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"When You Think Like the State"

The Political Ecology of Pastoral Modernization in Finnmark, Norway

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DECLARATION

I, Erik Johan Langfeldt Borgenvik, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature……..

Date……

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The submission of this thesis marks the end of 5 years of studies at Noragric and the Norwegian University of Life Sciences.

SUMMARY

Reindeer herding in Norway is an indigenous pastoral livelihood exclusive to the Sámi people. The regulation of this source of livelihood by the Norwegian state intensified with the introduction of a new law and policy from the late 1970s. As a result of this increased state control and management of the reindeer industry, the Ministry of Agriculture and Food, working through the Reindeer Herding Administration, has in particular focused on increasing the sustainability and productivity of the industry. This has led to an overall aim of increasing meat production through implementing a bioeconomic model called the Røros model. The model, which has been promoted through economic incentives and information work entails reductions in reindeer numbers, the altering of herd structures and increased calf slaughter. Many reindeer herders have contested these recommendations. They claim that the model undermines the traditional knowledge that has been, and still is, accumulated and reproduced through experience in the herders' own social institutions

Through qualitative interviews with reindeer herders in Finnmark I have explored such indigenous perspectives on herd structuring. Findings revolve around the following key issues: the products derived from reindeer husbandry; the importance of herd structure for coping with critical climatic events; and the role of the various animal categories. While the scientific criteria of the Røros model are presented as universal criteria by the promoters of this model, the herders own criteria seem to result from local contexts, with specific adaptations conditioned by heterogeneous landscapes.

The second part of the thesis is a quantitative study, which assesses the scientific uncertainty behind the claim that reindeer herding operates in a stable and predictable environment, which is a premise of the Røros model. I argue that methodology applied by the Ministry and the Reindeer Administration for calculating maximum stocking rates is unreliable.

The thesis is a contribution to the political ecology of environmental governance in Norway. Political ecology provides critical tools for analyzing human-environment issues. Through perspectives provided by Scott (1998), Li (2007) and Ferguson (1994), the management of reindeer husbandry is understood as a process that simplifies reality to create legibility and to implement policy through technically defined criteria. This is a process that expands the power of bureaucracies and which promotes scientific solutions in a narrow and technical sense to problems that are imbued with questions of politics and power.

The thesis is not an argument against the Røros model as such. The thesis is rather a critique of the model's claimed general applicability. I want to direct attention to the importance of the *local context* and the *expert knowledge* that the herders hold about their own landscapes.

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MAP OF THE STUDY AREA

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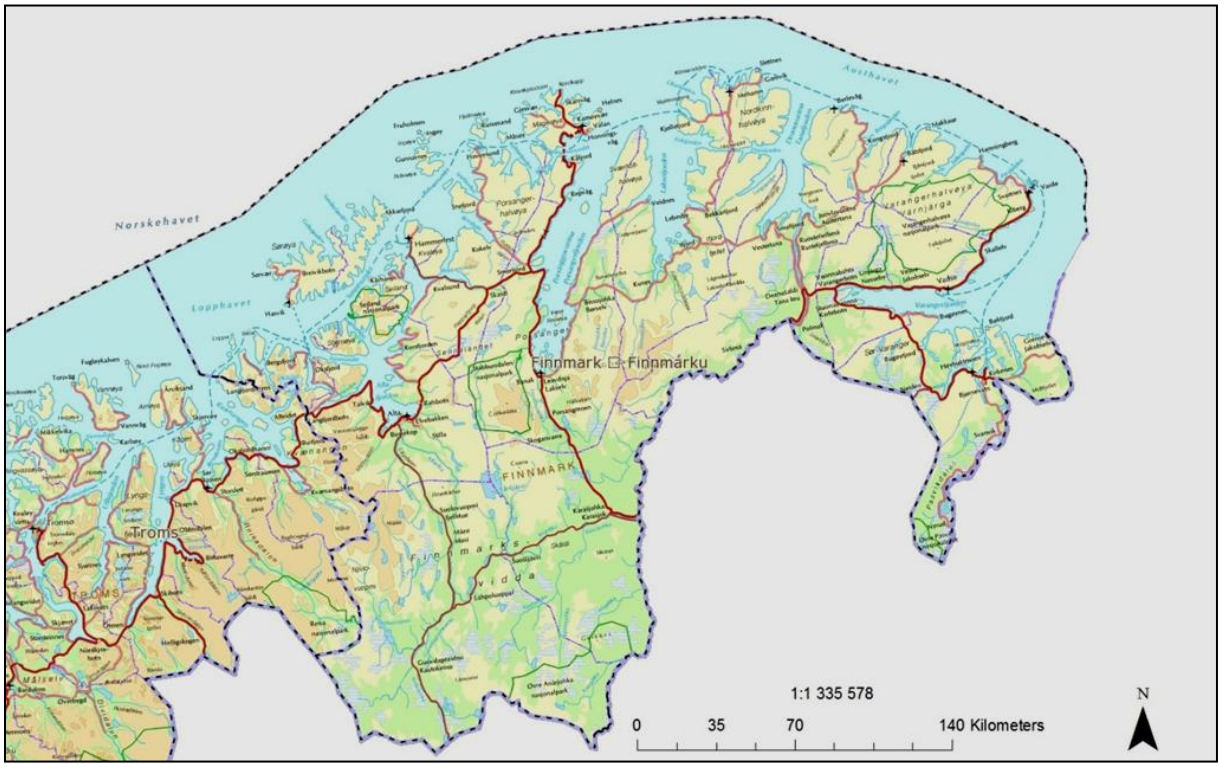

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1. INTRODUCTION

Reindeer herding is the profession and way of life for more than 20 indigenous people across the Arctic and sub-Arctic (Staaland et al. 1995). Among these are the Sámi people, the indigenous population of the Northern Cap. Although no official figure exist, the Sámi population of Norway is an ethnical minority estimated between 50000 and 80000 people (Gaski 2013). The cultural region traditionally inhabited by the Sámi people, referred to as Sápmi, spans northern Norway, northern Sweden, northern Finland and northwestern Russia. The Norwegian branch of Sápmi stretches from Hedmark in the south to Finnmark in the north. There are a number of time-honored Sámi livelihoods, the most notable among them being fisherman farming, river fishing and reindeer herding. The latter is today a growing profession (Angell et al. 2014) exclusive to the Sámi people, performed on half of Norway's land surface (Staaland et al. 1995). In 2012, 3097 people were employed in Norwegian reindeer husbandry (Reindriftsforvaltningen 2013). 2359 of these worked in Finnmark, the largest reindeer herding region in Norway. Reindeer herding in Finnmark is based on annual migrations between season-specific grazing lands at the coast and inlands. Reindeer pastoralism in Finnmark has probably existed in its current form, based on seasonal migrations, for 150-200 years (Bjørklund 2013). A number of boarder closures in the 19th century hampered the original system, which was based on transboundary migrations. When faced with such challenges, reindeer herding has proven to be an immensely flexible and adaptive livelihood (Sara 2006).

Reindeer herding have for many years been regarded as a problematic field for the state-led management authorities. The discourse regarding contemporary reindeer herding in Finnmark is centered on how overstocking allegedly has caused land degradation, declining economic returns and land conflicts (Benjaminsen et al. 2015a forthcoming). This has resulted in policies, warranted by a unified Norwegian parliament, that have attempted to stabilize the reindeer population within estimated sustainable limits. The policies have not been entirely successful, and the reindeer administration has been heavily critiqued by the Office of the Auditor General of Norway for not fulfilling the objectives set in the policies (Riksrevisjonen 2012). The appropriateness of the official policies are highly disputed among reindeer

herders, and certain scholars have suggested that the industry needs flexibility instead of rigid policies (Marin 2006; Reinert et al. 2010).

One important strategy aimed at reaching the overall goals of sustainability in the reindeer herding industry has been the promotion of a bioeconomic model known as the Røros model. The model entails altered sex and age structures in the herd as well as a slaughter strategy based solely on calves. The model is supposed to maximize meat production per animal in the winter herd. Although the model was not formalized before the end of the 1990s, calf slaughter and herd restructuring has been promoted by the state for almost five decades. Economic incentives were introduced with the reindeer agreement in 1976 and information work has been carried out through the quarterly publication *Reindriftsnytt* since 1967 (See e.g. Villmo (1967b) and (Villmo 1967a).

The approach taken by the model is radically different from a more traditional herd structure where the male to female ratio is higher and non-productive animals like castrates and sterile females are valued. It has been claimed that the Røros approach is in opposition to an indigenous understanding of reindeer husbandry and that it was developed in light of a fordist mass-production agricultural logic that was arcane to the reindeer herders (Reinert 2006). Among bureaucrats and politicians on the other hand, herd structuring according to the Røros-model is seen as the only solution, and the policies were strengthened through the reindeer agreement for 2014/2015.

Little interdisciplinary research has previously been carried out on herd composition in the reindeer industry of Finnmark, although such policies have cultural and social dimensions. This research will therefore attempt to fill parts of this knowledge gap by investigating Sámi perspectives on herd composition and how these perspectives are related to the management policy exemplified by the Røros-model. The thesis will also look closer at two of the biological paradigms that have formed the reindeer policy: Sustainable yield and equilibrium ecology.

The research process and analysis was guided by political ecology, a dynamic and critical perspective employed by many social scientists when studying environmental management. Studies in Political Ecology, as opposed to apolitical ecologies, recognize that environmental governance issues often are permeated by vested interest and subjectivity. Political ecologists therefore often take a more explicitly normative stance on such issues than other researchers

(Benjaminsen & Svarstad 2010; Forsyth 2011). Studies in political ecology often focus on asynchronous power relations between winners and losers in political processes (Robbins 2012). This makes political ecology relevant for reindeer husbandry in Finnmark.

1.1 Objectives and research questions

The objective of this thesis is to critically investigate what role bioeconomic models developed for the optimization of production promoted by the Norwegian authorities plays in the husbandry of reindeer herders in Finnmark. The objective is conceptualized through the following research questions:

- How do Sámi pastoralists in Finnmark evaluate the appropriateness of the herd structures and slaughter strategies that the Røros model promotes?
- What are the social and ecological premises of herd structuring and how do these presumptions relate to reindeer herding in Finnmark as seen from the perspective of the pastoralists?
- How does the official management of reindeer husbandry, exemplified through bioeconomic models for increased production resonate with wider theoretical debates in political ecology concerning the relationship between local land managers and state management authorities?

1.2 Structure of the thesis

Chapter 2 introduces political ecology as a theoretical perspective and further discusses its relevance for the case of reindeer herding in Finnmark. The chapter also expands upon ontological considerations and some of the critique that has been raised against political ecology.

Chapter 3 presents the background of the thesis. It includes sections on the biology of reindeer, judicial developments, governance structures, the social organization of reindeer herders and the development of the Røros model.

Chapter 4 presents the qualitative and quantitative methodology that was used in the thesis.

Chapter 5 gives an introduction to the informants and their general attitudes in addition to a section that focus especially on two of the informants who had reorganized their herding.

Chapter 6 discusses possible consequences of herd structuring for the products that are derived from reindeer herding based on the findings from the interviews.

Chapter 7 discusses the role of the buck in Sámi reindeer herding and its relationship to herd structuring based on the findings of the study.

Chapter 8 discusses the relations between herd structuring and supplementary feeding in light of the interview findings. In addition to this, the chapter outlines how herd diversification is a tool that can buffer unpredictable climatic events.

Chapter 9 deals with the quantitative data analysis. This chapter discusses the uncertainty behind the sustainable yield and equilibrium models that have underpinned reindeer herding policy, including the Røros model.

Chapter 10 presents key differences between reindeer herding and agriculture and its implications on policy. It also discusses the uniqueness of Sámi reindeer herding knowledge.

Chapter 11 discusses the findings of the study in light of the political ecology framework that was presented in chapter 2.

Chapter 12 concludes the research.

2. THEORETICAL PERSPECTIVES

2.1 Political Ecology

The analytical perspective of the thesis is provided by Political Ecology. This is a critical community of practice (Robbins 2012) interested in analyzing how vulnerable groups often lose out in political processes around land and environmental governance. Political ecology emerged from marxist political economy and cultural ecology and is among others influenced by post-colonial studies, peasant studies, environmental justice and common property theory. A common assumption in political ecology is that in practice, researchers and bureaucrats often function as political actors (intentionally or unintentionally) and that influential knowledge systems and environmental characteristics are constructed and analyzed by actors who behave in accordance with normative values internalized through disciplinary science (Benjaminsen & Svarstad 2010). Political ecology is therefore critical to typical positivistic explanations of environmental systems because "[T]hey frame environmental problems in selective ways, are frequently inaccurate, and encourage land-use policies that restrict local livelihoods in unnecessary ways" (Forsyth 2011). This necessitates an analysis of how characteristics and relations of nature are socially constructed through discourse (Bryant 2001).

Instead of looking at linear relationships between actions and outcomes, political ecologists tries to identify broader systems (Robbins 2012) and analyze environmental issues at multiple geographical scales. According to Robbins (2012), Political Ecology texts are unified by the fact that they often tell stories of winners and losers and understand these processes through human-non-human dialectics. The texts often "start from, or end in a contradiction". They also make "Claims about the claims about the state of nature", where often both realist and constructivist ontologies are acknowledged.

In the seminal book Land Degradation and Society by Blaikie and Brookfield (1987) the term "chains of explanation" was introduced. This was a way of analyzing an environmental issue in the context of multiple political, temporal and spatial scales, which has influenced the thinking within political ecologies. Much Political Ecology research have focused on the "degradation and marginalization" thesis, where the argument is that otherwise sustainable systems tend to get degraded as a result of modernist developments with marginalization of

the local people as the result (Robbins 2012). Other research foci in Political Ecology has often been "the causal relationships between social and environmental degradation in smallholder agriculture (Blaikie & Brookfield 1987), conflicts over the creation and maintenance of protected "natural" areas (Neumann 1998) and the influence of often specious beliefs and narratives concerning environmental conditions and changes (Fairhead & Leach 1996)." (Mcarthy 2005).

2.2 Challenges and critique of political ecology

Political ecology, being a wide and diverse community of practice has also been subjected to critique. Vayda and Walters (1999) criticized what they saw as orthodox a priori judgments from political ecologists:

> "Problematically, they insist that political influences – especially political influences from the outside, from the so-called *wider* political-economic system – are *always* important, arguably more important than anything else, and should accordingly be given priority in research" (Vayda & Walters 1999)

This results, according to Vayda and Walters (1999) in analyses that miss out on "other factors and the complex and contingent *interactions* of factors whereby environmental changes often are produced". Another objection against political ecology made by Vayda and Walters (1999) regarded what they termed "green romanticism": that some political ecologists claim that the devolution of power from state authorities to local communities always lead to sustainable resource management. Vayda and Walters (1999) further called political ecology "politics without ecology" and criticized researchers within the approach for paying too little attention to the actual biological relations of the environmental issues they study.

Walker (2005) met the argument of Vayda and Walters (1999) concerning "politics without ecology". He showed that there had indeed been shifts in the focus of political ecology, from studies relying chiefly on ecology (e.g., Blaikie and Brookfield (1987)) to a poststructuralist political ecology in the 1990s which entailed a larger focus on the political dimension (e.g. (Peet & Watts 1996)). He does however point out that the conclusion that political ecology ultimately has become "politics without ecology" is plain wrong and exaggerated. Walker (2005) support this argument by bringing up many examples of newer studies in political ecology that rely on both social and biophysical ecology.

In another article, Walker (2006) address the issue of political ecology and policy: Most of the writings within political ecology have potential for implicating practical policy, but much of it has been met with skepticism and distrust from bureaucrats and policy-makers. Walker attributes this to a number of factors: that political ecology is too vast and diverse; that more compelling and effective counter-narratives are needed; that too much political ecology is performed at the micro-scale; that policy-makers shun theories that explicitly employ Marxian theory and terminology; that political ecology need to speak to broader audiences; and that there are no agreed upon definitions that firmly establish political ecology as a coherent field of study. These are challenges that need to be overcome in order for political ecology to speak to broader audiences. Walker (2006) argues that until that happen, "it can be expected that fields with more narrow perspectives that reinforce the status quo will dominate public debates and decision-making, leaving political ecology to the verdant but largely peripheral pastures of academia".

2.3 Critical Realism in political ecology

Critical realism is a common ontological approach in Political Ecology (Benjaminsen & Svarstad 2010), which has been developed through critique of positivism and post-modernism (Hjørland 2005). It is thus an intermediate position between realism and constructivism (Benjaminsen & Svarstad 2010). Realists hold that reality exists independently from individual actors and can be directly accessed through meticulous empirical observation. Constructivism asserts that reality is socially constructed through the perceptions and actions of social actors and can therefore only be indirectly accessed. The most radical constructivists argue that no claim about reality is more valid than any other (Robbins 2012). Such a position would for a political ecologist mean that only the discourses that construct environmental characteristics are valid for explaining environmental issues. Non-human processes consequently become irrelevant (Robbins 2012). An orthodox realist position on the other hand, would entail a downplaying of power relations in environmental management, where only those explanations that are rooted in deductive, systematic observation are accepted. Critical realism can in this respect be a useful approach because it enables the researcher to recognize both an independent existence of reality and the social constructions that shape people's perceptions of it. Such an approach is especially relevant for studies on environmental management, where there often are competing visions of the reality and

causality of environmental governance issues. Many studies in political ecology have shown that issues regarding land degradation and desertification often have relied on powerful constructions that reflect flawed understandings of the issue's causality (Forsyth 2001). Through a critical realist approach, the researcher can study the competing perspectives of different actors and at the same time perform individual empirical observations (Benjaminsen & Svarstad 2010). Political ecology and critical realism can thus function as a form of "reality check" (Benjaminsen & Svarstad 2010). For example, Fairhead and Leach (1996) dispelled the myth that local forest users were causing widespread deforestation in Guinea by employing both quantified science and qualitative studies based in local populations.

2.4 Bringing political ecology "home"

A majority of work in political ecology has centered around rural primary producers in developing countries (Mcarthy 2005). In recent years however, it has been argued that the research topics covered by political ecologists are in no way unique to the third world context and that the framework of political ecology might be just as useful in studies situated in western, industrialized countries (Mcarthy 2005; Schroeder et al. 2006). Benjaminsen and Svarstad (2008) and Vik et al. (2010) are two examples of how political ecology has been brought "home" (Wainwright 2005) to the Norwegian setting: By using discourse analysis, Benjaminsen and Svarstad (2008) found that local opposition to dog sledding in Gausdal, Norway was rooted in an internationally and nationally well-known "rural traditionalist discourse". The narrative of the local population consisted of four elements: (1) that "environmental values are threatened"; (2) that "traditional economic activities are threatened"; (3) that "outsiders take over the mountain; and (4) that "local people are powerless". In another political ecology study in Norway, Vik et al. (2010) studied narratives at the interplay between tourism development, farming and conservation in Geiranger, Norway. They found two discourses which often are identified in political ecology theory: A win-win discourse reflected through a "synergy"-narrative and a modernization discourse articulated through a narrative of "marginalization".

This thesis is a contribution to the effort of bringing political ecology "home". It will do this by especially drawing on the critical perspectives of three books: Seeing Like a State (Scott 1998), The Anti-Politics Machine (Ferguson 1994) and The Will To Improve (Li 2007).

2.5 Seeing Like a State

Scott (1998) sets forth to explain how high modernist developmental schemes initiated by authoritarian states throughout history often have failed. He uses examples of failed policies from a wide range of fields and situations: forced villagization in Tanzania, Soviet collectivization, monocultural agriculture and Le Corbusiers grand urban planning schemes. He argues that the "administrative ordering of nature and society" that is performed through such social engineering schemes often are the result of a states' need to simplify local practices to make them "legible" for their bureaucracies, which has had detrimental effects on local communities. He further claims that such policies have failed to account for Mētis, the practical and experiential knowledge that is required to manage the complex social realities that high modernist schemes simplify.

2.6 The Will to Improve

A similar position is reflected in Li (2007), who studied development programs in Indonesia. The notion that she calls "The will to improve" has been shared by missionaries, colonial officials, development agencies and alike since the 19th century. These trustees seamlessly exercise a power over the subjects whose conditions are to be improved. In the book she incorporates Michel Foucaults theories of "governmentality"[1] and Antonio Gramscis notion of "hegemony"[2] to explain how the will to improve functions. Two practices are required in order to translate the will to improve into practice; "problematization" and "rendering technical". Problematization implies "identifying deficiencies that need to be rectified". Rendering technical is a process of making a field intelligible, by establishing characteristics and boundaries (Rose 1999) cited in Li (2007). Li (2007) argues that rendering technical "confirms the expertise and constitutes the boundary between those who are positioned as trustees, with the capacity to diagnose deficiencies in others, and those who are subject to expert direction." When an issue is rendered technical it is also rendered "non-political",

[1] In brief terms, governmentality refers to the way by which "people internalize the mandates of the state" (Robbins 2012)
[2] Hegemony refers to "the ability of the elite to achieve the spontaneous consent of the non-elite populace through the control of culture, opinion and ideology." (Robbins 2012)

which effectively excludes political-economic relations. The book is ultimately a critique of expert-driven development interventions.

2.7 The Anti-Politics Machine

The Anti-Politics Machine (Ferguson 1994) is a critique of the concept of development in the third world, exemplified through the Thaba-Tseka project in Lesotho from 1974 to 1984. By employing a Foucauldian governmentality and bio-power framework, Ferguson found that development projects in Lesotho often had failed on their own terms. New projects had been framed in the ashes of the failed ones, which now had been redefined as success stories. He showed how development functioned as an exercise that provided "technical solutions to 'problems' which were not technical in nature". In many instances, the only apparent effect of development projects in Lesotho was the expansion of the state's bureaucratic power. The development apparatus thus functioned as an "Anti-politics Machine", which suspended "politics from even the most sensitive political operations".

These three books tell stories of how simplistic development schemes fuelled by expert advice often have failed in taking local practices, contexts, power relations and environmental histories into consideration in the formation of policies. Such processes may also be relevant for understanding the political ecology of reindeer herding in Finnmark.

3. BACKGROUND OF THE STUDY

3.1 Development and promotion of the Røros model

The promotion of new herd compositions and slaughter strategies started at the end of the 1960s through informational work in the quarterly publication *Reindriftsnytt*[3] issued by the Ministry of Agriculture. The first two issues of the journal contained articles that recommended herds with a majority of females and fewer bucks (Villmo 1967a; Villmo 1967b) and slaughter strategies based on younger animals (Fjellheim 1967). The recommendations had not been systematically researched yet and were still at the conceptual stage, although similar strategies had been implemented in the Soviet Union in the 1930s and in Finland in the 1960s (Holand 2006). The recommendations were given at a point in time when reindeer herding in Finnmark was still reliant on draught animals and traditional herd structures.

Paine (1994), reporting about reindeer husbandry in the 1960s in Finnmark wrote that herd structure was all about proportions: proportions between females and calves; females and males; males and castrates and the relations between these three proportions. He further claimed that these relations were products of ecologic, economic or aesthetic constraints and opportunities from owner to owner. Paine (1994) investigated seven herds in western Finnmark and explained the different herd compositions from individual well-considered preferences, which he termed a "pastoral handwriting". Some herders were concerned with maximizing production and economic income and therefore slaughtered more yearlings than others. Others valued the pastoral lifestyle higher and maximized "the herd as a the primary source of esteem and aesthetics" (Paine 1994), and were therefore not as concerned with slaughtering to maximize possible economic income. There was a high reliance on the slaughter of bucks and castrates. The herds also needed more tamed males due to the need for draught power. Yearlings and calves were seldom slaughtered (Paine 1994). Vorren (1951) gives an example of the proportions in a herd in eastern Finnmark as early as in the 1940s: 300 females, 130 one-year-old calves, 6 rutting bucks, 90 two-year-old bucks, 90 two-year-old females, 120 "fattening-animals" and 30 draught animals.

[3] Translation: Reindeer news

The calf slaughter subsidy was introduced through the Reindeer Agreement in 1976/77 (St.prp. nr. 46 (1996-97)). The Røros model was still not formalized at this time, although systematized research on improved herd structures had been in progress together with a group of reindeer herders in Riast/Hyllingen reindeer pasture district in Sør-Trøndelag since 1970 (Lenvik 1981). The 11 reindeer herding families in Riast/Hyllingen had agreed on a maximum reindeer population of 4500 animals in their district and had divided herd sizes evenly between them (Elgvin 1996). The district wanted help to be able to achieve higher production within the confinements of this stocking rate, which they considered where the maximum number that their winter pastures could withstand. This help was provided by Dag Lenvik, the newly employed Lapp Bailiff (*Lappefogd*) (Elgvin 1996). Lenvik was a biologist who was concerned with increasing the productivity of the reindeer herding industry (Elgvin 1996). The development of the model was based on a conventional sheep rearing system, where the winter fodder is limiting and production is based on lambs (Elgvin 1996). The research was concluded in 1985, after 15 years (Holand 2006).

The finalized herd optimization model was presented in Lenviks doctoral dissertation (Lenvik 1988) as well as in journal articles (Lenvik 1990) and reprints and summaries from the Reindeer Administration. The main point of the model was that basing meat production on yearling bucks, which was a common slaughter strategy in Finnmark (Lenvik 1990), yielded less meat per animal than a system based on the slaughter of calves. A slaughter strategy based on yearlings also put unnecessary strains on the winter pastures, which were believed to be the limiting factor and therefore vulnerable to overgrazing. Instead, the production was to be based on the annual calf output, which meant that a large share of the herd was to be slaughtered each year. In addition to adapting the reindeer number to the available pasture resources, three structures in the herd needed to be optimized in order to be able to carry out a successful calf slaughter strategy:

- The mean weights of the female reindeer in the herd needed to increase. It was found that a mean weight of 60 kg or more would ensure a pregnancy rate of 95% and a high calf survival rate. This could be achieved by culling the lightest individuals.
- The mean age of the females needed to increase. For each year the age of a female increases, the live-weight of her calf increase by 1,13 kg. After the age of five, the effect wears off.

- The third major implication of the optimization model was an altered sex structure, where males only were kept in the herd for reproductive purposes. A male share of about 10% was found to be sufficient. Yearlings were considered to be just as capable rutting animals as older bucks.

These three structures could be optimized by altering the slaughter strategies and pasture pressure in each district. This would lead to an increased production per animal in the winter herd. It was claimed that a production system based on 1,5 or 2,5 year old bucks had a maximum production potential of 10-12 kg per female in the spring herd, while after herd optimization was carried out, a production of 20 kg per female could be achieved.

The factor that had made the drastic restructuring described in the model viable as a policy alternative was the fact that in the 1960s, snowmobiles had replaced the traditional reindeer sledges and therefore decreased the need for bucks as draught animals (Holand 2006).

The research in Riast/Hyllingen was considered a success and a breakthrough for the productivity in the reindeer industry. Since the model had been developed in the southernmost reindeer herding region in Norway, it became an issue of exporting a success story from the south to the north (Elgvin 1996). The model, which had been formulated in light of the rationalization thinking in Norwegian agriculture, became the very definition of sustainable reindeer husbandry among politicians, bureaucrats and researchers.

The introduction of the model in Finnmark has not been a smooth run. Herders have disagreed with some of the prescriptions of the model, for example the decreased reliance on bucks (Reinert 2006). Another obstacle to the introduction of the Røros model in Finnmark has been the fact that the authorities have not yet succeeded in keeping reindeer numbers within defined sustainable limits.

It is apparent that the calf slaughter subsidy and the informational work from the state have influenced the herding strategies of reindeer owners in Finnmark, but it has not led to any large scale adoption of the Røros model. Today, many herders do indeed slaughter calves, but the total herd share that is slaughtered is often lower than what the model recommends, and other animal categories than calves are still slaughtered, especially for domestic consumption and sales in the private markets. It seems as if the goals and circumstances that influence herding strategies in Finnmark are variable. These factors are among others connected to the

traditional knowledge of the reindeer herders, which I will come back to in later chapters. Table 3 shows the percentage slaughter for the last 10 years in Sør-Trøndelag/Hedmark and in 3 sub-regions of the western Finnmark reindeer pasture area. The figure illustrates the differences that still exist between reindeer herding in the north of Norway and reindeer herding in the south.

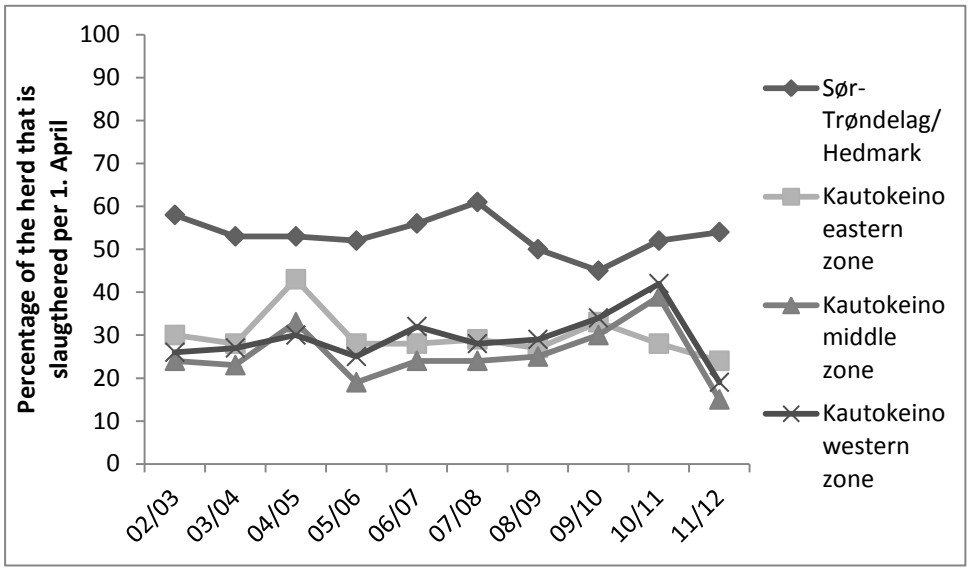


Figure 3. Percentage slaughter 2003-2012 in western Finnmark and Sør-Trøndelag/Hedmark (Reindriftsforvaltningen 2013)

3.2 Foraging behavior of reindeer

The reindeer (*Rangifer tarandus)* is a ruminant ungulate and the only livestock in Norway that grazes in the outfield all-year-round. It utilizes many different plants, plant parts and plant societies in its diet, since forage is differentially available throughout the season. The reindeers' use of the vegetation types varies by season, weather and degree of harassment from insects (Holand 2003). It is classified as an intermediate feeder in the deer classification system of Hofman (1985). The reindeer is a selective grazer and will at any time pick out the most nutritious and digestible plants and plant parts. Selective grazing is a premise for growth, since the reindeer are able to increase the digestibility of the forage by picking out the best plant parts. A digestibility above 55% is needed to provide surplus energy for body growth (Holand 2003). The animals make grazing decisions at different spatial and temporal scales, and they stay in the landscapes that offer the best grazing conditions at any time based on degree of harassment, predation, human activity and earlier experiences (Holand 2003).

Reindeer in Finnmark rely on many different species of lichen, grasses, herbs, grassy plants and leaves, depending on season (Staaland et al. 1995).

3.3 Pastures and foraging species

A main delineation of the reindeer pastures can be made between pastures dominated by green plants and pastures dominated by lichen. Lichen is the staple winter forage for reindeer in Finnmark (Staaland et al. 1995). Reindeer are the only mammals that are able to survive on this protein-poor plant (Tømmervik et al. 1996). Continental areas at the interior of Finnmark are ideal winter grazing ranges with abundant lichen coverage, low temperatures and little snow (Holand 2003). The most important species of lichen are *Cladonia Stellaris*[4], *Cladonia rangiferina*[5], *Cladonia arbuscula*[6] and *Cladonia arbuscula* ssp. *Mitis*[7] (Tømmervik et al. 1996). Depending on availability, the reindeer also eat vascular plants like blueberries (*Vaccinium myrtillus),* lingonberries (*Vaccinium vitis-idaea)* and scotch heather (*Calluna vulgaris)* during winter (Tømmervik et al. 1996).

A number of species of grasses, herbs, heathers, shrubs and trees are consumed in the period when the ground is snowless. Protein-rich green plants provide the basis for growth during summer. In early spring, where the snow has melted, protein rich rhizomes and shoots from grasses like Bigelows sedge (*Carex bigelowii)* and Highland rush (*Juncus trifidus)* are central. Other important species in spring are blueberry heather and birch shoots. In summer, the animals graze on richer grasses and herbs in meadows and snow-beds. A decisive factor in this period is the degree of insect harassment. Cool summers decrease the activity of insects, which increase the reindeer's effective grazing time and weight gain. Throughout fall, the marches rise in significance, where rhizomes and shoots from Swamp horsetail (Q*uisetum fluviatile)* and Buckbean (*Menyanthes trifoliata)* are grazed. Herbs and grasses are still grazed during this period, where Wavy Hair-grass (*Deschampsia flexuosa*) and Highland rush are especially important. Reindeer also love mushrooms in the fall. As the ground gradually

[4] *Kvitkrull*
[5] *Grå reinlav*
[6] *Lys reinlav*
[7] *Fjellreinlav*

freezes and is covered by snow, lichen increase in importance until it is the only available forage.

3.4 Seasonality and migrations

Reindeer husbandry represents a unique pastoral adaptation to a marginal environment and the animals' life history is adapted to migrations between seasonal pastures. In Norway, migratory organizations are determined by the biological and climatic conditions and the relation between the different seasonal pastures in each region. In some parts of Troms reindeer pasture area for example, the summer pastures are in abundance, while the production is limited by marginal winter pastures (Holand 2003), which has limited the extent of reindeer herding in the region. In Finnmark on the other hand, the balance between the different seasonal pastures is more favorable (Holand 2003). This has conditioned a system with larger herds and more reindeer owners. Reindeer pastoralism in Finnmark is based on long annual migrations between seasonal grazing lands. At the tundra at interior of the county, lichen is available in abundance. Combined with favorable snow conditions which enable easy access to forage, such areas are ideal winter pastures. The summer pastures are located closer to the coast where the biological production is higher and green foraging plants can be accessed in abundance. Depending on the location of the summer ranges, this organization makes for migratory routes of quite variable length, some as long as 250 kilometers (Holand 2003).

The seasonal migrations are complex and the reindeer owners need to coordinate their movements with many other herds. Bjørklund and Brantenberg (1981) describe the system like this (my translation):

> "The task of the reindeer herder is to control the annual cycle of a herd in such a way that it gives him economic returns. He needs to coordinate the behavior of the reindeer with his own and potentially his family's demands to daily life. This demands extensive knowledge, and such knowledge is the result of learning and socialization. The reindeer herder take over the knowledge that the older generation holds about the relationship between people, animals and terrain; and this enables a coordination of the behavior of reindeer and people. This coordination constitutes a routinized behavior of humans and animals in the form of an annual cycle and enables complex actions such

as the migration between summer and winter pastures." (Bjørklund & Brantenberg 1981)

The important point is that the annual migrations constitute more than a technical maneuvering through a geographical landscape according to a fixed set of legal regulations; it is rather a system that is socially learned. Paine (1994) called this a migration in a social landscape.

As a result of the large variations and transition periods between seasons, the Sámi herding year is divided into eight seasons, each with its own characteristics and challenges. The classification below is based on Sara (2001).

Giđđa (spring) sets in when the weather gets milder and bare spots start to appear on the ground. The reindeer stop digging grazing pits and get ready for the spring migration towards the calving areas. There is still snow on the ground and the best conditions for movement is when a load bearing snow crust prevents the reindeer from stepping through. This is the calving season. (Sara 2001)

Giđasgeassi (springsummer). The reindeer starts grazing on nutritious green sprouts. It is an advantage if this season is as long as possible since it will increase the time that the animals can graze in the absence of insect harassment. Another advantage is a smooth transition from marginal spring pasture to abundant springsummer pasture. (Sara 2001)

Geassi (summer). The animals shed their hairs at the same time as the mosquitoes start to fly. This can be a large nuisance for the reindeer and impede their effective grazing. The summer districts in Finnmark are dissimilar and climatic conditions, especially temperature, can hit differently from herd to herd. Depending on the topography of the district, snow will melt away higher and higher in the terrain throughout the summer and the reindeer will follow this in search of *rahttá*, fresh sprouts. The degree of harassment from nasal bot flies and skin warble flies, which is affected by temperature and wind conditions, is also important for the reindeer's nutritional uptake. The branding of the calves is done toward the end of the summer season. (Sara 2001)

Čakčageassi (autumnsummer). Towards *čakčageassi,* insect harassment decreases and the reindeer can now utilize lower-lying pastures and mushrooms *(vissta)* if the summer has been humid. The animals get ready for the autumn migration. (Sara 2001)

Čakča (autumn). The migration towards the winter ranges starts and the herds need to reach land that is suitable for rutting. The rut is initiated towards the end of September which means that the movement of the herds will stop. The spring and autumn migrations are carried out in the same areas, but within this landscape there are season-specific pastures. The autumn migration pastures are located at lower laying terrain with another species composition than the spring migration pastures. Spring migration pastures are composed of lichen located higher up in the terrain due to the snow cover and season. During autumn, there is a danger of mix-ups between the herds in western Finnmark because many herds maneuver through the same areas. (Sara 2001)

Čakčadálvi (autumnwinter). The rut is now over and the herd starts moving again. The weather gets colder and ice is soon formed on the lakes. The snow cover is still shallow so there is still forage available. The animals are generally in good condition, except the large bucks that have lost body mass during the rut and have shed their antlers. Gradually, the ground is covered by snow.

Dálvi (winter). The herds are now in their winter ranges. The reindeer have a mixed diet at the start of the winter, both green plants and lichen, since this is still accessible through the snow. The grazing situation at this time is vulnerable to the formation of ice-layers. Throughout the winter, the snowpack gets thicker and the access to pastures gets harder.

Giđasdálvi (springwinter). In *giđasdálvi* the snowpack is thick and the reindeer are drawn from the birch forests into more open spaces where it is easier to access the pastures through the snow. The competition for grazing pits increases and calves are often weak and vulnerable in this situation. The herd is stationary and easy to watch. The springwinter lasts until the weather gets milder and the snow starts to melt.

3.5 Social organization of reindeer herders - Siida and Baiki

The main social institution in reindeer herding is the *siida.* The *siida* can be defined as "a group of reindeer owners who live and migrate together, and to the herd of reindeer owned and herded by them" (Bjørklund 2004). The *siida* is a working community of reindeer herders who cooperate and work towards common goals. Depending on gener, the leader of the *siida* is called the *siida-isit* or *siida-eamit* (Turi 2008). It is a traditional flexible institution which enables an optimization of the relations between reindeer, people and pastures, resources

which fluctuates throughout the year (Bjørklund 2013). The size and composition of the *siida* varies from season to season according to grazing conditions (Sara 2001), a winter *siida* can for example be divided into multiple summer *siidas* (Turi 2008). Some of the flexibility that traditionally was incorporated in the *siida* has been lost as a result of government regulations (Paine 1994). The *siida* was not a formalized part of the reindeer herding legislation until the passing of the Reindeer Husbandry Act of 2007. The *siida* is made up of several individual households, *báiki*. Sara (2001) describe three important aspects of the *báiki:* (1) the infrastructure consisting of residence, equipment, production factors and animals; (2) the personnel and (3) the operative part of the *baiki* that secures an economically independent management. The household must supply resources (personnel, knowledge and equipment) that enables them to function in the *siida*-cooperative (Sara 2001). *Siida* and *baiki* are primary facilitators of reindeer herding knowledge (Eira et al. 2015 Forthcoming).

3.6 State governance and legislation of the reindeer herding industry

3.6.1 Boarder closures and the reindeer act of 1933

Reindeer herding was for a long time unregulated by the Norwegian state and migratory routes ran independently of national borders. For example, herders in Torne Lappmark in Sweden did until the end of the 19th century migrate to summer pasture areas all over Troms and the northern parts of Nordland counties (Holand 2003). These transboundary migratory systems were severely hampered through a series of boarder closures occurring in the 19th century. The border between Norway and Russia was closed in 1826, the Norwegian-Finnish border was closed in 1852 and the border between Sweden and Finland was closed 1889. Continued migrations between Norway and Sweden have since been regulated strictly through Norwegian-Swedish reindeer grazing conventions. The border closure between Finland and Norway changed the herding dynamics of *siidas* from Guovdageaidnu permanently. They could no longer use winter pastures in Finland and had to develop new adaptations (Sara 2006). This was the time when the first official regulations of reindeer husbandry were introduced. Common winter pastures for Guovdageaidnu and Kárášjoga [8] were established and the size of the reindeer population was attempted controlled (Holand 2003). The first

[8] Guovdageaidnu (in Norwegian: Kautokeino) and Kárášjoga (in Norwegian: Karasjok) are the two main reindeer herding villages in inner Finnmark.

general law about reindeer husbandry was passed in 1933. It was a law that regulated the relations between reindeer herders and other primary producers, mainly to the benefit of agriculture and forestry. Reindeer herding was regarded as a threat to agriculture (Heikkilä 2006). Through this law, reindeer herding was merely "tolerated" by the state, but the herding was not considered to be a customary right (Heikkilä 2006; Holand 2003). The "permission" to pasture could be taken away if the state saw it fit (Paine 1994). The law allowed for the division of the ranges into summer districts, common winter- and fall-pastures and the larger reindeer parishes *(reinsogn)*. The law did not directly regulate the internal operation of the reindeer herding industry (Sara 2001).

3.6.2 Reindeer act of 1978, the reindeer agreement, modernization and rationalization

The law of 1978 had greater consequences for the reindeer herding industry than the act of 1933. The act of 1933 primarily regarded the industry's relationship to farmers and other primary industries, while the law of 1978 further attempted to regulate internal relations in the reindeer herding industry (NOU 2001: 35). The law granted the reindeer authorities wide judicial assessment possibilities. The authorities could now decide district-divisions, maximum reindeer numbers and assign management units as they saw it fit (NOU 2001: 35). The current governance structure was also established. One of the presumptions of the law was that the reindeer numbers needed regulation due to the fact that there allegedly were too many reindeer owners with too few reindeer each on the ranges (Paine 1994).

Paine (1994) also points out that the regulation initiated through the act was a furthering of social democratic ideals:

> "Putting ethnicity aside, reindeer pastoralism becomes increasingly regarded as one primary resource in the nation economy among several. Thus it is included in a system in which "change" means "development" and whose principal conduit is a *statism* (state bureaucracies) morally connected to the premises of social democracy." (Paine 1994) (original emphasis)

According to Paine (1994), such social democratic ideals include: (1) Economical support for primary industries in exchange for rational and efficient production. (2) That the state is concerned with productivity goals in the primary industries with no prejudice to other

livelihoods. (3) The ideal that equality and welfare for the whole population justifies mobility of labor.

These three principles justified the state-initiated and expert-driven rationalization (maximizing meat production and income) and modernization (applying new technology and techniques) programs for the reindeer industry.

The rationalization ideology is promoted through the annual reindeer agreement, which was forged in accordance with the corresponding agreement for agriculture in 1976 (Paine 1994). The agreement is negotiated between the National Association of Sámi Reindeer Pastoralists (*Norske Reindriftssamers Landsforbund*, NRL) and the Ministry of Agriculture and Food. The agreement allocates funds for specific objectives within the reindeer policy. Herd structuring is for example promoted through the calf slaughter subsidy.

3.6.3 The Reindeer act of 2007

The Reindeer Husbandry Act of 2007 (From now on referred to as RHA) puts more emphasis on the internal self governance and co-management aspect of the reindeer industry than earlier laws. For the first time, the reindeer industry's own institutions are legally recognized.

In the 2007 law, the s*iida* is formalized as an important institution for the internal organization of the reindeer husbandry (§51-56). The term "operational unit" *(driftsenhet)* is replaced by "Siida-share" *(Siidaandel)* (§10).

Each district has to make a district plan (§57) containing specific rules of usage. Among others, the plans have to contain rules about pasture use (§59) and reindeer numbers (§60) at the *siida*-level. The County Mayor (earlier the Area Board) approves the district plans, and controls whether the stipulated reindeer figures are ecologically sustainable (§58). If the County Mayor finds that the reindeer figures are not sustainable, the district will, under supervision of the Reindeer Agronomist[9], work out a new reindeer figure (§58). If this does not succeed, the County Mayor will determine the reindeer figure for the district (§58). The reindeer husbandry board ratifies the final reindeer number stipulations (§58).

[9] *Reindriftsagronomen*, the leader of the local reindeer offices of the County Mayor.

If the reindeer population in the *siida* exceeds the determined maximum, the *siida* have to make a reduction plan (§60). If the *siida* is not able to do this, each *siida*-share have to proportionately reduce their herd according to the determined reindeer figure (§60). This article has spurred much controversy and it has been claimed that a proportionate reduction will unfairly hit the herders who have complied with the regulations (Sametinget 2013).

The authorities have been granted extended sanctioning possibilities if rules and regulations are not followed (chapter 11 of RHA).

3.6.4 Current reindeer herding policy

The goals and aims of the reindeer herding policy were first outlined in the white paper *En bærekraftig reindrift*[10] (St.meld. nr. 28 (1991-1992)) and in the corresponding parliament proposal (Innst. S. nr. 167 (1991-1992)). The main principles of this policy were continued in the white paper *Velkommen til bords*[11] (Meld. St. 9 (2011-2012))

The main goals of the current reindeer herding policy are:

- To base reindeer husbandry management on goals of ecological, cultural and economical sustainability, where ecological sustainability is central.
- To secure the reindeer industry's pastures.
- To secure a sustainable reindeer husbandry with adjusted reindeer figures, reduced losses and increased production. Excessive reindeer populations must be reduced.
- To increase the business-aspect of the current political instruments.
- To arrange for dialogue between the reindeer industry and other stakeholders in the reindeer herding areas.
- Suggest that the Land Consolidation Court[12] should be granted the competence to clarify internal rights in the reindeer industry.
- Invite the industry to cooperate on tourism-based business development.
- Make sure that the instruments of the reindeer agreement support an orderly business operation in line with the Reindeer Act of 2007.

[10] Translation:"A Sustainable Reindeer Husbandry"
[11] Translation: "Dinner is Served"
[12] In Norwegian: Jordskifteretten

- Contribute to a stable market situation in order to secure the economic foundation of the industry.
- Simplify and make the official management of the reindeer herding industry more efficient. (Meld. St. 9 2011-2012)

It is especially the first and third goals who are relevant for this thesis. According to the first goal, ecological sustainability is supposed to underpin economic and cultural sustainability. The Office of the Auditor General of Norway[13] criticized this goal for not being sufficiently operationalized (Riksrevisjonen 2004). This led to the appointment of a committee consisting of researchers, bureaucrats and reindeer owners whose mandate was to develop criteria that could measure the degree of sustainability. The committee decided that the main criterion of a sustainable reindeer husbandry should be mean carcass masses, operationalised through the following goals (LMD 2008):

- Mean carcass mass of calves should be 17-19 kg
- Mean carcass mass of yearlings should be 25-27 kg
- Mean carcass mass of females older than 2 years should be 27-29 kg

Carcass masses were chosen instead of live weights, because carcass masses are easier to measure. The main assumption of the criteria were density dependence between animals and pastures (my translation):

> "[T]here has by and large been a mutual understanding [in the committee] that there exists a close relationship between pasture resources, animal density, condition and production." (LMD 2008)

The committee also chose two supplementary goals:

- A production between 8 and 9 kg per animal in the spring herd.
- An interannual variation of calving rates in the fall between 10 and 15 %.

The policy of stimulating reindeer herders into slaughtering calves and composing their herds according to the Røros model lies at the heart of the ecological and economic sustainability

[13] In Norwegian: Riksrevisjonen

goal. The argument is that by restructuring the herds, more meat can be produced per animal, which will lead to fewer animals on the ranges and less wear and tear. This is also an operationalization of the third policy goal: To reduce the reindeer population, reduce losses and increase production. The calf slaughter subsidy is central to this. In the reindeer agreement for 2014/2015 the subsidy was increased from 275 to 350 NOK per calf. In addition to this, the subsidy is extended so that it can be received all year round (LMD 2014).

The reindeer agreement for 2014/2015 has a scope of 111,5 million NOK. 69,1 million NOK of these are set aside for direct subsidies. The subsidies fall into two categories: those that are granted to the reindeer herding districts and those that are granted to individual *siida*-shares.

The purpose of the district subsidies is to provide an economic foundation that will facilitate sustainable development. Such development may entail adjustments to the reindeer population, the protection of pastures from encroachments, the increase of economic returns or the establishment of a disaster relief fund (LMD 2014).

The subsidies granted for the *siida*-shares include a production premium, a calf slaughter subsidy, operational grants for youths and young *siida*-share leaders, a spouse and partner supplement, an establishment subsidy and a transport subsidy. The economic frame of the subsidies is shown in table 1.

Table 1. Monetary allocations for subsidies over the reindeer agreement

Type of subsidy	Million NOK
District subsidy	10,3
Production premium	32,7
Calf slaughter subsidy	17,8
Operational grants for youth	1,3
Establishment grant	2,2
Spouse supplements	1,8
Transportation subsidy	3
Sum	69,1

Source: (LMD 2014)

3.6.5 Administrative Division of Reindeer Husbandry in Finnmark

There are six regional reindeer husbandry areas[14] in Norway: eastern Finnmark, western Finnmark, Troms, Nordland, Nord-Trøndelag and Sør-Trøndelag/Hedmark. The Reindeer husbandry areas are further divided into districts[15]. In western Finnmark there are 25 summer districts with legally established boarders and 3 winter districts, where the boarders are customary and defined as common pastures. There are 10 districts in eastern Finnmark. Figure 4 shows the administrative boarders of the reindeer herding industry in Finnmark.

Individual districts are further divided into *siida* of variable size depending on season. The legal definition of a *siida* is (my translation): "[A] group of reindeer owners who practice reindeer herding in collaboration on a defined area" (RHA §51). A winter *siida* is a group of reindeer owners who (my translation) "perform reindeer herding in collaboration primarily on the winter- and spring pastures" (RHA §51). A summer *siida* (my translation) "performs reindeer herding in collaboration primarily on the summer- and fall pastures." (RHA §51). As described in section 3.4, the indigenous definition of the *siida* institution is wider than the legal definition.

Each *siida* consist of a number of *Siida*-shares[16]. A *Siida*-share is legally defined as (my translation) "a family group or an individual who is part of a *siida*, cf. §51, who performs reindeer herding under the supervision of a person or by spouses or partners in cooperation" (RHA §10).

Table 2 shows the number of individual administrative units and reindeer owners in western- and eastern Finnmark.

Table 2. Administrative units and individuals in the reindeer herding industry of Finnmark

Reindeer husbandry area	Summer districts	*Siida*-shares	Number of individuals in *siida*-shares	Winter *siidas*	Summer *siidas*
Western Finnmark	25	210	1450	36	53
Eastern Finnmark	10	175	909	19	51
Total	35	385	2359	55	104

Source: (Reindriftsforvaltningen 2013)

[14] In Norwegian: Reinbeiteområde
[15] In Norwegian: Reinbeitedistrikt
[16] In Norwegian: Siidaandel

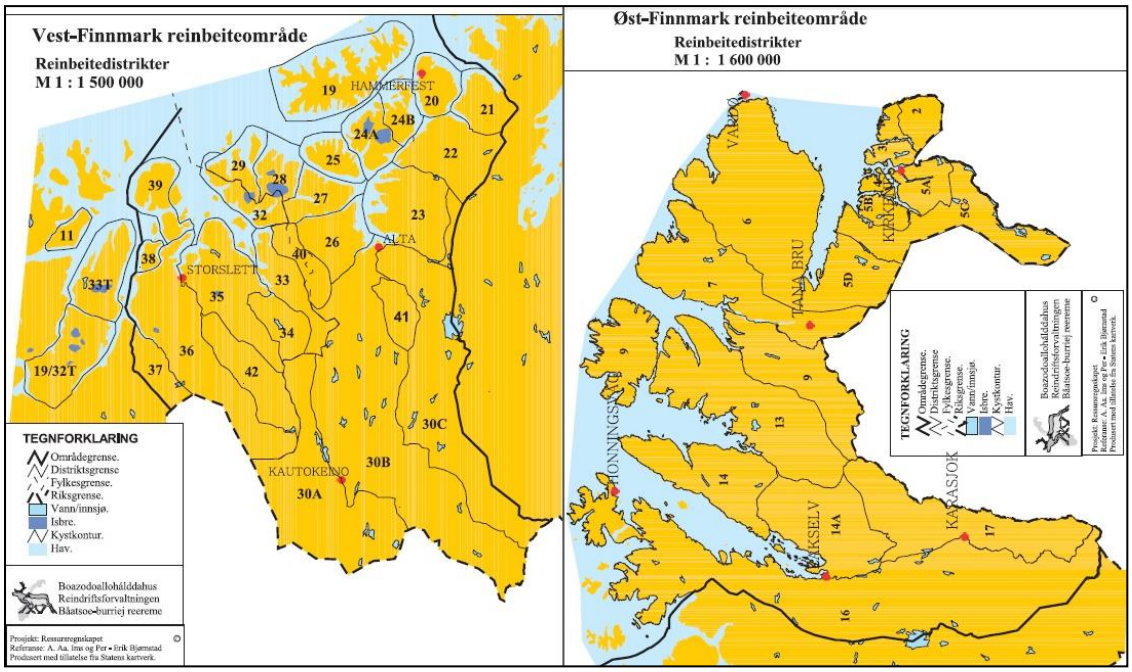


Figure 4. Map of administrative units of reindeer husbandry in Finnmark. (Reindriftsforvaltningen 2013)

3.6.6 Current governance structure

The Reindeer Herding Administration[17] (RA) was established in 1979. The main office is located in Alta and with one local office in each herding region. The RA is a directorate and executive body under the Ministry of Agriculture and Food. The ministry has the overall responsibility for the reindeer policy. As of 1 July 2014, the RA will merge with - and become a unit under The Norwegian Agricultural Authority[18].

At the national and local levels there are three[19] co-management institutions. The Reindeer Husbandry Board is politically appointed while the two local boards are elected by and among the reindeer herders in each district and *siida*.

- The Reindeer Husbandry Board (*Reindriftsstyret)* is a collegial organ which was established as the overall governing body for the reindeer industry in 1979. The RA

[17] In Norwegian: Statens Reindriftsforvaltning
[18] In Norwegian: Statens Landbruksforvaltning
[19] There used to be a fourth politically appointed governing body in the reindeer industry. This was called the Area Board and operated at the regional level. As of 1 January 2014 these boards were shut down and their duties were transferred to the Reindeer section of the County Mayors Office.

functions as the secretariat for the reindeer management board. 4 of its members are appointed by the government and 3 are appointed by the Sámi Parliament (RHA §71).

- The District Board. This board is appointed by the members of the district (RHA§ 43). The district boards represent the interests of the district and ensures that the herding in the district is in accordance with rules and regulations (RHA §44).
- The Summer *Siida* Board. This board is responsible for organizing the joint herding in the *siida* and for managing joint installations such as roundup corrals and slaughtering sites (RHA §52).

4. METHODOLOGY

4.1 Introduction

Various data sources were used in the thesis. Perspectives on herd composition can only be fully understood through in-depth qualitative interviews with the practitioners themselves. The study did therefore to a large degree rely on qualitative interviews with reindeer herders. In addition to this, quantitative data was used in the retesting of a statistical analysis which has been influential in the formation of reindeer policy. The study is interdisciplinary and did also rely on extensive literature review. The research was not based on a pre-defined hypothesis, it was rather an inductive study with a focus on theory-building and a spiraling research process. Question guides and theoretical inputs were updated throughout the process based on experiences made in the interviews. The findings were placed in the context of the reviewed literature. The findings and discussion sections of the study are therefore presented in conjunction over the next chapters. The present methodology chapter presents the qualitative and quantitative research approaches in addition to a small section on the literature review.

4.2 Qualitative data – interviews with reindeer herders

4.2.1 Research area

The geographical focus of the thesis is Finnmark. A common feature of the reindeer herding in the county is that it is based on long annual migrations from continental to coastal areas. Reindeer herding in Finnmark is regarded as an area of concern for the state, both in terms of the environmental issues and productivity. Alleged negative conditions in specific areas have often been generalized as if they applied to the whole region, even though institutional and ecological conditions within individual reindeer herding districts are highly variable. Such differences have resulted in different operational adaptations. A study of herd structuring in Finnmark should therefore take its departure in a study area that is large enough to be able to account for some of these differences between districts.

The chosen research area was in line with recommendations made by Berg and Lune (2012): (1) That the research setting should be accessible; (2) that appropriate respondents should be

available at study site, (3) that the research questions should be researchable at the setting and (4) that it should be possible to perform the research effectively at the chosen setting.

4.2.2 Sampling and data collection methods

I strove towards recruiting informants that evenly represented eastern- and western-Finnmark as well as herders that represented the different geographic conditions within each area. The study relied on a non-probability sampling procedure, which is common in qualitative research. Qualitative research often aim for description instead of measurement and statistical inference (Berg & Lune 2012). Qualitative data reveals "meanings, concepts, definitions, characteristics, metaphors, symbols and descriptions of things", as opposed to quantitative data that show the "counts and measures of things [and] the extents and distributions of our subject matter" (Berg & Lune 2012).

I decided that the informants from western Finnmark should come from island-, peninsula- and mainland districts. The group of informants from eastern Finnmark had to represent districts with both long migratory routes and communal winter pastures as well as districts with shorter migrations and exclusive winter pastures. Based on these criteria, districts were drawn randomly.

The data demands were presented to a member of the *Dávggas* project team who has a large network in the reindeer herding communities of Finnmark. This team-member suggested possible informants that would fulfill the data needs. The sampling strategy of this study was therefore a combination of a random and purposive sampling. The names of the districts were drawn randomly while the interview object in each district was chosen purposively. In a purposive sample, "researchers use their special knowledge or expertise about some group to select subjects who represent this population" (Berg & Lune 2012).

Since the sampling procedure combines random and purposive procedures, I characterize the sampling procedure as "quasi-random", which is a suggestion from Berg and Lune (2012)

I recruited the informants over telephone and carried out the interviews face to face with a sound recorder during the months of July and August 2013. I visited the informants at their location, which often was close to their summer pasture areas. This was a natural setting for discussing reindeer husbandry. Before the initiation of the interview, I assured the

respondents that their personal data would be kept confidential to minimize the risk of identification.

In total, seven herders and two key informants participated in the study. Three of the herders were from eastern Finnmark and four from western Finnmark. Western Finnmark is larger than eastern Finnmark[20], so it was natural that the informants from western Finnmark were in majority. The key informants were also reindeer herders, but they were interviewed by virtue of their expertise and experience concerning reindeer herding issues at an academic and organizational level. Therefore, these interviews did not deal with the key informants own reindeer herding, but rather more general and overarching issues. A more thorough introduction to the informants will be made in chapter 4.

The interviews followed a predefined open-ended question guide (Appendix A). Specific questions related to the situation of the interviewees were based on the more general research questions. The interview questions regarded themes like traditional herd structures; productivity; the importance of the buck; consequences of managerial interventions; local and context-sensitive circumstances; the rationality of the reindeer herder; and the sustainability of reindeer herding. Since the goal of the research was description of meaning, the interview could be semi-structured. A semi-structured approach allows for more flexibility in digressing beyond the question guide (Berg & Lune 2012). It also allows for the question guide to be individually adapted to each respondent.

4.2.3 Secondary data: use of literature

The thesis is also based on extensive literature review. This was an important method of triangulating the primary data and to increase the trustworthiness of my arguments. Peer-reviewed articles, government documents, legislation, reports from government agencies, books and popular articles have been used in the thesis. The literature did among others cover fields like biology, political science, anthropology, geography and sociology. Databases and search engines like Sciencedirect, Wiley, Springer, Google Scholar and Bibsys were used in the literature search. I also frequently visited the library at NMBU to get access to master theses and books that were not available online.

[20] 1450 people are employed in western Finnmark and 909 people are employed in eastern Finnmark (Reindriftsforvaltningen 2013).

4.2.4 Data analysis

I transcribed all the interviews verbatim by listening to the voice recorder and entering the interviews into separate Microsoft Word documents. This was a time-consuming process that resulted in massive bulks of data. The data needed to be reduced and categorized so that regularities and patterns could be exposed. I relied on a common analysis method of qualitative data called content analysis. Content analysis is defined as "a careful, detailed, systematic examination and interpretation of a particular body of material in an effort to identify patterns, themes, biases and meanings" (Berg & Lune 2012). The main operation in content analysis is the coding of data into sub-categories. This gives the researcher an overview of the theme and a basis for addressing the research questions. This was possible to do with my interview data since they were expressed as text. I based coding on concepts that were related to the research questions. The interviews were coded as statements and inserted in word documents for each of the themes. Themes included the role of the buck; pastures; influences on herd structure; differences from pasture district to pasture district; cultural landscapes; productivity and profitability concerns; pastoral practice and supplementary feeding.

4.2.5 Ethical considerations

According to Berg and Lune (2012), the main principle in ethically sensitive research is the notion of do no harm. This is supposed to permeate every aspect of the research strategy, and involves both mental and physical harm done to yourself and the participants of the study. Some common ethical concerns are: (1) ensuring voluntary participation; (2) ensuring prior and informed consent; (3) assessing the role of the researcher in relation to the participants; (4) securing confidentiality/anonymity of participants and (5) ensuring a secure data handling. These critical aspects were taken care of in the study. All the respondents participated in the study voluntarily. To ensure prior and informed consent, I clearly stated the intentions of my research and my plan for data handling. I also kept all names confidential. I have to emphasize that it is not possible to ensure an absolute anonymity of the respondents. Contextual information may reveal the informants' identities, although such information has been kept to an absolute minimum. The research did not include any covert methods.

Research in Sámi communities needs extraordinary ethical consideration due to the Sámi peoples status as both an ethnical minority and an indigenous population (NESH 2002). The

Sámi were culturally and socially oppressed through targeted "norwegianisation"-policies in the 19th and 20th centuries (NOU 2001: 34). Much has been done to atone for this[21], but the relations between Sámi and non-Sámi communities are still affected by the legacy of the period. Awareness of how the conduct and dissemination of the research potentially can harm these communities is needed. I was therefore vigilant about paying respect to local traditions, values and language.

4.2.6 Evaluation of qualitative research, limitations of the study and possible biases

Quantitative research is assessed on the basis of its validity, reliability and objectivity (Fangen 2004). Validity refers to whether you measure what you are supposed to measure (internal validity) and the ability to generalize the results to other settings (external validity). Reliability refers to whether other researchers are able to replicate your findings (external reliability) and whether a team of researchers can observe the same relationships with the same methods (internal reliability). Objectivity means the degree to which the findings are free from bias.

These criteria, developed in a positivistic tradition are often also transferred to the realm of qualitative research. Many scholars have stated that the nature of qualitative data requires different assessment criteria (Kvale & Brinkmann 2009). Qualitative researchers are of course also concerned with the reliability and validity of their research, but the terms may need to be understood differently (LeCompte & Goetz 1982). Qualitative research is most often not about measuring the relationship between variables, establishing statistical generalizability or about employing methods that can be exactly replicated. It is more often about trustworthy descriptions and analyses of the particular meanings that people put into phenomena. Bryman (2008) proposes four alternative criteria of trustworthiness that are better adapted to qualitative data: *credibility*, *transferability*, *dependability* and *confirmability*. *Credibility* parallels internal validity, but stress the existence of multiple accounts of social reality, it is thus "the feasibility or credibility of the account that a researcher arrives at that is going to

[21] Measures that have been taken to secure the rights and to atone for the cultural and social oppression of the Sámi people: The passing of the Sámi Act in 1987 and the establishment of the Sámi Parliament in 1989; the signing and ratification of ILO convention nr. 169 in 1990; and the amendment of a Sámi article to the Norwegian constitution.

determine its acceptability to others" (Bryman 2008). Credibility therefore boils down to good research design through thick description (Ceertz 1973), triangulation or respondent validation. *Transferability* parallels external validity, and holds that observed relationships and explanations *can* be present in similar circumstances elsewhere, but are not fully generalizable due to contextual uniqueness (Bryman 2008). *Confirmability* is an approximation of objectivity, but it recognize that complete objectivity of a qualitative researcher is impossible (Bryman 2008). *Dependability* is the parallel of reliability and entails an "auditing approach" where the research process is as open and honestly described as possible (Bryman 2008).

I cannot claim that the qualitative results of this study are representative beyond the sample in mere statistical terms. That would have required a random sampling strategy, a structured questionnaire and another analysis method. I argue instead that this not necessarily is a weakness, since the issues I describe could not have been revealed without employing an explorative, qualitative method that emphasizes meaning and not measurement. Even though the perceptions that are reflected in the thesis cannot be inferred statistically to a larger population, they still say something about the status of the reindeer management in Norway.

A bias could have been introduced by the fact that the interviews were carried out in Norwegian and not in Sámi. Even though the herders were fluent in Norwegian, Sámi is their professional language, and the language that they normally use to communicate about reindeer herding issues. There are also many specialized terms that do not easily translate to Norwegian.

The formulation of the questions is another potential source of bias. Questions should be formulated so that they can easily be understood by the respondent (Berg & Lune 2012). I strove towards this goal, but still encountered some difficulties in asking understandable questions. A reason for this could be that reindeer herders communicate about reindeer husbandry in Sámi, and probably quite differently than someone who only have read about reindeer and reindeer herding in scientific publications.

Leading questions is another issue. Upon transcribing my interviews I noticed that some of the questions had been framed in such a way. There exists a widespread assumption that leading questions decrease the reliability of interviews. However, Kvale and Brinkmann

(2009) argue that this is an apprehension rooted in a positivist and empiricist tradition focused on the objective existence of reality. They argue that leading questions actually often increase the reliability of qualitative interviewees by enabling the researcher to extract information that is withheld. In addition to this, a qualitative interview situation decreases the type of leading questions that often are used in surveys with pre-defined answer alternatives (Kvale & Brinkmann 2009).

Another situation that can have biased the interviews is the fact that I am a student at the Norwegian University of Life Sciences, an institution that for many reindeer herders represents the hegemonic agricultural science and models of the Norwegian authorities. In addition to this, I am ethnically Norwegian which, based on the troubled past between the Norwegian state and the Sámi population, can have affected the respondents attitude towards me.

4.3 Quantitative data - regression analysis of carcass masses and animal density

4.3.1 Introduction

This section explains the methodology of a regression analysis of slaughter weights and animal density inspired by the methodology in Ims and Kosmo (2001). While the analysis by Ims and Kosmo (2001) was based on data from three years (1998-2000), this analysis was extended to include available data from the period 1980-2012. The results of the analysis is presented and discussed in chapter 9.

4.3.2 Study area

The study area included all districts belonging to the western Finnmark reindeer area. The regression analysis was aggregated to the regional scale. Island/peninsula districts and mainland districts were separated into individual groups in the analysis. In addition, analyses on a smaller scale based on individual summer districts were carried out.

4.3.3 Carcass mass and population data

Age- and sex-specific carcass masses and population data were retrieved from the reindeer administration. Calf statistics were available back to the slaughter season of 1983/84. Yearling bucks were available from 96/97. For the scope of this analysis, carcass mass data was the best available measure of production. Carcass mass is the live body mass minus

head, skin, viscera, blood and hoods from the wrist and down (Holand et al. 2010). Analyzing carcass masses instead of live weights eliminates possible bias from fur moisture and variable filling of the rumen (Ims & Kosmo 2001), but it is not certain that carcass masses accurately represent the actual condition of a herd since slaughter outtake is a product of individual slaughter strategies and preferences. Both data on calf and yearling bucks were used. Yearling bucks are a more homogenous group than calves, since the calf statistics comprise both sexes. This makes analysis on yearling bucks less prone to bias than calve masses. The yearling masses are affected by two summers, while calves have been through one. Another bias could have been introduced by the fact that the yearling masses were composed of both pre-rut and post-rut figures. A yearling buck loses body mass throughout the rut, but considerably less than older bucks (Mysterud et al. 2003). This can affect the validity of the data when tested for density dependence. Each observation in the analysis is a mean weight for a given year in a given district. Table 3 shows the distribution of observations among the districts. Some districts had few observations and were therefore left out of the individual district analyses. The districts with few observations were included in the regional scale analysis. The mean carcass masses were based on a total of 229,155 individual calf masses and 56,945 individual yearling buck masses.

Table 3. Number of observed mean carcass masses in each summer district

District	*Varit*[22]	Calf	District	*Varit*	Calf
19	15	25	29	14	28
20	15	24	32	15	28
21	12	27	33	16	28
22	16	28	40	16	28
23	16	28	33T	9	22
24A	11	27	19/32T	16	27
24B	11	19	34	16	27
25	15	23	35	14	27
41	12	16	36	14	24
26	15	19	37	10	17
27	15	27	39	14	27
28	9	24	42	6	18
Sum	322	588			

[22] *Varit* is the Sámi word for a yearling buck. The two terms will be used interchangeably in the thesis.

4.3.4 Density and area

The density calculations were based on the area figures from Ims and Kosmo (2001). Three area-categories were defined: gross area, net area and high productive area. The gross area is the total area within the outer boarders of each summer district. Net area is the gross area subtracted by impediments[23] and cultivated land. The high productive areas are net area subtracted by low productive area[24].

4.3.5 Climatic data

The weather stations used in the analysis in Ims & Kosmo (2001) were not stated in the report. The time series is longer in this analysis than in the report and many of the weather stations in Finnmark have not been operational long enough to provide data for the whole period. The type of data collected is also very different from station to station. My data needs were daily temperature recordings and daily mean temperatures. Daily mean temperature is needed to calculate degree days. These aspects narrowed down my range of choices. Districts where therefore given weather data from the closest available weather station. This method has also been followed in Blixgård (2005). Data from three weather stations were retrieved from the Norwegian Meteorological Institute. Table 4 shows the location and associations of each of the three weather stations that were used in the analysis. Data for all the years except precipitation at Alta airport in 2010 was available.

Table 4. Information about weather stations used in the analysis

Weather station	Elevation	Location	Districts represented
Alta Lufthavn	3	69,9775° N, 23,3582° W	19, 20, 21, 22, 23, 24A, 24B, 25, 26, 27, 28, 41
Nordstraum i Kvænangen	6	69,8353° N, 21,8925° W	29, 32, 33, 34, 35, 36, 37, 39, 40, 42
Tromsø Langnes	8	69,6767° N, 18,9133° W	33T, 19/32T

[23] Impediments are unproductive land like lakes/water, snow/glaciers, shadow areas, stoneruns and gravel soil.
[24] Examples of low productive areas are lichen- and heather-rich forests and lichen moors.

Such an approximation of district-specific climate data should be interpreted carefully. There are large climatic variations between districts. All the weather stations are located at sea level and at the coast. The height gradient in many districts may therefore affect temperature and precipitation (Holand 2003). The western zone and the islands have especially large differences in altitude. The effect of oceanity/continentality may also have impacts on the accuracy of the data used in the analysis. Oceanic areas have more precipitation than continental areas (Holand 2003). Some of the districts are also located far away from the weather station that was used to represent the weather conditions in the district. This may also have introduced a bias.

Total precipitation was found by adding up all the daily observations for a given period of time. The growing degree day[25] is the sum of the difference between daily mean temperature and a chosen base temperature for a period of time. If the daily mean temperature is lower than the base temperature the degree day is zero. 6° C was chosen as base temperature. The period when the temperature is above 6° C is considered as the summer grazing period (Ims & Kosmo 2001).

4.3.6 Data analysis

Data analysis was done in the statistical package R (R Core Team 2013) and Microsoft Excel 2010. Simple and multiple ordinary least squares (OLS) regressions were done and significance was accepted at the 5% level. In the simple regressions the dependent variable was carcass mass and the independent variable was the animal density on the net area. In the multiple regressions, eight climate variables were defined in addition to the density variable. As in Ims and Kosmo (2001) the summer grazing period (14. May – 14. September) was divided into four sub-periods: 14. – 31. May; 1. – 30. of June; 1. – 31. July; and 1. August – 14. September. For each of these four ranges, total precipitation and number of degree days was given. This resulted in a total of nine independent variables in the multiple regression analysis.

The full models:

Model 1: Carcass $mass_i$ = density net area + $\underline{e}$

[25] Growing degree day is a measure of heat accumulation.

Model 2: Carcass $mass_i$ = density net area + degree days 14-31 may + degree days 1-30 june + degree days 1-31 July + degree days 1 aug – 14 sept + precipitation 14-31 may + precipitation 1-30 June + precipitation 1-31 july + precipitation 1 aug – 14 sept + e

Where i = animal category (calf or yearling)

Model 1 was run with the carcass masses of both calves and yearling bucks at these spatial scales:

- Mainland districts in western Finnmark.
- Island and peninsula districts in western Finnmark.
- Individual districts.

Model 2 was run at the mainland and island scale.

There were too few observations to be able to run model 2 on the individual district scale.

The mainland scale included districts 21, 22, 23, 41, 26, 27, 33, 40, 34, 35, 36, 37 and 42.

The island scale comprised districts 19, 20, 24A, 24B, 25, 28, 29, 32, 33T, 19/32T, and 39.

Since the number of observations in each district was low, the regressions from the district analyses must be interpreted with care. An average of 14 observations for *varit* and 24 observations for calf in each district is low.

5. INTRODUCTION TO THE INFORMANTS AND THEIR ATTITUDES

5.1 Interviewed herders and key informants

In this introductory section the informants and their general attitudes towards herd structuring will be briefly outlined. Personal information will be kept to a minimum to ensure anonymity. Their standpoints were quite diverse, but there was a stark division between two of the herders, who had followed the Røros-model strictly, and the rest, who had not followed the model. Within the group of informants that had not followed the model, a varying degree of positivity towards a uniform calf slaughter strategy was conveyed. All of them did to some extent practice it, but none of them were totally reliant on it. They also conveyed critical opinions about the conduct of the reindeer authorities. The two herders who had followed the model[26] practiced their reindeer husbandry in two geographically distinct regions: herder 4 belonged to a large district in the east, while herder 5 belonged to a smaller district in a more populated area to the west of the county. They described a drastic reorganization of their husbandry, which none of the other informants had been through. They were also more positive towards the conduct of the authorities. All the interviewed herders felt they did what was right under the circumstances in their own districts. For each herder, two figures are shown, representing their slaughter strategy and herd composition. The figures show results at an aggregated level in each district/*siida*. Some of the districts/*siidas* are larger than others, so the figures do not necessarily depict the interviewed herders exact herd compositions and slaughter strategies.

Herder 1 from western Finnmark have his reindeer on an island in the summer. He practiced calf slaughter because of the difficult transitions between good summer pastures on the island and relatively marginal fall pastures.

> "The slaughter of calves is the thing. Because of the calf-loss we experience during the year makes it profitable for us to slaughter them the first fall and not the next. The winter-loss of calves from the island districts, that have very good summer pastures, is

[26] These herders will further on in the thesis often be referred to as "the structured herders".

high. When we get to the marginal pastures the animals tolerate far less than animals that have been on bad pastures the whole summer". (Herder 1)

He was clear on how he thought calf slaughter was the best option for the reindeer husbandry in Finnmark because it would prevent the reindeer population from rising. Although calf slaughter worked for him he was more critical to the claimed universality of the Røros-model.

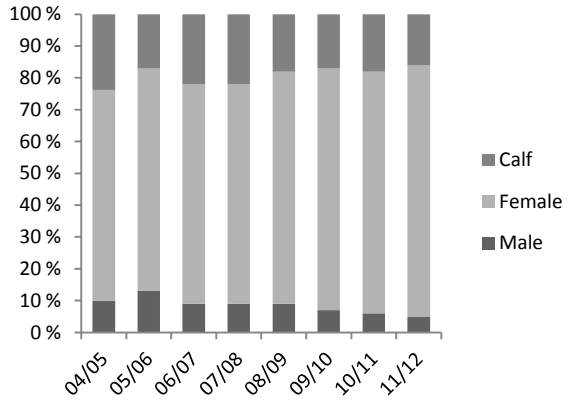


Figure 5. Herd composition of herder 1

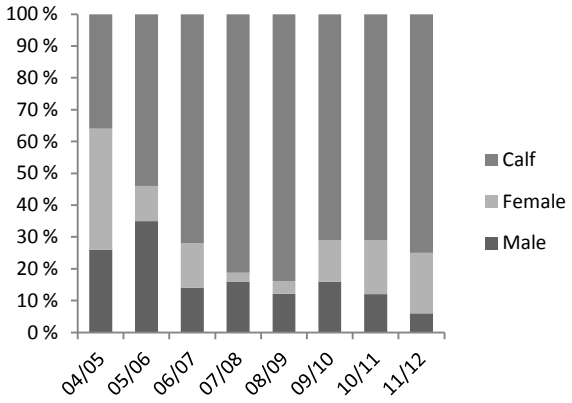


Figure 6. Slaughter strategy of herder 1

Herder 2 had his summer pastures on a headland in western Finnmark. He was very critical to calf slaughter and claimed that it did not fit his district. He relied to a large degree on the slaughter of *varit* as can be observed in figure 8. A high share of calves and a low share of bucks in the winter herd (figure 7) indicate a high number of yearling bucks on the summer ranges and therefore a slaughter strategy based on this animal category. One of his main objections against the Røros-model was that it did not take the buck pastures into consideration. He also criticized the widespread supplementary feeding schemes. Figure 8 shows that the slaughter strategy in his district has fluctuated largely. This can be ascribed to a variable production from year to year.

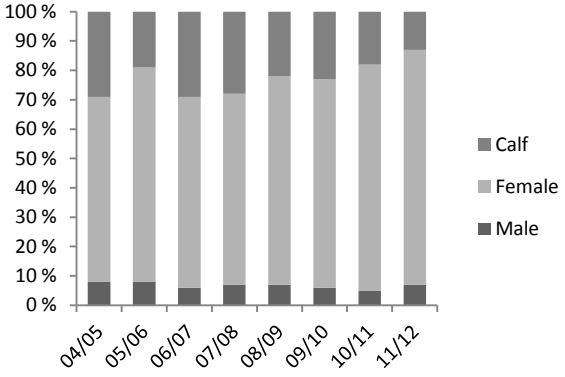


Figure 7. Herd composition of herder 2

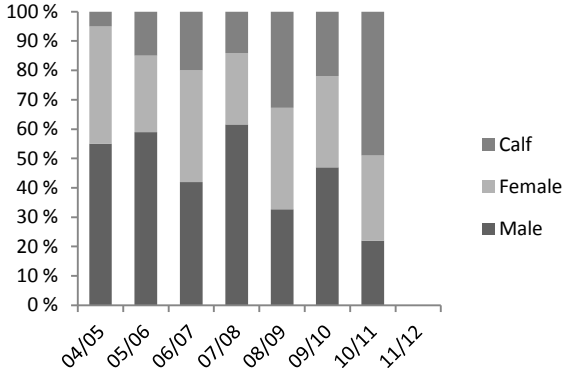


Figure 8. Slaughter strategy of herder 2

Herder 3 was also situated in western Finnmark, and belonged to the western range. His summer pastures were located in the head of a fjord. He was also critical to the model and relied even more than herder 2 on the slaughter of yearlings. In some years, his districts' slaughter-herd has been composed of up to 50% males (figure 10). His main concerns regarded the narrowing down of the product range to only include calf meat and the Røros models' uniform focus on meat production per animal.

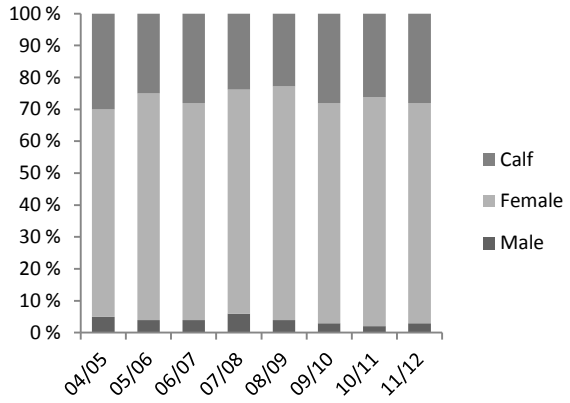


Figure 9. Herd composition of herder 3

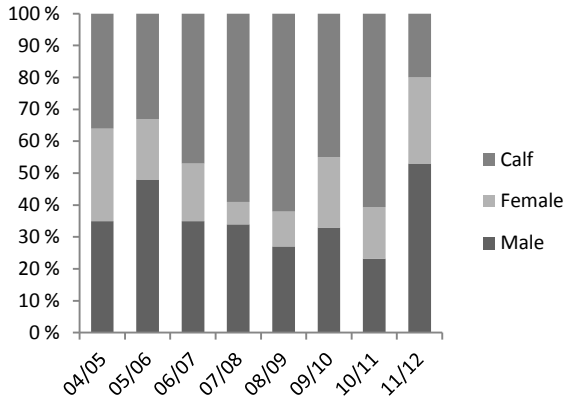


Figure 10. Slaughter strategy of herder 3

Herder 4

> "In terms of meat production, when you are speaking of maximizing production, calf [slaughter] is the best. That is undisputable. In our district we have a mean calf carcass mass (…) of 18,5-20,5 kilograms. It has varied a bit from year to year. And that means that if a calf weighs 20 kg, you have produced those 20 kg in six months. Then you haven't actually had to work that much. The only thing is the branding in the spring and then they move on to the summer ranges. And then we move to the autumn pastures and slaughter the calves there." (Herder 4)

Herder 4 had his summer pastures in the eastern zone of the western Finnmark reindeer area. He had restructured his herd and changed his slaughter strategy in accordance with the Røros model and was very pleased with the result. Statistics from the eight last seasons show that he has slaughtered more than 90% calves most years. His winter herd has been composed of more than 90% females most years. He is, however, not pleased with how his neighbors have increased their reindeer herds while he has decreased his. This has lead to a situation where he has had to guard and feed the animals to prevent them from mixing with other larger herds.

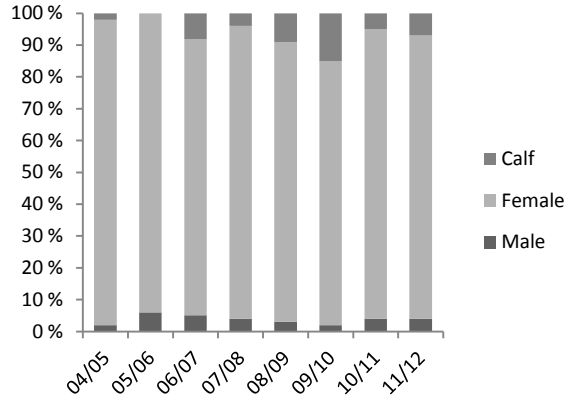


Figure 11. Herd composition of herder 4

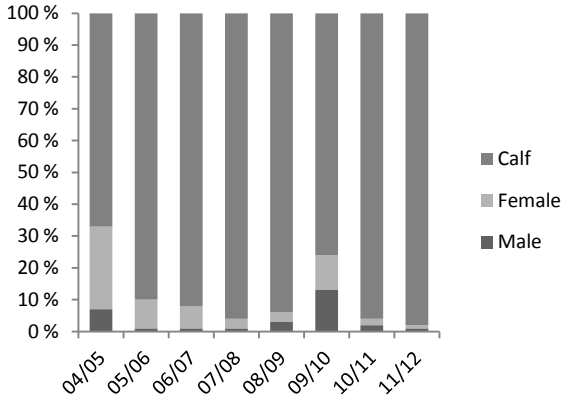


Figure 12. Slaughter strategy of herder 4

Herder 5

> "After we first [reduced our herd], we saw that next year, there were many more calves than we had ever had in our district before. And suddenly our production increased. And then we saw that next year and the year after, the production increased even more. The weights increased and our price per kg increased. We were paid more for the reindeer. Why should we quit that? The subsidies come in the spring, in large amounts. We developed a new mindset." (Herder 5)

Herder 5 was situated in eastern Finnmark. He had also structured his herd according to the model and was pleased with the result. He had enclosed his winter pastures, which had helped him to cope with the consequences of mix-ups. He recommended an increased focus on the improvement of infrastructure, which would enable people to feed their animals and to buffer the effects of harsh climatic events in winter. He thought that a herding strategy based on the Røros model was the best approach for reindeer husbandry all over Finnmark due to its potential for improving the economy of the reindeer owners.

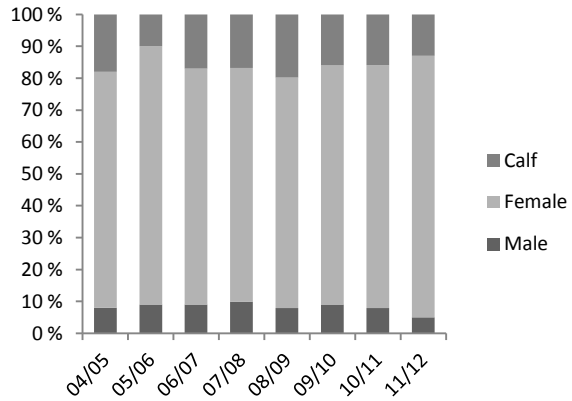


Figure 13. Herd composition of herder 5

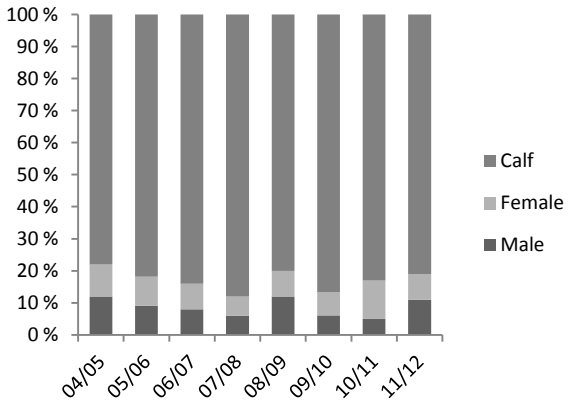


Figure 14. Slaughter strategy of herder 5

Herder 6 is part of a large district in eastern Finnmark. Calves are what they slaughter but they have not followed the optimization theories strictly. Their production fluctuates from year to year and they make most of the slaughter decisions at the roundup corral in the fall. They do what they think is right for their district without strictly following the recommendations from the authorities. He isn't pleased with some of the detailed prescriptions of the Røros-model.

> "A representative of the authorities visited us, but he was irritated that the theories weren't correct. We tried to do like the theories said, but it was nonsense. The main problem was that he said we should slaughter in September, but that was at least one month too early. If we had followed the theories we would have lost two kilograms per calf. That would have been a large loss." (Herder 6)

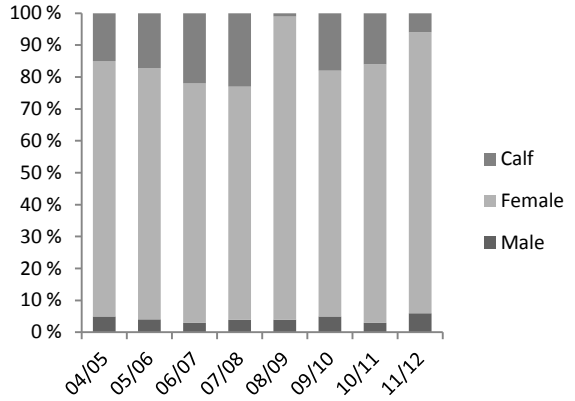


Figure 15. Herd composition of herder 6

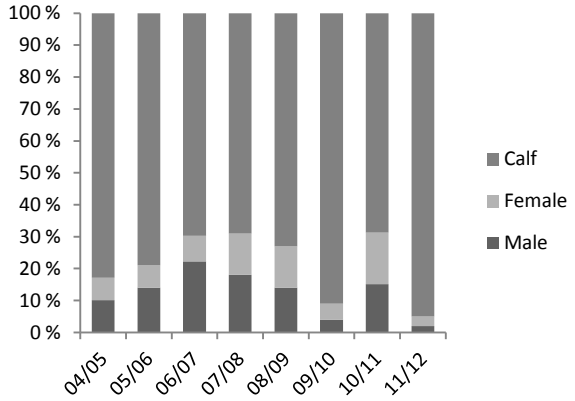


Figure 16. Slaughter strategy of herder 6

Herder 7 was situated in the eastern Finnmark reindeer pasture area with summer pastures located by the Porsanger fjord. He practiced an adaptive slaughter strategy based on multiple categories of reindeer due to a fluctuating production. He criticized the rigidity of the models promoted by the authorities and wanted a management that was more based on the traditional Sámi understanding of reindeer husbandry.

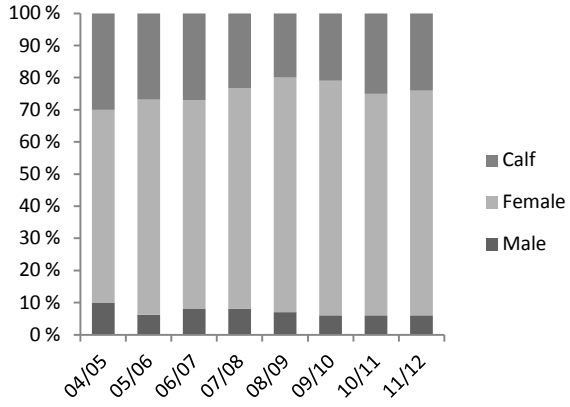


Figure 17. Herd composition of herder 7

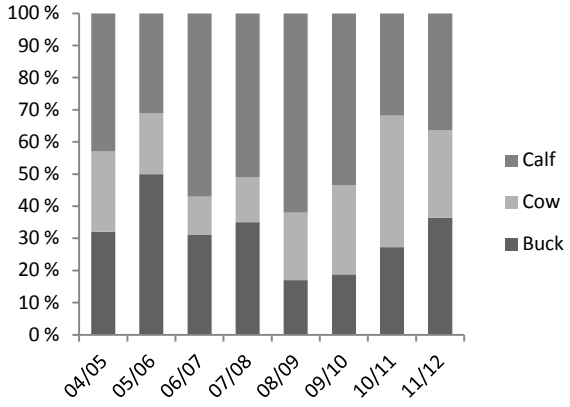


Figure 18. Slaughter strategy of herder 7

Two key informants were interviewed in addition to the seven herders. They provided information at a more holistic scale and gave me a wider understanding of many of the issues that were raised during the interviews with the herders. Both of them are experienced and respected reindeer herders. They have both been involved in reindeer herding research from an indigenous perspective as well as the dissemination and collection of traditional reindeer herding knowledge.

Key informant 1 is an experienced reindeer herder and academic from Guovdageaidnu.

Key informant 2 is also an experienced reindeer herder from Guovdageaidnu. He has occupied central positions in important reindeer herding institutions and organizations.

5.2 The reorganization of herder four and five

5.2.1 Reasoning behind the restructuring

Herder four and five differed from the rest of the informants in how they had organized their husbandry. They followed the Røros model and had therefore based their meat production solely on calf slaughter. Their winter herds contained a majority of female reindeer and few bucks. Most of the calf production was slaughtered each fall. Herder fours' flock was composed of about 95 % females and 3-4% bucks. Some calves were kept each year to replace unproductive elder females and yearling bucks were used in the rut. Their argument was that fewer and larger animals secured a higher calf production and enabled a high slaughter-intensity in the calf segment. The herders had significantly reduced their herds and

adopted a totally new production strategy. Herder five answers this when asked about the conditions in his district before he restructured his herd in the early 2000s:

> "It was a power struggle [between the *siidas*], only *varit* [was slaughtered]. There were few calves. Maybe we slaughtered the calves that had not been branded during the summer. We never slaughtered branded calves. And the herds grew, we accrued larger losses and lower production. There were few calves, some years as low as 20 %. Many entered the liquidation and reorganization programs, me included, because I couldn't see a future in the industry. But suddenly, within five years we got a generational change in my area. People grew old and liquidated for natural reasons and there was more space." (Herder 5)

Herder five decided to reenter the reindeer industry after he had been out for a few years. There was more room, which enabled him to try out the Røros-model.

Herder four had a different reasoning behind the restructuring:

> "(…) It has been the authorities' wish to reduce [the reindeer population]. And we saw that already back then there were way too many reindeer on the common pastures. We could see that the quality of our reindeer declined. The authorities requested that we reduced our herd. We were also told that those who did not slaughter would have to expect coercive measures… That was [decisive for us]." (Herder 4)

In the wake of the decisions on maximum reindeer numbers that were made by the Reindeer Husbandry Board in 2002 he was proactive and decided to reduce his herd and adopt a calf production strategy. He was able to come to agreements with the rest of the herders in his district.

5.2.2 Difficulties accrued in the wake of restructuring

Herder four was disappointed that the reindeer population in western Finnmark had continued to increase after he reduced his herd at the start of the 2000s. He fears that new reduction schemes will unfairly hit reindeer owners who have complied with the regulations.

> "(…) [The authorities] made threats about coercion [before we restructured]. We figured that if this coercion came, we would receive extra punishment if we had not

complied with the demands. Unfortunately, these penalty rounds are now starting. The herders that have reduced will become the targets. (…)" (Herder 4)

Article 60, third paragraph in the Reindeer Husbandry act states that each *siida*-share must reduce its herd proportionally according to the reindeer population decisions if the *siida* cannot agree on how to reduce (Reindriftsloven 2007). A proportional reduction may entail a collective punishment where herders who have been loyal to the decisions will have to additionally reduce their herds (Sametinget 2013).

More reindeer on the common winter pastures has made herder 4's small herd vulnerable to mix-ups with other herds. And since the winter pastures are shared, he could not enclose them. Consequently he has had to shepherd his animals more intensely during the winter. He did not expect that this would happen.

> "Before we reduced, we calculated and found that our operational expenses would decrease. That almost came true. But the problem was the winter pastures. We reduced while the others just increased and increased. And we had to watch [our herd] all the time, even more than before because [the other districts] lost their respect for us." (Herder 4)

Herder 5 also had a problem with mix-ups, but this was solved by enclosing the winter-pastures. He could do this since he had exclusive user rights to them. He described potentially grave consequences of mix-ups between small structured herds and larger herds:

> "We saw that it was easier to handle the herd through the winter and we had lower operational costs. But then it started again. [Reindeer from other herds] started to come in. We had to build a fence for 3 million NOK around the district, so that the neighboring herds wouldn't come in and trample. If you mix when you have reduced your herd, if you for example mix 400 to 500 reindeer, it can take two to three years [before you get them back]. Maybe the neighbor has 25000-30000 reindeer, and you are supposed to find those 4-500 reindeer the year after, or during the first parting. You will never get your herd back again. It can take three to four years before you find them." (Herder 5)

Herder 5 went on to talk about how the authorities haven't fully understood the mechanisms of mix-ups between large and small herds, which has meant that the herders with the smaller herds often have gotten in trouble when they haven't been able to account for their animals:

> "Then you get in trouble with the authorities again. The reindeer show up after three or four years. We have had large quarrels with the authorities about this: "So you are not in control?" they ask us. And we reply: "But we aren't the ones who are responsible for the mixup, [another *siida*] came in with 3000 reindeer and swept up those 500, is that our problem?" "Yes that is your problem." So you come across that situation at the administrative level. They are not able to see that as a problem. If a person has 500 reindeer and the animals are mixed with a large neighboring *siida,* then that is a large problem. And if a year and a half goes by, that is a huge loss. Maybe you aren't even able to brand your calves. That is the worst thing. Maybe you get them after the branding deadline is out. Then you will only get your females. And they keep the unbranded calves in the neighboring *siida*." (Herder 5)

This section has given a general introduction to the interviewed herders and their attitudes toward herd composition and slaughter strategies. In the following chapters, issues raised by the interviewed herders and key informants will be further expanded upon.

6. THE PRODUCTS OF REINDEER HERDING

6.1 Shavings and calf meat

> "I only sell larger animals, 1,5 year-olds. My opinion is that when you sell adult animals, you have good quality. You get larger filet steaks and everything. Everything gets bigger. [The management policies] go more and more towards lamb slaughtering, like with sheep, that you only slaughter lambs. But that doesn't work with reindeer, reindeer are not cowshed animals. That is my opinion." (Herder 3)

Herders want to produce quality products. For some of the herders, such quality was connected to the production of larger animals. Herder 3 wanted to deliver bulls that could be processed and sold as more than reindeer shavings (*finnbiff)*. This product is often connected to a different production strategy than the one maintained by the state through the calf slaughter subsidy. There is also a private market in Finnmark where people can buy carcasses directly from the reindeer owners. Private slaughter for own use and sales in the private market in eastern and western Finnmark stood for respectively 8 and 22 percent of the overall slaughter quantity in 2012 (Reindriftsforvaltningen 2013). Calf carcasses are not popular among the private customers, which mostly buy buck carcasses. Reindeer meat is of course also an important part of a reindeer herder's diet. The herders preferably slaughter older animals for themselves and not calves (Key informant 2). According to key informant 1, animals of different weights are also valued differently. Light animals are often good for smoked and boiled meat, while meat from fatter animals is more suitable for drying. When the sole goal of reindeer herding is defined as the maximization of carcass masses per animal, the lighter animals that reindeer herders also value in their own diet are defined as inferior.

There seems to be a distance between the product that the herders supply (or are encouraged to supply through the subsidy system) to the market and the product that they produce and consume for themselves. The result of such a separation can for some herders result in a type of alienation, like was the case for herder 3:

> "When you think like the state and are supposed to only sell calves, it feels like a factory, you have almost become a factory" (Herder 3)

The issue of the factory-like production logic that herder 3 criticize was also brought up by Reinert (2006). He criticized the reindeer policies for being too fixed at the standardization of the product maintained through a "fordist" mass production ideology. Such principles are produced in contexts very different from those of Arctic reindeer herding, which Reinert claim is an adaptive and cyclical industry where scientifically produced knowledge can never fully replace the experiential-based knowledge of the herders.

The concerns raised above were not shared by herders 4 and 5. They were clear on the point that their goal was maximum production. They had no doubts about producing only calf meat. To the contrary, they were proud of their high productivity. Unfortunately, herder 5 felt frowned upon in the larger herding communities as a result of this.

> "It is almost as if you want to resign from the ordinary reindeer herding communities because you don't feel like you fit in. They have a totally different ideology than we have. It is frowned upon that you slaughter and produce something. And that you are proud of it. You feel that you are doing the right thing, while other people have a different opinion." (Herder 5)

6.2 Authenticity of a product that is increasingly based on external inputs

Another concern that was raised about the quality of the product was the ethical and economic dimensions of an increased reliance on supplementary winter feeding. Herder 3 was concerned about the authenticity of reindeer meat.

> "Some feed their animals continuously to achieve a high production. It looks good on paper, but in reality it is a totally different story. I think it can destroy the quality of your product. If you feed your reindeer extensively you cannot say that this is an animal that has grazed out in the wild. It is fake, really." Herder 3

Reindeer meat is a unique ecological product. The integrity of reindeer meat will be challenged if supplementary feeding becomes more widespread. Its comparative advantage are its unique production methods based on all-year outfield grazing (Riseth & Oksanen 2007). This is different from a more conventional system like sheep husbandry, which is dependent on several months of indoor feeding every winter. It is not guaranteed that the consumers will be pleased if the reindeer herding industry is altered to a system where pellets

and grass ensilage have replaced the natural winter pastures (Holand 2003). Supplementary winter feeding is a practice that becomes more and more widespread. The reindeer herders also had other concerns about this practice, which will be discussed in chapter 8.

6.3 Handicrafts

Another important issue with regards to the standardization of the product is the issue of access to the byproducts from slaughter. This consequence has been given limited attention in the framing of official policy. Byproducts from reindeer are the main component in traditional Sámi handicrafts, *duodji*. First, herders need to pay the slaughterhouses to get the byproducts from their delivered animals back, and second, the shins from the calves are not suitable for *duodji*-products. Key informant 1 expressed concern about the future access to raw materials if reindeer herding in Finnmark was to be uniformly organized for the production of calf meat. Larger animals are required for *duodji*, and calf slaughter waste is unsuitable. For one, the hides are not large enough. And to make them attractive for the market, the calf hides are cut right above the legs at the slaughterhouse. The consequence of this is that there is nothing left for use in the production of s*kaller* (Norwegian word). *Skaller* is a traditional winter footwear which is widely used among the Sámi population. According to key informant 2, raw material is getting increasingly harder to procure. The only viable raw material originates from domestic slaughter, but the limited extent of this slaughter prohibits the scale of the production of *skaller* and sends the prices up. A lack of raw material also means that fewer people learn the skills of *duodji* which means that there will be fewer to carry on the traditions in the future. According to key informant 2, the lack of raw material for handicrafts has also lead to a situation where women are less involved in reindeer herding than they were before. Women are still present in the round-up corrals and at important events, but it is mostly the men who are in charge of the daily running.

7. THE ROLE OF THE BUCK

The Røros-model regards the buck as irrelevant apart from the fact that it secures reproduction: "Males that are superfluous in a mating-perspective, occupy pasture that can be alternatively utilized by females" (Lenvik 1990). A buck-share of about 10% in the winter herd was found to be the lowest proportion that would ensure a high pregnancy rate. Other functions, that many herders value, are therefore disregarded (Reinert 2006).

Most of the informants had a different understanding of the bucks role in the herd than the one conveyed by the Røros model. They claimed that bucks perform many important functions at the summer and winter ranges and during the migrations. According to the herders, they ensure full exploitation of available pastures, they are good diggers in the winter and they make the herd more manageable. Some of the informants also contested the suitability of yearlings as mating animals. Such attributes are harder to observe and document scientifically and are therefore often not emphasized in managerial interventions.

7.1 Buck pastures

> "We [the reindeer herders and the state] have two different points of departure with regards to how you are supposed to get as much as possible out of the animals. And in that regard I can say that in some areas it is ok to have quite a few bucks, while in other areas it is ok to have calves." (Herder 7)

Herder 7 accentuates one of the main arguments of the informants: that some areas are especially suitable as grazing land for bucks. Fewer bucks could mean that these areas are not fully exploited. With a "Røros-structure", the herder would actually not fully utilize his or her pastures and the result may be a lowered production potential.

Herder 2's summer district is on a headland with a road that runs along the coast. He says that the areas around this road cannot be used by females with calves. The reason for that is that females are more evasive when they are tending to their offspring. Bucks on the other hand, are less evasive and are therefore able to utilize areas that are closer to human settlements. Herder 2 has large areas that he defines as buck pastures. If he decreased his buck share he would not be able to utilize these pastures optimally:

> "We use all this area along the road [He points at a map]. I don't dare to let the females down there. They are drawn away from the road, but the bucks do not care about that. They go all the way down to the sea. And that is the way we utilize our district. If we had slaughtered all the bucks, we would not have needed this area. But there are good green pastures around there" (Herder 2)

This was also supported by herder 6:

> "The females can be all the way down at the beach before calving. But once they have given birth, they are drawn up to higher ground and then the bucks take over those areas. That is the way that you utilize your areas and resources" (Herder 6)

As more and more land developments are initiated, with more infrastructure and human disturbances on pastoral land, the need for bucks might actually increase, since they are less evasive and therefore able to utilize areas that are closer to infrastructure. The ranges in Finnmark are not evaluated on the basis of their suitability for different animal categories and the term buck pasture is virtually non-existent in the research vocabulary concerning the biology of reindeer. A generalization of the relationship between reindeer and pastures would not make sense to many herders. Key informant 1 criticizes how such an important part of a reindeer herder's reality is not taken into consideration under the management regime. This is a point where Sámi herding knowledge and scientific knowledge is at a collision course.

Another important point with regards to buck pastures is that most herders do not have private ownership to the ranges, but exercise user rights. When these rights are not exercised, they may lose their legitimacy. When an area is not used as reindeer pasture, it become easier for municipalities to change land use plans and allow for land developments, which in turn would decrease the pasture value of the area. Reindeer pasture rights are thus maintained by a system of "use it or lose it" (Marin 2003).

> "You lose land [when you only have few types of reindeer]. If you don't use the land, you lose it. If there are some types of land you do not use, you lose it. I do not think that it is beneficial for the reindeer husbandry that you only have one type of reindeer that only use one type of terrain. That is especially the case at the coastal areas. Here, at the interior, you do not lose land since it has no alternative usage here. And in the winter the reindeer are not distributed on the various pasture types, but in summer and

especially spring the different categories of reindeer seek different pastures" (Key informant 2)

It could therefore be in the interest of the herder to have a buck share that allows for a full utilization of such vulnerable areas. And that would in some cases mean going against the herd structure recommendations from the authorities.

7.2 Bucks as diggers in the winter

Having adult bucks in the winter can also be an insurance strategy against extreme climatic events and reduce the need for supplementary feeding. Winter forage is mostly found by digging through the snow. The Sámi term for grazing is *guohtun* and is translated as "the availability of pastures through snow" (Eira et al. 2010; Eira, I. M. G. 2012). *Guohtun* demands a set of strategic choices by the herder that will secure the reindeer access to the forage. One such strategy can be to include in the herd a number of adult bucks that are able to dig through the snow (Reinert 2006). The social hierarchy in the herd makes this beneficial for the females and calves:

> "At a point during winter, the bucks lose their antlers, and then the females take charge of the herd [since they don't shed their antlers in winter]. And then the females start to conserve their energy by digging less. But the bucks still dig, they need food, unfortunately for them they are not armed, so when they have dug the pit, the females come and chase them away. So bulls are important survival aids for the weakest calves and the females because they have to use less energy to access the food. And when you observe the herd out on the pastures, you can see that the calves stand behind the bucks and wait for something to fly out of the grazing pit. On a good lichen mat a lot of food is thrown out of the pit" (Herder 1)

> "Let us say that you only sell calves. Then you would want many females in the herd to get as many calves as possible. But I think that is a bit wrong, especially if there is too much snow. The elder Sámi used to say that you need to have bucks in your herd, since they are good diggers. When there's too much snow, the bucks prepare the grazing pits and get chased away by the females because the bucks don't have antlers in winter." (Herder 1)

Having animals that are good diggers can be especially important when icing of pastures occur. This happens when wet snow freezes and a hard ice crust that locks the pastures is formed. This prevents the reindeer from accessing plants. Such extreme events occur at irregular intervals, and when they do, the herds scatter in search of fodder. The result can be that the herders lose control over their animals. Such situations are called *goavvi* in Sámi and denotes a catastrophic situation where the reindeer are not able to get through the snow (Eira, R. B. M. 2012).

8. SUPPLEMENTARY FEEDING AND HERD DIVERSIFICATION

When *goavvi* events like the icing of pastures occur, supplementary feeding can be a solution. The traditional coping strategy was to move the animals from the locked pastures to reserve areas in search of better grazing conditions. This coping strategy has today to a large extent been replaced by a supplementary feeding regime. The mobility of the herders has been reduced, because of encroachments on pastures from other land-users (Eira, R. B. M. 2012). Supplementary feeding has also been put to use by many herders under more normal circumstances. The two structured herders pursued this strategy. A consequence of this is that the nutritional demands of the reindeer increase, because of their improved condition (Holand 2003), and they will dig and graze more than they would if they had not been fed. This may have ramifications for the regeneration of lichen and the sustainability of pastures (Holand 2003). Feeding a herd is very labor intensive and not necessarily profitable. Profitability depends, among other things, on the herd size: a large herd would be harder to feed than a small herd (Holand 2003). None of the informants questioned the use of supplementary feeding under *goavvi* conditions. But feeding under non-extreme conditions was more contested. Some were of the opinion that the reindeer should be able to utilize the available resources in their natural habitat and not be dependent on external inputs. The herders who had this opinion included most of the informants who had not structured their herds. This is a common conception in Sámi reindeer herding. Herders regard their animals as belonging to the wild (*luohtu)* and there are ethical objections against making the reindeer dependent on human beings through feeding (Magga et al. 2001).

The two herders who had structured their herds practiced supplementary feeding and saw it as a necessity to secure the production or to prevent animals from spreading out and mixing up with other herds.

8.1 Tameness

According to Sara (2001), reindeer herding is performed as a compromise between the territorial binding and natural behavior of the reindeer and the wishes of the herder. The Sámi word for semi-domesticated reindeer, *boazu*, and its wild counterpart, *goddi,* bear no reference to tolerance or shyness of humans (Sara 2009). Instead, the Sámi understanding of

boazu is connected to their ability to control the animals so that they serve human purposes, while at the same time preserving a degree of wildness that enables the reindeer to find pastures independently. Such an understanding differs widely from the popular view, where reindeer are perceived as tame in the same manner as sheep and cattle. Such an understanding is reflected in the Norwegian term *tamrein,* which is translated to "tame reindeer". Sara (1997) puts the issue of control and tameness like this (my translation):

> "The reindeer are not bound to humans. This is not said with regret, instead it is perceived as valuable that the reindeer are free, mobile and independent. And because it is like that, humans have to compromise with the reindeer in their work. As support for this, humans must closely observe and hold knowledge about the nature of the reindeer, the topography of the areas, weather and climate, and the reciprocal relationships between all these factors. The goal is that the reindeer find pastures and at the same time stay as a coherent, delineated unit" (Sara 1997)

The reindeer may become tamer if supplementary fodder is given (Magga et al. 2011). Increased tameness may entail a higher tolerance to human infrastructure and shorter avoidance distances. This is a compromise with the natural behavior of the reindeer. Herder 1 mentioned possible negative consequences of increased tameness.

> "It is a problem for us that the tameness of the animals increases because there are areas that require a certain degree of wildness. When we come to the coast we run into problems, because our animals have become so tame that they run straight through the cabin villages. And they get into cultivated areas. The animals don't stop at anything. We didn't have such problems before. Even though people had poorer fences, we managed to keep the animals off cultivated land. Now it is hopeless." (Herder 1)

Supplementary feeding can also affect the grazing dynamics of the herd. The animals may lose some of their ability to find pastures independently and instead be reliant on feed that is supplied by humans. Prolonged feeding may actually suppress natural grazing: when fed, the reindeer stay more at feeding sites, they follow in the tracks of snowmobiles and when they smell hay, they start running in the direction of the scent (key informant 1). This was also emphasized by herder 2:

> "I have seen that when you give reindeer supplementary fodder, they behave almost like cattle. If you bring a round bale, the whole herd is gathered and they stop grazing" (Herder 2)

Herder 2 also said that there is no going back once the feeding scheme has been initiated, since the animals become tamer and more dependent on humans. Herder 2 wanted a resilient herd that could get through the winter as independently as possible, and thought he could achieve this by not feeding his animals and by maintaining a herd structure that favored independence. This was especially connected to a higher buck share.

Herder 5, who had a small and structured herd, practiced supplementary feeding. In his case, the supplementary feeding was an unwanted consequence of his relations to other herders. It enabled him to control and protect his small herd, which was vulnerable to mix-ups with larger neighboring *siidas*. He saw it as a necessary evil since few of his neighbors had reduced their herds according to the decision on maximum reindeer populations. This situation had made his herd more dependent on herding and feeding. In addition to having a smaller herd, which is easier to feed than a large one, he had access to a road that made the transportation of fodder easier.

The other structured herder fed his herd every springwinter to make the transition to spring as smooth as possible. He had been able to invest in this because his economy had improved due to the restructuring. A positive effect of this was that his husbandry now had become less work intensive:

> Q: Why is feeding an advantage?
> "Because the snow becomes rock solid, it is packed, and the animals don't get through. And then they walk more and you have to drive more. Then we might as well just bring food to them, so that they don't wander off. (…) When they are hungry they walk from tree to tree and spread out in all directions, and then you have to guard them more closely and drive more. You have to use a lot of resources on that. And you also wear the animals out." (Herder 4)

It seems as if Herder 4 has chosen to put less weight on some of the characteristics of reindeer herding that other herders emphasize. He is content with a less independent herd because he is able to buffer unfavorable climatic events by feeding. This was made possible by good

infrastructure and the fact that his winter pastures are exclusive and enclosed. Other herders may not operate under the same conditions, or they may value an independent herd higher. The issue of independent and resilient herds is connected to herd structure (Magga et al. 2011), and especially how bucks can secure access to pastures in the winter. Herders and scholars have argued that homogenous herds with fewer good diggers may be less resilient when faced with harsher winter conditions than heterogeneous ones (Reinert et al. 2010; Turi 2008). An effect of a homogeneous herd structure would therefore entail an increased demand for supplementary fodder since the other coping strategies (migrating and spreading) are mostly unavailable. Magga et al. (2011) argues that applying available traditional knowledge about herd structuring can decrease the herds vulnerability to harsh climatic events.

8.2 Diversification

Diversification is a well known strategy in non-intensive production systems. Scott (1998) mentions how many traditional cultivators have developed multiple landraces of the same crop and how "a working knowledge of many, if not all, of these landraces provided cultivators with enormous flexibility in the face of environmental factors they could not control" (Scott 1998). The crops of the farmer would be so diverse and hold so many different traits that there would always be survivors in the wake of an unforeseen climatic event. This was an insurance strategy that secured the farmer a certain minimum production at every occasion. This is very different from a strategy aimed at maximization of production where fields are homogenized and planted with monocultures.

Analogies can be drawn to the management of reindeer husbandry in Norway. The Røros model narrows down the herders managerial choices by basing culling exclusively on weights and to a certain degree age. The goal is a herd with a mean weight as high as possible and a low buck to cow ratio. This leads to homogenous herds. Such a strategy can be radically different from a more indigenous way of composing a herd. An optimal herd for a reindeer owner is a herd that has a diverse age and sex composition that is adapted to the season-specific landscapes, different herd functions and that facilitate a wanted herd behavior (Eira et al. 2015 Forthcoming). This way of thinking is captured in the Sámi term *čáppa eallu*, which means "beautiful herd" (Eira, R. B. M. 2012). According to (Magga et al. 2011) the concept is the antithesis of the monocropping logic employed in modern, high-yielding ruminant systems. *Čáppa eallu* refers to a phenotypic diversity expressed by including multiple

categories of reindeer in a herd, assuming that each animal possess certain traits, or that the combined effect of these traits create a herd that is able to cope with unexpected critical events.

In livestock science, categories of animals are typically delineated into categories like bulls, cows, calves, heifers, steers, stags and yearling calves. Reindeer herders have a developed a richer terminology for their animals. A reason for this is that in reindeer herding, animals serve many purposes, and there is a need to make exact descriptions of them (Magga 2006). Such a need is, among others, derived from the activities of culling and herd composition and the identification of ownership to individual animals (Magga 2006). For example, the female reindeer, *njiŋŋelas,* have many variations based on reproductive status and age. Some of these terms are listed in table 5.

Table 5. Sámi terms for female reindeer

Animal category	Description
Njiŋŋelas	General term for a female reindeer
Áldu	General term for a fertile female reindeer
Čoavjjet	Pregnant female reindeer
Čoavččis	A female reindeer that has lost her calf
Rotnu	A female that has not been pregnant that year
Stáinnat	A sterile female
Čearpmat-eadni	Female reindeer which has lost her calf but is accompanied by the last years calf
Vuonjal	Yearling female

Source: (Magga 2006)

The male reindeer are mostly categorized based on age and whether they have undergone castration. Table 6 shows some of the categories.

Table 6. Sámi terms for male reindeer

Animal category	Description
Varit-čoarvedahkki[1]	Male aged 1-1,5
Varit	Male aged 1,5-2
Vuobirs-čoarvedahkki	Male aged 2-2,5
Vuobirs, vuorsno	Male aged 2,5-3
Gottos-čoarvedahkki	Male aged 3-3,5
Gottos	Male aged 3,5-4
Goasohas-čoarvedahkki	Male aged 4-4,5
Goasohas	Male aged 4,5-5
Máhkanas-čoarvedahkki	Male aged 5-5,5
Máhkanas	Male aged 5,5-6
Nammalápat	Male aged >6,5
Spáillit	Castrated male not yet tamed
Heargi	Castrated male used as draught animal

1: Čoarvedahkki is a term that indicates the transition to a new category
Source: (Magga 2006)

In addition to such sex-specific categories, there are various terms that describe the reindeer's body size, body shape, condition, fur color, coat, head, antlers and feet. Magga (2006) lists many of these terms, among them 22 terms for body size and condition and 22 terms for antlers. These terms can be combined to constitute an exact description of individual reindeer or the totality of a herd's composition (Magga 2006). This intricate classification system has made it so that few herds are identical in the same manner as in other ruminant systems. This is what *čáppa eallu* is about. According to one of the key informants, such qualitative variables can be read by an experienced reindeer owner upon the observation of a herd.

> "When you see a herd, you will immediately identify the share of *varrásat*, large males; *njiŋŋelas/áldu*, which are adult females and *smoaldarat*, the other small animals. (…) When you see a herd, you will immediately see its composition, you don't need numbers. And a herd with larger animals will in a way be larger, not in numbers, but the herd will look larger. (…) Instead of saying that it is a large herd because it is composed of many animals, you say that it is large because it has more

> body mass. That is a visual variable. (…) And that is how you visualize when you are adapting your herd to the landscape and to the pasture" (Key informant 1)

This regards the totality of the herd and the traditional knowledge of the herders which many of the informants emphasized. Herders often hold non-quantifiable information about their reindeer and there has been no tradition in the reindeer industry of keeping exact numerical records of their animals (Eira et al. 2015 Forthcoming). Such a logic is captured in the Sámi reindeer herding terminology (Eira et al. 2015 Forthcoming).

Key informant 1 further mentions that a herd composition based on the optimization theories may lead to a herd that is not well adapted to the landscape. A more diverse herd structure on the other hand, could be an insurance strategy against unexpected climatic events:

> "If climatic events influence the next year's calf production and body growth, then herds with a large share of females will be more fluctuating. There will be larger fluctuations since the annual production of calves may be low. So for the slaughtering season, you are totally dependent on a good calf production. But if you spread [your production] and maybe slaughter a few calves and some yearlings and two-year-olds, then you would have a herd that does not fluctuate that much, a herd that is not as exposed to climatic events." (Key informant 1)

He also mentioned an example from Sweden where the calf production had been catastrophically low and where they had nothing to sell. He further pointed out that there is nothing in the model that guarantees a good calf production.

> "It is not only the herd size that fluctuates, the body mass fluctuates from year to year too. And that manifests itself in the condition of the calves and the females you are supposed to sell. There are a few promises of stability in the model" (Key informant 1)

Good calf production is in fact what the model promises, because the mean live mass and the high mean age of the females are supposed to lead to high pregnancy and calf survival rates (Lenvik et al. 1988; Lenvik 1990). But the assumption is, as key informant 1 points out, that reindeer herding operates in a stable and predictable ecological system. This understanding, that much of the managerial policies are rooted in, is contested among reindeer herders.

There is a widespread understanding in Sámi tradition that it is hard to make slaughter decisions before the animals are put in the roundup corral.

> "It is common in the Sámi tradition that you do not pick out individual animals for slaughter [in advance], because there is a great uncertainty about it. Will they be there when you slaughter? They can be run down in traffic, fall off steep slopes in the mountains or be taken by carnivores. In Sámi tradition there is an understanding that if you plan this too much, take it for granted, it will beat back. You cannot determine this in advance, you have to wait and see" (Key informant 1)

Herder 7 mentions that such an uncertainty has demanded a more diverse and adaptive slaughter strategy than the one that is promoted by the authorities.

> "The model that the state promotes, a template based on the sheep industry, this and this much calf growth, is what we struggle with. We have our reindeer out in the wild. I don't know until the end of September how the calf production has been so that I know what I can slaughter." (Herder 7)

This uncertainty has lead to a quite adaptive and dynamic slaughter strategy:

> "In our *siida* we do the culling in September. We select mostly young and elder bucks, and we pick out animals for breeding. (…) In November/December we divide up the herd and we slaughter females and all the calves. (…) Our slaughter herd is composed of at least 50% calves. (…) As a rule of thumb, I take out 15-20% of the calves in my own herd. And I have structured my herd so that I take out about half of the bucks. I leave some calves that are supposed to become adult bucks too" (Herder 7)

This strategy secures herder 5's economy. He thinks that a production based solely on calves is too insecure, because of the variation in calf production. Even though he loses some of the calves that he has kept in the winter due to predation and other causes, he feels that such a diversification is safer than a more uniform calf slaughter strategy. Figure 18 in the introductory section illustrates how the slaughter strategy of herder 7 fluctuated in the years between 2004/2005 and 2011/2012. The share of females slaughtered has been fairly stable, while buck and calf slaughter has fluctuated more. It must be noted that the slaughter strategy that the figure depicts is the aggregated slaughter strategy in the *siida*, which comprise 18 *siida*-shares, and not the slaughter strategy in herder 7's individual herd.

Herder 2 also reports of variable calf production and therefore also a reduced reliance on calf slaughter. Instead of slaughtering calves, his district let them go on for a year or two until they have gotten large enough. As mentioned earlier, his district has large areas of buck pastures, which also influence their herd composition.

> "We have tried to slaughter calves. It doesn't fit this district when we are supposed to go through the annual cycle. (…) We have to wait until they are one or two years old. That is what we have always done. I have tried to slaughter calves, but it hasn't worked" (Herder 2)

There were also objections against such diversification logics. Herders 4 and 5 argued against the practice from a productivity perspective. They claimed that postponing the slaughter until the calves had become adults was a waste of resources. Herder 4 had tried to base his production on *varit*, but argues that this was far worse than the slaughter of calves:

> "We have tried to postpone the slaughter until [the calves] are 1,5 years and we have also tried to postpone it until they become *Vuobirs* (2,5-3 years) (…) but that turned out to be bad for business, because you lose all the time. Out of a hundred calves, when they become *varit*, you have lost maybe six to seven of them. And you lose six to seven more the third year. And that is actually a *small* loss. But still, the 10-15 reindeer you have lost during those three years, they amount to something. (…) You don't get more kilos out of the 80 you have left than you would have gotten from those 100 calves, had you delivered them to the slaughter. That is the first aspect of it. The second thing is that you have to (…) take care of those reindeer for two full years before they become *vuobirs*." (Herder 4)

8.3 Summary

- A common goal in Sámi reindeer husbandry is *čáppa eallu,* which entails a diverse herd. By including multiple categories of animals in the herd, you may minimize the effects of unexpected climatic events.
- A diverse herd may be better adapted to the grazing conditions in a specific landscape. Different reindeer types utilize different parts of the pasture. The herders have a rich terminology for the different animal categories and these are related to how a herd is composed and adapted to the pasture.
- A diverse herd and slaughter strategy also means that the herder can sell a more diverse product. This can be an insurance strategy against fluctuations in the market. A uniform production of calf meat on the other hand, may oversupply the market and lead to decreased economic returns.

9. A STABLE OR UNSTABLE ENVIRONMENT?

9.1 Two production logics

The Røros model was developed in an environment that was assumed to be stable. In a stable environment, the animal density on the range is perceived to be the main driver of productivity. A static ecologically sustainable stocking rate can in such a system be calculated by modeling productivity over time. It is asserted that an animal population above the defined sustainable stocking rate will cause a general overstocking of the ranges and result in declining carcass masses due to grazing competition. It then becomes the task of the authorities to find methods of setting limits for each individual herding unit. In such a perspective it makes sense to try to maximize production within the confinements of the stocking rate. With this comes the realization of the Røros model that one should take as few animals as possible through the winter, since the winter ranges are believed to be the minimum factor, and base the meat production exclusively on the summer resources. This can be achieved by maximizing the share of fertile females (productive animals) in the winter herd, and slaughter most of the calves each fall. A calf has a higher growth per female potential than for example a yearling buck (10-15kg vs. 20kg) (Lenvik 1988). When they are slaughtered as early as possible they do not put strains on the winter pastures and the mothers will have more time to focus on their own condition. The result is a maximization of meat production per animal in the winter herd. This is why herder 4 and 5 saw it as unprofitable to slaughter animals that were older than half a year. A *varit* have a lower daily weight gain than the calves and will take up unnecessary space on the winter pastures.

The counter to the stability argument is the view that varying environmental conditions, in line with non-equilibrium thinking, and not animal density, is the primary determinant of the production in a reindeer herd. Climatic events affect the attributes of the snow cover in winter, the intensity of the insect harassment in summer and the length of the growing season. This creates unique conditions each year that need to be dealt with adaptively by the herders. Sara (2001) discuss *jahkodat*, a term that captures the variation and uniqueness in climatic conditions from year to year and their impact on the grazing of the reindeer. He draws up nine examples of negative climatic configurations that may occur alone or in concert:

1: A cold weather type and late snowfalls in the spring may lead to the death of the last year's calves due to starvation. Newborn calves may freeze to death in blizzards.

2: A late snow melt means a quick transition from marginal to nutritious pastures and to the period where insects are active. Starved calves may risk death due to the sudden abundance of nutritious fodder. The period from when the green pastures are available until the insect harassment starts may be short. This may inhibit growth as the reindeer have less time to graze undisturbed than normal.

3: Warm summers with a lot of insects means less time for undisturbed grazing. Calves will more easily get parasites.

4: Dry summers result in a modest mushroom-growth, which may affect the reindeer's weight-gain.

5: Wet snow in early winter freeze and a solid layer of ice is formed. This prevents the reindeer for accessing the pastures.

6: The formation of multiple hard layers of snow may reduce the reindeer's ability to break through to the pasture.

7: After the ground has been covered by snow in winter, periods of mild weather or rain may make the upper layer of the snow wet. When the weather turns cold again, the top layer of the snow will freeze and the pastures will be locked.

8: The snow quantity during winter impacts how much energy the animals need to use on digging.

9: The formation of a load-bearing upper layer either by cold, strong winds or mild weather will restrict the access to pastures.

If such climatic conditions are decisive for production, then there is a need to reduce the severity of the effects. Among them are the diversification strategy and the notion of *čáppa eallu* which was discussed above. Such a strategy can collide with what the state regards as rational reindeer husbandry.

Unfortunately, there seems to be a discrepancy between the comprehension of many reindeer herders and the state. While many reindeer owners emphasize the importance of rapid

adaptations to shifting and unpredictable climatic events, the official management strategy is focused on stability, density dependence between reindeer and pastures, and economic incentives to alter herd compositions and slaughter practices. There exists a cross-political consensus in the Norwegian parliament that the main task of the reindeer authorities is the reduction and stabilization of the reindeer numbers (Benjaminsen & Svarstad 2010). This has resulted in resolutions that stipulate the exact maximum reindeer numbers for each individual *siida*.

Researchers have indicated that the relationship between reindeer numbers, density and climatic variation is more complicated and that conservative equilibrium models probably do not capture the dynamics of the system well enough (Behnke 2000; Holand 2006; Kumpula & Colpaert 2003). They rather point to an interplay between density and climate. Holand et al. (2010) found that the relationship between density and carcass masses was scale-dependent in time and space. Despite such nuanced insights, the state management institutions and policy are still exclusively based on the equilibrium and sustainable harvest logic. This is reflected in the official sustainability criteria that I outlined in chapter 2.

9.2 Sustainable harvest, equilibrium ecology and non-equilibrium ecology

Sustainable yield assumes logistic growth of a stock over time (figure 19). When the stock is small, it will reproduce. As the population increases, it will start to compete for fodder and the reproduction will slow down and converge toward an upper ecological carrying capacity (point K in figure 19 and 20). Ecological carrying capacity is defined like this:

> "[W]hen the production of forage equals the rate of its consumption by animals, and the livestock population ceases to grow because limited feed supplies produce death rates equal to birth rates." (Behnke et al. 1993)

This principal relationship is depicted in figure 19. The relationship can also be expressed as growth rate as a function of population size (figure 20).

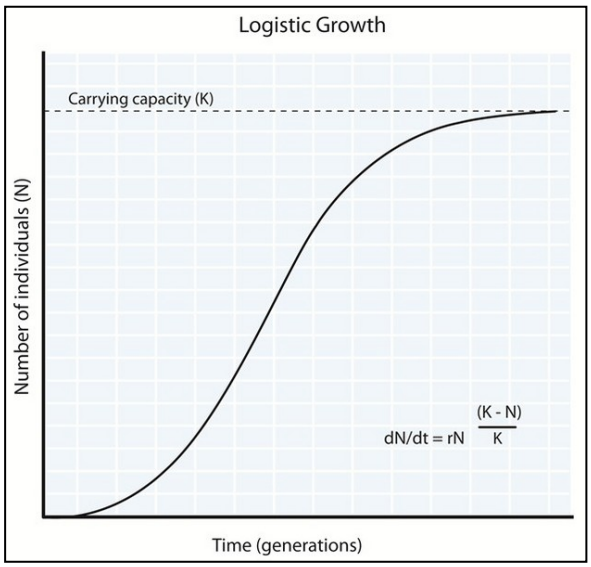


Figure 19. Logistic growth of a renewable resource
Source: (Stokes 2012)

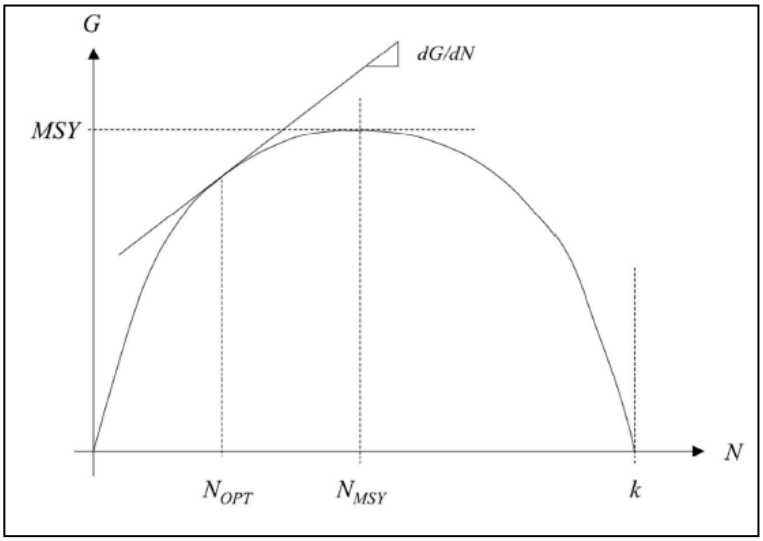


Figure 20. Growth rate as a function of population size Source: (Benjaminsen et al. 2015a forthcoming)

Another important concept is the economical carrying capacity, which sets "a theoretical limit, which marks the number of livestock units that pastoral resources in a certain area can support in order to attain a certain management objective (e.g., optimal meat or milk production)" (Benjaminsen et al. 2006). In figure 20, the points N_{OPT} and N_{MSY} denotes two economic carrying capacities: the first one expresses efficient stock size and the other maximum meat production (Benjaminsen et al. 2015a forthcoming).

The summit of the curve in figure 20 expresses the population size that maximizes the growth of the stock. It corresponds to the steepest point in figure 19. This is the Maximum Sustainable Yield (MSY) which always occurs at half the carrying capacity population. If the population is maintained at this level, the largest possible surplus can be harvested without compromising the size of the stock over time.

These concepts take their departure in population dynamics based on equilibrium ecology. Equilibrium ecology "stresses the importance of biotic feedbacks between herbivores and their resource" (Vetter 2005). This is rooted in the well known "balance of nature" metaphore (Cuddington 2001). It is asserted that a stable equilibrium state between pastures and herbivores is mediated through density dependence:

> "[A] stable balance of species densities is maintained through inter- and intra-specific interactions, which fine-tune the biotic component of the ecosystem within the opportunities and constraints presented by a constant abiotic environment" (Sullivan 1996).

In such an environment, the future productivity of the pasture resource is stable and can easily be predicted. This result in the ability to project optimal stocking rates based on the framework presented above. The equilibrium model has for a long time underpinned policies that focus on controlling defined excessive livestock numbers (Vetter 2005).

Towards the end of the 1980s this position was challenged by a range of theorists who claimed that the abiotic factors in many systems overruled its biotic interactions. This position is often related to the argument that rainfall, and not grazing pressure is the main determinant of possible animal numbers in many semi-arid rangeland systems in Africa (Vetter 2005).

> "The ‘‘new rangeland ecology’’ posits that traditional, equilibrium-based rangeland models have not taken into account the considerable spatial heterogeneity and climatic variability of semi-arid rangelands, and that mobility, variable stocking rates and adaptive management are essential for effectively and sustainably utilizing semi-arid and arid rangelands." (Vetter 2005).

This has lead to a paradigm shift in range ecology concerning African drylands (Campbell et al. 2006) which implies that "[l]ivestock grazing in drylands, widely thought to cause

degradation and "desertification" through bad management practices leading to overstocking, might not be causing irreversible ecological change through over-use of vegetation." [after all] (Sullivan & Rohde 2002).

It has been argued that such a view on population dynamics, most often referred to as the "non-equilibrium model" also is relevant in the sub-Arctic context. Behnke (2000) suggested in a comparative review article between semi-arid areas in Africa and northern ungulate systems that fluctuations in temperature, snow cover and rainfall creates widely different grazing conditions from one year to another. This may imply that an analysis inspired by non-equilibrium models can capture the dynamics of the system in Finnmark better than a more orthodox equilibrium model.

9.3 Applying the sustainable harvest logic

The equilibrium model and sustainable harvest logic still serves as the backdrop of research on reindeer herding and production (e.g. Bårdsen et al. (2014)) and animal density is seen as the determinant of the sustainability of the system, cf. LMD (2008). The equilibrium thinking was even more prevalent in the management of the reindeer industry at the end of the 1980s: In the articles "Reintall og beiteressurser" (Riseth 1988) and "Flokkstrukturering – tiltak for lønnsom og ressurstilpasset reindrift" (Lenvik 1990) figure 21 was shown.

The linear regression line shows total slaughter in metric tons related to the number of reindeer in the spring herd, while the solid curvilinear line shows total production. Total production is calculated by adding the total slaughter to the growth of the stock from one year to another. The curvilinear line suggests that as the stock increases, the total production will increase up to a maximum where the production will start to decline. The summit of the curve is the maximum sustainable yield (MSY). When the stock increases beyond this point the productivity will decrease due to density dependence. It can be read from the curve that the same production quantity, 700 tons, was achieved at a population of 100,000 and 65,000. This was used as an argument for reducing and keeping the reindeer population at 65,000 heads in western Finnmark (Lenvik 1990; Riseth 1988). In the latter scenario, the production per animal is much higher than in the other. With a population of 100,000 the production per animal would be lower and the strain on the pastures and operational costs would be higher.

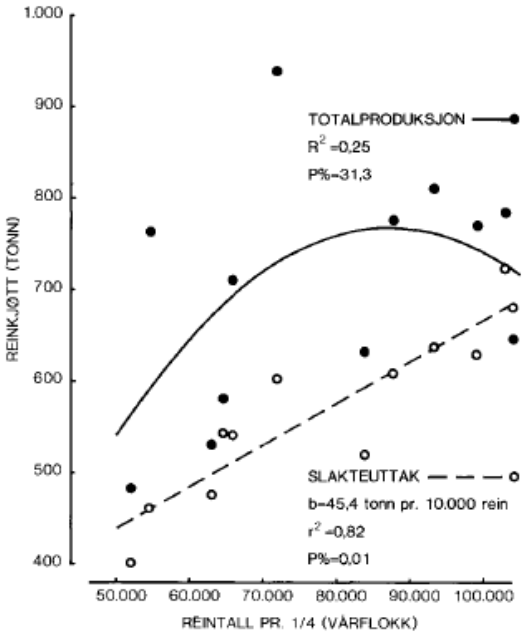


Figure 21. Slaughter and total production in western Finnmark 1977/78 – 1987/88 related to the reindeer population in spring
Source: (Lenvik 1990)

The figure reflects compliance to the paradigm of logistic growth and sustainable harvest. Such models have been applied in economics, population ecology and game- and fisheries management, but have also been criticized for being too simplistic (see for example Holt (2011)). Paine (1994) argues that the notion of overfishing, originating in the MSY-thinking, was conveniently transferred to the realm of reindeer husbandry where politicians and researchers had defined the system as having too many reindeer. The term overgrazing was termed analogous to overfishing. The overgrazing narrative has ever since taken the form of an institutionalized fact (Benjaminsen et al. 2015b forthcoming).

It is often possible to spot a trend by simply looking at plotted observations. In this case, for the solid data points in figure 21, the trend is not obvious. It can however be observed that the lowest production was achieved with the smallest stock (about 50,000) and that the highest production was achieved when the stock was closer to the peak of the curve. The observations deviate largely from the curvilinear regression line, which had an R^2 of 0,25, but was not statistically significant (P-value of 0,31). These drawbacks were not mentioned in the articles where the figure was printed.

A regression analysis can also be used for prediction by extrapolating the trend line, but one should be cautious about making such predictions outside of the data range. A simple graphic extrapolation of the regression line has been made in Figure 22.

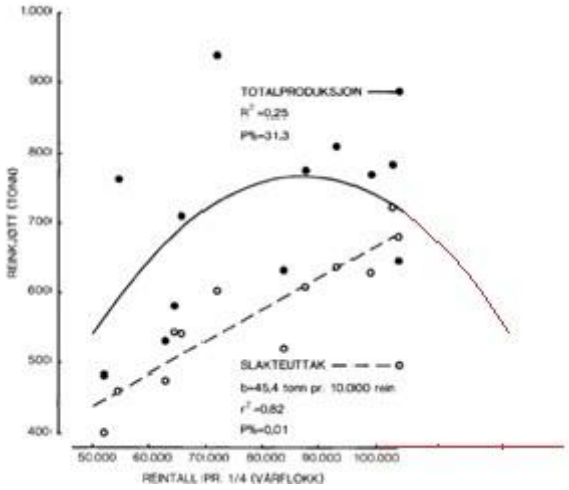


Figure 22. Slaughter and total production in western Finnmark 1977/78 – 1987/88 related to the reindeer population in spring with a graphically extended regression line Adapted from (Lenvik 1990)

In figure 22, the horizontal axis scale and the regression line have been extended graphically to forecast what would happen at higher densities than what has been recorded empirically. It can be seen that the curve will intersect the x axis somewhere between 130,000 and 140,000 animals. This would then be the ecological carrying capacity, *k*. According to the sustainable harvest paradigm, a population beyond *k* implies overgrazing and is not ecologically sustainable. This also means that all stocking rates up to the ecological carrying capacity would be sustainable and not degrade the long term productivity of the resource. Based on the analysis in figure21, the reindeer population of western Finnmark can actually *grow* and still be sustainable, provided you define sustainability as *k.*

In figure 23, slaughter data from year 1981-2012 has been modeled in a similar way as in figure 21 and 22. The production is given as total animals produced instead of total meat production in metric tons. Slaughter data was retrieved from the reindeer administration.

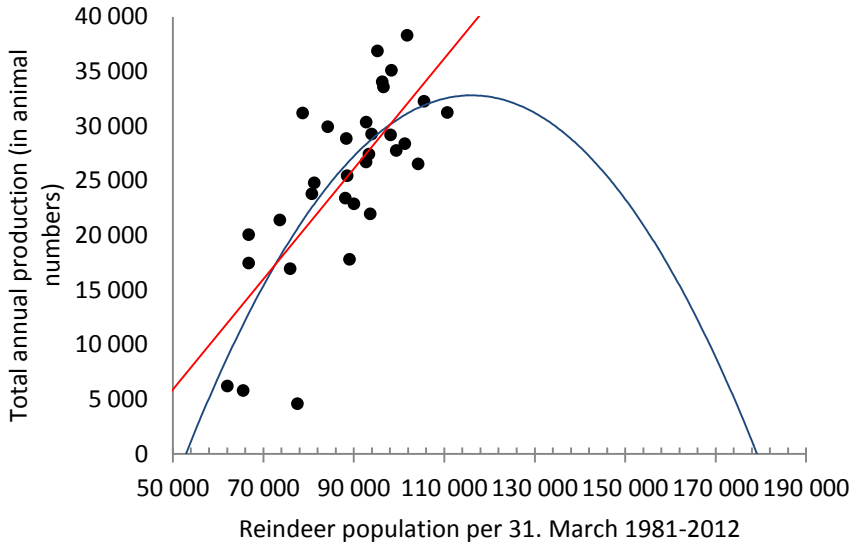


Figure 23. Growth rate of the reindeer population in western Finnmark 1981-2012 with linear and polynomial regression lines

The growth rate was found by calculating the growth of the stock from one year to the next and adding the total slaughter to this. This is expressed through the following formula:

Growth rate year t= Stock year t - stock year t-1 + slaughter in year t.

The plotting of the growth rates reveals an obvious trend: that an increased reindeer population leads to an increased production of new reindeer. According to the logic of the sustainable harvest paradigm though, the growth is logistic and should start to decrease at a certain population size. Such a decrease cannot be observed in figure 23. If there is a critical point where the growth starts to decline, this would appear at a population higher than the highest population that has ever been observed in western Finnmark so far.

A polynomial regression line to the second power was included in figure 23 to illustrate the logistic growth that is assumed in the sustainable harvest model (the blue line). In addition to this, a linear regression line was also included to assess for best fit (the red line). There was little difference in the explanation value (linear fit: 0,56, polynomial fit: 0,59).

A model like this pays no attention to environmental variables, and the density of animals is perceived to be the only driver of population growth. But research has shown that many other factors influence the production in a reindeer herd. This analysis has illustrated how such a simple model probably does not fit the population dynamics of reindeer in western Finnmark

well enough. Based on available data on the reindeer population and slaughter, the point where the growth of the stock flattens out, the carrying capacity, has not been observed. But by fitting a polynomial regression line to the observations, the logic of the sustainable harvest model was "forced" upon the data. This reveals an MSY of around 120,000 and a *k* of approximately 180,000 animals. These are densities that have never been present in Finnmark. Also, the polynomial fit did not give a much higher explanation value than a linear fit. Despite from these shortcomings, the MSY and carrying capacities are still concepts that are mentioned in connection to the management of reindeer husbandry in Finnmark.

9.4 Density dependence as the foundation of reindeer population decisions

The equilibrium logic also underpinned the decisions about maximum reindeer populations that were made in 2002. The Reindeer Husbandry Board established the maximum reindeer population in western Finnmark at 64,300 reindeer on their meeting the 30. January 2002. This decision was preceded by a report commissioned by the authorities.

In 2000, the government instructed the Reindeer Administration to determine a maximum reindeer population for western Finnmark. A consultation paper written by Ims and Kosmo (2001) served as a method and framework for the decisions. The report assessed the pasture capacity in western Finnmark and suggested how the reindeer numbers should be divided among summer districts.

Here is a summary of the approach that was followed in Ims and Kosmo (2001):

The winter pastures are regarded as the systems minimum factor and therefore the determinant of how large a winter herd can be. A maximum winter population was therefore calculated at the regional scale, based on the productivity of the lichen mats. Since the winter pastures are shared among many districts, it was not possible to directly establish reindeer numbers for individual summer districts based on these calculations.

So instead, individual summer district capacities were estimated. A regression analysis was the foundation of the summer capacity estimation method. It expressed slaughter weights as a function of animal density and is shown in figure 24.

The individual districts' allowed winter populations were then defined based on their share of the total summer capacity adjusted for degree of land interference and pasture quality.

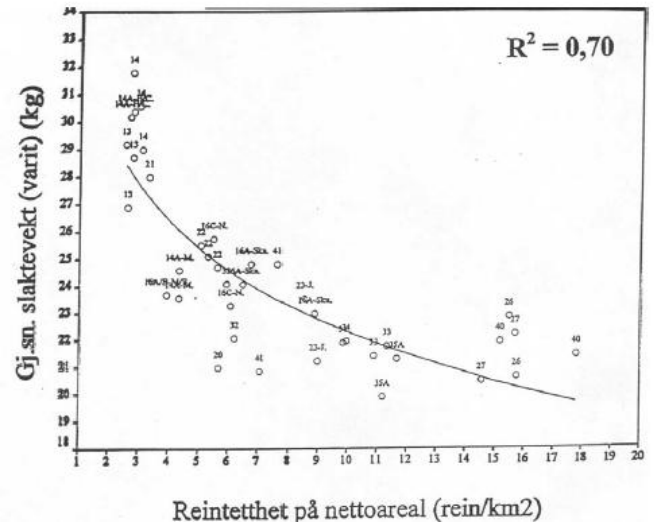


Figure 24. Mean carcass masses of yearling bucks as a function of reindeer density on net area
Source: (Ims & Kosmo 2001)

The results of the analysis showed a significant negative relationship between the variables. As the density of animals increased, the carcass masses decreased. The analysis was based on the masses of yearling bucks and reindeer population statistics from the years 1998, 1999 and 2000 on the district/*siida* level. An R^2 of 0,70 meant that 70% of the variation in slaughter weights could be attributed to density. The remaining 30 % were attributed to a variable climate and working conditions. This sent a clear message the authorities that reindeer-husbandry in Finnmark operated in an equilibrium system. The report has been an important reference point for the management of reindeer herding since its publication, although reindeer herders were skeptical to the method:

> "Ims and Kosmo have chosen a regression analysis as the calculation method of the maximum reindeer numbers. In the regression analysis, 2 variables are used: mean carcass masses of *varit* and animal density on net area. The method of Ims and Kosmo is way too narrow. There are many variables that are just as important as those that are used in the analysis. To illustrate this you just need to remove data from the districts that are not in western Finnmark, or view these for themselves, then you will clearly see that there is no relation between pasture area and the weights of *varit*" (Consultative statement for Ims and Kosmo (2001) by NRL, my translation)

"Concerning the carcass mass statistics, *jahkodat*-variations have not been taken into consideration. For example, weights from the 1960s are compared to weights from 1998 without bringing in climatic data in the assessment. We know that icing, lots of snow and late thawing in the spring of 1997 made the pasture conditions extremely bad, something which have affected the weights of *varit* in 1998 greatly." (Consultative statement for Ims and Kosmo (2001) by Johttisápmelaččaid searvi, my translation)

9.5 Retesting the method of Ims & Kosmo (2001)

In the following section, I have retested the methodology used in Ims & Kosmo (2001) and extended the time series (1980-2012). A more detailed description of the methodology is included in chapter 4. The analysis includes simple OLS regressions on carcass masses and animal densities on the mainland-, island- and district scale. In addition to this, I performed a multivariate regression including climatic variables (growing degree days and precipitation) on the mainland scale.

9.5.1 Results from the mainland scale

Table 7. Ordinary least squares (OLS) linear regressions of *varit* and calf carcass masses at Finnmark mainland scale

	Calf			*Varit*		
	E	SE	P	E	SE	P
Intercept	18.4646	0.2518	<0.001 ***	28.1026	0.5264	<0.001 ***
Density	-0.1523	0.0204	<0.001 ***	-0.3069	0.0436	<0.001 ***
	R^2=0,15 N= 314			R^2=0,22 N= 178		

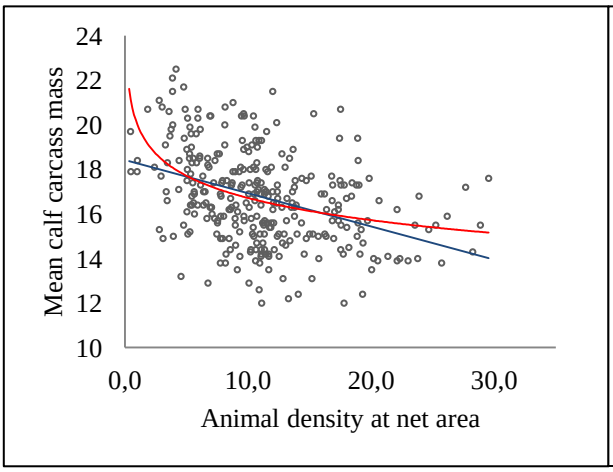


Figure 25. OLS regression of calf carcass masses at Finnmark mainland with linear and logarithmic regression lines fitted

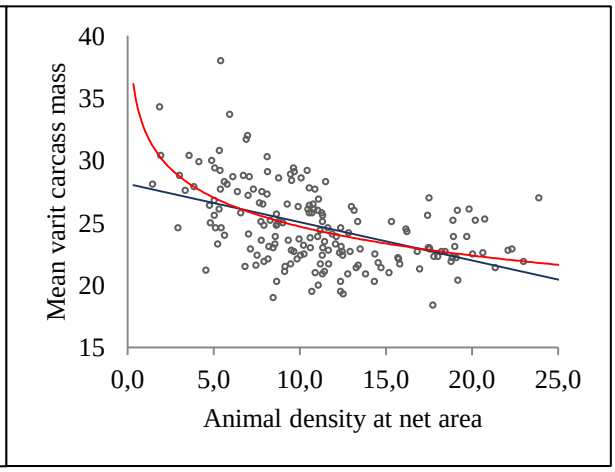


Figure 26. OLS regression of *varit* carcass masses at Finnmark mainland with linear and logarithmic regression lines fitted

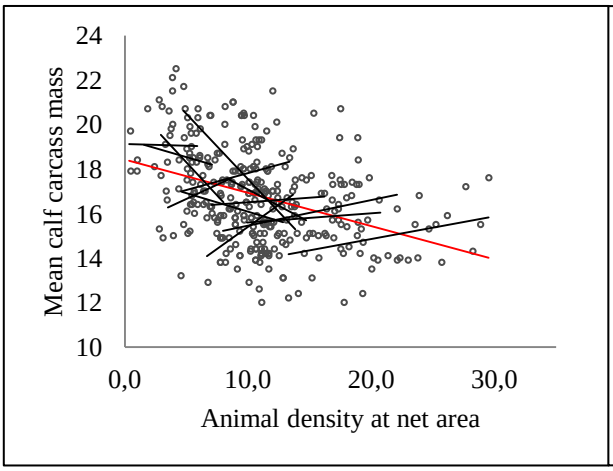


Figure 27. OLS regression of calf carcass masses at Finnmark mainland with linear regression lines for mainland and individual summer districts fitted

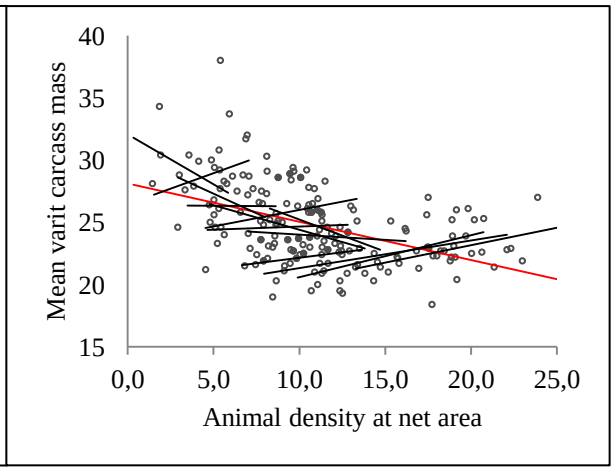


Figure 28. OLS regression of *varit* carcass masses at Finnmark mainland with linear regression lines for mainland and individual summer districts fitted

Table 8. Ordinary least squares (OLS) multiple linear regressions of *varit* and calf carcass masses at Finnmark mainland scale

	Calf			*Varit*		
	E	SE	P	E	SE	P
Intercept	18.5290	0.8199	<0.001 ***	25.3447	1.8661	<0.001 ***
Density	-0.1588	0.0192	<0.001 ***	-0.3203	0.0369	<0.001 ***
Temp. May	0.0308	0.0064	<0.001 ***	0.01908	0.0123	0.12348
Temp. June	-0.0079	0.0037	0.0346 *	-0.0200	0.0069	0.00412 **
Temp. July	0.0034	0.0027	0.1971	-0.0021	0.0053	0.69331
Temp. Aug	-0.0005	0.0028	0.8645	0.01023	0.0049	0.03965 *
Precip. May	0.0011	0.0099	0.9140	0.04778	0.0175	0.00712 **
Precip. June	-0.0374	0.0060	<0.001 ***	-0.0535	0.0099	<0.001 ***
Precip. July	0.0191	0.0045	<0.001 ***	0.03546	0.0074	<0.001 ***
Precip. Aug	-0.0010	0.0036	0.7825	0.03219	0.0075	<0.001 ***
		R^2=0.30			R^2=0.49	
		N= 314			N= 178	

9.5.2 Results from the island scale

Table 9. Ordinary least squares (OLS) linear regressions of *varit* and calf carcass masses at Finnmark island scale

	Calf			*Varit*		
	E	SE	P	E	SE	P
Intercept	19.02758	0.30796	<0.001 ***	29.0254	0.6810	<0.001 ***
Density	-0.10229	0.04568	0.0259 *	-0.1243	0.1154	0.283
	R^2=0.0082 N= 274			R^2=0.0081 N= 144		

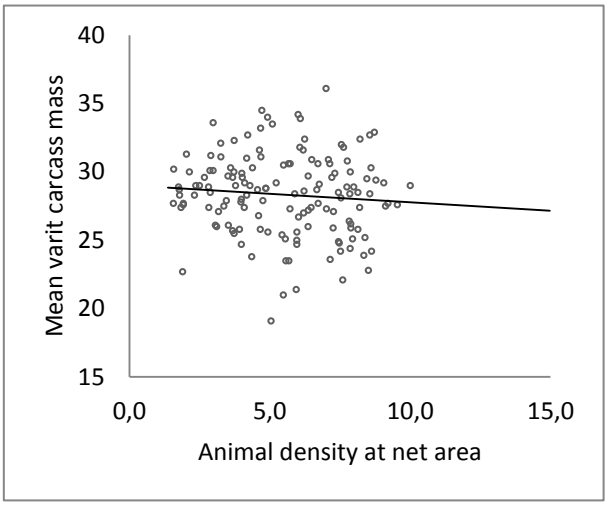


Figure 29. OLS linear regression of *varit* carcass masses at Finnmark island scale

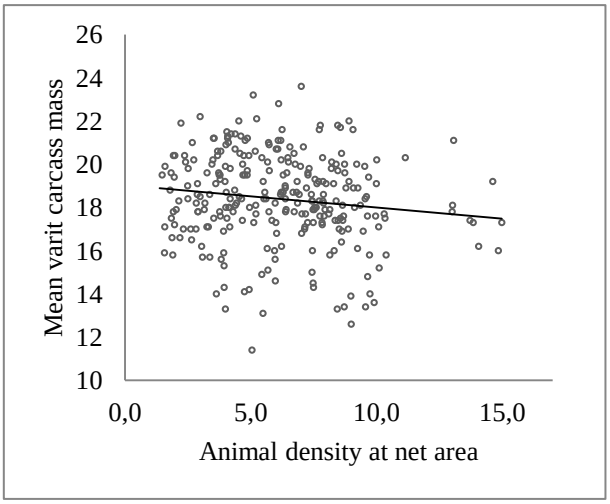


Figure 30. OLS linear regression of calf carcass masses at Finnmark island scale

9.5.3 Results from the district Scale

Most of the 50 simple regressions on the district scale were not statistically significant. Table 10 shows the number of significant models for each animal category in the analyses. The trend was that density affected carcass masses negatively. Five models out of fifty were significant. Estimates are shown in table 11 and the models are plotted in figures 31-35. In district 20, 25 and 26, density was significantly positively correlated with carcass masses. In districts 36 and 21, carcass mass was negatively correlated with density.

Table 10. Number of significant results in OLS regressions at district scale

	Calf		*Varit*	
Significant	Yes	No	Yes	No
	2	23	3	22

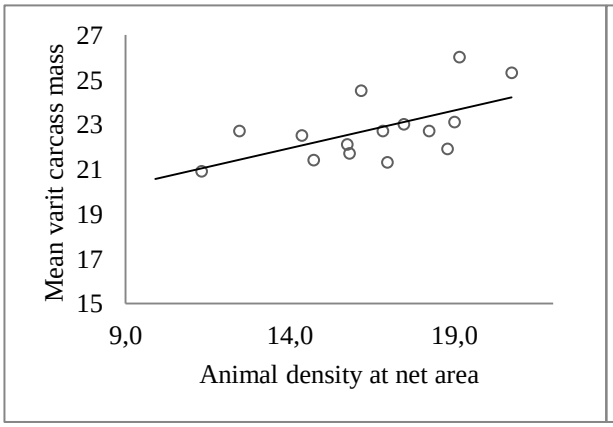


Figure 31. OLS linear regression of *varit* carcass masses in district 26

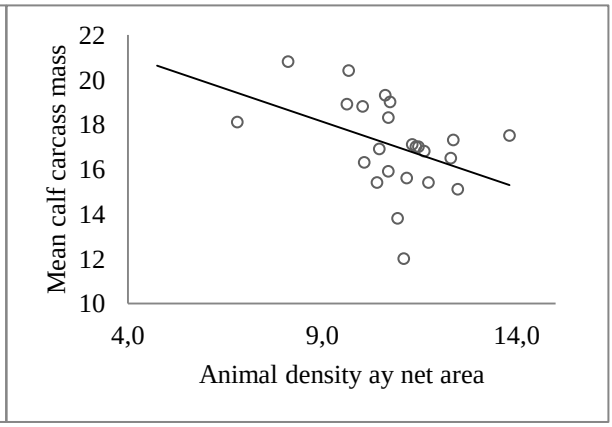


Figure 32. OLS linear regression of calf carcass masses in ditrict 36

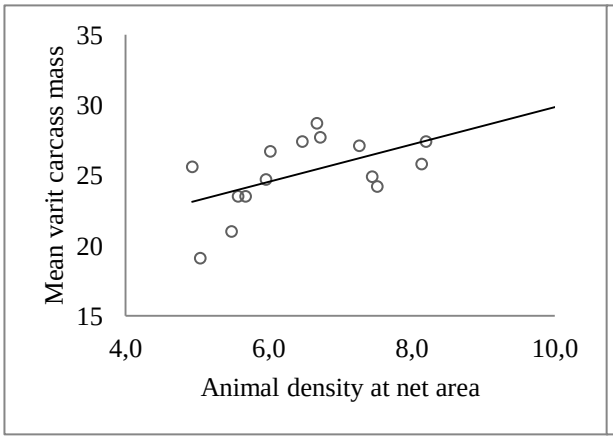


Figure 33. OLS linear regression of *varit* carcass masses in district 20

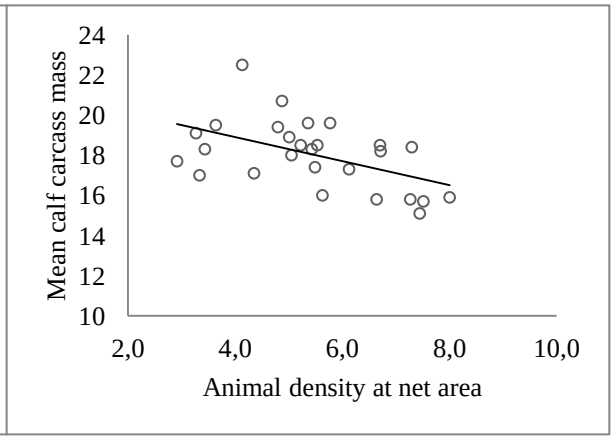


Figure 34. OLS linear regression of calf carcass masses in district 21

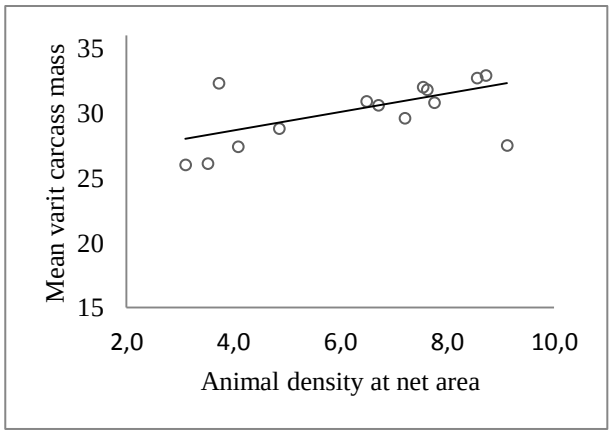


Figure 35. OLS linear regression of *varit* carcass masses in district 25

Table 11. Ordinary least squares (OLS) linear regressions of *varit* and calf carcass masses in districts 20, 25, 26, 21 and 36

			Intercept	Density	
District 20	*Varit*	E	16.416	1.350	
		SE	3.775	0.576	R^2= 0.30 N= 15
		P	<0.001 ***	0.036 *	
District 25	*Varit*	E	25.7807	0.7166	
		SE	2.2162	0.3312	R^2= 0.27 N= 15
		P	<0.001 ***	0.050 *	
District 26	*Varit*	E	17.2266	0.3367	
		SE	2.1323	0.1277	R^2= 0.35 N= 15
		P	<0.001 ***	0.021 *	
District 21	Calf	E	21.2534	-0.5929	
		SE	1.1426	0.2034	R^2= 0.25 N= 27
		P	<0.001 ***	0.0074	
District 36	Calf	E	23.4173	-0.5887	
		SE	2.9801	0.2732	R^2= 0.17 N= 24
		P	<0.001 ***	0.0424	

9.5.4 Discussion of results at mainland and island/peninsula scale

No effect of density on carcass masses was seen at the island districts. The problem in the island districts is rather that they have relatively bad pasture conditions when they come to the mainland after the summer season (herder 1). The island districts had a significantly lower mean density than the mainland districts. This does not, however, imply a conclusion that the reindeer husbandry on the islands in Finnmark is density-independent. It is unknown what would happen at higher densities, and there might be thresholds that induce declining carcass masses.

The picture looked quite different at the aggregated mainland scale. A clear significant negative effect of density on carcass masses could be seen. On the long time scale used in this analysis, the highest carcass masses were achieved in the districts that had the lowest animal densities and vice versa. This coincides with the results in Ims and Kosmo (2001), although the R^2 in the *varit* analysis was smaller in this study (0,22) than in the report (0,70). Both linear and logarithmic regression lines were added to the plot to assess for best fit. The difference in explanation value between the two trend lines was small[27]. Ims and Kosmo (2001) argued that 70 % of the variation in carcass masses could be explained by density dependence alone. The remaining 30 % was attributed to other factors, including climatic events. The analysis in this study could explain 15 % of the variation in calf masses and 22 % of the variation in *varit* masses with a comparable method, only at a different time scale. One could, based on this, apply the same logic as in the report and conclude that 85 and 78 percent of the variation in the carcass masses of calf and *varit* could be explained by other factors than density, in other words, a system that to a large degree is density independent. Such a conclusion is of course unwarranted. It is an undisputed fact today that density dependence is present in the reindeer husbandry of Finnmark in one form or another. Benjaminsen et al. (2015a forthcoming) argues that one therefore should separate between *spatial* and *dynamic* density dependence. *Spatial* density dependence regards grazing competition in a given area at given time, which can be present in any system while *dynamic* density dependence is primarily an aspect of an equilibrium system. Indicating that an opposite conclusion from that of Ims and Kosmo (2001) regarding the density dependence of reindeer husbandry can be

[27] R^2 of 0.157 on the logarithmic trend line as compared to 0.151 on the linear trendline in the calf analysis and 0.2765 logaritmic and 0.2197 linear for *varit*

drawn based on a similar method, illustrates how a simple statistical method can be misused. Ims and Kosmo (2001) laid the foundation for the reindeer population decisions that were made in 2002. The report has also been referenced in biological publications when the issue of density dependence in reindeer husbandry of Finnmark has come up (see for example Fauchald et al. (2004) p. 5; Holand (2003) p. 123 and Blixgård (2005)).

Ims and Kosmo (2001) also tested climatic variables against carcass masses. They found a significant relationship between carcass masses and precipitation in May[28]. Temperature in June correlated with carcass mass (r^2=10), but was not significant. The authors were not able to conclude about the effects of climatic factors on carcass masses based on these results.

Various earlier studies have looked at the effects of climate on the population dynamics of northern ungulates. Climate mostly works indirectly on the body mass of the animals through different degrees of forage availability and quality as well as insect activity. Temperatures influence the degree of insect harassment and the length of the growing season. Temperatures also regulate the snow melt, which affects the phenologic development and availability of plants throughout the summer season. In winter, temperatures and precipitation influence the structure, density and depth of the snow cover, which regulate the reindeer's access to lichen (Tyler 2010).

Weladji et al. (2003) found a clear correlation between insect harassment of skin warble flies and nasal bot flies and calf carcass masses in the districts Esand, Riast/Hylling and Elgå in southern Norway. The extent of the effect was reliant on the availability of insect relief sites. Insect activity is dependent on wind conditions and temperature. The flies are able to fly at temperatures from 15°C. At days with considerable insect harassment, reindeer grazing activity is reduced to zero. The reindeer can partly compensate for this by grazing at night, but grazing time in the mornings and evenings is greatly reduced (Holand 2003).

The fluctuations in the North Atlantic Oscillation index (NAO)[29] influence plant phenology and in turn the demography and reproduction of ungulates (Post & Stenseth 1999). A cold

[28] R^2=0,15; p= 0,015

[29] Definition of NAO: "[A] large scale alternation of atmospheric mass between the North Atlantic regions of subtropical high surface pressure (centered near the Azores) and subpolar-low surface pressure (extending south and east of Greenland." (Lamb & Peppler 1987)

summer is preferable for the body mass of reindeer. This leads to a slower melting of snow-clad areas which ensures a prolonged supply of nutritious and digestible forage (Weladji et al. 2002). High temperatures also lead to increased lignification of cell walls in plants, which decreases their digestibility (Weladji et al. 2002).

Climate may also directly affect the condition of reindeer, which under such circumstances are referred to as weather effects. At high temperatures the reindeer pants more to get rid of excess heat, which can negatively affect their energy budget (Holand 2003). Newborn calves are vulnerable to wind and sleet (Sara 2001).

The results from this analysis indicate a positive correlation between temperature in May and the carcass masses of calves. This effect can be due to early snow melt, which can be beneficial for the body mass of reindeer (Holand 2003). The results for calf and *varit* also indicate a significant negative relationship with temperature in June, the explanation for this can be both insect harassment and a decreased availability of plants at an early phenologic stage. The *varit* analysis also found a significant positive effect of temperature in August. This may be attributed to an extended growing period (Lundqvist 2003). There were also significant correlations between precipitation and carcass masses, but the results went in different directions. The correlations were negative in June for *varit* and calf. They were positive in May, July and August for *varit* and in July for calf. Weladji et al. (2002) pointed out that the effects of climate are scale dependent and often the result of interplay with animal density. Precipitation can be a limiting factor for plant production in continental areas in Finnmark during summer. A relatively high precipitation may therefore be preferable in these areas. At the coast on the other hand, a drier weather type can be better since the mean precipitation is high (Holand 2003). Dry weather also reduces the hatching of mosquitoes and midges. The scale this analysis is performed at has aggregated all summer districts into one variable, meaning that such inter-district variations have been erased. It has also erased the difference in height gradients from district to district, which is important for coping with insect harassment. A variable landscape where the animals can move over large height gradients can also decrease the negative effect of hot and dry summers (Holand 2003).

Tyler (2010) reviewed thirty-one population declines in 12 circumpolar populations of reindeer and notes:

> "In all cases, the observed dynamics are best interpreted as a product of interaction between internal processes (density dependence) and the external abiotic conditions (density independence). The strength and the form of density independence, parameterized in terms of local weather or large-scale climate, varies widely between populations, reflecting the enormous range of climate conditions across the circumpolar distribution of *Rangifer*. This complicates the search for abiotic components likely to be consistently important determinants of population growth in the species." (Tyler 2010)

The results in this analysis are probably not reliable explanations of interactions between climate and reindeer carcass masses. Still, the analysis accentuates how unsophisticated and simple statistical models can be uncritically employed to get a message across. By the time when Ims and Kosmo (2001) was written, the view of reindeer husbandry as a density dependent system was already cemented in the public opinion, the report thus confirmed an already established conclusion. In Ims and Kosmo (2001), the climatic variables gave results that were not statistically significant and had low correlation-coefficients. The way this was presented in the report gave the impression that density was the only important factor for explaining carcass masses. In the similar analysis that I have performed in this study, there were significant results on many climatic variables. Even though Ims and Kosmo (2001) stated that the times series were too short to be able to conclude about the effects of climate, the results of the report gave the impression to decision makers that climatic effects were not important. This is problematic when it has in fact been documented by biologists and reindeer herders that climatic variables indeed can be decisive for production.

9.5.5 Discussion of results at the district scale

Density was not a good predictor of carcass masses at the district scale. Figures 31-35 show the five models out of fifty that were statistically significant. In district 20, 25 and 26 the correlation was positive, meaning that a higher density resulted in higher carcass masses. Other factors than density can have influenced carcass masses favorably in these districts or the population could have been so low that density dependent factors were non-existent. It is unknown what role density dependence would play at higher densities. District 20 and 25 were island districts with a low animal density (between 3 and 9 animals/km^2). District 26 is a mainland district with a higher density (between 11 and 20 animals/km^2) where density co-

varied with higher carcass masses. In districts 36 and 21 the trend was negative. The remaining 45 analyses were not statistically significant. The directions of the relationships in these analyses were also highly variable.

My analyses show large between-district variations in density and carcass masses. Such a variation is concealed in an analysis that is aggregated to a high spatial scale (all mainland districts in Finnmark) and a short time period (data from three years). It is hard to model developments in individual districts when you only have observations from three years.

The time scale in my analysis enabled such a modeling. The large variations from district to district are visualized in figures 27 and 28[30]. Some of the district regression lines are even indicating positive relationships between density and carcass mass.

In figure 36, the regression lines of three individual summer districts have been highlighted in red. It can be observed that the density in individual summer districts fluctuated within ranges.

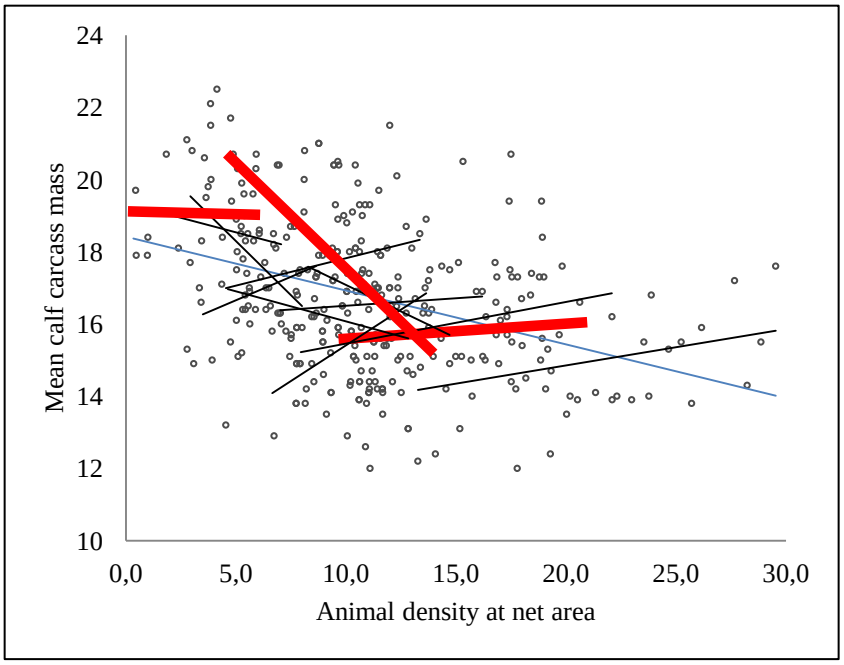


Figure 36. OLS regressions of calf carcass masses in Finnmark with linear regression lines for mainland and individual summer districts and highlighted regression lines for district 42, 36 and 26

[30] Most of the district regressions were not statistically significant and must be interpreted with care.

The mainland scale regression (in blue) must not be interpreted as if each individual summer district has gone the full distance from very low animal densities (1-2 animals/km^2) and high carcass masses to very high densities (29-30 animals/km^2) and lower carcass masses. As shown in the figure, the densities in district 26 were in the range of 11-20 animals/km^2; densities in district 36 ranged between 7 and 14 animals/km^2 and the density in district 42 fluctuated between 1 and 6 animals/km2. Reading from the slopes of the curves, district 36 seems to have experienced a large decline in carcass masses after a doubling of the density; while carcass masses in district 42 has remained stable within a narrow density range. District 26 seems to have experienced higher carcass masses even though the density has fluctuated largely.

The aggregated mainland regression line gives the best possible explanation and summary of the strength and direction of the trends in the dataset. This summary is the result of different stocking practices in heterogeneous summer districts. Such a summary is thus of limited use. An analysis of density dependence should therefore take its starting point in individual districts. This conclusion points to a management system that is adapted to individual contexts.

9.5.6 Conclusion

It was not the goal of this analysis either to prove or disprove the equilibrium model. The data quality was limited and the method was simple. The point was rather to show how such simple methods can have low validity and be scale dependent. In this analysis the method followed in Ims and Kosmo (2001) was retested on extended spatial and temporal scales, which revealed a more nuanced picture.

Ims and Kosmos method was preapproved by the reindeer administration (Joks et al. 2006) and the results were received with a high degree of confidence from state actors. The report has since its publication contributed, probably unintentionally, to the dichotomy between density dependence and density independence. The narrative that animal density is the main problem in almost all reindeer pasture districts in Finnmark and that the only counter to this is herd reductions and restructuring has been cemented. The latest resource accounts publication establish with authority that:

“The low carcass masses in many districts in West-Finnmark and Karasjok the later years is the result of the fact that animal density has become so high in these districts that it has overshadowed the positive effects of favorable climatic conditions and the increased availability of pastures in this period.” (Reindriftsforvaltningen 2013).

10. AGRICULTURAL KNOWLEDGE AND REINDEER HERDING KNOWLEDGE

10.1 Tragedy of the Commons

The popular view of reindeer husbandry in Finnmark is that it is an indigenous family-based industry in need of strict state regulations in order to combat the increasing overgrazing and degradation of the ranges. The management of reindeer husbandry rests on a hegemonic discourse that finds its legitimacy in a claimed tragedy of the commons-situation (Marin 2003). It is asserted that in the absence of state regulation, reindeer owners will act in an individually rational way and not cooperate, a sort of "prisoners dilemma" (Vatn 2005) situation, which leads to overgrazing and degradation of the common pastures. Lenvik (1990) saw the prisoner's dilemma as the main obstacle to a full-scale adoption of the Røros-model. As a counter to this, he prescribed more scientific advising. Such a modernization discourse is produced by politicians, the public administration, environmentalists and the media (Benjaminsen & Svarstad 2010). A recent example of this discourse can be found in an interview with the publicly well-known Norwegian biologist Dag Hessen about environmental issues:

> "[T]he sum of how all of us want to optimize our existence becomes dangerous and may lead to the tragedy of the commons. Take a classic example: reindeer and reindeer husbandry. There are too many reindeer on the Finnmark mountain plateau. This leads to overgrazing, and the reindeer are starving, but no one wants to let go of their animals" Dag Hessen interviewed in Schøyen (2013).

When such a situation is depicted, strict state management becomes the solution. And under state management the policies have been inspired by ideology and values from the agricultural sciences. This can in some situations be problematic, especially when this epistemology conflicts with Sámi reindeer herding knowledge.

10.2 The importance of scientific advice in Norwegian agriculture

The Reindeer Administration is a directorate organized under the Ministry of Agriculture and Food. Because of this administrative organization, reindeer herding has often been put under

the same standards as more conventional agricultural industries. The maximization of meat production is the overarching goal, and the belief that all herders should organize their husbandry uniformly to achieve this is prevalent among bureaucrats and decision makers. Such models downplay the importance of the experiential and traditional knowledge that reindeer herders rely on.

Conventional agricultural production systems in Norway on the other hand, are based on agricultural scientific advice concerning feeding, fertilization, tillage and breeding, among others. An important point is that such knowledge has legitimacy among farmers (pers. comm. regional Farmers Union leader). Norwegian agriculture relies on standardization and rationalization of production methods; a market regulation system that secures uniform pricing and balance between supply and demand; and large farmer-owned cooperatives which guarantee the delivery of agricultural produce.

For example, livestock live in highly controlled environments where the inputs and outputs of the production are thoroughly planned and documented. The farmers are to a large degree reliant on scientific advice to maximize their production and there exists numerous advisory services, which are organized through the cooperatives. Examples of such services are feed planning, fertilizer planning, tillage, maintenance of machinery, veterinarian services and economic advising. There are large livestock breeding cooperatives in Norway. Geno for example, is owned by 10,500 Norwegian dairy farmers and is the breeding organization for the Norwegian Red cattle (NRF), the main dairy breed in Norway (Geno 2013). Geno supplies bull-semen for artificial insemination to farmers all over the country. Farmers can check the pedigree of their animals and order semen from a catalogue of sires. Each participating farmer must report the production parameters of their animals to the cooperative. This material is then used in continued research to improve the breed. The system ensures a healthy gene pool and productive animals. There are equivalent organizations for sheep, beef cattle and pork breeding.

10.3 Language and traditional reindeer herding knowledge

There are not many equivalent advisory services in the reindeer herding industry, and reindeer herders are not organized in cooperatives. Breeding work is also not centralized in the same way as in the agricultural industries. There are many goals in reindeer breeding, not one

standardized goal of maximum meat production per animal. Paine (2009) describes breeding goals in reindeer husbandry in the early 1960s: "Selection of reliable lead animals, of reliable mothers, of strong bulls, of strong draught animals, and the culling of weak animals and those that are troublesome." All of these goals, maybe with the exception of draught animals, are still valid in contemporary reindeer husbandry. Key informant 2 stated that selection for such traits is hard to perform on calves. He said it was better to wait and see how the animals develop and how they perform in the landscape before they are culled. Reindeer herding relies more on knowledge that is accumulated through experience and transmitted between generations within a family.

In addition to this, the conditions in a reindeer herding district can never be controlled in the same way as in a cowshed. Landscapes are heterogeneous and there are shifting environmental conditions from year to year. This has necessarily lead to many different landscape adaptations.

Previous studies have found that the management system and the official policies have lacked legitimacy among reindeer herders (Ulvevadet 2000; 2008; 2011). The introduction of new production methods, such as herd structuring theories has for many herders taken the form of a forced imposition (Reinert 2006). Such a top-down approach is accentuated by the case of traditional knowledge and language.

> "My opinion is that if we hadn't had reindeer husbandry up here in the north, we would have spoken Norwegian, because we have many words that are only about snow, technical herding language. When you say one word, everyone understands" (Herder 3)

In reindeer husbandry, the contextual herding knowledge can never be replaced by research-based advice. Meløe (1988) notes:

> "A landscape belongs to those who belong to it. So this landscape belongs to the Saami reindeer herders. The truth about it is what their life with the reindeer has taught them about it. The reindeer herders' description of this landscape is the only description of it that is fit to guide their own activities in it. And there are no other activities in it (with even a semblance of a claim to it). Any description of this

> landscape that does not fit with the reindeer herders' description of it is foreign to it" (Meløe 1988)

The case of snow terminology mentioned by herder 3 is an example of such lived knowledge. In a recent study, Eira et al. (2013) outlines how traditional snow terminology is paramount to the management of reindeer herds:

> "Snow is a prerequisite for mobility, tracking, visibility and availability of pasture plants. The terms used to describe the snow on the ground include characteristics needed to communicate snow properties relevant to reindeer herding".

They found that Sámi snow terminology shared similarities with the scientific classifications of snow, but was more holistic and contextual. The terminology was linked to the ecology of the reindeer and herding practice. It was shown how such terminology could be highly relevant for management decisions. A conclusion of this research was that reindeer herding knowledge should never be overlooked in managerial policies.

Reindeer herding and conventional agriculture both produce marketable food, but reindeer herding is ultimately pastoralism, not agriculture. It differs from conventional agriculture in many respects. As described above, a different knowledge system is involved. And as mentioned by key informant 1, there is not a tradition for quantitative information about animals and herds in reindeer husbandry, herds are instead often evaluated based on qualitative criteria. In Norwegian agriculture on the other hand, the exact numbers and production parameters of the livestock are reported.

Another issue is property rights. Property rights are not defined in the same way as in agriculture and pasture use is characterized as one of "sequential usufruct" (Paine 1994; Reinert et al. 2008). The notion of control over animals, both of their movement and production, is very different in reindeer herding.

10.4 Reindeer herding as an irrational livelihood

Within political ecology, a vast body of research on the relations between pastoralists and the state exists. Much of this is focused on nomads in Africa, where authoritarian states often have defined pastoralists as economically irrational where they want them to settle and become farmers (Benjaminsen & Svarstad 2010). The narrative about economical irrationality

is frequently ascribed to "the cattle complex"[31], which asserts that nomads have large herds because they are emotionally attached to them and that a large herd is a symbol of power and wealth (Benjaminsen & Svarstad 2010). There exists a similar apprehension among Norwegians: That Sámi reindeer herders keep large herds as a symbol of wealth and prestige and that the ultimate goal of reindeer herding is to have a herd as large as possible. Such a narrative further fuels the idea that reindeer herders must modernize their production and adopt more rational production methods.

The idea of reindeer husbandry as an irrational livelihood has deep historical roots. At the start of the 19th century, societies were ranked according to stages of cultural development where sedentary agriculture was seen as the most well developed stage (Ravna 2011). Sámi pastoralists were thus regarded as inferior to the Norwegian farmer, both culturally and spiritually (Ravna 2011). Towards the end of the 19th century, Social Darwinism further fuelled this thinking (Paine 1994; Ravna 2011). Social Darwinists had adapted Charles Darwins biological theories of natural selection (Darwin 1859) and survival of the fittest (Spencer 1864) into a deterministic social theory. It asserted that some cultures were more advanced and higher developed than others and therefore more important for society (Ravna 2011). In light of this, Sámi reindeer husbandry did not fit the Norwegian nation-building project which had emerged after Norway had gotten its own constitution in 1814, after some 400 years of union under Denmark (although Norway entered a new union, with Sweden, which lasted until independence in 1905). Reindeer herding was tolerated as long as it did not hinder agricultural development (Paine 1994). This view permeated the Reindeer act of 1933, which is regarded as a law of phased elimination (Holand 2003).

The legislation and public view of reindeer husbandry has changed much since this time. As mentioned in chapter 4, important hallmarks of this change have been the signing and ratification of ILO convention nr. 169 - Convention concerning Indigenous and Tribal Peoples in Independent Countries (ILO 1989); the amendment of the Sámi paragraph (§110a) to the constitution; the passing of the Sámi law in 1987 and the establishment of the Sámi

[31] The cattle complex term was erroneously adopted from Herskovits (1926), who described a complex network and not a state of mind among the pastoralists (Benjaminsen & Svarstad 2010).

parliament in 1989; the Reindeer Act of 2007 which recognize reindeer husbandry's own institutions; and a series of supreme court sentences regarding the legal protection of reindeer husbandry.

Despite from these developments, it has been argued that the state still regards reindeer husbandry as problematic, although in a different form, and that the state still do not understand the culture of the reindeer herders. Paine (1996) summarize what he regarded was the states' view on reindeer husbandry from 1960 to 1990:

> "Indeed, far from being privileged as an exception the pastoralists are seen as presenting special problems: They are *on the move*; they lay claim to *so much space*; they appear to *lack social cohesion* and would *defy regulation*" (Paine 1996) (original emphasis)

Similar apprehensions can be identified in the contemporary debate: Reindeer herders in opposition to proposed mining projects in Finnmark are in the media and public opinion increasingly regarded as barriers to progress and development in municipalities that suffer under low unemployment rates and migration. Media headlines like "Reindeer husbandry in opposition to goldhunt" (Utsi 2010) and "Reindeer-Sámi wants to stop his mining dream" (Vermes 2010) are common.

The state is today obliged to take Sámi and reindeer herding interests into consideration[32] when planning for initiatives such as mining operations. But instead of defining exactly how these interests are to be taken into consideration, the state have through vague formulations, that invites for negotiations between affected parties, become a negotiator in land disturbance issues (Bjørklund 2015 Forthcoming). For example, the state wants to promote a "balanced coexistence" (Nærings- og handelsdepartementet 2013) between the reindeer herding industry and the extractive industries. Such a negotiation situation will imply asynchronous power relations where the states' knowledge hegemony based on biological and economic models

[32] Through a consultation agreement, the government is obliged to consult with the Sámi parliament in matters that deal with Sámi interests (Kommunal- og Moderniseringsdepartementet 2005). According to the Planning and Building Act, spatial planning in accordance with the law has to "secure the natural resource base of Sámi culture, livelihood and social life" (Plan- og bygningsloven 2008:§3-1,c) (my translation). The Mineral Act have a similar clause that oblige the authorities to take Sámi circumstances into consideration when planning for mining operations (Mineralloven 2009:§2,b).

may suppress the reindeer herders' traditional knowledge about the consequences of land encroachments (Bjørklund 2015 Forthcoming).

10.5 Reindeer herding and politics

The farmers' cooperatives and their advisory services as well as the scientific agricultural research programs are prerequisites for Norwegian agriculture. The cooperatives and unions occupy a strong position in the industry and have a strong influence on agricultural policy. The same cannot be said for Sámi organizations (Paine 1996), especially back when the reindeer husbandry act of 1978 was passed and the reindeer agreement and managerial system was institutionalized.

In the law, the science- and production-driven way of thinking in the agricultural cooperatives was extended to the realm of reindeer husbandry, even though the transition from subsistence to market-oriented production methods had not been as clear in reindeer herding as it had been in conventional agriculture. Paine (1994) criticized how the process leading up to the 1978 reindeer act and the negotiation of the reindeer agreement was lead by "experts" whose experience was derived from the agricultural negotiations and the framing of the agricultural act (original emphasis):

> "After all, they, or their predecessors had put together Jordloven (the Agricultural Act), and they negotiate the Agreements with the farmers and their rival national associations. So dealing with reindeer pastoralists should simply be a matter of applying knowledge, insight, and technique learned in one domain (with *its* animals and practitioners) to another". (Paine 1994)

He claimed that this mentality was the reason why the intended political goal of rationalization had not been met. The pastoralists saw an increasing number of "experts" entering the official management as advisers to the state. The experts and pastoralists spoke different languages, the insights of one was arcane to the other. As an example of this, the indigenous system of earmarks was proposed to be removed (Paine 1994). The system was confusing to the authorities (my translation):

> "In 1962, 55 new reindeer marks were registered. There are now more than 3000 earmarks in the county. Approximately 50% of these belong to persons who have reindeer herding as a second job. These earmarks do too often have limited

> justification, either because the persons only have one or two reindeer, or because the earmark-owners are members of a family that have a distinct mark for each family member. It should be enough with one earmark per family in these instances. A resolution on this should be made as fast as possible" (Lappefogden 1963).

This system was of course not confusing to the reindeer herders (Paine 1994). Keeping several ear markings in a family made it easier to control the number and categories of reindeer in the family herd (Paine 2009). It also had an important function for the inheritance of reindeer and marks from parents to children: the children's ear marks could be combined from both parents and grandparents marks (Paine 2009).

Another issue that, according to Paine (1994) shows how different practitioners and experts are, regards the issue of evaluating pastures. He claims that practical herding knowledge is required to evaluate the actual consequences of land encroachments in a "spatially extensive system of considerable ecologic and logistic complexity". A diversity of landscape alternatives is preferable, and this means that all land, regardless of its vegetation at a certain point in time may have value for a reindeer herder. This can for instance regard relief habitat from insects. Such areas are often denoted as impediments in the ecological literature. It has not been attempted to quantify the value of such areas. An example of such "neglect" can be found in Ims and Kosmo (2001), where the possible value of impediments for the production system was not taken into consideration.

11. THE POLITICAL ECOLOGY OF REINDEER HERDING IN FINNMARK

"Certain forms of knowledge require a narrowing of vision" James C. Scott

11.1 Seeing like a state

Pastoralism is a livelihood that often does not fit into the lucid categories needed in a modern bureaucracy. The process of making simplifications and relying on expertise in the management process can be regarded as a way of making reindeer herding manageable and legible for the bureaucracy. James C. Scott calls such a process "seeing like a state" in his 1998 book with the same name.

In the first chapter of the book, Scott (1998) discusses the consequences of high-modernism in authoritarian states through the metaphor of scientific forestry. In modern scientific forestry, only revenue-bearing trees are given value. Other parts of trees as well as trees in different growth stages are discarded. But such trees are often important for the local populations who depend on a diverse forest. The promotion of scientific forestry lead to the creation of new forests, that were easier to count, manipulate, measure and assess, often to the detriment of local populations. The schematic principles of scientific forestry lead to a situation where forests could be managed by relatively inexperienced personnel.

Some of the characteristics of this story can be recognized in the management of reindeer herding. When the authorities determine that calf meat is the most rational commodity to produce, other outcomes from the herding are given less priority. As this study has pointed out, reindeer herders often ascribe value to more than a maximization of economic income through calf slaughter. Herders need raw material for handicrafts; they want to maintain traditions such as the castration and taming of bucks; they want to have multiple categories of animals in their herd to reach *čáppa eallu*; and many practice breeding based on other criteria than weights. Such aspects are ruled out in a uniform Røros-strategy.

Uniform herds that are created according to a narrow set of criteria are easier to assess and manage from the outside. By replacing Sámi animal category terms with the objective and universal terms of conventional ruminant systems as well as basing management exclusively

on biological models, reindeer herding has been reshaped to fit the worldview of functionaries socialized into the Norwegian agricultural tradition. The lucid categories of the Røros-model and the defined criteria of sustainability can easily be codified, taught and measured. Such simplifications make it easier to operationalize objectives and measure to what degree the objectives have been reached, something which is required in effective public administration. As mentioned earlier in the thesis, the criteria of sustainability (LMD 2008) were defined in the wake of critique from The Auditor General (Riksrevisjonen 2004). The RA was critiqued for operating according poorly operationalized objectives.

11.2 State measurements versus local measurements

> "The reindeer herders will, through observation, listening, and the tracking of reindeer and their movements, also be able to gain a type of knowledge about the surroundings not attainable through mere sensing or meticulous investigations." (Sara 2009) (my translation)

Scott (1998) also claim that local measurements are impediments to the administrative uniformity needed in a modern state. Central authorities need units of measurements that can be generalized across contexts. Local measures on the other hand, are "relational and commensurable". They are only meaningful in the contexts they are created and are therefore often of limited value to a management system which is based on distance to the practitioners. There are many indigenous measurements involved in reindeer herding. For example: When evaluating their herds, many reindeer herders visualize the herds qualitatively through more holistic variables (Key informant 1). There exist a number of evaluative terms for the totality of a herd in the Sámi language, some of them are shown in table 12.

Table 12. Sámi evaluative terms for the totality of a herd

Term	Translation	Meaning
Čáppa eallu	Beautiful herd	Good reindeer and a right herd structure
Skárba eallu	Thin herd	Few or almost no bucks in the herd
Lojes eallu	Tame herd	The reindeer are tame, graze willingly and require little herding.
Skirče eallu	Shy herd	The herd is shy and easily scatter
Mannis eallu	Wandering herd	The reindeer easily wander during migrations

Source: (Oskal 1999)

Bohcco luondu is another important term in reindeer husbandry (Sara 2009). A somewhat inaccurate translation of the term would be "the nature of reindeer" (Sara 2009). Sara describe the term like this:

> "The term encapsulates many different phenomena with the purpose of describing the characteristics of reindeer that are apparent through their habitual reactions and behaviors in relation to their surroundings. *Bohcco luondu* is, in other words, an explanatory principle (cf. Bateson, 1972, about instinct). It includes features such as reflexes, reactions to external stimuli, typical behavior in relation to other reindeer, natural surroundings and seasons, behavioral characteristics of groups of animals, and, finally, imprinted or learned affiliation to specific landscapes."

Bohcco luondo is clearly an indigenous measurement, one that different practitioners would ascribe different meaning to, and one that would not contribute to administrative uniformity. This way of classifying a herd is very different from a quantitative measure based on exact animal counts and carcass masses that can be generalized and compared across contexts.

Another example concerns snow: Indigenous snow terminology expresses locally relevant meanings which can be hard to systematically record and generalize. In the perspective of a reindeer herder, the expression of snow cover only as total precipitation does not convey characteristics that are needed for the practical performance of reindeer husbandry. The reindeer herder needs to know more. Such knowledge is conveyed through the indigenous terminology (Eira, I. M. G. 2012; Eira et al. 2013).

Scott (1998) adds to this story by bringing up indigenous measurements of land: "Telling a farmer only that he is leasing twenty acres of land is about as helpful as telling a scholar that he has bought six kilograms of books." It is the local characteristics of the measurement that is important to the farmer, for example, "units of work and yield, type of soil, accessibility, and ability to provide subsistence, none of which would necessarily accord with surface area" (Scott 1998). In reindeer herding, there is a similar situation. The measurement of land is often described as the size of the productive surface area. For example, Ims and Kosmo (2001) mainly expressed the usefulness of the reindeer herding areas as km^2 of net productive land in their evaluation of pasture capacities. In practice, such a simplification is not relevant

for a reindeer herder. The reindeer herder would rather base her or his evaluation on the balance between different landscape alternatives (Paine 1994).

It becomes apparent that the state and the reindeer herders often speak totally different languages: the RA is concerned with the ability to make objective judgments, while herders are more concerned with the localized characteristics in their own specific ecological and social contexts. The quantitative approach cater for the need to be able to make comparisons, aggregations and summary descriptions, all in order to grasp a complex social reality (Scott 1998). For example: The documentation of mean carcass masses enables the state to make comparisons between districts and to aggregate the data. An example of aggregation is the density analysis in Ims and Kosmo (2001), where statistics from all the districts in western Finnmark was aggregated to a regional scale, resulting in the erasure of local variation. The result of this is legibility at the expense of context sensitivity. The assertion that "The modern state, through its officials, attempts with varying success to create a terrain and a population with precisely those standardized characteristics that will be easiest to monitor, count, assess and manage." (Scott 1998), might be valid for the case of reindeer husbandry management in Norway.

11.3 Antithesis: Mētis

What is disregarded or even lost in the process of simplification is what Scott (1998) terms mētis. Mētis is understood as:

> "[A] wide array of practical skills and acquired intelligence in responding to a constantly changing natural and human environment." (Scott 1998)

It represents the type of knowledge that can only be learned by engaging in the activities themselves. Examples of such activities are learning how to sail, how to fly a kite, how to fish and how to drive a car. They are skills who are developed in shifting environments through practice. The skills of the activity cannot easily be conveyed through written or oral instructions.

A reindeer herder's knowledge is an excellent example of Mētis. For example, a common breeding criterion in reindeer husbandry is fur color, where certain colors are regarded as more valuable than others. As one of the key informants stated:

> "It is hard to explain. You need a trained eye to see it. Everyone have their own criteria and their own methods of selecting animals for slaughter. But it has to do with fur color. I think that certain colors a better than others. I know that from experience" (Key informant 2)

As he states, such a skill is developed from experience. He was also quick to mention that he could not guarantee that other herders in other areas shared the same experience. His knowledge is localized, and not subject to easy codification and transfer. Such a contextual experience was a recurring theme in many of the interviews.

The different states described by the evaluative terms for herd totalities mentioned above (table 12) are, according to Oskal (1999) expressed through different operational methods and individual assessments of what a good herd is. This is also a process that is guided by mētis.

Scott (1998) further notes that:

> "[The] practice and experience reflected in mētis is almost always local. Thus a guide on mountain climbing may be best at Zermatt, which she has scaled often; an airplane pilot is best on Boeing 747s, on which he was trained; and the orthopedic surgeon best at knees, where her surgical experience has given her a certain expertise. It is not entirely clear how much of these experts' mētis would be transferable if they were suddenly shifted to Mont Blanc, DC3s, and hands." (Scott 1998)

The same goes for reindeer husbandry, the herders are the experts of their own specific pasture areas. Families have often used the same areas for generations and transferred their local knowledge from generation to generation. Learning reindeer husbandry can be regarded as a socialization process, or a long apprenticeship, where you constantly experiment and generate new knowledge and rules of thumb in an unpredictable environment. A much quoted Sámi saying accentuates this unpredictability: "a year is not another year's brother" (Eira, R. B. M. 2012).

Certain social conditions are required for the reproduction of mētis. There need to exist (1) a community of interest, (2) accumulated information and (3) ongoing experimentations (Scott 1998). The *siida* is an institution which fosters mētis: "Traditional herding knowledge is carried out, tested, and renewed within the framework of the *siida*" (Sara 2009).

Scott (1998) see high-modernist schemes based on quantitative science as a threat to mētis.

> "One major reason why mētis is denigrated, particularly in the hegemonic imperium of scientific knowledge, is that its "findings" are practical, opportune, and contextual rather than integrated into the general conventions of scientific discourse." (Scott 1998)

He emphasize that the destruction of mētis not necessarily is negative per se, many scientific developments have improved the human condition greatly and made certain important knowledge developments more democratically available. But he claims that a large scale undermining of mētis becomes dangerous in a science that becomes imperialistic. The combination of "universalist pretensions of epistemic knowledge and authoritarian social engineering" has often created a situation where utopian schemes have failed.

In such a context, mētis has no chance of getting through. Such a situation does to some extent reflect the historical conditions of reindeer management in Norway. The state has to a large degree relied chiefly on quantitative science in its policy formulation, without taking Sámi mētis into consideration. The state did for example for a long time even deny the importance of the *siida* institution (Sara 2009). In a discourse where there has been little official recognition of the reindeer herders own knowledge production and experimentation, "imperial" knowledge systems have prevailed.

This especially applies to the case of herd structuring, where the state has promoted a universal template that reindeer herding should operate after. The authoritarian bit lies in how the subsidy system has been organized to only stimulate for calf slaughter and the way by which the model has been presented as the only rational way to perform reindeer husbandry by influential and powerful actors in the industry, including the media. The model was brought up as recently as in the third issue of *Reindriftsnytt* in 2013.The headline of the article reads: "The reindeer administration points out: to increase the productivity – slaughter more calves!" (Reindriftsnytt 2013). The model was also the theme of two speeches titled "How did I increase the profitability in my reindeer herd?" and "How to increase the production in a reindeer herd" which were held at a conference organized by the RA in August 2013.

Many herders claim that the model undermines the traditional knowledge or mētis produced and reproduced by reindeer herders in their own *siida*-institutions (Eira et al. 2015

Forthcoming). This can be part of the explanation why there has been no large-scale adoption of the model despite concerted efforts at getting the herders to change their practices.

11.4 The Will to Improve and the Anti-politics Machine

These insights can also be looked at from the angle of Li's Will to Improve and Ferguson's Anti-politics Machine. Two processes guide the will to improve: problematization and rendering technical. First, a problem that needs fixing have to be defined, and second, the problem needs to be made intelligible with established boundaries between those whose conduct are to be directed and the experts who are supposed to guide the process. In the case of reindeer husbandry, herders are defined as if they are operating according to irrational criteria while the state accordingly is positioned as the helper and facilitator of more rational modes of operation. Since the problem has been established as a technical issue, it has also been rendered non-political. In light of Ferguson (1994), it can be said that politics have been expelled from an issue that is inherently political and resulted in extended bureaucratic power.

12. CONCLUSION

This study has investigated the cultural appropriateness, the biological premises and the consequences of the Røros model (Lenvik 1990), a bioeconomic model developed for increasing the productivity and sustainability of reindeer husbandry in Norway. The study has further proposed how these issues resonate with wider debates in political ecology.

A combination of methods was used in the thesis. The qualitative approach sought to understand the issue of herd structuring from the perspectives of seven reindeer herders and two key informants in Finnmark, northern Norway. Written secondary sources were linked to these findings and discussed in conjunction. The quantitative part of the study assessed the uncertainty behind the basic premise of the model: the assumption that reindeer husbandry operates in a stable and predictable environment. Regression analysis was used to replicate and extend two statistical models from two articles (Ims & Kosmo 2001; Lenvik 1990) that have been influential in the framing of reindeer policy in Finnmark.

The Røros model represents a narrowing of the product range as most of the meat is cut down and sold as "reindeer-shavings" *(reinskav).* Such a uniform production can thus come to resemble an assembly-line production setting where the worker is alienated. Herders want to deliver quality produce that they can be proud of.

My findings show that supplementary feeding is associated with herd structuring. Reindeer meat is an ecological product which has a comparative advantage in how it is the only livestock that is based on all-year outfield pasturing (Riseth & Oksanen 2007). This integrity is threatened when supplementary feeding becomes more widespread.

The production of traditional handicrafts, *duodji,* is threatened because of the increased slaughter of calves. Calf hides are not useable in *duodji*, and the byproducts from slaughter must be bought back from the slaughterhouse.

The Røros model reduces the bucks' role to only cover reproduction. Reindeer herders claim that the buck is important for the utilization of the pastures and for the winter survival of the herd. Certain areas are better suited as pastures for bucks than for females with calves. Districts with large buck pastures may therefore have more bucks than others in order to utilize available landscapes to the fullest.

Bucks are also good snow diggers in winter. The social hierarchy in the herd makes it so that bucks often dig grazing pits that females and calves take over. This mechanism may ease the access to winter feed for the whole herd.

Reindeer herders some years suffer under *goavvi*, unexpected climatic events. Such situations can be dealt with either by moving the herds to better pastures or by providing supplementary fodder, which today is the most common coping strategy (Eira 2012). Some herders have also started to feed their herds under non-extreme conditions to increase and secure their production.

Supplementary feeding can increase the tameness of the animals and increase their dependence on humans, something that some herders regard as negative since reindeer husbandry is performed as a compromise between the natural inclinations of the animals and the wishes of their herders (Sara 2001). The animals may as a consequence become less able to find pastures independently.

A more precautionary measure against harsh climatic events can be *čáppa eallu*, a beautiful herd (Oskal 1999). It is a subjective expression of a certain diversification logic and entails including animals of different categories in the herd. There is a rich animal category terminology in the Sámi language.

The quantitative section of the thesis looked at two basic premises of the Røros model: Equilibrium ecology and sustainable harvesting. I assessed two statistical models that have been influential in the formation of reindeer herding policy.

An analysis presented in Lenvik (1990) assumed logistic growth of the production in western Finnmark over time and showed this with an inverse u-shaped curve. The curve expressed total production as a function of animal numbers based on data from 1977-1988. It shows how total production increases up to a point, the maximum sustainable yield, where the production starts to decline. A problem with this analysis is that the text makes no mention of the P-value of the model. The model was actually not statistically significant and a visual observation of the data points showed no apparent logistic relationship. Another problem is that the paper did not fully follow through with the sustainable harvest argument. It was not mentioned that the ecological carrying capacity in such a model would lie far beyond the observed animal densities. I extended the curve graphically and found that the theoretical ecological carrying

capacity following the data presented by Lenvik (1990) would lie somewhere between 130,000 and 140,000 animals. The implication of this is that all stocking rates below this point would be ecologically sustainable. I must emphasize that this is a simple theoretical exercise that must not be taken literally. The point of the exercise was rather to expose the problematic nature of the sustainability concept as it has been defined and applied as a management tool in the reindeer herding industry of Finnmark. I also created a similar model for the period 1981-2012. A polynomial regression line to the second power was added to the plot, logistic growth was in this way "forced" upon the data. This curve did not have a much better adaptation to the data than a linear regression line. I thus argue that an orthodox sustainable harvest model is probably not suitable for reindeer husbandry in Norway.

The second statistical model I assessed was a regression analysis of carcass masses and animal densities in western Finnmark published in Ims and Kosmo (2001). The authors found a strong and significant relationship between the variables. The analysis was criticized by herders in consultation statements and some researchers (Joks et al. 2006) for being too simplistic. The analysis was, among others, only based on three years that had been climatically difficult. According to the herders, climatic events can be decisive for their productivity. I retested the methodology of the regression analysis with an extended data set on the mainland- island- and individual district scale. I found a significant negative relationship between density and carcass masses at the mainland scale, no effect at the island scale, and more variable results at the district scale. In addition to this, I performed a multivariate regression with climatic variables on the mainland scale and found significant relationships between many of the climatic variables and the carcass mass variable. My analysis exposed weaknesses in the methodology of Ims and Kosmo: (1) By using a similar method with an extended dataset, a much weaker relationship between carcass masses and density was found. (2) The extended method also found significant relationships between climatic variables and carcass masses, something that Ims and Kosmo did not find in their analysis. (3) There were few significant analyses at the district scale, which indicates that density effects are scale-dependent. These insights show how simple methods have been employed by the state to justify management interventions. The analysis exposed some of the uncertainty associated with such methods.

Scott (1998) offers a toolkit for analyzing development schemes initiated by states. This toolkit proved highly relevant for understanding the political ecology of the reindeer industry

in Norway. The state needs simplifications to be able to govern effectively through its bureaucracy. A uniform policy like the Røros model can be regarded as a way of making reindeer husbandry more legible and manageable. It is a generalized model that easily can be codified, taught and measured. In addition, reindeer herders rely on a number of contextual measurements which threaten the administrative uniformity needed by the state. Reindeer herding knowledge is based on experience and is fostered in the *siida* institution. Such knowledge is threatened by the epistemic knowledge contained in influential management models such as the Røros model. The management system is centered upon providing technical solutions to problems that have often not been defined by the industry itself. Such a situation resonates with Li (2007) on "problematization" and "rendering technical" as well as Ferguson (1994) on how development projects often provide technical solutions to problems that are political by nature. By rendering the problems technical, political dimensions are effectively ruled out. This expands the power of the bureaucracy and the discursive power of scientific knowledge.

Management models such as the Røros model have often been presented as objective notions of how the reindeer system in Finnmark works and how it should be organized. This study has highlighted how the criteria presented in the model are disputed by many reindeer herders. It has also shown that the model, which is based on seemingly value-free scientific premises, rest on assumptions that are permeated by methodological uncertainty.

One could also argue that such models are the products of the production logics that guide management thinking in conventional Norwegian agriculture (Paine 1994; Reinert 2006). There are important differences between reindeer herding and agriculture. These differences regard the legitimacy and importance of scientific advice; the large scale breeding programs, the power of the industries' political lobby; and the controllability of the industries' environments. Reindeer herders operate according to highly variable, but well considered values and criteria, which are products of their social and ecological contexts. The *local context* is paramount for understanding the political ecology of reindeer herding in Finnmark. The local context and the experiential knowledge of the reindeer herders should be taken more into consideration in management policies.

13. REFERENCES

Angell, E., Gaski, M., Lie, I. & Nygaard, V. (2014). Næringsutvikling i samiske samfunn - En studie av sysselsetting og verdiskapning i nord: Norut Alta-Áltá Rapport 2014:4.

Behnke, R. H., Scoones, I. & Kerven, C. (1993). *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas*: Overseas Development Institute.

Behnke, R. H. (2000). Equilibrium and non-equlibrium models of livestock population dynamics in pastoral Afrika: their relevance to Arctic grazing systems. *Rangifer*, 20 (2-3): 141-152.

Benjaminsen, T. A., Rohde, R., Sjaastad, E., Wisborg, P. & Lebert, T. (2006). Land Reform, Range Ecology, and Carrying Capacities in Namaqualand, South Africa. *Annals of the Association of American Geographers*, 96 (3): 524-540.

Benjaminsen, T. A. & Svarstad, H. (2008). Understanding Traditionalist Opposition to Modernization: Narrative Production In a Norwegian Mountain Conflict. *Geografiska Annaler: Series B, Human Geography*, 90 (1): 49-62.

Benjaminsen, T. A. & Svarstad, H. (2010). *Politisk økologi - miljø, mennesker og makt*. 1 ed.: Universitetsforlaget. 248 pp.

Benjaminsen, T. A., Reinert, H., Sjaastad, E. & Sara, M. N. (2015a forthcoming). Misreading the Arctic Landscape: A Political Ecology of Reindeer, Carrying Capacities and "Overstocking" in Finnmark, Norway. *Norsk Geografisk Tidsskrift*.

Benjaminsen, T. A., Sara, M. N. & Sjaastad, E. (2015b forthcoming). Myter om "overbeiting". In Benjaminsen, T. A., Eira, I. M. G. & Sara, M. N. (eds) *Samisk reindrift: myter i forskning, forvaltning og politikk*. Trondheim: Akademika.

Berg, B. L. & Lune, H. (2012). *Qualitative research methods for the social sciences*. Boston: Pearson. 432 pp.

Bjørklund, I. & Brantenberg, T. (1981). *Samisk Reindrift - Norske Inngrep - om Altaelva, reindrift og samisk kultur*. 1 ed. 162 pp.

Bjørklund, I. (2004). Sami pastoral society in northern Norway: the national integration of an indigenous management system. In Anderson, D. & Nuttall, M. (eds) *Cultivating Arctic Landscapes*, pp. 124-135. New York: Berghahn Books.

Bjørklund, I. (2013). Domestication, Reindeer Husbandry and the Development of Sámi Pastoralism. *Acta Borealia*, 30 (2): 174-189.

Bjørklund, I. (2015 Forthcoming). Fra formynder til forhandler: Om inngrep, konsekvensanalyser og "balansert sameksistens". In Benjaminsen, T. A., Eira, I. M. G. & Sara, M. N. (eds) *Samisk reindrift: myter i forskning, forvaltning og politikk*. Trondheim: Akademika.

Blaikie, P. M. & Brookfield, H. C. (1987). *Land Degradation and Society*: Methuen.

Blixgård, A. K. (2005). *Klima, tetthet og beitekvalitet påvirker reinens høstvekt i Vest-Finnmark*. Master thesis: Norwegian University of Life Sciences. 44 pp.

Bryant, R. L. (2001). Political ecology: a critical agenda for change? In Castree, N. & Braun, B. (eds) *Social Nature: Theory, Practice and Politics*, pp. 151-169. Oxford: Blackwell.

Bryman, A. (2008). *Social Research Methods*. 3rd ed.: Oxford University Press.

Bårdsen, B.-J., Berglann, H., Stien, A. & Tverraa, T. (2014). Effekten av høsting på produksjon og lønnsomhet i reindriften. *NINA Rapport 999*. Tromsø: Norsk Intitutt for Naturforskning. 44 pp.

Campbell, B. M., Gordon, I. J., Luckert, M. K., Petheram, L. & Vetter, S. (2006). In search of optimal stocking regimes in semi-arid grazing lands: One size does not fit all. *Ecological Economics*, 60 (1): 75-85.

Ceertz, C. (1973). Thick Description; Toward an lnterpretive Theory of Culture. *The interpretation of cultures*: 3-30.

Cuddington, K. (2001). The "Balance of Nature" Metaphor and Equilibrium in Population Ecology. *Biology and Philosophy*, 16 (4): 463-479.

Darwin, C. (1859). *On the Origin of Species by Means of Natural Selection, Or, The Preservation of Favoured Races in the Struggle for Life*: J. Murray.

Eira, I. M. G., Magga, O. H. & Eira, N. I. (2010). Muohtatearpmaid sisdoallu ja geavahus. *Sámi dieñalaš áigečála*, 2: 3-24.

Eira, I. M. G. (2012). *Muohttaga jávohis giella, Sámi árbevirolaš máhttu muohttaga birra dálkkádatrievdamis [The Silent Language of Snow, Sámi traditional knowledge of snow in a time of climate change]*. PhD dissertation: University of Tromsø.

Eira, I. M. G., Jaedicke, C., Magga, O. H., Maynard, N. G., Vikhamar-Schuler, D. & Mathiesen, S. D. (2013). Traditional Sámi snow terminology and physical snow classification—Two ways of knowing. *Cold Regions Science and Technology*, 85 (0): 117-130.

Eira, I. M. G., Sara, M. N., Svarstad, H., Benjaminsen, T. A., Reinert, H. & Mathiesen, S. D. (2015 Forthcoming). Hva er en bærekraftig reindrift? In Benjaminsen, T. A., Eira, I. M. G. & Sara, M. N. (eds) *Samisk reindrift: myter i forskning, forvaltning og politikk*. Trondheim: Akademika.

Eira, R. B. M. (2012). *Using Traditional Knowledge in Unpredictable Critical Events in Reindeer Husbandry – The case of Sámi reindeer husbandry in Western Finnmark, Norway and Nenets reindeer husbandry on Yamal Peninsula, Yamal Nenets AO, Russia*. Master Thesis: University of Tromsø.

Elgvin, D. (1996). Sørsamisk reindrift i etterkrigstiden. *Ottar* (3): 42-48.

Fairhead, J. & Leach, M. (1996). *Misreading the African Landscape: Society and Ecology in a Forest-Savanna Mosaic*: Cambridge University Press.

Fangen, K. (2004). *Deltagende observasjon*: Fagbokforlaget.

Fauchald, P., Tveraa, T., Yoccoz, N. G. & Ims, R. A. (2004). En økologisk bærekraftig reindrift - Hva begrenser naturlig produksjon og høsting? . *NINA Fagrapport 76*. 35 pp.

Ferguson, J. (1994). *The Anti-politics Machine: "development," Depoliticization, and Bureaucratic Power in Lesotho*: University of Minnesota Press.

Fjellheim, P. (1967). Utvalg av slakterein. *Reindriftsnytt*, 1 (2): 5-7.

Forsyth, T. (2001). Critical realism and political ecology. In Stainer, A. & Lopes, G. (eds) *After postmodernism: critical realism*. London: Athlone press.

Forsyth, T. (2011). Politicizing Environmental Explanations: What Can Political Ecology Learn from Sociology and Philosophy of Science? In Goldman, M. J., Nadasdy, P. & Turner, M. D. (eds) *Knowing Nature - Conversations at the Intersection of Political Ecology and Science Studies*, pp. 31-46. Chicago: The University of Chicago Press.

Gaski, H. (2013). *Samer*. Store Norske Leksikon. Available at: http://snl.no/samer (accessed: 05.04.2014).

Geno. (2013). About Geno. Available at: http://www.genoglobal.no/Home/About-Geno/ (accessed: 28.03.2014).

Heikkilä, L. (2006). *Reindeer Talk: Sámi Reindeer Herding and Nature Management*: University of Lapland.

Herskovits, M. J. (1926). The Cattle Complex In East Africa. *American Anthropologist*, 28 (1): 230-272.

Hjørland, B. (2005). *Library And Information Science And The Philosophy Of Science*: Emerald Group Publishing.

Hofman, R. R. (1985). Digestive physiology of the deer—their morphological specialisation and adaptation. In Fennesy, P. F. & Drew, K. R. (eds) *Biology of Deer Production*. Wellington: The Royal Society of New Zealand.

Holand, Ø. (2003). *Reindrift - Samisk næring i brytning mellom tradisjon og produksjon*: GAN forlag.

Holand, Ø. (2006). Flokkstruktur og slaktestrategi i reindrifta - et historisk perspektiv. *Rangifer report No. 12*: 21-33.

Holand, Ø., Ims, A. A. & Weldadji, R. b. (2010). Scale-dependent effects of summer density on autumn mass in reindeer. *Rangifer*, 30 (1): 15-29.

Holt, S. (2011). *Maximum Sustainable Yield: The Worst Idea in Fisheries Management*. Breaching the blue. Available at: http://breachingtheblue.com/2011/10/03/maximum-sustainable-yield-the-worst-idea-in-fisheries-management/ (accessed: 19.03.2014).

ILO. (1989). *ILO convention nr. 169 - Convention concerning Indigenous and Tribal Peoples in Independent Countries*.

Ims, A. A. & Kosmo, A. J. (2001). Høyeste reintall for distriktene i Vest-Finnmark - Høringsdokument. Alta: Reindriftsforvaltningen.

Innst. S. nr. 167. (1991-1992). *Innstilling fra landbrukskomiteen om fremtidig reindriftspolitikk. (en bærekraftig reindrift)*. Stortinget. Oslo.

Joks, S., Magga, O. H., Mathiesen, S. D. & Henriksen, I. M. (2006). Reintallet i Vest-Finnmark Forskningsbasert vurdering av prosessen rundt fastsettelse av høyeste reintall i Vest-Finnmark: Samisk høgskole/Nordisk Samisk Institutt.

Kommunal- og Moderniseringsdepartementet. (2005). *Prosedyrer for konsultasjoner mellom statlige myndigheter og Sametinget*. Oslo.

Kumpula, J. & Colpaert, A. (2003). Effects of weather and snow conditions on reproduction and survival of semi-domesticated reindeer. *Polar research*, 22 (2): 225-233.

Kvale, S. & Brinkmann, S. (2009). *Det kvalitative forskningsintervju*: Gyldendal akademisk.

Lamb, P. J. & Peppler, R. A. (1987). North Atlantic Oscillation: Concept and an Application. *Bulletin of the American Meteorological Society*, 68 (10): 1218-1225.

Lappefogden. (1963). Beretning om reindriften i Finnmark i 1962. *Lappefogdens årsmeldinger*.

LeCompte, M. D. & Goetz, J. P. (1982). Problems of Reliability and Validity in Ethnographic Research. *Review of Educational Research*, 52 (1): 31-60.

Lenvik, D. (1981). Kjønns- og alderssammensetning i vårflokken. *Reindriftsnytt*, 15 (3): 23-26.

Lenvik, D. (1988). *Utvalgsstrategi i reinflokken*. Dr. Agric. Dissertation. Alta, Reindriftsadministrasjonen: Norges Landbrukshøyskole.

Lenvik, D., Bø, E. & Fjellheim, A. (1988). Relationship between the weight of reindeer calves in autumn and their mother's age and weight in the previous spring. *Rangifer*, 8 (1): 20-24.

Lenvik, D. (1990). Flokkstrukturering - tiltak for lønnsom og ressurstilpasset reindrift. *Rangifer*, Special Issue No. 4: 21-35.

Li, T. M. (2007). *The Will to Improve: Governmentality, Development, and the Practice of Politics*: Duke University Press.

LMD. (2008). Kriterier/indikatorer på økologisk bærekraftig reintall - Rapport fra arbeidsgruppe opprettet av Landbruks- og matdepartementet: Landbruks- og Matdepartementet.

LMD. (2014). Reindriftsavtale 1. juli 2014 - 30. juni 2015: Landbruks- og Matdepartementet.

Lundqvist, H. (2003). Review of factors affecting productivity of reindeer husbandry: Sveriges Lantbruksuniversitet.

Magga, O. H., Oskal, N. & Sara, M. N. (2001). Dyrevelferd i Samisk kultur: Sámi allaskuvla/Samisk høgskole.

Magga, O. H. (2006). Diversity in Saami terminology for reindeer, snow, and ice: UNESCO.

Magga, O. H., Mathiesen, S. D., Corell, R. W. & Oskal, A. (2011). Reindeer Herding, Traditional Knowledge and Adaptation to Climate Change and Loss of Grazing Land. Kautokeino: Association of World Reindeer Herders.

Marin, A. F. (2003). *Protean reality: discourses for managing the winter reindeer ranges in Finnmark, northern Norway*. M.sc. thesis. Ås: Agricultural University of Norway, Noragric. 96 pp.

Marin, A. F. (2006). Confined and sustainable? a critique of recent pastoral policy for reindeer herding in finnmark, northern norway. *Nomadic Peoples*, 10 (2): 209-232.

Mcarthy, J. (2005). Guest editorial: First World Political Ecology: Directions and Challenges. *Environment and Planning A*, 37: 953-958.

Meld. St. 9. (2011-2012). *Landbruks- og matpolitikken - Velkommen til bords*. Landbruks- og matdepartementet. Oslo.

Meløe, J. (1988). The two landscapes of northern Norway. *Inquiry*, 31 (3): 387-401.

Mineralloven. (2009). *Lov om erverv og utvinning av mineralressurser av 19. juni 2009 nr. 101*.

Mysterud, A., Holand, Ø., Røed, K. H., Gjøstein, H., Kumpula, J. & Nieminen, M. (2003). Effects of age, density and sex ratio on reproductive effort in male reindeer (Rangifer tarandus). *Journal of Zoology*, 261 (4): 341-344.

NESH. (2002). Samisk forskning og forskningsetikk. *Publikasjon nr. 2, 2002*: Den nasjonale forskningsetiske komité for samfunnsvitenskap og humaniora.

Neumann, R. P. (1998). *Imposing Wilderness: Struggles Over Livelihood and Nature Preservation in Africa*: University of California Press.

NOU 2001: 34. *Samiske sedvaner og rettsoppfatninger – bakgrunnsmateriale for Samerettsutvalget*. Justisdepartementet. Oslo.

NOU 2001: 35. *Forslag til endringer i reindriftsloven*. Landbruksdepartementet. Oslo.

Nærings- og handelsdepartementet. (2013). *Strategi for mineralnæringen*. Oslo.

Oskal, A. I. (1999). Tradisjonelle vurderinger av livdyr. In Haugerud, E. (ed.) Rangifer Report No. 3 (1999), *Conference report (including non-peer reviewed articles) from the 10th Nordic Conference on Reindeer Research, 13-15 March 1998, Kautokeino, Norway*.

Paine, R. (1994). *Herds of the Tundra: a portrait of Saami reindeer pastoralism*. Smithsonian series in ethnographic inquiry. Washington: Smithsonian Institution Press.

Paine, R. (1996). Saami reindeer herders and & the Norwegian state, 1960s-1990s. *Nomadic Peoples* (38): 125-136.

Paine, R. (2009). *Camps of the Tundra: Politics Through Reindeer Among Saami Pastoralists*: Instituttet for sammenlignende kulturforskning.

Peet, R. & Watts, M. J. (1996). *Liberation Ecologies: Environment, Development, Social Movements*: Routledge, Chapman & Hall.

Plan- og bygningsloven. (2008). Lov om planlegging og byggesaksbehandling av 27. juni 2008 nr. 71.

Post, E. & Stenseth, N. C. (1999). Climatic Variability, Plant Phenology, and Northern Ungulates. *Ecology*, 80 (4): 1322-1339.

R Core Team. (2013). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. URL: http://www.R-project.org/.

Ravna, Ø. (2011). Samenes rett til land og vann, sett i lys av vekslende oppfatninger om samisk kultur i retts- og historievitenskapene. *Historisk tidsskrift*, 90 (02).

Reindriftsforvaltningen. (2013). Ressursregnskap for reindriftsnæringen for reindriftsåret 1. April 2011-31. Mars 2012.

Reindriftsloven. (1933). *Reindriftsloven av 12. mai 1933*.

Reindriftsloven. (1978). *Lov om reindrift av 9. juni 1978 nr. 49*.

Reindriftsloven. (2007). *Lov om reindrift av 15. juni 2007 nr. 40*.

Reindriftsnytt. (2013). Reindriftsforvaltningen presiserer: For økt lønnsomhet i reindrifta - slakt mer kalv! *Reindriftsnytt* (3): 34-39.

Reinert, E. S. (2006). The economics of reindeer herding: Saami entrepreneurship between cyclical sustainability and the powers of state and oligopolies. *British Food Journal*, 108 (7): 522-540.

Reinert, E. S., Aslaksen, I., Eira, I. M. G., Mathiesen, S., Reinert, H. & Turi, E. I. (2008). Adapting to Climate Change in Reindeer Herding: The Nation-State as Problem and Solution. *Working Papers in Technology Governance and Economic Dynamics no. 16*: The other canon foundation, Norway; Tallinn University of Technology, Tallinn.

Reinert, H., Mathiesen, S. & Reinert, E. (2010). Climate change and pastoral flexibility: a Norwegian Saami case. In Winther, G., Duhaime, G., Kruse, J., Southcott, C. & Aage, H. (eds) vol. 1 *The political economy of Northern regional development*: Nordic Council of Ministers.

Riksrevisjonen. (2004). Riksrevisjonens undersøkelse av bærekraftig bruk av reinbeiteressursene i Finnmark. *Dokument nr. 3:12 (2003–2004).*

Riksrevisjonen. (2012). Riksrevisjonens undersøkelse av bærekraftig reindrift i Finnmark. *Dokument nr. 3:14 (2011-2012).*

Riseth, J. Å. (1988). Reintall og beiteressurser - Hva er grunnlaget for Reindriftsadministrasjonens tilrådninger om beitekapasitet? *Reindriftsnytt*, 22 (3): 5-9.

Riseth, J. Å. & Oksanen, L. (2007). Ressursøkonomiske og økologiske perspektiver på grenseoverskridende reindrift. In Broderstad, E. G., Niemi, E. & Sommerseth, I. (eds) *Grenseoverskridende reindrift før og etter 1905*. Tromsø: Universitetet i Tromsø.

Robbins, P. (2012). *Political Ecology: A Critical Introduction*. Chichester: Wiley-Blackwell.

Rose, N. (1999). *Powers of Freedom: Reframing Political Thought*: Cambridge University Press.

Sametinget. (2013). *Kollektiv avstraffelse er uakseptabelt* Available at: https://www.sametinget.no/Arkiv/Valgperiode-2009-2013/Artikler/Kollektiv-avstraffelse-er-uakseptabelt (accessed: 25.04.2014).

Sara, M. N. (1997). *Hvilke kunnskaper om beite brukes i utøvelsen av reindrift?* Fagseminar i reindriften Kautokeino 10. - 12. okstober 1997, Kautokeino: Reindriftens Fagråd.

Sara, M. N. (2001). *Reinen - et gode fra vinden: reindriftens tilpasningsformer i Kautokeino*: Davvi Girji.

Sara, M. N. (2006). Reindrift og grensesperringer - om eldre tiders årssyklus i Kautokeino. *Ottar* (259): 4-9.

Sara, M. N. (2009). Siida and Traditional Sámi Reindeer Herding Knowledge. *The Northern Review*, 30 (Spring 2009): 153-178.

Schroeder, R. A., Martin, K. S. & Albert, K. E. (2006). Political ecology in North America: Discovering the Third World within? *Geoforum*, 37 (2): 163-168.

Schøyen, L. (2013). Dag O. Hessen: Det menneskelige paradoks Available at: http://www.svanemerket.no/magasinet/dagohessen/ (accessed: 28.03.2014).

Scott, J. C. (1998). *Seeing like a state: how certain schemes to improve the human condition have failed*. New Haven: Yale University Press. 445 pp.

Spencer, H. (1864). *The Principles of Biology*: William and Norgate.

St.meld. nr. 28. (1991-1992). *En bærekraftig reindrift*. Landbruksdepartementet. Oslo.

St.prp. nr. 46 (1996-97). *Om reindriftsavtalen 1997-98, om dekning av kostnader vedrørende radioaktivitet i reinkjøtt og om endringer i statsbudsjettet for 1997*. Stortinget. Oslo.

Staaland, H., Nedkvitne, J. J. & Garmo, T. H. (1995). *Beitedyr i kulturlandskap*: Landbruksforlaget.

Stokes, M. (2012). Population Ecology At Work: Managing Game Populations. *Nature Education Knowledge*, 3 (10).

Sullivan, S. (1996). Towards a non-equilibrium ecology : perspectives from an arid land. *Journal of biogeography*, 23 (1): 1-5.

Sullivan, S. & Rohde, R. (2002). On non-equilibrium in arid and semi-arid grazing systems. *Journal of Biogeography*, 29 (12): 1595-1618.

Turi, E. I. (2008). *Living with climate variation and change; A comparative study of resilience embedded in the social organisation of reindeer pastoralism in Western Finnmark and Yamal Peninsula*

Tyler, N. J. C. (2010). Climate, snow, ice, crashes, and declines in populations of reindeer and caribou (Rangifer tarandus L.). *Ecological Monographs*, 80 (2): 197-219.

Tømmervik, H., Karlsen, S. R. & Johansen, B. (1996). Reinbeitene gjennom året. *Ottar* (211): 32-38.

Ulvevadet, B. (2000). *Penger teller, kultur avgjør: analyse av statens virkemiddelbruk for å oppnå en bærekraftig reindriftsnæring i Vest-Finnmark, og reindriftssamenes reaksjoner på denne politikk*. Master Thesis. Oslo: Centre for Development and the Environment, University of Oslo.

Ulvevadet, B. (2008). Mangement of reindeer husbandry in Norway - power sharing and participation. *Rangifer*, 28 (1): 53-78.

Ulvevadet, B. (2011). Problems and challenges for user participation: The system of representation in reindeer husbandry in Norway. *Rangifer*, 31 (1): 161-182.

Utsi, J. A. (2010). Reindrift i mot gulljakt. (28.04.2013). Available at: http://www.nrk.no/kanal/nrk_sapmi/1.7319425.

Vatn, A. (2005). *Institutions and the Environment*: Edward Elgar.

Vayda, A. & Walters, B. (1999). Against Political Ecology. *Human Ecology*, 27 (1): 167-179.

Vermes, T. (2010). *Rein-samer vil stoppe gruvedrømmen hans*: ABC Nyheter. Available at: http://www.abcnyheter.no/nyheter/miljo/100505/rein-samer-vil-stoppe-gruvedrommen-hans (accessed: 27.04.2014).

Vetter, S. (2005). Rangelands at equilibrium and non-equilibrium: recent developments in the debate. *Journal of Arid Environments*, 62 (2): 321-341.

Vik, M. L., Benjaminsen, T. A. & Daugstad, K. (2010). Synergy or marginalisation? Narratives of farming and tourism in Geiranger, western Norway. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, 64 (1): 36-47.

Villmo, L. (1967a). Kan vi gjøre reindriften mer lønnsom? *Reindriftsnytt*, 1 (2): 3-5.

Villmo, L. (1967b). Kan vi gjøre reindriften mer lønnsom? *Reindriftsnytt*, 1 (1): 8-10.

Vorren, Ø. (1951). Reindrift og nomadisme i Varangertraktene. *Tromsø museums årshefter*, 69 (2).

Wainwright, J. (2005). The geographies of political ecology: after Edward Said. *Environment and Planning A*, 37 (6): 1033-1043.

Walker, P. A. (2005). Political ecology: where is the ecology? *Progress in Human Geography*, 29 (1): 73-82.

Walker, P. A. (2006). Political ecology: where is the policy? *Progress in Human Geography*, 30 (3): 382-395.

Weladji, R. B., Klein, D. R., Holand, ø. & Mysterud, A. (2002). Comparative response of Rangifer tarandus and other northern ungulates to climatic variability. *Rangifer*, 22 (1): 33-50.

Weladji, R. B., Holand, Ø. & Almøy, T. (2003). Use of climatic data to assess the effect of insect harassment on the autumn weight of reindeer (Rangifer tarandus) calves. *Journal of Zoology*, 260 (1): 79-85.

APPENDICES

Appendix A: Question guide

Can you describe your herd structure?

What characterizes a good herd?

What factors influence your choice of herd structure?

Have your herd structure changed the later years?

If yes: why?

What is a traditional herd structure?

Describe a good reindeer herding year.

How has the state attempted to alter herd structures and slaughter strategies?

How have you responded to this?

How do this relate to your own understanding of reindeer herding?

How would your herd have been composed in absence of the calf slaughter subsidy?

If you restructure your herd according to the Røros model, is there a way back?

Does the Røros structure fit all areas in Finnmark?

What is the role of the buck in a herd?

What can be the consequences of altering the age-, weight- and sex structures of the herd?

What criteria do you employ in the selection of slaughter animals?

Does this change from year to year, or do you use the same criteria each year?

Is calf meat the best meat?

Would you rather produce something else?

How do you compare yourself to neighboring districts with regards to production?

What is your opinion on the scientific assessment behind your stipulated maximum reindeer number?

Is the maximum sustainable reindeer population the same every year?

How do climatic events affect your production?

What is your opinion on mean carcass masses as an indicator of sustainability?

How would you alternatively asses sustainability?

How do land encroachments and predation affect your reindeer herding?

How has the promotion of structuring affected the reindeer herding industry in a wider sense?

How has herd structuring affected the relations between the industry and the state?

Appendix B: Information letter to informants

Forespørsel om å delta i intervju i forbindelse med en masteroppgave

Jeg er masterstudent i Internasjonale Miljøstudier ved Universitetet for Miljø- og Biovitenskap (UMB) og holder nå på med den avsluttende masteroppgaven. Temaet for oppgaven er reindriften i Finnmark, og jeg skal undersøke ulike perspektiver på flokkstrukturering, slaktestrategier og statlig styring av dette. Jeg er interessert i å finne ut om det er forskjeller og likheter mellom informanter. Formålet er å gjøre en kritisk gjennomgang av hvordan forskning og reindriftsforvaltning har påvirket flokkstrukturering og slaktestrategier i reindriften. Jeg vil legge særlig vekt på reineieres egne historier.For å finne ut av dette, ønsker jeg å intervjue aktører innen praktisk reindriftsutøvelse, forvaltning og forskning. Jeg vil bruke båndopptaker og ta notater mens vi snakker sammen. Intervjuet vil ta omtrent en time, og vi blir sammen enige om tid og sted.

Masteroppgaven er en del av *Dávggas* ("The economics and land-use conflicts in Sámi reindeer herding in Finnmark: Exploring the alternatives"), som er et forskningsprosjekt finansiert av Norges forskningsråd som går frem til 2015. Prosjektet er et samarbeid mellom Institutt for internasjonale miljø og utviklingsstudier (Noragric) ved Universitetet for miljø og biovitenskap (Ås), Internasjonalt senter for reindrift (Kautokeino) og Norsk institutt for naturforskning (Oslo).

Hovedmålsettinger med prosjektet er å bidra med forskning som kan foreslå hvordan det økonomiske utbyttet til reineiere kan økes og hvordan arealbrukskonflikter som involverer reindrift kan dempes.

Det er frivillig å være med og du har mulighet til å trekke deg når som helst underveis, uten å måtte begrunne dette nærmere. Dersom du trekker deg vil alle innsamlede data om deg bli anonymisert. Opplysningene vil bli behandlet konfidensielt, og ingen enkeltpersoner vil kunne gjenkjennes i den ferdige oppgaven. Opplysningene anonymiseres og opptakene slettes når oppgaven er ferdig, innen 31.12.2014.

Hvis det er noe du lurer på kan du ringe meg på 95790955, eller sende en e-post til Johanborgenvik@gmail.com. Du kan også kontakte min veileder Tor Arve Benjaminsen ved Noragric, UMB på telefonnummer 93445199.

Med vennlig hilsen
Johan Borgenvik
Postboks 1051
1432 Ås

Samtykkeerklæring:

Jeg har mottatt skriftlig informasjon og er villig til å delta i studien.

Signatur …… Telefonnummer ……..

Appendix C: Sami words used in the thesis

Varit – Yearling buck

Siida – A cooperative pastoral institution

Goavvi – Extreme weather event

Duodji – Traditional Sámi handicrafts

Čáppa eallu – A beautiful herd

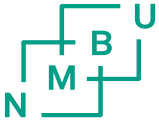
Guohtun – Pasture

Boazu – Semi-domesticated reindeer

Goddi – Wild reindeer

Njiŋŋelas – Female reindeer

Jahkodat – Climatic variations in a pasture year



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