rows, while the Fagerhaug system (500 to 600 m a.s.l.) consists of a continuous row (Fig. 2). *Individual* reindeer pitfall traps are aligned so that their long axis is perpendicular to the main centerline of the valley. The *line* of traps runs parallel to the line of the valley (Fig. 5).

Measured pitfall dimensions varied considerably (Fig. 6). The average length in the bottom of the pitfalls was about 130 cm. (Fig. 6). The depth varied considerably and was about 100 cm (probably as a result of the pitfalls deterioration). The pitfall top was a little larger in the Fagerhaug system than in the Dovrefjell system (Fig. 6). The average length at the top was measured to about 430 cm in the Fagerhaug system and 500 cm in the Dovrefjell system. Average distance between the pitfalls in the Dovrefjell system was about 38 m.

The conspicuous variation in pitfall dimensions may suggest that both reindeer and moose were caught in these trapping systems. However, the direction and dimension of the pitfall rows, in relation to landscape topography, indicate that the systems were mainly built for reindeer trapping. Pitfall rows built for moose trapping usually lie mainly across the direction of the valleys, as moose movements mainly follow the line of the valley (Jakobsen & Andersen, 1992).

The majority of large scale trapping systems known in the region date from the same period (Late Viking period – early Middle age) (Mikkelsen, 1994; Barth, 1996; Jordhøy *et al.*, 2005; Jordhøy, 2007; Weber *et al.*, 2007). However, these systems were probably also used both earlier and later. The trap remains evident today represent the maximum extent in this trap era. The pitfall systems probably developed over several centuries.

Many people must have been involved in

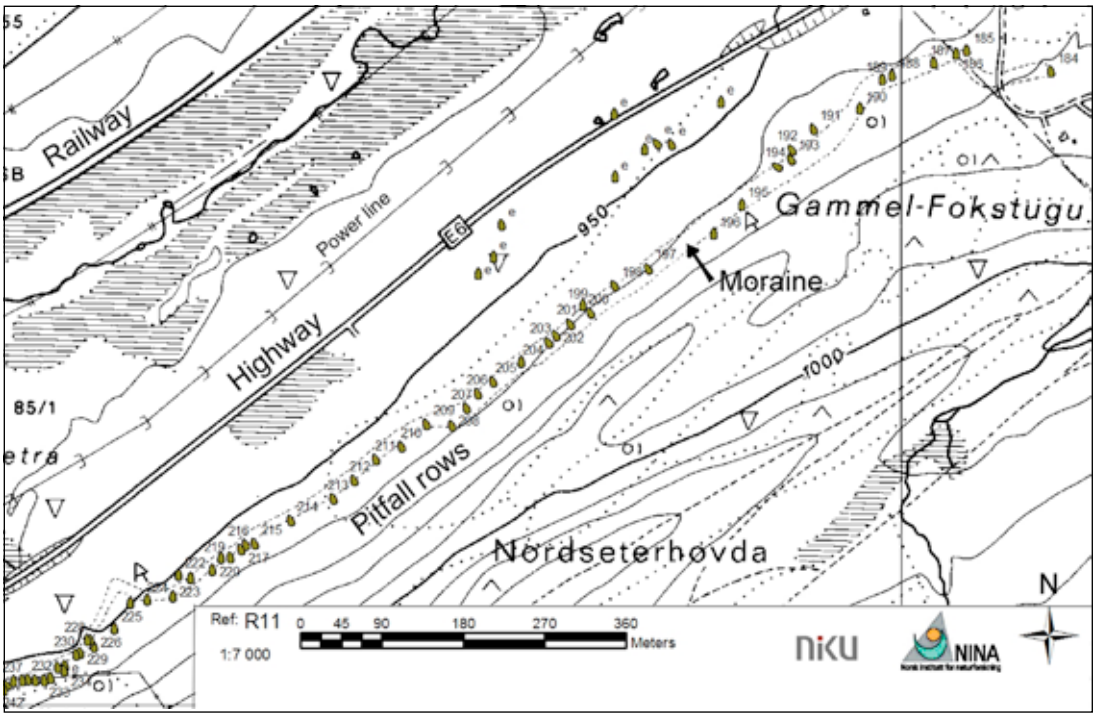

Fig. 5. Details from the south-western part of the trapping system at Dovrefjell. Most of the pitfalls are placed in longitudinal moraines. The *individual* pitfall traps are aligned so that their long axis is about 90 degrees to the the line of the valley. The *line* of traps runs parallel to the line of the valley (Jordhøy, 2005).

trapping operations since the sites required well-organised construction, maintenance and operation. The potential catch in these extensive trap systems suggests that the wild reindeer population must, at least periodically, have been considerable larger than than the few thousand reindeer roaming in the fragmented ranges today. Dating evidence suggests clear fluctuations in trapping activity (Mikkelsen, 1994), which probably reflect corresponding fluctuations in the reindeer population influenced by trapping, predators or grazing conditions, or a mixture of all three factors.

Vesle Hjerkinn, a settlement near the Dovrefjell trapping system (Fig. 2), was a farmstead and an important moun-

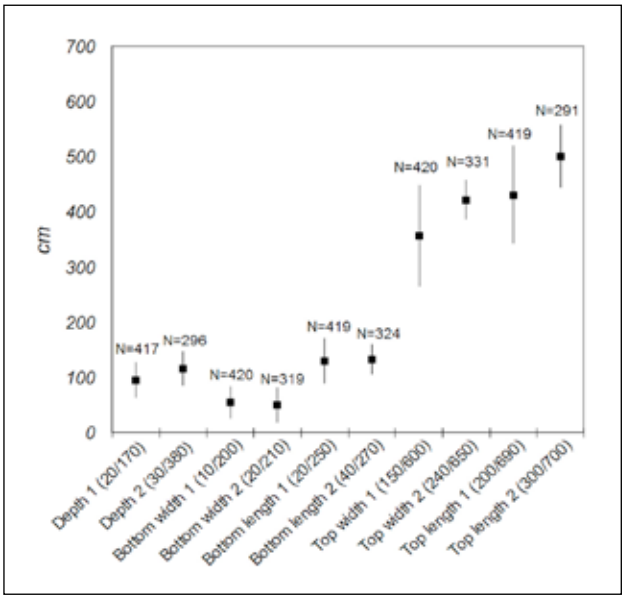

Fig. 6. Mean ± standard deviation of pitfall dimensions in the Dovrefjell - (1) and Fagerhaug (2) systems (*N*=418/296). Min. and max. values in cm are shown in parentheses.

tain lodge for the king in the late Viking- and early Middle Ages (Weber *et al.*, 2007). Historical data and archaeological investigations show that the king had great economic interests in reindeer hunting here, since antlers, skin, etc. were important exports and sources of income (Weber *et al.*, 2007). 88% of all animal bones founds at Vesle Hjerkinn originate from reindeer, and bones from bucks dominate this material (>60%). Presence of large buck antlers, and finds of such material in Oslo and Trondheim from the same period, suggests antlers had export importance. The use of antlers use in comb production in the Middle Ages is well known (Weber *et al.*, 2007). In addition, reindeer meat was consumed both at Vesle Hjerkinn and in surrounding rural communities. Analysis of antler- and bone material from Vesle Hjerkinn and some other similar settlements in the region, indicates that almost all the trapping activity took place in the summer/autumn (Weber *et al.*, 2007; Mikkelsen, 1994). None of the finds indicate reindeer trapping activity during westbound spring migration in the above mentioned periods (Anne Karin Hufthammer, pers. comm.). Pitfalls filled with remaining winter snow and ice during the spring migration periods may also have made hunting impossible, at least in the Dovrefjell system.

What are the main underlying factors for the east-west migration in the Dovre – Rondane region? Migration and lichen utilization are known to be important factors in reindeer adaption to limited food resources and existence in marginal mountain habitats (Skogland, 1990).

The reindeer grazing resources of the region have been studied in detail (Gaare *et al.*, 2001; Rekdal, 1995). These, and other results (Skogland, 1986; 1989; 1990), suggest that the winter grazing grounds would have been in Knutshø and Rondane , east of the Dovre axis (modern railway line), while the summer grazing grounds almost entirely were located in Snøhetta and Trollheimen, west of the same axis (Table 1.). Important main elements in the summer habitats include a varied topography combined with a high amount of precipitation/snowcover. Because of this, reindeer usually have access to germinating herbs throughout the summer period as the snow cover retreats to higher altitudes. These herbs are rich in protein, constitute a very important food resource, and are important for reindeer body growth. The summer habitats contain also a considerable proportion of high mountain areas with many peaks and glaciers and much scree - increasingly so westwards towards the coast. These stony, high altitude landscapes have poor vegetation cover and corresponding grazing conditions with only a modest and scattered occurrence of herbs. The importance of these areas for reindeer foraging are therefore strongly limited. Plants at lower landscape levels obtain runoff water from these higher altitudes and are therefore less exposed to drying. This situation affects forage quality through the summer season.

Despite the poor vegetation cover in the high altitude grounds, they still constitute an important element of the reindeer summer habitat. Their wind exposure combined with patches of snow cover and glaciers (prevailing in shade slopes), form important cool niches in warm periods when the reindeer are exposed to insect stress and parasite attacks. Common, problematic parasites are the two reindeer bot flies, the warble fly *(Hypoderma tarandi)* and the nose bot fly *(Cephenemyia trompe)*. Both species have reindeer as their larval host and in calm and sunny weather, they can fly even at temperatures down to ca. 10 °C (Anderson & Nilssen, 1996; Hagemoen & Reimers, 2002). Dipterian blood suckers also contribute to stressing reindeer in summertime.

Finds of a large number of old, lost hunting arrows in these high altitude areas, indicate

reindeer presence in earlier periods (Farbregd, 1991). Nowadays annual reindeer calf counts (groups of hinds, calves, yearlings) in June-July are usually carried out in periods of fair weather (high barometric pressure), and at that time flocks are often observed in such snowcovered peak areas (Jordhøy *et al.*, 1996). At the same time we have observed single buck groups in the higher, western- and outermost parts of the habitat.

It is assumed that the main calving grounds in the region also were located towards the west, near to the summer grazing lands (Skogland, 1990). This was probably an important triggering factor for a western early spring migration, from inland winter pasturages in Rondane North and Knutshø (Fig. 2). A similar seasonal migration is known to have taken place at Hardangervidda (Strand *et al.*, 2006a) further south in southern Norway.

The marginal winter grazing land in Snøhetta/Trollheimen is found in the eastern districts and represents 17%/13% of the total habitat. Uncontrolled reindeer population increase and overgrazing (of lichen resources) in Snøhetta in the 1950s and 1960s produced food stress/winter starvation and trigged migration over the Dovre axis and into winter grazing land in Knutshø throughout the period 1956-1984. These movements took the reindeer through the earlier pitfall trap lines (Mølmen & Skogland, 1980). Since then the population has been controlled at a low level to hold numbers within the foraging potential of winter grazing resources in the Snøhetta area.

In easterly, dry areas like Rondane North and Knutshø, lichen (winter grazing resources) have good growth conditions and thus are common and well-distributed. At the same time, green plant growth conditions are limited in the summer period (particularly in Rondane North), because of restricted precipitation. Rapid snow melting leads to drying out of the landscape in the late summer period, and accordingly diminished plant growth and protein value in plants. While these areas have considerable high mountains (particularly in Rondane North), the much lower abundance of summer snowfields and glaciers make them less functional for reindeer in many ways, compared to the humid high mountain areas in Snøhetta and Trollheimen. The westernmost part of Knutshø is a little more humid and contains high mountain areas with intermediate levels of summer snow cover.

The two trapping systems dealt with in this paper constitute a small part of the total number of reindeer trapping systems in the Dovre – Rondane region (Barth, 1996; Mølmen, 1978). However, taken together with the ecological situation the location of the two systems supports the hypothesis of ancient main migration corridors over the Dovre axis between summer- and winter grazing land. This east-west migration was funnelled by natural barriers through relatively restricted areas of high, rolling mountain plateau (Fig. 1, 2) and this migration has now stopped entirely, mainly because of increasing highway- and railway traffic in the last 100 years (Skogland, 1986; Jordhøy, 2001). Artificial control of the population intended to keep it within the limits of grazing availability in Snøhetta and the surrounding wild reindeer districts, has probably also been a contributing cause to absence of migration in modern times.

Acknowledgements

Many thanks to my field technicians Endre Hage, Runar Hole, Frode Ålbu, Odd Enget and the volunteers whose assistance made this study possible. Thanks also to Duncan Halley for language comments, and Frank Hanssen for map supports. Thanks also to Roy Andersen, Kari Støren Binns, Eldar Gaare, Christian Nellemann, John Olsen and Olav Strand at NINA for informal discussions and support. This study was funded by the Directorate for Nature management and the Provincial administration in Oppland, Hedmark and Sør-Trøndelag provinces.

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Manuscript received 13 February, 2008
accepted 15 May, 2008

Gamle fangstgropsystemer for rein som indikatorer for tidligere trekkmønster og habitatbruk i Dovreregionen, Sør-Norge

Abstract in Norwegian / Sammendrag: Utbredelse av fangstgropsystemer for rein tyder på at det har vært et regionalt trekkmønster mellom ulike sesongbeiter innen deler av Sør-Norge. Trekket har vært styrt av naturlige barrierer over et variert, bølgende fjellandskap. I dovreområdet er to store fangstgropsystemer på totalt minst 1547 fangstgroper registrert og kartfestet etter en standard prosedyre. Migrerende rein har krysset over dalsenkningene mellom høyere fjellpartier. Fangstgroprekkene har derfor vært anlagt langs dalbunnen og retningen på selve gropene går overveiende på tvers av dalretningen. Fangstgroper for elg er også vanlig i regionen, men i motsetning til fangstgropene for rein går retningen på disse oftest parallelt med dalretningen. De er også gjennomgående større enn gropene som har vært beregnet på reinfangst. Vandring og utnyttelse av lav som vinterbeite er viktig faktorer i reinens tilpasning til et skrint næringsgrunnlag og marginele habitater i fjellet. Fangstsystemene og økologiske holdepunkter/faktorer støtter hypotesen om et tidligere trekk øst/vest over dovreaksen, mellom sommerbeiter i vest og vinterbeiter i øst. Trekket her har nå opphørt helt på grunn av trafikkårene og tilhørende ferdsels- og trafikkøkning over Dovre. En redusert villreinbestand har også trolig medvirket til dette.