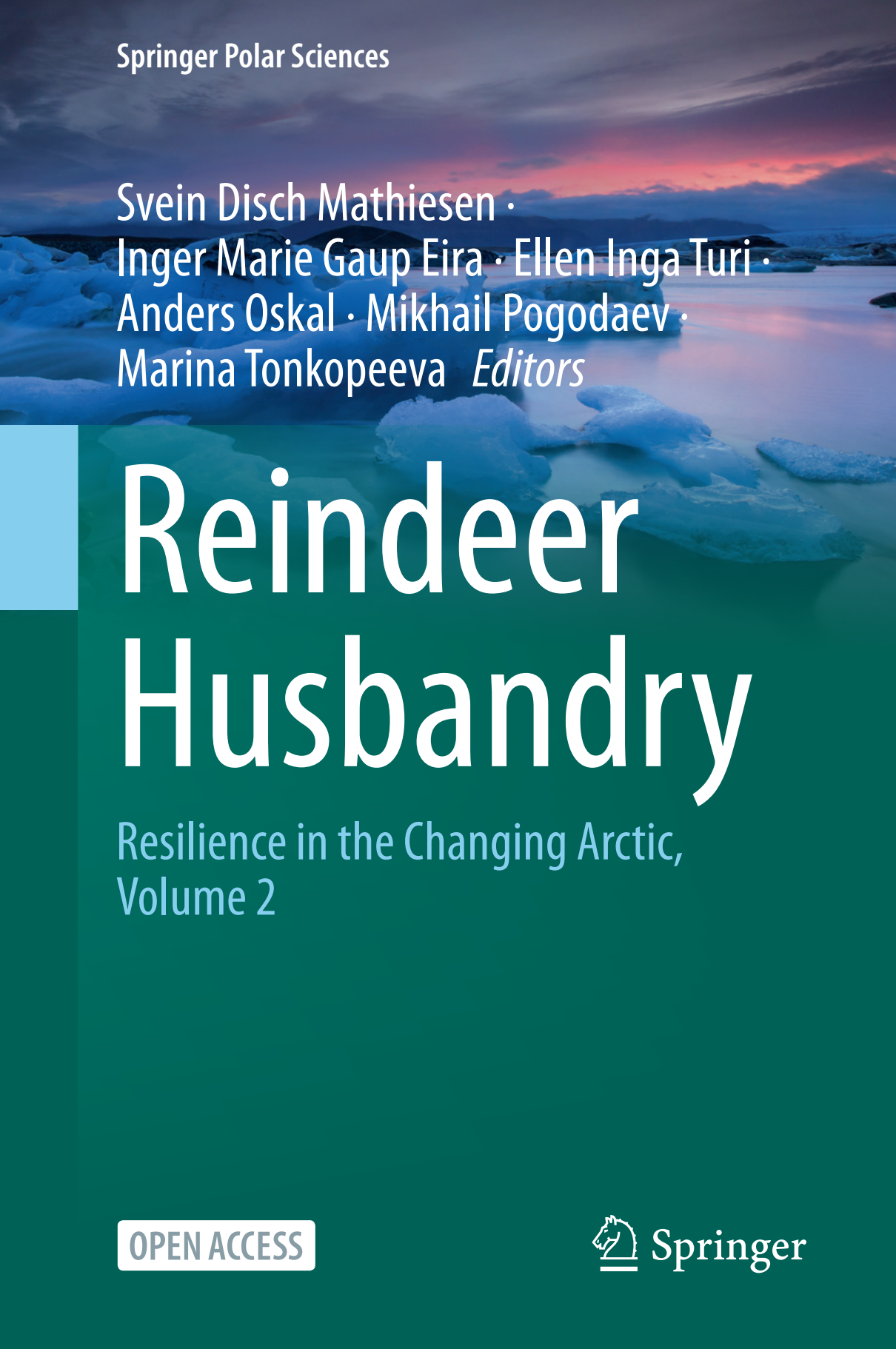
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Reindeer Husbandry
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Svein Disch Mathiesen • Inger Marie Gaup Eira
Ellen Inga Turi • Anders Oskal
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Editors

Reindeer Husbandry

Resilience in the Changing Arctic, Volume 2

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Preface

Resilience in the Changing Arctic is the second of two Reindeer Husbandry books published by Springer Polar Sciences. The second book comprises nine peer-reviewed chapters, each reviewed by two to six renowned international researchers and scientists. The authors express their immense gratitude to the reviewers and deeply acknowledge their unique contribution.

The book addresses the critical issues faced by the Indigenous peoples in the Arctic: climate change, how it affects their societies and livelihoods, environment, and economies. It is important that all available forms of knowledge – academic, traditional, Indigenous, and local – are included when addressing the adaptation and resilience of the reindeer husbandry in the Circumpolar North. The two volumes provide novel insights into the Arctic Indigenous reindeer herding communities and how resilience can be built locally through the use of traditional knowledge and co-production.

Kautokeino, Norway

S. D. Mathiesen
M. Tonkopeeva

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We would like to express our deepest gratitude and appreciation to all the authors and contributors who have played a crucial role in creating these two *Reindeer Husbandry* books. Your expertise, insights, and dedication have been invaluable in shaping this work and ensuring its quality and relevance. We extend our heartfelt thanks to each and every one of you.

First and foremost, we would like to thank our esteemed reviewers and contributors, who provided their time and expertise to meticulously review the manuscript and offer invaluable feedback. We are grateful for your commitment to maintaining high standards of scholarship and for the rigorous scrutiny you applied to this work.

We would also like to acknowledge Indigenous students and researchers, practitioners, and knowledge holders for their outstanding contributions and for sharing their exceptional expertise. Your commitment to preserving traditional knowledge and promoting sustainability has inspired both volumes and continues to drive progress in this field.

We would like to thank the Research Council of Norway for supporting the chapters in Volumes 1 and 2 through the *RIEVDAN* Project grant № 238326 and grant № 270819 "Opportunities and Challenges for Integrating Sámi Reindeer Herding Traditional Environmental Knowledge in Environmental Governance." The books were also supported by the *NordForsk* Project № 97299 "Feasibility study on co-production of knowledge between researchers and Indigenous communities for climate change adaptation" and UArctic President, and the *Nordregio* Project № 18010 "Training of Arctic Indigenous Youth for Climate Change" and Arctic

Council *EALLU* Project, Ministry of Local Government and Regional Development, Norway, and Ministry of Foreign Affairs, Norway. We would also like to acknowledge the in-kind support received for the production of Volume 2 from the Global Environment Facility and the UN Environment Programme through the "Reindeer Herding and Resilience Project".

Finally, we would like to express our deep appreciation to the publishing team. Your dedication, professionalism, and attention to detail have ensured this publication's high quality. We would like to extend our special thanks to Margaret Deignan, Senior Editor at Springer, for always being there for our team and supporting us throughout this journey.

To all those mentioned and to those whose names may have inadvertently been omitted, please accept our sincerest thanks for your contributions. We hope it will serve as a valuable resource for researchers, practitioners, and enthusiasts in reindeer husbandry.

With heartfelt gratitude,
Svein Disch Mathiesen, Inger Marie Gaup Eira, Ellen Inga Turi, Anders Oskal, Mikhail Pogodaev, and Marina Tonkopeeva

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Chapter 1
Co-production of Knowledge on Climate Change Adaptation in Reindeer Sámi Culture: Research Methodology and Ethics

Klemetti Näkkäläjärvi and Suvi Juntunen

Abstract This paper presents part of the results of the "Feasibility study on co-production of knowledge between researchers and Indigenous communities for climate change adaptation" project. The research hypothesis was that academia and Sámi communities could find ways for culturally sustainable adaptation with the ethical and systematic co-production of knowledge. The research material comprises six workshops organized in the Finnish Sámi homeland with Sámi reindeer herders. Traditional knowledge and expertise of the Sámi people were considered equal alongside academic knowledge. The workshops conveyed distrust of researchers but considered future collaboration with the academia important. Participants identified critical prerequisites for research collaboration with the academia: the projects need to support the reindeer herding culture, and Sámi participation has to be included in the projects from the beginning. The chapter provides a procedure for the ethical co-production of knowledge in the reindeer Sámi context. Effects of climate change are widespread in Sámi reindeer herding culture. Workshops concluded that climate adaptation requires, among other things, action from the administration; collaboration with reindeer herders, authorities, and researchers; and the development of the status of reindeer herding.

Keywords Sámi reindeer herding · Co-production of knowledge · Climate change · Research ethics

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1.1 Introduction

The original aim of the project was to co-produce knowledge ethically on climate change adaptation in collaboration with the reindeer Sámi communities and academia by using the search conference method. This approach entails community members coming together to reflect in a structured way on problems affecting their community and seeking common ground on how to understand and address a problem (Schafft & Greenwood, 2003; Schusler & Decker, 2003). Co-production of knowledge can address the complex nature of contemporary sustainability challenges better than more traditional scientific approaches (Norström et al., 2020).

The plan was to organize an extensive research seminar by using search conference methodology and inviting members of academia and reindeer herders to the seminar to co-produce knowledge on climate change adaptation. The implementation had to be significantly modified from the original plan due to the COVID-19 pandemic and the resulting national and international restrictions and recommendations. Cross-border and internal travel was restricted, and meetings for over ten persons were forbidden. As a result, the involvement of external researchers was not possible.

The revised objectives of the project were (1) to identify the needs, topics, limits, and prerequisites of the Sámi reindeer herding communities for the co-production of knowledge with academia, (2) to identify the effects of climate change and climate change adaptation to reindeer Sámi culture, and (3) to explore how the Sámi have experienced the research collaboration and research ethics and (4) how research can be conducted ethically from a Sámi perspective.

1.2 Background

This paper presents the results of the feasibility study on the co-production of knowledge between researchers and Indigenous communities for climate change adaptation, a project implemented in the Finnish Sámi home region. Sámi are Indigenous people of Europe. In Finland, 10,795 persons were registered in the electoral register of the Sámi Parliament in 2019 (Sámediggi, 2019). There are 1220 reindeer owners and less than 300 full-time reindeer herders in the Sámi homeland. Most of the reindeer owners and full-time herders are Sámi (Näkkäläjärvi et al., 2020, 50–60).

The projected effects of climate change on the Sámi home region in Finland are significant. It is estimated that temperatures will continue to rise, precipitation will increase, the growing season will lengthen, and heat cycles will become more frequent. The duration of the snow cover will also shorten, and the amount of snow will decrease. Vegetation changes would also be significant as the boreal forest spreads farther north and to higher altitudes, replacing bare *fjeld* vegetation (Ruosteenoja et al., 2011; Ruosteenoja, 2016). Sámi reindeer herders have reported

that the ongoing effects of climate change are significant for their culture, environment, and livelihoods. The first Sámi observations of climate change have been dated to the 1960s. They have started adapting to climate change by changing, e.g., reindeer work models, introducing new technology, and starting supplementary feeding of reindeer (Näkkäläjärvi et al., 2020). The limited number of Sámi people, legislative challenges, emigration from the homeland, and low profitability of traditional livelihoods make Sámi culture vulnerable to social and environmental changes (Jaakkola et al., 2018). Indigenous reindeer herding is threatened by multiple drivers of environmental and social changes that affect the sustainability of grazing lands and the traditional use of environmental resources (Eira et al., 2018).

1.3 Methodology and Implementation

The methodology followed was the co-production of knowledge. Norström et al. define the co-production of knowledge as *iterative and collaborative processes involving diverse types of expertise, knowledge, and actors to produce context-specific knowledge and pathways toward a sustainable future* (2020). Our hypothesis is that academia and Sámi communities can find ways for culturally sustainable adaptation by using ethical and systematic co-production of knowledge. Research aimed at addressing sustainability challenges in the Anthropocene is most effective when co-produced by academics and non-academic stakeholders. A total of six workshops were organized covering all the reindeer herding cooperatives in the Sámi homeland (Fig. 1.1). The number of participants was limited to less than ten for each workshop. Only the lead researcher (who is an ethnic Sámi) and the photographer participated in the workshops. There were 32 participants, of which 5 were women (16%) and 27 were men (84%). The age range of the participants varied from 16 to 73 years old. The average age of the participants was 49.

Participants were selected systematically while taking into consideration COVID-19 restrictions and aiming at pluralistic co-production of knowledge (cf. Nielsen et al., 2017; Tengö et al., 2017). The following inclusion criteria were implemented: participants (1) have enculturated to reindeer Sámi culture, (2) have at least 10 years of experience from reindeer work (encompasses the experience a herder has had from childhood), (3) include reindeer herders who speak Sámi as their native language, (4) must include both sexes and different age groups, and (5) represent different *siidas* (reindeer herding communities). The criteria were first introduced in the SAAMI – Adaptation of the Sámi people to climate change project (Näkkäläjärvi et al., 2020), which proved successful. A systematic criterion ensured a diverse representation. All three Sámi linguistic and cultural groups in Finland were represented (North, Inari, and Skolt Sámi).

The languages of the workshops were North Sámi, Finnish, Skolt Sámi, and Inari Sámi, the language preferred by the participant. Workshops were videotaped for analysis. The length of the workshop varied from 2 to 4 h. The project was implemented with respect to the participants' intellectual property rights and ownership

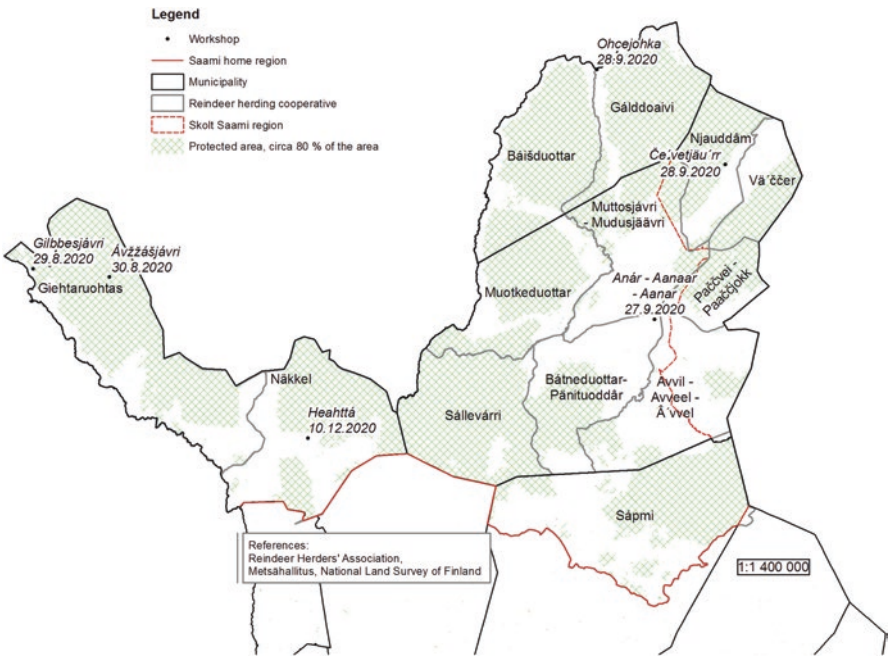

Fig. 1.1 Borders of Sámi home region, reindeer herding cooperatives, and organized workshops

of traditional knowledge. Participants were compensated economically for participation, and their travel expenses were reimbursed. The participants filled in a written consent form, available in North Sámi and Finnish. Participants could restrict or limit the use and reuse of video, photo, and other material in social media and outside the scope of this research project.

A set of topics was identified beforehand as a starting point for discussion. Participants could also freely introduce other topics and themes concerning climate change and the co-production of knowledge. The main topics for all the workshops were past, present, and future collaboration with academia and the effects of climate change and climate adaptation. Other topics that came into discussion were supplementary feeding of reindeer and its effects on the environment and reindeer culture (Heahttá workshop), competing land use (Anár workshop, Fig. 1.6), and legal obstacles for adaptation (all the workshops). Participants anonymously filled in a voluntary feedback questionnaire after the workshop, available in North Sámi and Finnish. The questionnaire included questions on workshop methods, usefulness, and collaboration with academia.

The Finnish Sámi Parliament has issued a procedure for acquiring free, prior, and informed consent for research projects dealing with Sámi cultural heritage and/or traditional knowledge (Sámediggi, 2016). This project applied for consent from Sámi Parliament and the Skolt Sámi Village Assembly. Both institutions consented to the project. The Sámi Parliament required research data to be handed over to the

Sámi Archives after the research project was completed as a condition for its consent. Some of the participants have in their consent form forbidden the transfer of research material to archives and external research projects. For this reason, the proposal of the Sámi Parliament couldn't be fulfilled. All informants were anonymized.

1.4 Results

1.4.1 Methodology

The workshop's themes were considered relevant and important for all the reindeer herding communities (32 answers, 1 missing). The participants' viewpoints are supported by research data, according to which climate change and adaptation are major everyday challenges for Sámi communities (Näkkäläjärvi et al., 2020; Eira et al., 2018; Jaakkola et al., 2018; Furberg et al., 2011).

> *Of course, the current situation in the world limits activities. A good workshop, despite it all.*
> Participant in the Gilbbesjávri workshop.

The participants were also asked whether the workshop method is a good practice for addressing these kinds of topics. Eighty-one percent of the participants considered the workshop a good practice, 11% preferred a more extensive workshop, and 5% preferred individual interviews. The workshop method has been widely used in studies on climate and environmental change (Lépy et al., 2018; Christie et al., 2018; Durkalec et al., 2015).

Fig. 1.2 Ávžžášjávri workshop participants. (Photo: Markku Kauranen)

1.4.2 Perception of Climate Change: Changes Are Constant

The effects and challenges of climate change were discussed extensively in the workshops. Climate change is commonplace for reindeer herders. Observed changes have accelerated in the twenty-first century (cf. Näkkäläjärvi et al., 2020). Changes in vegetation, seasonality, temperature, weather conditions, precipitation, and animal species behavior and an increase in extreme conditions have been observed. Winters are milder, and extreme weather events are more common. Altered conditions affect reindeer herding work and reindeer behavior. Wind velocity and frequency have accelerated. Wind affects the reindeer's movements and knocks down the reindeer fences (see Fig. 1.3). Fence work has increased everywhere. Winter conditions have become more extreme, and especially winter 2019–2020 was difficult. One participant (age 60–70) reported that winter conditions were the most difficult at the time of his life. There was already a deep snow cover (on average 0.5–1 m thick) in October. Long-lasting and thick snow cover prevents the reindeer from getting sufficient nutrition. Changes in the ice cover create challenges to reindeer herding and the safety of reindeer and reindeer herders. Waterways freeze later,

Fig. 1.3 Fallen reindeer fence between Norway and Finland in Rávdooaivi, Eanodat. The fence had fallen for several miles due to ice, snow, and strong wind combined. (Photo: Lemet Ánde Näkkäläjärvi, 2020)

and carrying capacity has weakened due to temperature fluctuations and heavy snow cover. For herders and reindeer, weak ice poses safety risks. Herders have reported falling through the ice in pasture work.

> *Climate change has been visible for many years. Pastures mold and freeze. Reindeer can't find nutrition.*
>
> Participant in the Če′vetjäu′rr workshop.

Forests have thickened and are growing faster, and pine seedlings have begun to grow above the tree line (see also Franke et al., 2015; Näkkäläjärvi et al., 2020). Reindeer herders try to mitigate the spread of invasive species by uprooting pine seedlings (Fig. 1.4).

The drying of the palsa mires has accelerated in the mountainous *fjeld* region (Fig. 1.5), and this was discussed in the Ávžžásjávri, Gilbbesjávri, and Ohcejohka workshops. All the palsa mires have disappeared in the twentieth century in south and central Finnish Sápmi. Their disappearance negatively affects the food intake of reindeer, as palsa mires are nutrient-rich areas. This directly affects Sámi nutrition since cloudberries have disappeared from areas where there used to be palsa mires. The disappearance of palsa mires changes the landscape, and, in some places, the change makes it difficult and dangerous to move around the terrain (Fig. 1.5).

Participants reported that reindeer work had increased considerably due to climate change, and the work has become physically and mentally heavier. Reindeer herding equipment, maintenance, supplementary feeding, and increased herding work bring more expenses. Subsidies for reindeer herding are still small, less than 14–18% of the reindeer herder's income. The subsidy is insufficient to cover the costs and losses in reindeer herding. Participants reported that in the 2000s, there had been mostly bad reindeer years (meaning conditions where many reindeer died

Fig. 1.4 Alien species in the fell region, Skadjaváreroavvi, Ohcejohka – pine seedlings and reindeer herder's way to protect biodiversity. (Photo: Urpo Vuolab, 2020)

Fig. 1.5 Dried and cracked former palsa mire in Áitejávri, Ohcejohka. (Photo: Urpo Vuolab, 2020)

Fig. 1.6 Participants of the Anár workshop. (Photo: Markku Kauranen)

during winter and few calves were born). In recent years, such as 2019–2021, few reindeer have been sold, as many reindeer died due to difficult winter and predatory conditions. Challenging winter conditions increase predation. Predators move easily in deep snow, and weak reindeer make easy prey.

> *Climate change is a great threat to Reindeer Sámi culture because it is the reason why young people are hesitant to start reindeer herding; they fear the effects and the future. If they don't start, our reindeer herding culture will disappear.*
>
> Participant in the Gilbbesjávri workshop.

The participants of the Heahttá workshop, compared to other workshops, pointed out that climate change was not currently considered a significant threat to their reindeer working model. The invasion of Finnish reindeer herding in the pasture areas of Sámi reindeer herders was considered a particularly significant challenge. The effects of climate change on nature, reindeer, and reindeer herding in the area were deemed significant, accelerating since the 1980s. Despite the significant impacts of climate change, the participants shared a common understanding that their traditional herding model can adapt to climate change. Sufficient pastures, traditional pasture rotation, and the end of invasions are prerequisites for this.

1.4.3 Limits and Possibilities for Adaptation

In addition to observing the effects of climate change, the workshops discussed what should be done to adapt to climate change. Reindeer herders have adapted to the changes in different ways regionally. Reindeer herders see changes daily while practicing reindeer herding, but the causal effects of climate change are not observed in the short term. Since this is a new situation, reindeer herders do not know whether their chosen adaptation method is correct. Every adaptation method also has cultural consequences. Reported adaptation means have been supplementary feeding of reindeer and technologies (such as drones and GPS collars for reindeer) have been introduced, the *siidas* have merged/divided, and the model of reindeer herding has been changed. Ávžžásjávri's workshop (Fig. 1.2) pointed out that supplementary feeding is almost the only way to adapt to climate change. Other workshops also highlighted the central role of supplemental feeding in adapting to climate change, except the Heahttá workshop. It did not consider supplementary feeding as appropriate means of adaptation.

> *Personally, I think that supplementary feeding does not fit our reindeer working model; it is completely different from what we have learned from previous generations. It would completely change our attitude towards reindeer, learned customs, traditions, work, and everything.*
>
> Participant in the Heahttá workshop.

Participants thought that the situation was unfair – they were not to blame for climate change, but they must bear the consequences. There was also distrust toward the authorities, and they experienced frustration toward the authorities. They felt

that the authorities were not taking climate change seriously and climate change could not be tackled by writing strategies. Rather, changes to legislation, administration, and herding subsidies are needed.

> *The authorities don't care how the Reindeer Sámi cope. Our view is nowhere to be seen and should be better presented.*
>
> Ávžžásjávri workshop participant

> *A lot of research data is available; we have also participated in several research projects. The effects of climate change have begun to show in our reindeer herding in the 1990s. Thirty years have passed, and the authorities have done absolutely nothing. Nothing has changed in legislation or administration.*
>
> Participant in the Heahttá workshop

> *I have thought a lot about this adaptation. After all, we humans may be able to adapt, but how can these animals of ours, this nature? Reindeer have difficulty adapting. As these extreme phenomena vary, droughts, persistent rains, and snow. What they all do to our animals. It would be important for people to be able to adapt, to facilitate the adaptation of reindeer.…To take care of reindeer welfare. When a man starts supporting a reindeer, things get bad. That's what this climate change is leading to.*
>
> Participant in the Anár workshop

> *It seems that this is the bureaucracy of Finland, that everything is investigated and investigated before decisions can be taken. After all, everyone saw that winter 2019–2020 was catastrophic for reindeer herding…Reindeer couldn't find nutrition. In Norway, the state used helicopters to send fodder and hays for the reindeer…But in Finland, nothing concrete, just researchers were hired to find out if it was a bad winter…Then it's going to be another year before we see if we can get some compensation…Then it might be too late…That response from the State has been slow.*
>
> Participant in the Če′vetjäu′rr workshop.

The participant refers to the study on the effects of difficult winter conditions on reindeer herding by the Natural Resources Institute Finland (Kumpula et al., 2020). As a result, a subsidy scheme was developed to cover the losses, but the scheme excluded three cooperatives from the Sámi homeland. The subsidy was allowed to be applied for in August 2021, and compensation was paid in December 2021. Reindeer herders from three reindeer herding cooperatives in Sápmi were forbidden to apply for support because the authorities felt that the number of reindeer in the reindeer herding cooperative was too high (Finnish Food Authority 2021a, b). Some Sámi herders have appealed the decision to the court. The participants pointed out that the State should be able to react quickly to extreme conditions, and emergency aid and support should be available in exceptional circumstances.

> *If and when reindeer herding becomes more difficult, it will be a major setback for the whole Skolt Sámi culture and language.*
>
> Participant of Če′vetjäu′rr workshop.

Participants felt that current legislation and governance hamper climate adaptation and do not allow cultural adaptation to climate change. The Reindeer Herding Act does not address Sámi reindeer herding, climate change, or the *siida* communal system, which was considered a major shortcoming.

The Sámi should be given the right to decide more broadly about their livelihood and culture. Participants argued that the Sámi are the best experts on their own culture, not the authorities in the Finnish capital region. Participants considered that reindeer herding maintains the Sámi language, culture, and vitality of the Sámi homeland. If reindeer herding disappears or its position worsens, it will harm the entire Sámi culture.

Adaptation requires action from the State; collaboration with reindeer herders, authorities, and researchers; and the development of a positive image and status of reindeer herding.

Herders are afraid of what the future changes will bring to the Sámi and Sámi culture. Questions were raised, such as will the traditional knowledge, the Sámi way of practicing reindeer herding, and the Sámi way of life be preserved in a changing climate? Herders hope these questions could be answered in collaboration with academia.

Climate change is a major challenge for Sámi reindeer herders, but reindeer herders have to compete for land use with other livelihoods such as tourism, infrastructure, mechanical gold placer mining, and logging (cf. Furberg et al., 2011; Jaakkola et al., 2018).

> *We would be able to cope with climate change and adapt if we were left alone to herd and reindeer can graze without interference. We are now more hampered by competing forms of land use, such as forestry, tourism, mechanical gold placer mining, and infrastructure projects of all kinds.*
>
> Participant in the Anár workshop.

All the participants of the Anár workshop shared this view. Anár and Vuohčču regions have significant land-use competition (see Anttonen et al., 2011; Kivinen & Kumpula, 2014).

1.4.4 Collaboration with Academia

All the participants have participated in research projects as informants, stakeholders (members of Sámi Parliament/Skolt Sámi Village Assembly), members of a steering group, workshop participants, or guides/drivers. The workshops discussed experiences of collaboration with academia on general terms.

> *Collaboration does not work with the researchers. They write what they want.…The reindeer Sámi have been involved in some research projects, but the role has been modest, I would say, as quota Sámi without any real significance.*
>
> Participant in Gilbbesjávri workshop.

The Gilbbesjávri workshop found that researchers do not understand Sámi reindeer herding in climate change research. It is argued that reindeer grazing threatens biodiversity (Kontula & Raunio, 2018), but it is also argued that reindeer grazing mitigates the negative effects of climate change (cf. Cohen et al., 2013; te Beest et al., 2016). The positive impact of reindeer grazing on mitigating the adverse effects of

climate change was expressed in all workshops. The Gilbbesjávri workshop provided a concrete example of a study in which the Sámi traditional knowledge was completely ignored. White-tailed eagle (*Haliaeetus albicilla*) population study started 20 years ago. Reindeer herders informed the scientists that the eagles were killing reindeer calves. The scientists did not believe the herders. Only now, 20 years later, have scientists confessed that the white-tailed eagle kills reindeer calves.

> *Reminds me of 30 years ago, when a study was published that you can see the condition of a reindeer in a reindeer's tibia. I remember my dad laughing in a fold and saying why they couldn't have asked the reindeer herders that too. We've always known where to see the condition of the reindeer. It's a good idea to investigate and investigate, but why not ask those who have lived through it first.*
>
> Participant in the Anár workshop.

The workshops conveyed a distrust of researchers and the feeling that the Sámi have been treated as resources, not as equals. The main drawback that emerged is that researchers do not know enough about Sámi culture and livelihood in advance and do not value the Sámi knowledge and skills at the same level as an academic science. Negative examples of non-cooperation were research projects on the state of reindeer grazing lands and research projects implemented by state research institutes. Research projects that do not take into consideration the importance of reindeer and reindeer herding for the Sámi and northern nature received a great deal of criticism in the workshops.

> *In my opinion, the Sámi have not held researchers in good regard, and usually it is because the researcher comes from outside, from the university or some research institute…A Sámi comes from his/her physical environment, in a way from a different world from the researcher…For more than generations, the Reindeer Sámi people have put their resources, their expertise into reindeer work. And knowledge has passed down from generation to generation, and of course, knowledge is created through experience. And yes, it is noticeable that scientists in some fields have directly stolen this information from the Reindeer Sámi and say that it is their new research and new knowledge of the matter, even though the Sámi have known it very long ago. The Sámi don't want to shout out their knowledge to all the world. That, too, is perhaps what we are used to; we do not make a big deal out of our livelihood expertise once we have seen how society and researchers have responded to this…Older generations say the researcher came over, asked a few questions, and went, and after that, there was no word. I personally expect that if the Sámi is interviewed and involved in the studies, then some benefit must come to Sámi.*
>
> Participant in the Anár workshop.

The participants were negative to the objectives of the previous studies to create a consistent picture of reindeer herding that it would be the same in both Finnish and Sámi reindeer herding. The participants pointed out that Sámi reindeer herding has several different working models within the reindeer herding cooperatives (Näkkäläjärvi et al., 2020). Regional differences and different working models should always be considered in studies to understand the local culture and adaptation to climate change.

> *Once, they wanted to study what reindeer eat and how it survives. One group eats lichen, the other group is given hay and some fodder, and someone is hit with sawdust in front.*

Let's wait month two and see. The reindeer ate lichen, hay, and fodder. Sawdust it did not eat and died. They're some crazy studies. And if you go to what the benefits of these studies are for us. Actually, there have been no studies on this side of the climate, or they are at the very beginning on that side. We don't really have any role in the investigation. And then we don't have access to the results on the results that would affect us. There is only one project (the SAAMI project) that has involved Sámi reindeer herders in climate change research. We should make the investigation better. Let's bring the Sámi traditional knowledge into research and see if we can find medicine for these difficulties or not.

Participant in the Anár workshop.

Some participants pointed out that they have experienced that their statements have been distorted in the final research papers or their message has been ignored. They argued that these research projects had only benefited the researchers themselves in their scientific careers. The informants felt they were just a resource and were not informed about the research results. This partly reflects that the Sámi have high expectations from research projects but are disappointed when expectations are not met. The criticism also indicates that communication between researchers and the target group must be improved, and interaction must continue after fieldwork.

Some pointed out that research is also evolving, and in recent years, there has been a positive development in climate change researchers' attitudes toward traditional Sámi knowledge and skills. Participants had positive experiences with research projects involving Sámi culture expertise.

Although experiences from previous collaborations with the research field have been mostly negative, the workshops considered collaboration with academia important for the future of their culture and livelihood.

Research can influence decision-makers and legislation. That is my motive for participating in research projects.

Participant in the Heahttá workshop

*It would be interesting to work with researchers, but they should take into account our views, and studies should be of benefit to us.*Participant in the Ávžžášjávri workshop.

Participants reported following research on reindeer herding. They see that researchers and reindeer herders can work together to find ways to adapt to climate change and meet the other modern challenges, such as competing land use, experienced by the Sámi people. The workshop revealed that reindeer herders want the research to be effective and concrete, trying to find solutions to the challenges faced by the Sámi together with the Sámi community (Table 1.1).

All topics that support the survival of the livelihood (reindeer herding).

Participant in the Ohcejohka workshop

On saving the mountain region for traditional nomadic reindeer herding. How supplementary feeding affects reindeer, Sámi reindeer herding and nature in the northern region.

Participant in the Heahttá workshop

Taking traditional knowledge into account in legislation.

Participant in the Ohcejohka workshop.

Table 1.1 Topics for future collaboration with the research community

	H	A	G	Á	Č	O	%
Effects of competing land use to reindeer herding	6	6	1	6	4	3	30%
Traditional knowledge and how it can be safeguarded	5	6	1	3	3	4	25%
Current and future effects of climate change in the Sápmi and for the reindeer herding	6	5	1	3	4	2	24%
Legislation concerning reindeer herding and subsidy system	5	5	0	3	2	3	20%
Missing			1				1%

H Heahttá, *A* Anár/Anaar/Aanar, *G* Gilbbesjávri, *Á* Ávžžášjávri, *Č* Če′vetjäu′rr, *O* Ohcejohka

Table 1.2 Possible methods for cooperation with the scientific community

	H	A	G	Á	Č	O	%
To be involved as an equal partner in planning and implementation of research projects	6	5	2	5	4	1	34%
Participate in workshops and seminars	6	5	1	2	4	4	32%
To be interviewed	3	4	1	2	11	0	31%
Missing	0	0	1	1	0	0	2%
I don't know yet	0	0	0	0	1	0	1%
No collaboration	0	0	0	0	0	0	0

H Heahttá, *A* Anár/Anaar/Aanar, *G* Gilbbesjávri, *Á* Ávžžášjávri, *Č* Če′vetjäu′rr, *O* Ohcejohka

> *It is important to involve Reindeer Sámi in research projects for the big picture. The rights of Indigenous people through reindeer herding must be presented to the public, and the image of reindeer herding should be turned useful for the Sámi – not the opposite – through research. Research results have to be returned to the community and given to political organizations to advance the common good.*
>
> Participant in the Ohcejohka workshop.

The workshops raised concerns about the poor public image of Sámi reindeer herding. Herders feel that in public, they are blamed for poor pasture conditions, for illegal killing of predators, and on making other livelihoods more difficult. It was considered that one of the reasons for the poor image is researchers. The research data, which the herders did not consider accurate, has been passed on to decision-makers and has therefore conveyed a poor view of reindeer herding. The poor public image of reindeer herding was considered detrimental to the adaptation of reindeer herding culture to climate change.

> *Sámi reindeer herding and traditional knowledge must be taken into account in all activities concerning our area and way of life.*
>
> Participant in the Ohcejohka workshop.

Most of the participants were interested in participating actively in research projects in the future on their own terms, also influencing the content and objectives of the research. No participant replied that he or she did not want to collaborate with the researchers (Table 1.2).

1.4.5 We Want to Be Treated as Equals

Although previous collaborations with the academia were considered largely negative among the participants, the workshops saw an opportunity for cooperation with the scientific community if herders were treated as equals and the researchers have expertise on Sámi culture, reindeer herding, and knowledge of Sámi language (Table 1.3).

The workshops sent a message about the demand for equality and genuine co-production of knowledge. Armitage et al. have suggested that knowledge co-production can serve as a trigger or mechanism for learning and adaptation (2011). Participants wanted to influence research by participating in the design and implementation of the whole research project. At no point did the participants demand a waiver of research independence. They felt that quality and ethical research that combines traditional knowledge and academic science could help them. Participants felt that co-production of knowledge refers to a procedure where *emic* (cultural) and *etic* (academic) knowledge are combined on a specific topic. Emic represents the way in which members of a culture perceive structure and value matters within their own sphere of life. The etic approach is the researcher's way of looking at things from the perspective of an outsider (Pike, 1967: 41–42.)

The workshop results indicate that Sámi people have become more aware of their own rights and the importance and benefits of traditional knowledge for research. At the same time, the Sámi have discovered new ways in which they can influence issues that are important to them, such as participating in research projects on their

Table 1.3 Identified prerequisites for research collaboration with academia

	H	A	G	Á	Č	O	%
Reindeer herders are treated as equals and traditional knowledge is regarded equal to scientific knowledge	6	6	1	4	3	3	18%
Reindeer herders have to be included in planning and implementation of the project	5	3	2	4	6	1	16%
The researchers have to have expertise on Sámi culture and reindeer herding	5	5	3	5	3	1	16%
Research project has to be carried out partly in Sámi language	5	5	1	2	1	2	13%
Consent form where the participant can restrict how the information can be used	5	5	1	2	3		13%
Research project has to have free, prior, and informed consent given by Sámi parliament and Skolt Sámi Village assembly	3	4	0	0	6	2	12%
Reindeer herders have to be compensated financially for their time	4	2			3	2	9%
Missing	0	0	2	1	0	1	3%

H Heahttá, *A* Anár/Anaar/Aanar, *G* Gilbbesjávri, *Á* Ávžžášjávri, *Č* Če′vetjäu′rr, *O* Ohcejohka

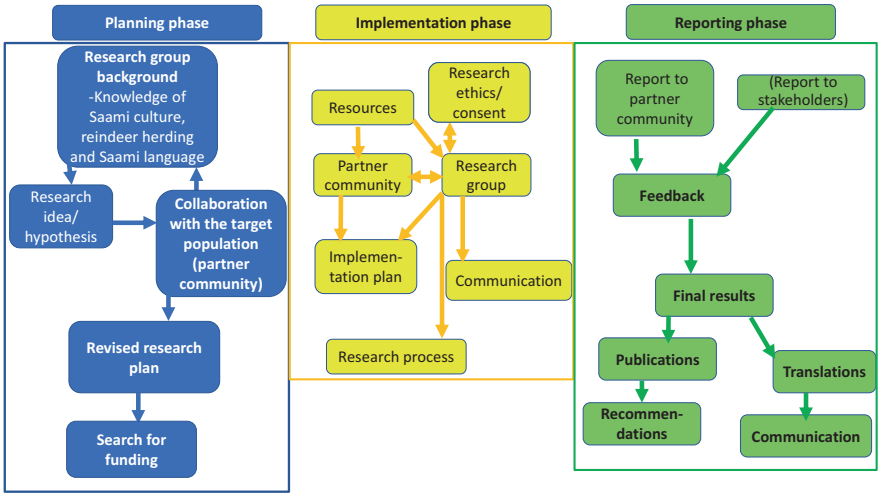

Fig. 1.7 Concept of co-production of knowledge adapted to the workshop results

terms. Figure 1.7 expresses the results of the workshops on the procedure of co-production of knowledge in studies concerning Sámi reindeer communities.

The message brought by informants is to deepen the intracultural approach in anthropology, in which the relationship of individuals and groups to their environment must be viewed from the perspective of the people who belong to it and have been enculturated to it (Sarmela, 1979:19). This suggests that genuinely intracultural research requires the involvement of the target population throughout the research project. This can improve the reliability, quality, and usability of research. In addition to the involvement of the target population, it is important to follow case-specific ethical guidelines.

Co-production of knowledge requires new skills and a new kind of thinking by academia. The research community must participate in the research design and in the definition of research questions, and researchers are required to have knowledge of Sámi culture. The Sámi do not want to teach researchers basic information about the Sámi culture but expect to reach a deeper level in collaboration with the researchers. The genuine co-production of knowledge also requires that the research community and researchers trust each other. The need for mutual trust was raised in several workshops. Research results should be available to the research community in a form that allows them to benefit from the information.

> *When considering implementation of the research projects on Sámi culture, the project has to take always into consideration that three Sámi languages are spoken in Finland.*
> Participant in the Če′vetjäu′rr workshop.

Ethical research requires additional resources, which must be considered when applying for funding. The Sámi want to use their own language, and this should be considered in project communication, materials, and publications.

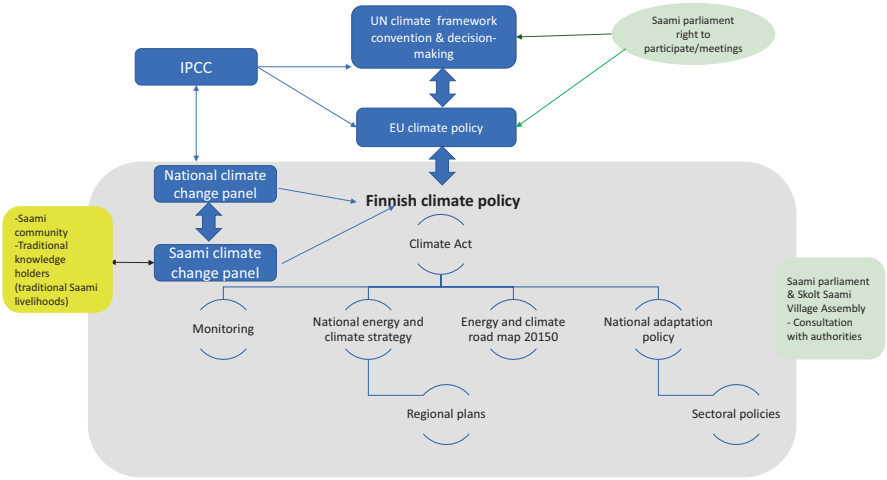

Fig. 1.8 Proposal to establish Sámi panel on climate change. (Näkkäläjärvi et al., 2020)

The SAAMI project proposed the establishment of the Sámi panel on climate change (Näkkäläjärvi et al., 2020, Fig. 1.8). This proposal was also discussed in the workshops and gained wide support. The climate panel would be represented by holders of Sámi traditional knowledge and representatives of the scientific community. The panel would co-produce knowledge and provide solutions for climate adaptation and mitigation. The proposal has received broad support from the Sámi society, the Sámi Parliament, and the Skolt Sámi Village Assembly. The workshops highlighted that the panel could be a means of bringing traditional knowledge and research data to decision-makers and enabling the development of legislation and administration. The Finnish Climate Change Act has established a Sámi Climate Council (Climate Act 423/2022). The State Council of Finland will appoint Sámi Climate Council in 24.8.2023. The State Council has appointed the Sámi Climate Council is for the time period of 1.9.2023–31.8.2027.

1.5 Discussion and Conclusion

Previous research and workshops show that the Sámi people follow the environmental conditions and changes in detail (Näkkäläjärvi et al., 2020; Jaakkola et al., 2018; Furberg et al., 2011). Not all the causal effects of climate change can be perceived and understood other than by living amid these changes. Academia and Sámi can learn from each other and produce information, measures, and solutions to mitigate the effects of climate change.

The workshop is an effective and fast way to reach participants. When comparing different methods, the workshop is a collaborative approach. At the same time, in-depth interviews (Näkkäläjärvi et al., 2020) can provide in-depth knowledge and broader interaction between the researcher and the interviewees. Indeed, some of the participants in the workshop hoped they would be interviewed again in-depth, as they wanted to report and explain the new observed effects of climate change in more detail. We conclude that a method combining workshops and interviews can effectively study the impact of climate change and adaptation measures.

We hypothesized that with the ethical and systematic co-production of knowledge, the academia and Sámi communities could find ways for culturally sustainable adaptation. Based on the results, our hypothesis received support from the Sámi community. Further studies are needed to include the views of a broad scientific community on the possibility of collaboration with the Sámi community and the co-production of knowledge.

Co-production of knowledge has been defined as one of the innovations needed to address climate change, but the best approach for co-production processes remains unclear (Harvey et al., 2019). Based on the workshop results, we see the process of co-production of knowledge as contextual, ethical, and adaptive (Figs. 1.7 and 1.8). Co-production of knowledge can be an effective and useful method of discussing climate challenges at a local level and improving legislation and administration on climate adaptation. The major challenge is the transformation of information into actions and decisions in the governance and activities of the State. The interaction of researchers and the Sámi community alone is not enough to solve the challenges experienced by the Sámi.

The need for ethical guidelines on Sámi research has been discussed within the framework of Sámi research (Drugge, 2016; Stordahl et al., 2015), and the Finnish Sámi Parliament has its own guidelines (Sámediggi, 2016). Ethical guideline for Sámi studies is currently being prepared in collaboration with universities (University of Lapland, 2021). The message of the workshops is that participants want to be involved in the process of defining case-specific ethical principles to be followed in the research. General ethical guidelines for science, such as the ethical guidelines for anthropology and the Sámi Parliament's guidelines, provide general framework conditions.

From the point of view of the social acceptability of the research, the workshops consider that the Sámi community has not been able to utilize previous research results, i.e., research has not had a social impact on the Sámi community. Sámi culture has not been considered in climate work, resulting in inadequate governance. Participation of holders of traditional knowledge in climate policy and scientific data production was considered vital, and an organ, like the Sámi climate council, was considered essential (Fig. 1.8). Muhonen et al. argued that science policy and academic practices should ensure and enable researchers to answer societally valuable questions in their research activities (2020). Our findings support this argument.

The workshops have shown that there is a need for the co-production of knowledge on the part of the Sámi community and that they are interested in the co-production of knowledge on themes that are important to the community in ethical cooperation with the scientific community. The traditional system of project planning, where researchers plan a project, apply for funding, and only collaborate with the target population in the implementation phase, is no longer sufficient when studying Sámi reindeer herding culture. The workshops have created a basis for ethical and equitable co-production of knowledge (Fig. 1.7) together with the scientific community and highlighted themes important for the Sámi community for further studies.

The workshops extensively discussed the participants' experiences on various research projects and expressed criticisms openly. The result of the study would certainly have been different if the original plan for joint workshops between researchers and herders had been implemented. The changed research setting enabled the participants to provide feedback and plan and develop research on the Sámi without external cultural guidance and from the perspective of Sámi reindeer culture.

Due to the COVID-19 pandemic, we only heard the reindeer Sámi community's views on the co-production of knowledge with the academia. Further research is needed to hear the scientific community's views on collaboration with the Sámi community, the co-production of knowledge, and the criticisms raised by the workshops.

Further discussion is needed on how inclusion and traditional Sámi knowledge can be considered throughout the research process and how, e.g., a peer review process can consider traditional knowledge and co-production of knowledge.

The results show how widespread and deep climate change is affecting Sámi culture and Sámi living environments. We can conclude that small research projects are not sufficiently effective, but there is a need for a comprehensive research program and monitoring to support adaptation to climate change. Although the results of this study concern the Sámi in Finland, they are also applicable in Indigenous research, especially among reindeer people and other Indigenous peoples of the Arctic.

References

Anttonen, M., Kumpula, J., & Colpaert, A. (2011). Range selection by semi-domesticated reindeer (Rangifer tarandus tarandus) in relation to infrastructure and human activity in the boreal forest environment, Northern Finland. Arctic Journal 64:1–14. https://doi.org/10.14430/arctic4075, 1.

Armitage, D., Berkes, F., Dale, A., et al. (2011). Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Global Environmental Change, 21*, 995–1004. https://doi.org/10.1016/j.gloenvcha.2011.04.006

Christie, K. S., Hollmen, T. E., Huntington, H. P., & Lovvorn, J. R. (2018). Structured decision analysis informed by traditional ecological knowledge as a tool to strengthen subsistence systems in a changing. *Arctic, 23*, 10.5751/ES-10596-230442.

Climate Act 423/2022. https://www.finlex.fi/fi/laki/alkup/2022/20220423
Cohen, J., Pulliainen, J., Ménard, C. B., et al. (2013). Effect of reindeer grazing on snowmelt, albedo and energy balance based on satellite data analyses. *Remote Sensing of Environment, 135*, 107–117. https://doi.org/10.1016/j.rse.2013.03.029
Drugge, A. L. (2016). Ethics in indigenous research: Past experiences – Future challenges. Vaartoe – Centre for Sami Research, Umeå. Available: urn:nbn:se:umu:diva-119987
Durkalec, A., Furgal, C., Skinner, M. W., & Sheldon, T. (2015). Climate change influences on environment as a determinant of indigenous health: Relationships to place, sea ice, and health in an Inuit community. *Social Science & Medicine, 136–137*, 17–26. https://doi.org/10.1016/j.socscimed.2015.04.026
Eira, I. M. G., Oskal, A., Hanssen-Bauer, I., & Mathiesen, S. D. (2018). Snow cover and the loss of traditional indigenous knowledge. *Nature Climate Change, Nature, 8*(11), 928–931. https://doi.org/10.1038/s41558-018-0319-2
Finnish Food Authority. (2021a). *Compensation for reindeer husbandry damage*. https://www.ruokavirasto.fi/viljelijat/tuet-ja-rahoitus/porotalous-ja-kolttalain-mukaiset-tuet/porotalousvahinkojen-korvaus/. Accessed 22 Oct 2021.
Finnish Food Authority. (2021b). Talven 2019–2020 porotalousvahinkojen korvauksia haettiin 12 miljoonaa euroa (A total of EUR 12 million was applied for compensation for reindeer herding damages in winter 2019–2020. https://www.ruokavirasto.fi/viljelijat/tuet-ja-rahoitus/uutiset/talven-2019-2020-porotalousvahinkojen-korvauksia-haettiin-12-miljoonaa-euroa/-. Accessed 20 Nov 2022.
Franke, A. K., Aatsinki, P., Hallikainen, V., et al. (2015). Quantifying changes of the coniferous forest line in Finnish Lapland during 1983–2009. *Silva Fennica, 49*, Article id 1408. https://doi.org/10.14214/sf.1408
Furberg, M., Evengård, B., & Nilsson, M. (2011). Facing the limit of resilience: perceptions of climate change among reindeer herding Sámi in Sweden. *Global Health Action, 4*, 1–11. https://doi.org/10.3402/gha.v4i0.8417
Harvey, B., Cochrane, L., & Van Epp, M. (2019). Charting knowledge co-production pathways in climate and development. *Environmental Policy and Governance, 29*, 107–117. https://doi.org/10.1002/eet.1834
Jaakkola, J. K. J., Juntunen, S., & Näkkäläjärvi, K. (2018). The holistic effects of climate change on the culture, well-being, and health of the Saami, the only indigenous people in the European Union. *Global Environmental Health and Sustainability, 5*, 1–17. https://doi.org/10.1007/s40572-018-0211-2
Kivinen, S., & Kumpula, T. (2014). Detecting land cover disturbances in the Lappi reindeer herding district using multi-source remote sensing and GIS data. *International Journal of Applied Earth Observation and Geoinformation, 27*, 13–19. https://doi.org/10.1016/j.jag.2013.05.009
Kontula, T., & Raunio, A. (toim). (2018). Suomen luontotyyppien uhanalaisuus 2018. Luontotyyppien punainen kirja. Osa 1: Tulokset ja arvioinnin perusteet. Suomen Ympäristö 5/2018. Ympäristöministeriö, Helsinki.
Kumpula, J., Jokinen, M., Siitari, J., Siitari, S. (2020). Talven 2019–2020 sää-, lumi- ja luonnonolosuhteiden poikkeuksellisuus ja vaikutukset poronhoitoon. Luonnonvarakeskus.
Lépy, É., Heikkinen, H. I., Komu, T., & Sarkki, S. (2018). Participatory meaning making of environmental and cultural changes in reindeer herding in the northernmost border area of Sweden and Finland. *International Journal of Business and Globalisation, 20*, 203–221. https://doi.org/10.1504/IJBG.2018.089868
Muhonen, R., Benneworth, P., & Olmos-Peñuela, J. (2020). From productive interactions to impact pathways: Understanding the key dimensions in developing SSH research societal impact. *Research Evaluation, 29*, 34–47. https://doi.org/10.1093/reseval/rvz003
Näkkäläjärvi, K., Juntunen, S., & Jaakkola, J. J. K. (2020). SAAMI – Saamelaisten sopeutuminen ilmastonmuutokseen -hankkeen tieteellinen loppuraportti. Valtioneuvoston kanslia, Helsinki.
Nielsen, M. W., Alegria, S., Börjeson, L., et al. (2017). Opinion: Gender diversity leads to better science. *Proceedings of the National Academy of Sciences of the United States of America, 114*, 1740–1742.

Norström, A. V., Cvitanovic, C., Löf, M. F., et al. (2020). Principles for knowledge co-production in sustainability research. *Nature Sustainability, 3*, 182–190. https://doi.org/10.1038/s41893-019-0448-2

Pike, K. L. (1967). *Language in relation to a unified theory of the structure of human behavior*. Mouton.

Ruosteenoja, K. (2016). Climate projections for Finland under the RCP forcing scenarios. *Geophysica, 51*, 17–50.

Ruosteenoja, K., Räisänen, J., & Pirinen, P. (2011). Projected changes in thermal seasons and the growing season in Finland. *Environmental Research Letters, 31*, 1473–1487. https://doi.org/10.1002/joc.2171

Sámediggi. (2016). Procedure for seeking the free, prior, and informed consent of the Sámi from the Sámi Parliament in Finland for research projects dealing with Sámi cultural heritage and traditional knowledge and other activities that have or may have an impact on this heritage and knowledge. Available: https://www.samediggi.fi/procedure-for-seeking-consent-for-research-projects/?lang=en

Sámediggi. (2019). *Number of Sámi in Sámi electoral roll (statistics)*. Sámi Parliament.

Sarmela, M. (1979). *Paikalliskulttuurin rakennemuutos: raportti Pohjois-Thaimaan riisikylistä*. Suomen antropologinen seura.

Schafft, K., & Greenwood, D. (2003). Promises and dilemmas of participation: Action research. *Search Conference Methodology, and Community Development., 34*, 18–35. https://doi.org/10.1080/15575330309490101

Schusler, T., & Pfeffer, M. (2003). Social learning for collaborative natural resource management. *NJAS – Wageningen Journal of Life Sciences, 16*, 309–326. https://doi.org/10.1080/08941920390178874

Stordahl, V., Tørres, G., Møllersen, S., & Eira-Åhren, I. M. (2015). Ethical guidelines for Sámi research: The issue that disappeared from the Norwegian Sámi Parliament's agenda? *International Journal of Circumpolar Health, 74*. https://doi.org/10.3402/ijch.v74.27024

te Beest, M., Sitters, J., Menard, C. B., & Olofsson, J. (2016). Reindeer grazing increases summer albedo by reducing shrub abundance in Arctic tundra. *Philosophical Transactions of the Royal Society B: Biological Sciences, 11*, 125013. https://doi.org/10.1088/1748-9326/aa5128

Tengö, M., Hill, R., Malmer, P., et al. (2017). Weaving knowledge systems in IPBES, CBD and beyond—Lessons learned for sustainability. *Current Opinion in Environmental Sustainability, 26–27*, 17–25. https://doi.org/10.1016/j.cosust.2016.12.005

University of Lapland. (2021). Saamelaisia koskevan tutkimuksen eettiset ohjeet. https://www.ulapland.fi/FI/Kotisivut/Saamelaisia-koskevan-tutkimuksen-eettiset-ohjeet-. Accessed 8 Feb 2021.

Chapter 2
Adaptation to the Future Climate in Sámi Reindeer Husbandry: A Case Study from Tromsø, Norway

Kia Krarup-Hansen and Berit Oskal-Somby

Abstract Climate projections for Northern Norway show an increase in winter temperatures in the nearest future. What are the consequences of such rapid changes for Sámi reindeer husbandry? How can herders adapt? This case study, just outside Tromsø in Northern Norway, seeks to answer these questions by analyzing local climate history and interviewing herders. In the 1950s, a herd of Sámi reindeer changed both summer and winter pasture grounds. Subsequently, changing especially winter pasture grounds from inland Kautokeino to the coastal areas near Tromsø challenged both reindeer and herders. As a result, in Troms, the herders had to develop adaptation strategies to manage herding in winters with a high frequency of rain-on-snow conditions, large amounts of snow, and decreased access to reindeer pastures. The situation in interior Finnmark, where they were located originally, is historically different: less snow and colder temperatures. However, future climate projections show that the herders in Finnmark could face today's situation in Troms within the next 50 years, with warm winters and high precipitation. Reindeer herders in Troms adapted to the new climate by changing their herding systems and increasing supplementary feeding. Yet their adaptive capacity is constrained by different external factors discussed in this chapter. The future of reindeer herding in both Finnmark and Troms, Northern Norway, depends on cooperation with authorities to protect the grazing land and provide herding flexibility.

Keywords Reindeer herding · Climate change · Encroachment

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https://doi.org/10.1007/978-3-031-42289-8_2

2.1 Introduction

Most Sámi reindeer husbandry in Norway is located in Finnmark, but reindeer husbandry is also practiced in Troms, Nordland, and Trøndelag. This case study investigates one reindeer herding unit that herds their reindeer close to Tromsø in Troms, Northern Norway—the Mievki-Stuoranjárga/Mauken-Tromsdalen reindeer husbandry district (RPD) (Fig. 2.1).

We focused on the loss of pastures and the impact of climate change. Initially, the studied Sámi reindeer herders herd their reindeer near Guovdageainnu/Kautokeino in Finnmark during the winter. In the 1950s, they moved their herd to the coastline of Troms, which has different climate conditions compared to inland Finnmark (Figs. 2.2a and 2.2b).

Nowadays, herders in the district have to cope with warmer and more unpredictable winters in Mievki/Mauken with frequent rain-on-snow events and a greater amount of snow (Vikhamar-Schuler et al., 2010; Hanssen-Bauer et al., 2023; van Rooij et al., 2023). Sámi reindeer herders refer to the melting and freezing snow cycle "when the snow melts, and the water freezes to form a hard coating of ice on the ground and plants" as *bodneskárta* (Eira et al., 2023). If followed by a period of cold weather, it forms strong ice layers (*geardni*) on the pasture plants or in the snow. Such weather events "lock" pastures making it nearly impossible for the reindeer to reach the feed and act as grazing barriers. In severe cases, this could lead to the starvation of reindeer (Halfpenny & Ozanne, 1989; Putkonen & Roe, 2003; Eira, 2012; Eira et al., 2012).

Fig. 2.1 The reindeer herd on migration between their winter pasture in Mievki/Mauken and their summer pasture in Stuoranjárga/Tromsdalen. The city of Tromsø is seen in the background. (Photo: Kia Krarup-Hansen)

Fig. 2.2a Orientation of Stuoranjárga/Tromsdalen, Mievki/Mauken, and Finnmark, Norway. (Map: downloaded and modified based on data from Kartdata, Geovekst, reindrift)

In addition to the effects of the coastal winter climate, this reindeer husbandry district has experienced substantial encroachments and disturbances over the last 70 years. Urban development of Tromsø city, sprawling ski and cabin resorts (Danielsen & Tømmervik, 2006), and modernized agricultural activity have shrunk the pasture lands in the area. Place-based studies help understand the complex nature and local dependencies of the social and ecological changes experienced in the area (Turner et al., 2003). A better understanding of the local stresses and vulnerabilities from the reindeer herders' perspective could assist in framing adaptation strategies based on Indigenous and traditional knowledge (Corell et al., 2019; Tonkopeeva et al., 2023). The Arctic Climate Impact Assessment (ACIA, 2005) showed the necessity to engage various cultural perspectives, including reindeer herders (McCarthy et al., 2005), in analyses of vulnerabilities to climate change.

Climate projections suggest that the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD is vulnerable to future climate change as their mean midwinter air temperature is moving closer to the freezing point within the next 50 years. As the winters are crucial for reindeer survival and reproduction, and climate projected studies predict the most remarkable changes in winter (Hanssen-Bauer et al., 2009; Hanssen-Bauer et al., 2023), this chapter will focus on the winter pastures in view of rain-on-snow events and snow precipitation. In the case of Finnmark, with increasing temperatures and precipitation (Benestad, 2008) and urbanization sprawling (Tonkopeeva et al., 2023), this investigation of the reindeer herders' adaptive strategies might help shape the adaptation strategies for reindeer husbandry in future Finnmark.

This research involved analysis and comparison of the future ambient temperature and precipitation projections for the area of Troms and Finnmark; the author conducted semi-structured interviews with the herders in a respective herding district. Information obtained within the interviews was mapped with the given projections. Interviews were conducted in Norwegian and Sámi and then translated into English by the author.

Fig. 2.2b Map of Stuoranjárga/Tromsdalen summer pasture district (red) and Mievki/Mauken winter pasture district (blue). (Map: downloaded and modified based on data from Kartdata, Geovekst, reindrift)

2.2 Study Area

Since the dissolution of the union between Sweden and Norway in 1905, cross-border reindeer herding has been controversial (NOU, 2007). Before 1950, the Oskal family herded their reindeer on the territories between Aidejávri near Guovdageainnu/Kautokeino in winter and Àkšovuotna/Øksfjord on the coast of Finnmark in summer (Fig. 2.2a). Due to limited grazing land around Kautokeino already in 1950, they applied to use the pastures in what is now known as the Stuoranjárga/Tromsdalen reindeer husbandry district. In 1950, they started a 4-year-long journey from Aidejávri to Stuoranjárga/Tromsdalen (Fig. 2.3).

Since the winter of 1957, the Oskal family has moved between winter pastures in Mievki/Mauken and summer pastures in Stuoranjárga/Tromsdalen outside Tromsø, as shown in Figs. 2.2b and 2.4 (Berg, 1991).

Before World War II, herders from Gárasavvon/Karesuando in Sweden used Stuoranjárga as summer pastures. Then the Mievki/Mauken pasture area worked as calving ground for reindeer on their annual trek from Gárasavvon/Karesuando to the coast. The historical use of these pasture areas is described by Sveen (2003).

Today, the usage of the pasture area of Mievki/Mauken is legally restricted to the period between October 15 and May 15 and Stuoranjárga/Tromsdalen April 15 and January 15 (Landbruksdirektoratet, 2020). The growing season on the coast is longer, and here the reindeer have access to a wider variety of forage (Hanssen-Bauer et al., 2009; Warenberg et al., 1997). Thus, the summer pastures in Stuoranjárga/Tromsdalen are rich; the calves of the Oskal family became larger after they moved

Fig. 2.3 Berit Oskal with the reindeer in lead when the Oskal family moved with their herd from Aidejávri in Finnmark to Stuoranjárga in Troms in the 1950s. (Photo: the Oskal family)

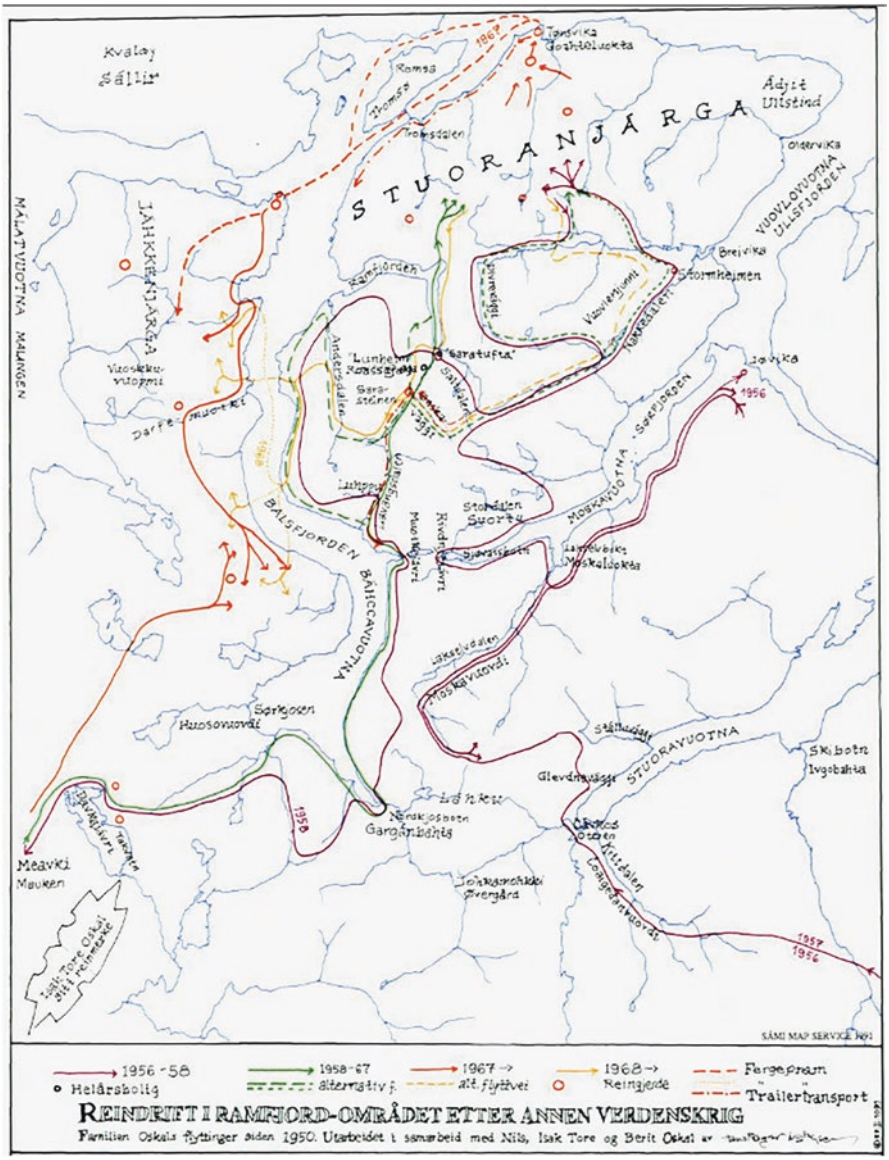

Fig. 2.4 Migration routes used by the Oskal between Mievki/Mauken and Stuoranjárga/Tromsdalen RPD from 1956 until today: 1956–1958 (purple arrow), 1958–1967 (green arrow), 1967–today (red arrow), alternative migration routes (yellow arrow), boat or truck transport (dashed line), fence (circle). (Representation of illustration made by cartograph Hans Ragnar Mathiesen in cooperation with herders of Mievki/Stuoranjárga RPD published in Berg, 1991, 76)

there from Finnmark (reindeer herder B). In autumn, the nutrient content of the summer pastures is low, and the mild winter on the coast often leads to "locked" pastures. The higher and steeper mountains at the coast also increase the risk of avalanches making the Stuoranjárga/Tromsdalen pasture area unfavorable for winter grazing (reindeer herder A; Berg, 1991).

The summer-winter pasture migration routes used by the Oskals since the 1950s appear in Fig. 2.4 (Berg, 1991 p. 76). In the 1960s, the reindeer husbandry district and their reindeer migrated along Balsfjord on the mainland (purple line, Fig. 2.4). However, the expansion of agricultural areas and the increased traffic along the coast made them revert to another migration route (yellow arrow in Fig. 2.4). Today they move the reindeer using an old military seagoing landing craft (Figs. 2.5a and 2.5b) from Tønsvik to Balsnes/Vikran in Malangen (dashed red line in Fig. 2.4). From here, the reindeer trek to Mievki/Mauken for the winter (Berg, 1991).

The loss of calves in Troms reindeer pasture area is high (53%) compared to, e.g., West Finnmark (42%) and East Finnmark (34%) (Landbruksdirektoratet, 2020). This is despite the high quality of the summer pastures and, thereby, higher slaughter weights in Troms. Higher calves' losses might be caused by increased predation and difficult winter grazing conditions. Due to the latter, reindeer, for example, are allowed and need to roam freely in search of pasture plants. The pasture area per reindeer for the Mievki/Stuoranjárga/Mauken-Tromsdalen RPD is higher than for Finnmark districts (1.47 vs. 2.9 reindeer/km^2; Landbruksdirektoratet, 2020).

Fig. 2.5a Reindeer waiting to be transported by an old military seagoing landing craft between winter pastures in Mievki/Mauken and summer pastures in Stuoranjárga/Tromsdalen. (Photo: Kia Krarup-Hansen)

Fig. 2.5b Reindeer transported using an old military seagoing landing craft between winter pastures in Mievki/Mauken and summer pastures in Stuoranjárga/Tromsdalen. (Photo: Kia Krarup-Hansen)

2.3 Outlining Climate History

The warm North Atlantic Current greatly influences the Norwegian climate. The Norwegian coast receives temperate sea air with westerly winds, and the air temperatures here are well above the temperatures observed in Alaska or Siberia at the same latitude. The Norwegian coast experiences moderate daily and annual temperature fluctuations (Hanssen-Bauer et al., 2009). Since the topography of Mauken RPD variates, with pastures at sea level to above 1300 meters, significant local variations in temperatures, wind and snow conditions, snow depth, pasture plants, and pasture access exist.

In general, the winter in Mievki/Mauken in Troms is much warmer (−10 °C) compared to more continental Guovdageainnu/Kautokeino in Finnmark (−16 °C) (Fig. 2.6).

Mievki/Mauken in Troms also receives far more winter precipitation than inner Finnmark (Fig. 2.7), 150–400 cm against 25–100 cm of snow over the winter, respectively (Fig. 2.8).

In addition, frequent rain-on-snow events in Mievki/Mauken occur due to winter temperatures near 0 °C. Figure 2.9a illustrates warm weather events during midwinter in Tromsø. In Kautokeino, the winter temperature is, on average, 2 °C lower today than in the early 1970s, though the temperature remains well below the freezing

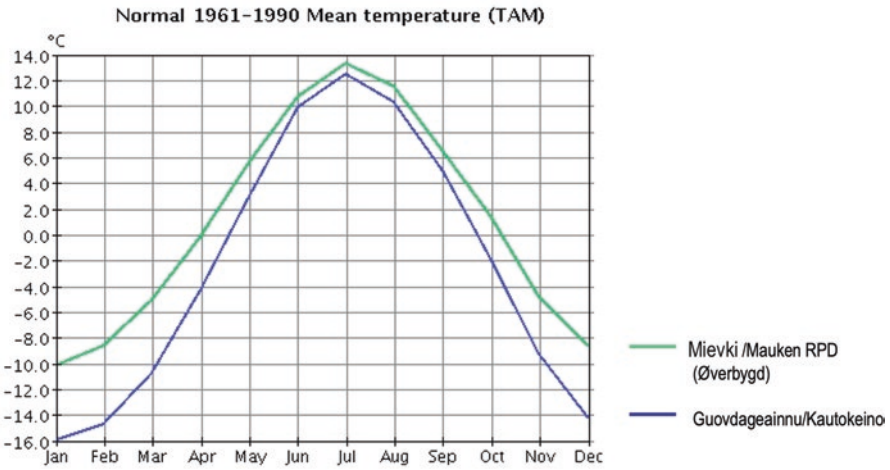

Fig. 2.6 Mean monthly air temperature (1961–1990) in the Mievki/Mauken RPD in Troms (Øverbygd, weather station no. 89800) and Guovdageainnu/Kautokeino in Finnmark (weather station no. 93700). Norwegian Meteorological Institute

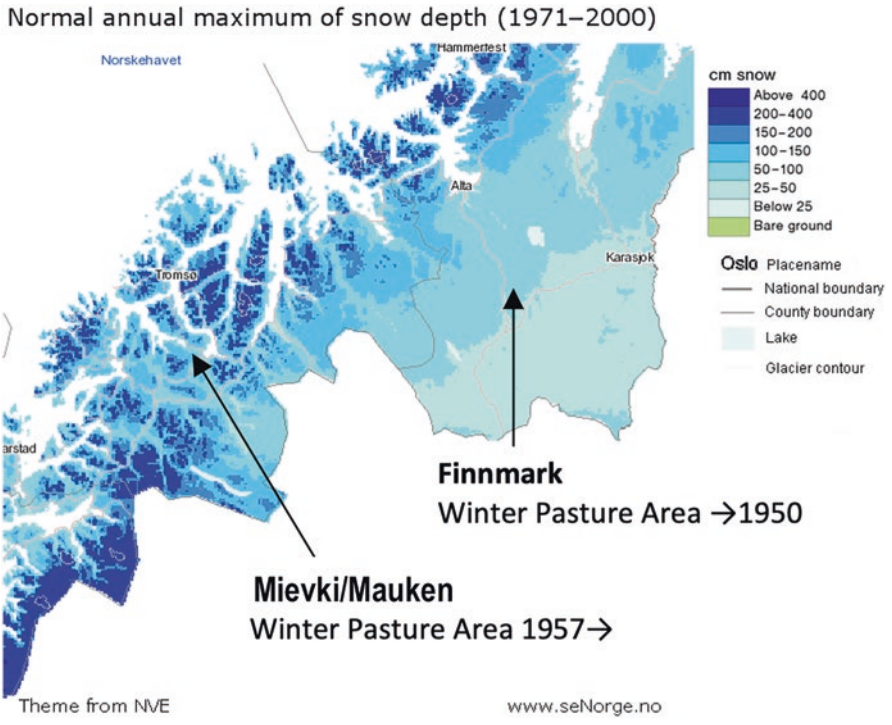

Fig. 2.7 Normal precipitation (1961–1990) in the Mievki/Mauken RPD in Troms (Øverbygd, weather station no. 89800) and Guovdageainnu/Kautokeino in Finnmark (weather station no. 93700). Norwegian Meteorological Institute

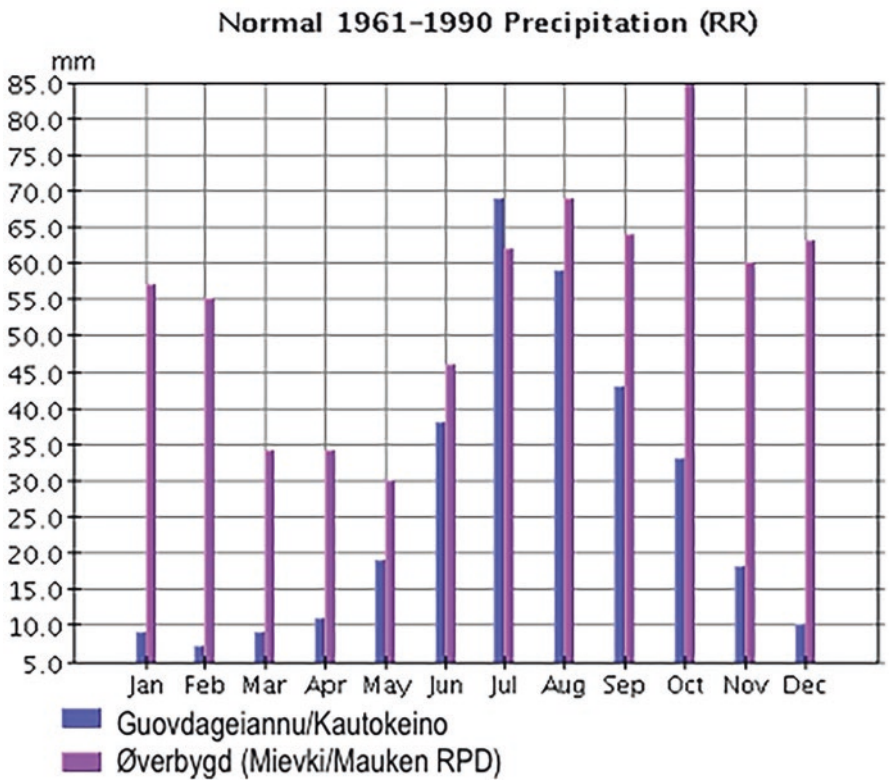

Fig. 2.8 Normal annual maximum of snow depth (1971–2000) for Troms and Finnmark, Northern Norway. www.senorge.no

point over the same time period (Fig. 2.9b), eliminating the risk of critical rain-on-snow events. The frequency of rain-on-snow events in the Mievki/Mauken RPD is lower compared to Tromsø (Fig. 2.9a) but higher than in Kautokeino (Fig. 2.9b).

In Northern Norway, there has been a clear trend in annual temperature and precipitation alterations over the last century (Hanssen-Bauer et al., 2009). In Troms, the winter temperature has increased by 0.8 °C (Fig. 2.10a), whereas the spring temperature has increased as much as by 1.3 °C (Hanssen-Bauer & Nordli, 1998). The increase in winter precipitation has been greatest in Northern Norway, rising by 28% in Troms (Hanssen-Bauer & Førland, 1998).

Herders in Mievki-Stuoranjárga/Mauken-Tromsdalen noted that winters have been "different" since 1981, with an increase in rain-on-snow events: "I remember 1980/81 as the first mild winter standing out in my memory…in February there was no ice on the lakes and the ground was bare at the winter pastures in Malangen" (reindeer herder A). This observation correlates with the trend in Fig. 2.10a starting from the beginning of the 1980s. As shown in Fig. 2.10a for Bardufoss (Mievki/Mauken RPD) and Fig. 2.10b for Guovdageainnu/Kautokeino, mean midwinter

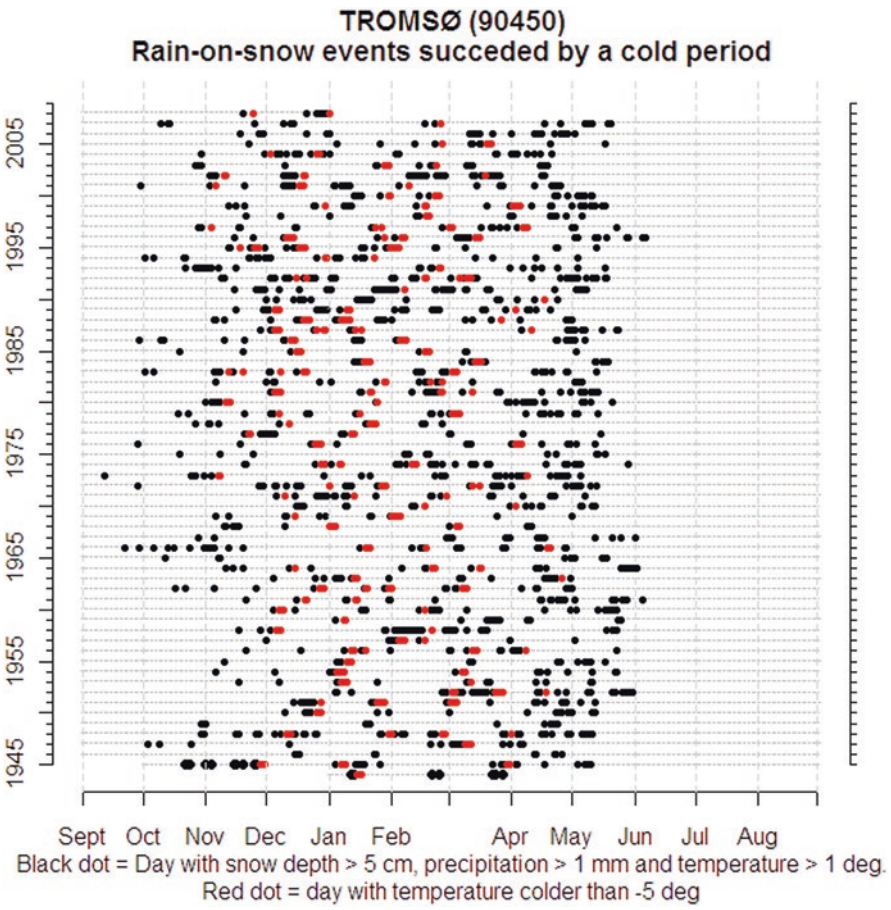

Fig. 2.9a Rain-on-snow events throughout the year in Tromsø from 1945 to 2009. (Report from the Norwegian Meteorological Institute no. 6/2010; Vikhamar-Schuler, 2010)

temperature fluctuates a lot from year to year. The increasing trend for Mievki/Mauken is closer to the freezing point compared to Guovdageainnu/Kautokeino (Figs. 2.10a and 2.10b).

> Even though we have had mild winters over the last 30 years, some periods in spring have been cold and with a great amount of snow. That is a change. Before when the spring came, it stayed with rain and thawing (reindeer herder A).

Difficult spring conditions can be particularly problematic for reindeer because their fat deposits are at their lowest at that time of the year (Larsen et al., 1985). At this time of year, their pregnancy is at its highest. Studies have shown that the highest reindeer losses occur with the three following scenarios: (1) early winter locked pastures, harsh late winter, and late spring; (2) early winter locked pastures, large areas of

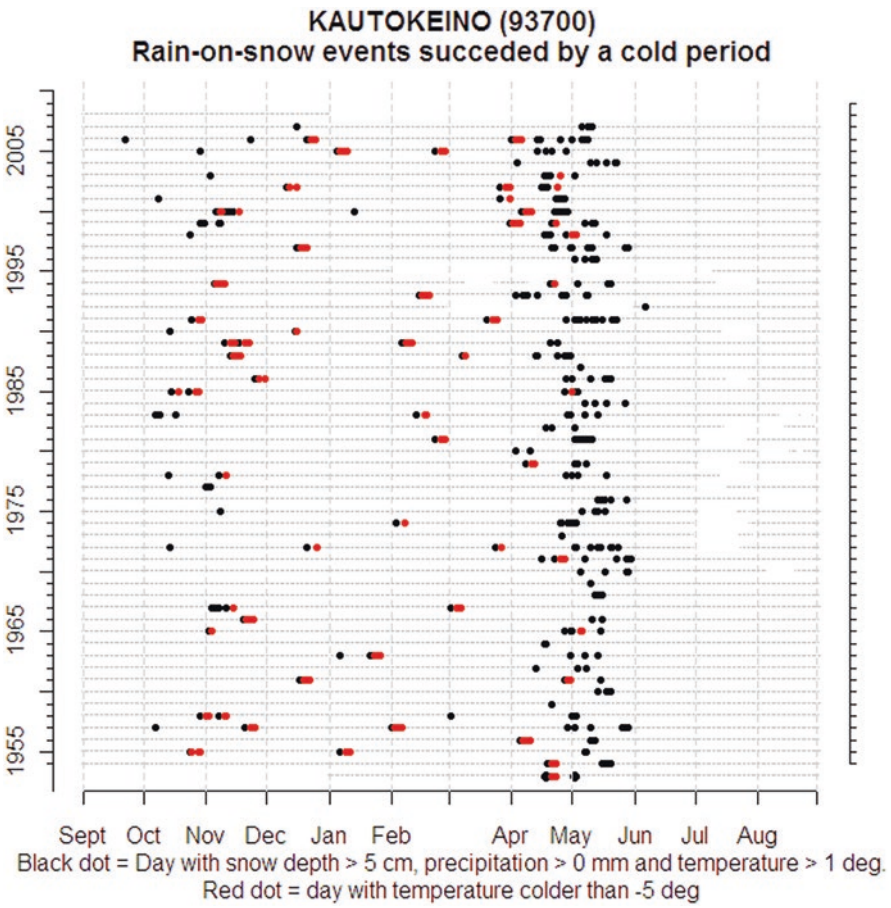

Fig. 2.9b Rain-on-snow events throughout the year in Kautokeino from 1945 to 2009. (Report from the Norwegian Meteorological Institute no. 6/2010; Vikhamar-Schuler, 2010)

locked pastures, and late spring; and (3) heavy snowfall followed by mild weather and frost (Lie et al., 2008).

2.4 Climate Change Projections: What Is to Expect?

Precipitation and temperature are critical factors for accessing pasture plants in winter (Benjaminsen & Svarstad, 2010). Projecting climate could help outline the future prospects of reindeer husbandry in the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD. However, as noted by Førland et al. (2009), it is essential to be aware that local and regional climate projections are affected by multiple factors, such as unpredictable internal natural variabilities that might weaken downscaling techniques. Thus,

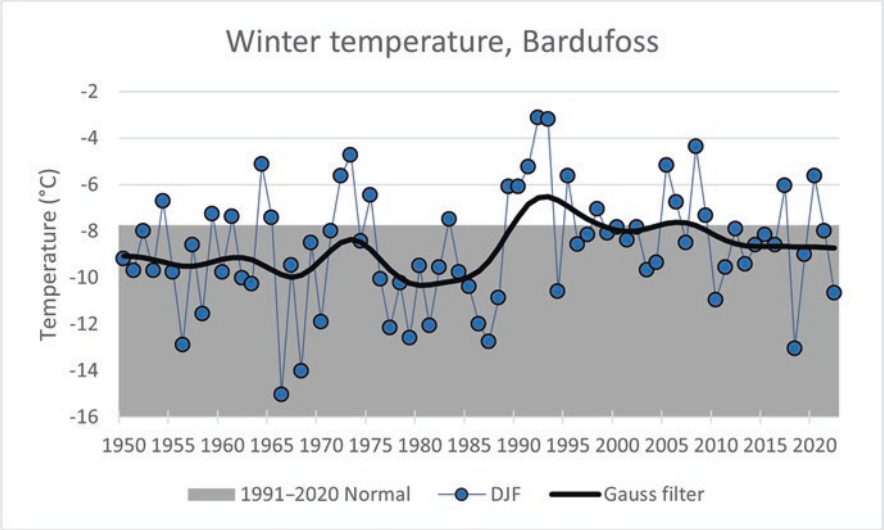

Fig. 2.10a Historical fluctuation in mean midwinter temperature (DJF; December, January, and February) from 1950 to 2020 in Mievki/Mauken (Bardufoss), Troms. Norwegian Meteorological Institute

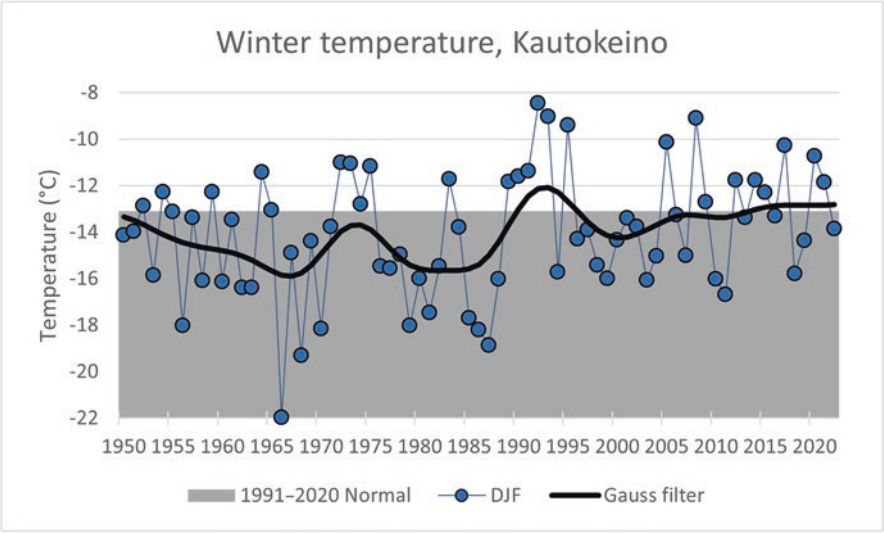

Fig. 2.10b Historical fluctuation in mean midwinter temperature (DJF; December, January, and February) from 1950 to 2020 in Guovdageainnu/Kautokeino, Finnmark. Norwegian Meteorological Institute

the significant climate and topography variations in Mievki/Mauken could affect the future climate remarkably.

Nevertheless, overall scenarios projected for the winter in Northern Norway are the following:

Highest temperature increases in the interior parts of Finnmark.
Lowest temperature increases in coastal areas such as Troms (Hanssen-Bauer et al., 2009).
Thus, the consequences of future climate change will differ for Mievki/Mauken in Troms compared to Guovdageainnu/Kautokeino in inner Finnmark.
In Tromsø, near Stuoranjárga/Tromsdalen, the mean winter temperature is expected to rise from −5 °C to +2 °C (Benestad, 2008).

In Mievki/Mauken (Bardufoss weather station), the mean midwinter temperature (December–February) could rise to −1 °C by 2100 (Fig. 2.11a, Benestad, 2008). A mean midwinter temperature near the freezing point could boost the number of rain-on-snow events and lead to more extended bare ground periods. Both will affect the pastureland usage practices and reindeer survival. Conditions might be similar to winter conditions in Tromsø (Stuoranjárga/Tromsdalen) today.

In Guovdageainnu/Kautokeino, the mean winter temperature could rise to −10 °C by 2050 (Fig. 2.11b; Benestad, 2008). This is the average winter temperature in Mievki/Mauken today. Thereby, 30 years from now, the districts in Finnmark could face similar climate hardships as the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD.

Increased spring temperatures could reduce the snow season, particularly in coastal areas, by as much as 2 months. In Mievki/Mauken (Bardufoss weather

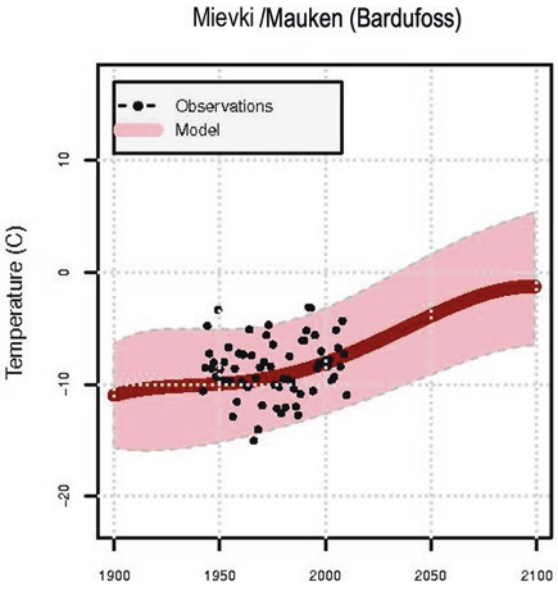

Fig. 2.11a Midwinter (December–February) temperature observations and projections from 1900 to 2100 for Mievki/Mauken (Bardufoss) in Troms. Downscaled IPCC models SRES A1b, estimated on the inclusion of reduced emissions by Benestad (2008)

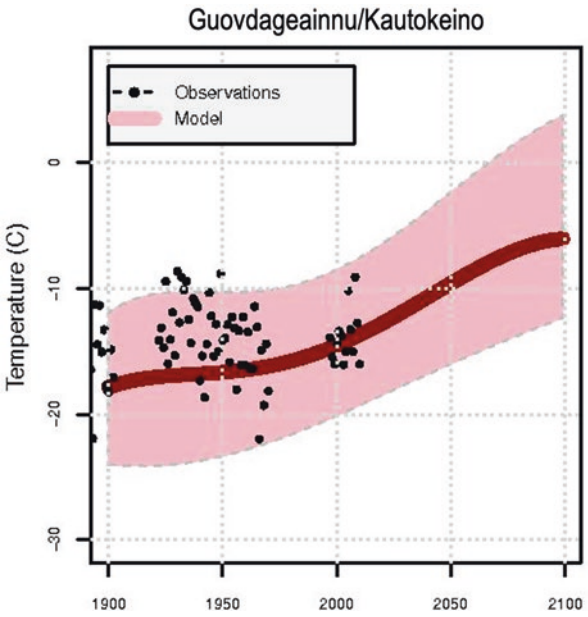

Fig. 2.11b Midwinter (December–February) temperature observations and projections from 1900 to 2100 for Mievki/Mauken (Bardufoss) in Guovdageainnu/Kautokeino. Downscaled IPCC models SRES A1b, estimated on the inclusion of reduced emissions by Benestad (2008)

station), mean spring (March–May) temperatures are projected to increase by +6 °C by the year 2100 (Benestad, 2008). In Guovdageainnu/Kautokeino, spring temperature is projected to increase, shortening the snow season by 1 month (Førland et al., 2009). An early spring or a late winter could be advantageous for the reindeer as pastures would be more accessible. However, for the herders, milder and more unpredictable weather during the spring and autumn migration is challenging: snowmobiles cannot drive across unfrozen lakes, streams, and lots of bare ground (reindeer herder A).

The winter precipitation is projected to increase by 12.7% in Troms and 15.6% in Finnmark from 1961–1990 to 2071–2100 (Hanssen-Bauer et al., 2009). For the reindeer in general, dense snow cover is not an issue as long as they have free access to the ice-free ground (reindeer herder A). To some extent, grazing in deep snow cover is strenuous, affecting the animals' energy loss (Fancy & White, 1987).

2.5 Climate Change: Herders' Ways to Adapt

The central question is whether changes in herding practices can diminish the potential impacts of climate change. Adaptation strategies could help reindeer herders. Flexibility lies at the core of reindeer husbandry: when working with the herd, the herder seeks to increase benefits and avoid undesirable situations.

Increased rain-on-snow events could, perhaps, to some extent, be compensated by an earlier melting and a longer growing season. Reindeer can extend their

calving by some weeks if pasture conditions or access is scanty (reindeer herder A). However, the compensation depends on the reindeer's capacity to adapt to early spring regarding the correlation between calving, pasture quantity, and quality. An elderly herder in Mievki-Stuoranjárga/Mauken-Tromsdalen RPD notices that today's estrus begins several days earlier than 40 years ago. That could signal a reindeer adaptation strategy to early spring.

What are the options for the herders in the face of current changes? Let's have a look at the alternative herding systems. Today's climate in Nordland and Northern Trøndelag is similar to the projected climate for Mievki-Stuoranjárga/Mauken-Tromsdalen approximately 100 years from now. Herders from the coastal Northern Trøndelag winter pasture area do not recall rain-on-snow issues (Lie et al., 2008). Trøndelag's seasonal migration is the opposite of Troms and Finnmark's. In summer, the reindeer pasture at the far coast; they pasture further inland, higher up the mountains in winter. Replicating the herding practices of Northern Trøndelag might also act as an adaptation strategy for the studied area in the future.

Once, the Oskal herders let the herd overwinter in Stuoranjárga/Tromsdalen because pastures in Mievki/Mauken were locked. Herders mentioned that it was a positive experience. In contrast, "*the winter of 2011 was probably the worst because the winter pastures* [in Mievki/Mauken] *were locked for a long time, with many rain-on-snow events starting already in November*" (reindeer herder A). The number of calves born the following summer was insignificantly low. During winter 2012, herders reported that the reindeer stayed in Malangen long, and the pasture conditions were favorable. Herders suggest that the best practice for a similar winter would be to let the herd scatter from Malangen. Malangen is the coastal area of their winter pasture grounds (Fig. 2.2b). Having several optional pastures is crucial during challenging winter conditions when pastures are locked.

Another adaptation option is supplementary feeding. Reindeer husbandry value depends on the ratio between the pasture and animal population. Supplementary feeding can maintain this relationship between those two so that more reindeer survive even though the pasturelands are or have been reduced due to losses or ice-locking. Over the last decades, the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD has supplied the herd with an increasing amount of supplementary feed during the winter. However, supplementary feeding is costly. It might become a sustainable adaptation strategy for the district's herders if (1) the feed is improved, (2) the taxes on feed are reduced, or (3) the government subsidizes supplementary feeding.

We have described several adaptation strategies for the herding district investigated. The expected increase in rain-on-snow events and its consequences could perhaps compensate for a longer growing season, but the critical factor is the flexible pastureland use.

2.6 Coping with Non-climate Drivers of Change

Coping success depends to a large degree on their freedom of action. Most non-climate influences, which affect the district's vulnerability, lie within spheres under the regulation of the Norwegian government: predation, encroachments, meat, feed, and other prices, subsidies, and production limits. All these constraints reduce the herders' ability to respond creatively and productively to a changing climate.

Until 1974, there were few lynx and wolverines in the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD; while the state allocates compensations for reindeer lost to predation, the onerous documentation required to demonstrate loss seems capricious to herders, and as a result, only a minority of lost reindeer are compensated.

The traditional diversity of herd composition has been a long-term coping strategy to reduce its vulnerability. In the 1950s and 1960s, the composition of the herd was different than it is today (reindeer herder A). Since 1976, the Ministry of Agriculture has governed reindeer husbandry similarly to the industrial, agricultural production systems. This has been done, for example, through subsidies for calf slaughtering with a desire to achieve the most outstanding possible production (Reinert, 2006; Reinert & Oskal, 2024). As a result, today's herd primarily consists of productive female reindeer, whereas in the past, a much more significant proportion of the herd was male (Degteva et al., 2024). Male reindeer play an essential role in keeping the herd together, protecting against predators, and accessing ice-locked pastures. Subsidies might have had the opposite effect of what they had initially aimed at. An unbalanced herd structure also led to the disproportional distribution of the reindeer (reindeer herder A). This illustrates the consequences of the government's management that fail to listen to the reindeer herders and utilize their traditional knowledge.

However, the loss of pastureland is one of the most significant threats to reindeer husbandry in the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD. On the coast, 35% of the land is influenced by human activity; see Fig. 2.12 (UNEP, 2001).

If the expansion continues at this rate, this will increase to 80% by 2050 (Lie et al., 2006). Due to their proximity to Tromsø, continuing expansions might significantly constrain the adaptive capacity of the herders in the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD. The district has experienced increased encroachment in both summer and winter grazing areas. Challenging weather conditions demand maintaining the size of the Mievki/Mauken winter pastures. Pasture loss intensely increases the district's vulnerability. In addition to the ski and cabin resort development (Målselv Fjellandsby), military firing ranges cause the most significant encroachment and disturbances of the winter pastures, accounting for approximately 30% of the central part of the winter pasture area (Andersen et al., 2007; Reindeer at War, 2006; Danielsen & Tømmervik, 2006).

These military and tourist encroachments will significantly negatively affect reindeer husbandry in the area: the number of reindeer would have to be reduced by 233–433 animals (Danielsen & Tømmervik, 2006; Andersen et al., 2007). While the compensation may seem high, the loss of pastureland would increase the amount of supplementary feeding (Fig. 2.13a and 2.13b). Expenditures for feeding are

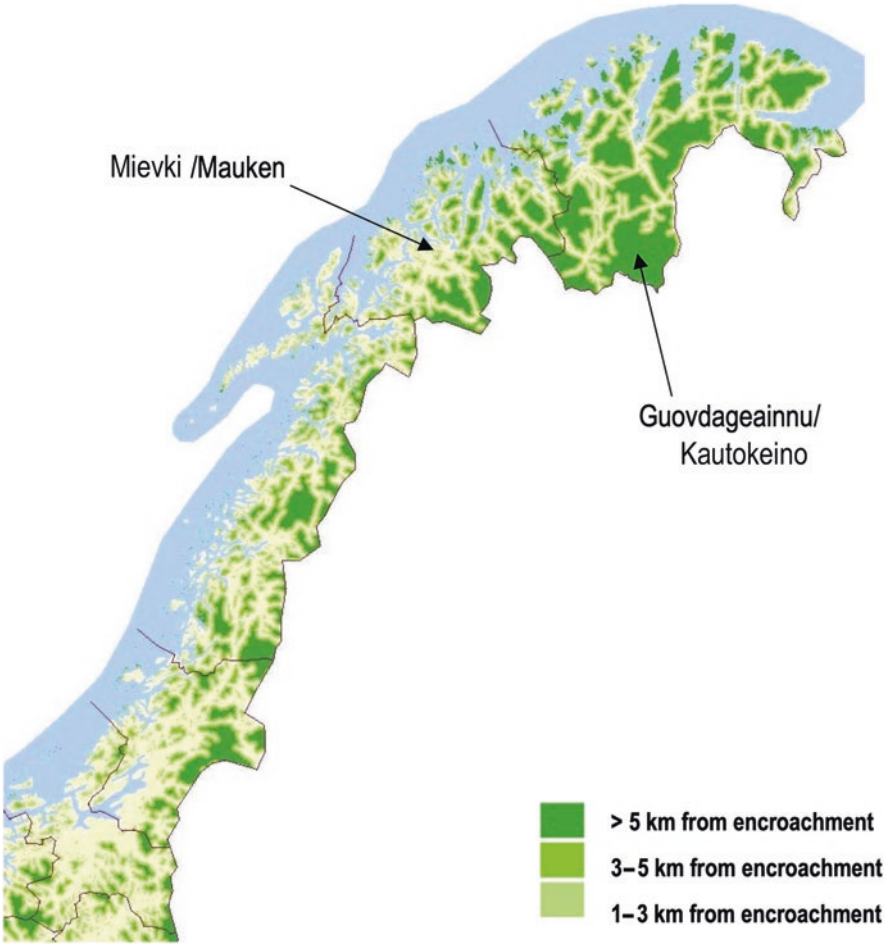

Fig. 2.12 Encroachment-free areas (green) of Northern Norway. (Norwegian Environment Agency, 2013)

currently 500 000–600 000 NOK annually and would likely expand over time as these developments progress (Reindeer at War, 2006). The herding district might face challenging years ahead if rain-on-snow events also increase.

> When we have no money left, we would have to decrease the feeding, and then we will feel the consequences of these encroachments. Then some of us would be forced to stop herding (reindeer herder A).

Bit-by-bit encroachment may have a limited individual effect but, taken together, lead to significant cumulative effects reaching the tipping point of sustainable reindeer husbandry (Landauer et al., 2021; Nelleman et al., 2003). For example, developments along the migration route used before 1967 (see green line in Fig. 2.4) changed their migration route (Fig. 2.14) and limited the herders' coping and

Fig. 2.13a Supplementary feeding of the reindeer in Mievki/Mauken RPD. (Photo: Kia Krarup-Hansen)

adaptive capacity. In the future, the cumulative effect might be increased loss of reindeer, increased mixing with neighboring districts' herds, increased need for feeding, and increased need for herding (reindeer herder A). Thus, one cannot simply consider each encroachment individually.

Several pasture alternatives available in Mievki-Stuoranjárga/Mauken-Tromsdalen RPD make the district less vulnerable, but should the encroachment continue, the situation might change dramatically.

2.7 Conclusion

Reindeer husbandry is paramount for Sámi culture and communities whose livelihoods depend on the Arctic (Brännlund & Axelsson, 2011). In the last decades, reindeer husbandry has experienced rapid change in every facet of the herding system regarding technology, economy, and organization. Yet the landscape management, including the migration system, has changed very little. Considering the predicaments Mievki-Stuoranjárga/Mauken-Tromsdalen RPD is facing today and the projected future warm climate, it is high time to evaluate the internal organization for herders to be able to migrate with their herd in the future. It is a unique case study since it investigates the reindeer herding district close to Tromsø with its urban

Fig. 2.13b Supplementary feeding of the reindeer in Mievki/Mauken RPD. (Photo: Kia Krarup-Hansen)

activities. Climate projections show that even within 50 years, reindeer herding districts in Finnmark will face the climate challenges currently experienced in Troms today.

It is difficult to predict how all the impacts on reindeer husbandry in the district affect each other. We suggest that a more thorough and detailed investigation of the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD's vulnerabilities and bottlenecks to change is needed. Such studies are also crucial for the herders in Finnmark, considering the projections that indicate similar challenges there as in Troms today.

The vulnerability of the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD might be mitigated if the herders' operational flexibility is increased. Freedom of action will enable herders to work aligned with nature as it has been in traditional reindeer husbandry for millennia. Embracing the benefits of the day and age, such as transportation or supplementary feed, is also reported helpful. The local consequences of future climate changes in this reindeer herding district are still heavily dependent on decisions yet to be taken at different authority levels. It remains to be seen if these include the voices of reindeer herders, as reported in the present case study.

Fig. 2.14 Herders and reindeer on their annual migration in Malangen, Troms. (Photo: Kia Krarup-Hansen)

References

ACIA. (2005). *Arctic climate impact assessment*. Cambridge University Press. www.acia.uaf.edu

Andersen, O., Tømmervik, H., Danielsen, I., & Nellemann, C. (2007). Sammenbindingskorridor mellom Mauken og Blåtind skyte- og øvingsfelf. Konsekvenser for reindrift. NINA rapport 305 (Connecting corridor between Mauken and Blåtind firing- and training range. Consequences for reindeer husbandry. NINA report 305).

Benestad, R. E. (2008). Downscaled regional Norwegian temperature and precipitation series, met. No report 07/2008.

Benjaminsen, T. A., & Svarstad, H. (2010). *Politisk Økologi; Miljø, mennesker og makt* (Political ecology; environment, people and power). Universitetsforlaget.

Berg, E. (1991). *Ramfjorden: Samisk historie og samtid i Ramfjordområdet* (Ramfjorden: Sami history and contemporaries in the Ramfjord area). Ramfjordforlaget, .

Brännlund, I., & Axelsson, P. (2011). Reindeer management during the colonization of Sámi lands: A long-term perspective of vulnerability and adaptation strategies. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2011,03.00S

Corell, R. W., Kim, J. D., Kim, Y., Moe, A., VanderZwaag, D. L., & Young, O. R. (2019). The Arctic in world affairs: A North Pacific dialogue on Arctic 2030 and beyond—pathways to the future: 2018 North Pacific Arctic conference proceedings.

Danielsen, I. E., & Tømmervik, H. (2006). Målselv fjellandsby. Konsekvensutredning, deltema reindrift. NINA rapport 179 (Målselv mountain village. Impact assessment, sub-theme reindeer husbandry. NINA report 179).

Degteva, A., Okotetto, E., Slepushkin, I., Romanenko, T., Borodina, A., & Mathiesen, S. D. (2024). Reindeer husbandry trends: Nenets autonomous okrug and western finnmark. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer.

Eira, I. M. G. (2012). Muohttaga jávohis giella – Sámi árbevirolas máhttu muohttaga birra dálkkádatrievdanáiggis (The silent Language og Snow – Sámi traditional knowledge of snow in times of climate change). Ph.d thesis, University of Tromsø, Tromsø, Norway.

Eira, I. M. G., Jaedicke, M. O. H., Maynard, N. G., Vikhamar-Schuler, D., & Mathiesen, S. D. (2012). Traditional Sámi snow terminology and physical snow classification – Two ways of knowing. *Cold Regions Science and Technology, 85*, 117–130.

Eira, I. M. G., Turi, E. I., & Turi, J. M. (2023). Sámi traditional reindeer herding knowledge throughout a year: Herding periods on snow-covered ground. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_4

Fancy, S. G., & White, R. G. (1987). Energy expenditures for locomotion by barren-ground caribou. *Canadian Journal of Zoology, 65*, 122–128.

Førland, E. J. Benestad, R. E., Flatøy, F, Hanssen-Bauer, I., Haugen, J. E., Isaksen, K., Sorteberg, A., & Ådlandsvik, B. (Eds.) (2009). Climate development in North Norway and the Svalbard region during 1900–2100. Report series no. 128 Norwegian Polar Institute.

Halfpenny, J. C., & Ozanne, R. D. (1989). *Winter: An ecological handbook*. Johnson Books.

Hanssen-Bauer, I., & Førland, E. J. (1998). Annual and seasonal precipitation variations in Norway 1896–1997 *Klima-report* 27/98, Norwegian Meteorological Institute.

Hanssen-Bauer, I., & Nordli, Ø. (1998). Annual and seasonal temperature variations in Norway 1876–1997. *Klima-Report* 25/98, Norwegian Meteorological Institute.

Hanssen-Bauer, I., Drange, H., Førland, E. J., Roald, L. A., Børsheim, K. Y., Hisdal, H., Lawrence, D., Nesje, A., Sandven, S., Sorteberg, A., Sundby, S., Vasskog, K., & Ådlandsvik, B. (2009). Klima i Norge 2100 – Bakgrunnsmateriale til NOU Klimatilpassing (climate in Norway 2100 – A knowledge base for climate adaptation), Norwegian Centre for Climate Services (NCCS), September 2009, Oslo.

Hanssen-Bauer, I., Benestad, R. E., Lutz, J., Vikhamar-Schuler, D., Svyashchennikov, P., & Førland, E. J. (2023). Comparative analyses of local historical and future climate conditions important for reindeer herding in Finnmark, Norway and the Yamal Nenets autonomous Okrug, Russia. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_8

Landauer, M., Rasmus, S., & Forbes, B. C. (2021). What drives reindeer management in Finland towards social and ecological tipping points? *Regional Environmental Change, 21*, 32.

Landbruksdirektoratet 2020. Ressursregnskap for reindriftsnæringen. Reindriftsåret 1. april 2019–31. mars 2020. (In Norwegian; Resource accounting for the reindeer husbandry industry. The reindeer herding year April 1, 2019 – March 31, 2020.) Report no. 43/2020.

Larsen, T. S., Nilsson, N. Ö., & Blix, A. S. (1985). Seasonal changes in lipogenesis and lipolysis in isolated adipocytes from Svalbard and Norwegian reindeer. *Acta Physiologica Scandinavica, 123*, 97–104.

Lie, I., Vistnes, I., & Nellemann, C. (2006). Hytteutbygging i reindriftsområder (cabin constructions in areas of reindeer husbandry). NORUT-NIBR Finnmark Rapport 2006: 5.

Lie, I., Riseth, J. Å., & Holst, B. (2008). Samisk reindrift i et skiftende klimabilda (Sami reindeer husbandry in a changing climate). Report 2008:8. Norut Alta.

McCarthy, J. J., Martello, M. L., Corell, R., Selin, N. E., Fox, S., Hovelsrud-Broda, G., Mathiesen, S., Polsky, C., Selin, H., Tyler, N. J. C., Strøm Bull, K., Eira, I. M. G., Eira, N. I., Eriksen, S., Hanssen-Bauer, I., Kalstad, J. K., Nellemann, C., Oskal, N., Reinert, E., Siegel-Causey, D., Storeheier, P. V., & Turi, J. M. (2005). *Climate change in the context of multiple stressors and resilience chapter 17 in ACIA: Arctic climate impact assessment*. Cambridge University Press.

Norwegian Environment Agency. (2013). Maps available at https://kartkatalog.miljodirektoratet.no/MapService/Details/inngrepsfrinatur Accessed Nov 2020.

Nelleman, C., Vistnes, I., Jordhöy, P., Strand, O., & Newton, A. (2003). Progressive impact of piecemeal infrastructure development on wild reindeer. *Biological Conservation, 113*, 307–317.

NOU. (2007). Norges offentlige utredninger 2007:14. Samisk naturbruk og rettssituasjon fra Hedmark til Troms. Bakgrunnsmateriale for Samerettsutvalget. (Official Norwegian Reports

2007:14. Sami nature use and legal situation from Hedmark to Troms. Background material for the Sami Law Committee), Departementenes servicesenter, Informasjonsforvaltning, Oslo 2007.

Putkonen, J., & Roe, G. (2003). Rain-on-snow events impact soil temperatures and affect ungulate survival. *Geophysical Research Letters, 30*(4), 1188.

Reindeer at War. (2006). Documentary by Svein Andersen & Karl Rikardsen. Relation04 media AS.

Reinert, E. (2006). The economics of reindeer herding – Saami entrepreneurship between cyclical sustainability and the powers of state and oligopolies.

Reinert, E. S., & Oskal, A. (2024). Reindeer herding in Norway: Cyclicality and permanent change vs. governmental rigidities. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer.

Vikhamar-Schuler, D. V., Førland, E. J., & Hanssen-Bauer, I. (2010). Long-term climate trends of Finmarksvidda, Northern Norway. Met.no report no 6/2010. Norwegian Meteorological Institute. Available at http://www.senorge.no/mappage.aspx. Accessed April 2011.

Sveen, S. B. (2003). Boazosápmelaš, boazu ja sutnu guohtoneanan – Reinen, reineieren og reinbeitelandet. In *En studie av reindriftssamisk landskapsbruk og landskapsforståelse, forankret i sommerlandet Stuoranjárga (in Norwegian)*. University of Tromsø. Master thesis in Archeology.

Tonkopeeva, M., Corell, R. W., Maynard, N. G., Turi, E. I., Eira, I. M. G., Oskal, A., & Mathiesen, S. D. (2023). Framing adaptation to rapid change in the Arctic. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_2

Turner, B. L., Kasperson, R. E., Matson, P., McCarthy, J. J., Corell, R. W., Christensen, L., Eckley, N., Kasperson, J. X., Luers, A., Martello, M. L., Polsky, C., Pulsipher, A., & Schiller, A. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences, 100*, 8074–8079.

UNEP. (2001). *GLOBIO – Global methodology for mapping human impacts on the biosphere*. United Nations Environmental Programme.

van Rooij, W., Aslaksen, I., Eira, I. H., Burgess, P., & Garnåsjordet, P. A. (2023). Loss of reindeer grazing land in Finnmark, Norway, and effects on biodiversity: GLOBIO3 as decision support tool at Arctic local level. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_9

Warenberg, K., Danell, Ö., Gaare, E., & Nieminen, M. (1997). Flora i reinbeiteland (Flora in reindeer grazing land). Landbruksforlaget (Nordic council for Reindeer Research).

Chapter 3
Adaptation to Change in Reindeer Husbandry in the Republic of Sakha (Yakutia), Russia

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Abstract With 170,000 domestic reindeer and 1295 reindeer herders, the Republic of Sakha (Yakutia) is a vital region for the reindeer herding economy. The Republic is the homeland of five Indigenous peoples that herd reindeer – Evenki, Even, Dolgan, Yukaghir, and Chukchi.

The paper looks at the history and characteristics of Yakutia's reindeer herding and herding peoples and analyzes the transformation of the traditional reindeer husbandry model into a collectivized industry from the 1930s. Loss of pastures, predators, and decline of traditional knowledge are affecting reindeer herders, with climate change exacerbating the problems. Another aim of the paper is to show the impact of climate change on the reindeer herding development through the example of four reindeer herding regions of Yakutia from the north to the south. In this regard, the article examines the climate change trends and, in a historical retrospective, the economic settings of this traditional nature management sector, which

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employs only the Indigenous peoples of the North. The identified climate change trends suggest that climate warming combined with other economic transformations has diverse effects on reindeer husbandry in the four districts under investigation.

The findings indicate that challenges such as loss to predators, loss of grazing land, and decline in traditional knowledge preservation affect herding communities already affected by climate change. The authors highlight the relevance of engaging Indigenous reindeer herding communities and their traditional knowledge in developing mechanisms for adaptation to climate change and predation. It is essential to support herders in their aspiration to decide their destiny and strengthen the family-based economy.

Keywords Reindeer herding · Collectivization · Poor weather conditions for reindeer herding · Predators · Traditional knowledge

3.1 Introduction

The Republic of Sakha (Yakutia) is located in the northeastern part of the Eurasian continent and is the largest region of the Russian Federation. The total area of the continental and insular territory of Yakutia, located in the basins of the rivers Lena, Yana, and Indigirka and the lower reaches of the Kolyma River, including the New Siberian Islands of the Arctic Ocean, is 3103.2 km^2, i.e., 1/6 of the territory of Russia. More than 40% of Yakutia lies north of the Arctic Circle. Yakutia stretches 2500 km north-south and 2000 km east-west. The average thickness of the frozen layer reaches 300–400 m and, in the Vilyuy river basin, even 1500 m. The territory of the Yakutia is the largest reserve of the Earth's biosphere, a global ecological reserve, and one of the climate regulators of the entire planet. Yakutia accounts for over 30% of the untouched nature of Russia and about 10% of the entire world (Popova et al., 2023). The territory of Yakutia is divided into four geographical zones: taiga forests (almost 80% of the area), tundra, forest tundra, and Arctic desert. The operational reserves of the Republic's forest resources are estimated at 10.3 billion cubic meters.

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Currently, the most pressing issues in the Yakutia herding industry are the disruptions of the snow cover, mining development, and predator population growth. The massive loss of reindeer due to predators exceeds the number of anomalies that the nomads can manage (Lavrillier & Gabyshev, 2018). This paper reviews the adaptive capacity in four reindeer herding regions in Yakutia (Fig. 3.1) using official statistical data and scientific literature.

Domesticated reindeer livestock is a vital resource for the traditional economy of the Indigenous peoples of the Russian Arctic. Klokov (2012, 2020) analyzed the variability of the reindeer population trends in different Arctic regions, the reasons why reindeer livestock increases in some areas and decreases in others, and how the population of domestic reindeer was affected by the collapse of the USSR. According to Golovnev et al., (2014), as cited by Klokov (2020), the dissolution of the Soviet Union caused a crisis in the social and political environment which Indigenous peoples had been adapting to for decades. In the crisis conditions, the peculiarities, which formerly would not be seen, played a decisive role: they helped some communities to overcome the crisis, while others were taken to the edge of catastrophe (Klokov, 2020).

3.2 The Homeland for Indigenous Peoples

Yakutia is home to five Indigenous reindeer herding peoples: Evenki, Even, Dolgan, Yukaghir, and Chukchi. Evenki and Even belong to the Tungus ethnolinguistic group, Dolgan is Turkic-speaking people, and Yukaghir forms an isolated language group.

In the north of the Republic, Yakut (Sakha) people also practice reindeer herding (Fig. 3.1). Reindeer husbandry in Yakutia covers a territory of 2.5 million km^2 which is about 83% of the total area of the Republic (Oskal et al., 2009: 71). This section is focused on describing traditional reindeer herding practices of Evenki, Even, Dolgan, Yukaghir, and Chukchi peoples engaged in different types of herding: taiga and tundra reindeer herding. The changes brought by the Soviet power and later periods will be addressed separately.

Evenki inhabit a vast territory from the coast of the Sea of Okhotsk in the east of Russia to the Yenisei in the west, from the Arctic Ocean in the north to the Baikal region and the Amur in the south. They are also settled in Northern China. Traditionally, the Evenki led a nomadic lifestyle engaging in traditional economic activities such as reindeer herding, hunting, and seasonal fishing. According to the 2010 census, the number of Evenki in Yakutia is 21,008 people, or 55.5% of all Evenki living in Russia (Neustroeva & Semenova, 2018). Evenki reindeer herding belongs to the taiga type: reindeer herds were small and used for transportation purposes – Evenki would ride the animals – and milking. Domestic reindeer are slaughtered for meat only if fishing, a seasonal activity, is unsuccessful or when the family faces hunger.

Even live in five regions of the Russian Federation: the Republic of Sakha (Yakutia), Khabarovsk Krai, Magadan Oblast, Kamchatka Krai, and Chukotka

Autonomous Okrug. In Russia, most Even live on the territory of Yakutia: 15,071 Even in 2010, or 67.3% of the total number of Even in Russia (Neustroeva & Semenova, 2018). The nomadic Even are reindeer herders and hunters, while fishing is secondary. Their reindeer herding belongs to the taiga mountain and tundra types. The Even used reindeer as transport for hunting and practiced riding and milking the animals. If hunting or fishing was unsuccessful, they slaughtered their reindeer for food. Their connection with the reindeer was very close, so the Even never killed them unless necessary.

Dolgan are nomadic Indigenous people. According to the 2010 census, 1906 Dolgan live in Yakutia, or 24.2% of all Dolgan in Russia (Neustroeva & Semenova, 2018). Their traditional occupations are reindeer herding, hunting, and fishing in some areas. The Dolgan lead a nomadic lifestyle without going beyond the forest tundra. Dolgan reindeer husbandry combines taiga-type reindeer herding and techniques of the Nenets sleigh herding. The Dolgan milked reindeer, used shepherd dogs, and hunted arctic foxes, geese, ducks, partridges, and wild reindeer.

Yukaghir inhabit three regions of the Russian Federation: the Republic of Sakha (Yakutia), Magadan Oblast, and Chukotka Autonomous Okrug. The Yukaghir are divided into two groups: tundra and taiga Yukaghir. According to the 2010 census, there were only 1603 Yukaghir in Russia – with 1281 people or 79.9% living in Yakutia (Neustroeva & Semenova, 2018). Traditionally, the Yukaghir have a nomadic and semi-nomadic lifestyle, which includes fishing and hunting. The tundra Yukaghir also herd reindeer, using them mainly for transportation.

Chukchi are the oldest inhabitants of the continental areas of the extreme northeast of Siberia, carriers of the intra-continental culture of wild reindeer hunting and fishing. The Chukchi are the smallest Indigenous group in the Republic of Sakha (Yakutia). According to the 2010 census, there were 670 Chukchi in the Republic, or 4.2% of all Chukchi living in Russia (Neustroeva & Semenova, 2018). The majority of Chukchi in Yakutia settle in the Nizhnekolymsky District – 506 people. Traditionally, coastal Chukchi hunt marine mammals, and inland Chukchi herd reindeer, their main source of subsistence, leading a nomadic lifestyle and using reindeer for transportation and meat.

Historically, there were two types of traditional economy in Yakutia: one based on reindeer herding and another one on sea mammal hunting. In the nineteenth century, the herd had from 3000–5000 to 10,000–12,000 animals. In the summer, the herders moved to the ocean coast or the mountains. With the onset of autumn, they moved inland to the forest borders for winter pastures, where they migrated between 5 and 10 km if necessary.

3.3 Important Reindeer Husbandry Region

With more than 170,000 reindeer, Yakutia is the area with the third largest number of reindeer in Russia. Today, 21 out of 34 municipal districts in the Republic are engaged in breeding domesticated reindeer (Table 3.1). In South Yakutia, taiga

reindeer husbandry is spread throughout the administrative districts of Aldansky, Olekminsky, Ust-Maysky, and Neryungrinsky. Mountain taiga reindeer husbandry occupies most of the Republic, and most of the reindeer here are bred and herded by the Even, such as in the Tomponsky District. Tundra and forest-tundra reindeer husbandry is practiced in the Arctic zone, where all five Yakutia's Indigenous peoples and Sakha people are involved in herding, and the northwest of Yakutia.

Today, 104 reindeer herding brigades employ 1295 people in Yakutia: brigadiers, herders, veterinarian reindeer herders, and workers in 21 districts (Official Portal of the State Assembly (Il Tumen) of the Republic of Sakha (Yakutia), 2021). These statistics do not aggregate data on the small number of personal subsidiary farms, but only the number of employees of officially registered legal entities. While the central part of the Republic no longer practices reindeer husbandry, the region has the potential for significant reindeer husbandry growth. There is a high diversity of reindeer breeds and sub-breeds in Yakutia. After the collapse of the Soviet Union and the transition to the market economy, reindeer husbandry in Yakutia deteriorated. Large reductions in domesticated reindeer were experienced (Fig. 3.2). In the 1990s alone, the number of reindeer fell by 2.5 times (Fig. 3.2). With a curtailment in breeding work, the rapid increase in predator populations as a control mechanism was halted. The economy weakened, and subsidies were reduced, topped by a reindeer slaughtering moratorium (Oskal et al., 2009). The moratorium on the commercial slaughtering of domesticated reindeer was lifted in 2005 (Dayanova et al., 2020). The reindeer livestock trends in different Russian Arctic regions depended on the number of reindeer in different institutional forms of reindeer husbandry (Klokov, 2020). The rapid growth of the livestock was observed only in the Nenets unregistered self-managing households in the West Siberian tundra, which were out of strict state control in the sphere of an informal economy. Another institutional form, reindeer herding enterprises, evolved in all other territories of reindeer husbandry in the Russian Arctic. It happened due to historical reasons, regional policies, and specific features of Indigenous communities' adaptation. The future of reindeer husbandry is determined mainly by state support (Klokov, 2020).

Reindeer herding constitutes the basis of the traditional economy and culture of many Indigenous peoples in Eurasia. By the beginning of the twentieth century, most Evenki, Even, Chukchi, Yukaghir, and Dolgan households had already become significantly diverse, albeit remaining subsistence. Transportation reindeer herding, a core activity, was supported by hunting, fishing, and collecting berries and plants. Some peoples focused on hunting wild reindeer and elk, while Chukchi were engaged in large-scale reindeer herding, their main source of subsistence. However, most Indigenous peoples in the North were involved in domestic reindeer herding, which was of great importance as transportation.

By the end of the nineteenth century, gold was mined in South Yakutia, and Evenki began to transport goods on reindeer (Maksimov et al., 2001). Aldan gold mining in South Yakutia led to the construction of the Amur–Yakutsk Road (AYaM) in the 1920s and Evenki worked for the transportation of goods and post, while hunting became of secondary importance (Rumyantcev, 2015). By the end of the 1920s, reindeer herders had to extra feed the reindeer involved in intensive

transportation of post; therefore, Evenki had to master a new type of labor – to harvest hay – while complementary feeding of reindeer with compound feed and salt was introduced after the Second World War (Rumyantcev, 2015). To our best knowledge, few reindeer were accounted for before the revolution. A sharp decrease in the reindeer population occurred over the early 1920s. Firstly, due to the First World War, when goods delivery was disturbed: there were no deliveries from 1918 to 1923, which led to the mass reindeer slaughter to feed the starving people. Secondly, the situation was aggravated by constant requisitioning and reindeer loss during the Civil War. The spread of necrobacillosis (*Fusobacterium necrophorum*) and icy ground led to mass reindeer mortality. Some pastures deteriorated during these years due to continuous grazing in the same place (Filippova et al., 2020: 178–179).

Collectivization in the northern territories began in 1927. It aimed at organizing supply, marketing, credit, and state financial assistance. Collectivization brought together consumption and production. In its initial stage, collectivization was voluntary and incentivized with loans and credit. In the beginning, only 15% of households undergo collectivization, mainly the poorest ones. The elimination of the prosperous households, known as *kulaks*, took place before, in 1930. By 1933, more than 80% of households were collectivized. After the expropriation, many herder families joined the *kolkhozes*, a form of a collective-owned enterprise (Kolesov, 1993). The establishment of the *kolkhoz* system brought immense changes. In some tundra areas, the emergence of large herds of domestic reindeer led to a reduction and then the disappearance of wild reindeer, which were the main hunting target for the Yukaghir and Even people. In the past, this would have inevitably resulted in starvation for the Indigenous communities. However, *kolkhozes* favored a shift from hunting to reindeer husbandry (Gogolev et al., 1975: 146). The authorities organized land and water allocation to secure the territories for *kolkhozes*. It resulted in the expropriation of the best pastures, hunting, and fishing lands from the *kulaks*. In 1931–1934, all these were assigned to *kolkhozes* (Postanovlenie VCIK, SNK RSFSR, 1930). As a result, during the 1930s, there was a widespread increase in the number of *kolkhoz*-owned reindeer. Reindeer numbers continued to increase even during the Second World War (1941–1945). In the post-war years, "*millionaire collective*[1]" *kolkhozes* emerged, in which the number of reindeer exceeded 10,000.

Reindeer husbandry technologies were changed, which led to fewer losses of reindeer. *Kolkhozes* used new grazing methods to tackle rapid pasture depletion, considering rotation grazing. Permanent corrals were built in the areas of the autumn slaughter and spring calving. As the economy of the *kolkhozes* strengthened, their facilities and equipment gradually improved. Later, the Soviet government launched a new round of social reforms in the 1950s. These reforms included the consolidation of agricultural enterprises, the removal of non-profitable settlements, and the relocation of the population to new villages. It had a detrimental effect on the life of the peoples of the North. *Kolkhozes* were merged and transformed into state-owned enterprises, or *sovkhozes*. The social conditions, living conditions, and production

[1] A cooperative enterprise that makes millions in profits.

technologies in *sovkhozes* improved (Astahova et al., 2013). According to Khakhovskaya (2019) as cited by Klokov, "when the *kolkhozes* were reformed to *sovkhozes*, the reindeer became state property, and a new 'war' against reindeer herders started. The local authorities and the *sovkhozes*' administration tried to make them change traditional ways of reindeer pasturing and increase the *sovkhozes*' reindeer stock" (Klokov, 2020). From 1965 to 1968, land management aimed to increase the efficiency of pasture usage to benefit households. Reindeer husbandry innovations focused on enhancing meat production, which determined the herd structure with a predominance of the female population (Figs. 3.9a and 3.9b). However, this caused a setback in the traditional relationship between humans and reindeer. The reindeer were no longer a family member but a source of meat production. The herders started using rotation shift grazing: the brigade included two shift teams. One team was at the settlement, and the other was on round-the-clock duty with the herd. The reindeer were under constant supervision and control, which significantly increased herd survival. It also attracted more young people to reindeer husbandry, enabling them to spend quite a lot of time in the settlements. By the end of the 1970s, more than half of the reindeer herders were under 30 years of age. The shift method, however, replaced the family and clan organization of reindeer herding. The number of women in reindeer husbandry decreased dramatically, which also marked the disruption of the traditional nomadic way of life (Figs. 3.5a and 3.5b). Another innovation from the late 1970s was the slaughtering of yearlings for industrial meat production (Filippova et al., 2020: 187).

Since the 1990s, the number of reindeer and reindeer herders sharply decreased (Fig. 3.2 and Tables 3.4a, 3.4b and 3.5). Istomin (2020) discussed the diverse trajectories reindeer herding in Russia has taken in different areas of Russia after the collapse of the Soviet Union: (1) the northeastern/taiga trajectory, characterized by a collapse of Soviet-era state farms (*sovkhozes*) and a dramatic decrease of reindeer herding, and (2) the West Siberian trajectory, characterized by a collapse of *sovkhozes* and a boom in private reindeer herding. This diversity can be explained by three factors: the degree to which local reindeer herding has been "modernized" in the Soviet era, the legal status of the herders, and, most importantly, the worldview of "*sovkhoism*" as a complex of informal practices that manipulate collective property for personal advantage and communal security (Istomin, 2020).

3.4 Social and Economic Development of Neryungrinsky, Tomponsky, and Nizhnekolymsky Districts

Table 3.2 depicts the population scale of the Neryungrinsky District. In 1975, the industrial development of South Yakutia led to the foundation of the city of Neryungri. Before the Neryungrinsky region, the Timpton region was formed here in 1926 and abolished in 1963 (Rumyantcev, 2015). Today, the area of the municipal "Neryungrinsky District" is 98,800 km^2, which is comparable with an average

European country. According to the All-Russian Population Census of 2010, 1.6% of the population belongs to the Indigenous peoples of the North (in Yakutia −4.2%). The territory includes the city of Neryungri, six urban-type settlements, and two villages. The economy of the Neryungrinsky District is based on coal and gold mining industries and electricity generation. The Neryungrinsky District accounts for 20% of the total output of products and services in the Republic: 95% of the total coal produced in the Republic and over 30% of electricity (Investment Passport of Neryungri District). The region belongs to one of the most industrially developed regions of Yakutia and the entire Far East.

The population fluctuations in Tomponsky District are shown in Table 3.2. The decrease in the number of people is illustrated in Figs. 3.5a and 3.5b. The Tomponsky District was established on May 20, 1931, from four *naslegs*:[2] Tattinsky, Verkhoyansk, and two *naslegs* of the Oymyakonsky District. According to the All-Russian Population Census of 2010, 7.4% of the population belongs to the Indigenous peoples of the North. Today, the municipal district includes 2 urban-type settlements and 12 villages, united in 7 *naslegs*. Industrial production is developed in the region; coal and gold are mined.

The population scale of Nizhnekolymsky District is shown in Table 3.2. Nizhnekolymsky District was established in 1931. According to the All-Russian Population Census of 2010, 32.3% of the population belongs to the Indigenous peoples of the North. It includes the village of Chersky, a district center, and 11 other villages, united into 4 settlements. The district economy is based on reindeer herding: 12.2% of the Republic's reindeer livestock settles in this district.

Despite the different patterns of natural resource use in the represented regions of Yakutia, all of them have reindeer herding enterprises in common. In general, reindeer herding is practiced in 21 districts of Yakutia in diverse areas, tundra, forest tundra, mountain taiga, and taiga, i.e., in the areas inhabited by the Indigenous peoples of the North. Reindeer herding is a unique economic enterprise that employs only Indigenous peoples. At the same time, it also remains an Indigenous way of life.

3.5 Dangerous and Poor Weather Conditions for Reindeer Husbandry in Nizhnekolymsky, Neryungrinsky, and Tomponsky Districts (Between 2016 and 2020)

Biological diversity is the basis and an indicator of biosphere integrity (Kirpotin et al., 2021). Together with climate change, its loss is one of the two most essential planetary boundaries (Tonkopeeva et al., 2023; van Rooij et al., 2023). Current

[2] *Nasleg* (Yakut *нэһилиэк*) is the smallest administrative unit in Sakha (Yakutia), a rural area/settlement with local self-government. From the time of the Russian Empire, the Yakut ulus (districts) were subdivided into *naslegs*.

changes in biodiversity in the vast landmass of Siberia are at an initial stage of inventory, even though the Siberian environment is experiencing rapid climate change, weather extremes, and a transformation of land use and management. Biodiversity changes affect traditional land use by Indigenous peoples (Kirpotin et al., 2021) and affect grazing conditions for reindeer (van Rooij et al., 2023). Mean air temperature in March, April, and May from 1960 has increased by more than 6 °C in Nizhnekolymsky compared to only 2 °C from 1966 in Tomponsky and more than 3 °C in Neryungri from 1920 until the present, showing variation in the territory of Yakutia (Figs. 3.3a, 3.3b, and 3.3c). These combined effects of an increase in spring temperature and biodiversity impact the economy of reindeer herders through "bad grazing years" (Table 3.3). Weather and climatic conditions are crucial factors in reindeer husbandry (Hanssen-Bauer et al., 2023). The seasonal weather conditions determine the features of grazing, the quality of feed, and the reindeer's health (Liskevich et al., 2018). According to the report of the World Economic Forum (WEF) in 2017, extreme weather events rank first in the top 5 global risks. Between 1990 and 2000, 150–200 hazardous events of weather were registered annually in the Russian Federation. Since 2007, the number of dangerous weather events has exceeded 400 per year (Roshydromet, 2017). According to the reindeer herders and environmentalists themselves, the weather hazards for reindeer husbandry are:

1. In winter (during the period of snow cover):
   (a) Ice crust on the surface of the snow, in its thickness, or on the surface of the soil. The formation of the crust usually occurs during the pre-winter period when temperatures are close to zero, with subsequent frosts that prevent its breakdown, and less frequently during winter thaws.
   (b) Severe and prolonged frosts.
   (c) Blizzards and severe snowstorms.
   (d) Very deep snow cover, making it difficult for reindeer to forage (Fig. 3.8a, 3.8b).
2. In spring (April–June):
   (a) Blizzards or blizzards during calving season (in domestic reindeer, this is the month of May).
   (b) Sharp temperature fluctuations during the first weeks of calf life.
   (c) Violation of the usual timing of spring, especially the melting of ice too early on the water barriers that reindeer herders have to cross during migration.
3. In summer (July and August):
   (a) Prolonged hot, dry, windless weather.
4. In fall:

(a) Disruption of the usual ice break timing due to the late onset of cold weather causes disruption in the normal rhythm of migrating and moving reindeer to winter or slaughter sites (Makeev et al., 2014).

However, warm winters in the tundra are much worse than cold ones, as thaws increase the risk of ice crust formation. And reindeer are adapted to cold temperatures because the thermoregulatory system is aimed at generating heat in the body. In summer, on the contrary, in hot weather, body thermoregulation works on "caloric extinguishing," which in critical conditions leads to the fact that reindeer stop feeding and stop accumulating fat reserves and reindeer simply cannot survive the next winter and bring healthy offspring (Klokov & Mikhailov, 2017). Therefore, in order to understand the dangers of dangerous years and bad weather conditions for reindeer husbandry, we learned the opinion of the reindeer herders themselves, who directly face the consequences of adverse weather events (Table 3.3).

According to the All-Russia Research Institute of Hydrometeorological Information, World Data Centre (RIHMI-WDC), in early November and December 2016 in Chersky, the daytime temperature rose to positive values (Nizhnekolymsky). On December 8, 2016, a strong increase in temperature by +22.3° per day (Tmin for December 7 was −18.3 °C, and Tmax for December 8 rose to +4.0 °C) occurred. There was rain, wet snow, and wind from the southeast of 4–9 m/s, with gusts of up to 11–16 m/s. On December 9, the daytime temperature was +1 °C. There fell 4 mm of rain, and at the same time, there was heavy snow with a snow depth of 42 cm. At the station Ambarchik Bay on December 8 and 9, 2016, the synoptic situation was as follows: light snow, snowstorm, a southerly wind of 10–15 m/s, gusts of up to 17–22 m/s, and maximum temperature of +4.2 °C. This synoptic situation was caused by the eastern process – the removal of warm air and a cyclone from the Sea of Okhotsk in a northwesterly direction. This process is characterized by temperature increases, snow, strong wind, and snowstorms in some places. The duration of the process is 3–4 days, while in neighboring areas and stations, the temperatures may stay as low as −40 °C and even below because of the stable influence of the Siberian anticyclone.

These synoptic conditions in December 2016 resulted in the formation of an ice crust, which made it difficult for reindeer to get food. According to the reindeer herders themselves, December 2016 was abnormally warm; the temperature rose to 0 °C and above, followed by a sharp cold spell, which led to the death of 500 reindeer. According to the Hydrometeorological Centre, in November 2016, the air temperature was 6–11 degrees above average, and the amount of precipitation was five times higher than the monthly norm (maximum snow height = 72 cm). In general, 2016 was a record-breaking year in terms of precipitation (398 mm) over the past 30 years (Hydrometeorological Centre of Russia, 2016).

There was a sharp decline in reindeer from January to May 2018 in the Nizhnekolymsky District. It was due to the icing of pastures and deep snow cover with icy infusions, which made it difficult for the animals to find food. As a result, 5316 reindeer died because of the natural catastrophe.

According to the Hydrometeorological Centre of Russia, during the period from January to April 2018, 14 cases of air temperature rise to 0 °C and above (abnormal weather in winter) were registered: 2 cases in January and 12 cases in April. On January 30–31, 2018, warming was caused by the removal of warm air from the south of China together with a cyclone through Kamchatka to Chukotka, Kolyma, and the Arctic coast. During the day in Chersky, the maximum temperature was +2.0 °C, with south wind of 3–8 m/s, little snow, and a snow depth of 79 cm. First strong winds and snowstorms were observed in Nizhnekolymsky District followed by abrupt warming, and the air temperature was 20–24 °C above average. Such sharp temperature fluctuations in winter lead to the compaction of snow cover and the formation of snow and ice crusts, which significantly complicates the extraction of snow fodder by reindeer. As a result, in Nizhnekolymsky District, more than 5000 reindeer (young animals) died over a 5-month period (from January to May 2018). In addition, the situation was complicated by the fact that fodder for domestic animals, including reindeer, was delivered too late because of the late opening of winter routes. As a result, the number of reindeer across the Republic decreased by 2.7% compared to December 2017 (Pavlova, 2018) (Figs. 3.8a and 3.8b).

The average annual temperature in 2017 reached a maximum, repeating the achievement of 2007 in the Neryungrinsky District (Chulman and Neryungri) (Table 3.3) (Roshydromet, 2017). There were anomalies in the annual average air temperature during the whole year: up to 1 °C in EPR (European part of Russia), up to −2 °C in Siberia and in the Far East, and + 3 °C to +5 °C in the Arctic regions, in the northeast of Yakutia, and in Chukotka (Hydrometeorological Centre of Russia, 2017; Popova et al., 2023). Autumn 2017 was also remembered for the fact that there was a lot of precipitation. The amount of precipitation was 2–3 times larger than average or even more. In the south of Yakutia, the amount of precipitation was 2–3 times higher, in Yakutia, at the end of October, and the amount of precipitation exceeded monthly norms (Hydrometeorological Centre of Russia, 2017). According to reindeer herders, the autumn of 2017 was remembered for the fact that the first snow fell late, and in some places, ice crusts formed on the pastures. According to the actual data for the Nagorny settlement, temperatures in October ranged from −12.1 to +4.5 °C, respectively; it rained until mid-October, and the first snow fell on October 19, with 4 mm of precipitation falling per 1 day. Due to temperature fluctuations and zero-crossings, the snow melted and formed a crust of ice, making it difficult for the reindeer to get food. During the month, the snow depth varied due to snow melting, and only in November a stable snow cover was established. In October–November 2017, the snow fell late and then melted; on some reindeer pastures, there was a crust in places where the snow did not melt (Kolesov: personal communication 2020). Also, in October, there was low drifting snow and snowstorms (12 cases in October), with gusts of wind of up to 10–15 m/s, which also complicated reindeer grazing and worsened the visibility – a prerequisite for herders to control their reindeer.

One of the adverse events in autumn is wet snow and rain, which is often observed in the south of Yakutia. On November 5 at Neryungri station, a rain shower was observed (RIHMI-WDC). The day or two before the onset of rain, the air

temperature at night dropped to −22.1 °C, the daytime temperature was −12.2 °C, there was little snow, and the weather was warm. Then, during the day, the temperature increased by +10 °C, there was a weak rain shower, the wind was 5–10 m/s from the south, and during the day, the temperature was −0.8 °C. This synoptic situation was caused by warm air from the south and Neryungri District was located in front of the cyclone. Rain in winter and an abrupt temperature rise contribute to the formation of rain crust on the snow, which, if thick enough, is dangerous for the reindeer. On the next day, November 6, the temperature dropped by 10 degrees, and there was heavy rain snow and wind with gusts of up to 10–15 m/s. In the following days, the temperature was within −10 to −15 °C, and then starting from November 15, there were frosts of −20 °C and lower (typical for November temperature). Also, for October–November at this station, 23 cases of gusty wind of up to 10–15 m/s, low-level snow drifting, and snowstorms were recorded.

In general, October and November are characterized by unstable weather, temperature changes, mixed precipitation (snow, wet snow), drifting snow, and blizzards, which are quite common. But rain in November is a rare phenomenon and is considered abnormal for this period.

3.6 Reindeer Husbandry Adaptation in Yakutia

In biology, adaptation refers to the process of adjusting behavior, physiology, or structure to become more suited to an environment. Johan Mathis Turi, the former Chair of the International Centre for Reindeer Husbandry (ICR) and President of the Association of World Reindeer Herders (WRH), stated that the concept of adaptation, rather than stability, is inherent in reindeer herding societies: We have some knowledge about how to live in a changing environment. The term “stability” is a foreign word in our language. Our search for adaptation strategies is not connected to “stability” in any form but is focused on constant adaptation to changing conditions (Mathiesen, 2023; Tonkopeeva et al., 2023). Massive loss of reindeer due to predators exceeds the number of anomalies that the nomads can manage and can be seen as maladaptation (Lavrillier & Gabyshev, 2018). In addition to the accumulation of climate change anomalies, economic crisis, industrial development (which also reduces nomadic space), and the absence of land rights (which complicates access to ancestral lands), the disaster provoked by predators reveals vulnerability (Lavrillier & Gabyshev, 2018). We can adapt to climate anomalies, industrial development, new illnesses, and economic crisis, but how can we protect our herd against predators (Lavrillier & Gabyshev, 2018)? Alexander Struchkov, Even reindeer herder from Tomponsky region, expressed in 2009: “Every herder has to adapt himself as you say adaptation, everyone has their method” (Oskal et al., 2009). Istomin and Dwyer (2010) suggested that as far as reindeer herding systems are concerned, animal behavior and the herders’ actions can be best understood as being a product of a dynamic mutual adaptation (or the lack of) between animal behavioral patterns

and the herders' patterns of actions. They conclude: "dynamic adaptation results in shaping specific animal behavioral traits and human herding technologies that either lead to increased efficiency of a pastoralist system or lead to the destabilization of such systems and even their eventual collapse." Vassily Namchaivyn, Chukchi herder, expressed: "Remember, it is not us reindeer herders who have been the cause of climate change. The reindeer know what paths to take. Many people have lost their connection with Nature, but the animals maintain this connection and that is why we follow the reindeer" (Mathiesen et al., 2018).

One of the main threats to reindeer husbandry in Yakutia is predation. The main threat to the future existence of some of these Indigenous societies is the high population of bears, wolves, wolverines, lynxes, and eagles that prey on reindeer during the calving season (Figs. 3.4a and 3.4b). Over the past years, the number of wolves in Yakutia has remained at approximately 3500–4000 (Akimova, 2021). The Directorate of Biological Resources, Specially Protected Natural Areas and Natural Parks of Yakutia is no longer able to provide effective assistance to wolf control in the districts, and the number of reindeer loss to wolves is growing (Akimova, 2021). Russia did not ratify the Bern Convention for the protection of large predators yet but follows the convention in local management practice. Russia is an observer to this convention and could have allowed the regulation of predators via helicopter hunting. Spring is the reindeer calving season. Evenki reindeer herders in South Yakutia report that the loss of calves to bears can be as high as 50% in the first few weeks after calving. It is affecting reindeer herding communities all over Yakutia. According to the Ministry of Ecology, Nature Management, and Forestry of Yakutia, the total number of brown bears in 2017–2018 is estimated at 17,000 bears. The number of brown bears seems to increase due to the lack of recruited hunters, the high cost of the tax levy for issuing a permit to hunt brown bears, migration from neighboring regions due to fires, an improvement in the food supply, and a high birth rate (Ministry of Ecology, Nature Management, and Forestry of Yakutia, 2018). After bears are coming out of hibernation, the size of bears' stomachs is rather small, which makes them forage less than in autumn. For that very reason, bears mainly eat small reindeer calves after they are born and they do not hunt grown reindeer (Kolesov, personal conversation, 2021). Hunting for these predators is especially difficult in the mountainous and taiga regions of the Republic due to the landscape. As a consequence, the use of motor vehicles for transportation to hunting wolves is not particularly effective. "Wolf hunting in the taiga is completely different from hunting in the tundra, where you can use snowmobiles. Wolves are very difficult to get, so the control over their population should be carried out systematically involving the experience of herders, because we have the traditional methods of dealing with wolves, and we know a lot about their habits" (Pogodaev & Oskal, 2015).

Indigenous peoples hold ancient knowledge that was enacted in everyday life, developed over millennia, and transmitted through generations. This knowledge helped them thrive in the harshest conditions of tundra and taiga. It also reflects in the hunting skills of the Indigenous peoples of Yakutia and their knowledge about animals' behavior. For example, Evenki reindeer herders, whose main traditional

activity besides reindeer herding is also hunting, know what kind of reindeer bears would choose to chase and kill (Kolesov, personal conversation, 2021). Another example is about Yukaghir elders who remember that one should not hunt all the wolves that inhabit your area, because wolves will also protect "their" territory from wolves of a "stranger" territory, meaning they will not let other wolves hunt on your area (Shadrin, personal conversation, 2020).

Routine reindeer and household chores and hunting regulations prevent herders from the meaningful hunt for predators to protect the reindeer. Thus, it is necessary to cooperate and assist in controlling the number of predators to preserve the reindeer population and reindeer husbandry in the region. The appearance of wild dogs that attack reindeer also aggravates the current problem. The dogs arrived in the taiga with industrial shift workers. Quite often, when the shifts are over, laborers leave and abandon dogs that later stray into herds (Personal conversion with reindeer herders, 2020). Therefore, we recommend that mining and industrial enterprises impose strict rules for their employees for inappropriate treatment of personal animals. Reindeer herders in the taiga regions believe that shooting predators from helicopters and fencing off the calving pastures with an animal net can be more effective for controlling predators' numbers and protecting reindeer.

The Working Group II of the Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC AR 5 WG II) concluded that the protection of grazing land should be the most important adaptive strategy for reindeer herders under climate change (Larsen et al., 2014). The decreasing of pastures for wild and domestic reindeer is affected by an increase in the densities of predators on the remaining territories. The loss and degradation of reindeer pastures are often associated with oil and gas production, mining, and infrastructure development. Taiga reindeer herding areas in South Yakutia also face challenges: industrial development and loss of pastures (Figs. 3.6, 3.7a and 3.7b).

3.7 Conclusion

In reindeer husbandry, as in other sectors of the economy, weather conditions play a significant role, and if domestic reindeer are kept year-round, adverse weather conditions are observed in every season. Throughout the year on reindeer pastures, there are changes associated with the change of seasons but also rapid changes in weather conditions during the day or several days.

Unfavorable weather phenomena for reindeer herding are extremely low temperatures, high snow cover (height from 1 m and more), sharp warming (thaw) in winter, wet snow (during the calving period), rain (in winter), blizzards, and abnormal heat in summer. Such unfavorable weather conditions lead to different consequences, such as the death of reindeer, low business output, the death of young animals, and exhaustion from lack of food due to pasture endowment. Due to late autumn, as noted by reindeer herders, the "corallization" of reindeer and other work

sometimes takes place 1 month late, which also has a negative impact on reindeer herding.

Authors argue that the condition for the success of traditional reindeer husbandry is the informal economic environment. Peculiarities of the regional politics and adaptation of Indigenous communities affect the numbers of reindeer differently (Klokov, 2020). After the collapse of the Soviet Union, the development of reindeer herding took very different trajectories in different parts of Russia. The northeast Siberian and taiga direction is characterized by a dramatic decrease in reindeer herding. It went hand-in-hand with the collapse of post-*sovkhoz* collectives in the 1990s (Istomin, 2020). The number of reindeer has reduced in all regions, but the number of reindeer herders decreased more in the south (taiga) than in the north (tundra) (Fig. 3.2). Young reindeer herders in the taiga zone of South Yakutia must not be left behind and have equal support as those in the Arctic zone of Yakutia (Fig. 3.5b).

The large population of wolves (3500) and bears (14,000–17,000) as well as other predators such as lynxes, wolverines, and eagles in Yakutia became a challenge to reindeer herding communities. The industrial Soviet transformation of reindeer husbandry in Yakutia affected the Indigenous communities. The fact that traditional reindeer husbandry in South Yakutia still exists despite heavy industrial development in the region shows that Evenki reindeer herders can be resilient to changes. Yet, there are more challenges and changes, which means that it is necessary to enhance the resilience of the herding communities. There is a need for technical and financial assistance in the development of traditional livelihoods. Herders also have to resort to Indigenous knowledge of adaptation and resilience. The past 100 years of transforming reindeer husbandry and collectivization have affected traditional knowledge transfer from one generation to another. The original family-based system was gone after the Indigenous lifestyle became sedentary. Such a transition weakened the direct connection between practical experience and family life. It is an opportunity for them to observe and experience the nomadic way of life and participate in traditional practices.

Indigenous peoples hold ancient knowledge that was enacted in everyday life, developed over millennia, and transmitted through generations. This knowledge helped them thrive in the harshest conditions of tundra and taiga. It also reflects in the hunting skills of the Indigenous peoples of Yakutia and their knowledge about animals' behavior. Co-producing knowledge between Indigenous communities and scientists should aim for increased hunting efficiency, especially in the reindeer breeding season during the first weeks after calving to protect reindeer and Indigenous economies.

Adaptation to climate change requires long-term sustainable thinking training for local leaders within Indigenous and grassroots communities. This educational goal should reside on the best available adaptation knowledge. It is necessary to offer new means of delivering education to practitioners of traditional livelihoods, especially those in remote areas.

Appendices

Appendix 1: Figures

See Figs. 3.1, 3.2, 3.3a, 3.3b, 3.3c, 3.4a, 3.4b, 3.5a, 3.5b, 3.6, 3.7a, 3.7b, 3.8a, 3.8b, 3.9a, and 3.9b

Fig. 3.1 The Republic of Sakha (Yakutia) is located in the northeastern part of the Eurasian continent and is the largest region of the Russian Federation. With 170,000 domestic reindeer and 1200 reindeer herders, Yakutia is an important region for the economy of reindeer husbandry. While 30% of the Republic's territory belong to the protected areas of Russia, global warming and globalization affect the four regions investigated differently: Nizhnekolymsky, Tomponsky, Aldansky, and Neryungrinsky

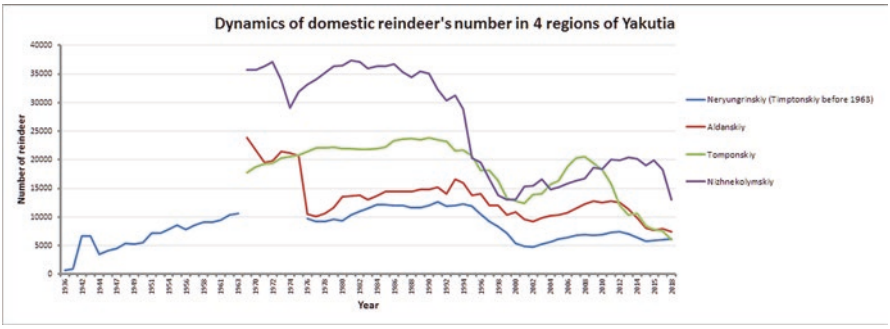

Fig. 3.2 Dynamics of domesticated reindeer population in Nizhnekolymsky, Tomponsky, and Aldansky districts in the period of 1969–2018 and Neryungrinsky District in the period of 1936–2018. Timptonsky District existed until 1963 and then became part of the Aldansky region. The Neryungrinsky District was created in 1976 after the city of Neryungri was founded in 1975. After the collapse of the Soviet Union and the transition to the market economy, reindeer husbandry in Yakutia deteriorated. Large reductions in domesticated reindeer were experienced. In the 1990s alone, the reindeer numbers dropped by 2.5 times (Official Statistics from the Government of the Republic of Sakha (Yakutia))

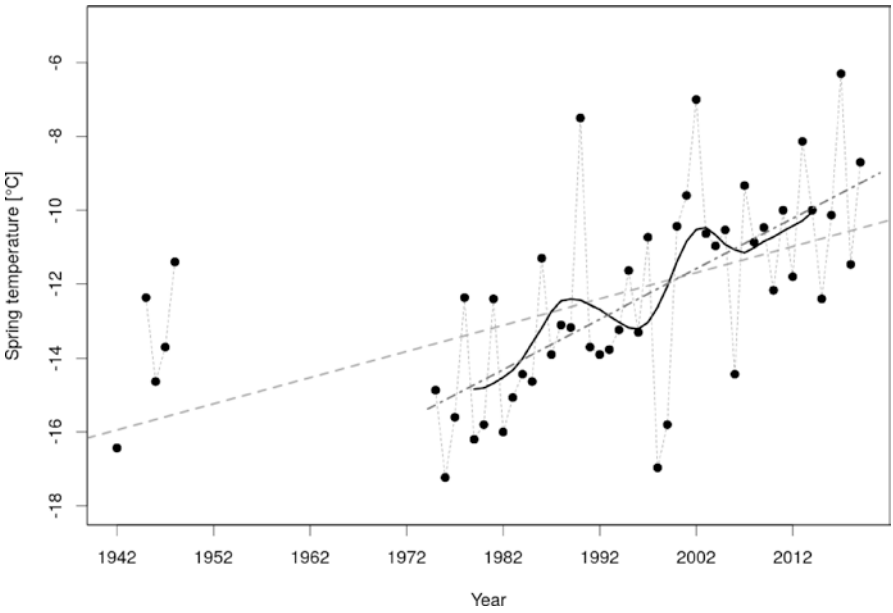

Fig. 3.3a Mean air temperature in March, April, and May in Nizhnekolymsky. From 1960, the mean air temperature has increased by more than 6 °C in Nizhnekolymsky compared to only 2 °C from 1966 in Tompo and more than 3 °C in Neryungri from 1920 until the present. The decrease in spring temperature and biodiversity impacts the economy of reindeer herders, what they refer to as "bad grazing years"

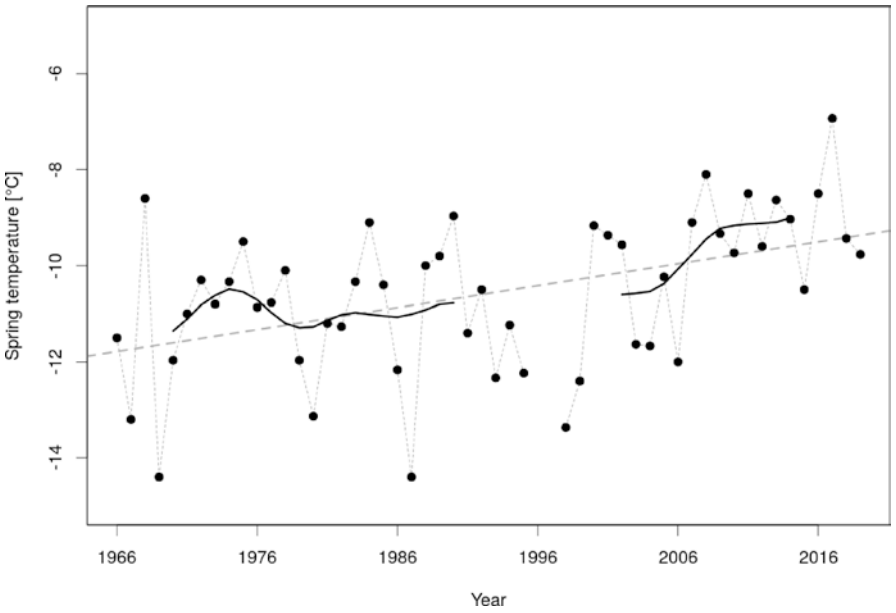

Fig. 3.3b Mean air temperature in March, April, and May in Tomponsky. From 1960, the mean air temperature has increased by more than 6 °C in Nizhnekolymsky compared to only 2 °C from 1966 in Tompo and more than 3 °C in Neryungri from 1920 until the present. The decrease in spring temperature and biodiversity impacts the economy of reindeer herders, what they refer to as "bad grazing years"

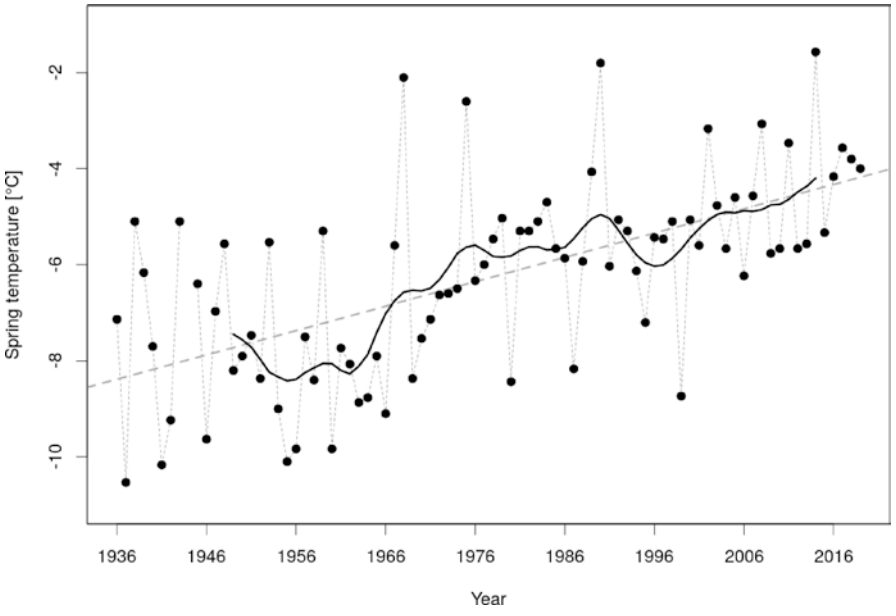

Fig. 3.3c Mean air temperature in March, April, and May in Neryungri. From 1960, the mean air temperature has increased by more than 6 °C in Nizhnekolymsky compared to only 2 °C from 1966 in Tompo and more than 3 °C in Neryungri from 1920 until the present. The decrease in spring temperature and biodiversity impacts the economy of reindeer herders, what they refer to as "bad grazing years"

Fig. 3.4a One of the main threats to reindeer husbandry in Yakutia is predation. The main threat is the high population of bears and wolves that prey on reindeer during the calving season. Photo from the Neryungrinsky District (2018). (Photo: Igor Kolesov)

Fig. 3.4b Over the past years, the number of wolves in Yakutia has remained at 3500–4000. The total number of brown bears in 2017–2018 is estimated at 17,000 bears. Herders often found remains of reindeer eaten by predators. Photo from the Neryungrinsky District (2018). (Photo: Igor Kolesov)

Fig. 3.5a During the Soviet time, the shift method replaced the family and clan organization of reindeer herding. The number of women in reindeer husbandry decreased dramatically, which also marked a disruption of the traditional nomadic way of life. Neryungrinsky District (2018): Evenki reindeer herder Valentina collects spruce. Herders cover the ground in a tent with a thick layer of spruce in winter and with larch in summer. (Photo: Alena Gerasimova)

Fig. 3.5b Young reindeer herders in the taiga zone of South Yakutia must not be left behind and have equal support as those in the Arctic zone of Yakutia. The past 100 years of transforming reindeer husbandry and collectivization have affected traditional knowledge transfer from one generation to another. The original family-based system was gone after the Indigenous lifestyle became sedentary. Neryungrinsky District (2017): a young Evenki couple with their child. (Photo: Yuri Kokovin)

Fig. 3.6 Taiga reindeer herding areas in South Yakutia also face challenges: industrial development and loss of pastures. While the Republic of Sakha (Yakutia) has not yet experienced progress, like that in the Yamal region or along the Norwegian coast, there are substantial development plans on the table. Construction of the "Power of Siberia" gas pipeline. Neryungrinsky District. (Photo: Svein D. Mathiesen)

Fig. 3.7a Evenki reindeer walking nearby the gold mines. Aldansky District. (Photo: Svein D. Mathiesen)

Fig. 3.7b Evenki reindeer walking nearby the gold mines. Aldansky District. (Photo: Svein D. Mathiesen)

Fig. 3.8a Elena Antipina, Director of the Arctic College of the Peoples of the North in Chersky, stands on a narrow pathway cleared of snow. The photo illustrates the amount of snow in the north of Yakutia. Nizhnekolymsky District. (Photo: Elena Antipina)

Fig. 3.8b There was a sharp decline in reindeer between January and May 2018 in the Nizhnekolymsky District. Icing of pastures and deep snow cover with icy infusion made it difficult for the animals to find food. As a result, 5316 reindeer died because of the natural catastrophe. Chukchi reindeer herder points at ice crust in the layers of snow. Nizhnekolymsky District. (Photo: Elena Antipina)

Fig. 3.9a Soviet reindeer husbandry innovations focused on enhancing meat production, which determined the herd structure with a predominance of the female population. This caused a setback in the traditional relationship between humans and reindeer. The reindeer were no longer a family member but a source of meat production. Even reindeer in Tomponsky District. (Photo: Svein D. Mathiesen)

Fig. 3.9b Even reindeer in Tomponsky District. (Photo: Svein D. Mathiesen)

Appendix 2: Tables

See Tables 3.1, 3.2, 3.3, 3.4a, 3.4b, 3.5, 3.6

Table 3.1 The number of reindeer herders in Neryungrinsky, Aldansky, Tomponsky, and Nizhnekolymsky compared to other regions of the Republic of Sakha (Yakutia), Russia, according to the Territorial Body of the Federal State Statistics Service for the Sakha Republic (Yakutia)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total for the Republic of Sakha (Yakutia)	*2257*	*2157*	*2252*	*2183*	*1996*	*2060*	*2009*	*1842*	*1792*	*1490*
Abyisky	8	8	8	8	6	6	7	6	6	0
Aldansky	260	267	272	272	278	267	260	160	150	140
Allaikhovsky	20	20	17	10	15	21	6	0	0	0
Anabar	117	98	99	92	92	94	98	97	109	112
Bulunsky	148	133	154	144	147	140	115	129	163	150
Verkhnekolymsky	19	19	20	13	13	13	13	13	13	14
Verkhoyansk	81	74	86	90	57	45	40	48	48	22
Vilyuisky		3	4	3	3	4	3	3	3	0
Gorny	9	7	6	7	6	7	7	8	6	4
Zhigansky	130	111	130	110	76	68	76	75	76	75
Kobyaysky	149	148	145	123	143	155	118	130	93	83
Momsky	220	215	230	209	110	92	118	142	140	96
Nizhnekolymsky	169	172	182	195	140	219	216	162	162	112
Oymyakonsky	96	63	55	68	63	65	65	57	69	56
Olekminsky	78	14	74	97	92	88	117	111	116	71
Oleneksky	53	52	52	52	65	65	54	65	65	65
Srednekolymsky	26	61	56	57	49	38	40	37	28	28
Tomponsky	178	157	185	140	122	123	132	108	109	65
Ust-Maisky	13	17	13	13	10	9	6	5	9	9
Ust-Yansky	143	143	143	164	169	195	205	170	169	142
Eveno-Bytantaysky	182	208	152	160	170	181	157	109	128	135
Neryungrinsky	156	165	168	156	170	165	156	156	143	94
Yakutsk	2	2	1	0	0	0	0	0		

Table 3.2 The total population of the districts of Yakutia, Neryungrinsky, Nizhnekolymsky, and Tomponsky districts (per 1000), according to the Territorial Body of the Federal State Statistics Service for the Sakha Republic (Yakutia)

	1939	1959	1970	1979	1980	1989	1990	2000	2005	2010	2015	2020
Neryungrinsky[a]	7.2	9.4		57.5	66.6	120.2	119.9	93.1	89.4	82.8	77.1	73.9
Nizhnekolymsky	2,3	4.2	11.6	12.2	12.4	14.00	13.7	6,7	5.5	4.7	4.4	4,3
Tomponsky	0.8	10.0	13.2	18.1	18.8	23.00	22.7	16.3	15.2	14.1	13.5	12.5
Total population of Yakutia	413.8	487.4	666.7	851.8	876.0	1094.1	1111.5	962.5	953.2	958.5	956.9	971.9

[a]Formed in 1975, before that the size of the Timpton region was introduced (1926–1963), which between 1963 and 1975 was part of the Aldansky region

Table 3.3 Dangerous and poor meteorological conditions for reindeer over the past 5 years (from 2016 to 2020 in Nizhnekolymsky, Neryungrinsky, and Tomponsky districts)[a]

Date	Station/district	Meteorological conditions	Consequences
December 2016	Chersky/ Nizhnekolymsky	Abnormal weather conditions wet snow and rain	Reindeer mortality
October–November 2017	Chulman/ Neryungrinsky	Late snowfall, ice crust formation due to temperature changes; rain on November 5 in Neryungrinsky (RIHMI-WDC)	
January–May 2018	Chersky/ Nizhnekolymsky	Icing of pastures and deep snow cover (snow height in April to 1 meter)	Case and mass death from exhaustion (over 5316 heads) (Pavlova, 2018), low business output
October 2019	Kanku/ Neryungrinsky	October rainfall (RIHMI-WDC)	Reindeer corralling started a month late
October 2019	Aldansky and Olekminsky	Rainfall from October 1–3 (RIHMI-WDC)	Threat of reindeer exhaustion and mass death
Autumn 2020	Neryungrinsky	Late and warm autumn; marshes did not freeze and thawed under snow	Difficulty of reindeer movement
Winter 2020	Anabarsky	Lots of snow and warm winter	

[a]The table is based on the information given by the reindeer herders themselves for the years when it was unfavorable for reindeer husbandry

Table 3.4a Reindeer herd structure for Neryungrinsky, Aldansky, Nizhnekolymsky, and Tomponsky mean percentage and total reindeer in 1976 and 2018

District	Female %	Male %	Castrated %	Calves % in the herd January, 1	Calves % from females	Total quantity of reindeer (1976)	Total quantity of reindeer (2018)
Neryungrinsky (1976–2018)	45.2	16.2	16.1	19.9	43.8	9781	6204
Aldansky (1976–2018)	45.8	16.0	16.1	22.1	48.1	10,542	7366
Nizhnekolymsky (1976–2018)	51.7	15.3	5.4	27.5	53.5	33,211	13,094
Tomponsky (1976–2018)	50.2	13.5	10.2	26.1	52.3	21,484	6060
Mean for all	*48.2*	*15.2*	*11.9*	*23.9*	*49.4*	–	–

Table 3.4b Information for each region (%) for 1976 and 2018 highlighting the evolution in the composition of the herd in terms of females/castrated/males

District	Female %	Male %	Castrated %	Calves % in the herd	Calves % from females	Total reindeer number
1976						
Neryungrinsky	54.5	9.3	11.0	25.1	46.1	9781
Aldansky	47.5	12.0	16.2	24.3	51.1	10,542
Nizhnekolymsky	48.4	15.7	4.5	31.5	65.1	33,211
Tomponsky	49.8	9.4	7.2	33.7	67.7	21,484
Mean % in four districts	50.0	11.6	9.7	28.6	57.5	*75,018*
2018						
Neryungrinsky	38.2	14.0	31.2	16.6	43.4	6204
Aldansky	44.3	21.0	19.6	15.1	34.0	7366
Nizhnekolymsky	50.9	24.5	3.7	20.9	41.1	13,094
Tomponsky	51.9	17.0	16.1	15.1	29.1	6060
Mean % in four districts	46.3	19.1	17.6	16.9	36.9	*32,724*

Table 3.5 Characteristics and statistics of reindeer and reindeer herds in Neryungrinskynsky and Aldansky districts of the Republic of Sakha (Yakutia)

Taiga reindeer husbandry in Neryungrinsky and Timptonsky	Taiga reindeer husbandry in Aldansky
From 1981 to 1996, the number of reindeer in the Neryungrinsky District exceeded 10,000 reindeer The largest number of reindeer in the Neryungrinsky District was 12,632 reindeer in 1991 The smallest number of reindeer in the Neryungrinsky District was 4912 reindeer in 2001 A gradual decrease in the number of reindeer in the Neryungrinsky District has been noted since 1997 A sharp decline in the number of reindeer in the Neryungrinsky District occurred in 1999–2000, from 7129 to 5435 reindeer Female reindeer amount to 50% or more of all the reindeer in the herds (if we count all calves, females and males) in the Neryungrinsky District: in 1976, 54.5% (5331 reindeer); 1977, 50.6% (4667 reindeer); 1979, 50.1% (4801 reindeer); and 1980, 50% (4677 reindeer)	From 1969 to 1975, the largest number of reindeer was recorded, with more than 19,000 reindeer The largest reindeer population in the Aldansky District was 23,855 reindeer in 1969 The smallest number of reindeer in the Aldansky District was 7366 reindeer in 2018 A sharp decline in the number of reindeer in the Aldansky District occurred in 1975–1976 – from 20,645 to 10,542 reindeer. This is possibly due to the formation of the Neryungrinsky District and the transition of some farms to the new district From 2013 to present, there has been a gradual decrease in the number of reindeer Female reindeer in the amount of more than 50% of all the reindeer in herds (if we count all the calves, male and female) occurred only once, in 1997 (51% – 6143 reindeer). In other years, the number of females does not exceed 50% in the herd
The smallest percentage of female reindeer, 30.4%, of all reindeer in a herd (if we count all calves, females and males) (2008 reindeer) was noted in 1943 in Timpton District (which included Zolotinka and Chulman village sel'sovets; currently that area belongs to the Neryungrinsky District) If the herd is divided into males and females, then the highest percentage of the female reindeer can be found during 1970–1980, where females amounted to more than 60% During 2010–2018, the ratio of females to males was 45–50% If the herd is divided into males and females, then we can conclude that for 1969–2018, the number of females in the herd varies between 39% and 72%	The smallest percentage of female reindeer with 41.6% (4313 reindeer) of all reindeer in the herd (if we count all calves, females and males) was in 2005 If the herd is divided into males and females, for 1969–2018, we can conclude that the number of females in a herd ranged from 42% to 51% Since the 2000s, the ratio of females to males has been no more than 45%

Table 3.6 Characteristics and statistics of reindeer and reindeer herds in Nizhnekolymsky and Tomponsky districts of the Republic of Sakha (Yakutia)

Tundra reindeer husbandry in Nizhnekolymsky	Mountain taiga reindeer husbandry in Tomponsky
The largest number of reindeer was 37,336 reindeer in 1981	The largest number of reindeer was 23,892 in 1990
The smallest number of reindeer was 13,000 in 1999	The smallest number of reindeer was 6060 reindeer in 2018
A sharp decline in the number of reindeer occurred in 1990–1991 – from 35,138 to 32,246 reindeer	A sharp decline in the number of reindeer occurred in 1998–1999 – from 16,286 to 13,332 reindeer
Another particularly sharp decline in the number of reindeer occurred in 1994–1995 – from 28,796 to 20,320 reindeer	Since 2009, there is a constant decline in the number of reindeer
From 2004 to 2014, there was a gradual increase in the number of reindeer (from 14,808 to 20,130 reindeer)	During 1973–1995, the number of reindeer did not fall below 20,000
From 2017 to 2018, there was a sharp decline in the number of reindeer from 18,317 to 13,094	From 2001 to 2008, there is a gradual increase in the reindeer population (from 12,381 to 20,545 reindeer)
Female reindeer in the amount of more than 53.5% of all reindeer in herds (if we count all calves, females and males) was noted during 1980–1990	The smallest percentage of female reindeer with 43.4% (8358 reindeer) of all reindeer in the herd (if we count all calves, females and males) occurred in 1971
The smallest percentage of female reindeer in the amount of 45.7% (9207 reindeer) of all reindeer in the herd (if we count all calves, females and males) was in 2014	The highest percentage of female reindeer with 57.7% (7689 reindeer) of all reindeer in the herd (if we count all calves, females and males) occurred in 1999
If the herd is divided into males and females, for 1969–2018, we can conclude that the number of females in a herd ranged from 45% to 56%	If the herd is divided into males and females, for 1969–2018, we can conclude that the number of females in a herd ranged from 43% to 57%
Since the 2000s, the ratio of females to males has been no more than 45%	From 1993 to 2001, the number of females in herds varied within 51–57%

References

Akimova, M. (2021). *Courses for wolf hunters are needed in Yakutia*. Sakha Parliament. Available at: https://www.sakhaparliament.ru/ru/natsproekty/ekologiya/5176-innokentij-semenov-v-yakutii-nuzhny-kursy-volchatnikov. Accessed 15 Apr 2021.

All-Russian Population Census. (2010). Available at: https://catalog.ihsn.org/index.php/catalog/4215. Accessed 15 Apr 2021.

Astahova, I. S., Grigor'ev, S. A., Sulejmanov, A. A., Filippova, V. V., & Shadrin, V. I. (2013). Tundrennye yukagiry v social'no-ekonomicheskih processah HKH – nach. XXI vv. (na materialah Olyorinskogo Suktula). *Kazanskaya nauka, 5*, 47.

Dayanova, G. I., Egorova, I. K., Protopopova, L. D., Krylova, A. N., & Nikitina, N. N. (2020). Analysis of formation of a model of state support of northern domestic reindeer husbandry in northern Russia (on the example of the republic of Sakha (Yakutia)). *International agricultural journal, 63*(6 (378)), 31–36. https://doi.org/10.24411/2587-6740-2020-16109

Filippova, V. V., Sulejmanov, A. A., Shadrin, V. I., Astahova, I. S., & Grigor'ev, S. A. (2020). *Prostranstvo zhiznedeyatel'nosti «ischezayushchego» etnosa: yukagiry Yakutii v XX–XXI vv* (pp. 178–179). Dal'nauka.

Gogolev, Z. V., Gurvich, I. S., Zolotareva, I. M., & Zhornickaya, M. Y. (1975). *Yukagir: Historical and ethnographic study*. Nauka.

Golovnev, A. V., Lozova, S. V., Abramov, I. V., Belorussova, S. Y. U., & Babenkova, N. A. (2014). *Etnoekspertiza na Yamale: Nenetskiye kochev'ya i gazovyye mestorozhdeniya. [Ethnoexpertiza on the Yamal Peninsula: Nenets nomadic and gas deposits]* (p. 232). AMB. (In Russian).

Hanssen-Bauer, I., Benestad, R. E., Lutz, J., Vikhamar-Schuler, D., Svyashchennikov, P., & Førland, E. J. (2023). Comparative analyses of local historical and future climate conditions important for reindeer herding in Finnmark, Norway and the Yamal Nenets Autonomous Okrug, Russia. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_8

Hydrometeorological Centre of Russia. (2016). *The main weather and climatic features observed in the earth's Northern Hemisphere in 2016*. Available at: https://meteoinfo.ru/categ-articles/96-climate-cat/clim-var/severnoe-polusharie/2016-climat-analysis/14123-osnovnye-pogodno-klimaticheskie-osobennosti-nablyudavshiesya-na-severnom-polusharii-zemli-v-2016-g-yakor19. Accessed 22 Nov 2020.

Hydrometeorological Centre of Russia. (2017). *The main weather and climatic features observed in the earth's Northern Hemisphere in 2017*. Available at: https://meteoinfo.ru/categ-articles/116-climate-cat/clim-var/severnoe-polusharie/2017-climat-analysis/14687-osnovnye-pogodno-klimaticheskie-osobennosti-nablyudavshiesya-na-severnom-polusharii-zemli-v-2017-g. Accessed 15 Nov 2020.

Investment Passport of Neryungri District. Municipality of Neryungri District Sakha Republic (Yakutia). (n.d.). Available at: http://www.neruadmin.ru/upload/2020/%D0%98%D0%BD%D0%B2%D0%B5%D1%81%D1%82.%20%D0%BF%D0%B0%D1%81%D0%BF%D0%BE%D1%80%D1%82.pdf. Accessed 15 Apr 2021.

Istomin, K. V. (2020). Post-soviet reindeer herders: Between family and collective herding. *Region: Regional Studies of Russia, Eastern Europe, and Central Asia, 9*(1), 25–52. https://doi.org/10.1353/reg.2020.0005

Istomin, K. V., & Dwyer, M. J. (2010). Dynamic mutual adaptation: Human-animal interaction in reindeer herding pastoralism. *Human Ecology, 38*(5), 613–623. https://doi.org/10.1007/s10745-010-9341-3

Khakhovskaya, L. (2019). Interaction between humans and domestic deer on Chukotka in the modern period (anthropological study). *Vestnik Arheologii, Antropologii i Etnografii*. https://doi.org/10.20874/2071-0437-2019-44-1-098-107

Kirpotin, S., Callaghan, T., Peregon, A., Babenko, A., Berman, D., Bulakhova, N., Byzaakay, A. A., Chernykh, T. M., Chursin, V., Interesova, E., Gureev, S., Kerchev, I., Kharuk, V., Khovalyg, A. O., Kolpashchikov, L. A., Krivets, S., Kvasnikova, Z., Kuzhevskaia, I., Merzlyakov, O. E., Nekhoroshev, O. G., Popkov, V. K., Pyak, A. I., Valevich, T. O., Volkov, I. V., & Volkova, I. (2021). Impacts of environmental change on biodiversity and vegetation dynamics in Siberia. *Ambio, 50*, 1–27.

Klokov, K. B. (2012). Changing in reindeer number in Russia: Political context or climatic impacts? *Rangifer, 32*(1), 19–33.

Klokov, K. B. (2020). Raznonapravlennost' trendov v tradicionnom olenevodstve narodov Sibiri i Arktiki. In N. V. Davydov (Ed.), *Energiya Arktiki i Sibiri: ispol'zovanie resursov v kontekste sotsial'noekonomicheskih izmeneniy* (pp. 46–86). Kuntskamera.

Klokov, K. B., & Mikhailov, V. V. (2017). *Mechanisms of the impact of natural and social factors on the livelihoods of local communities of reindeer herders in taiga and tundra landscapes* (204p.). Stary Sad.

Kolesov, M. I. (1993). *Istoriya Kolymskogo kraya. Chast' II* (p. 55). Yakutsk.

Larsen, J. N., Anisimov, O. A., Constable, A., Hollowed, A. B., Maynard, N., Prestrud, P., Prowse, T. D., & Stone, J. M. R. (2014). Polar regions. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate change 2014: Impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change* (p. 1567). Cambridge University Press.

Lavrillier, A., & Gabyshev, S. (2018). An emic science of climate: A reindeer Evenki environmental knowledge and the notion of an extreme process. *Etudes Mongoles Sibériennes Centrasiatiques et Tibétaines, 49*, 24–56. https://doi.org/10.4000/emscat.3280

Liskevich, N. A., Kopyltsova, I. Y., & Porshunova, L. S. (2018). The role of weather conditions in the production practice of reindeer herders of the polar Urals. *Vestnik of Archaeology, Anthropology, and Ethnography, 4*(43), 156.

Makeev, V. M., Klokov, K. B., Kolpashchikov, L. A., & Mikhailov, V. V. (2014). *Reindeer in a changing climate* (p. 244). Lemma.

Maksimov, P. S., Lekhanov, B. I., & Rumyantsev, N. A. (2001). *Evenki yuga Yakutii: istoriya i sovremennost'* (Vol. 32). Izdatelstvo Yakutskogo Gosudarstvennogo Universiteta.

Mathiesen, S. D. (2023). Reindeer husbandry in the circumpolar north. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences*. Springer. https://doi.org/10.1007/978-3-031-17625-8_1

Ministry of Ecology, Nature Management and Forestry of Yakutia. (2018). *Ministry of Ecology: The number of brown bears is increasing in Yakutia*. Available at: https://minpriroda.sakha.gov.ru/news/front/view/id/2923103. Accessed 17 Apr 2021.

Neustroeva, A. B., & Semenova, L. A. (2018). Peculiarities of the settlement of Indigenous small-numbered peoples of the north in the territories of traditional nature management of the Republic of Sakha (Yakutia). *Urbanistika, 4*. Available at: https://cyberleninka.ru/article/n/osobennosti-rasseleniya-korennyh-malochislennyh-narodov-severa-na-territoriyah-traditsionnogo-prirodopolzovaniya-respubliki-saha. Accessed 6 Apr 2021.

Official Portal of the State Assembly (Il Tumen) of the Republic of Sakha (Yakutia). (2021). *Participants of the round table discussed issues of reindeer herding and social protection of reindeer herders*. Available at: https://iltumen.ru/news/20794. Accessed 8 Feb 2022.

Oskal, A., Turi, J. M., Mathiesen, S. D., & Burgess, P. (2009). *EALÁT. Reindeer herders voice: Reindeer herding, traditional knowledge and adaptation to climate change and loss of grazing lands*. International Centre for Reindeer Husbandry.

Pavlova A. (2018). *In Yakutia, the number of reindeer decreased*. YSIA.RU. Available at: https://ysia.ru/v-yakutii-sokratilas-chislennost-olenej/. Accessed 22 Nov 2020.

Pogodaev, M., & Oskal, A. (2015). *Youth the future of reindeer herding peoples*. Executive summary. Arctic Council EALLIN Reindeer Herding Youth Project 2012–2015, p. 27.

Pogolov'ye oleney po polovozrastnym gruppam po kategoriyam khozyaystv (1969–2018) [Reindeer population by age and sex groups by farm category (1969–2018)].

Popova, L., et al. (2023). Trends and effects of climate change on reindeer husbandry in the republic of Sakha (Yakutia). In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_7

Postanovlenie VCIK, SNK RSFSR ot 10.09.1930 *Ob utverzhdenii Polozheniya o pervonachal'nom zemel'no-vodnom ustrojstve trudovogo promyslovogo i zemledel'cheskogo naseleniya severnyh okrain RSFSR*. Available at: http://www.consultant.ru/cons/cgi/online.cgi?req=doc&base=ESU&n=22946#02778445679747703. Accessed 15 Jan 2021.

RIHMI-WDC Russian Research Institute of Hydrometeorological Information – World data center. Available at: http://meteo.ru/english/data/ Accessed 15 Nov 2020.

Roshydromet. (2017). *Extreme weather events topped the list of global risks*. Available at: http://www.meteorf.ru/press/news/13145. Accessed 20 Nov 2020.

Rumyantcev, N. A. (2015). *Timptonskie Evenki Yuzhnoi Yakutii. Istoriya I sovremennost'*. Lan, Planeta muzyki.

Statistics on Reindeer and Reindeer Herders. (n.d.). *Ministry of Agriculture of the Republic of Sakha Yakutia*. Available at: https://minsel.sakha.gov.ru/news/front/view/id/3233787. Accessed 16 Jan 2021.

Statsvedeniya i dokladnaya zapiska Upravleniya sel'skogo khozyaystva Narkomzema RSFSR ob itogakh otela oleney v severnykh rayonakh. (1939).

Svodka dvizheniya pogolov'ya oleney v severnykh rayonakh SSSR v 1936. (1936).

Svodnye statisticheskiye otchety po perepisi skota i oleney po Timptonskomu rayonu za 1942–1945. (n.d.). [Consolidated statistical reports on the census of livestock and reindeer in the Timpton region for 1942–1945].

Territorial Agency of the Federal State Statistics Service for the Republic of Sakha (Yakutia). (2019). *Pogolov'ye oleney po polovozrastnym gruppam po kategoriyam khozyaystv (1969–2018)* [Reindeer population by age and sex groups by farm category (1969–2018)].

Tonkopeeva, M., et al. (2023). Framing adaptation to rapid change in the Arctic. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_2

van Rooij, W., Aslaksen, I., Eira, I. H., Burgess, P., & Garnåsjordet, P. A. (2023). Loss of reindeer grazing land in Finnmark, Norway, and effects on biodiversity: GLOBIO3 as decision support tool at Arctic local level. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_9

Chapter 4
Historical Aspects of Cross-Border Cooperation Between Nordic and Soviet Experts in Reindeer Husbandry

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Abstract Nordic experts on Sámi reindeer husbandry cooperated with the reindeer husbandry experts from the Soviet Union, exchanging knowledge, experiences, and insights from 1957 until 1974. The Soviet Union had been collectivizing Indigenous reindeer herders' property since the 1930s, using results from experimental research and collectivization as a method to increase the rationalization and efficiency of reindeer meat production. The Soviet reindeer husbandry expert professor Andreev first visited Finland in 1957, starting cooperation that would last for years. In 1960, after the Sámi leader from Røros Anders Fjellheim visited the USSR, he articulated that "the Russians are far ahead of us in the practice of reindeer herding. The reindeer herding industry receives more support than us." Later, after another Norwegian delegation visited the Nenets National District in 1965, the local newspaper *Naryana Vynder* reported: "Everything looked new and significant for Norwegians: our planned economy, accounting principles, and the new system of organizing herding." Expert Sven Skjenneberg from Norway said in an interview with this newspaper: "Reindeer herding is no longer romance, but the economy; and we are striving

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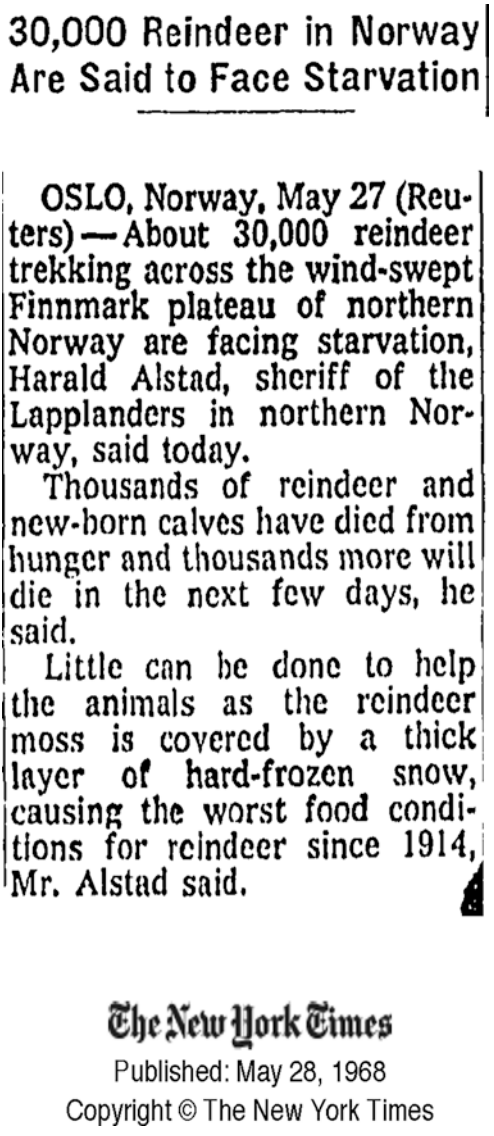
to study your best practices and learn your lessons, for we share common problems, and you are solving them quite successfully." Later in 1968, Soviet experts documented the views of their Norwegian colleagues who stated that "it is not easy to teach the former Sámi nomads to use houses and property correctly, to transit to a sedentary way of life"…"Norway began making a lot of efforts…to thoroughly understand the herd structure in Norwegian reindeer herding, which is developing chaotically now." After this cross-border cooperation, Sámi reindeer husbandry in Finland and Norway was reformed to increase the efficiency of meat production. This chapter argues that neither the Norwegian nor the Finnish experts had insights into the Indigenous knowledge and practices of the reindeer herders in the Soviet Union to understand the limitation of reforms that affected the Sámi reindeer herders' practices and society.

Keywords Reindeer husbandry · Nordic-Soviet cooperation · Reindeer husbandry modernization

4.1 Introduction

Over the last 100 years, Indigenous Sámi reindeer herders in Finnmark, Norway, have repeatedly experienced extremely bad winter grazing conditions (Eira, 2012). In 1968, *The New York Times* reported that more than 30,000 reindeer starved to death in Western Finnmark during the winter of 1967/1968 (Fig. 4.1). This winter weather was characterized by thick snow layers packed above the grazing pastures from November to May (Eira et al., 2018; Johnsen et al., 2023; Hanssen-Bauer et al., 2023).

The extreme winter conditions of 1967–1968 became an impetus for the Norwegian government to initiate reforms in Sámi reindeer husbandry. The Norwegian Official Report (1972) and the Norwegian Parliament's White Paper 108, 87, 1972, state that "cooperatives are not only relevant in the production and sales sector. While Sweden and Finland have had good experiences with modern cooperatives, the old form of reindeer husbandry **in Finnmark has disintegrated without being replaced by anything new.** An organized operational collaboration in the reindeer husbandry industry could lead to rationalization and income equalization within the industry, and it must be right that both organizations and guidance services in the future focus on disseminating information about cooperatives and their benefits" (NOU 33, 69, 1972). "It is of great economic importance that the herd consists of an optimal number of females that get calves. The goal should be 5–10% breeding bulls and 90–95% females in the breeding herd" (NOU 33, 69, 1972). The Norwegian Parliament's White Paper on the Regional Plan for Northern Norway followed the NOU report in the same year. The White Paper suggests the future management of reindeer husbandry: "An improvement in the sex and age composition of the reindeer herds and selection among breeding animals should be promoted" (Norwegian White Paper 108, 87, 1972).



30,000 Reindeer in Norway Are Said to Face Starvation

OSLO, Norway, May 27 (Reuters) — About 30,000 reindeer trekking across the wind-swept Finnmark plateau of northern Norway are facing starvation, Harald Alstad, sheriff of the Lapplanders in northern Norway, said today.

Thousands of reindeer and new-born calves have died from hunger and thousands more will die in the next few days, he said.

Little can be done to help the animals as the reindeer moss is covered by a thick layer of hard-frozen snow, causing the worst food conditions for reindeer since 1914, Mr. Alstad said.

The New York Times
Published: May 28, 1968

Fig. 4.1 Facsimile from *The New York Times* 28 May 1968, where Harald Alstad, the director of the Sámi reindeer husbandry administration of Finnmark in Norway, is interviewed about significant deaths of reindeer in 1967–1968

As early as 1809, the Norwegian Society for Welfare (Det Kongelige Selskap for Norges Vel) was founded and got actively engaged in reforming agriculture which was seen as a means of social development. The growing human population, fishery crises, and loss of access to the European market forced the country to alter its agriculture practices in the early 1800s. From the middle of the 18th century, partially following the royal decrees and partially – their zest, the so-called potato priests encouraged the population of Norway to implement agricultural reforms conveying their social and material benefits while also tending to their clergy duties; Bjørkdahl

and Lykke (2023) interpreted the importance of these agricultural reforms. Benefits stimulating potato growth were introduced (Tveite, 1974; Tveite, 1959, p. 94).

However, traditional Sámi reindeer herding knowledge has not been included in the reforms' design: neither at a country level as part of the development program nor when it directly had to do with the Sámi reindeer herders.

In 1946, the ethnographer and researcher of Sámi culture, Ørnulv Vorren, concluded that reindeer herding in Western Finnmark as a nomadic livelihood needed to be rationalized and modernized in order not to be lost (Vorren, 1946). Later in June 1948, when the Norwegian Sámi Reindeer Herders Association was established in Tromsø, the Sámi reindeer pastoralists from Western Finnmark met the suggestion for reforms with hostility and unwillingness (Newhouse 1952, 136–137). Newhouse reported on the first Norwegian government plan to establish a central slaughterhouse using humane methods to kill reindeer and keep carcasses in cold storages. The new proposals were met with enthusiasm by the reindeer owners from the South of Norway but with active opposition from the Finnmark Sámi:

> An elderly Sámi from Kautokeino stood up and assured the assembly that the knife had been used for generations to slaughter reindeer. With a knife, the Sámi could kill an animal in two minutes. He saw no reason to change his method. Several young Sámi also said that the state had no right to persuade the nomads to sell their animals for meat. They would oppose central slaughterhouses in every way." Finnmark Sámi were repugnant to this plan: they still regarded their animals as a symbol of wealth and not a market product (Newhouse, 1952: 137). Newhouse (1952) argues: "The first steps towards a new policy did not come from the government, but from Sámi people from central Norway. These Sámi herd their flocks in Nordland, North, and South Trøndelag and differ from the Finnmark Sámi in many ways. They originally came from the Jokkmokk regions in Sweden and adopted the language and clothing of their neighbors. The Finnmark Sámi did not understand them, so these two groups had to communicate in Norwegian. Moreover, the operating conditions in the South are so different from those in the North that the goals of these two groups are often in direct conflict.

Norwegian experts believed that it was necessary to reform Sámi reindeer husbandry significantly. Like their potato-preaching predecessors, agriculture experts in the twentieth-century Norway tended to look for the answers elsewhere. As we discuss later in this chapter, the reforms of Norway's Sámi reindeer husbandry in 1970 were initiated in the South and later implemented in Finnmark. However, the knowledge behind the reforms evolved due to cross-border exchange.

Despite the Cold War between East and West, cooperation between experts in reindeer husbandry continued. Between 1965 and 1968, delegations from the Soviet Union paid several visits to Norway (Figs. 4.2 and 4.3).

The Soviet experts observed that the Norwegians experimented with reindeer herds and "began making a lot of efforts…to thoroughly understand the herd structure in Norwegian reindeer herding, which is developing chaotically now" (Vostryakov & Mezhetskiy, 1968; Vostryakov, 1968a, b). Norwegian experts were determined to reform reindeer husbandry based on new insights and ideas after the bad grazing winter of 1968. This chapter analyzes selected historical, scientific, and media sources and reports from Norway, USSR, and Finland that document reindeer husbandry cooperation between the Nordic countries and the Soviet Union; the

Russisk rendrifts-delegasjon

En sovjetisk reindriftsdelegasjon har besøkt Finnmark. Her er to av delegasjonens medlemmer fotografert mens de var i Vadsø. Mannen til venstre er Alkesy Mezhetskiy og til høyre Petr Votzjakov. Begge er zoologer av utdannelse.

Det er meningen at en norsk reindriftsdelegasjon seinere skal besøke Sovjet for å sette seg inn i hvordan reindriftsnæringa i Sovjet drives. Der har uten tvil de norske reindriftsutøverne mye å lære.

Fig. 4.2 Facsimile from the *Finnmarken* newspaper in Norway from 13 October 1965. The Soviet delegation to Vadsø, Norway, in October 1965 included A. Mezhetskiy (to the left) and P. Vostryakov (to the right) and translator V. Tsyrlina, a member of the Soviet-Norwegian Friendship Society. Following their visit to Norway, Vostryakov and Mezhetskiy wrote a report about Norwegian reindeer husbandry in 1968 (Vostryakov & Mezhetskiy, 1968). Petr Vostryakov was director of the Research Institute of Agriculture of the Far North (Norilsk), and Aleksei Mezhetskiy was head of the Yamalo-Nenets National District Agricultural Department. The delegation also visited Harstad. There, they got familiar with the working process of reindeer herding veterinary station and met the station's director Sven Skjenneberg, a chief Norwegian researcher in reindeer husbandry. Together with Skjenneberg and Hans Prestbakmo, the members of the Soviet delegation visited an experimental field facility of the station. The newspaper writes: "It is intended that a Norwegian reindeer herding delegation will later visit the Soviet Union to see how the reindeer herding industries in the Soviet Union are run. Undoubtedly, the Norwegian reindeer herders have a lot to learn"

chapter argues how this mutual exchange might have affected the 1970s reindeer husbandry reforms in Finland and Norway.

4.2 Visits to the Soviet Union

In August 1955, 12 politicians from the Committee of Agriculture in the Norwegian Parliament (Stortinget) led by L.K. Hognestad (Labour Party) visited the Soviet Union to learn about Soviet agriculture (Arbeiderbladet, 1955a, b). Later, expert networking between Norway and the Soviet Union continued. At first, the committee focused solely on the South, but later the Arctic expert networks were developed (Naryana Vynder, 1959).

In 1958, Yrjö Alaruikka from Finland joined Professor Vladimir Andreev in the Soviet Union to learn Soviet reindeer husbandry. Alaruikka reported: "…my impression was that with determined research and selective breeding of reindeer

Russisk delegasjon imponert over slakteriet i Kautokeino

Delegasjonen: Fra Venstre Petr Vostrajakov, den russiske tolken Valentina Tsyrlina, U. D. s tolk Ingvild Broch og Aleksej Mezhetskij.

Alta FD: Tirsdag forlot den sovjetiske pels- og reinsdyrdelegasjonen Alta og dermed også Finnmark, etter å ha tilbrakt nærmere en uke i fylket. — Selskapet besto av de to pelsdyrekspertene Petr Vostrajakov og Aleksej Mezhetskij samt den kvinnelige tolken Valentina Tsyrlina. — Alle

Over til siste side 8

Fig. 4.3 Facsimile from the *Finnmark Dagblad* from 16 October 1965, reporting on the "Russian delegation impressed by Kautokeino slaughterhouse." The delegation included (from left to right) Petr Vostryakov, Russian interpreter Valentina Tsyrlina, U.D. interpreter Ingvild Broch, and Aleksei Mezhetsky

husbandry, they have greatly improved the standard of living and livelihood for the Northern peoples of the Soviet Union" (Alaruikka, 1959; Naryana Vynder, 1959) (Figs. 4.4, 4.5, and 4.6).

In 1960, Anders Fjellheim was the board member of the Norwegian Sámi Reindeer Herders' Association (NRL). Subsequently, the leader of the reindeer husbandry of Riast-Hyllingen district in Røros, Southern Norway, visited the Soviet Union to learn "modern" and "rational" reindeer husbandry. After his visit, Anders Fjellheim reported in the journal *Reindriftsbladet* (1960): "The Russians are far ahead of us in the practice of reindeer herding. The reindeer herding industry receives more support than us" (Fjellheim, 1960; Adresseavisen, 1960; VG, 1960).

The local newspaper interviewed the Sámi delegation of seven reindeer herders in Murmansk on 19 April 1960: "The guests were also to learn that common salt was given to animals in wintertime, and more than 50% of the calves were slaughtered as calves in order to protect the pastures and to raise the quality of meat and hides. The Norwegians slaughter only mature animals." *"I never" came the exclamation when the visitors saw a vast herd of more than 3000 reindeer, "We have no*

Fig. 4.4 During his multiple visits to the Soviet Union, Yrjö A Alaruikka, from Finland, visited Nenets reindeer herding brigades in the Nenets National District, where the role of scientific experts impressed him (Photo: printed with the permission given by *Paliskuntain yhdistys*, Rovaniemi, Finland)

Fig. 4.5 Professor Vladimir Andreev (right) and an unknown reindeer husbandry expert from Finland (left) observed the Red Reindeer brigade in the Nenets tundra in 1958. (Photo: printed with permission given by *Paliskuntain yhdistys*, Rovaniemi, Finland)

Fig. 4.6 Yrjö Alaruikka, director of *Paliskuntain yhdistys*, Reindeer Herders' Association in Finland, was well connected with the Finnish political leadership during his work of reforming Sámi reindeer husbandry. In the photo, Y. Alaruikka is in a reindeer coral in Finnish Sapmi with the President of Finland Urho Kaleva Kekkonen (1900–1986). A Finnish politician for the Center Party, Urho Kekkonen was the Prime Minister of Finland in the periods 1950–1953 and 1954–1956 and president from 1956 to 1981. During the Cold War, Kekkonen pursued a conciliatory policy toward the Soviet Union while simultaneously advocating for close cooperation with the Scandinavian countries. (Photo: printed with permission given by *Paliskuntain yhdistys*, Rovaniemi, Finland)

herds of more than 400 to 450 reindeer," the Sámi guests said (Moshnikov, 1960) (Fjellheim, 1963) (Figs. 4.7 and 4.8).

The Norwegian newspaper *Dagbladet* described the visit: … After returning home, Anders Fjellheim sent us a private telegram saying "that the Soviet Russians operate domestic reindeer herding according to completely different guidelines than we do in this country" (Dagbladet, 1960). Later in the 1960s, Vostryakov and Mezhetskiy reported: "Norwegian specialists are unanimous in their opinion that nomadic reindeer husbandry is impractical in terms of modern conditions. This results from the general economic environment of the country, which has improved greatly and to which reindeer husbandry has to adapt. New means of communication appear, together with modern food products, clothes, footwear, etc., that indigenous peoples begin to use widely. Reindeer herders' demand for money grows, which, in its turn, makes them search for ways of increasing the profitability of reindeer husbandry" (Vostryakov & Mezhetskiy, 1968).

In 1965, the director of the Sámi reindeer husbandry administration of Finnmark in Norway, Harald M. Alstad, visited the brigade *Naryana-Ty* (Red Reindeer) (Figs. 4.8, 4.9a and 4.9b) together with veterinary Sven Skjenneberg and the

Fig. 4.7 Sámi reindeer herders from Norway in Leningrad in April 1960. From right to left: Nils O. Kappfjell, Lars Dunfjell, Sofie Kappfjell, Anton Lifjell, Maja Lifjell, Anders Fjellheim, and Odd Kappfjell (Fjellheim, 1961; Fjellheim, 1963)

director of agriculture in Finnmark Arthur Bartholsen and translator Per Mohr (Skjenneberg et al., 1966a).

The Norwegian delegation commented: "In the field of reindeer herding and the way of life of reindeer herders, I must confess, you have overtaken Norway." Mr. Alstad said: "We can tell our reindeer herders about a great job you have done…we want our herders to see with their eyes how your reindeer herders live." Sven Skjenneberg expressed: "Reindeer herding is no longer romance, but the economy and we are striving to study your best practices and learn your lessons, for we share common problems, and you are solving them quite successfully" (Ledkov-Malozemelskiy, 1965) (Figs. 4.9a, 4.9b, 4.10a, and 4.10b).

The Norwegians visited a Nenets village, where herders managed herds of 1500 to 2000 tame animals. The *Naryana-Ty* collective owned the herd, which included 173 people, with 36 engaged in reindeer husbandry. The reindeer number 1/10 was at 10800. Families of the collective's members lived in a small settlement of 20–30 houses in the tundra. Herders worked in shifts, changing every 10 days, half a month, or a month – depending on the distance from the settlement. Herders stayed in mobile huts when working with the herd (Skjenneberg et al., 1966b). Families of reindeer herders were spared the inconvenience of nomadic life (Ledkov-Malozemelskiy, 1965).

Norwegian delegation met collective farm chairman Arkadiy P. Khatanzeyskiy and foreman Konstantin A. Popov. The group discussed reindeer husbandry in the

Fig. 4.8 Sámi reindeer herders from Norway in Lovozero, Kola Peninsula, Russia. Nils O. Kappfjell, president of NRL (right), and Anders Fjellheim (middle), together with the chairman of Lovozero District Executive Committee tundra collective, Komi reindeer herder, Artemiy P. Terentyev (left) in April 1960. (Photo: published with permission given by Røros Museum, Norway)

region, explaining to the guests that the area had four reindeer herds, each between 2500 and 3600 animals. Khatanzeyskiy and Popov informed the guests that after the animals had been handed over to the state, the size of the fifth herd was reduced by 1000 heads. In 1964, they managed to retain 95 percent of adult animals and raised 835 calves from every 1000 female reindeer (Skjenneberg et al., 1966b).

Ledkov-Malozemelskiy (1965) reported further for *Naryana Vynder*: "Norwegians listened attentively and enthusiastically. With notebooks on their laps, Mr. Alstad and Mr. Skjenneberg were writing down the data." The guests were told of a new grazing system introduced 5 years before, the so-called shiftable grazing that was then gradually distributed to other collective farms.

The delegation also had an opportunity to visit the herd and see herders catching the reindeer with *tynzey*, a special type of lasso, which they used to seize a fat calf for lunch. Ledkov-Malozemelskiy (1965) remembered how Mr. Skjenneberg, enthusiastic about everything he saw, got so carried away by photography that he

Fig. 4.9a In 1965, Harald M. Alstad (in the middle), the director of Sámi reindeer husbandry in Finnmark (lappefogd), visited the brigade *Naryana-Ty* (Red Reindeer) in Naryan-Mar, Nenets National District. (Photo: Sven Skjenneberg; Copyright International Centre for Reindeer Husbandry)

got lost in the huge herd. He continued by mentioning that *balok*[1] aroused a lot of interest among the Norwegians: "They studied it carefully, took measurements, and said that they would try to introduce this experience of the Nenets reindeer herders in Norway."

Herders explained to the guests that earlier when they [herders] had lived in *chum*[2] with their families, the household was rather cumbersome. They needed up to 50 carts (and sometimes more) and hundreds of sledding male deer to move around. After *balok* was introduced, five male reindeer were enough to carry housing, and the rest of the property was placed on three carriages. In the *balok*, as Ledkov-Malozemelskiy (1965) described, herders treated the Norwegians to a delicious dinner: "Guests were engaged in a friendly business conversation over lunch. Every now and then, the walls of the *balok* shook with loud laughter and jokes. They called the guests 'Messrs capitalists'. It was very warm in the *balok*, although frost pinched ears and nose outside. People were sitting at the table in suits. The warmth and comfort raised everybody's spirits, especially those of the visitors from a distant Western country. After all, as they confessed, they did not expect to meet in the severe Arctic tundra reindeer herders in such a beautiful dwelling."

[1] A light mobile tent on sleds for temporary housing or utility purposes.

[2] A traditional cone-shaped tent used by the nomadic herders.

Fig. 4.9b In 1965, veterinarian Sven Skjenneberg visited the brigade *Naryana-Ty* (Red Reindeer) in Naryan-Mar, Nenets National District, where he learned about the modernization of reindeer husbandry. (Photo: Sven Skjenneberg; Copyright International Centre for Reindeer Husbandry)

Fig. 4.10a The Norwegian delegation visited the Red Reindeer brigade in the Nenets National District by helicopter in 1965. S. Skjenneberg arrives at the tundra (Photo: Sven Skjenneberg; Copyright International Centre for Reindeer Husbandry)

Fig. 4.10b The Norwegian delegation arrives at the tundra at the Red Reindeer brigade in 1965. (Photo: Sven Skjenneberg; Copyright International Centre for Reindeer Husbandry)

S. Skjenneberg concluded the visit: "During our short stay in your herd and *balok*, we saw and learned a lot of interesting and useful things. **We sincerely thank our Soviet comrades for this opportunity and for the hospitality shown by the chairman, foreman, and herders.** We will be happy to receive guests from the Nenets District in Norway. We wish Mr. Popov, chairman Khatanzeyskiy and all collective farmers great success in reindeer herding…" (Ledkov-Malozemelskiy, 1965).

The translator Per Mohr expressed the general opinion of the delegation at an official reception given by the head of the region: "One of the problems [for Norway] to improve are the working and living conditions of those who are engaged in reindeer herding. We understand that our countries have a common problem to solve: the use of the wealth of the Northern nature for the benefit of people. We want to take with us to Norway not only memories of your beautiful country and wonderful people **but all the knowledge we can use to get better results**" (Ledkov-Malozemelskiy, 1965).

Naryana Vynder concluded: "Everything looked new and significant for Norwegians: our planned economy, accounting principles, and the new system of organizing herding. They studied it carefully, took measurements, and said that they would try to introduce this experience of the Nenets reindeer herders in Norway" (Ledkov-Malozemelskiy, 1965).

A Swedish delegation also paid a visit to Naryan-Mar in December 1965. During their 3 days in the Nenets National District, the delegation visited fur and reindeer herding brigades at the *Kharp* collective farm and saw their housing (Naryana Vynder, 1966). Collective leaders introduced Swedish guests to the economy of reindeer husbandry management and the problems they faced when transferring reindeer herders to the settled lifestyle. The final day was given to the agricultural experimental station visit, where the farm leader, F. I. Semyashkin, presented labor organization in the reindeer herding highly praised by the delegation. F. I. Semyashkin also presented a brochure to the foreign delegation about organizing reindeer grazing (Naryana Vynder, 1965; Wikman et al., 1967). Unfortunately, we have not been able to follow up on the effect of this visit in Sweden or Swedish media. However, 2 years after the visit, in 1967, Wikman et al. followed with a report: "Scientific news or outcome from the visit was less than expected. The Soviet Union prioritizes the development of systematic research methods in reindeer husbandry research, but we are in front of reindeer slaughtering in Sweden" (Wikman et al., 1967).

The president of the Norwegian Sámi Reindeer Herders' Association (1965–1973), Paul Fjellheim, and Sámi reindeer herders Per Anders Smuk, rector at Sámi Reindeer Herding School, and Per Holm Varsi visited the Murmansk region in 1974. Their visit was supported by the Norwegian Ministry of Foreign Affairs' cultural development program. It took place before the reindeer husbandry reform in Norway (Reindriftsnytt #3, 1975), but we have not been able to find their reports.

A detailed description of the observations reported by the Nordic and Soviet experts follows the historical outline of their respective visits.

4.3 Observations Reported by the Nordic Experts

4.3.1 On Reindeer Husbandry Research

Yrjö Alaruikka (1959) "… In some places, we were told that they were testing lavvu-like huts made of aluminum. These huts were also built of hardboards…" (Naryana Vynder, 1958a, b).

Anders Fjellheim (1960) "The Russians conduct research and experimental activities. It had 5000 reindeer distributed and isolated in several herds at its disposal – for its research work (Fjellheim, 1960, 1961; Fjellheim, 1963). Each major reindeer husbandry area had its own research station, and they carried out a great deal of scientific work. Research has been conducted for 20 years. Reindeer herding has attracted significant interest from the authorities and the idea, and a lot of investment is being made in developing the industry. The research stations investigate the economic issue, combating diseased dams and genetic traits. Grazing areas are examined and analyzed to see what food they can produce for the reindeer. Spraying

poisonous bags had given good results in the fight against reindeer. Reindeer antler was used to produce medicines."

Anders Fjellheim for Dagbladet (1960) "The Soviet Russians operate domestic reindeer herding according to completely different guidelines than we do in this country. They have established research stations and, through planned breeding, developed large, powerful animals. They use specially selected breeding bulls. To make it as rational as possible, half of the calves were slaughtered in October – about eight months old" (Adresseavisen, 1960; VG, 1960; Dagbladet, 1960).

Sven Skjenneberg et al. (1966a) "The reindeer herding research has been well developed. The main impression of the Soviet Russian reindeer husbandry was positive. Reindeer herding uses the vast areas in the North and is a natural part of the exploitation of nature here. Reindeer husbandry is treated equally with agriculture in the past. Master efforts to develop it even more show the extensive research effort. Although the conditions in many ways are very different, we still have a number of common problems in terms of research, such as the reindeer biology and diseases, grazing and nutrition issues, breeding and other practical methods of operation, training, and several things that we should absolutely keep close contact" (Skjenneberg et al., 1966b).

4.3.2 On Education

Anders Fjellheim for *Reindriftsbladet* **(1960)** "Two and three-year vocational schools were established for reindeer herders. Here they were taught business, anatomy, reindeer diseases, herding techniques, combating predators, slaughtering, and castration. There was a great deal of academic literature on reindeer husbandry" (Fjellheim, 1960).

4.3.3 On Collective Farms

Anders Fjellheim for *Reindriftsbladet* **(1960)** "A collective farm's reindeer herd was usually divided into smaller units called brigades. Each brigade was kept strictly separate and had its own brand. To rationalize the work, they used fences. Women did not participate in the work with reindeer, but it was common with a couple for each brigade who was responsible for the household. A herder was allowed to have up to 50 animals of his own; otherwise, they had a salary."

Sven Skjenneberg et al. (1966b) "Reindeer husbandry is today organized either in state-owned (sovkhozes) or collective-owned reindeer herds (kolkhozes). Only a

few small and isolated tribes practice their old reindeer nomadism and own the reindeer themselves….Each family can have up to 50 reindeer privately, but there are some who have more….”

4.3.4 On Breeding

Yrjö Alaruikka (1959) “…In Russia, they have focused greatly on the selective breeding of reindeer. They have set up test sites where they closely follow the speed and extra growth of the development of different animal species. They also consider the temper of the animals. The degree of selective breeding (Figs. 4.11a and 4.11b) is highest in the test sites, then in the Soviet farms, and lastly, in the herds of the collective farms. They trade studs mostly between the state test sites and the state farms; therefore, the degree of selective breeding is higher in these than in the collective farms…” (Naryana Vynder, 1959).

Sven Skjenneberg et al. (1966b) “Breeding work is conducted in the experimental groups and in some of the better state herds. The breeding animals are selected according to their performance when it comes to producing large and good calves. During the mating season, the best animals are distinguished into particular herds. Therefore, one mates the best with the best and supplies the whole breeding herd from these ‘elite herds’. Mr. Priobratchenskiy at Loparskaia claimed that the breeding work could yield good results regarding the animals’ size and ability to survive under difficult conditions.”

4.3.5 On Slaughtering

Yrjö Alaruikka (1959) “Depending on the profitableness of the year, about 25–33% of the reindeer are slaughtered. The chosen animals are separated from the herd and driven to the slaughterhouses, where the actual slaughtering happens.”

Anders Fjellheim for *Reindriftsbladet* **(1960)** “To make it all as rational as possible, half the calves are slaughtered in October, about eight months old. They have then achieved a carcass weight of up to 40 kg, or almost twice what one can expect in this country.…In October, 50% of the calves were slaughtered. After this calf slaughter was completed, the flocks were counted. During this count, professionals who decided what would be slaughtered or used for breeding were present. The breeding animals and slaughter animals were then each marked with a mark.” “The state bought off the products that were not used within the collective. The average weight of the calves was 32 kg, but they could be up to 40 kg.”

Fig. 4.11a Selective scientific breeding in the Nenets National District impressed the Finnish delegations visiting in the late 1950s with the scientific selection of breeding bulls and special breeding herds. (Photo: printed with permission given by *Paliskuntain yhdistys*, Rovaniemi, Finland)

Fig. 4.11b Finnish delegations visiting the Soviet Union in the 1950s witnessed the slaughtering of large 5–6 months old calves. (Photo: printed with permission given by *Paliskuntain yhdistys*, Rovaniemi, Finland)

Sven Skjenneberg et al. (1966b) "The slaughter was based on calf slaughter. Up to 75–80% of calves were slaughtered in the fall. The average carcass weight for calves was 25 kg, and for adult animals, 45–60 kg. Slaughter took place on the farms under the supervision of a veterinarian. The slaughter of calves requires a small amount of loss in order for the herd to be maintained after slaughter, 47–65% were females over one year, and 10% were sledding males. One breeding male is used for 15–18 females. The bucks are used until they are about five years old."

Wikman et al. (1967) "…but we are in front of reindeer slaughtering in Sweden. In Russia, one male reindeer to 15–18 female reindeer is recommended. **Slaughtering of calves exists in Murmansk and Archangelsk, as much as 60% of calves are slaughtered if the percentage of females is high.** In Magadan, mainly adult reindeer are slaughtered, and only 25% of the calves. Meat from calves is cheaper to produce when migration routes are short and do not take much of the calves' body condition when herders do not need many reindeer for transport. Adult reindeer slaughtering was considered risky due to disease-based losses and accidents. Hence the calves are preferred for slaughtering. In addition, calf meat is tastier and should be better paid for, and even in Russia, there is a tendency to convert to less fat in human nutrition."

4.3.6 On Herd Composition

Yrjö Alaruikka (1959) "…56–60% of the reindeer in the experimental herd were females, and their calving rate varied between 90–98%. 90% of the calves survived each year, so there were relatively few females without calves in the herd who had not been able to sustain and take care of their calves. This rate is, of course, due to the selective breeding…the population renews itself approximately within eight years since about 75% of calves are slaughtered every fall."

Sven Skjenneberg et al. (1966b) "This herd could be between 1500 and 2000 animals. The animals were slightly larger than Norwegian reindeer. This was especially seen in the calves. The animals were tame. Approximately 10% of the herd was sledding males, 3–4% intact males, and 62% breeding females."

Wikman et al. (1967) "When visiting Kharp Kolkhoz 5 miles north of Naryan-Mar, the reindeer herd was comprised of 18500 animals, divided into 11 brigades with 4–5 herders each" (Fig. 4.12).

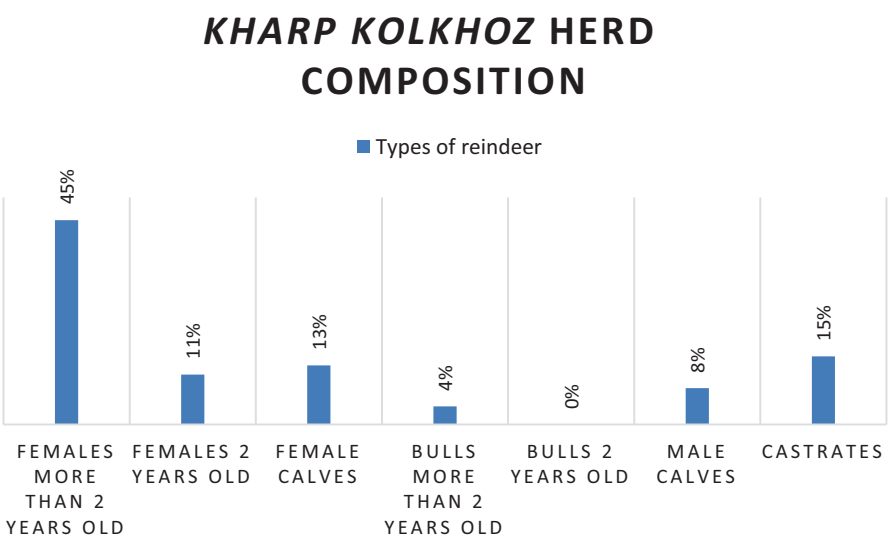


Fig. 4.12 Herd composition in the *Kharp Kolkhoz* by Wikman et al. (1967)

4.3.7 On Meat Production

Yrjö Alaruikka (1959) "They have made meat production self-sufficient in an area where keeping cattle would be many times more expensive, which in turn would have further complicated people's livelihood…."

Sven Skjenneberg et al. (1966b) "The total reindeer meat production was 25000 tons yearly or 12.5 kg per reindeer. In the Nenets National District, early production of 75000 calves of the total of 172000 reindeer."

4.4 Visits to the Nordic Countries

In 1957, the first delegation of reindeer husbandry experts to visit Finland on October 4–23 included Dr. Professor Vladimir N. Andreev of the Naryan-Mar Agricultural Experimental Station, Nenets National District, and veterinarian D. N. Tsypanov. Tsypanov was the head of reindeer herding and agriculture in the Republic of Komi. In Rovaniemi, the Soviet delegation met with the director of the *Paliskuntain yhdistys*, Yrjö Alfred Alaruikka, the founder and first director of the Reindeer Herders' Association in Finland, and translator Otto V. Itkonen (Figs. 4.13 and 4.14).

In 1957, Professor Andreev's delegation traveled across Finland's Sámi lands: in Sodankylä, Inari, and Enontekiö, the group interviewed reindeer herders, and in

Fig. 4.13 Reindeer husbandry expert from the Soviet Union in Rovaniemi, October 1957. From left to right: Dr. Prof. of Biology Vladimir N. Andreev, veterinarian Dmitrii M. Tsypanov, translator Otto Itkonen, and director Yrjö Alaruikka. (Photo: printed with permission given by *Paliskuntain yhdistys*, Rovaniemi, Finland). In October 1957, as part of a scientific expedition, the deputy director of the Research Institute of Agriculture of the Far North, Doctor of Biological Sciences, V.N. Andreev, and the head of reindeer husbandry department of the Ministry of Agriculture of the Komi Republic, Honored Veterinary Officer, D.M. Tsypanov, visited Finland. They thoroughly studied the Finnish reindeer herding structure and management system

Fig. 4.14 Soviet experts viewing the Norwegian-Finnish national reindeer border fence close to Hetta, Enontekiö, Finland, in October 1957. Prof. Andreev (to the left), veterinarian Tsypanov (in the middle), and translator Itkonen (to the right) reporting on the analyses of the fence (Andrejev, 1959) (Photo: printed with permission given by *Paliskuntain yhdistys*, Rovaniemi, Finland)

Inari, they were introduced to the fish farming facility and the Sámi school. The Soviet experts reported that reindeer management in Eastern Siberia still faces many unsolved issues, but science helps to find solutions. The delegation discussed that the perfect utilization of pastures at suitable times is achieved by drawing up reindeer relocation plans. It was noted that special attention should be paid to assessing and mapping pastures (Figs. 4.13 and 4.14). They argued that this approach would allow using pastures in the best possible way (Alaruikka, 1959; Naryana Vynder, 1958a, b).

In 1958, the newspaper *Naryana Vynder* in Naryan-Mar reported on the visit: "Generally, the object of interest of the guests was the reindeer pastures and their vegetation. We have hiked for two and a half weeks with the reindeer husbandry experts of our big eastern neighbor in Lapland and most recently in the main town, where we happily accompanied them when the Finish-Norwegian joint committee meeting happened to be on the same days. The development of friendly Soviet-Finnish relations allowed for our trip to this country, during which we visited all the main Finnish reindeer breeding centers. For the first time, reindeer herders of Finland hosted their Soviet counterparts. Finnish reindeer husbandry develops in the capitalist economy and is deprived of the advantages and achievements characteristic of Soviet socialist reindeer herding. However, the experience of Finnish reindeer breeders can also be partially used in our reindeer husbandry" (Naryana Vynder, 1958a, b).

In 1965, Vostryakov and Mezhetskiy visited Finnmark in Norway and reported this visit in subsequent publications (Figs. 4.2 and 4.3).

In 1971, Finland hosted the International Reindeer Herding Symposium. One of the conference participants was P. Rochev, Director of the Naryan-Mar Agricultural Experimental Station. Upon his return, he reported his experience of the Finnish reindeer husbandry in a lecture to the reindeer herders from Volkova, Verkhnyaya Pesha, and Nizhnyaya Pesha settlements, and *Way to Communism* and *Naryana Ty* collective farms, and Malozemelskaya group of brigades of the Naryan-Mar agricultural cooperative (Rochev, 1971c).

As of 13 June 1971, the *New North* newspaper reported that P. Rochev "repeatedly underlined that Finland had made good use of reindeer by-products – horns and skins. Finns make various souvenirs, which are very popular among tourists using these materials. However, Finns agree on the fact that, in general, Soviet reindeer husbandry gives more products than theirs. Based on the experience of reindeer herding in the Nenets okrug, the Finns set themselves the task of increasing breeding stock to 60–70 percent" (Rochev, 1971a).

A visit of the Soviet delegation to the symposium was made possible after the decision of the 1969 first all-Scandinavian scientific conference on reindeer herding that brought together Finland, Norway, and Sweden experts in reindeer husbandry. The unanimous wish to have the delegation of Soviet experts brought the USSR researchers to Finnish Rovaniemi in 1971. The symposium raised the issues of reindeer husbandry in the Soviet state and Scandinavian countries, the results of scientific research on reindeer breeding, methods of reindeer gadfly extermination, blood-sucking insects, and protection of reindeer from them, reindeer

necrobacteriosis, scientific research of rational use of reindeer pastures, coordination of the research and cooperation on reindeer husbandry, etc. (Rochev, 1971a).

The Scandinavian participants of the symposium showed great interest in the Soviet experience in reindeer husbandry research. The delegations of Finland, Norway, and Sweden claimed that the establishment of contacts with Soviet specialists was especially valuable for reindeer herders of the Scandinavian countries because the research work on reindeer husbandry in the USSR was at a higher level compared to Scandinavia (Rochev, 1971a). Losses in the reindeer husbandry of the USSR were much smaller than in Finland, which proves that under conditions of socialist agricultural production, the level of reindeer husbandry is higher (Rochev, 1971b).

Reindeer husbandry expert F. Filippov, Chief scientist at the Naryan-Mar station, told the *New North* newspaper of his observations from the visit: "The central organ of the association is the Reindeer Herders' Association of Finland, founded in 1926. The tasks of this organization are to connect all these separate associations, develop reindeer husbandry, organize the marketing of products, conduct various scientific research, and comply with laws and regulations in the field of reindeer husbandry" (Filippov, 1971).

Filippov remembered the visit of the Finnish delegation led by Y. Alaruikka to the Nenets tundra in 1958: "In 1958, he [Yrjö Alaruikka] visited our Nenets district. He was driving reindeer along the brigades of the Malozemelskaya tundra from Hangurei to Indigi" (Fig. 4.15).

"He is still pleased with that trip. And his journey was very useful for Finnish reindeer husbandry. **The Finns borrowed from us the structure of the herd with a high proportion of the breeding stock. This experience enabled them to increase the production of reindeer meat significantly.** According to Alaruikka,

Fig. 4.15 Yrjö Alaruikka from Finland sledding with reindeer in Nenets tundra in 1958. (Photo: printed with permission given by *Paliskuntain yhdistys*, Rovaniemi, Finland)

the Reindeer Herders' Association of Finland sets the task of increasing the number of heads in breeding stock up to 60–70 percent" (Filippov, 1971). More of their observations are followed in the next section of the chapter.

In 1974, Finland hosted another reindeer husbandry conference attended by Soviet reindeer husbandry specialists. Reindeer husbandry expert, Dr. O. Rapoport, who then worked at the Murmansk Zonal Reindeer Experimental Station, expanded on the Soviet research experience in the field: "the State supports financial support to research institutions and experimental stations, such as in Magadan, Yakutsk, Murmansk, Taimyr, and Yamal. Several Scandinavian researchers have visited Soviet research institutions and learned from our work in reindeer breeding." Conference participants agreed, however, that one of the key challenges for both Soviet and Nordic reindeer herders was the increased production, the problem which in the USSR was solved through selective breeding (Brushinin et al., 1980; Rapoport, 1975).

4.5 Observations Reported by the Soviet Experts

4.5.1 On Economy

Vostryakov and Mezhetskiy (1968) "The private nature of reindeer husbandry limits the possibilities of state regulation of this branch of the economy. The state's influence is limited to drafting legislation on reindeer herding, outreach, and control over its implementation. The state is also engaged in the construction of internal fences on reindeer pastures, subsidizes the construction of production facilities for reindeer herders (slaughter stations, corals), residential buildings, purchasing modern transportation vehicles (cars, snow motorcycles, etc.) and other needs."

4.5.2 On Reindeer Ownership

Vostryakov and Mezhetskiy (1968) "The organizational principles of Norwegian reindeer husbandry are determined primarily by full private ownership of reindeer. There is no public reindeer ownership in Norway, and private owners are very numerous: only in the province of Finnmark are there more than three thousand different owners registered. Even the experimental herd of the state veterinary experimental station for reindeer herding (the city of Harstad) consists of reindeer leased under contract from four owners. However, the economy and culture development makes us look for new forms of reindeer herding organization. **Such a recognized form of reindeer husbandry organization in Norway is cooperatives that unite a large number of reindeer owners**."

4.5.3 *On Herd Composition*

Vostryakov and Mezhetskiy (1968) "The structure of herds has always been given importance. Recently, a lot of efforts have been made to thoroughly understand the herd structure in Norwegian reindeer herding, which is developing in a chaotic way now." "With such a herd structure, the main slaughter animals are one-and-a-half-year-old males and adult reindeer of mixed age-sex groups" (Vostryakov & Mezhetskiy, 1968).

Vostryakov and Mezhetskiy (1968) also compiled the figures on reindeer husbandry and concluded that in autumn, after the slaughter of reindeer, the structure of the herd of Norwegian reindeer looked like this (Fig. 4.16).

Yet Vostryakov and Mezhetskiy (1968) made a note that "however, according to Skjenneberg, this structure is not characteristic of the country because special experiments are carried out in the herd, providing for a smaller number of **khors.**[3]"

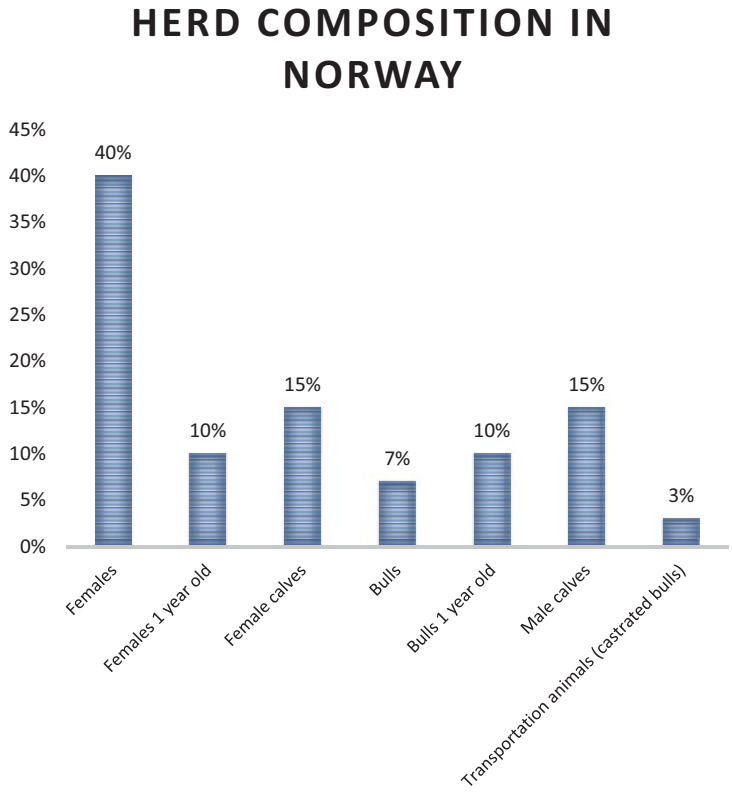


Fig. 4.16 Reindeer herd composition in Norway by Vostryakov and Mezhetskiy (1968)

[3] A breeding reindeer buck.

They continued their observation: "**Reindeer herders believe that the herd should significantly increase the number of females, bring it up to 80% and slaughter mainly calves at 5–6 months of age.** This, according to experts, will increase revenues from reindeer herding" (Vostryakov & Mezhetskiy, 1968).

"Nowadays, transport reindeer in the structure of the herd make up about 2–3%: the average reindeer herder family has up to 30 sledging reindeer. Over the past 5–8 years, strict rules for the castration of reindeer have been developed and applied in Norway. Since 1957, reindeer herders have been allowed to use only one method of castration – bloodlessly cutting the spermatic cord with special forceps. This method is taught to reindeer herders, and only veterinarians are allowed to castrate reindeer in an open way" (Vostryakov & Mezhetskiy, 1968).

4.5.4 On Breeding

Vostryakov and Mezhetskiy (1968) "In the Norwegian reindeer herding, no purposeful breeding work is carried out. Human intervention is limited mainly to the autumn culling of animals. When culling reindeer, they first take away old and weak animals and those that do not satisfy the owner for one reason or another. Also, females who have been farrowed for two years are slaughtered. For 30 females, 3–4 males are left for rutting; the best producers are males aged 3–4 years."

4.5.5 On Herders' Livelihoods

Vostryakov and Mezhetskiy (1968) "Presently, there is an average of 5.5 children in a Sámi family in the province of Finnmark, where 48% of all the Sámi live; many families have 8–10 children, more than 10% of Sámi families have more than 10 children. Due to the high birth rate of the Sámi, there arises a problem of employment. The situation is only going to get worse since there's no increase in the country's reindeer herd envisaged because of the absence of vacant pastures. That is why the increase in the number of reindeer belonging to a reindeer herder, whose family only gets larger, is also impossible."

4.5.6 On Sedentarization

Vostryakov and Mezhetskiy (1968) "The transition of the Sámi reindeer breeders to settled life began relatively long ago. At first, it was spontaneous, but later – with intervention and participation of the state. The transition is required due to the general technical and cultural progress in the country and the need for intensification of reindeer herding, as well as state interests. The decisive factor in the successful

transition of Norwegian reindeer herders to settled life is the construction of good roads in the country. Other positive factors, especially the natural-geographical conditions favorable for reindeer herding, enabled the reindeer herders to use the semi-free reindeer grazing system successfully. In order to interest the Sámi in the quickest transition to settled life and facilitate this process, the state first built houses for reindeer herders. Later, houses were built at the expense of reindeer herders using long-term government loans. Most families of reindeer herders have two houses: summer and winter; the first is built on summer pastures, and the second on winter reindeer pastures."

Vostryakov and Mezhetskiy (1968) also note that according to Norwegian experts, "**it is not easy to teach the former Sámi nomads to use houses and property correctly, to transit to a sedentary way of life.** The newspapers appeared in the national language, with the reindeer herders becoming sedentary. For example, two newspapers are published in the province of Finnmark, and radio programs are broadcast periodically in the Sámi language."

4.5.7 On Migration

Vostryakov and Mezhetskiy (1968) "Reindeer herders migrate from winter pastures to summer ones, depending on roads and transport, nomadic routes, and some other conditions in one of the following ways. 1. A part of the reindeer herder's family lives in the winter house permanently, and only those family members who watch the reindeer go to summer pastures. 2. Reindeer herders transport property and family to the summer houses on reindeer. In this case, it takes a lot to transport animals. 3. The most popular way of migrating to summer pastures is by a car when roads recover after the thaw. Before moving the family with a herd of reindeer, only herders go to the pastures, living there in tents or primitive earth huts."

4.5.8 On Herd Management

Vostryakov and Mezhetskiy (1968) "The reindeer in Norway are counted as of 1 April of the current year. This is attributed to the fact that with the reindeer's semi-free grazing, their gathering, counting, and autumn slaughter starts in mid-October and ends in March of the next year. All the summary information on reindeer breeding for the last year is received only by April. The results of the reindeer count are obtained in a peculiar way. The count is based on the number of adult reindeer remaining after slaughter with 25% of calves added; this will constitute the main reindeer population."

4.5.9 On Slaughtering

Moshnikov (1960) "The guests were also to learn that common salt was given to animals in wintertime, and more than 50% of the calves were slaughtered as calves in order to protect the pastures, and to raise the quality of meat and hides. The Norwegians slaughter only mature animals." "'Well, I never!' came the exclamation when the visitors saw a vast herd of more than 3000 reindeer, 'We have no herds of more than 400 to 450 reindeer,' the Sámi guests said."

Rochev (1971a) "It was nice to hear that the Scandinavian specialists spoke positively after their visit to the Nenets okrug about our reindeer husbandry. As a result, they borrowed from us the idea of a high percentage of the breeding stock. Previously, the largest number of slaughtered reindeer in Finland was adult reindeer. Now Finns slaughter calves because their meat is more tender and tasty."

Rochev (1971d) "Thus, many associations achieve maximum meat production because of the summer pastures and increased calf stock. It is a well-known fact that calves born within the period from May to the end of September gain their weight by 9–10 times. Young reindeer older than six months do not achieve such results, either relative or quantitative. In the second year of life, the weight of young animals is not even 30% of the autumn weight. Reindeer herders understand this factor. Therefore, they strive to slaughter calves in autumn; they kill mainly young animals of the current year of birth."

4.5.10 On Reindeer Numbers

Vostryakov and Mezhetskiy (1968) "In 1958, the percentage of reindeer herders that have less than 100 reindeer amounted to 28.6%; in 1965, it decreased to 16.9%. At the same time, the number of reindeer herders with larger herds rose. Thus, the number of owners of more than 200 reindeer increased by 6% compared to 1958. Together with a certain increase in the number of reindeer in the stock, there is an increase in the number of Sámi reindeer herders. Therefore, the average number of reindeer to one member of a reindeer herder's family increased from 50 to 74 in the period 1949–1957 and decreased to 66 reindeer by 1965."

4.5.11 On Pastures

Naryana Vynder (1958a, b) "Generally, the object of interest of the guests was the reindeer pastures and their vegetation. We have hiked for two and a half weeks with the reindeer husbandry experts of our big eastern neighbor in Lapland and

most recently in the main town, where we happily accompanied them when the Finish-Norwegian joint committee meeting happened to be on the same days. The development of friendly Soviet-Finnish relations allowed for our trip to this country, during which we visited all the main Finnish reindeer breeding centers. For the first time, reindeer herders of Finland hosted their Soviet counterparts. Finnish reindeer husbandry develops in the capitalist economy and is deprived of the advantages and achievements characteristic of Soviet socialist reindeer herding. However, the experience of Finnish reindeer breeders can also be partially used in our reindeer husbandry."

Rochev (1971d) "In Finland, the construction of wire fences on pastures is widely used. It makes the process of grazing much easier. Summer soil does not limit the development of reindeer husbandry; therefore, summer pastures are used for fattening up as much as possible. For these purposes, it was decided that the number of dams in the structure of a herd must be the largest."

Rochev (1971a) "Unfortunately, in Finland, Sweden, and Norway, the desire to increase the number of deer does not comply with the organization of pastures. Professor Andreev, one of the leading Soviet reindeer pastures experts, criticized the Scandinavians during his speech at the symposium. He said that the Scandinavian reindeer pastures are unsuccessful, and a further increase in the number of reindeer can lead to a disaster. Therefore, the main task in the reindeer husbandry of Finland, Sweden, and Norway is the organization of proper pastures. The reindeer herders of Scandinavia gratefully accepted this remark of the Soviet scientist."

4.5.12 On Feeding

Moshnikov (1960) "The guests were also to learn that common salt was given to animals in wintertime."

4.5.13 On Collective Farms

Vostryakov and Mezhetskiy (1968) "People in Norway believe that the main and only way to progress in reindeer husbandry is to unite scattered reindeer herders into cooperatives (not only cooperative grazing of reindeer herds but also slaughter, processing and marketing products, building production facilities, etc.). Such associations will help increase the profitability of reindeer husbandry. In the future, numerous reindeer owners will hire professional herders to free themselves from work in sedentary agricultural sectors. Even though cooperatives are formed with difficulty, the state does not push, but only systematically explains the need for these measures to the reindeer herders."

4.6 Discussion

The Norwegian researcher Dag Lenvik is known for his implementation of a new model, a different herd structure in Sámi reindeer husbandry. His research started during the early 1970s in Norway and was formally referred to as a "structuring and optimization process" (Lenvik, 1990). According to Lenvik and Fjellheim, Dobrotvorskiy's herd structuring research in the 1930s and 1940s catalyzed the Soviet calf slaughter practices that later inspired Nordic experts (Lenvik, 1988; Lenvik & Fjellheim, 1987; Dobrotvorskiy, 1938). Dobrotvorskiy's work is little referred to in Fennoscandia (Lenvik, 1988). However, these structural and rational practices negatively affected reindeer-herding Nenets people in the Nenets Autonomous District (Degteva, 2006; Degteva et al., 2023). According to Holand (2006), the highest possible proportion of reproductive females combined with a slaughtering scheme based on calves was introduced in the 1960s in Finland and, subsequently, Norway. The new development of Finnish reindeer husbandry gained success due to a stationary operating system in Finland with less need for traction, and reindeer husbandry was strongly influenced by Finnish agriculture.

In the Soviet Union, increasing the size of the reindeer herds was imperative. The herds could increase by five times when both forage and rational resources were available (Polyakov, 1930). Polyakov (1930) argues that reindeer husbandry can become a commodity branch of animal husbandry under certain conditions. This branch can also be organized in the form of large, socialized farms – state farms and, later, collective farms. In fact, herd numbers depended on a number of economic considerations (Polyakov, 1930); more prosperous herds had a larger percentage of females than the poor and therefore yielded a larger population and size of offspring. Polyakov (1930) states that the method developed in the 1930s with a high proportion of females was to increase the number of reindeer and meat production in the Soviet Union.

Yet simultaneously, the Soviet state collectivized reindeer herders' property using experimental research and collectivization results to increase the rationalization and efficiency of reindeer meat production. Modernization and rationalization left reindeer herders behind with a systematic failure in production (Degteva et al., 2023). Increased numbers of reindeer, new herd structures, and calf slaughtering were essential factors in the Soviet collectivization processes.

Subsequently and indirectly, these processes affected the social organization of the Sámi reindeer husbandry in Norway. The chapter highlights the important milestones of the cross-border exchange and cooperation that resulted in feasible amendments in reindeer husbandry on both sides.

In Norway, large-scale slaughtering of reindeer calves for meat production was low before 1965. In 1967, Loyd Villmo argued that calf productivity in Norway should be increased. He concluded that "to keep 40% bucks was of little economic advantage" and argued that 10% males would be enough for 90% females (Elgvin, 1996).

Furthermore, a large number of Norwegian white papers and official reports on the modernization of Sámi reindeer husbandry in Norway published between the 1960s and 1970s discussed the need for a new model, for example, NOU 33, 72 report mentioned earlier.

A subsequent white paper from the Norwegian Government to the Norwegian parliament (Norwegian White Paper 108, 1972–1973) underlined: "through guidance and information work, it will be possible to prevent forms of husbandry that lead to large losses of animals…It is also necessary to improve the sex and age composition of reindeer herds and to select breeding animals" (p. 87).

The reforms in reindeer husbandry were welcomed by Norwegian officials (Figs. 4.17 and 4.18). Norwegian White Paper 108 (1972–1973) wrote: "Cooperative models are not only relevant in the production and sales sector; Sweden and Finland have had good experiences with modern operational (herding) cooperatives. An organized operational cooperative in the reindeer husbandry industry could lead to rationalization and income equalization within the industry."

Based on these assumptions, a new type of reindeer herders' collective was established in Southern Norway (Fig. 4.16): "There are 12 families in Riast-Hyllingen, and each family has their own herd and its own earmarks. The plan was

Reineierne i Røros over til kollektivdrift

Et merke og likt utbytte til alle

Trondheim

(NTB) Reineierne i Riast-Hyllingen reinbeitedistrikt på Røros-vida planlegger en kollektivisering av driften, opplyser bladet Fjell-Ljom.

Det er 12 familier som driver med reindrift i Riast-Hyllingen, og hver familie har sin egen flokk og sine egne merker. Planen går ut på at hele tamreinstammen i distriktet skal betraktes som en flokk, og hver familie skal eie en like stor del i hver rein.

Den nye ordningen vil innebære en økonomisk utjevning mellom familiene, og den fører til at både arbeid og utbytte blir den samme for alle. Dersom planen blir gjennomført, vil det blant annet bli lettere å drive et målbevisst avlsarbeid.

Fig. 4.17 Facsimile of the *Finnmarken* newspaper as of 30 August 1973: "The reindeer herders in Røros over to collectivization. One earmark and equal sharing between everyone. The reindeer herders in the Riast-Hyllingen reindeer grazing district on Røros Vidda are planning to collectivize their operations, says Fjell-Ljom"

Fig. 4.18 After the visit to the Nenets tundra and the Red Reindeer brigade in 1965, reindeer husbandry experts from the Soviet Union – Petr N. Vostryakov, director of the Research Institute of Agriculture of the Far North (Norilsk) (left), and Vasily S. Fedotov, director of the Murmansk Zonal Reindeer Experimental Station – were invited for dinner to the Norwegian ambassador to the USSR, Frithjof Halfdan Jacobsen (ambassador in Moscow 1961–1965 and 1970–1975), in the Norwegian embassy together with the delegation of experts from Norway. Frithjof Halfdan Jacobsen would later become the Norwegian government's vice minister (1966–1979) for the Høyre party (Right). The group was also interviewed and broadcast in Norwegian on 22 December 1965. (Photo: Sven Skjenneberg. Copyright International Centre for Reindeer Husbandry)

to collect all reindeer herds of the district into one herd, and each family should own an equal share of each reindeer. The new scheme meant a financial equalization between the families and will result in both work and dividends being the same for everyone. If the plan is implemented, it will, among other things, be easier to carry out targeted breeding work" (Finnmarken, 1973).

In 1972, 50% of herders had less than 200 reindeer, which was regarded as too low to meet the economic needs of modern society. In 1975, the Norwegian White Paper nr. 13-1974–75, "On the action plan for the central Sámi settlement," wrote: "If the reindeer husbandry is to survive and be a satisfactory place for work, there must be a structural change. The main problem today is that there are too many herding units in relation to natural resources. More than half of the herding units have such a small population that it does not allow for a proper livelihood. On the other hand, the units that have such a herd are not so large that it allows for internal regulation."

In 1976, Norway decided to modernize and rationalize its Sámi reindeer husbandry by developing a modern administration of reindeer husbandry (Norwegian White Paper 9). The agreement formally incorporated Sámi reindeer nomadism and

described monetary transfers to the industry "on the understanding that the rationality and efficiency of production" would be ensured (Paine, 1996: p. 159).

As the Soviet experts also set a goal for increased productivity, Finland and later Norway aimed to increase meat production. Their observations show that they considered improved herd structure, slaughtering a higher percentage of calves, changing reindeer ownership, and introducing novel labor standards such as shift working, housing programs, and mobile herding cabins.

As one can notice, reforms implemented by Norway failed to include reindeer herders' Indigenous knowledge (Eira et al., 2023) on one side; yet also, these reforms were not nested within science on the other side. Sámi reindeer husbandry reform ensued by extensive outer strive for "knowledge and expertise" elsewhere failed to see the depths of knowledge accumulated for millennia within. None of the reindeer husbandry experts back in the day tried to understand the limitation of the implemented reform and how it affected Sámi reindeer husbandry. Sámi traditional reindeer herding knowledge has always been time- and space-oriented: all decisions in reindeer husbandry are based on the first-hand knowledge gained through generations and centuries of life with and from the reindeer.

Neither Norwegian nor Soviet experts investigated reindeer herders' Indigenous knowledge. One of the few exceptions is Yuzhakov (2004). Pilyasov and Kibenko (2023) articulated and discussed the challenges between state-supported reindeer husbandry and entrepreneurship of private reindeer husbandry in the Yamalo-Nenets Autonomous Region, Russia. Private family reindeer husbandry in Yamal should be viewed as a full-fledged small business. Only such a view allows us to understand the new motives of the economic behavior of nomads, which were hidden or did not appear during the period of the dominance of the model of state reindeer husbandry in the last decades of the Soviet era (the 1960s–1980s). We argue that a similar study in Norway should follow up on Pilyasov and Kibenko's work (2023) (Fig. 4.18).

References

Adresseavisen. (1960). Norske samer har sett på reindrift i Sovjet. Interessant tur til Kola-halvøya 27 April. Norwegian Sami have seen reindeer husbandry in the Soviet Union. Interesting trip to the Kola Peninsula 27 April.

Alaruikka, Y. (1959). Reindeer husbandry among Fin-Ugric Peoples, Rovaniemi. In Finnish 48 pp.

Andrejev, V. N. (1959). Pronhoidon kehitys-mahdollisuudet ita-siperiassa. Poromies, No 1. 4–9. The development possibilities of reindeer herding Siberia. *Poromies, 1*, 4–9. In Finnish.

Arbeiderbladet. (1955a). Landbrukskomiteen tatt vel imot i Moskva 15 August side 1. The Agricultural Committee welcomed in Moscow 15 August page 1. Newspaper article in Norwegian.

Arbeiderbladet. (1955b). Landbrukskomitéen gikk i kloster ved Odessa og badet i Svartehavet. 17 September 1955 side 11. The Agricultural Committee went to a monastery at Odessa and bathed in the Black Sea. 17 September 1955 page 11. Newspaper article in Norwegian.

Bjørkdahl, K., & Lykke, K. V. (2023). *Live, die, buy, eat* (p. 10158, 305 pp). London and New York.

Brushinin, P. I., Ledkov, V. M., Rapoport, O. L., Rychlitsky A. D., Khylma Y. F., & Makridin V. P. (1980). *Guidelines for reindeer husbandry in Nenets Autonomous Region.* The guide-

lines are recommended for publication by the Academic Board of the Naryan-Mar Agricultural Experimental Station, Minutes of Meeting №5 of May 12, 1980. The Department of the Non-black Earth Zone of All-Union Academy of Agricultural Science. (RSFSR).

Dagbladet. (1960). Norsk same fra Sovjet. Reinen i kollektivbruk i Murmansk. p 10 nr 95, April 25th Norwegian Sami from the Soviet Union. Reindeer in collective use in Murmansk. p 10 nr 95 April 25th. Private telegram from Anders Fjellhein.

Degteva, A. (2006). *Oil industry and reindeer herding: The problems of implementing indigenous rights in the Nenets autonomous Okrug, Russia.* (Master thesis of philosophy in indigenous studies). Faculty of Social Science, University of Tromsø.

Degteva, A., Okotetto, E., Slepushkin, I., Romanenko, T., & Mathiesen, S. D. (2023). Reindeer husbandry trends: Nenets Autonomous Okrug and Western Finnmark. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer.

Dobrotvorskiy, I. M. (1938). Growth and development of reindeer calves in land-poor tundra. In *Scientific proceedings*. Scientific Research Institute of Polar Agriculture, Cattle Husbandry and Game Farming. Reindeer husbandry series. L., Vol. 3, pp. 7–98. [Добротворский И. М. (1938). Рост и развитие телят оленей в условиях малоземельной тундры // Науч. тр. / НИИ поляр, земледелия, животноводства и промысл, хоз-ва. Сер. Оленеводство. Л., Вып.3. -С. 7–98.] Translated from Russian.

Eira, I. M. G. (2012). *The silent language of snow. Sámi traditional knowledge of snow in times of climate change* (PhD thesis). UIT The Arctic University of Norway. https://munin.uit.no/bitstream/handle/10037/9843/thesis.pdf?sequence=6&isAllowed=y

Eira, I. M. G., Oskal, A., Hanssen-Bauer, I., & Mathiesen, S. D. (2018). Snow cover and the loss of traditional indigenous knowledge. *Nature Climate Change, 8*(11), 928–931.

Eira, I. M. G., Turi, E. I., & Turi, J. M. (2023). Sámi traditional reindeer herding knowledge throughout a year: Herding periods on snow-covered ground. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences*. Springer. https://doi.org/10.1007/978-3-031-17625-8_4

Elgvin, D. T. (1996). Reindeer pastoralism in southern Norway: A model for Northern Norway? *Acta Borealia, A Nordic Journal of Circumpolar Societies*, 109–124. https://doi.org/10.1080/08003839608580456

Filippov. (1971). Lecture and conversation about Finland's reindeer husbandry. "Naryana-Vynder" Newspaper 161 August 17.

Finnmarken. (1973, August 30). Report: Reindriftsutøverne på Røros over til kollektivisering. Ett øremerke og lik deling mellom alle "*The reindeer herders in Røros over to collectivization. One earmark and equal sharing between everyone.*" In Norwegian.

Fjellheim, A. (1960). Russerne ligger langt foran oss i utøvelse av reindriften. Reindriften får mer støtte enn hos oss "The Russians are far ahead of us in the practice of reindeer husbandry. The reindeer industry receives more support than with us." Reindriftsbladet no 2, pp. 3–4.

Fjellheim, A. (1961). Om Russisk reindrift. Fjell-Nytt nr 2 June side 7–13, About Russian reindeer husbandry. Fjell-Nytt no. 2 June pages 7–13. In Norwegian.

Fjellheim. (1963). Samedelegasjon på studiereise i Russland. Årg side 57. Joint delegation on a study tour in Russia. year page 57. In Norwegian.

Hanssen-Bauer, I., Benestad, R. E., Lutz, J., Vikhamar-Schuler, D., Svyashchennikov, P., & Førland, E. J. (2023). Comparative analyses of local historical and future climate conditions important for reindeer herding in Finnmark, Norway and the Yamal Nenets Autonomous Okrug, Russia. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_8

Holand, Ø. (2006). *Flokkstruktur og slaktestrategi i reindrifta – et historisk perspektiv*. Rangifer Report No. 12 (2007): 21–33 Vantaa, Finland, 20–22. Mars 2006.

Johnsen, K. I., Eira, I. M. G., Mathiesen, S. D., & Oskal, A. (2023). 'Leaving no one behind' – Sustainable development of Sámi reindeer husbandry in Norway. In S. D. Mathiesen,

I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_3

Ledkov-Malozemelskiy, V. (1965). No. 251, December 22. Newspaper «Naryana Vynder» Mr. Alstad: You have done a good job. В. Ледков – Малоземельский Газета «Нярьяна Вындер» № 251, 22.12.1965 г.Господин Алстат: У вас хорошо поставлены дела. In Russian.

Lenvik, D. (1988). *Utvalgsstrategier i reinflokken*. Reindriftsadministrasjonen.

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

Lenvik, D., & Fjellheim, A. (1987). Utvalgsstrategi i Reinflokken. 1 Standard tilleggskode for rein. (Selection strategy in domestic reindeer. 1 Standard tag system for reindeer) Norsk Landbr. Forskn.

Moshnikov, A. (1960). *Guest from Norway in Kola Peninsula*. Polyarnaya Pravda, April 19th, p 1–3. Translated from Russian.

Naryana Vynder. (1958a). Travel to Finland 1957, Naryana Vynder Newspaper article. To be checked.

Naryana Vynder. (1958b). Finnish guest on their trip to the Soviet Polar region. No 201 Newspaper article in Russian.

Naryana Vynder. (1959). Finnish guests about their trip in the Circum Polar Soviet 10th August nr 717, 10 Apr 1959.

Naryana Vynder. (1965). A delegation of Swedish agricultural experts stayed in our district for three days. In *No 240 October*. In Russian.

Naryana Vynder. (1966). V. Ledkov-Malozemelskiy Mr Noorqvist: We haven't expected that… #7 "In the Northern Light" 11th January newspaper.

Newhouse, J. (1952). *Reindeer are wild too*. Murray.

Norwegian Official Report Regional Plan for Nord Norge, The regional plan for Northern Norway (NOU 33, 1972). In Norwegian.

Norwegian White Paper 108 1972–73 St. meld Om et utbyggingsprogram for Nord-Norge / Kommunal- og arbeidsdepartementet 104 pp About a development program for Northern Norway / Ministry of Municipal Affairs and Employment. In Norwegian.

Norwegian White Paper nr 13. Reindeer Husbandry −1974–75.

Paine, R. (1996). *Saami reindeer pastoralism & the Norwegian state, 1960s–1990s* (pp. 125–135). Nomadic Peoples.

Pilyasov, A. N., & Kibenko, V. A. (2023). The phenomenon of entrepreneurship in reindeer husbandry in Yamal: Assessment of the situation, paradoxes, and contradictions. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer Husbandry*. Springer Polar Sciences. Springer. https://doi.org/10.1007/978-3-031-17625-8_10

Polyakov, N. (1930). Reindeer breeding and collectivization – Moscow, from: KNIGOSOYUZ, 1930. 96 p.

Rapoport, O. L. (1975). Huvudriktingen for vetenskaplig forskning innom renskotsel i Murmanskområdet. The main direction for scientific research in reindeer husbandry in the Murmansk area. Report from the International Symposium on Reindeer Husbandry, Finland 1974. Translated from Swedish.

Reindriftsnytt. Nrls leaders in Russian #3, 1975.

Rochev, R. A. (1971a). Reindeer symposium on northern reindeer husbandry in Finland. Krasnaya Pechora Newspaper no 84 June 13.

Rochev, R. A. (1971b). Symposium on the northern reindeer husbandry in Finland. "Naryana Vynder" no 123 June 24.

Rochev, P. A. (1971c). Symposium on the Northern Reindeer Husbandry in Finland. "Pravda Severa / Truth of the North" Newspaper. No 164 July 18th [in Russian]

Rochev, P. A. (1971d). Reindeer Husnandry in Finland. "Novyi Sever" New North Newspaper. No 96. August 10.

Skjenneberg, S., Bartolsen, A., & Alstad, H. (1966a). Beretningen fra studiereise i Sovjet-Samveldet 21/10 – 3/11 1965 for å studere reindrift og pelsdyrnæring. The report from a study

trip to the Soviet Union 21/10 – 3/11 1965 to study reindeer herding and fur industry Report in Norwegian pp 9.
Skjenneberg, S., Bartolsen, A., & Alstad, H. (1966b). Reindrift i Sovjet-Samveldet 21/10 – 3/11 1965. Reindeer herding in the Soviet Union 21/10 – 3/11 1965. Report in Norwegian pp 11.
Tveite, Stein. (1959). Jord og gjerning: Trekk av norsk landbruk i 150 år. Oslo: Bøndenes forlag. In Norwegian.
Tveite. (1974). Review: The Lessons of Norwegian Agrarian History: A Review Article. Reviewed Work: *Jord og Gjerning. Trekk av Norsk Landbruk i 150 år. Det Kngl. Selscap for Norges Vel, 1809–1959 (Land and Work. An Outline of Norwegian Agriculture over 150 Years: The Royal Agricultural Society of Norway, 1809–1959)* by Stein.
VG. (1960). Russerne foran oss i reindriften, Norsk delegasjon tilbake fra studiereise til samedistriktene på Kola-halvøya. 16 June, The Russians ahead of us in the reindeer herding, the Norwegian delegation back from a study trip to the Sami districts on the Kola Peninsula. 16 June, Newspaper article in Norwegian.
Vorren, Ø. (1946). Reindriften i Norge. *Norsk Geografisk Tidsskrift – Norwegian Journal of Geography, 11*(5–6), 199–220. https://doi.org/10.1080/00291954608551627
Vostryakov, P. N. (1968a). Reindeer farming in Norway, The Naryana Vynder 5 March 46, Newspaper article in Russian.
Vostryakov, P. N. (1968b). Reindeer farming in Norway, The Naryana Vynder 6 March 47, Newspaper article in Russian.
Vostryakov P. N., & Mezhetskiy A. A. (1968). Olenevodstvo v Norvegii [Reindeer Husbandry in Norway]. 50 pp. Востряков П. Н., & Межецкий А.А. (1968). Оленеводство в Норвегии. М. 50с.
Wikman, Å., Persson, S., Nordkvist, M. (1967). Renskötsel och renforskning i Soviet Union (in-tryck från en studieresa under tiden 30/11-14/12 1965.). – *Kungl. Lantbruksstyrelsen meddelanden,serie B,* Lantbruksavdelingen, 69: 1–2.
Yuzhakov, A. A. (2004). *Nenets aboriginal breed of reindeer. Dissertation for competition doctoral degree agricultural science*. Yamal Agricultural experimental station Russian Academy of Agricultural Sciences Siberian branch UDC 636.294.082.

Chapter 5
Reindeer Herding in Norway: Cyclicality and Permanent Change vs. Governmental Rigidities

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Abstract Reindeer herding is a complex, highly mobile, and environmentally adaptive form of livestock management, and a traditional way of life, practiced by indigenous peoples across the circumpolar Arctic. Given its distinctive characteristics, appropriate economic governance and regulation of the practice demands a clear understanding of its social, cultural, and environmental characteristics. In the following, we outline some of these and discuss their implications for economic management of the practice, with reference to the case of Norway in the late twentieth and early twenty-first centuries. In closing, we identify some key current threats and challenges that confront reindeer herding and present some suggestions for enhancing its economic viability and resilience, based on a strategy of revitalizing core economic and social mechanisms.

Keywords Pastoralism · Reindeer economics · Governance

5.1 Introduction

Reindeer herding has been practiced in the indigenous Sámi areas of Scandinavia and Russia for centuries. Over time, the gradual solidification of national borders in the region – the border treaty between Norway and Sweden in 1751 and the border closure with Finland in 1852 – has divided the Sámi territories, creating distinct legislative and administrative regimes and thus leading reindeer pastoralism to move toward nationally distinctive forms in each country. In Norway, implementation of the first Reindeer Herding Agreement (1976) and the new Reindeer Herding Act (1978) continued an integration of reindeer pastoralism into the national

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agricultural framework, a management regime based on principles of centralization, economic planning, industrialization, and scientific rationalization. Within this framework, the reform and restructuring of indigenous pastoralism unfolded along lines that were sometimes ethnocentric – by importing organizational or administrative concepts from other agricultural sectors, for example, or by "optimizing" herd structures in line with narrowly defined parameters for productivity that disregarded traditional indigenous knowledge of herd composition (Bjørklund, 2004).

Within a framework dominated by naturalized assumptions based on practices from sedentary agriculture, reindeer pastoralism has tended to appear as a sub-par, highly inefficient form of livestock ranching, governed with limited attention to the complex social, economic, and environmental characteristics that distinguish it. Given the challenges of climate change, land encroachment, and predator population management, a continuing lack of clear understanding of reindeer pastoralism from national authorities has been pinpointed as a main threat to Sámi reindeer herding in Norway (Benjaminsen et al., 2016). Impacts on reindeer herding from multiple drivers of environmental and social changes are exacerbated by indigenous peoples' lack of voice in governance strategies, management, and adaptation responses (Eira et al., 2018). The management models for Sámi reindeer herding that were implemented in Norway in the 1970s did not include reindeer herders' traditional knowledge as a basis for decisions and management (Eira et al., 2018), and still today, traditional knowledge is deprioritized in public management in favor of scientific knowledge and notions of rationality and practicality (Turi, 2016). Presently, as a result of a series of complex trends – including social, technological, and environmental change, shifting demographics, and increased reliance on mechanized transport and fossil fuels – Sámi reindeer herding in Norway finds itself at a precarious juncture, where administrative interventions have rewritten practice, amplifying and sometimes even creating the very problems they were designed to prevent.

As a consequence of the factors mentioned above – and due to comments from referees – the authors would at this point like to flag that their chapter is critical to the policies that have been pursued by the Norwegian Ministry of Agriculture since the mid-1970s. Dr. Reinert, who was invited to take part in annual negotiations between the Reindeer Herders' Association (NRL) and the Norwegian government in the early 2000s, was deeply disturbed by several issues during the meetings.

1. The extremely uneven balance of power in the negotiations. On one side of the table, the government was represented by seven ministries, and the Sámi Parliament and, on the other side of the table, NRL, which at the time had one full-time and one half-time employee and Dr. Reinert as a consultant, but otherwise very few resources at hand.
2. The lack of understanding of nomadism – which is an academic subfield in anthropology – on part of the government "experts," contributing to an eerie feeling of "internal colonialism" taking place.
3. The strong position of the national farmers' meat cooperative and monopoly (*Norsk Kjøtt*) in the government's delegation. Reindeer meat was the only competitor to *Norsk Kjøtt*, and the vested interest (Veblen, 1919) of the (ethnically Norwegian) farmers in *Norsk Kjøtt* toward the Sámi herders was seen by

Dr. Reinert as economic discrimination and evident structural racism. Statistics from the annual reports published by the Ministry of Agriculture itself in Fig. 5.1 shows the successful policy to drive down the price of reindeer meat as compared to the most expensive ethnic Norwegian meat (filet of beef). Figure 5.2, also with the data from the Ministry of Agriculture itself, shows how reindeer herding went from being an unusually profitable activity to being a loss-making one.

4. Rogue behavior. Mr. Aslak Eira, Chair of the NRL, expressed that "it is good that you are here, Erik, then they behave in a more civilized way. Last year they told us to leave the meeting room and gave us the choice between either by the window or by the door" (the meeting room was on the ground floor on the main governmental building in Oslo).
5. Ministry of Agriculture governing of these matters, through the Reindeer Herding Organisation (*Reindriftsforvaltningen*) in Alta, has alone in effect held all the powers which in democratic societies are consciously separated: legislative, executive, and judicial (Montesquieu, 1748/1977). *Reindriftsforvaltningen* makes the rules; they police the rules and also serve as the court of appeal. This profoundly undemocratic treatment of the national ethnic minority was reported to the Parliamentary Ombudsman in the early 2000s. After these sequences of events, Prof. Reinert vividly remembers the shame he felt by being a Norwegian.[1]

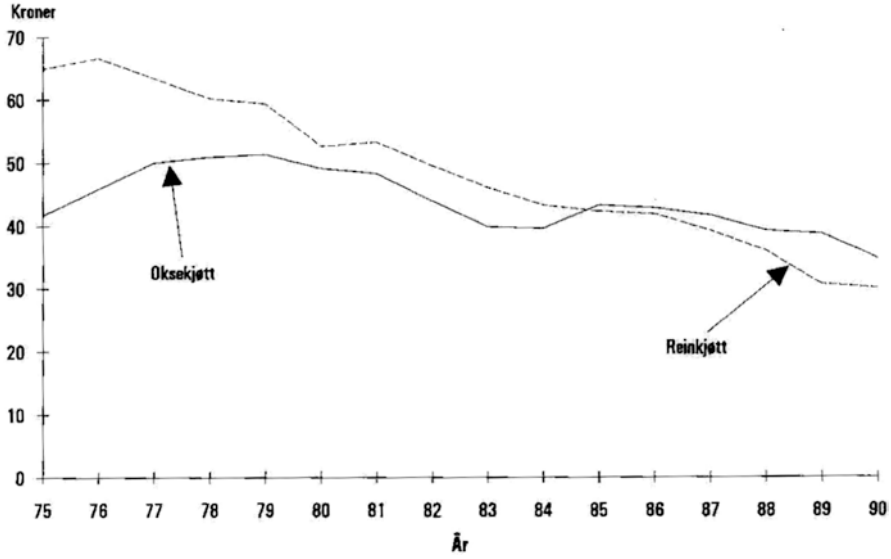

Fig. 5.1 Ethnic Norwegian beef wins the price war against reindeer meat. Oksekjøtt = beef, Reinkjøtt = reindeer meat. (Source: Totalregnskapet for Reindriftsnæringen, Oslo, Landbruksdepartementet, November 1992, page 10)

[1] Reinert's later studies of the much better reindeer management in Sweden and Finland only contributed to this feeling.

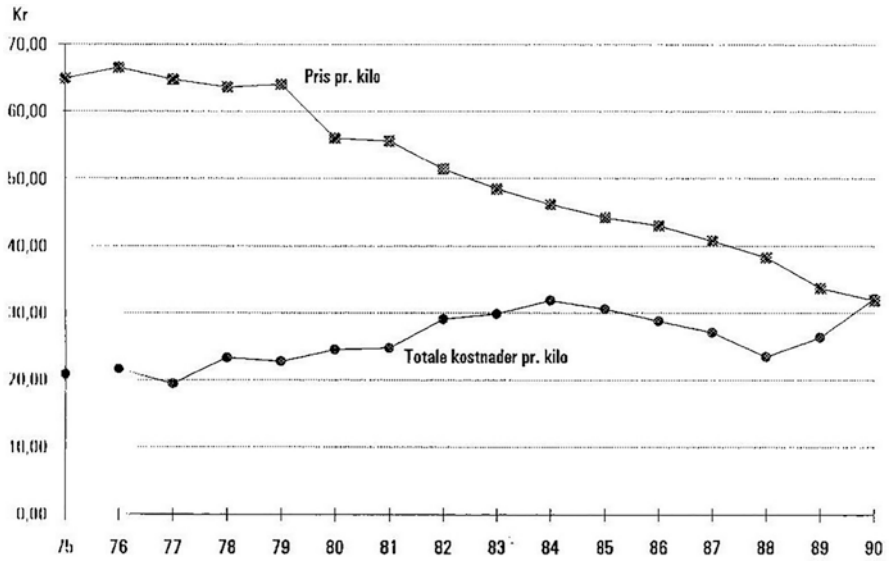

Fig. 5.2 1976–1990: Total costs per kilo produced compared to sales price. The policies of the Ministry of Agriculture (LMD) convert reindeer herding from an unusually profitable business to a loss-making one. (Source: *Totalregnskapet for Reindriften*. LMD, 1991. Numbers in fixed 1990 Norwegian kroner)

This led to an urge on his part to understand the context and situation of reindeer herders, which we shall now explore.

5.2 The Geographical and Climatic Context

Arctic reindeer pastoralism distinguishes itself from more "conventional" livestock industries in a number of key respects. Understanding how nomadic herding differs from conventional livestock production is a precondition for understanding the present problems of Norwegian reindeer herding, problems that are partly different from those of the herders in neighboring Sweden and Finland.

However, in order to understand the organization structure of the reindeer herders, it is necessary to understand the special geography and climatic context in which the Sámi operate. To illuminate this discussion, we shall now go into examples from other geographical areas and alternative theoretical frameworks (see also Reinert et al., 2009, 2010). When the European explorers gradually came to understand the Americas, they found it somewhat contradictory that what to them looked like huge fertile prairies in North America had a relatively small population, while the seemingly inhospitable Andes probably had the largest population density on the whole continent.

A good explanation for the high population density is found in the landscape ecology of extreme climates as explained by German geographer Carl Troll

(1899–1975). Troll envisioned a world consisting of a huge number of ecological niches, and with differences in altitudes, these would form what he called landscape belts (*Landschaftsgürtel*). On the prairies, one could travel weeks inside the same climatic niche, while in mountainous areas like the Andes, very different ecological niches – like those fit for growing cotton and those fit for growing potatoes – are found relatively near to each other (Troll, 1966).

Carl Troll's work was continued by anthropologist John Murra (1916–2006).[2] Studying a huge number of Peruvian court documents from colonial times and present annual migration patterns, Murra found that Peruvian labor had been highly mobile between the different ecological niches, sequentially following the seasons where harvests and other work were found. Murra developed the concept of a "vertical archipelago" of ecological niches that – due to the great variations in climate from sea level to more than 4.000 m above sea level – are relatively close to each other in terms of kilometers and travelling time (Murra, 1975). If we look at the cradle of European agricultural civilization – in places like Armenia and Georgia – we can observe the same short geographical distances between climate zones, e.g., between a climate suitable for cotton and a climate suitable for potatoes (seen in today's crops).

What the Arctic and sub-Arctic areas have in common with the Andes is often short distances between geographical niches. Travelling in Finnmark, one can observe sharp differences in temperatures. In summer, reindeer find the last patches of snow (*jassa*) where they are relatively free from insects. In our view, reindeer herding and the annual migrations must be understood in Murra's framework as a sequential usufruct of different ecological niches which – like in the Andes – are often close to each other (see Fig. 5.3).

Moving between different ecological niches is the key to traditional nomadism, also in the Andes and for the reindeer herders in Northern Eurasia. Moving according to where nature produces food (for animals and/or for people) is the very key to survival.[3] The more extreme the climate, the number of ecological niches needed to survive will increase. In other words, the more extreme the climate, the longer the annual migrations will tend to be. So, in Southern Norway, one would expect shorter migration routes than in Finnmark. Even before the recent changes in climate, the weather varied from year to year. The Sámi saying that "one year is not the other year's brother" means that pasture use will have to vary. Here administrative borders become a hindrance: during the problematic years when the ground froze over early, herders could in the old days move into the forests in Finland where the ground would not be frozen over with ice, as one example.

Later we shall show how "normal" climatic cycles have affected reindeer herding. Now, with a more unpredictable climate, herders would ideally need access to a larger number of ecological niches. However, the opposite is happening.

Temperature is of course important, but in Carl Troll's "geography of extreme climates," *one particular range of temperature*, the days of the year when the

[2] One of the authors, Reinert, studied under Murra at Cornell University.

[3] In this sense, the Sámi follow the advice of Francis Bacon in his *Novum Organum* (1620): "Nature, to be commanded, must be obeyed."

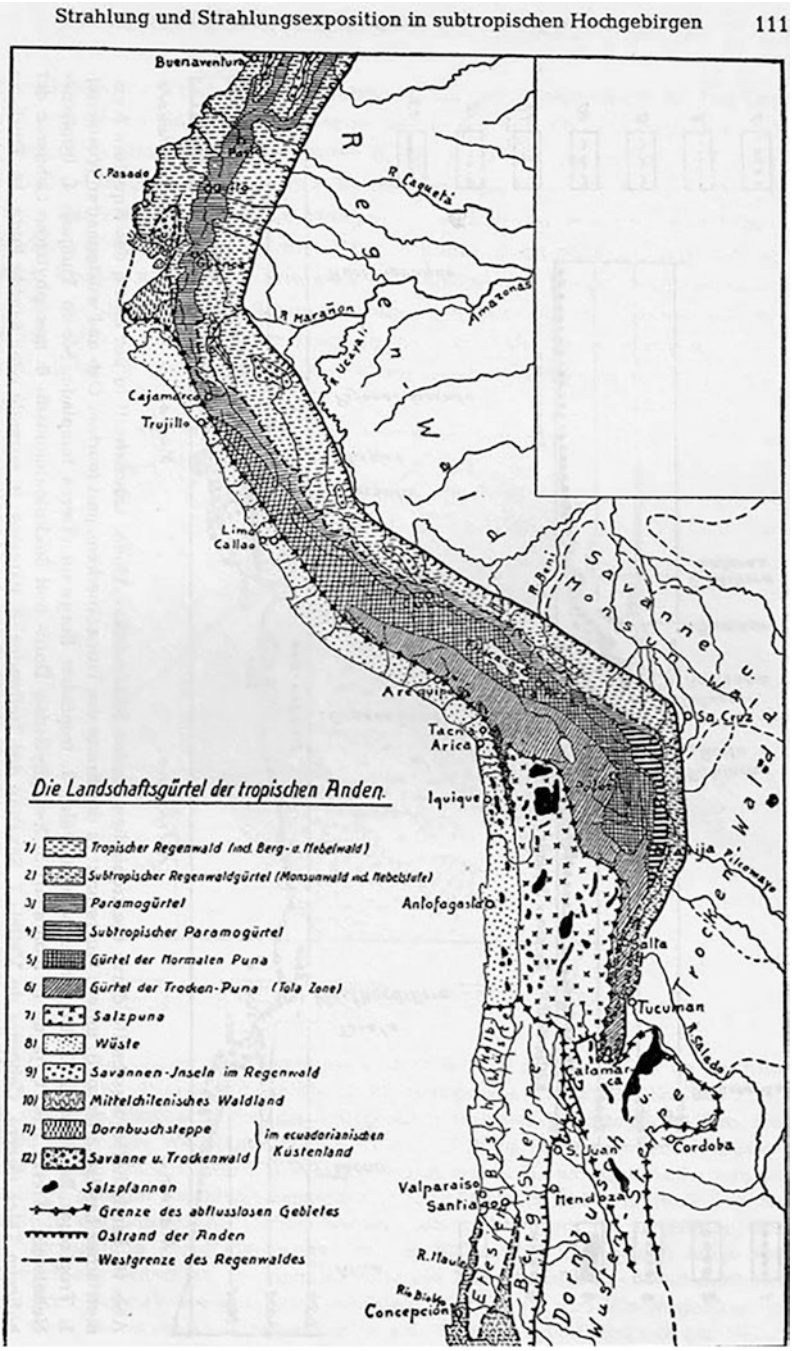

Fig. 5.3 The geographical proximity of widely different ecological niches (or landscape belts) in the Andes: the proximity of qualitatively different niches – from sea level to 4.000 m above sea level – allowed for a very high population density in the pre-Columbian cultures here.

temperature is both above and below zero during the same 24 hours, is crucial. Whether it is 20 or 30 below zero is normally not important; what German geographers refer to as *Frostwechselhäufigkeit* – how often you find freezing and thawing in the same 24 hours – is *extremely* important.

In the Andes, a high *Frostwechselhäufigkeit* would allow the production of freeze-dried potatoes (chuño), freezing the potatoes every night and subsequently drying them in the sun during daytime. It has been argued that the nutritional importance of *chuño* explains why the three main pre-Columbian cities in present Ecuador, Peru, and Bolivia all are located above 3.000 m: Quito, Cuzco, and the area around Lake Titicaca. At this altitude, the frequency of *Frostwechselhäufigkeit* is sufficient to make the production of *chuño* possible.

For reindeer herding – on the other hand – the phenomenon of *Frostwechselhäufigkeit* is normally a negative feature. It may lead to "locked pastures": ice layers could form in the snow, making it difficult – especially for the females and calves – to have access to the pastures under the ice. Sámi language holds several hundred terms for snow and snow conditions (Eira, 2012). For instance, the northern Sámi term *goavvi* refers to extremely bad grazing conditions (beyond simply bad winters) that cause starvation and loss of reindeer and subsequent negative impacts on herders' economy and organization (Eira et al., 2018). Interviews with elderly herders some 20 years ago indicated that the sharp drop in the number of reindeer that could be observed in 1931 (see Fig. 5.4) was due to early locked

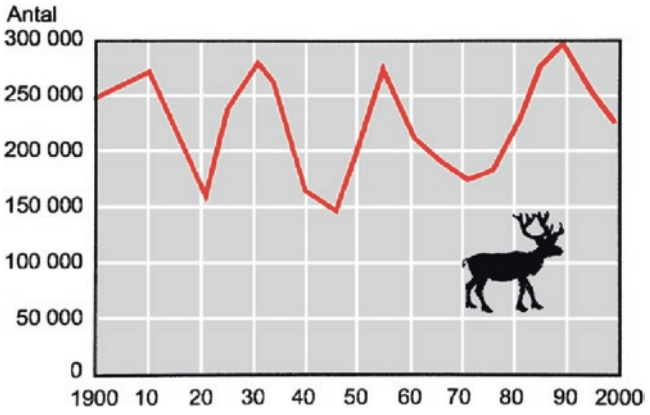

Fig. 5.4 The natural cyclicality of the reindeer population: number of reindeer in Sweden, 1900–2000. Norway only has reliable numbers for the latter decades, but the cycles here correspond to those found in Sweden. (Source: Statistics Sweden)

Fig. 5.3 (continued) Different products would dominate niches at different altitudes: fish and cotton near the sea level, fruits higher up, then maize and further up potatoes, and at the top level around 4.000 m *quinua,* a key crop related to millet (millet was an important crop in Europe before the arrival of potatoes and maize from the Americas), and the herding of different types of animals, llamas, alpacas, and vicuñas. In the Arctic, such ecological niches can be even closer together. The efficient management of herding across this "archipelago" of different ecological niches is *at the very core of reindeer herding.* (illustration Troll: 1931/1932, reproduced in Troll, 1966, p. 111)

pastures and to a year when most calves died. Understanding snow and snowchange are of paramount importance for reindeer herding under climate change with increasing extreme weather events, where a particular concern is that the frequency of *goavvi* seems to display an increase in some reindeer herding areas (Eira et al., 2018).

Under this heading of geographical and climatic context, we refer back to the problems listed initially, which in the view of the authors have led to a systematic mismanagement of reindeer herding in Norway. Completely ignoring that nomadism is actually an academic subdiscipline in the science of anthropology, the employees dealing with reindeer herding in the Norwegian Ministry of Agriculture (hereafter LMD) were largely graduates from the Norwegian School of Agricultural Sciences (now NMBU). Employing the logic of normal animal husbandry – with an almost complete lack of attention to the Arctic climatic context – several crucial factors were ignored. The fact that the one person who actually had a Ph.D. in reindeer husbandry had done his thesis based on data from the southernmost herders – around Lake Femunden – could lead to refusal to recognize the cyclical nature of the reindeer population.[4] Any student of ecology would know that the animal population – from lemmings to ptarmigan (a fowl) – is cyclical in Northern Norway. This was arguably in effect not recognized by the Ministry of Agriculture.

5.3 The Social Organization

Reindeer herding is essentially a pre-capitalist mode of production, a mode of production that has survived only in the most inhospitable climates of the planet, in the Arctic, in the extreme mountainous areas of the world, and in the deserts of Africa. Day-to-day interaction with a variable and capricious nature makes this mode of production the most sustainable anywhere: if all the amenities of modern life – from heat and electricity to modern communications – broke down, reindeer herders would likely be among the least affected in Norway. They could retire to the self-sufficiency of their old ways.

Karl Polanyi (1944) is the one who most efficiently has contrasted capitalism to pre-capitalist societies. The organizational units are extended family groups, in the Andes called *ayllu* and in Sámi called *siida.* Work inside a *siida* is divided and shared as a kind of *joint venture* inside a family group. In Norwegian, the traditional word *dugnad* renders something of the same idea. It is important to note that the ownership of reindeer is individual, but the management of the herd is done by the *siida* "joint venture." If the tasks so require, the *siida* can also be split according to seasons and conditions (Sara, 2001).

Karl Polanyi (1944) has pointed to what he calls the three *fictitious commodities* of capitalism that are all missing in pre-capitalist societies: *money*, *labor as a commodity*, and *private ownership of land.* This still today essentially applies inside the

[4] In fact, it has been found that the weight of reindeer calves in the southern areas varies according to the same pattern as does the number of animals in Finnmark.

Sámi production system, while their relationship with the outside world of course is organized according to the market system. Instead of land ownership, pre-capitalist societies – including the Sámi herders – have traditional and well-organized sequential usufruct of land. The different groups have the right to use the land at different times of the year.

Such climatic differences and variations are vital to understanding its conditions for productivity, and they also shape the scope of its interactions with the market. An appreciation of the manner in which reindeer herding is embedded in and interacts with its environment is an important first step. In the perspective of pre-capitalist cultures, reindeer herding is "normally" organized.

The elements for understanding an appropriate governance of reindeer herding encompass a wide range of factors: the mobility and autonomy of animals; the complex and variable risks presented by constantly shifting environments; the skill required to herd effectively within them; the structure of the herding year, which follows the reproductive cycle of the animals and concentrates reindeer meat production into seasonal peaks of availability; and so on (Reinert et al., 2009; 2010). Under this unpredictable reality, the concept of fuzzy logic can illustrate reindeer herders' decision making (Eira, 2012). The kind of knowledge needed to understand and manage reindeer herding is a type of knowledge which is not found in written form: much of it is what is scientifically called *traditional knowledge* or *tacit knowledge* which is accessible to the practitioners, as pointed out by Michael Polanyi (1966).

Reindeer are migratory animals, over which herders exercise a clear but yet limited degree of control. While one can see intensive livestock production as founded on an unlimited human control of the animals across time and space, with an underlying premise that man can control nature, reindeer pastoralism is at the other end of this scale: reindeer herding peoples have always known that they must work in collaboration with nature, not against it (Turi, in Oskal et al., 2009). Throughout the year, reindeer act with considerable autonomy with regard to (for example) finding suitable grazing, seeking shelter, defending themselves from predators, or moving to high ground to protect themselves from insects. Skilled human practice complements and guides the "semi-domesticated" animals, particularly at critical junctures, but does not supplant their agency – in other words, pastoralism differs fundamentally from agricultural practices based on close control and confinement of "captive" animal populations (Magga et al., 2001). The need for mobility and autonomy follows in large part from the complex and rapidly changing demands of Arctic environments and landscapes: an environmental variability that is encoded in traditional herder knowledge through maxims, proverbs, and anecdotes, but also through a complex technical language developed to describe, in great detail, the characteristics of environmental features such as snow (see Eira et al., 2018). Within such environments, a key skill of herding lies in identifying and making use of specific ecological niches that meet the shifting requirements of the herd (Reinert et al., 2009). This in turn demands an ongoing and finely tuned observation of pastures, temperature conditions, ice and snow qualities, weather systems, and wind directions – all factors which determine access to pastures and the behavior of the herd (Heikkilä, 2006). Such monitoring is particularly important on the winter pastures, where the availability of feed through snow becomes vital and where, under certain circumstances,

the ability to rapidly and precisely move a herd to the appropriate grazing grounds can determine life or death for a large number of animals. Qualities of the snow cover – such as density, hardness, and depth – are key to determining access to forage and therefore the suitability of winter grazing grounds (Tyler et al., 2007; Eira, 2012). These qualities in turn can vary rapidly and over short distances, depending on local landscape features, weather systems, and other factors (Sara, 2001).

Given mobile animals, rapidly changing conditions, and a high-risk environment, flexibility is a key dimension of pastoral practice, and sustaining such flexibility is a vital requirement for its continued development and future flourishing (Reinert et al., 2010). Such flexibility can take a range of forms – from the ability of individual herders to locate and utilize microclimatic niches, to their ability to control the composition of their herds and regulate the rate at which living animals are transformed into meat, to the flexible movement of labor in and out of the practice, including the ability to supplement incomes with alternative forms of employment during unfavorable periods and "bad years."

5.4 Nature and Social Organization vs. the Government

We initially referred to the problems of negotiating with the government. We elaborate on some of them in the bullet points below. One overriding problem, evident to an outsider, was that there were important cultural problems hindering effective communication between the ministerial bureaucrats and the Sámi herders. In Norway, like generally in Western Europe, it is assumed that silence in a negotiation is a sign of approval. Sámi culture, on the other hand, is more in line with the Japanese in this matter: it is impolite to openly disagree. A second basic problem is that the main Ministry (Agriculture) day-to-day management deals with the agricultural cooperatives, in the case of meat a national semi-monopoly (*Norsk Kjøtt*; see below), which is the main competitor for reindeer meat. That reindeer meat was more expensive than the best beef cuts appeared to be a problem for the farmers in *Norsk Kjøtt*, resulting in the mechanism described in bullet point one below:

- The insistence on a stable production and stable prices (in effect set by the LMD as in a planned economy) led to some years of "overproduction" and some years of "underproduction" compared to fairly stable demand. Prices were allowed to fall in years of high production, but only extremely slowly allowed to rise as production plummeted, reflecting the vested interest of *Norsk Kjøtt* (see Fig. 5.4 for the dynamics).
- Traditionally reindeer steak – from adult animals – was a luxury item among urban consumers. However, with the logic of minimizing the number of animals grazing in winter and maximising meat production, LMD started subsidizing the slaughtering of young calves, which impacted the product ranges and the quality of the meat in the eyes of the consumers.
- An extreme focus on females and calves led to a policy that would have been logical inside a barn: males were there only for reproduction processes. However, *Frostwechselhäufigkeit* would "lock" access to the pastures for calves and

females. Males – and especially the castrates – had the very important task of literally breaking the ice between the animals and the food below. However, the Norwegian government, by forcing the percentage of females up to 90%, made the flocks extremely vulnerable not only to "locked pastures" but also to predatory animals. The castrates kept their horns and were the "gentlemen of the tundra" who not only broke the ice and gave females and calves access to the rich food below but could also protect the herd from predatory animals.

- Although the Norwegian Ministry of Agriculture would never likely not admit to it, the almost systemic cultural miscommunication between the Ministry (LMD) – and consequently Norwegian society at large – and the Sámi herders in practice clearly boils down to a form of structural racism. The term of "locked pastures" was in Norwegian society at large normally translated as "overgrazing" (*overbeite*). Referring to Fig. 5.4, whether the number of reindeer was at their cyclical peak or their cyclical trough, the government mantra was always "too many reindeer on the tundra." Underlying the whole problem was a seemingly colonial type of economic relationship between the Sámi culture and the Norwegian Ministry of Agriculture (Reinert, 2007). In a historical international context, colonial ministries tended to have some knowledge of anthropology, and in the United States, in the similar Bureau of Indian Affairs, a Native American has traditionally been (at least) second in command. In Norway, the Ministry of Agriculture (LMD) has been given the *de facto* economic powers of a Colonial Office (cf. Reinert, Op.cit).[5] Traditionally, the unit in charge of reindeer herding has not spoken the native languages.

The Norwegian governance system for reindeer pastoralism presents a case of very strong bureaucratic centralization – seemingly more so than in other Scandinavian countries. In 2000, to supervise less than 600 individual herding units, the Norwegian Reindeer Herding Administration employed more than 50 people (Lie & Nygaard, 2000). This extensive administrative structure produces a constant flow of detailed and rapidly changing regulations. On one level, this extensive structure could provide a social and economic safety net for herders: a structure capable of providing support or subsidies in "bad years" and mitigating the negative economic impact of climatic change and extreme events. Currently, however, questions are raised as to the capacity of this system to do this: a joint letter from 34 of the 39 mayors of Troms and Finnmark County in Norway of March 23, 2020, to the Norwegian Minister of Agriculture pleads for emergency help, demanding that the Minister take responsibility to secure economic resources for reindeer herders given the current crisis observed with critical snow conditions (NRK Sápmi, 2020). On another level, incentive structures and subsidy systems can create patterns of dependence (Paine, 1977) and negative feedback cycles, both of which leave herders increasingly at the mercy of unpredictable shifts in policy, opinion, and

[5] Formally, the Sámi issues are under the *Ministry of Local Government and Modernisation*, but the key economic issues for the main economic activity of reindeer herding are under the *Ministry of Agriculture and Food* (LMD).

regulatory parameters – a particular concern in countries such as Norway, where reindeer pastoralism and Sámi interests have in large part been historically shaped by terms dictated by the shifting interests of central powers.

Embedded as it is in risky and unpredictable environments, the productivity of Arctic reindeer pastoralism is not easily reducible to straightforward projections or to simple economic formulas for optimization. In terms of meat production, for example, a particular herd structure may optimize annual yield by favoring fertile cows and minimizing the proportion of mature bulls, but the same structure may also weaken the ability of the herd to defend itself against predators or extreme snow conditions, thereby exposing herders to higher losses during difficult periods; similar issues arise with regard to other aspects of herding practice. Unlike livestock managers operating with artificial or controlled environments, pastoralists must account with a range of variables that lie beyond their direct control, predators, weather, climate, and snow patterns, all of which may affect the annual productivity and meat output of their practice, in ways that are difficult to predict. Putting it simply, a key corollary of this embedding of pastoralism in variable environments is *variable productivity* – that is to say, an inherent irregularity in meat production and supply.

Within a given year, this variability is given primarily by the animals' annual cycle of migrations and calving, which dictates that slaughter takes place only at certain times of the year, generally during autumn and winter roundups: during the rest of the year, the animals may be busy mating, bulking up for the winter, or calving, and rounding them up would be unduly disruptive. This makes the availability of fresh reindeer meat seasonal, a function of cycles that are not (and cannot be) artificially manipulated. Therefore, another key trait of reindeer pastoralist production is *seasonality*. Between years, furthermore, the meat output of the industry cannot easily be projected as an annual constant. Herd sizes and animal health vary from year to year, according to environmental and human variables; decisions concerning which and how many animals to slaughter are also made (and changed) on the basis of the long-term objectives, the cash requirements of individual herders or the district, the overall condition of the herd, the estimates concerning coming years, the fluctuations of the market, the important life events, and so on. Environmental constraints and non-market considerations thus make the supply curve for reindeer meat irregular – with production peaking at certain times of the year and an oscillating annual output dependent on conditions that may range from the overall state of grazing access through snow to the degree of financial insecurity perceived within the industry.

Running directly against this, a key goal of successive Norwegian administrations has been precisely to *regulate* the meat production in reindeer herding: to ensure social, economic, and ecological stability by stabilizing the meat outputs of the reindeer industry at a predictable level (Reinert, 2006). This pressing demand for a relatively stable meat output – both within 1 year and between years – limits the choices of herders and constrains their options to slaughter fewer animals in a given year. We suggest that this aim is based on a theoretical misrepresentation of the variability and cyclicality of reindeer pastoralism as a practice embedded in a

complex, rapidly shifting, and high-risk environment – ill-informed at best, dangerous at worst.

As we indicated, a key point of reindeer pastoral productivity is that it functions in close coupling with a set of highly variable environmental conditions – and that its production is therefore also necessarily variable. Given a more or less regular level of demand, sustained from year to year, such variability generates two kinds of crisis: a crisis of *overproduction* at peak productivity and a crisis of *underproduction* at the point of minimum productivity. In the former type of crisis, reindeer numbers are large, mortality is low, and high annual production exceeds the capacity of the market to absorb products; during the latter, mortality may be high, the animals weak, and losses to predatory animals at a peak: whatever the reason, slaughtering is limited, and the amount of meat that reaches the market is significantly below rates for a "normal" year. At minimum production, the volume available for sale is very low; at the peaks, conversely, production exceeds normal demand. In a normal market situation, low production volume or underproduction would increase the unit price and thereby compensate producers. In cases of overproduction, similarly, prices per unit of production would fall as production exceeded demand. In resource-based industries such as agriculture, fishing,[6] or mining, market forces may thus cause total production *value* to peak when production *volume* is at its lowest. In the Norwegian administration of reindeer herding, however, such mechanisms were effectively neutralized – often, by the very policies designed to support the industry (Reinert, 2006; Reinert et al., 2009).

Today there exists no theoretical-empirical economic model adapted or genuinely suitable for reindeer herding as a traditional, family-based, indigenous, nomadic livelihood in cyclical and highly variable natural environments (Pogodaev & Oskal, 2015). Still against this backdrop, reindeer herding management authorities insist on detailed regulations and control of operational reindeer herding practices, e.g., herd structure, a focus on slaughtering of calves, reindeer herding district usage rules, reindeer counting, and so on.

There could be a vicious circle at work here. The government's lack of understanding of the basic nature of reindeer herding – and any resulting frustration as measures do not work as envisioned – leads to an urge to manage in detail. The basic inability of the government system to recognize the natural cyclicality of reindeer herds is at the core of the problem. Rejecting traditional knowledge as "superstition," for the Ministry in Oslo with their background in normal agriculture, the herds of the tundra to them appear to be a disorganized barn. Regardless of the position in the cycle – see Fig. 5.4 – to LMD there are always "too many reindeer on the tundra." Historically versed in dealing with an unpredictable nature, the herders now also had to deal with an unpredictable government. On the one hand, to attempt to govern something you don't understand is a serious matter. Medieval philosophers thought about the importance of *docta ignorantia*, being aware of

[6] A previous employee at the Norwegian Ministry of Fisheries wisely suggested that reindeer herding should be transferred from the Ministry of Agriculture to the Ministry of Fisheries, a ministry where the management of a highly variable resource base was at the core of their activity.

what you do not know. There, however, seems to be few signs of this in the Norwegian government organization on this issue. Rather the situation at times reminds one of what US author Upton Sinclair described in 1934: "It is difficult to get a man to understand something, when his salary depends on his not understanding it."

It was the national states that started public management of reindeer herding, which up until that point had essentially been a fully self-managed system, a system which had been present in Scandinavia since before national borders were drawn in the North (Fig. 5.5). In Norway, this management was introduced through different legal and economic instruments from especially the latter part of the 1800s (the assimilation period), the latest of which include the Reindeer Act of 1933, the Reindeer Herding Agreement System of 1976, the Reindeer Act of 1978, and the Reindeer Act of 2007.

We now suggest, it is rather about time to understand reindeer herding for what it really is, namely, a family-based, indigenous, nomadic, pastoral way of life, and a system especially adapted to utilizing marginal resources under cyclicality and constant variability.

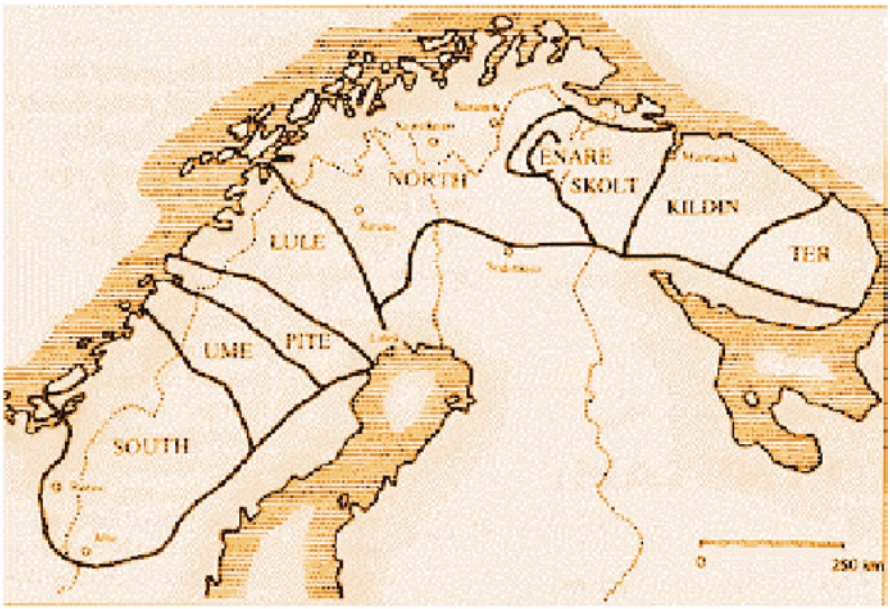

Fig. 5.5 Map showing the Sámi ethnic language groups in Northern Fennoscandia and on the Russian Kola Peninsula. The linguistic groups largely correspond to the migration areas, from the summer pastures on the coast to the winter pastures in the inland. Just like in Africa, the borders of the Nordic nation-states in the Nordic countries (dotted lines mark) came to divide the ethnic groups. This created challenges to the herders, but to which subsequent adaptation took place

5.5 The Negative Effects of Government Intervention

In 2000 and 2001, one of the authors undertook a study of profitability in the Norwegian reindeer industry, on behalf of the Ministry of Agriculture, which illustrates important points in the development of economic governance of reindeer herding. An early finding in this study was that the reindeer meat market appeared to be organized around a remarkable two-tier price system (Reinert, 2006; also Reinert, 2002). Most herders were selling their animals to so-called listed slaughterhouses, ensuring their own eligibility for subsidies in return for a price of about 42 kroner per kilo on the hoof. Other herders, on the other hand, were able to operate outside the subsidy system and sell on the open market, obtaining a price of more than 60 kroner per kilo for their own slaughtered meat – 50% more than herders operating within the subsidy system. To an external observer, particularly one trained in economics, this was a peculiar, even astonishing situation – particularly so, given the perception of reindeer herding in Norway as a highly subsidized indigenous industry, supposedly sustained through a large support apparatus (Fig. 5.1).

In 2000, the first-hand market value of reindeer meat produced in Norway was about 70 million Norwegian kroner (Reinert, 2006). At the time, there were approximately 550 individual production units within the Sámi reindeer herding areas, all under the supervision and management of the Reindeer Herding Administration, or *Reindriftsforvaltningen* – which employed around 50 people, with an annual budget of over 40 million Norwegian kroner and reporting to the Ministry of Agriculture (Lie & Nygaard, 2000). In addition, the annually negotiated agreement between reindeer herding and the state had at the time a base budget of 80 million, with an additional 25 million kroner earmarked for reindeer herding over the budget of the Ministry of Environment. Direct annual government expenditures on reindeer herding thus added up to 140 million kroner – or approximately twice the value of the first-hand production in the reindeer herding industry. As late as 1976, with a minimum of government intervention or subsidies, reindeer herding had been a very profitable activity (see Fig. 5.2). Despite very high levels of government subsidy and a large public support, a quarter century later, this once-profitable indigenous industry was now operating with huge losses. Several questions lingered: How had this come to pass? If reindeer herding was so highly subsidized, where were these subsidies going? Who were they benefitting? What were the underlying causes?

We trace the problem back to the late 1970s, when reindeer herding and reindeer meat production in Norway first came under direct government control, through the regulatory framework of the Reindeer Herding Act (1978) and the first annual Reindeer Herding Agreement (1976), negotiated between herders and the Norwegian state. In Norway, relations between the government and the national agricultural sector are regulated through an annually negotiated agreement that defines the economic framework and subsidies for the sector – including also the so-called target prices [*målpriser*] for agricultural products. In 1976, drawing on this model, the first Reindeer Herding Agreement was set up between the government and the Norwegian Sámi Reindeer Herders' Association (*Norske Reindriftssamers Landsforbund* or

NRL). Establishing policy objectives, an economic framework, and subsidy parameters, including "target prices" for reindeer meat, this agreement repositioned reindeer pastoralism within the context of Norwegian post-war agricultural policy – a policy context that had been shaped, in no small part, by the twentieth-century project to equalize the market power of agriculture compared to industry and manufacturing, in the wake of the disastrous financial crisis of the 1930s (Reinert, 2006). Norwegian agriculture was historically composed of small units of primary production, but the twentieth century saw a concerted push toward achieving economies of scale in processing and distribution – both of which were managed as mass production systems, characterized by centralization and product standardization. Over the decades following the first Reindeer Herding Agreement, this orientation toward centralized mass production was applied to reindeer pastoralism, with problematic effects.

In the case of meat and meat products, the cooperative that managed and coordinated the production system was the Norwegian Office for Meat and Lard (*Norges Kjøtt- og Fleskesentral*) – established in 1931 – which subsequently became *Norsk Kjøtt* in 1990 and *Nortura* in 2006. Soon after the first Reindeer Herding Agreement was signed, faced with increasing volumes of reindeer meat, the Norwegian Ministry of Agriculture delegated responsibility for marketing reindeer meat to this cooperative. Representatives from the cooperative were initially well received by the reindeer herders: they paid promptly and were easy to deal with. According to former employees of the cooperative, however, reindeer meat was at the time considered a competitor against the upper end of the beef market and, thus, a rival to the interests of the farmers who owned and ran the cooperative. Responsibility for reindeer meat had been forced on the cooperative by the Ministry of Agriculture: the herders, whose meat production comprised less than 2% of total domestic red meat volume, found that the government in essence had handed over their marketing to a competitor that dominated the remaining 98% of the market.

With no or little incentive for key actors to market reindeer meat, the stores of frozen meat started to mount, and with this came escalating storage costs. The Ministry of Agriculture intervened, using subsidies to effectively give the meat farmers' cooperative a blank check to store – rather than sell – the frozen meat of their competitors. Subsidized in this fashion, the stores of accumulated meat continued to grow. Year after year, at the annual agreement negotiations, herders heard the same story: there was too much reindeer meat in stock; therefore, the negotiated "target price" for reindeer meat must be reduced. This "target price" slowly became the only price paid for reindeer meat, and over time, the sums paid to Norsk Kjøtt for the costs of freezing the growing mountain of unsold reindeer meat – paid from the annual sum of subsidies granted to the herders by Parliament over the terms of the agreement – reached enormous proportions, sometimes up to half the first-hand market value of annual meat production in the industry. Within the incentive structure produced by government policy, freezing and storing reindeer meat may well have been more profitable than marketing and selling the same meat. Another mechanism thus institutionalized was shaking off the competition for the key players,

introducing the danger of price dumping as a key risk for any new actors wanting to enter the industry as a real barrier to entry, and also impacting existing actors.

As the reindeer herders started to lose money, the Norwegian government responded by establishing arguably what were effectively social welfare programs, granting subsidies based on the volume of meat produced while at the same time continuing to subsidize the storage of frozen meat. In order to keep reindeer numbers in check and prevent claimed overgrazing, such social payments were tied to slaughtering animals; to avoid fraud – i.e., herders counting the same slaughtered animal twice – an elaborate control system was set up that required the individually marked ears of slaughtered animals to be kept in frozen storage for months, subject to auditing by the Reindeer Herding Administration. A "double entry" bookkeeping system was thus established that kept track of all reindeer slaughtered in Norway. As a further layer of security against fraud, subsidies were only disbursed for reindeer slaughtered at state-approved slaughterhouses – i.e., the so-called *listeførte slakterier* or listed slaughterhouses. Herders who slaughtered at these slaughterhouses were paid only the low "target price" – forcing herders who depended on subsidies to sell their meat cheaply, while some herders, whose herds were sufficiently large to operate independently of government subsidies, could slaughter their reindeer independently and sell their meat locally at much higher prices. In this manner, the "listed slaughterhouses" could acquire reindeer meat cheaply and made money with little marketing effort – not least, through government payments for storing what reindeer meat they themselves did not sell. Government policy thus effectively created a *monopsony* – a monopoly on purchasing, supported by the government subsidy to herders, but controlled largely by non-Sámi actors. The government had uncoupled supply from demand, inserting itself as a "buffer" between the reindeer meat production chain and the market.

In 2002 – 26 years after the first Reindeer Herding Agreement – an estimated 80% of all reindeer in Sweden and Finland were slaughtered in establishments owned and controlled by herders. In Norway, the figure was approximately 20% (Reinert, 2002). In Norway, government interventions had let the farmers' organization – *Norsk Kjøtt* – take over the part of the value chain where most of the value added was to be found: slaughtering, partitioning, branding, and marketing. The reindeer herders had been decoupled from the market and the end users, and in effect, control had been passed over to the farmers' meat cooperative that managed the reindeer meat value chain to serve its own interests, often against the interests of the herders. When these restrictive measures were combined with the rapid escalation of new hygienic requirements for commercial slaughter from the 1970s onward, herders were effectively excluded from their own value chain, losing control over their own means of production, and were reduced to suppliers of raw material for slaughterhouse operators. The function of slaughter and meat elaboration in Norwegian reindeer herding, both as key elements of pastoral culture *and* as vital sources of profit, had been severely diminished. Possible ways out of this situation needs to be explored, which we will now turn to.

5.6 Challenges and Opportunities

During the last quarter of the twentieth century, the economic policies of the Norwegian government with regard to herding present a clear example of governance that was completely – and for some, catastrophically – at odds with the logic of herding, particularly with its ecological determinations. While most forms of agricultural meat production in Norway take place within stable, regulated environments – shielded from environmental variability or its effects – reindeer herding does not. Extrapolating the logic of stable and predictable outputs from other sectors, based on highly controlled production conditions, the Norwegian government implemented an inflexible "planned economy" that failed to take into account inherent variability in the practice they were regulating – separating the "target price" for reindeer meat from oscillations in productivity, but not to the advantage of the herding industry. An industry defined by its variable environment, and the resulting variable productivity, had been managed through a pricing regime premised on stability, which kept unit prices fixed independently of supply or demand. Rather than offsetting the negative aspects of a variable productivity, Norwegian economic policies thus *amplified* their effects, disconnecting the market mechanisms that could have mitigated the problems. Instead, the policies imposed by the government added to the economic vulnerabilities.

Compliance with the requirements of the state subsidy system forced herders to sell at prices far below the market rate – "subsidies" earmarked for indigenous herders were thus effectively channeled to non-indigenous operators in the meat industry. Over the span of a quarter century, government policy thus converged with broader trends – social, technological, economic – to shift reindeer pastoralism from a position of affluence and relative strength to one of relative poverty and dependence on state mechanisms of support.

As we suggested at the outset, the position of reindeer herding today is precarious – not least, because the inherent variability of the practice is still poorly acknowledged. Climatic variations are discussed primarily as random events causing occasional "crises" in an environment otherwise presumed stable. This problem is compounded by the fact that the two structurally distinct kinds of economic crises that reindeer herding is subject to – underproduction and overproduction – tend not to be clearly distinguished in Norwegian public discourse. One effect of this is to create the impression of an industry in a continuous state of crisis, an effect that is further accentuated by the tendency to define and operationalize "sustainability" as a fixed, stable number of reindeer, marking deviations from this number as a problem of responsibility – leading to a phenomenon we would term "cyclic irresponsibility," as environmental fluctuations lead to regular "crises" and accusations against herders. Many of the changes that have taken place in the last few decades are irreversible, or very likely so. Some of them, however, are not. Here, in closing, we review some possible strategies for improving the economic situation of reindeer herding, centering on the notion of revitalizing core mechanisms and institutions of pastoral practice.

Reclaiming the Value Chain Perhaps the most important effect of government intervention since the late 1970s has been to exclude most herders in Norway from the value chain of their own products, reducing them to providers of raw material within a commodity chain dominated by other actors. While there are exceptions, this remains the overall picture of the industry. Measures against this "colonial" situation – where the reindeer herders supply raw material on hoof – are a continued support of field and small-scale abattoirs, adaptive regulation designed to support local value generation, and systematic support for "alternative" products, e.g., traditional smoked meats. This will also increase financial returns on slaughter for individual herders, thereby incentivizing animal outtake and contributing to the stated government aim of increasing slaughter rates in the industry.

Localize Markets Some of the negative social trends in recent years are linked to the disappearance of local reindeer meat sales and markets. This is a complex trend, which encompasses a range of factors – government-driven centralization, the industrialization of meat production, increasingly severe hygiene regulations, and enforced control of the market circulation of meat products – but the effects have been clear. With the loss of direct-to-consumer sales, reindeer herders also lost a key mechanism for establishing and maintaining personal social relations with local non-herders: with this loss have come increasing social distance, hostility, accusations, and escalating of conflict levels in herding areas. As a corollary of developing herder control over the later stages of the reindeer meat value chain, establishing a visible presence for reindeer herders as local providers of reindeer-based commodities will likely help consolidate relations, create social cohesion, and reduce social conflicts currently associated with pastoralism.

Revive Existing Mechanisms On a related note, as a dimension of utilizing economic transactions to build local social integration, it may be useful to examine (with an eye to reviving) the relatively neglected institution of *verdde* –traditionally a form of close alliance or friendship between herders and non-herders which involved the exchange of favors and goods. An aspect of this institution involved non-herders, often coastal Sámi, owning a small number of reindeer in the herds of their herding *verdde* partners, a practice which was rendered problematic by the introduction of regulations that prohibited the ownership of reindeer by non-herders (Bjørklund & Eidheim, 1999) – again, an unintended consequence of measures ostensibly designed to support the industry. The institution nonetheless survives, on an informal level, but as a pathway to strengthening local relations between herders and non-herders, and reducing conflict, it may be relevant to explore options for reviving this and similar institutions (Reinert et al., 2010).

Decentralize Control As the case of state (mis)management in Norway makes clear, centralized top-down control has not served the interests of reindeer pastoralism particularly well – herders are in some ways much like their reindeer, better left to manage for themselves. In Sweden and Finland – where the market forces have been allowed to rule more than in Norway – the herders themselves do most of the

slaughtering. In an interview with the managing director of Polarica/Norrfrys – a main player in the Swedish market for reindeer – he claimed that the herders could slaughter much more efficiently than his company would be able to do. To this can be added that the herders – when they are allowed to slaughter themselves – utilize virtually every fiber of the animal: an important consideration in times of ecological awareness.

Reindeer meat has every possibility to become a luxury food, as it used to be in Oslo 50 years ago when the steaks still had the traditional quality. An indigenous cookbook supported by the Arctic Council won the 22nd annual Gourmand World Cookbook for "Best Book of the Year in All Categories" in 2018, and in 2020 *The New York Times* article highlighted reindeer meat as follows: "Reindeer meat is lean and as mild as veal, clean and delicate, tasting of pastures and mountain springs."

If the herders themselves again can get control over the value chain, there are many possibilities for marketing this healthy and exotic product. In the Swiss and Italian Alps, dried meat – called, respectively, *Bündnerfleisch* and *Bresaola* – command high prices. In a test with Italian cooks and restaurant owners, dried Norwegian reindeer meat received an enthusiastic welcome.

Reindeer herding is a traditional, indigenous family-based way of life, based on utilization of marginal resources under cyclicality and ever-changing natural conditions. If the Norwegian government lets go of its basically 'colonial' practices and gives the most profitable part of the value chain back to the herders, reindeer herding can have a great and sustainable future.

References

Bacon, F. (1620). *Novum Organum*. Apud Joannem Billium.

Benjaminsen, T. A., Eira, I. M. G., & Sara, M. N. (Eds.). (2016). *Samisk reindrift, norske myter*. Fagbokforlaget.

Bjørklund, I. (2004). Saami pastoral Society in Northern Norway: The National Integration of an indigenous management system. In D. Anderson & M. Nuttall (Eds.), *Cultivating arctic landscapes*. Berghahn Books.

Bjørklund, I., & Eidheim, H. (1999). Om reinmerker – kulturelle sammenhenger og norsk jus i Sapmi. In I. Bjørklund (Ed.), *Norsk ressursforvaltning og Sámiske rettsforhold*. Ad Notam.

Eira, I. M. G. (2012). Muohttaga Jávohis Giella: Sámi Árbevirolaš Máhttu Muohttaga Birra Dálkkádatrievdanáiggis (The silent language of snow: Sámi traditional knowledge of snow in times of climate change). University of Tromsø.

Eira, I. M. G., Mathiesen, S. D., Oskal, A., & Hanssen-Bauer, I. (2018). Snow cover and the loss of traditional indigenous knowledge. *Nature Climate Change, 8*, 928–931.

Heikkilä, L. (2006). The comparison in indigenous and scientific perceptions of reindeer management. In Forbes et al., pp. 73–93.

Lie, I., & Nygaard, V. (2000). Reindriftsforvaltningen: En evaluering av organisasjon og virksomhet. *NIBR Prosjektrapport* 16.

Magga, O. H., Oskal, N., & Sara, M.N. (2001). Dyrevelferd i Sámisk Kultur. Report by Sámi allaskuvla/Sámisk høgskole [http://www.regjeringen.no/nb/dep/lmd/dok/rapporter-og-planer/rapporter/2001/dyrevelferd-i-Sámi sk-kultur.html. Accessed 21 Aug 2012].

Montesquieu. (1748/1977). In D. W. Carrithers (Ed.), *The spirit of the laws: A compendium of the first English edition*. University of California Press.

Murra, J. (1975). El «control vertical» de un máximo de pisos ecológicos en las sociedades andinas. In J. Murra (Ed.), *Formaciones económicas y políticas del mundo andino*. Lima.

NRK Sápmi. (2020). Ordførere med desperat rop om hjelp til landbruksministeren. News story including referred letter, published March 23, 2020, by the Norwegian Broadcasting Corporation, Sámi News, NRK Sápmi. https://www.nrk.no/sapmi/34-ordforere-med-desperat-rop-om-hjelp-til-landbruksministeren-1.14957066

Oskal, A., Turi, J. M., Mathiesen, S. D., & Burgess, P. (2009). EALÁT. Reindeer herders voice: Reindeer herding, traditional knowledge and adaptation to climate change and loss of grazing lands.

Paine, R. (1977). *The white Arctic – Essays on tutelage and ethnicity*. Memorial University of Newfoundland.

Pogodaev, M., & Oskal, A. (2015). *Youth – The future of reindeer herding peoples.* Arctic council ministerial meeting deliverable report, by sustainable development working group, Association of World Reindeer Herders and International Centre for Reindeer Husbandry. Final report from the Arctic council EALLIN reindeer herding youth project 2012–2015, 123 pages. International Centre for Reindeer Husbandry, Guovdageaidnu/ Kautokeino, Norway.

Polanyi, K. (1944). *The great transformation*. Beacon Press.

Polanyi, M. (1966). *The tacit dimension*. Routledge.

Reinert, E. (2002). *Reinkjøtt: Natur, Politikk, Makt og Marked*. SND.

Reinert, E. (2006). The economics of reindeer herding. Sámi entrepreneurship between cyclical sustainability and the powers of state and oligopoly. *British Food Journal, 108*, 522–540.

Reinert, R. (2007). *How rich countries got rich and why poor countries stay poor* (Vol. 94). Constable.

Reinert, E., Reinert, H., Mathiesen, S., Aslaksen, I., Eira, I., & Turi, E. I. (2009). Adapting to climate change in reindeer herding – The nation-state as problem and solution. In I. Lorenzoni (Ed.), *Living with climate change: Are there limits to adaptation?* Cambridge University Press.

Reinert, H., Mathiesen, S., & Reinert, E. (2010). Climate change and pastoral flexibility. In G. Winther (Ed.), *The political economy of northern regional development*. Nordic Council of Ministers.

Sara, M. N. (2001). *Reinen – et Gode fra Vinden*. Davvi Girji.

Troll, C. (1931). Die geographische Grundlage der Andinen Kulturen und des Inkareiches. *Ibero-Amerikanisches Archiv, 5*, 1–37.

Troll, C. (1966). *Ökologische Landschaftsforschung und vergleichende Hochgebirgsforschung*. Steiner.

Turi, E. I. (2016). *State steering and traditional ecological knowledge in reindeer herding governance: Cases from Western Finnmark, Norway and Yamal, Russia*. Umeå University.

Tyler, N. J. C., Turi, J. M., Sundset, M. A., Bull, K. S., Sara, M. N., Reinert, E., Oskal, N., Nellemann, C., McCarthy, J. J., Mathiesen, S. D., Martello, M. L., Magga, O. H., Hovelsrud, G. K., Hanssen-Bauer, I., Eira, N. I., Eira, I. M. G., & Corell, R. W. (2007). Sámi reindeer pastoralism under climate change: Applying a generalized framework for vulnerability studies to a sub-arctic social-ecological system. *Global Environmental Change, 17*, 191–206.

Veblen, T. (1919). *The vested interests and the state of the industrial arts*. Huebsch.

Chapter 6
Reindeer Herders' Food Knowledge Systems

Anders Oskal, Ravdna Biret Marja Eira Sara, Kia Krarup-Hansen, Inger Anita Smuk, and Svein Disch Mathiesen

Abstract Reindeer husbandry is part of an Arctic civilization strongly tied to nature and dependent on it in multiple aspects, including the diets of its peoples. Food production in nomadic Sámi reindeer herding has, through generations, been nested within the seasonal use of pastures, securing biodiversity, and traditional knowledge of food preservation techniques. The traditional knowledge, culture, and language of reindeer herders provide a central foundation for building sustainable food systems and social-ecological resilience in the Arctic. Food knowledge systems of Arctic Indigenous peoples should be viewed as indicators of social-ecological resilience. There is a need to rethink the food systems' strategies in the governance of Indigenous reindeer herders' societies, their economy, and external relations. Arctic Indigenous food knowledge systems are damaged due to climate change, loss of biodiversity, loss of grazing land, and failure in economic reforms since traditional knowledge about food was not included in sustainable development planning and public management.

Keywords Indigenous food systems · Reindeer herders' food systems · Traditional knowledge

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6.1 Introduction

Indigenous civilizations (Mathiesen, 2023) have been part of the Arctic ecosystem for thousands of years, shaping their relationships with the northern climate, flora, and fauna. The interconnections between peoples, wildlife, and the environment within the Arctic underpin these relationships. Since time immemorial, Indigenous peoples have built unique knowledge systems and rich and diverse cultures that allowed the Arctic peoples to sustain their livelihoods through biological resources by hunting, gathering, fishing, and reindeer herding, affecting what people eat and their health. The Inuit Circumpolar Council Alaska has pioneered the insight into and understanding of Inuit food security and food sovereignty connecting Indigenous peoples' food to their identity and future (Inuit Circumpolar Council Alaska, 2020), where food culture is a cornerstone of Inuit culture and self- and shared identity. Harvesting traditional food resources is how cultural values, skills, and spirituality are learned – all learn to be within their environments and be part of the ecosystem.

Reindeer husbandry is part of an Arctic civilization strongly tied to nature and affecting the diets of its peoples (Mathiesen, 2023). The food culture of Arctic reindeer herders is a unique phenomenon, and its knowledge systems are complex and holistic, including the use of pastures, traditional food production, and human health. The food systems of reindeer herders are thus also nomadic, founded on the use of mobility in utilizing marginal and variable resources. Indigenous peoples have a very rich understanding of food, with many unique flavors and knowledge, but this culinary world has largely been "hidden" for those who are not a part of this culture. Yet, in many cases, it is overlooked, misunderstood, and assimilated. Experience shows that there can sometimes even be a danger of Indigenous peoples feeling ashamed of their own food culture (Oskal & Pogodaev, 2019a, b).

Arctic biodiversity is the basis for food production systems with the crucial role of traditional and expert knowledge for its sustainable use, protection, and management (Sara et al., 2020). What is the importance of food and food traditions in the context of resilience, biodiversity, and traditional knowledge? Culture develops from food production systems. The freedom to eat food from your land and water is crucial for Indigenous peoples. Food connects peoples to our homelands, both in Indigenous and other cultures. Food reminds us of where we come from, who we are, and where we belong (Sara et al., 2020), and "…to remain who we are, we must continue to eat what we do" (Oskal et al., 2017, p. 15).

Traditional knowledge among Sámi reindeer herders related to reindeer welfare, handling of animals, and Sámi food culture is rich (Burgess et al., 2018). Two reports to the Arctic Council Ministers in 2017, *EALLU* "*Indigenous Youth, Arctic Change and Food Culture, Knowledge and How we have Thrived on the Margins*" and the report *EALLU II* "*Arctic Indigenous Peoples' Food Systems: Youth, Knowledge & Change 2015–2019*" (Burgess et al., 2018; Oskal & Pogodaev, 2019a, b), communicated in a unique way the richness and diversity of Arctic food resources, knowledge, and food preparation and insights in the Indigenous peoples' circumpolar communities. The EALLU book was awarded the 23rd Gourmand

Fig. 6.1 Boska (*Angelica Archangelica*) is a plant with high levels of vitamin C used in both Greenlandic and Sámi food cultures. In the conditions of a lack of vitamins, berries and some types of edible herbs play a special role in the formation of the Nenets diet (Okotetto, 2018). (Photo: Ravdna BME Sara)

Awards Best Food Book of the World in 2018. Indigenous youth from the circumpolar North documented their knowledge of Arctic foods and food systems in a special issue of the scientific journal *Dieđut* (Mathiesen et al., 2018) (Fig. 6.1).

However, nowadays, Indigenous knowledge systems face an erosion of their cornerstone – traditional knowledge – due to various effects of globalization and climate change (Eira et al., 2018). These also affect what Indigenous peoples in the Arctic are going to eat in the future. While Indigenous food systems play a vital role in ensuring food security, promoting community resilience, and supporting sustainable development in the Arctic, they face multiple hazards and challenges. These often co-occur with loss of grazing land, climate change, pandemic, modernization reforms, and rising prices for food and production inputs (Mathiesen et al., 2018; Reinert & Oskal, 2023; van Rooij et al., 2023). Increased human activity and land encroachment lead to the irreversible fragmentation of reindeer pastures and migration routes (Krarup Hansen & Oskal-Somby, 2023; Oskal, 2022). Mathiesen et al. (2018) described Indigenous reindeer herding in Norway and its adaptation to new hazards in the Arctic. Loss of pastures and biodiversity negatively affect reindeer herders' livelihoods, well-being, and ability to adapt to climate change. Fennoscandia

now faces the most difficult situation regarding the cumulative loss of reindeer pastures (Oskal, 2022). As pointed out by the IPCC, the protection of grazing lands represents the most important adaptive strategy for reindeer herders under climate change (Nymand-Larsen et al., 2014) (Fig. 6.2).

It is also important to understand that such processes invariably take place against the backdrop of assimilation. Due to direct discrimination and inequities, the consequences are typically worse for marginalized communities (Sara & Mathiesen, 2020). Therefore, Sámi reindeer husbandry in Norway finds it challenging to determine a sustainable economy based on traditional knowledge and Indigenous worldview. Gordon et al. (2017) stress a disconnection between people and the biosphere and the lack of capacity to monitor changes that could affect sustainable food production. This disconnection might be due to asymmetrical feedback between producers and consumers in the Circumpolar North. The Congress of World Reindeer Herders (2017) recognized that reindeer herders' rich understanding and knowledge base of food and crafts had not been fully utilized for economic development in and by their societies (World Reindeer Herders, 2017). It also noted the need for food

Fig. 6.2 (**a**) Kalaaliaraq market (*Brædtet*) is a fresh food market in Nuuk, Greenland. An example of a resilient food production system nested in the Greenlandic food culture connecting the hunters directly with the market in a period of Greenlandic history where modern supermarkets dominate the capital. This market sells fresh fish, whale, reindeer, and seal meat, sold directly. It is an important place for social interaction for many inhabitants. (Photo: Svein D. Mathiesen, 2022). (**b**) Kalaaliaraq market (*Brædtet*). (Photo: Svein D. Mathiesen, 2022). (**c**) Kalaaliaraq market (*Brædtet*). (Photo: Svein D. Mathiesen, 2022)

Fig. 6.2 (continued)

security for reindeer herding peoples based on equitable resource access, food empowerment, utilization of traditional food knowledge, and food safety regimes adapted to realities and Indigenous cultures in the circumpolar north (World Reindeer Herders, 2017).

Stewardship of the land, hunting, and fishing have always been part of the reindeer herders' daily lives in the Circumpolar North. Lund Olsen (2019) described the value of food through hunting: a hunter in Greenlandic is called *piniartoq*, which literally means "one who wants". 20–30 years ago, *perngarneq*, the first catch, was dedicated to the boys and men in the societies. Today, they are indeed also ritualized toward girls and women. Lund Olsen described Miilu's first catch:

> Miilu is an 11-year-old boy who caught his first caribou in the autumn of 2016. I joined when his parents invited me to celebrate the meat. The family who came all had a gift for Miilu. He was very happy, and his pride was so strong you could almost smell it, and it was as if he had grown somehow, as if he had reached a new stage in his life. The meat of the caribou was made into four various dishes. There was caribou soup with rice pudding, roast, meat with rice, and dried. We all sat and ate it and enjoyed the meat a bit extra than normal because it was shot by one who had been killed for the first time. It was as if the taste of the meat changed because it was the first-catch meat.

Food, nutrition, and production are essential to human health and are key to a healthy life in the North (Oskal & Pogodaev, 2019a, b). As the Arctic is quickly becoming an integrated part of the global economy, reindeer herders are also facing highly varying socio-economic conditions and the effects of assimilation past and present (Oskal, 2022). We need to prepare Indigenous reindeer herders' food systems for future disruptions and to plan in a way that builds on assets and advances food systems that are equitable for the long term based on all available knowledge. Until recently, food knowledge was largely absent from resilience and disaster planning activities in Indigenous reindeer herders' communities in the Arctic.

This chapter provides an overview of Indigenous reindeer herders' food knowledge systems. We also highlight why the Arctic Indigenous food system is an indicator of social-ecological resilience. The chapter discusses how the resilience of Indigenous food systems in the Circumpolar North can recover from external shocks and changes to ensure a sufficient nutrient supply and economy for the Indigenous societies.

6.2 Social-Ecological Resilience in Indigenous Sámi Reindeer Herders' Food

> Food systems have the potential to nurture human health and support environmental sustainability; however, they are currently threatening both…Providing a growing global population with healthy diets from sustainable food systems is an immediate challenge…because much of the world's population is inadequately nourished, and many environmental systems and processes are pushed beyond safe boundaries by food production, a global transformation of the food system is urgently needed. (Willett et al., 2019, p 393)

Social-ecological resilience of Indigenous food systems refers to the capacity of these systems to maintain their integrity, function, and adaptability in the face of social, environmental, and economic changes or disturbances. Indigenous food systems are characterized by their reliance on traditional knowledge, practices, and relationships with the natural environment.

Indigenous food systems are deeply rooted in cultural traditions, values, and practices. They maintain and revitalize cultural knowledge, ceremonies, food sovereignty, and the transmission of traditional practices from generation to generation, such as the Sámi reindeer herders' knowledge of the seasonal use of pastures including the use of extensive land for migration. Traditional Sámi food products, like *dipma biergu* (soft meat), have a unique quality based on Sámi traditional knowledge of reindeer meat tenderization (Sara & Mathiesen, 2020).

The resilience of reindeer herders' food system also involves preserving cultural identity, promoting community cohesion, and reinforcing the intrinsic connections between food, language, spirituality, and social structures. Sámi language preserves the knowledge of traditional slaughtering practices and the quality of meat: *bakkahit* (a deliberate action by reindeer herder to leave the rumen inside the reindeer for tenderization), or *dipmat* (become soft(er) or tender), and *rotnu* (female reindeer that has not had a calf in the present year or that has lost the calf in the spring) (Sara & Mathiesen, 2020) (Fig. 6.3).

All these processes and products have a word or concept; therefore, naming is important. A reindeer herder expresses everything he or she does through the Sámi language, and the concepts contain knowledge.

Sámi reindeer herders use at least 42 concepts that represent the knowledge base and technical language of reindeer meat. Some key concepts are *buoidi*, *ađđamiin*, and *joládžiin*, which reindeer herders use in the assessment process for reindeer meat quality (Sara & Eira, 2021). Reindeer herders use more than ten different concepts for fat content when assessing the carcass after slaughtering. For example, *čáhceváibbat* is very poor quality, and this meat is not for human consumption. Furthermore, *váibbat* is also poor quality. The use of concepts such as *ađa* and *ađđamiin* refers to better quality, while those such as *jolli*, *suorbmajoliin* (one finger), *guovttisuorpmas* (two fingers), *golmmasuorpmas* (three fingers), *njealjisuorpmas* (four fingers), and *ceakkobealgi* (all four fingers plus the thumb up) are from good to very good quality, and the thickness of the fat layer is explained by measuring with fingers, which is also a quality indicator (Sara & Eira, 2021; Sara, 2019) (Figs. 6.4, 6.5, and 6.6).

Sámi reindeer herders tend to utilize traditional knowledge in their private slaughtering, starting with the reindeer selection process for food production (Sara & Eira, 2021). One has to consider multiple aspects: the type of reindeer and its gender, age, behavior, condition of the animal, and fat content. The time of slaughter influences the reindeer selection, likewise, the role of each reindeer in the herd. Sámi herders select reindeer depending on the food to be prepared. The preferred animal for food for the family is a castrated male (*spáillit*) and female reindeer without a calf (*rotnu*). It is meaty and has large amounts of fat (Sara & Eira, 2021). Sámi herders use the fat concept in many considerations resulting in many definitions, such as those describing the reindeer's welfare and outward appearance. Different types of fats and their melting characteristics determine the preparation process and dishes (Sara & Eira, 2021). Sara et al. (2022) conclude that the traditional Sámi method is based on systematic, complex, and holistic Indigenous knowledge and determines the foods reindeer herders eat (Figs. 6.7 and 6.8).

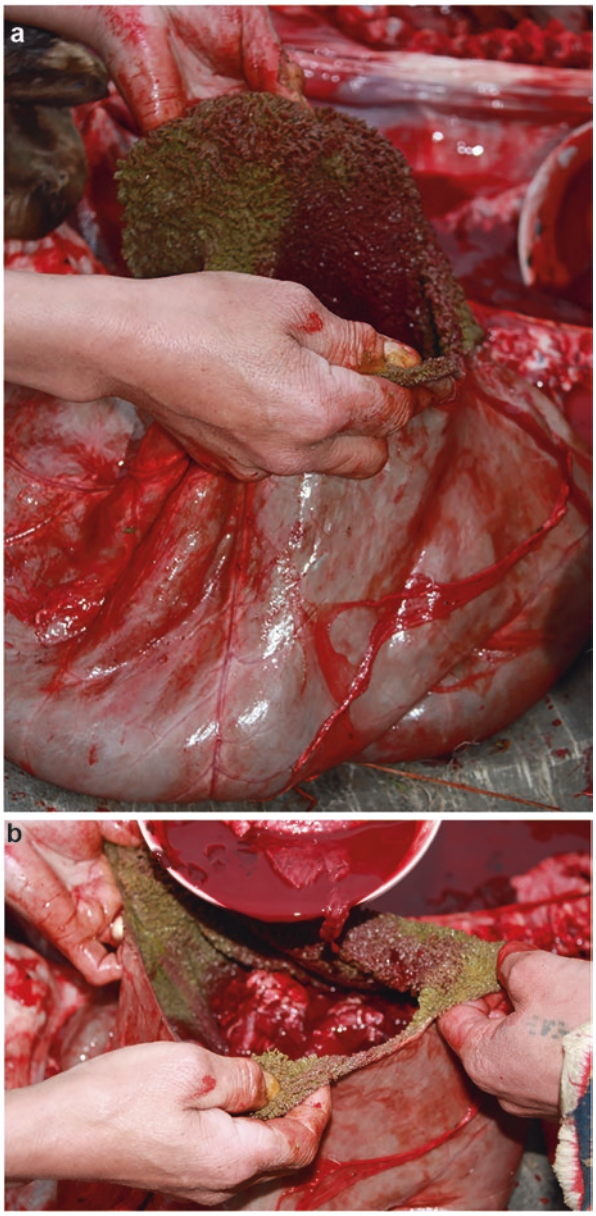

Fig. 6.3 (**a**) Reindeer rumen: the stomach is turned inside out and cleaned in snow. Then blood, meat, and fat are added. In the winter, the stomach is only cleaned with snow. The intestines are used for blood sausages as a taste enhancer after fermentation in bullion. After fermentation, the rumen is frozen, but in summer, it is preserved with fermentation only (Sara & Mathiesen, 2020). (Photo: Svein D. Mathiesen). (**b**) Reindeer rumen. (Photo: Svein D. Mathiesen). (**c**) Nenets reindeer herders in Yamalo-Nenets AO, Russia, are preparing reindeer rumen for fermentation with blood, meat, and fat. In the Nenets language, it is called *sorak* or *sydy* (Sara & Mathiesen, 2020). It is similar to the Northern Sámi *málle-čoavji* (Turi, J., 2010). (Photo: Svein D. Mathiesen)

Fig. 6.3 (continued)

Fig. 6.4 *Leavssosbuoidi*: the caul fat or fat netting around the reindeer rumen. (Photo: Ravdna BME Sara)

Fig. 6.5 (**a**) *Goastebuoidi:* fat from ruminal mesenteric fat (*leavssus*) packed hard inside the reticulum (*čalmmas*), dried and stored until rancid after about 1 year. It is fat used for frying fish and reindeer meat, added to different dishes to enhance the unique tastes of Sámi cuisine. In the picture, *goastebuoidi* is freshly prepared for drying. (Photo: Inga Margrethe Gaup). (**b**) *Goastebuoidi:* reindeer ruminal fat packed in the reticulum. In the photo, it is cut across after drying for 2 months outdoors. (Photo: Svein D. Mathiesen)

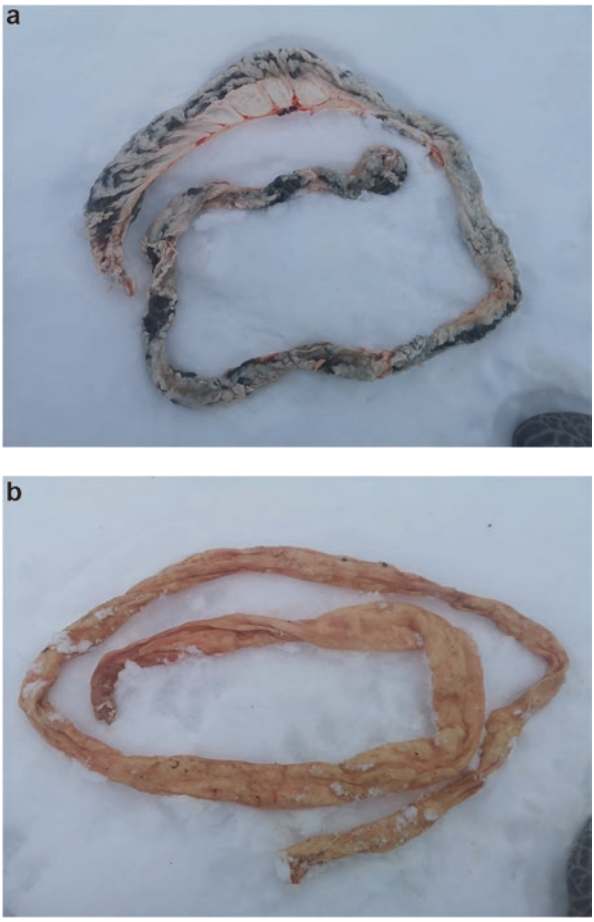

Fig. 6.6 (**a**) *Maŋŋebuoidi:* reindeer colon. (Photo: Aslak Ante Sara). (**b**) *Maŋŋebuoidi* turned inside out before blood is added and boiled. (Photo: Svein D. Mathiesen)

Indigenous traditional knowledge is rooted in generations of lived experience and observations specific to local environments. Traditional knowledge of Indigenous peoples has unique ways of expressing quality. For example, in Greenland, the food Inuits eat contains microorganisms that they ingest alongside the food. Industrialized food systems offer significant advantages from a safety point of view but have also been accused of depleting the diversity of the human microbiota with negative implications for human health. In contrast, traditional artisanal foods are potential sources of diverse food microbiota. Traditional foods of the Greenlandic Inuit are comprised of animal-sourced foods prepared in the natural environment and are often consumed raw. These findings have potential positive health implications for understanding the nature-sourced traditional Inuit diet, contrasting current diet recommendations and modern industrialized food systems (Hauptmann et al., 2020). The dietary importance of eating rumen content in

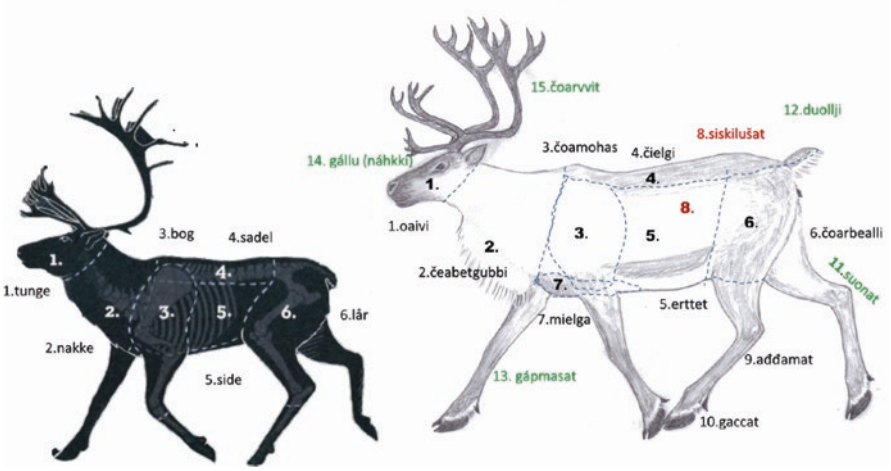

Fig. 6.7 The Norwegian or industrial (left) and Sámi way (right) of butchering a reindeer. The industrial way of butchering only uses some pieces of the reindeer as food, while the Sámi way utilizes the whole reindeer. (Illustration: Aslak Ante Sara, Ravdna BME Sara, Inger MG Eira & www.matprat.no, 2018)

Fig. 6.8 *Mielga*: reindeer breast cut across. From the left corner to the right, it is approximately 8–9 cm. (Photo: Ravdna BME Sara)

Greenland was reported as early as 1888 by Fridtjof Nansen (1893) and challenged the understanding of the quality of food resources. This part of food knowledge systems enables Indigenous communities to adapt their food systems to their regions' unique climatic, geographic, and ecological conditions, ensuring food security despite changing conditions.

Another example of the Sámi traditional food practice is smoking reindeer meat in a Sámi lávvu (nomadic tent) (Fig. 6.9). Smoking is a method of food preservation that has been a long tradition among Sámi reindeer herders (Krarup Hansen et al., 2022a), virtually unknown to science and public management (Krarup Hansen et al.,

Fig. 6.9 Sámi reindeer herders' approach to meat smoking in Northern Norway performed in the traditional Sámi tent, the *lávvu* (Krarup Hansen, 2022a, b)

2020). Due to carcinogenic polycyclic aromatic hydrocarbons (PAH) forming during smoking, smoked meat can be associated with human health risks (IARC, 1987, 2010; Ledesma et al., 2016).

However, this risk depends on the smoking method, the temperature, and the wood species. The first scientific study (Krarup Hansen et al., 2022b) using different Arctic wood species (willow, birch, and juniper) and plant parts (logs and twigs) for smoking reindeer meat confirmed reindeer herders' technique that birchwood, and especially birch twigs, generates higher smoking temperatures than willow (Krarup Hansen et al., 2022b). PAH levels of analyzed reindeer meat cuts were lower than EU-recommended maximum levels (Krarup Hansen et al., 2022b), except for reindeer meat smoked with birch twigs. The finding that birch-smoked reindeer fat could have relatively higher values also illustrates the need for co-production between traditional knowledge and science (Krarup Hansen et al., 2022b).

Indigenous food systems prioritize the consumption of a wide variety of traditional and locally available foods, including wild game, livestock, fish, foraged plants, and cultivated crops. This emphasis on nutritional diversity contributes to balanced diets, providing essential nutrients, vitamins, minerals, and dietary fiber (Sara et al., 2022).

Arctic food is the key to a healthy life in the north, so observed dietary shifts in the Arctic are a cause for concern (Burgess et al., 2018). While the Mediterranean diet is well known, the diet of Arctic Indigenous peoples is less familiar. However, the Arctic and its Indigenous food systems could be envisioned as a future "Mediterranean of the North" (Reinert et al., 2022). Using traditional and relatively simple production methods with relatively few ingredients, Arctic Indigenous peoples' diets are typically characterized by high levels of protein and polyunsaturated fat and low levels of carbohydrates (Oskal & Pogodaev, 2019a, b). Sámi reindeer herders' ecological resilience involves maintaining biodiversity, ecosystem health,

and sustainable resource practices. It includes strategies for conserving and regenerating traditional food species, protecting habitats, managing resources, and promoting practices that enhance ecological balance.

Reindeer herders' traditional knowledge base could provide new insights to help decision-making bodies and local governments more effectively prepare for and respond to crises that disrupt food security for their residents and ensure a secure food supply for the future (Burgess et al., 2018; Sara & Mathiesen, 2020; Sara et al., 2022; Sara & Eira, 2021; Krarup-Hansen et al., 2020, 2022a, b).

Enhancing the resilience of a food system can be achieved in different ways: through the food systems and knowledge based on the Arctic realities, through the ability of the Indigenous nomadic food system to bounce back and return to its sustainable stage through re-stock of animals and breeding. Resilience is also planted in the ability of the food system to deliver future acceptable food products by spreading risk based on high biodiversity and using the whole animal. Indigenous Arctic people's diets are highly varied, with a wide range of food all year round. Yet today Indigenous food knowledge production is affected by multiple stressors such as climate change, loss of grazing lands, erosion of traditional knowledge, as well as government reforms (Turi, 2002; Eira, 2012; Eira et al., 2013; Johnsen et al., 2017; Tonkopeeva et al., 2023; Mathiesen, 2023). Indigenous reindeer herders need immediate adaptive solutions and new societal opportunities for the preservation and development of the reindeer herders' food cultures.

6.3 Sámi Reindeer Herders' Circular Economies

The circular economy concept has recently gained increasing global attention also in the Circumpolar North (Oskal & Pogodaev, 2019a, b). The pillars of circular economy are waste elimination, product circulation, and nature regeneration. In short, a circular economy aims to eradicate waste in manufacturing processes and systems throughout the economic model. In contrast, the linear "take, make, and dispose of" economy wastes enormous amounts of resources such as materials, energy, and labor. Food waste is a substantial challenge in the global food system, where a third of all food produced in the world is never eaten because it is spoiled or discarded (FAO, 2011). The Arctic region is no exception (Oskal & Pogodaev, 2019a, b).

However, as far as Indigenous civilizations and traditional livelihoods go, the circular economy concept is in no way new: in a traditional family-based model of reindeer herding, there is no such thing as waste products from reindeer (Burgess et al., 2018), and similar norms and traditions are found across the Arctic (Unger, 2014). Indeed, reindeer herding and traditional Indigenous livelihoods and ways of life can be considered the oldest and best-performing part of a circular economy (Oskal & Pogodaev, 2019a, b). In such a food system, every part of the living creature is seen as a resource with some economic potential for usage. *Every part of the reindeer – from the hoof to the antlers – is seen as a resource with some sort of*

economic use potential. All parts can be utilized for something; if not as human food, then they can be applied to other products like clothing, tools, artifacts for sale, etc. This means that in some regards, reindeer herders' food systems are comprehensive in scope. Moreover, every extended family member is seen as an essential human resource, where everyone has a role in the traditional economic model – men, women, children, youth, elders, reindeer herders, their aides, and other local helpers. This also applies to knowledge, where different members of the family would have partly different bases of traditional Indigenous knowledge. This reflects a relatively wide scope of the food systems of Arctic Indigenous peoples in terms of resources and resource utilization, family roles, and diverse knowledge bases. These food systems can be seen as the very essence of Indigenous traditional knowledge in practice, representing real-world sustainability in praxis (Burgess et al., 2018). As formulated by Reinert et al. (2022), they are "sustainable to the bone".

Many Indigenous peoples and marginalized populations live in environments that are highly exposed to climate change impacts due to this heightened exposure and their natural resource-based livelihoods. These societies are already observing and responding to changes exacerbated by climate change. In her Ph.D. thesis, Ravdna BME Sara pioneers the importance of Indigenous knowledge in Sámi reindeer herders' food security and Sámi families' food sovereignty (Sara, forthcoming 2023).

In economic terms, the original Indigenous civilizations may be seen in the light of what the Austrian economist Karl Polanyi, in his studies of the industrial revolution in Britain, entitled *pre-capitalist societies*. In order for capitalism to function, argues Polanyi, one had to invent three fictitious commodities that did not previously exist as products in markets: money, paid labor, and private ownership of land (Polanyi, 1944).

Looking at reindeer herding as a form of pre-capitalist society (Reinert & Oskal, 2023), one might also see the original food systems of reindeer herders and other Indigenous peoples as *pre-capitalist food systems* based on subsistence, barter, external relations, family-based organization models, and traditional Indigenous knowledge.

In the time of transition to "modernity," Western and Soviet agricultural science was introduced to "modernize" reindeer herding into specialized meat production (Benjaminsen et al., 2015; Eira et al., 2018) and thus away from the diversity strategy known from before (Eira et al., 2018; Benjaminsen et al., 2015; Magga et al., 2011; Mathiesen et al., 2013). In the aftermath, at the very least, one can conclude that these "experiments" have had unintended detrimental effects on the social organization and economy of reindeer herding and thus affected reindeer herders' ability to adapt to change and the resilience of reindeer herding societies (Mathiesen, 2023). While objectives and intentions may have been good, as the saying goes, "the road to disaster is paved with good intentions." Reindeer herders have their own understanding and vision of the economy of reindeer husbandry, which are often different from those of mainstream society and the "Western scientific tradition" (Turi, 2016; Turi & Keskitalo, 2014).

For example, meat quality is viewed from the point of how attractive meat is as food for humans. The scientific definition of quality covers everything from food safety, ethics, animal welfare, durability, consistency, smell, the color of meat and fat content, and slaughtering processes (Langaker, 2010). Consumers associate the quality of meat with attributes such as tenderness, safety, water-holding capacity, and flavor and meat color (Wiklund et al., 2014). Even a European special classification has been developed for this purpose, the EUROP classification system (Wiklund, 2014).

Sámi reindeer herders focus on meat quality throughout the whole slaughtering process. Traditional slaughtering of reindeer holds different processes that imply meat quality before, during, and after slaughtering. Traditionally, reindeer herder follows certain customs that matter during slaughtering, such as the growing moon, killing method, season, pastures, and what type of reindeer is slaughtered. Firstly, the slaughtering takes place nearby the reindeer herd when it is the right season for slaughtering. Reindeer herder selects an animal in the herd to be slaughtered according to specific criteria that depend on age, shape, and condition and what type of food is planned to be made (Sara & Eira, 2021). The animal is slaughtered with traditional methods and processes which have not been scientifically documented. The slaughtering method is common in all Sámi regions but with some variations (Sara et al., 2022). These slaughtering methods have been used and passed over to the younger generations for a long time. However, traditional slaughtering practices are not visible to those "outside." So far, we are unaware of any scientific articles where Indigenous reindeer herder's traditional knowledge is used in planning, experimental design, or scientific analyses of reindeer meat quality (Sara, 2019). The knowledge embedded in the concepts used during the slaughtering explains the slaughtering process, names of different butchering methods, and meat and other parts of the reindeer (Sara et al., 2022).

One of the authors visited all former Sámi-owned field slaughterhouses for reindeer in Northern Norway in 2003, which had all been shut down in 1995–1998 due to new public regulations and their interpretation praxis. This experience brought about a new realization. On the one hand, the reindeer herders interviewed underlined the importance of their own handling of the market for reindeer meat for their own economy. But another element was strongly and consistently brought forward in the visited reindeer herders' own analysis: the importance of the closed field slaughterhouses for the whole *siida*, for the whole family, especially the women, and for utilizing every resource from the reindeer toward every market. This also included their relations with external actors and local society.

The foundation of a family-based economy was threatened when women's role was endangered after the modernization and rationalization of Sámi reindeer husbandry, when the women almost lost their right to own their own reindeer (Wiig, 1984, p. 313). The women's direct economic role in reindeer herding was severely diminished, which now meant pushing live reindeer onto transport trucks to industrial slaughterhouses, thereby, in effect, ending the valuable role of women and the family as an integral and traditional part of the reindeer herding economy (Reinert,

2007). Ulvevadet (2004) note that women almost completely disappeared from reindeer husbandry in worse cases.

This is very serious to the future maintenance of reindeer herding culture, language, values, and norms and maintenance and transfer of traditional Indigenous knowledge. The result is, among other things, the loss of language and understanding of food, also meaning a loss of many traditional products for potential markets.

Norway's social and economic reforms between the 1960s and 1970s affected the Sámi reindeer herders' food knowledge system since reindeer herders' Indigenous food knowledge system was not included in the mainstream Norwegian food reform (Sara, forthcoming 2023). In the article "The Art of Governing and Everyday Resistance: 'Rationalization' of Sámi reindeer husbandry in Norway since the 1970s," Johnsen and Benjaminsen (2017) documented that:

> for many pastoralists, the Agreement and the 1978 Act introduced a system that did not make sense. While some subsidies were seen as very valuable as they made life and work easier (e.g., support for snowmobiles), there were other subsidies that were described as "absurd". The authors continued: "They made jokes about "money being thrown" at them, referring to various subsidies that they received without having requested them. Interviewed pastoralists in West Finnmark said they received subsidies for purchasing cheese, which they traded for more desired goods at the grocery store, and they continued working and kept funds received for taking time off and paying a replacement to look after the herd. (Johnsen & Benjaminsen, 2017)

The following statement reflects the lack of integration of traditional food systems into modern forms of production through industrialized slaughtering and processing of reindeer meat:

> …The main challenge to Sámi reindeer husbandry today is that a large part of the raw materials of slaughtered reindeer, such as skin, bones, heads, blood, and intestines, are regarded as waste and are thrown away and not used for food production or economic development. In this modernized processing of reindeer, I believe that as much as sixty percent of the reindeer is not utilized. The bulk slaughtering of calves in our industry has been a major threat to the active participation of women in Sámi herding since the raw materials that Sámi women traditionally used are no longer available, thereby forcing us away from the herding business. If the traditional materials for clothes and food production are unavailable, the specialized language and traditional knowledge related to these processes will disappear. The calf slaughtering strategy imposed upon us as a reindeer herding people has so impacted the role and perspectives of women in reindeer husbandry that this is having significant consequences for the continued survival of family-based reindeer husbandry as we once knew it.
>
> Inger Anita Smuk, a senior Sámi reindeer herder from eastern Finnmark and Chair of the Board of the International Centre for Reindeer Husbandry (Degteva et al., 2017, p. 172)

In 2016, Chef Alfred Larsen in Guovdageaidnu, Sápmi, criticized in a local newspaper how only reindeer calf meat was available in the stores. He stated that reindeer calf meat was very tender and easy to prepare and chew, but with little taste and without consistency and could be destroyed with minimal preparation. In traditional Sámi cooking, much of the preparation is aimed at bringing the flavors. Prime meat cuts from reindeer calves are also small and less usable. The difference in meat

quality between older animals and calves is significant (Larsen, 2016; Oskal & Pogodaev, 2019b).

Within this holistic understanding of traditional family-based reindeer herding, one can find the essence of a truly circular economy. Now the world outside Indigenous societies seems to be "rediscovering" this model of thinking, forgotten in our time of sc. "modernity" with its great scientific discoveries, increases in living standards, perceived "endless" world resources, and corresponding "universal faith in everlasting growth." Alternatively, said in another way by Johan Mathis Turi:

> …from the beginning, human societies have been built on the application of traditional knowledge (...) As scientific knowledge developed and brought extraordinary results in almost all fields, a shift in people's attitudes towards traditional knowledge occurred, and it gradually became devalued. (J.M Turi, in Oskal et al., 2009)

Thus, earlier understanding and models may have been too easily forgotten. The original circular model seems to have disappeared in the visible or official economy of reindeer herding in Fennoscandia in the last 30 years. However, it is still practiced internally within families to varying degrees (Oskal & Pogodaev, 2019a, b). Attempts to specialize the economic activities of reindeer herders, thereby decoupling the family, its different members, and their different base of traditional Indigenous knowledge from the economic activities, might have additional negative effects beyond just the economic loss of product-market combinations and diversity in economic adaptation; it could weaken the original family-based reindeer herding model, the very core model upon which all reindeer cultures have historically been built.

6.4 New Economic Models and Innovation: *Boaššu – NOMAD Indigenous FoodLab*

Traditional ways of life and livelihoods have been and are central to the economies of Arctic Indigenous peoples. The food resources and production from these traditional livelihoods are often little known outside the indigenous context. However, they are much in line with global food trends, such as renewed interest in one's origins, physical health, organic foods, and ethnic roots (Oskal & Pogodaev, 2019a, b).

The traditional livelihood of reindeer pastoralism represents a model of sustainable exploitation and management of northern terrestrial ecosystems based on experience accumulated over generations, conserved, developed, and adapted to the climatic and political-economic systems of the North (Magga et al., 2011). It also represents a human-coupled ecosystem, which has developed a historically high resilience to climate variability and change (Magga et al., 2011; Mathiesen et al., 2013). The traditional economies that have existed for thousands of years have served as the foundation for the survival and prosperity of Indigenous peoples in the most severe natural environments of the world.

However, over the past 100 years, significant changes have occurred in the economic models of the Arctic Indigenous peoples (Oskal & Pogodaev, 2019a). In many Indigenous communities, attempts were made to transform their economy into "new" models ranging from capitalism to a socialist plan economy. This has jeopardized the existence of these peoples because the change in the traditional structure of the economy and social organization of Indigenous peoples was undermined by erroneous theories and ideas that were often implemented in various socio-economic experiments. As a result, the ancient traditional civilization of nomadic Arctic Indigenous peoples today is under pressure (Op.cit).

Yet as far as there is an abundance of food resources and food security, there is evidence to suggest that Indigenous peoples' food products have a positive market potential (Oskal, 2022; Yang et al., 2020). Indeed, revitalizing traditional food products for modern markets can generate local value and create sustainable businesses in the food sector (Oskal, 2022) (Figs. 6.10 and 6.11).

Of importance here is the diversification of the local economies and solving the problems of bringing untapped resources to new markets in a way that benefits the primary producing Indigenous societies. Innovation is also combining known things in new ways. The *Boaššu – NOMAD Indigenous FoodLab* initiative represents an innovative knowledge contribution on how local Indigenous societies can get into a position to exploit the opportunities arising from a rapidly changing Arctic. It is an example of the synergy between traditional knowledge of reindeer herders, sustainability, and innovation created by the International Centre for Reindeer Husbandry and World Reindeer Herders.

The *Boaššu – NOMAD Indigenous FoodLab* simultaneously represents *two ways of knowing about food*: on the one hand, a high-tech kitchen of steel and aluminum, with contemporary cooking methods and equipment operated on natural gas and limited electricity, and, on the other hand, a traditional Indigenous food system, where the food in the last instance is prepared on the open fire in the *lávvu* – the cone-shaped traditional nomadic tent used by reindeer herders. Such nomadic tents – *lávvu* – are the traditional home of the nomadic Indigenous reindeer herders. The open fireplace is called *árran* in the Sámi language, which marks the natural center of the *lávvu*. The inner part of the *lávvu* is the kitchen, which is called *boaššu* in the Sámi language.

The FoodLab is based on the interconnectedness of the tripartite concept: *boaššu* (the kitchen), *árran* (the fireplace), and *lávvu* (the tent, which also unifies the other elements). Easily transportable by road, the FoodLab is constructed in the spirit of the reindeer herders' nomadism. The kitchen modules also have skis underneath to transport them into the tundra in the winter, i.e., close to the reindeer herds in the seasonal migrations and pasture use. The FoodLab kitchen modules, the *lávvu* and the concept were constructed in cooperation with *KSH Arkitekt* and *Bakkely Smede- og Maskinfabrik* in Denmark, among others.

The *Boaššu – NOMAD Indigenous FoodLab* brings together traditional Indigenous food knowledge, reindeer herders' food production practices, and the Western world's most advanced technologies. It bridges the traditional Indigenous

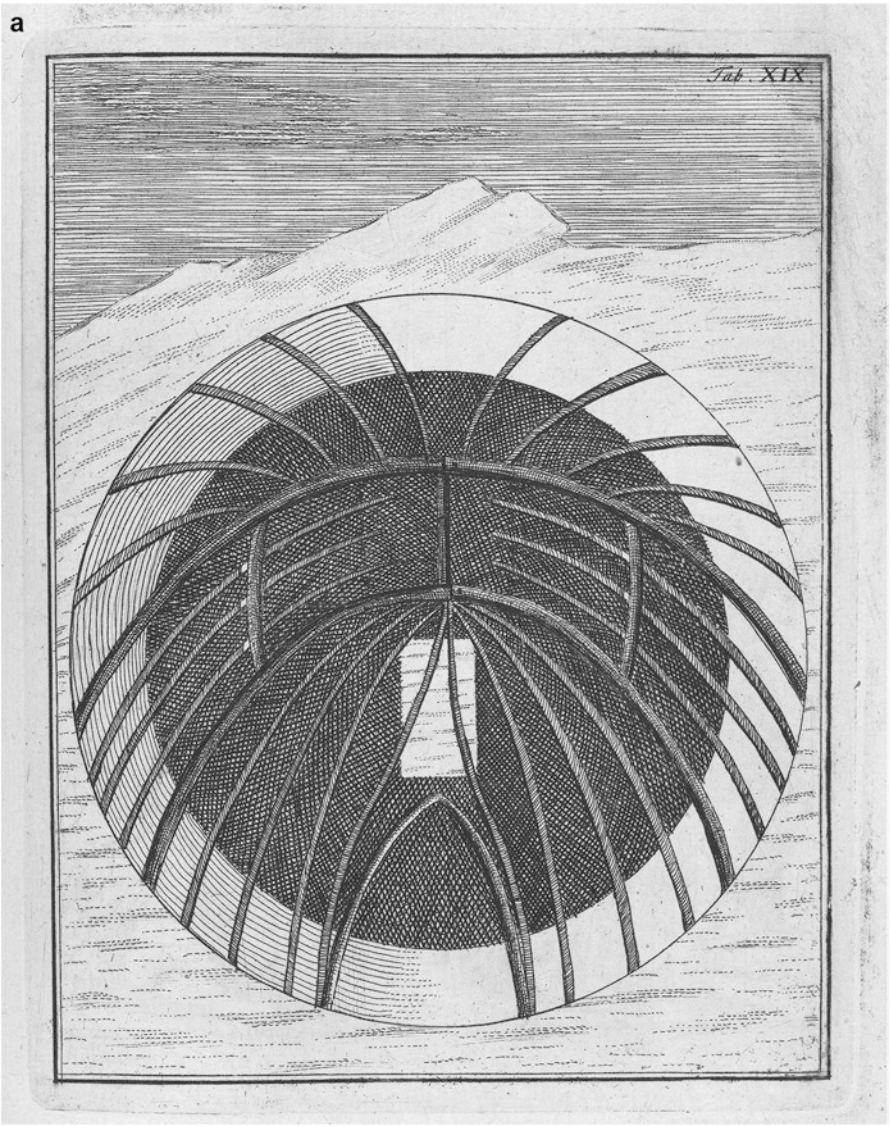

Fig. 6.10 (**a**) *A Winter Tent Seen from Above,* an image of a traditional Sámi *lávvu* from Knud Leem's book *Beskrivelse over Finmarkens Lapper, deres Tungemaal, Levemaade og forrige Afgudsdyrkelse*. Published in 1767, the book contains over a hundred illustrations by O.H. von Lode based on Leem's descriptions. Knud Leem was a Danish priest and scholar who studied the Sámi language, culture, and way of life. (Illustration: National Museum; Leem, 1808(1767)). (**b**) *The Construction of a Lávvu*. While the book was published in 1767, the original image plates were created in the 1750s, but the history of the *lávvu* itself dates centuries back. (Illustration: National Museum; Leem, 1808(1767))

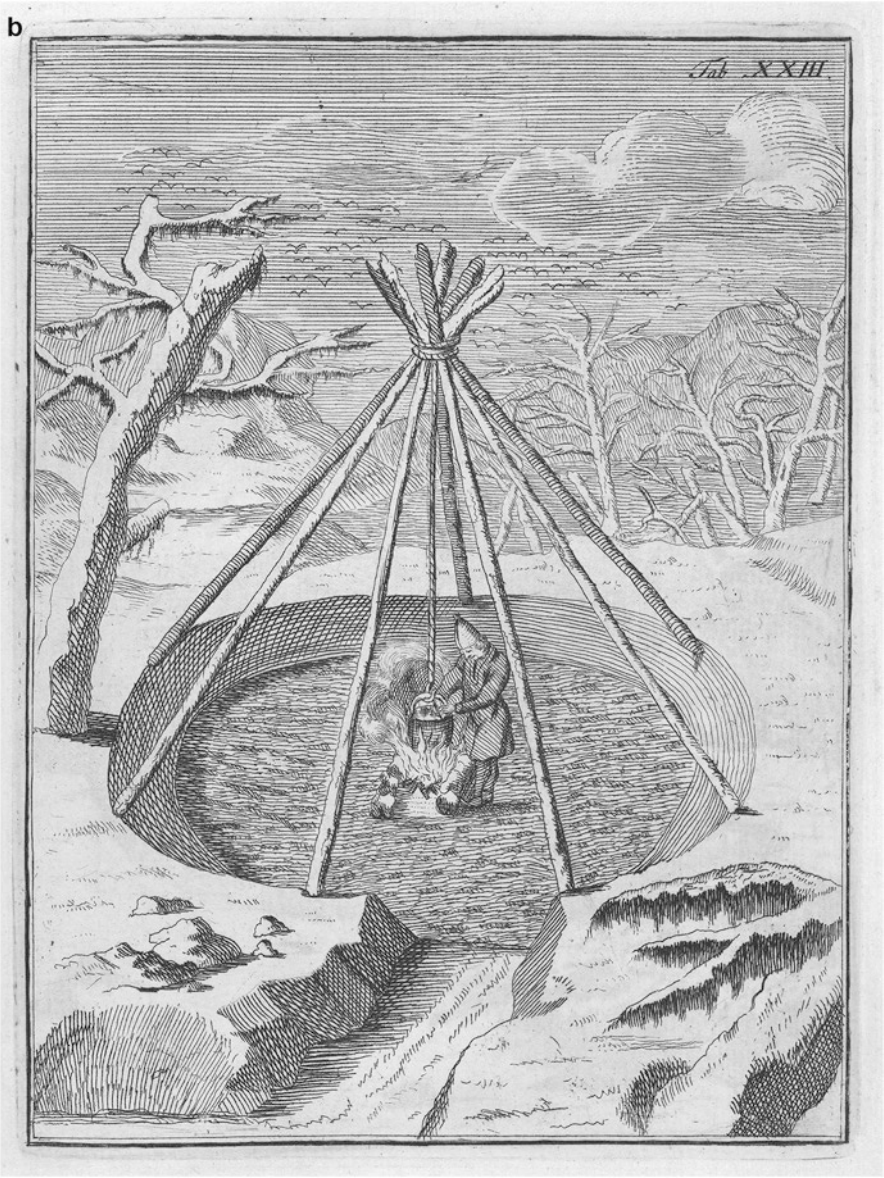

Fig. 6.10 (continued)

food systems with a nomadic high-tech Bocuse d'Or kitchen, the very first of its kind. This creates a nexus between different worlds and ways of knowing about food (Burgess et al., 2018), in a transboundary function between business and academia, between science and traditional Indigenous knowledge, and between traditions and the present. It aims to create opportunities to document traditional

Fig. 6.11 *Boaššu – NOMAD Indigenous FoodLab* at the UN World Food Forum, FAO HQ, Rome, October 16–21, 2022. (Photo: Anders Oskal/ICR, 2022)

Indigenous knowledge, using the available knowledge and resources and revitalizing what has been lost, instilling pride in Indigenous traditions, sparking creativity, shaping innovations, inspiring entrepreneurship, and ultimately strengthening Indigenous Peoples' economic base for the long term. *Innovation is also about creating new products from known resources (*Schumpeter*,* 1934*),* e.g.*, revitalizing traditional food products for new markets*.

To ensure successful adaptation for Indigenous peoples and their youth, traditional livelihoods, and societies, one must ensure that the young generations can also use the opportunities arising from Arctic change. This is part of what ICR's various youth engagements attempt to facilitate, to ensure that an opportunity of a changing Arctic is an opportunity for all – thereby leaving no one behind (Pogodaev & Oskal, 2019; Oskal, 2022). This way, the internal resources should be mobilized, and Indigenous youth should be empowered to take charge of the challenge of societal adaptation and resilience building. The FoodLab acts as a platform for Indigenous youth to take the lead in developing their own economies, societies, and destinies. It is also meant to serve as a connector between science and traditional knowledge that fully respects different knowledge systems while also driving the frontiers of our common knowledge about food (Fig. 6.12).

> Boaššu FoodLab tent at FAO shows the power of Indigenous Peoples' Knowledge systems, which combine traditional knowledge of food with new tech & innovation to address today's challenges. Thank you to Norway for supporting Artic Indigenous Peoples. (Qu Dongyu, FAO Director-General, 2022)

The FoodLab concept can also be seen as relevant in relations between reindeer herders and their surroundings, e.g., in relation to making visible Indigenous traditions, food knowledge, and local value added. This could also link to the old

Fig. 6.12 Indigenous food diplomacy in action: *Boaššu – NOMAD Indigenous FoodLab* hosting (from right to left) ICR Executive Director Anders Oskal, FAO Director-General Qu Dongyu, Norway's Ambassador and Permanent Representative to the UN agencies based in Rome Morten von Hanno Aasland, and Ambassador and Permanent Representative from Mexico to the UN agencies based in Rome Miguel Garcia-Winder on the sidelines of the UN World Food Forum. (Photo: Marina Tonkopeeva, 2022)

practice of *verddevuohta* (i.e., institutionalized "relational friendship" between nomadic Sámi reindeer herders and sedentarized people) (cf. Eidheim, 1966, p. 427), that has been a historically important and integral part of the traditional food system. The FoodLab concept has already shown strong potency in the outreach of food systems and Indigenous issues at large. This has been demonstrated in local, regional, and global arenas, including local Indigenous festivals, the Arendal-week political conference in Norway, the UNEP+50 anniversary in Stockholm, and the World Food Forum in Rome, Italy, and so on. The *Boaššu – NOMAD Indigenous FoodLab* is endorsed and has been supported by the University of the Arctic, Bocuse d'Or, International Gourmand Foundation, Arctic Council, UNEP/S+50, and FAO Indigenous Peoples' Unit, among others (Fig. 6.13). Arguably, the external relations and outreach of reindeer herding societies have become even more important under Arctic change and globalization, to raise awareness and spread understanding for reindeer herding societies' needs. Seen on this background, the NOMAD Indigenous FoodLab concept could thus also represent a new model of Indigenous diplomacy (de Costa, 2009; Beier, 2009), as an extension of traditional external relations

Fig. 6.13 Indigenous youth from the Circumpolar North is attending an international workshop on Indigenous Youth Leadership: "Advance Resilience in Arctic Communities" and practicing Indigenous food diplomacy on the premises of the *Boaššu – Nomad Indigenous FoodLab*, August 2022. (Photo: Anders Oskal)

practices of reindeer herders (Eidheim, 1966, p. 427), adapted to the challenges, needs and opportunities of current times – i.e., a model for *Indigenous food diplomacy*.

6.5 Conclusion

Arctic Indigenous food knowledge system evolved throughout centuries. The traditional knowledge, culture, and language of reindeer herders provide a central foundation for building food systems and social-ecological resilience locally. There is a need to rethink the food system strategies in the governance of Indigenous reindeer herders' societies. One must protect the pastures and rivers for the health and economy of the Indigenous communities. It is necessary to rewire the different parts of the food systems and reconnect to the biosphere through food cultures (Gordon et al., 2017, p.13). Arctic food governance must accept the sustainability of reindeer herders' Indigenous food systems and a deep understanding of the local ecosystems, including plant and animal species, seasonal cycles, and natural resource management that exist in Indigenous traditional knowledge systems. This knowledge is essential for sustainable food systems, as it ensures the long-term health and resilience of the environment. There is an urgent need to accommodate Indigenous traditional knowledge and family-based food when certifying Indigenous food

products to include different kinds of knowledge (Sara & Mathiesen, 2020; Burgess et al., 2018).

In principle, however, change means both challenges and opportunities (Oskal, 2022). But the realities of nomadic Indigenous peoples are often somewhat different: most of the time, one has to spend so many resources, time, and energy on the negatives that one is not really in a position to exploit the opportunities Arctic change brings effectively. Balance of opportunity is sometimes perceived as virtually impossible. As one young Sámi herder described their struggle against a multinational company: "It cannot be right that one side gets all the benefits and the other is struck with all the problems." Therefore, things need to be done differently for Indigenous reindeer herders also actually to benefit from Arctic change. It is necessary to call for culturally anchored development and entrepreneurship, building Indigenous economies and societies from within. Fair trade arrangements, friendly investments, joint ventures, and assistance for entrepreneurship and innovation are all useful ways by which mainstream businesses could assist Indigenous youth and their societies in developing their own economic base (Oskal, 2022).

In conclusion, we would refer to the Jåhkåmåhkke Declaration on the occasion of the sixth World Reindeer Herders' Congress in Sweden in 2017, which states:

> …Recognize that reindeer herders base their existence on a holistic economic system, where diversity and utilization of marginal resources are key fundaments, a system that is uniquely adapted to the seasons and risks of our natural environment, that keeps our people and societies healthy, that is integrated and expressed in our cultures and based on our Traditional Indigenous Knowledge, and that has kept our peoples secure from time immemorial, and underline that it is very important that this holistic system is understood and taken into account in public management.

One of the outcomes of the EALLU project is the *Food Innovation Leadership Program* which was initiated by the International Centre for Reindeer Husbandry (ICR) and Nord University of Norway in the realization of the Arctic Council Fairbanks Declaration point #22, in which the Arctic states:

> …Encourage the establishment of a program for training Indigenous youth in the documentation of traditional knowledge related to food, food entrepreneurship, and innovation.

The best available knowledge has to be used to rethink the future of Arctic food systems, both science-based knowledge and Indigenous peoples' traditional knowledge. The expression "less but better" is used to guide Western meat consumption toward sustainability. Its definition, however, lacks clarity and may push meat consumption further from sustainable practices (Sahlin et al., 2020). In a similar way as knowledge of sustainable food systems and traditional food security in Sápmi could be a keystone to developing future systems for local food security and food sovereignty in the European North (Nilsson, 2015, 2018), a similar model could be applied to Indigenous knowledge in the entire Circumpolar area.

In a nutshell, reindeer herders' Indigenous food systems encompass examples of environmental sustainability; societal, environmental, and community resilience; adaptation to local conditions; biodiversity preservation; seasonality; climate

change adaptation; effective governance and decision-making models; the source for identity strengthening and self-determination; and a platform for knowledge exchange and cross-generational learning and Indigenous diplomacy. Traditional knowledge of Indigenous reindeer herders offers valuable insights into coping with climate change impacts on food production. Therefore, the food knowledge system of Indigenous peoples in the Arctic can provide future indicators when observing social-ecological resilience to change.

References

Beier, J. M. (2009). *Indigenous diplomacies*. Palgrave Macmillan.

Benjaminsen, T. A., Reinert, H., Sjaastad, E., & Sara, M. N. (2015). Misreading the Arctic landscape: A political ecology of reindeer, carrying capacities, and overstocking in Finnmark, Norway. Norsk Geografisk Tidsskrift – Norwegian. *Journal of Geography, 69*, 219–229.

Burgess, P., Antipina E., Avelova, S., Chernyshova, S., Degteva, A., Dubovtsev, A., Dondov, B., Gerasimova, A., Mathiesen, S. D., Oskal, A., Pogodaev, M. et al. (2018). *Indigenous youth, food knowledge & Arctic change – EALLU, 2nd edition.* An Arctic Council Ministerial Meeting Deliverable Report, by Sustainable Development Working Group, Association of World Reindeer Herders, and International Centre for Reindeer Husbandry. ISBN 978-82-998051-4-8, 171 pp. Paulsen Publishing House, Moscow, Russia and International Centre for Reindeer Husbandry, Guovdageaidnu/Kautokeino, Norway.

de Costa, R. (2009). *Indigenous diplomacies before the Nation-State*. https://doi.org/10.1057/9780230102279_5

Degteva, A., Oskal, A., Mathiesen, S. D., Burgess, P., Iulie, A., Johnsen, K., Magga, A.-M., van Rooij, W., Brattland, C., Corell, R., Dubovtsev, A., Garnåsjordet, P. A., Holmberg, A., Klokov, K., Maynard, N. G., Nellemann, C. B., Niillas, P., Jonas, P., Pogodaev, M., Reinert, E., Sandström, P., Slepushkin, I. S., Inger, A., Steffanson, J., Strogalschikova, Z., Tyskarev, A., & Westerveld, L. (2017). Chapter 7: Indigenous peoples perspectives. In *AMAP, 2017. Adaptation actions for a changing Arctic – perspectives from the Barents area. Arctic monitoring and assessment Programme (AMAP)*, Oslo, Norway.

Eidheim, H. (1966, April). Lappish guest relationships under conditions of cultural change. *American Anthropologist, New Series, 68*(2, Part 1), 426–437. Wiley/The American Anthropological Association.

Eira, I. M. G. (2012). Muohttaga jávohis giella: Sámi árbevirolaš máhttu muohttaga birra dálkkádatrievdanáiggis (The silent language of snow: Sámi traditional knowledge of snow in times of climate change). 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 & Technology, 85*, 117–130. https://doi.org/10.1016/j.coldregions.2012.09.004

Eira, I. M. G., Mathiesen, S. D., Oskal, A., & Hanssen-Bauer, I. (2018). *Snow cover and the loss of traditional indigenous knowledge*. *Nature Climate Change, 2018*. ISSN 1758-678X.s. https://doi.org/10.1038/s41558-018-0319-2

FAO. (2011). *Global food losses and food waste – Extent, causes and prevention*. United Nations Food and Agriculture Organization (FAO). ISBN 978-92-5-107205-9.

FAO Director-General, QU Dongyu. (2022). Available at: https://arcticportal.org/ap-library/news/2914-reindeer-herders-in-rome-all-roads-lead-to-the-foodlab

Gordon, L., Crona, B., Henriksson, P., van Holt, T., Jonell, M., Lindahl, T., et al. (2017). Rewiring food systems to enhance human health and biosphere stewardship. *Environmental Research Letters, 12*(10). https://doi.org/10.1088/1748-9326/aa81dc

Hauptmann, A. L., Paulová, P., Hansen, L. H., Sicheritz-Pontén, T., Mulvad, G., & Nielsen, D. S. (2020). Microbiota in foods from Inuit traditional hunting. *PLoS One, 15*(1), e0227819.

IARC. (1987). Monographs on the evaluation of the carcinogenic risk of chemicals to humans. *Overall evaluation of carcinogenity: An updating of IARC monographs* (Vol. 1–42). International Agency for Research on Cancer.

IARC. (2010). *Monographs on the evaluation of carcinogenic risks to humans* (Vol. 92). International Agency for Research on Cancer.

Inuit Circumpolar Council Alaska. (2020). *Food sovereignty and self-governance: Inuit role in managing Arctic marine resources.* Anchorage, AK. https://iccalaska.org/media-and-reports/inuit-foodsecurity-project/

Johnsen, K. I., & Benjaminsen, T. A. (2017). The art of governing and everyday resistance: "Rationalization" of Sámi reindeer husbandry in Norway since the 1970s. *Acta Borealia, 34*(1), 1–25. https://doi.org/10.1080/08003831.2017.1317981

Johnsen, K. I., Mathiesen, S. D., & Eira, I. M. G. (2017). Sámi reindeer governance in Norway as competing knowledge systems: A participatory study. *Ecology and Society, 22*(4), Article 33. https://doi.org/10.5751/ES-09786-220433

Krarup Hansen, K., & Oskal-Somby, B. (2023). Adaptation to the future climate in Sámi reindeer husbandry: A case study from Tromsø, Norway. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry (Springer polar sciences)*. Springer.

Krarup Hansen, K., Moldenæs, T., & Mathiesen, S. (2020). The knowledge that went up in smoke: Reindeer herders' traditional knowledge of smoked reindeer meat in literature. *Polar Record*, 1–16.

Krarup Hansen, K., Sara, R. B. M. E., Smuk, I. A., & Brattland, C. (2022a). Sámi traditional knowledge of reindeer meat smoking. *Food Ethics, 7*, 13. https://doi.org/10.1007/s41055-022-00106-22022

Krarup Hansen, K., Turi, I., Sundset, M. A., & Mathiesen, S. D. (2022b). Bridging traditional and scientific knowledge on reindeer meat smoking – A pilot study. *International Journal of Circumpolar Health, 81*(1), 2073056. https://doi.org/10.1080/22423982.2022.2073056

Langaker, M. (2010). *Effekt av slaktealder og raser på mørhet (WB) og innhold av intramuskulært fett hos storfe* (transl.: Effects of slaughter age and breed on tenderness (WB) and contents of intramuscular fat in cattle). Norwegian University of Life Science, Department of Animal Husbandry and Aquaculture Sciences.

Larsen, A. (2016). *Er reinkjøtt snart ubrukelig som mat? Meninger: – snart står dyret i fjøsen og gomler soya*. Altaposten. Retrieved from https://www.altaposten.no/meninger/2016/02/24/%E2%80%93-Er-reinkj%C3%B8tt-snart-ubrukelig-som-mat-12199098.ece

Larsen, J. N., Anisimov, O. A., Constable, A., Hollowed, A. B., Maynard, N., Prestrud, P., Prowse, T. D., & Stone, J. M. R. (2014). Polar regions. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1567–1612). Cambridge University Press.

Ledesma, E., Rendueles, M., & Días, M. (2016). Contamination of meat products during smoking by polycyclic aromatic hydrocarbons: Processes and prevention. *Food Control, 60*, 64–87. https://doi.org/10.1016/j.foodcont.2015.07.016

Leem, K. (1808 (1767)). *An account of the Laplanders of Finmark, their language, manners and religion*. Translated from Danish "Knud Leems Beskrivelse ov Finnmarkens Lapper. Kjøpenhavn: Salikath, 1767".

Lund Olsen, N. (2019). Pernganeq – The first catch – Becoming a man in Greenland. In A. Oskal & M. Pogodaev (Eds.), *EALLU Arctic indigenous peoples food systems: Youth, Knowledge &*

Change. Arctic council sustainable development working group report from the EALLU project in 2015–2019, delivered to the 11th ministerial meeting of the Arctic council Rovaniemi, Finland, May 7, 2019. Association of World Reindeer Herders/International Centre for Reindeer Husbandry (ICR) Report 2019: 1. Guovdageaidnu/Kautokeino, Norway, 2019.

Magga, O. H., Mathiesen, S. D., Corell, R. W., & Oskal, A. (Eds.). (2011). *Reindeer herding, traditional knowledge and adaptation to climate change and loss of grazing land. A project led by Norway and Association of World Reindeer Herders (WRH) in Arctic council. Sustainable development working group (SDWG)*. International Centre for Reindeer Husbandry, Report 1:2011.

Mathiesen, S. D. (2023). Reindeer husbandry in the circumpolar north. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences*. Springer. https://doi.org/10.1007/978-3-031-17625-8_1

Mathiesen, S. D., Alftan, B., Corell, R. W., Eira, R. B. M., Eira, I. M. G., Degteva, A., Johnsen, K. I., Oskal, A., Roue, M., Sara, M. N. A., Skum, E. R. N., Turi, E. I., & Turi, J. M. (2013). Strategies to enhance the resilience of Sámi reindeer husbandry to rapid changes in the Arctic. In *Arctic Council Arctic Resilience Report (ARR), interim report to the Arctic Council ministerial meeting in Kiruna* (pp. 100–112). Stockholm Resilience Centre and Stockholm Environmental Institute.

Mathiesen, S. D., Gashilova, L., Chernyshova, S., & Gerasimova, A. (2018). СИСТЕМЫ ПИТАНИЯ КОРЕННЫХ НАРОДОВ АРКТИКИ – роль традиционных знаний для устойчивого развития [Arctic Indigenous Peoples Food Systems – the role of traditional knowledge for sustainable development. In Russian] (Vol. 1).

Nansen, F. (1893). *Eskimo Life*. Longmans, Green & Co.

Nilsson, L. M. (2015). Dietary patterns in a circumpolar context: A cultural approach to the interpretation of three studies on Mediterranean, traditional Sámi, and low-carbohydrate dietary pattern scores in northernmost Sweden. *The Mediterranean Diet Chapter, 51*, 579–588.

Nilsson, L. M. (2018). Food, nutrition, and health in Sápmi, Ch 7. In *Nutritional and health aspects of food in Nordic Countries* (pp. 1–7). Elsevier Inc. https://doi.org/10.1016/B978-0-12-809416-7.00007-X

Okotetto, E. (2018). Traditional knowledge of Nenets about herbs and berries Dieđut: Arctic Indigenous Peoples Food System – The role of traditional knowledge for sustainable development. In S. D. Mathiesen, L. B. Gashilova, S. L. Chernyshova, & A. E. Gerasimova (Eds.), *DIEĐUT (1). Arctic Indigenous Peoples Food Systems: Role of Traditional Knowledge for Sustainable Development* (pp. 68–78). Paulsen LLC, *In Russian.*

Oskal, A. (2022). (Action): Future Arctic business. In P. A. Berkman, A. N. Vylegzhanin, O. R. Young, D. A. Balton, & O. R. Øvretveit (Eds.), *Building common interests in the Arctic Ocean with global inclusion. Informed decisionmaking for sustainability*. Springer. https://doi.org/10.1007/978-3-030-89312-5_22

Oskal, A., & Pogodaev, M. (Eds). (2019). *EALLU Arctic indigenous peoples food systems: Youth, Knowledge & Change. Arctic council sustainable development working group report from the EALLU project in 2015–2019, delivered to the 11th ministerial meeting of the Arctic Council Rovaniemi, Finland, May 7, 2019*. Association of World Reindeer Herders/International Centre for Reindeer Husbandry (ICR) Report 2019: 1. Guovdageaidnu/ Kautokeino, Norway, 2019.

Oskal, A., & Pogodaev, M. (2019a). New economic models and innovation. In A. Oskal & M. Pogodaev (Eds.), *Arctic indigenous peoples' food systems: Youth, knowledge & change 2015–2019. Arctic Council SDWG EALLU Ministerial Meeting Report 2019*. International Centre for Reindeer Husbandry and Association of World Reindeer Herders.

Oskal, A., & Pogodaev, M. (Eds.). (2019b). *Arctic indigenous peoples' food systems: Youth, knowledge & change 2015–2019. Arctic Council SDWG EALLU Ministerial Meeting Report 2019*. International Centre for Reindeer Husbandry and Association of World Reindeer Herders.

Oskal, A., Pogodaev, M., Mathiesen, S. D., Gerasimova, A., & Avelova, S. (2017). SDWG EALLU 2017 executive summary and recommendations for the Arctic Council. In Burgess et al. (Eds.),

Indigenous youth, Arctic change and food culture – knowledge and how we have thrived on the margins – EALLU. Arctic Council SDWG EALLU Ministerial Meeting Report 2017. International Centre for Reindeer Husbandry and Association of World Reindeer Herders.

Oskal, A., Turi, J. M., Mathiesen, S. D., & Burgess, P. (2009). *EALÁT. Reindeer herders voice: Reindeer herding, traditional knowledge and adaptation to climate change and loss of grazing lands*.

Polanyi, K. (1944). *The great transformation*. Beacon Press.

Reinert, R. (2007). *How rich countries got rich and why poor countries stay poor* (Vol. 94). Constable.

Reinert, S. A., Lewis, Q., Oskal, A., & Stokvik, K. (2022). *Entrepreneurship in a changing Arctic: Siberian Reindeer Herders and the Northern Sea Route*. Harvard Business School Case 722-005, February 2022. Revised July 2022.

Reinert, E. S., & Oskal, A. (2023). Reindeer herding in Norway: Cyclicality and permanent change vs. governmental rigidities. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer Polar Sciences). Springer.

Sahlin, K. R., Röös, E., & Gordon, L. (2020). 'Less but better' meat is a sustainability message in need of clarity. *Nature Food, 1*, 520–522. https://doi.org/10.1038/s43016-020-00140-5

Sara, R. B. M. E. (2019). Insight in meat quality through indigenous reindeer herders' traditional knowledge. In *EALLU Arctic indigenous peoples´ food systems: Youth, knowledge & change 2015–2019, an Arctic Council Sustainable Development Working Group report from the EALLU project in 2015–2019*. International Centre for Reindeer Husbandry.

Sara, R. B. M. E. (2023, forthcoming). *Sámi reindeer herder's food knowledge system – Multiple ways of knowing* (PhD thesis). UIT the Arctic University of Norway.

Sara, R. B. M. E., & Eira, I. M. G. (2021). Ađđamiin vai jolážiin – boazosápmelaččaid bohccobiergokvalitehta árvvoštallan. Sámi Dieđalaš Áigečála 1/2021: 7–38. Guovdageaidnu: Sámi allaskuvla. https://site.uit.no/aigecala/sda-2021-ravdna-biret-marja-e-sara-ja-inger-marie-gaup-eira/

Sara, R. B. M. E., & Mathiesen, S. D. (2020). Sámi gastronomy: The role of traditional knowledge. *Journal of Gastronomy and Tourism, 5*(1), 33–49.

Sara, R. B. M. E., Syse, K. L., & Mathiesen, S. D. (2022). Precious blood and nourishing offal: Past and present slaughtering perspectives in Sámi reindeer pastoralism. *Pastoralism, 12*, 20. https://doi.org/10.1186/s13570-021-00224-2

Sara, R. B. M. E., Turi, E. I., Buljo, R. M. M., Oskal, A., Mathiesen, S. D., & Aslaksen, I. (2021). Sámi reindeer pastoralism in Norway: The role of traditional knowledge for economy and governance. In S. Glomsrød, G. Duhaime, & I. Aslaksen (Eds.). *The Economy of the North – ECONOR 2020*.

Schumpeter, J. (1934). *The theory of economic development*. Harvard University Press.

Tonkopeeva, M., et al. (2023). Framing adaptation to rapid change in the Arctic. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences*. Springer. https://doi.org/10.1007/978-3-031-17625-8_2

Turi, J. M. (2002). The world reindeer livelihood – Current situation, threats and possibilities. In S. Kankaanpää, L. Müller-Wille, P. Susiluoto, & M.-L. Sutinen (Eds.), *Northern timberline forests: Environmental and socio-economic issues and concerns* (pp. 70–75). The Finnish Forest Research Institute.

Turi, E. I. (2016). *State steering and traditional ecological knowledge in reindeer-herding governance: Cases from western Finnmark, Norway and Yamal, Russia* [University of Umeå]. Umeå.

Turi, E. I., & Keskitalo, E. C. (2014). Governing reindeer husbandry in western Finnmark: Barriers for incorporating traditional knowledge in local-level policy implementation. *Polar Geography, 37*, 234–251.

Ulvevadet, B. (2004). Norway. In B. Ulvevadet & K. Klokov (Eds.), *Family-based reindeer herding and hunting economies, and the status and management of wild reindeer/caribou populations*. Arctic Council 2002–2004. Centre for Sami studies, University of Tromsø.

Unger, S. (2014). *Qaqamiigux: Traditional foods and recipes from the Aleutian and Pribilof Islands* (p. 384). Aleutian Pribilof Islands Publ.

van Rooij, W., Aslaksen, I., Eira, I. H., Burgess, P., & Garnåsjordet, P. A. (2023). Loss of reindeer grazing land in Finnmark, Norway, and effects on biodiversity: GLOBIO3 as decision support tool at Arctic local level. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry*. Springer Polar Sciences. Springer. https://doi.org/10.1007/978-3-031-17625-8_9

Wiig, B. (1984). Kvinner selv: den skjulte norgeshistorien fra vår nære fortid. Cappelen.

Wiklund, E. (2014). Experiences during implementation of a quality label for meat from reindeer (Rangifer tarandus tarandus). In *Trends in game meat hygiene: From forest to fork* (pp. 165–180). Wageningen Academic Publishers.

Wiklund, E., Farouk, M., & Finstad, G. (2014). Venison: Meat from red deer (Cervus elaphus) and reindeer (Rangifer tarandus tarandus). *Animal Frontiers, 4*(4), 55–61. https://doi.org/10.2527/af.2014-0034

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., et al. (2019). Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet, 393*(10170), 447–492.

World Reindeer Herders. (2017). *The Jokkmokk declaration*. Available at: https://www.reindeerherding.org/images/wrh/declarations/pdf/2017-Jahkamahkke-Declaration.pdf

Yang, Y., Hobbs, J. E., & Natcher, D. C. (2020). Assessing consumer willingness to pay for Arctic food products. *Food Policy, 92*, 101846.

Chapter 7
Reindeer Husbandry Trends: Nenets Autonomous Okrug and Western Finnmark

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Abstract Nenets Autonomous Okrug (Nenets AO) in Russia and Western Finnmark in Norway are two large reindeer husbandry regions in the circumpolar North. The Soviet Union pioneered the industrialization and collectivization of reindeer husbandry in Nenets AO in the 1930s, while structural and rational practices of Sámi pastoralism in Western Finnmark started in the 1970s. Both regions aimed to increase meat production by manipulating the herd size and structure, seasonal calf slaughtering, changing reindeer ownership, and introducing novel labor standards such as shift working, housing programs, and mobile cabins for the herders. Experimental science of rational reindeer husbandry in the Soviet Union might have inspired reforms and a new model for reindeer husbandry established in Norway in 1976. This paper analyzes trends in reindeer husbandry in Nenets AO and Western Finnmark in light of these structural changes. An increase followed the expanded

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proportions of females during these periods of change in the total number of reindeer in both regions. However, we observed significant differences between trends in reindeer husbandry in Nenets AO and Western Finnmark. We conclude that while Norway implemented an adjusted version of the Soviet model with as much as 90–95% females in the herd and started slaughtering calves instead of adult females and 1.5 years old males, Soviet structural and rational practices never encompassed more than 65% females. Before this reform, 45% of the herd in Norway were traditionally females. Trend analyses in Western Finnmark and Nenets AO indicate that Norway's extreme implementation of the new reindeer husbandry model increased the variability of calf production in Western Finnmark compared to calf production in Nenets AO. Despite Norwegian subsidies and policies encouraging high female percentages, a regression analysis based on data from 1981–2018 showed a negative correlation between the percentage of productive females and calf productivity in Western Finnmark. The rationale for the change in the management model in Norway in the 1970s was based on the assumption that reindeer herders in the North did not fully utilize the potential of the favorable climate conditions in Finnmark. However, in the past years, winters in Western Finnmark have changed. Increased winter air temperatures and changing snow conditions affect female reindeer. We conclude that Norway's modernization program for Sámi reindeer husbandry in Western Finnmark resulted in a highly volatile production of reindeer calves that negatively affected reindeer herders' food security and herding economy. The top-down productivity policy model for reindeer husbandry in Norway was weakly nested within Sámi herders' traditional cultures and knowledge.

Keywords Herd structure · Nenets reindeer husbandry · Sámi reindeer husbandry · Calf production · Collectivization

7.1 Introduction

Poor winter grazing conditions in the late 1960s in Western Finnmark in Norway might have been one of the reasons why "The regional plan for Northern Norway" commented a few years after: "the old form of reindeer husbandry in Finnmark has disintegrated without being replaced by anything new…An improvement in the sex and age composition of the reindeer herds and selection among breeding animals should be promoted. It is of great economic importance that the herd consists of an optimal number of females that get calves. The goal should be 5–10% breeding bulls and 90–95% females in the breeding herd" (NOU 33, 1972, page 69; Mathiesen et al., 2023). Norway's White Paper from the government to the parliament underlined: "Through guidance and information work, it will be possible to prevent forms of husbandry that lead to large losses of animals... It is also necessary to improve the sex and age composition of reindeer herds and to select breeding animals" (Norwegian White Paper 108, 1972–1973, p. 87. This was not the first attempt to

modernize Sámi reindeer husbandry in Norway. Already, in 1947, the Sámi reindeer pastoralists in Western Finnmark met the suggestion for modernization with hostility or unwillingness during the founding meeting of the Norwegian Association of Sámi Reindeer Herders (NRL) in Tromsø (Newhouse, 1952, 136–137)).

From the 1970s, Dr. Dag Lenvik also attempted to modernize Sámi reindeer husbandry in Norway. In 1988, Lenvik noted that the original idea of "structural" and "rational" reindeer husbandry practices in Norway, with high female proportions and large-scale calf slaughtering, was first developed in the Soviet Union as part of the collectivization of reindeer husbandry in the 1930s (Lenvik, 1988). In the pursuit of efficient and rational reindeer husbandry systems, the large-scale slaughter of calves and herd structuring in the Nenets Autonomous Okrug (between 1930 and 1977 – Nenets National District) and the Murmansk Oblast in Russia were a part of the state collectivization in the 1930s (Terletsky, 1932; Degteva, 2006). Applying structural and rational practices to the Sámi pastoralism in Western Finnmark, Norway, began with the reforms as late as the 1970s. According to Holand (2007), the highest possible proportion of reproductive females combined with a slaughtering scheme based on calves was introduced in the 1960s in Finland and, subsequently, Norway. The new development of Finnish reindeer husbandry gained success due to a stationary operating system in Finland with less need for traction, and reindeer husbandry was strongly influenced by Finnish agriculture (Holand, 2007). Sámi herding practices in Finnmark had been presented as irrational in public discourse in Norway, and in the 1970s, the country's model for reindeer husbandry was modified toward calf slaughtering and high female proportions (Johnsen et al., 2015), based also on the results from the Røros experience in south Norway. Ten years earlier, Anders Fjellheim, a Southern Sámi, later responsible for reindeer husbandry in Røros, reported to *Dagbladet* in Norway after his visit to the Soviet Union: "The Soviet Russians operate domestic reindeer herding according to completely different guidelines than we do in this country. They have established research stations and, through planned breeding, developed large, powerful animals. They use specially selected breeding bulls. To make it as rational as possible, half of the calves were slaughtered in October – about eight months old" (Adresseavisen, 1960; VG, 1960; Dagbladet, 1960; Mathiesen et al., 2023). Before these reforms, the traditional practices of Sámi reindeer husbandry in Western Finnmark were considered neither optimal nor productive (Lenvik, 1990; Riseth, 2000). Mathiesen et al. recently documented the information exchange between reindeer husbandry experts from the Soviet Union and Nordic countries between 1957 and 1974. This cross-border exchange tracks how critical elements of rationalization in Norway had been borrowed from the Soviet practice (Mathiesen et al., 2023). Therefore, in the present chapter, we investigate the data behind this information exchange and compare the trend in total numbers of reindeer, herd structure, and calf production in two reindeer husbandry regions. The goal in Western Finnmark, Norway, and Nenets AO, Russia, was to increase meat production. The high ratio of female reindeer in the Nenets AO was intended to increase the total number of reindeer, and collectivization policies transformed small herds with simple cooperation into

industrial reindeer units (Khakhovskaya, 2019). In the chapter, we investigate how the new productivity policy model affected the number of reindeer and calf production in Nenets AO and Western Finnmark. We argue that Norway's top-down productivity maximization approach did not account for reindeer herders' traditional knowledge and failed.

7.2 Methodology

We compare reindeer husbandry productivity trends in Nenets AO, Russia, and Western Finnmark, Norway, to seek new insights into the dynamics of the development of reindeer husbandry in Norway.

Historical recordings from Russia on the number of reindeer, herd structure, and calf production were collected back in the 1930s at the Naryan-Mar Agriculture Research Station, N. Laverov Federal Centre for Integrated Arctic Research of the Ural Branch of the Russian Academy of Sciences, and Nenets Autonomous Okrug. The data accumulation in the Nenets AO in the 1930s was also related to the increased role of veterinary research and the interest of experts in general. Reindeer statistics from the Soviet period are easily accessible in local and regional archives. Istomin et al. (2022) note that collectivization meant that reindeer numbers never constituted a "commercial secret." Each dataset collected from the Nenets AO brigades (herding units) was photo documented and digitized. A group of reindeer husbandry experts counted each brigade in Nenets AO four times a year. Data from January 1 was used for the comparative trend analyses.

In contrast to the Nenets AO, little was known about using tundra pastures in Western Finnmark in Norway before the modernization. The reindeer husbandry statistics in Norway became available after the 1976 reform since the new model demanded official statistical data. Exact numbers about herd structure and calf production in Norway were not recorded systematically until 1980 (Landbruksdirektoratet, 2021), but herd numbers still indicate the population trend from 1946.

In this chapter, we define collectivization as the transformation of ownership from private to state property. In the 1930s, the Soviet state seized land and collective agricultural units where workers would produce for the state to distribute. Industrialization is understood as the social and economic change that transforms human communities from agricultural into industrial societies involving reorganization of the economy for the purpose of production and manufacturing.

Each Sámi reindeer herder reported the total number of reindeer, herd structure, and calf production on March 31 annually, and each herd was counted every fourth year by the Directorate of Reindeer Husbandry. Data from March 31 was used for the comparative trend analyses.

We sort the reindeer according to the three categories of Norwegian registration standards, e.g., "Report of reindeer husbandry": bulls, females, and calves. Females are all females over 1 year, bulls are all males over 1 year, and calves are both sexes under 1 year as of the day of data collection. Calf production per 100 females in Norway is the percent of total females as of March 31. It is the dominant indicator for managing reindeer husbandry in Norway today. "Calves after loss" are defined as the proportion of calves that either go to slaughter or are selected for future breeding (Ressursregnskap for reindriftsnæringen, 2017–2018, p. 13). The number of adult females (over 1 year) in the spring herd was used for analysis.

Using standard statistical analysis, we made a historical graph of the total number of reindeer in Nenets AO, Russia, between 1930 and 2020 and in Sámi reindeer husbandry in Western Finnmark, Norway, between 1946 and 2018 (Fig. 7.2). Moreover, we illustrated the percentages of productive females in herds in Nenets AO and Western Finnmark from 1981 to 2018 (Fig. 7.3). We calculated the population growth rate (average vs. specific) to distinguish trends in the total number of reindeer as the percentage of female reindeer increased in Nenets AO, Russia, and in Sámi reindeer husbandry in Western Finnmark, Norway (Fig. 7.4). We verified our observations using statistical data analysis techniques using Python's built-in descriptive mathematical statistics module. Finally, we calculated the correlation between productive female percentage and calf production percentage in Nenets AO and Western Finnmark between 1981 and 2018 (Fig. 7.4).

Western Finnmark in Northern Norway was a traditional nomadic reindeer husbandry region until permanent roads were built in 1973. It is an old administrative unit with a center in Guovdageaidnu, the largest municipality and reindeer husbandry area in Norway (69° 0′ 41.44″ N, 23° 2′ 29.33″ E). The primary language in Guovdageaidnu is Northern Sámi, both among nomadic herders and settlers and spoken by most inhabitants. Western Finnmark was selected as a study area since this nomadic society was built on the Sámi reindeer herders' culture, values, and traditional knowledge (Eira, 2012a). Reindeer husbandry in Western Finnmark is divided into three migration zones used by 213 rightsholders, 1490 private reindeer herders, and 29 herding districts (Landbruksdirektoratet report nr. 46/2022). Sámi herders migrate between coastal summer pastures and inland winter pastures and have, until recently, been autonomously using the grazing areas. Nenets AO was established in 1929 with the administrative center in Naryan-Mar, 67° 39′ 0.00″N, 53° 2′ 60.00″E. It is one of the largest reindeer herding areas in present-day Russia, accommodating 26 reindeer herding enterprises with different forms of ownership and employing 719 nomadic and semi-nomadic reindeer herders (GoArctic, 2022). The Nenets and Komi peoples practice reindeer husbandry in the area. The region was selected for the case study primarily because of its pioneer status in the collectivization and modernization of reindeer husbandry in the early 1930s. Western Finnmark in Norway and Nenets Autonomous Okrug (Nenets AO) in Russia totaled 78,909 and 177,822 domesticated reindeer in 2019, respectively (Fig. 7.1).

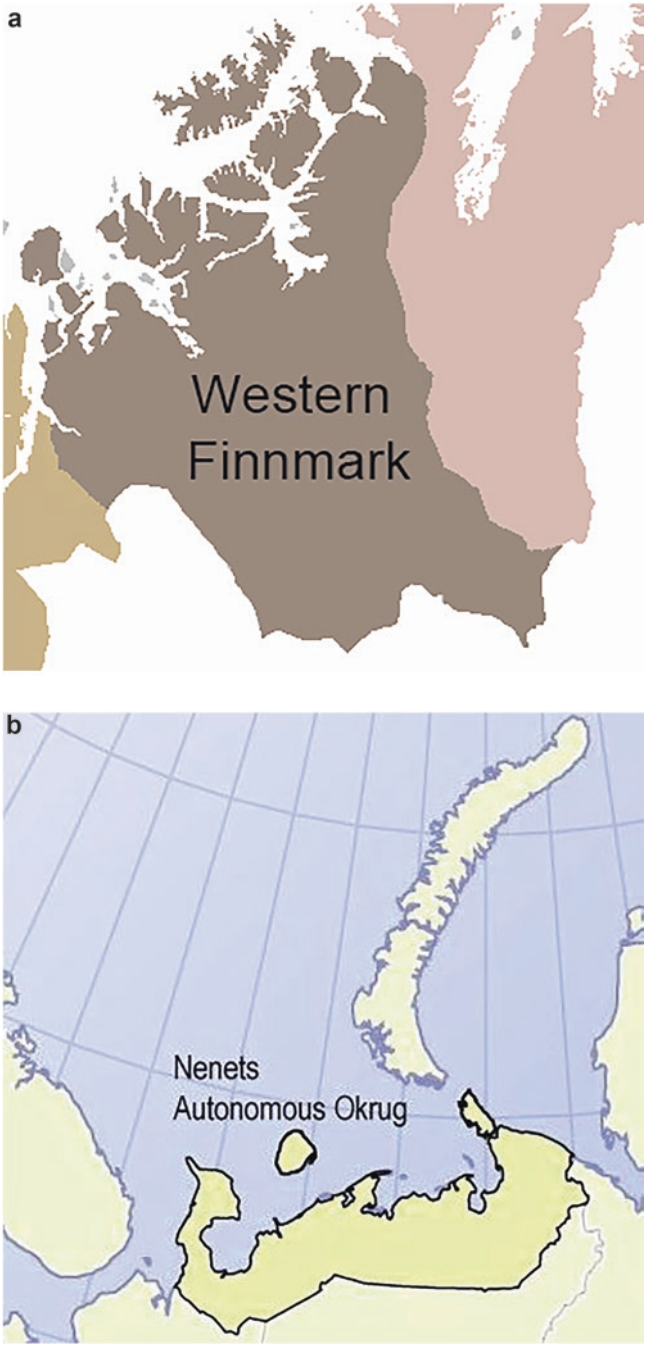

Fig. 7.1 (**a**) Western Finnmark, Norway, a reindeer herding region investigated, including Lyngen peninsula and Reinøya island. (Map: based on Johnsen et al., 2015). (**b**) Nenets Autonomous Okrug, Russia, a reindeer herding region investigated. (Map: GRID-Arendal)

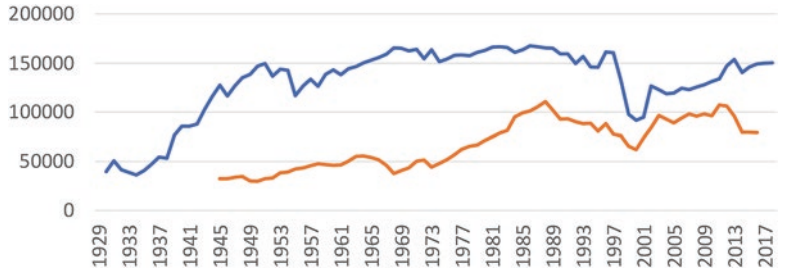

Fig. 7.2 The total number of reindeer in Nenets AO, Russia, from 1930 to 2020 (blue) and in Sámi reindeer husbandry in Western Finnmark, Norway, from 1946 to 2018 (orange)

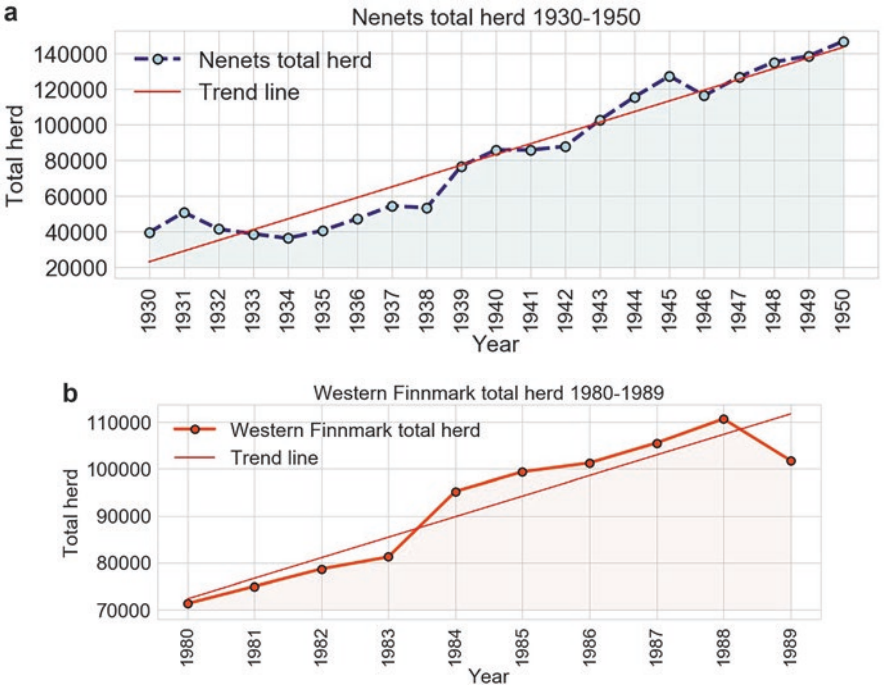

Fig. 7.3 (**a**) Trends in the reindeer increase rates after changes in herd structure in Russia and Norway, respectively. In Nenets AO, Russia, between 1930 and 1950, the average growth rate was 5363.6, and the specific growth rate was 0.1361 (divided by the initial number of individuals). (**b**) Trends in the reindeer increase rates after changes in herd structure in Russia and Norway, respectively. In Western Finnmark, Norway, between 1980 and 1989, the average growth rate was 3383.2

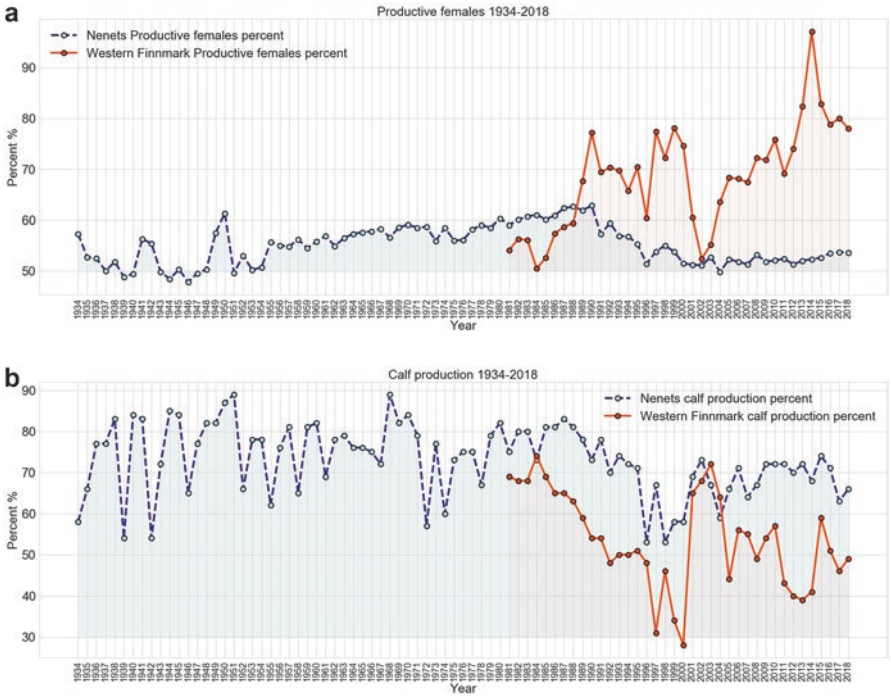

Fig. 7.4 (**a**) Percentage of the productive females in Nenets AO (blue) in 1930–2018 ($n = 177{,}822$) and in Western Finnmark (red) during the period 1981–2018 ($n = 78{,}909$) (above). (**b**) Calf production as a percentage of calves that are either slaughtered or selected for future breeding (calves after loss) in Nenets AO (blue) 1930–2018 and Western Finnmark (red) during the period of 1981–2018

7.3 Results

7.3.1 Trends in the Total Number of Reindeer in Nenets AO and Western Finnmark

Trends in total numbers of reindeer in Nenets AO from 1930 to 2020 and in Sámi reindeer husbandry in Western Finnmark from 1946 to 2018 are shown in Fig. 7.2. The total number of reindeer in Nenets AO increased between 1930 and 1950 when large-scale reindeer calf slaughtering, structuring of the herds, and expanded female proportions increased the sizes of the herds. In Western Finnmark, the total number of reindeer started to grow in the 1970s (Fig. 7.2) after implementing the official state program to change the structural and rational practices of Sámi reindeer herding with an increased proportion of females and large-scale calf slaughtering.

The specific growth rate of increase in the numbers of reindeer in Nenets AO from 1930, when the collectivization started, was 0.0645 with a variation coefficient (46.5%) (divided by the average number of individuals), compared to the specific growth rate of 0.0368 (the coefficient of variation 15.3%) in Western Finnmark, Norway, from 1980. The herd structure change might have affected the growth rate in Western Finnmark, but slightly less than in Nenets AO in the 1930s.

By 2019, the number of domestic reindeer in Nenets AO amounted to 177,822 (Fig. 7.2). Reindeer belong to various forms of ownership in Nenets AO, e.g., "*sel'sko-khozyaystvenniy kooperativ*" (SPK) (agricultural production cooperatives), family-clan communities or "*semeino-rodovaya obschina*" (SRO), and private owners (Klokov, 2020). SPK alone owned 119,012 heads, and 610 of 723 Nenets and Komi reindeer herds belong to SPK.

In 2019, Western Finnmark had 78,909 reindeer, 1535 private reindeer herders, 212 rightsholders, and 29 reindeer herding districts (Reindrifts resurssregnskap, 2019–2020) (Fig. 7.2).

7.3.2 Herd Structure in Nenets AO and Western Finnmark

Herds typically comprise females, castrated bulls, breeding males, and young animals (Polyakov, 1930). By 2019, the all-over reindeer herd in Nenets AO included 56% females, 27% males, and 17% calves (Tatyana Romanenkova, unpublished data). The data presented is a mean average for Nenets AO. However, the female percentages of some reindeer herding units today can be as high as 70% depending on grazing pastures and the short migration routes (<150 km).

In 2019–2020, in Western Finnmark, the mean herd structure comprised 79% females, 7% males, and 14% calves (Reindriftens Resurssregnskap 2019–2020). In the early 1980s, about 50–60% of the herds were females, which peaked at more than 90% in 2014. The proportion of females in the reindeer herds in Western Finnmark was highly variable between 1981 and 2018 (Fig. 7.4a). However, lower percentages of females in the herds were associated with higher calf production (Fig. 7.4b).

The share of female reindeer in the herd in Nenets AO was more stable: the herds comprised approximately 60% of females (Fig. 7.4a). Data from Western Finnmark indicate that the extremely high percentages of females in the herd are associated with reduced calf production (Fig. 7.4b). Norway's implementation of the new production model (e.g., high female percentages) increased the variability of calf production in Western Finnmark (27–77%) compared to calf production in Nenets AO (60–85%). In addition, we investigated the correlation between productive female percentage and calf production percentage (Fig. 7.5). The linear regression lines are marked in red for both regions (Fig. 7.5). There is a strong negative correlation for Western Finnmark and a positive correlation for Nenets AO. The Pearson analyses (−0.755 for Western Finnmark, 0.661 for Nenets AO) and rank-order Spearman analyses (−0.764 for Western Finnmark, 0.619 for Nenets AO) correlation

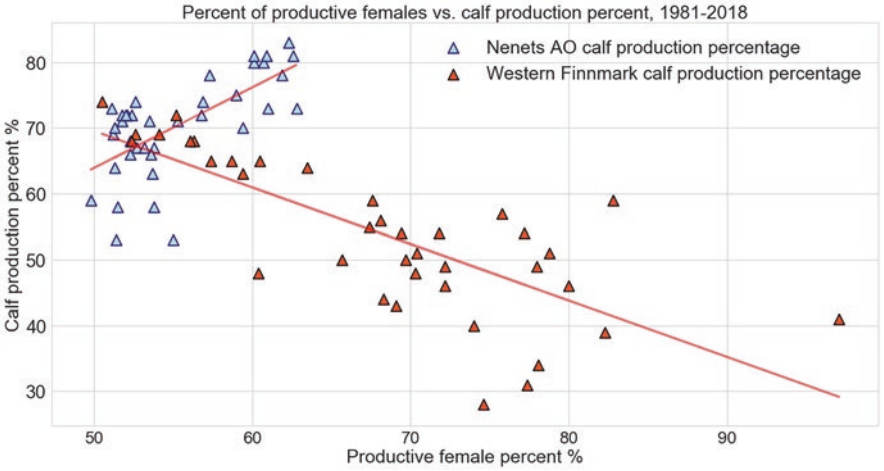

Fig. 7.5 Correlation between productive female and calf production percentages during the period 1981–2018 in Nenets AO and Western Finnmark. The Pearson (−0.755 for Western Finnmark, 0.661 for Nenets AO) and rank-order Spearman (−0.764 for Western Finnmark, 0.619 for Nenets AO) correlation coefficients are significant in both cases and close to each other

coefficients are significant in both cases. Increased numbers of females above 55% probably increase the density of female reindeer on the calving ground and affect the calf production percentage.

7.4 Discussion

7.4.1 Trends in the Number of Reindeer

According to Polyakov (1930), the Soviet government recognized the need to organize reindeer breeding in the public sector of the economy. The Soviet slogan "Million reindeer now!" appeared due to the new methods aimed at increasing the herd size (Khakhovskaya, 2019). In Nenets AO, the new model was initially used to transform small herds into industrial reindeer herding units (Khakhovskaya, 2019). The rationale behind the reindeer husbandry "modernization" in Nenets AO and Western Finnmark was to increase the numbers of females and calf production (Mathiesen et al, 2023). Yrjo Alaruikka, a Finnish expert in reindeer husbandry, accepted the new methods of reindeer husbandry and cooperated closely with the Soviet experts in reindeer husbandry for many years (Alaruikka, 1959). He also strongly influenced the reform of reindeer husbandry in Finland and Norway (Mathiesen et al., 2023). Subsequently, the number of reindeer in Finland, Sweden, and Norway increased in 1970 and through the 1980s, respectively (Helle & Kojola, 2006). We argue that the high proportion of female reindeer in the herds

introduced in the Sámi reindeer herding in these countries might explain this simultaneous increase in the numbers of reindeer. In Norway, overstocking of the reindeer population in Western Finnmark has been a part of the scientific-based discussion for quite a long time (Benjaminsen et al., 2015; Ims et al., 2007; Tveraa et al., 2007; Stien et al., 2022), but few have connected the overstocking with the unusually high proportions of female reindeer.

The official reindeer herding statistics in Norway and Russia used in this investigation have to be handled with precariousness in scientific analyses in both countries. The data aggregated by the officials "reflect the world as the state wants to see it" (Istomin et al., 2022: 2). We argue that statistical data are valuable sources of information for both countries' general overview and trend analyses of reindeer husbandry. The investigated trend in the number of reindeer in the two regions shows that the increased proportions of females in the herds are followed by an increase in the total number of reindeer in Nenets AO in the 1930s and Western Finnmark in the 1970s.

7.4.2 Traditional Knowledge in Reindeer Husbandry

In the twentieth century, Sámi herding practices in Finnmark were considered irrational in Norway's public discourse and referred to as "not so optimal and not so productive" (Lenvik, 1990; Riseth, 2000). As a result, in the 1970s, the traditional Sámi system was changed in favor of calf slaughtering and high female proportions (Johnsen et al., 2015). In the 1960s, Sámi reindeer herds in Finnmark typically comprised 43–50% adult females, and two-thirds of the males were castrated (Vostryakov & Mezhetsky, 1968; Paine, 1994; Tyler et al., 2007). Before the reform, the traditional Sámi herd structure would include 50% females (>1 year) (Vostryakov & Mezhetsky, 1968; Mathiesen et al., 2023).

Traditional knowledge is a systematic way of thinking and knowing elaborated and applied to phenomena across biological, physical, cultural, and linguistic systems, generated through cultural practices and lived experiences, including extensive and multigenerational observations, lessons, and skills (Ottawa Principles, 2014). Both Nenets reindeer husbandry culture in Russia and Sámi reindeer husbandry in Norway are rich in traditional knowledge reflected in their languages, practices, and livelihoods.

The Sámi language has a well-developed terminology to describe different individuals as part of the structure in the herd. The terminology includes, among other things, ear markings, color, shape of antlers, body structure related to behavior and grazing periods, use of pastures, slaughtering, and breeding (Degteva, 2006; Degteva & Nellemann, 2013; Eira, 1984, 2011, 2012a, b; Eira et al., 2023; Turi, 2016; Sara et al., 2022; Krarup-Hansen et al., 2022). The practices of Sámi and Nenets reindeer herders encompass intergenerationally inherited traditional knowledge, which was hardly included in the reforms carried out in their countries. The experts ignored

Indigenous reindeer herders' knowledge in the Soviet Union and Norway. Yuzhakov (2004a, b) concluded that there are two types of reindeer breeding in Russia: scientific selection and Indigenous selection of reindeer. In Russia's long history of practicing scientific selection, not a single breed of reindeer has been created by scientific selection, while Indigenous reindeer herders' selection resulted in five breeds (Yuzhakov, 2004a, b). According to Mathiesen et al. (2023), "The Norwegian reindeer husbandry experts visiting the Soviet Union in the 1960s were impressed with the models of collectivization and industrialization but might not have been able to see the difference between Indigenous and scientific breeding in the experimental herds."

7.4.3 Increased Densities of Reindeer in Critical Areas in Western Finnmark

We discuss the trends in development in the numbers of reindeer in view of reindeer herders' traditional knowledge. From the middle of April to the middle of May, the herd as a unit changes (Eira et al., 2023). At this time of year, the females separate from the males (*boskin*), on their way to the coastal summer pasture. After this, two different herds are established – a female herd (*čoavjjet eallu*, later called *aldu eallu* after the calves are born) and a male herd (*luovas eallu*) (Eira et al., 2023). The *luovas eallu* usually graze freely on vegetation not used by females and calves. The introduction of the new model of reindeer husbandry with high proportions of female reindeer in Western Finnmark in the 1970s resulted in the reduced proportion of male reindeer, intact and castrated reindeer. Consequently, reindeer herders had to keep only one mixed herd of females and males during migrations. The previous year's calves (*cearpmat*) would now follow the main herd, dominated by females. As a result, the presence of the previous year's calves increases the grazing density on the calving grounds and early summer pastures. This factor could contribute to the condition when calf production decreases with high numbers of females in the herd (see Fig. 7.5).

Issat Turi, a reindeer herder from Western Finnmark, reported that in such "modern herds," female reindeer with newborn calves might be found to kill their newborn calves in favor of caring for the calves born in the previous year (*cearpmat*). This might also explain why the herds with high numbers of female reindeer produce fewer calves than herds with a lower proportion of females. The high density of female reindeer in the herds, particularly in Western Finnmark, might have resulted in increased grazing pressure on calving grounds and early summer pastures, those pastures which are already under pressure from competing activities (van Rooij et al., 2023). This, in turn, might contribute to decreased calf survival.

Another factor affecting calf production in Norway is a high loss to predation (Gerasimova et al., 2023). According to reindeer herder Johan Daniel Turi as stated in the Arctic Council report on EALLIN Reindeer Herding Youth Project 2012–2015 (in Pogodaev et al., 2015) "...the high number of losses to predators in

Norway is a result of the authorities' economic subsidies for slaughtering calves. We have to save every female reindeer as a 'production reindeer' to yield enough economically, even though the weak female reindeer are not strong enough to protect their calves against predators. That system generates problems because the 'bad genetic' female reindeers that should have been slaughtered in the first place keep reproducing the frail reindeer. Such a herd is far more vulnerable to predators. We cannot adapt the herd structure based on our own knowledge. For example, in areas with a higher risk for predator attacks, one cannot have a herd structure based on the calf production as an economic centerpiece" (Pogodaev et al., 2015, p. 66). This statement could also explain why the calf production in Western Finnmark decreased with an increasing proportion of females in the herds. Traditional elements of Sámi governance, such as diversity, flexibility, and mobility, are not reflected in Norway's reindeer husbandry regulations (Turi, 2008). Instead, Norway's approach to governing Sámi reindeer herding systems uses equilibrium-based management tools such as carrying capacity and other tools designed for agricultural contexts that can undermine the system's resilience (O'Brien et al., 2009; Tyler et al., 2007).

Johan Mathis Turi, a former vice-president of the Norwegian Sámi Reindeer Herders' Association (NRL), a member of the Norwegian Reindeer Husbandry Board since 1978, and a founding president of the Association of World Reindeer Herders (WRH), expressed his concern on how the governmental intervention affected traditional knowledge in reindeer husbandry (Nergaard, 2019). Regarding "calf slaughtering," which was crucial for the new management model, Turi says today: "We agreed to it because we did not know the consequences." He further explains: "In the 1970s, the Ministry of Agriculture in Norway gave the reindeer herders financial support to keep fewer bulls in the herds and replace them with calves and females." The central keyword was "calf slaughtering," pursuing an incorporated model in agricultural management: "We had never thought about how the herds would behave on winter pastures with fewer bulls. Nature is arranged in such a way that the bulls lose their antlers when the mating season is over in the fall. The females get antlers when the bulls lose theirs. The females benefit from this on winter pastures, where the bulls are the strongest to dig and get to the pastures under the snow. The females can drive them away after they dig out pastures. With fewer bulls to dig, an unusual number of females and calves flock around the few bulls we have to keep. It leads to intense grazing in fewer areas. The bulls do not graze side by side. They spread the herd and, in this way, ensure a smoother and more gentle grazing," Turi explains.

> Living in marginal nature requires deep insight into the conditions and boundaries it sets for life. Insight is a prerequisite for the sustainable management of grazing areas. Those who harvest nature know the situation better than anyone else. They know that nature has its absolute limit. When they use and harvest, they operate within these boundaries. The rigorous direction that nature itself sets for sustainable management must therefore be marked in social patterns of the community that harvests. (Nergaard, 2019)

The rationale for the management model change in Norway in the 1970s was that reindeer herders in the North did "not fully utilize the potential for high production offered by favorable winters" in Finnmark (NOU 33, 1972). Recently, winters in

Western Finnmark have changed due to increased winter air temperatures and changing snow conditions (Hanssen-Bauer et al., 2023), affecting the female reindeer population.

According to Lenvik and Fjellheim, Dobrotvorskiy's herd structuring research in the 1930s and 1940s in Nenets AO catalyzed the Soviet calf slaughter practices that later inspired Nordic experts (Lenvik, 1988; Lenvik & Fjellheim, 1987; Dobrotvorskiy, 1938). Lenvik is known for implementing the new model based on a different herd structure in Sámi reindeer husbandry. His research started during the early 1970s in Norway and was formally referred to as a "structuring and optimization process" (Lenvik, 1990). However, as we have discussed, these structural and rational practices negatively affected Sámi reindeer husbandry in Western Finnmark. These changes, to a lesser extent, also affected the Nenets people in the Nenets Autonomous Region in Russia (Degteva, 2006; Mathiesen et al., 2023).

7.5 Conclusion

Understanding the dynamics of reindeer husbandry is crucial for sustainable practices. The chapter findings highlight the historical and contemporary trends in reindeer populations in Nenets AO and Western Finnmark, emphasizing the influence of factors such as herd structuring, shares of female reindeer in the herd, and calf slaughtering. We outline the historical trends in the number and ratio of reindeer and herd structures in both regions and contribute to the understanding of managing reindeer husbandry practices in the regions. The herd structure in Nenets Autonomous Okrug (AO) and Western Finnmark has undergone significant changes over the years, focusing on increasing the number of females and calf production. The data shows that the proportion of females in the herds has varied, with Western Finnmark experiencing higher percentages of females than Nenets AO. The increase in reindeer numbers in both regions was associated with changes in herd structure. The high density of female reindeer in the herds, particularly in Western Finnmark, might have resulted in increased grazing pressure on calving grounds and spring and summer pastures. This, in turn, contributed to decreased calf production. The presence of the previous year's calves following the main herd dominated by females has also impacted calf production. Additionally, the loss of grazing land used for calving and early summer use, high losses to predation, economic subsidies for slaughtering calves, and subsequent preservation of frail female reindeer further affected calf production in Western Finnmark. Traditional knowledge held by Indigenous reindeer herders, such as the Sámi and Nenets people, played a crucial role in understanding the productivity of reindeer herds. The increase in female reindeer proportions in both regions was influenced by the implementation of new production models and management practices: collectivization in the Soviet Union in the 1930s–1960s and reforms in Norway in the 1970s. Authorities in both states did not fully rely on the traditional knowledge of reindeer herders when designing and implementing their reforms. The traditional Sámi system in Western Finnmark

was changed to prioritize calf slaughtering and higher female proportions. Aimed to increase overall productivity, this change affected the Sámi reindeer husbandry, ignoring the potential of the Sámi family-based reindeer economy. The top-down productivity policy model for reindeer husbandry in Norway was merely nested within Sámi herders' traditional cultures and knowledge. We conclude that the new model of Sámi reindeer husbandry implemented in Norway resulted in a highly variable production of reindeer calves and altered the essence of reindeer husbandry in Western Finnmark. We argue that incorporating traditional knowledge, including observations and practices passed down through generations, could provide valuable insights into reindeer husbandry. Our findings suggest that the herd structure, especially the proportion of females, significantly impacts calf production and grazing capacities of summer and spring pastures. Balancing the herd structure and including traditional knowledge in reindeer husbandry practices could help mitigate the negative effects. Understanding and recognizing Indigenous knowledge can contribute to more sustainable and resilient reindeer husbandry.

7.6 Ethics

This article follows the ethical guidelines of the National Committee for Research Ethics in the Social Sciences and the Humanities (NESH) guidelines 6, 7, 8, 13, 16, 19, 21, 23, 24, 25, 43, and 46 (NESH, 2022); the ethical guidelines of the National Committee for Research Ethics in Science and Technology (NENT) guidelines 14, 15, and 16 (NENT, 2019); and the guidelines 1.3, 2.1, 4.3, and 7 of the International Centre for Reindeer Husbandry (ICR) (Sundset et al., 2007).

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References

Adresseavisen. (1960, April 27). Norske samer har sett på reindrift i Sovjet. Interessant tur til Kola-halvøya 27 April. Norwegian Sami have seen reindeer husbandry in the Soviet Union. Interesting trip to the Kola Peninsula.

Alaruikka, Y. (1959). *Poronhoito suomensukuisten kansojen keskuudessa* [Reindeer husbandry among Finnic peoples]. Rovaniemi: Lapin Maakuntapaino. 48 pp.

Benjaminsen, T. A., Reinert, H., Sjaastad, E., & Sara, M. N. (2015). Misreading the Arctic landscape: A political ecology of reindeer, carrying capacities, and overstocking in Finnmark, Norway. *Norsk Geografisk Tidsskrift–Norwegian Journal of Geography, 69*(4), 219–229. https://doi.org/10.1080/00291951.2015.1031274

Dagbladet. (1960). *Norsk same fra Sovjet. Reinen i kollektivbruk i Murmansk*. p 10 nr 95, April 25th Norwegian Sami from the Soviet Union. Reindeer in collective use in Murmansk. p 10 nr 95 April 25th. Private telegram from Anders Fjellhein.

Degteva, A. (2006). *Oil industry and reindeer herding: The problems of implementing indigenous rights in the Nenets autonomous Okrug, Russia* (Master thesis of Philosophy in Indigenous Studies). Faculty of Social Science, University of Tromsø.

Degteva, A., & Nellemann, C. (2013). Nenets migration in the landscape: Impacts of industrial development in Yamal peninsula, Russia. *Pastoralism, 3*, 15. https://doi.org/10.1186/2041-7136-3-15

Dobrotvorskiy I. M. (1938). Growth and development of reindeer calves in land-poor tundra. In *Scientific proceedings*. Scientific Research Institute of Polar Agriculture, Cattle Husbandry and Game Farming. Reindeer husbandry series. L., – Vol. 3, pp. 7–98. [Добротворский И. М. (1938). Рост и развитие телят оленей в условиях малоземельной тундры // Науч. тр. / НИИ поляр, земледелия, животноводства и промысл, хоз-ва. Сер. Оленеводство. Л., – Вып.3. -С. 7–98.]

Eira, N. I. (1984). *Boazobargi giella. Dieđut 1984/1. Guovdageaidnu*. Sámi Instituhtta.

Eira, N. I. (2011). *Bohccuid luhtte* (2nd revisited edition). In Northern Sami.

Eira, I. M. G. (2012a). *The silent language of snow. Sámi traditional knowledge of snow in times of climate change* (PhD thesis). UIT The Arctic University of Norway. https://munin.uit.no/bitstream/handle/10037/9843/thesis.pdf?sequence=6&isAllowed=y

Eira, R. B. M. (2012b). Using traditional knowledge in unpredictable critical events in reindeer husbandry. *The case of Sami reindeer husbandry in Western Finnmark, Norway, and Nenets reindeer husbandry in Yamal peninsula, Yamal-Nenets AO, Russia* (MS thesis). University of Tromsø, Norway.

Eira, I. M. G., Turi, E. I., & Turi, J. M. (2023). Sámi traditional reindeer herding knowledge throughout a year: Herding periods on snow-covered ground. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences*. Springer. https://doi.org/10.1007/978-3-031-17625-8_4

Hanssen-Bauer, I., Benestad, R. E., Lutz, J., Vikhamar-Schuler, D., Svyashchennikov, P., & Førland, E. J. (2023). Comparative analyses of local historical and future climate conditions important for reindeer herding in Finnmark, Norway and the Yamal Nenets Autonomous Okrug, Russia. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_8

Helle, T., & Kojola, I. (2006). Population trends of semi-domesticated reindeer in Fennoscandia – Evaluation of explanations. In B. C. Forbes, M. Bölter, L. Müller-Wille, J. Hukkinen, F. Müller, N. Gunslay, & Y. Konstantinov (Eds.), *Reindeer management in northernmost Europe* (pp. 319–339). Springer Science & Business Media.

Holand, Ø. (2007). Flokkstruktur og slaktestrategi i reindrifta – et historisk perspektiv. Herd structure and slaughter strategy in reindeer husbandry – A historical perspective. NORs 14. nordiske forskningskonferanse om rein og reindrift Rangifer Report No. 12 (2007): 21–33 Vantaa, Finland, 20.-22. Mars 2006 In Norwegian.

Gerasimova, A., Avelova, S., Lutz, J., Mathiesen, S. D., Moiakunova, A., Petrova, A., Pogodaev, M., Popova, L., Shadrin, V., Shishigina, A., & Zhozhikov, A. (2023). Adaptation to change in reindeer husbandry in the republic of Sakha (Yakutia), Russia. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences*. Springer.

GoArctic. (2022). V NAO gotovyatsya k sezdu olenevodov [NAO is getting ready for Reindeer Herders' Congress] in Russian. Available at: https://goarctic.ru/news/v-nao-gotovyatsya-k-sezdu-olenevodov/

Ims, R. A., Yoccoz, N. G., Bråthen, K. A., Fauchald, P., Tveraa, T., & Hausner, V. (2007). Can reindeer overabundance cause a trophic cascade? *Ecosystems, 10*, 607–622.

Istomin, K. V., Laptander, R. I., & Habeck, J. O. (2022). Reindeer herding statistics in Russia: Issues of reliability, interpretation, and political effect. *Pastoralism, 12*, 19. https://doi.org/10.1186/s13570-022-00233-9

Johnsen, K., Benjaminsen, T. A., & Eira, I. M. G. (2015). Seeing like the state or like pastoralists? Conflicting narratives on the governance of Sámi reindeer husbandry in Finnmark, Norway. *Norsk Geografisk Tidsskrift – Norwegian Journal of Geography, 69*(4), 230–241. https://doi.org/10.1080/00291951.2015.1033747

Khakhovskaya, L. N. (2019). The interaction of people and animals in the Chukchi reindeer husbandry of modern times (anthropological aspect). *Bulletin of Archeology, Anthropology and Ethnography, 1*(44), 98–107.

Klokov, K. B. (2020). Diversity of regional trends in traditional reindeer husbandry in the Russian Arctic. *5th International Conference "Arctic: History and Modernity" IOP Publishing IOP Conference Series: Earth and Environmental Science, 539*(2020), 012180. https://doi.org/10.1088/1755-1315/539/1/012180

Krarup-Hansen, K., Túri, I., Sundset, M. A., & Mathiesen, S. D. (2022). Bridging traditional and scientific knowledge on reindeer meat smoking – A pilot study. *International Journal of Circumpolar Health, 81*, 2073056.

Landbruksdirektoratet. (2021). Resource accounting for the reindeer industry report "Ressursregnskap for reindriftsnæringen 2019". Available at: https://www.landbruksdirektoratet.no/nb/filarkiv/rapporter/Ressursregnskap%20for%20reindriftsnæringen%202020–21%20versjon%202.pdf/_/attachment/inline/0166e952-6cb4-4bdd-893b-915b93d95c63:77d7b3e921a90632b1fff6070ab9c23b4049c194/Ressursregnskap%20for%20reindriftsnæringen%202020–21%20versjon%202.pdf. Report 32/2021, pp 81.

Lenvik, D. (1988). *Utvalgsstrategier i reinflokken*. Reindriftsadministrasjonen.

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

Lenvik, D., & Fjellheim, A. (1987). *Utvalgsstrategi i Reinflokken. 1 Standard tilleggskode for rein*. (Selection strategy in domestic reindeer. Standard tag system for reindeer) Norsk Landbr. Forskn.

Mathiesen, S. D., Aikio, P., Degteva, A., Romanenko, T., & Tonkopeeva, M. (2023). Historical aspects of cross-border cooperation between Nordic and Soviet experts in reindeer husbandry. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer.

NENT. (2019). Guidelines for research ethics in science and technology issued by the Norwegian National Committee for Research Ethics in Science and Technology (2016). Published: 8/7/2019. Available at: https://www.forskningsetikk.no/en/guidelines/science-and-technology/guidelines-for-research-ethics-in-science-and-technology/

NESH. (2022). *Guidelines for research ethics in the social sciences and the humanities*. Given by The National Committee for Research Ethics in the Social Sciences and the Humanities (NESH) in 2021 (5th edition). English translation published 2022. Available at: https://www.forskningsetikk.no/en/guidelines/social-sciences-humanities-law-and-theology/guidelines-for-researchethics-in-the-social-sciences-humanities-law-and-theology/

Nergaard, J. I. (2019). Dialoger med naturen – etnografiske skisser fra Sápmi. *Universitets Forlaget p, 194-195*, 215.

Newhouse, J. (1952). *Reindeer are wild too*. Murray.

Norwegian Official Report. (1972). *The regional plan for Northern Norway* (NOU 33).

Norwegian White Paper 108. (1972).

O'Brien, K., Hayward, B., & Berkes, F. (2009). Rethinking social contracts: Building resilience in a changing climate. *Ecology and Society, 14*(2), 12. Available at: http://www.ecologyandsociety.org/vol14/iss2/art12/

Oskal, A., Turi, J., Mathiesen, S., & Burgess, P. (2009). *EALÁT. Reindeer herders voice: Reindeer herding, traditional knowledge and adaptation to climate change and loss of grazing lands. Arctic Council Sustainable Development and Utilization Working Group EALÁT-Information Ministerial Report*. International Centre for Reindeer Husbandry and Association of World Reindeer Herders.

Ottawa traditional knowledge principles. (2014). Available (01.05.19) at http://www.Sámicouncil.net/fileadmin/user_upload/Documents/Eara_dokumeanttat/Ottawa_TK_Principles.pdf

Paine, R. (1994). Social construction of the 'tragedy of the commons' and Sámi reindeer pastoralism. *Acta Borealia B, 2*(3–20), 159.

Pogodaev, M., Oskal, A., Avelova, S., et al. (2015). Youth. The future of reindeer herding peoples. In *Executive summary. Arctic council sustainable development working group. EALLIN reindeer herding youth project 2012–2015* (p. 66). International Centre for Reindeer Husbandry.

Polyakov, N. (1930). *Reindeer breeding and collectivization – Moscow, from KNIGOSOYUZ, 1930*. 96 p.

Riseth, J. Å. (2000). *Sami reindeer management under technological change 1960–1990: Implications for common-pool resource use under various natural and institutional conditions. A comparative analysis of regional development paths in West Finnmark, North Trøndelag, and South Trøndelag/Hedmark, Norway Agricultural University of Norway*. Doctor Scientiarum Theses (Norway) Agricultural University of Norway.

Sara, R. B. M. E., Syse, K. L., & Mathiesen, S. D. (2022). Precious blood and nourishing offal: Past and present slaughtering perspectives in Sámi reindeer pastoralism. *Pastoralism, 12*, 20. https://doi.org/10.1186/s13570-021-00224-2

Stien, A., Tveraa, T., Ims, R. A., Stien, J., & Yoccoz, N. G. (2022). Unfounded claims about productivity beyond density for reindeer pastoralism systems. *Pastoralism: Research, Policy, and Practice, 11*(2021), 20. https://doi.org/10.1186/s13570-021-00209-1, p 1–7.

Sundset, M. A., Oskal, A., & Turi, J. M. (2007). *Ethical guidelines for handling traditional knowledge at the International Centre for Reindeer Husbandry*. Board Policy Document of International Centre for Reindeer Husbandry.

Terletsky, P. E. (1932). *Northern reindeer husbandry / Collected works on reindeer husbandry and tundra veterinary and zootechnics*. – Moscow, pp. 11–52. [Терлецкий П.Е. Северное оленеводство / Сборник по оленеводству и тундровой ветеринарии и зоотехнии. – Москва, 1932, С. 11–52.]

Turi, E. I. (2008). *Adapting to a changing environment; A comparative study of adaptive capacity of the Social Organisation of Reindeer Pastoralism in Guovdageaidnu and Yamal Peninsula*. Master thesis in Political Science, University of Oslo.

Turi, J. M. (2009). EALÁT – A model for local competence building in the Reindeer Husbandry. In A. Oskal, J. M. Turi, S. D. Mathiesen, & P. Burgess (Eds.), *EALÁT reindeer herders' voice: Reindeer herding, traditional knowledge and adaptation to climate change and loss of grazing land. Report 2* (pp. 9–14). International Centre for Reindeer Husbandry. https://oaarchive.arctic-council.org/handle/11374/47, p 131.

Turi, E. I. (2016). *State steering and traditional ecological knowledge in reindeer- herding governance: Cases from western Finnmark, Norway and Yamal, Russia* (PhD). Umeå University, Umeå, Sweden.

Tveraa, T., Fauchald, P., Yoccoz, N. G., Ims, R. A., Aanes, R., & Høgda, K. A. (2007). What regulate and limit reindeer populations in Norway? *Oikos, 116*, 706–715. https://doi.org/10.1111/j.2007.0030-1299.15257.x, Copyright # Oikos 2007, ISSN 0030-1299 Subject Editor: Esa Ranta, Accepted January 8, 2007.

Tyler, N., Turi, J., Sundset, M. A., Bull, K. S., Sara, M. N., Reinert, E., Oskal, N., Nellemann, C., McCarthy, J., Mathiesen, S., Martello, M., Magga, O., Hovelsrud, G., Hanssen-Bauer, I., Eira, N. I., Eira, I. M., & Corell, R. (2007). Sámi reindeer pastoralism under climate change: Applying a generalized framework for vulnerability studies to a sub-arctic social–ecological system. *Global Environmental Change-human and Policy Dimensions, 17*, 191–206.

van Rooij, W., Aslaksen, I., Eira, I. H., Burgess, P., & Garnåsjordet, P. A. (2023). Loss of reindeer grazing land in Finnmark, Norway, and effects on biodiversity: GLOBIO3 as decision support tool at Arctic local level. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences*. Springer. https://doi.org/10.1007/978-3-031-17625-8_9

VG. (1960, June 16). *Russerne foran oss i reindriften, Norsk delegasjon tilbake fra studiereise til samedistriktene på Kola-halvøya*. 16 June, The Russians ahead of us in the reindeer herding, the Norwegian delegation back from a study trip to the Sami districts on the Kola Peninsula. Newspaper article in Norwegian.

Vostryakov P. N., & Mezhetsky (1968). Olenevodstvo v Norvegii [Reindeer Husbandry in Norway]. 50 pp. Востряков П.Н, Межецкий А.А. Оленеводство в Норвегии. М. 1968.-50 с.

Yuzhakov, A. (2004a). O nasleduemosty i povtoryaemosty zhivoi massy u severnyh olenei. [On the heritability and repeatability of live weight in reindeer] [О наследуемости и повторяемости живой массы у северных оленей// Сиб. вестник с.-х. науки. №3 (149). С. 165–168].

Yuzhakov, A. A. (2004b). *Nenets aboriginal breed of reindeer dissertation for competition doctoral degree in agricultural science*. Yamal Agricultural experimental station Russian Academy of Agricultural Sciences Siberian branch UDC 636.294.082.

Chapter 8
Resilience Thinking in Reindeer Husbandry

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Abstract Resilience expresses the capacity of a social-ecological system to adapt to, absorb, or withstand perturbations and other stressors so that the system remains. Reindeer nomadic husbandry is a coupled social-ecological system that sustains resilience by interacting with the animals and environment: either the herders adjust their actions to animal behavior or change this behavior in ways that suit the herd and pastures. Stressors and shocks affecting Sámi reindeer husbandry are, for instance, sudden warm air temperatures with subsequent snow melting and freezing in winter, bad grazing conditions, loss of grazing lands, and even socio-economic reforms. All these are sudden, unprepared, or forced changes. Climate change resilience includes using reindeer herders' Indigenous knowledge of selective breeding

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by maintaining different phenotypes of reindeer such as non-productive and castrated animals in the herd. Nevertheless, in Sámi reindeer husbandry in Norway today, low numbers of male reindeer and the absence of castrated animals challenge the herders' resilience coping strategies. This chapter discusses factors that constrain resilience in herding societies, contribute to the transformation of reindeer husbandry and the erosion of resilience in the herding society.

Keywords Social-ecological resilience · Reindeer husbandry · Tipping points in reindeer husbandry

8.1 Introduction

What factors build or erode resilience in the Arctic? Huitric et al. (2016) discussed the possible answers to this complex question and concluded that the ability of people to self-organize determines resilience in the Arctic. Arctic case studies exhibited the erosion of this ability and subsequent loss of resilience. Self-organization requires knowledge, local-level monitoring, and the ability of people to define problems and implement an agreed-upon plan (Turi & Keskitalo, 2014; Huitric et al., 2016; Turi, 2016). In Finnmark, reindeer herding has been a traditional way of living for centuries. Herders' cultural practices and well-being are closely linked to ecological dynamics that is undergoing multiple changes. Political, economic, and social pressures have restricted herding in Finnmark with regard to the areas and traditional practices (Fig. 8.6). This chapter contributes to understanding the resilience thinking of reindeer husbandry in times of climate change, economic development, and the cultural conflict between an Indigenous community and modern Norway. It discusses examples of resilience sources in reindeer husbandry (Fig. 8.1). While traditional knowledge of reindeer herding in Finnmark has been a source of resilience, development continues to affect traditional practices (Huitric et al., 2016; Tyler et al., 2007). Rocha (2022) reported that ecosystems worldwide are at risk of critical transitions due to increasing anthropogenic pressures and climate change. With up to 29% of the global terrestrial ecosystem showing symptoms of resilience loss, Arctic tundra and boreal forests are the most affected (Rocha, 2022). Competing land use and climate change threaten the pastureland of Sámi reindeer herding. Reindeer pastures are exposed to infrastructure development, hydropower, mineral exploration, recreational cabin areas expansion, and wind power (Reinert et al., 2009; Eira et al., 2021; Krarup Hansen & Oskal-Somby, 2023). Land use conflicts are exacerbated by the climate policy with wind power plants in reindeer herding areas (Eira et al., 2021; Supreme Court Judgement, 2021).[1] Climate change and projected developments challenge reindeer herders' adaptive capacity and herding resilience (van Rooij et al., 2023; Tonkopeeva et al., 2023).

[1] https://www.domstol.no/en/enkelt-domstol/supremecourt/rulings/2021/supreme-court%2D%2D-civil-cases/hr-2021-1975-s/

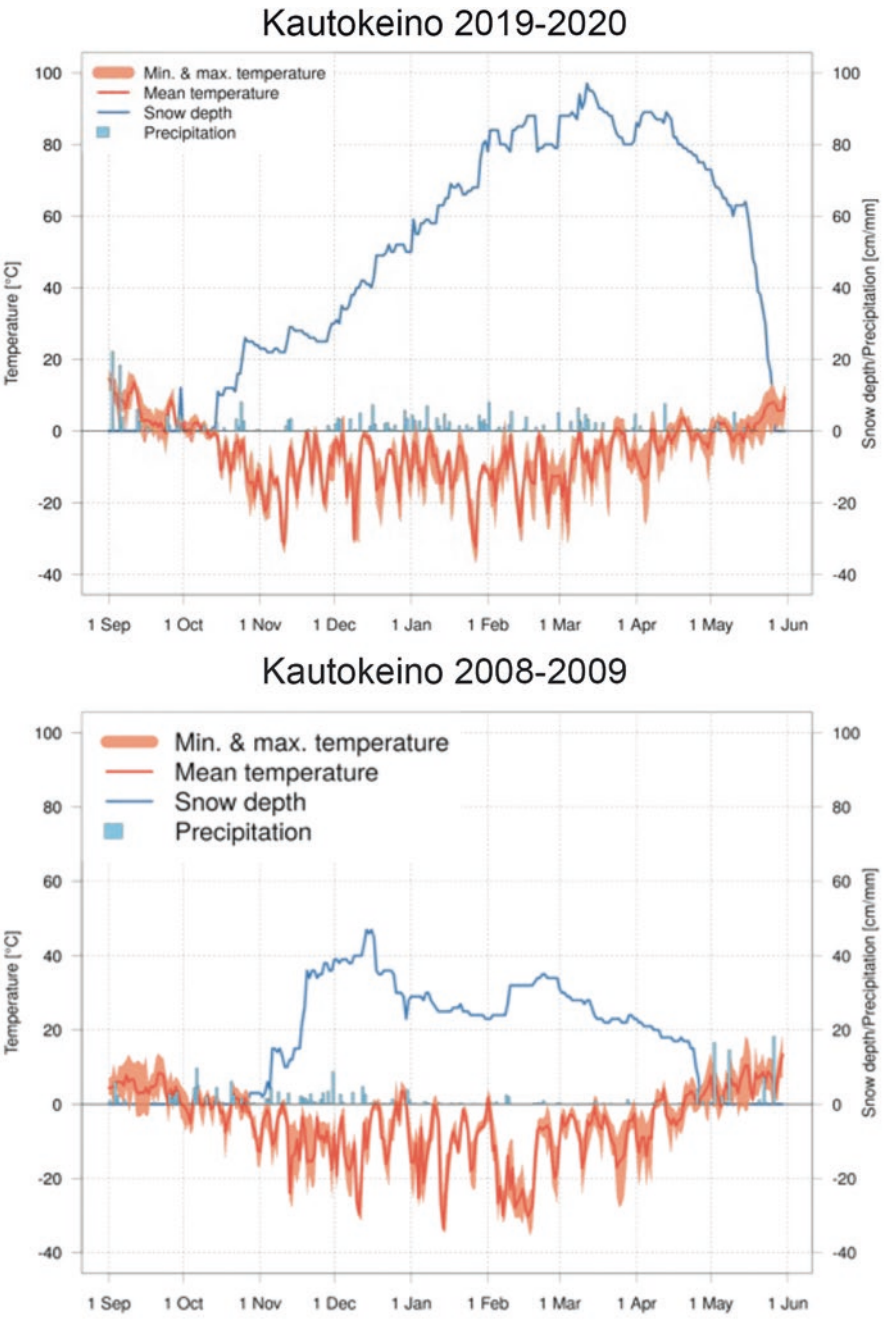

Fig. 8.1 Grazing condition, reflected through snow condition for reindeer in Finnmark. The year 2008–2009 was a good grazing winter, but in 2019–2020, heavy snowfall packed the snow hard and led to a bad grazing year with high animal mortality. The figure shows the minimum, maximum, and mean air temperature in degrees Celsius, snow depth (cm), and precipitation (mm) measured at the Kautokeino meteorological station. (Norwegian Meteorological Institute)

Temperatures in the reindeer pastures are increasing, and inland winter pastures in Finnmark may experience conditions earlier found along the fjords (Krarup Hansen & Oskal-Somby, 2023). Higher temperatures lead to a reduced snow season; model calculations indicate a 3-month reduction along the coast (Fig. 8.1). In contrast, the inland snow season may be 1 month shorter toward the end of the century (Hanssen-Bauer et al., 2023, b). Tonkopeeva et al. (2023) argue that safe operating space for Indigenous reindeer herders in the Arctic must be the ultimate priority for governance and policymaking during rapid changes in reindeer pastures. Anthropogenic impact on the earth system has reached a scale where it is no longer possible to exclude abrupt global environmental change (Larsen et al., 2014; Tonkopeeva et al., 2023). Landauer et al. (2021) reviewed the literature highlighting that land use, climate change, and governance drive the emergence of social-ecological systems' tipping points in Finland's reindeer husbandry (Landauer et al., 2021; Tonkopeeva et al., 2023). Should the global warming range exceed, potential tipping elements may advance to the increased risk of crossing critical thresholds in several Arctic regions. The danger of arriving at the tipping scale under a range of temperature overshoot scenarios was recently discussed by Wunderling et al. (2023).

Publications on the ecological and social-ecological systems provide multiple definitions of resilience. The Arctic Council Interim Resilience Report (Mathiesen et al., 2013) argues that resilience is a property of social-ecological systems that relates to the capacity of the system to cope with disturbances and recover in such a way as to maintain its core function and identity while also maintaining the ability to learn from and adapt to changing conditions and when necessary to transform (Mathiesen et al., 2013). The formal definition used in this book defines resilience as "the capacity of a system to absorb disturbances while retaining essentially the same function, structure, identity, and feedbacks" (Walker et al., 2004; Berkes, 2023). In Western Finnmark, Norway, traditional knowledge is a cornerstone for sustaining the nomadic livelihood and handling unpredictable shocks (Eira, 2012).

However, in the second half of the twentieth century, the Sámi reindeer husbandry in Norway was transformed and strongly assimilated into Norwegian society with the power of money. Mathiesen et al. (2023) and Degteva et al. (2023) argue that the goal of the state reforms in the 1970s was to increase meat production by improving herd structure, slaughtering a higher percentage of calves, changing reindeer ownership, and introducing novel labor standards such as shift working, housing programs, and mobile herding cabins. Norway implemented a reindeer husbandry model with as much as 90–95% females in the herd. Before this reform, the traditional ratio included 45% females (Tyler et al., 2007). The rationale for the change in Norway's management model was that reindeer herders in the north did "not fully utilize the potential for high production offered by favorable winters" in Finnmark (Norwegian Official Report, 1972; Degteva et al., 2023). The top-down productivity policy model for reindeer husbandry in Norway did not fully utilize Sámi herders' traditional cultures and knowledge (Mathiesen et al., 2023; Degteva et al., 2023). Therefore, the ability to deal with stress and shocks while maintaining stability and structure in the herding community might have been reduced.

Resilience thinking is one way to discuss adaptation in reindeer husbandry; it expresses the capacity of a social-ecological system to absorb or withstand perturbations and other stressors so that the system remains within the same regime, essentially maintaining its structure and functions (Holling, 1973; Gunderson & Holling, 2002; Walker et al., 2004). "Nomadic reindeer herders interact with their animals by either adapting their actions to animal behavior or by changing this behavior in ways that suit them" (Istomin & Dwyer, 2010, p. 613).

Nomadic reindeer husbandry is an example of a social-ecological system because of its traditional solid coupling between herders and reindeer (Mathiesen et al., 2013). When resilience is enhanced, the system is more likely to tolerate disturbances without collapsing into a qualitatively different state controlled by different processes. Equilibrium-based views are rooted in a Newtonian worldview in which the universe is orderly and mechanical. In such a clockwork universe, predictable by mathematical rules, it would make sense that a system (such as an ecosystem) experiencing a shock would or could return to its original state, i.e., the equilibrium in ecological and social systems. However, this assumption does not hold (Gunderson & Holling, 2002). Whether talking about a destroyed tropical forest or a mentally disturbed individual, there is no single equilibrium to return to (Berkes, 2023). This chapter presents some examples of resilience factors important for sustainable nomadic reindeer husbandry. It discusses reindeer herders' resilience thinking in perspectives of adaptive capacity and transformation in response to change.

8.2 Resilience Perspectives of Sámi Nomadic Reindeer Husbandry in Norway

Sámi reindeer herder Johan Mathis Turi described the interaction between the reindeer herd, herders, and its environment: "Some periods in the reindeer husbandry calendar are more fixed, such as breeding and calving time, which are pretty fixed times in the reindeer year, but these can also be shifted slightly both ways from year to year and from place to place. We discovered that it is possible to manipulate these established events in reindeer husbandry. Reindeer husbandry in Sapmi areas changed with the modified structure within the herds from using large bucks in the breeding before; today, they have mainly 1.5-year-old bucks to care for the breeding. In general, the calving time in Western Finnmark in Norway has been delayed by 1–2 weeks compared to 30 years ago, with the advantages and disadvantages this entails. Future climate change is a severe threat to reindeer husbandry in this respect and could further change the nature of reindeer husbandry. The adverse effects could, perhaps, be remedied with various aids such as fences or feeding" (Turi, 2002, 2009).

Traditional reindeer husbandry is based on using different seasonal pastures to make the best possible use of the ranges. A significant effort makes it possible to get the industry on the barren outfield pastures that no one else can utilize. It goes without saying that it will be challenging to have many males in an area that lacks the

type of pasture that males prefer. In the same way, it will be challenging to utilize the pastures effectively with only females if the type of areas where females thrive is the minimum factor. The general picture is that the reindeer grazing areas are composed of different types of pastures that cannot be utilized optimally without a differentiated gender and age structure in the reindeer herds. Traditionally, reindeer herders have utilized their grazing areas by operating herds with a nearly 50:50 distribution between the sexes and scattered age distribution of the animals. This rule applies to most reindeer husbandry areas worldwide, including Sapmi (Oskal et al., 2009).

8.3 Building Resilience in Reindeer Husbandry

8.3.1 Castration in the Sámi Reindeer Husbandry

Castration is one of the methods the reindeer herders use to create the composition of their herds to get control of the herd and strengthen the social-ecological resilience of reindeer husbandry (Fig. 8.2). Castration of the reindeer has been regularly mentioned in the historical literature on Sámi reindeer husbandry since as early as 1732 by Carl von Linné (Linnaeus, 1737) and later by Knut Leem (1767). The Sámi *gáskit* castration method was traditionally performed with the teeth, without anesthesia, and was first documented in 1732. Animals castrated with *gáskit* methods sometimes behave differently from those castrated with the later-developed Burdizzo method (Nergård et al., 2010).

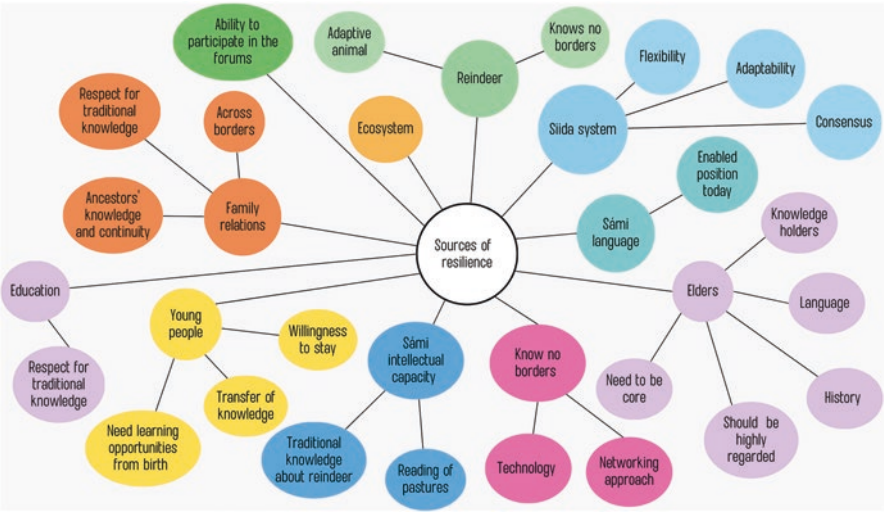

Fig. 8.2 Different sources of resilience were discussed in a workshop with reindeer herders in Kautokeino in November 2013, organized by the International Centre for Reindeer Husbandry and the Stockholm Resilience Centre (Mathiesen et al., 2013; Image: Marina Tonkopeeva)

One category of castrates is *Stohkkenámme-oaivi*, a castrated reindeer with porous antlers and permanent skin on the antler. *Čaloaivi* is the castrates without the skin on the antlers; *heargi* is a reindeer castrated to be a working or sledding reindeer that has undergone various manipulations of the testis anatomy (Fig. 8.3), probably maintaining testosterone production, and it was found that the testes of these male reindeer (> 2.5 years old) are traditionally treated by biting, leaving a small part of the testes tissue that might be responsible for certain hormone production (*Čaloai-spáillit*). These animals grow large, never go into rut, and are sterile but not castrated (Fig. 8.4).

In the 1960s, reindeer herds in Finnmark typically comprised as much as 50% adult males, and many are castrated (Paine, 1994). Modern agronomists have considered adult males unproductive; today, few herds in Norway's Western Finnmark have more than 6% males (Table 8.1). In Russia's Yamalo-Nenets Autonomous Region (YNAO), the percentages of males in the privately owned herds were as high as 28.9%. Lenvik (1990) concluded that a herd of male animals larger than necessary for good insemination results in Sámi reindeer husbandry should be based on factors other than meat production, such as tourism or special management techniques.

Over the last decades in Norway, reindeer herders have reduced the number of castrates compared to other regions of reindeer husbandry (Table 8.1) for several reasons. The Norwegian Animal Welfare Act, introduced in 1935, only allowed the castration of reindeer bulls with anesthesia performed by a veterinarian. In the field, only a bloodless method using the castrating forceps (e.g., the Burdizzo instrument) could be used: the spermatic cord and blood vessels to the testicles, together with the sensitive nerves, were crushed and damaged. This method was considered painful, and anesthesia was required. The procedure was costly and time-consuming and was eventually reduced in addition to other reasons (Nergård et al., 2010). Castrated reindeer in Norway disappeared from the official statistic after the reforms in the

Fig. 8.3 Castration of reindeer by Sven Skjenneberg in the early 1960s. He used the bloodless method of castrating forceps, i.e., the Burdizzo instrument. The spermatic cord and blood vessels to the testicles, together with the sensitive nerves, are crushed and damaged. (Photo: National Library of Norway)

Fig. 8.4 Castrated males are very important since they facilitate the managing of the herd. They obey humans, lead the rest of the herd, respond to calls, and can be harnessed in case of emergency. From a conversation with Nyadma Khudi, brigadier at Yamalo-Nenets Autonomous Okrug, Russia. (Photo: Svein D. Mathiesen)

Table 8.1 Illustration of proportions of male reindeer and percentages of castrates of the total herd (2016 survey analyses) in different regions of reindeer husbandry, including privately and collectively owned reindeer herders in Finnmark, Nenets Autonomous Region (NAO), and Yamal

	Western Finnmark	Nenets AO	Yamal Private Reindeer Herding Unit	Yamal Municipal Reindeer Herding Unit
Intact males	6	18.2	28.9	11.3
Castrated males	0	11	25.1	6.6

1970s also because of the new law on reindeer castration (Skum et al., 2016). The rationale was to increase the number of females and production. On 1 September 1956, a separate regulation on the castration of domestic reindeer entered into force based on Section 5 of the 1935 Act. The Regulations prohibit reindeer owners from using the Sámi traditional *gáskit* method, and violations become punishable. Section 1 of the Regulations requires reindeer owners, who need to castrate reindeer, to use castration tools according to a specified method as stated in the Circular issued by the Director of Veterinary Medicine (Skum et al., 2016).

Therefore, castration of reindeer should only be performed using forceps specially designed for crushing the spermatic cord and the large blood vessels without open bloody intervention. The provision was given for animal welfare reasons, as the old *gáskit* method "violated the Animal Welfare Act and inflicted unnecessary torment on the animals" (Skjenneberg, 1965; Skjenneberg & Slagsvold, 1968). In the years following the 1956 Reindeer Castration Regulations, Burdizzo pliers were actively distributed to all reindeer grazing districts in Norway, and the district veterinarians supervised that reindeer owners only used these pliers for castrations.

Soviet reindeer researcher P. Vostryakov visited Norway several times in the 1960s (Mathiesen et al., 2023). In 1968, he reported in the book *Reindeer Husbandry in Norway*: "Currently, due to the transition of reindeer herders to a sedentary lifestyle, appearance of a dense network of roads and modern means of communication in the reindeer herding (car, snowmobile, radio communication), and changes in the grazing system (hedging, semi-free reindeer grazing) – the importance of reindeer transport has dropped, and the number of sledding reindeer has decreased. Nowadays, transport reindeer in the herd structure make up about 2–3%: the average reindeer herder family has up to 30 sledding reindeer." Furthermore, Vostryakov and Mezhetsky (1968) reported that over the past 5–8 years, strict rules for the castration of reindeer, mainly males used for transport operations, had been developed and applied in Norway (Vostryakov & Mezhetsky, 1968; Mathiesen et al., 2023).

The turning point for reindeer castration in Norway arrived in 2001 when reindeer owners were banned from castration (Skum et al., 2016). The historical events led to the undermining of reindeer owners' traditional knowledge of castration. Before 1956, there was a rich knowledge of castration among reindeer herding Sámi (Rønnow, 1948).

In interviews with reindeer herders, we documented various aspects of reindeer castration: "…In the past, when we castrated [reindeer], they almost always used to be *čaloaivi*, castrated bucks with skin-free antlers…Today, when we use castration tools, they often become *námmeoaivi*, castrated bucks with antlers with skin, and *stohkkenámme-oaivi*, castrated bucks with antlers with skin that never goes..." (Sámi reindeer herder Karen Anna Logje Gaup; Oskal et al., 2009).

J. Antti Magga, a Sámi reindeer owner from Finland, articulated: "If we are not allowed to castrate our reindeer oxen, it will be the end of Sámi reindeer husbandry. Such a ban will put an end to the Sámi reindeer husbandry culture. Although we do not need castrates for transportation, they are important animals in the herd. We need the castrates and non-productive females since they can dig through the snow" (Oskal et al., 2009).

8.3.2 Castration in the Russian Reindeer Husbandry

Vladimir Etylin, a Chukchi reindeer herder from Russia, remarked in a workshop on reindeer husbandry in Oslo in 2007 that "it is impossible to survive in Chukotka without crushing ice during a so-called black ice period when everything gets covered with a layer of ice. When this happens, only castrates are strong enough to break such ice. [...] Females follow them and eat the fodder left over." Etylin commented: "…being an Indigenous representative and having been born on the tundra myself, I consider a ban on castration a severe threat to all reindeer husbandry [...] Castrated males do have their place in the herd's structure. Humans would not have been able to domesticate reindeer without castration. It is one of the cornerstones of the domestication process [...]. Without castrations, building up a controllable reindeer herd is impossible. Castration has many functions in a reindeer herd. The first one is that they are the calmest animals in a herd. It means that a reindeer herd with

castrates quiets down easily. The functions of reindeer in reindeer herding economies are not limited to meat production, reproduction, and transportation." There are many other functional classes of reindeer to which the official statistics remained blind (Istomin et al., 2022). The role of castrated males is not limited to transportation. They could play various other roles in herd operation: for example, digging feeding holes for female reindeer in winter (Istomin et al., 2022). However, the negative result is that males kept with females during winter are weaker and more exhausted by the spring than those kept separately.

Nenets reindeer herders in Russia would traditionally keep a particular category of reindeer called *menorui* in Nenets or *menurei* in the Komi language. These animals were castrated so they would not lose weight and power during the rut and would enter the winter in the best condition. This category was never used for transport and was always kept in the herd (Istomin et al., 2022). Usually, the herd's biggest, heaviest, and strongest males were selected to become *menorui*. They could dig through hard snow impenetrable for most female reindeer, thus enabling reindeer herders to use pasturelands that could not otherwise be used due to snow conditions. Even if the snow conditions were favorable, the presence of *menorui* sometimes significantly improved the spring condition of female reindeer and increased the calf survival rate (Istomin et al., 2022).

Nevertheless, *menorui* did not fit the logic of official categorization, and the Soviet officials launched a campaign against them, which lasted throughout the whole *kolkhoz*/*sovkhoz* period. *Menorui* were classified as *lodyri* (idlers) and *darmoedy* (spongers), and zootechnicians were instructed to have them slaughtered if they were to be found in collective herds (Istomin et al., 2022). Furthermore, using the *menorui* was referred to as *kulak* (upper-class) behavior, which hard-working reindeer herders should not be culpable of (Istomin et al., 2022).

The castrate numbers vary depending on the herds' needs. In Russia, reindeer herds in Nenets Autonomous Okrug and Yamalo-Nenets Autonomous Okrug maintain between 6.6% and 25.1% castrated non-productive males in the herd (Table 8.1). The castrates may lower the females' general activity level since they are stationary and less active in winter, contributing to increased net energy gain in the herd. Privately-owned herds seem to have a higher proportion of castrated males than municipal or state-owned reindeer herds in Russia.

8.3.3 Reindeer Castration: Lessons Learned

People's ability to navigate change and uncertainty, nurture diversity, and learn by combining different types of knowledge contribute to resilience (Huitric et al., 2016). In reindeer husbandry, the knowledge is to maintain control of the herd in uncertain times. Furthermore, improving the monitoring of this control is essential, which we discuss through examples in this section. Castration of ruminants has globally been critical to controlling herds and the pastoral food production systems, as well as in nomadic Sámi reindeer husbandry (Skum et al., 2016).

The low numbers of male reindeer and the absence of castrated animals in the Sámi reindeer herds in Finnmark might be the result of the lack of adaptive capacity caused by the series of reforms implemented in Norway in the twentieth century (see Mathiesen et al., 2023; Degteva et al., 2023). The procedures did not fully include traditional reindeer herders' knowledge, resulting in many losses. Reduced numbers of castrated reindeer in the herds in Norway might have lowered the herds' resilience in winters when temperatures fluctuate and are accompanied by thawing and freezing cycles that induce worse ice conditions.

Returning to castration could be a strategy for better winter survival and welfare for individual animals and the herd (Tonkopeeva et al., 2023). Enhancing the resilience of Indigenous reindeer husbandry in the Arctic requires locally informed and locally relevant knowledge in co-production with scientific knowledge about castration, herd structure, and the role of non-productive reindeer in meat production in nomadic systems.

8.4 Lichen Pastures and Methane Emissions

As discussed earlier in this chapter, the transformation of Sámi reindeer husbandry from traditional pastoralism peaked in the 1970s. This transformation included the exclusion of castrates and decreased number of male reindeer in Sámi reindeer husbandry. This might have affected the natural sexual segregation of the herd, which traditionally took place in most reindeer herds in the spring. This means that the 1.5-year-old males, which traditionally would have followed the male herd during summer, now follow the females with newborn calves. The consequence is increased densities of animals on limited spring pastures and added grazing pressure. Together, the high female reindeer population on spring pastures (Degteva et al., 2023), loss of grazing lands, and tendencies of a sedentary lifestyle might explain the pressure on lichen pastures.

Most Norwegians believe that the number of reindeer in Norway is too high and has reached a critical point regarding the pastures' carrying capacities. Analyzing Norwegian governmental documents and media, Johnsen and Benjaminsen (2017) identified the Norwegian narratives on why there are *too many reindeer* in Norway despite continued state efforts on destocking. The Norwegian government even used methane emissions as an argument to reduce the number of semi-domesticated reindeer in Norway by 30,000 animals (Landbruks-og Matdepartmentet, 2009). Methane is a greenhouse gas released by anthropogenic sources induced by human demands, including oil and gas drilling, coal mining, fossil fuel mining, and burning, as well as microorganisms (methanogens) in the digestive system of domestic ruminants. However, it is also produced by permafrost, termites, wildfires, wetlands, oceans and lakes, hydrates, and microbial fermentation in wild ruminants. Globally, the focus on the carbon footprint of meat production concerning climate and greenhouse gas emissions is high (Willett et al., 2019). However, in the production of different types of meat, significant differences in greenhouse gas emissions

have been demonstrated (Clune et al., 2017). Nevertheless, little was known about the gut methanogens of reindeer and what factors influenced their density, diversity, and methane production.

Reindeer are unique ruminants that have adapted to eat and utilize lichen as a source of energy and nutrients in winter (Aagnes & Mathiesen, 1994; Aagnes et al., 1995; Mackie et al., 2003; Mathiesen, 1999; Mathiesen et al., 2005; Olsen, 2000; Storeheier et al., 2002a; Storeheier, 2003; Storeheier et al., 2003; Sundset et al., 2007, 2008, 2010, 2013). This is despite the high content of antinutrient, antimicrobial, and potentially toxic antibacterial substances in lichens, including usnic acid (Cocchietto et al., 2002; Barboza et al., 2010; Glad et al., 2014; Palo, 1993; Sundset et al., 2008, 2010). Sundset et al. (2008) demonstrated that certain bacterial isolates from the reindeer rumen could resist high concentrations of lichen usnic acid. This finding indicated that the microorganisms in the rumen of reindeer had developed mechanisms for dealing with the antimicrobial lichen acids. Further studies demonstrated that usnic acid could be entirely degraded by microbes in the reindeer rumen and consequently not absorbed by the animal (Sundset et al., 2010). Sundset et al. (2009a, b) showed that the methanogens in the rumen of reindeer on natural pastures are closely related to methanogens found in the rumen of cows and sheep. However, they appeared to occur in lower concentrations. Furthermore, Salgado-Flores et al. (2016) found changes in the reindeer rumen and cecum microflora in response to a lichen diet that suggested lower methane emissions from lichen-fed animals. These findings are examples of new understandings and knowledge about reindeer's digestive physiology and microbial digestion related to the diet, which adds to the adaptive resilience of reindeer husbandry. Lower numbers of rumen methanogens in reindeer (Sundset et al., 2009a, b) suggest that reindeer on natural pasture may emit less methane compared to other ruminants investigated. Nevertheless, as illustrated, Norway's Minister of Agriculture in 2009 pointed out in a climate report that the country's goal was to reduce emissions from all parts of Norwegian agriculture and food industries, including reindeer husbandry: "We then believe that it is right to reduce the number of animals by 30,000 in order to meet the demand for reduced emissions from the industry. We also think it is important based on the sustainability of reindeer husbandry."[2]

Following up on this, Krarup Hansen (2012) and Krarup Hansen et al. (2018) provided novel data on how much methane is emitted by reindeer on different diets: lichen (mainly *Cladonia stellaris*) and concentrates (pelleted reindeer feed from Felleskjøpet in Norway). These studies were performed under controlled conditions in the laboratory using an open-circuit respiration calorimeter, a well-established and robust method for measuring methane emissions in ruminants.

The reindeer methane emission studies performed after 2009 showed that when the reindeer received pelleted feed, methane emissions increased almost sixfold during the first hour compared to when fed with lichens. Mean methane emissions from reindeer ($n = 5$) were only 7.5 ± 0.54 (SE) g CH_4/day when consuming a lichen

[2] https://www.nrk.no/sapmi/_-ogsa-reindrifta-ma-ta-ansvar-1.6635763

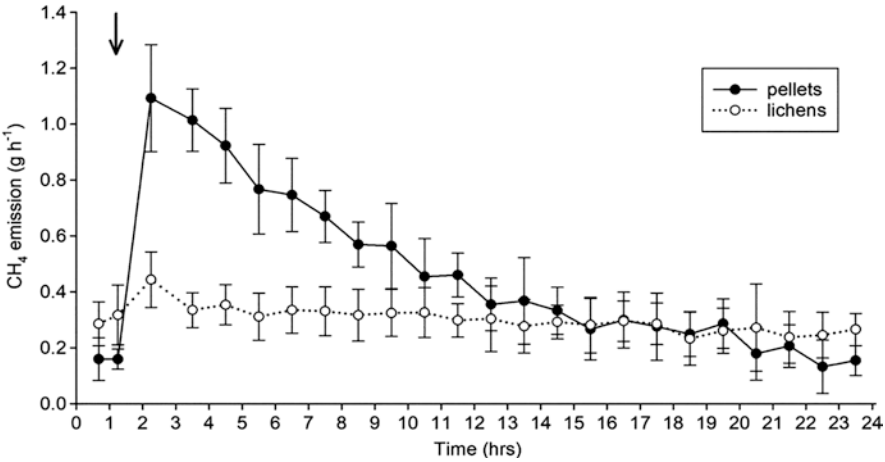

Fig. 8.5 Average methane emissions (± SD) (grams CH_4/h) from five reindeer in 1 day. The reindeer were fed 2 h after the measurement started (arrow) with reindeer feed from Felleskjøpet (solid line) or low (dotted line). (Figure: Krarup Hansen et al., 2018)

diet, compared to a higher emission ($p = 0.001$) of 11.2 ± 0.54 g CH_4/day in reindeer fed with the pelleted feed (Fig. 8.5).

These methane studies underline the importance of lichens as nourishment for reindeer in winter: both as an energy source and a means for methane emission reduction. Therefore, we suggest that lichen pastures should be protected for use by environmentally sustainable reindeer husbandry as a unique food production system. As mentioned in Chap. 4 by Mathiesen et al. (2023), Norway's political aspiration in the 1970s was to increase the female production in domestic reindeer herds to 90–95% (Regional Plan for Northern Norway/Norwegian Official Report NOU 33, 1972). Such a drastic change in herd structure resulted in a high density of female reindeer grazing on lichen pastures, calf slaughtering, unfavorable climate-driven snow conditions (Eira et al., 2018), and a sedentary lifestyle. All these factors might have forced reindeer herders to increase the use of pellets and hay, which might paradoxically have led to increased methane emissions. It resulted in *forced adaptation* and increased feeding of these female reindeer in winter when pasture territories were limited.

Today, the traditional nomadic Sámi reindeer husbandry is transformed: firstly because of the destocking with a high percentage of female reindeer in the herd and secondly due to the direct consequence of supplementary feeding in winter. Vice versa, feeding has become more vital because of the higher number of female reindeer. Reindeer herders addressed the state's emphasis on supplementary feeding to deal with poor grazing conditions (Johnsen et al., 2023). They explained that the focus on feeding undermined other adaptive measures and could negatively affect the resilience of reindeer husbandry. For example, pelleted reindeer feed and grass (hay, silage, round bales) used to feed reindeer today affect reindeer breeding and the herding economy but reconnect herders more closely with the reindeer and build social-ecological resilience in a new way.

8.5 Supplementary Reindeer Feeding

8.5.1 History of Supplementary Reindeer Feeding

To the best of our knowledge, the first documented supplementary feeding of reindeer was in 1927 with the Evenki herders in southern parts of the Republic of Sakha (Yakutia), Russia, who used hay to feed domestic reindeer (Rumyantcev, 2015). As early as 1952, Norwegian newspapers reported bad winter grazing conditions for reindeer in Finnmark (Mathiesen, 2023). The Norwegian experimental station at Lødingen worked with feed development since 1957. In 1964, veterinarian Sven Skjenneberg composed a food for reindeer comprising oats and barley groats, wheat rice and 6% mixed molasses peat litter, 35% ground barley, and 1% seaweed flour and minerals, fed to reindeer in the ratio 4:1 to reduce the protein content (Skjenneberg & Slagsvold, 1968). A commercial RF-71 feed for reindeer was in place in 1971, which consisted of barley, oats, wheat bran, grass flour, and soybean oil, ground and pelleted (Jacobsen & Skjenneberg, 1972; Jacobsen & Skjenneberg, 1975). In 1980, an updated RF-80 version of the commercial feed was produced based on marine fat and silage of fish slag and wheat bran with seaweed flour (Bøe & Jacobsen, 1981; Bøe et al., 1982). In 1984, Mathiesen et al. (1984) tested the usefulness of mill waste products to starving reindeer since it did not develop ruminal acidosis in reindeer compared to many other feeds.

Furthermore, the usefulness of timothy silage, hay, and pelleted grass was also tested as food for reindeer (Aagnes & Mathiesen, 1996; Moen et al., 1998; Hamnes, 2007; Josefsen et al., 1996; Olsen et al., 1997; Olsen & Mathiesen, 1998; Sara et al., 1996). In June 1994, King Harald V of Norway officially opened the Department of Arctic Biology, University of Tromsø, Norway, where most of these studies were carried out: "I would also like to point out the important research that has been carried out on reindeer. It has been particularly important to the reindeer husbandry industry and particularly relevant in the crisis feeding of starving reindeer." Since then, the climate change affecting the reindeer pastures has worsened. However, it was difficult to understand that supplementary feeding might be one of the many factors transforming traditional nomadic reindeer husbandry (Tonkopeeva et al., 2023).

8.5.2 Effects of Supplementary Reindeer Feeding

Sámi reindeer pastoralism in Norway has traditionally been based on the sustainable exploitation of natural pastures from which the animals select a large variety of vascular plants and lichens (Mathiesen, 1999; 2005; Turunen et al., 2009). Reindeer, unlike domestic ruminants, are highly adaptable mixed feeders able to survive without lichens by efficiently adapting their digestive system to fibrous food in winter and efficiently utilizing high-quality forage during the short Arctic summer (Nilsson

et al., 1996a, b; Mathiesen, 1999). Storeheier (2003) investigated the adaptation of reindeer to reduced availability and quality of forage in winter with particular reference to diet selection, forage quality, food intake, forage digestibility, and ruminal absorption of nutrients. The nutrient composition and digestibility of different lichens eaten by reindeer in winter vary considerably. In addition, the extent to which reindeer can utilize lichens depends not only on the species eaten but also on the recent diet composition and whether it has included lichens or not (Storeheier et al., 2002a). It points to the importance of rumen microbial adaptation to the diet. A combined lichens and vascular plants diet helps the reindeer meet their overall nutritional and metabolic needs: scrubs and graminoids, especially the wintergreen parts, have a higher content of nitrogen and minerals compared to lichens and may consequently play a role in the nitrogen and mineral balance of reindeer on winter pasture (Storeheier et al., 2002a, b).

Supplementary winter reindeer feeding could increase reindeer herders' resilience by maintaining closer relationships with the reindeer. It might also become a source of transformation of nomadic reindeer husbandry into a more assimilated Norwegian lifestyle. The amount of supplementary artificially produced pelleted feed has increased in the past decade (Tyler et al., 2007). Pelleted food used for reindeer, 810.400 kg in 2017, boosted to 5,015,659 kg during the winter crisis of 2019–2020. The Norwegian government allocated 40 million NOK to transport the pelleted food by helicopter in units of 800 kg to the respective herds (Johnsen et al., 2023).

8.6 External Factors Constraining Sámi Reindeer Husbandry

One of the pillars in the Sámi reindeer husbandry is grazing flexibility based on Indigenous knowledge (Reinert et al., 2010). Flexibility can be viewed as a strategy to alleviate risks associated with pastoral disasters, such as adverse snow or grazing conditions. Eira et al. (2018) argue the necessity to "spread the herd over the grazing land and let individual reindeer find adequate snow and grazing conditions themselves; increase local mobility of the herd within available winter pastures; migrate to the coast out of season; provide additional feeding for reindeer; and (in the long term) moderate herd structure diversity" (Eira et al., 2018, p. 929).

The formation of modern states of Norway, Sweden, Finland, and Russia and their gradual recognition of their respective borders affected Sámi reindeer herders (Fig. 8.6) practicing nomadic pastoralism rooted in the migration cycles and exercising flexibility of movement over the grazing lands. As immensely important for reindeer herders, pastures include various ecological zones and landscapes intended for different purposes throughout the year: calving grounds, winter pastures, etc. Grazing territories are also linked to the Sámi *siida* system. National governments would consider the *siida* territories and groups when establishing the boundaries in the reindeer herders' pastures (Forrest, 1997).

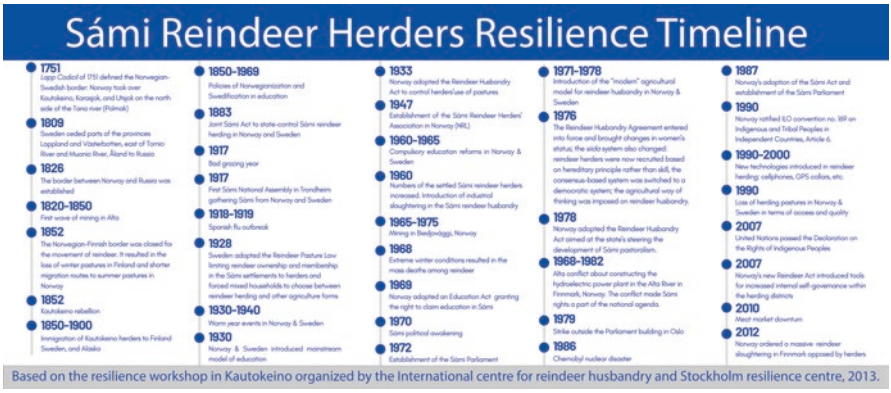

Fig. 8.6 Factors affecting the resilience of the reindeer herders based on the workshop with reindeer herders in Kautokeino in November 2013, organized by the International Centre for Reindeer Husbandry and the Stockholm Resilience Centre (Mathiesen et al., 2013; Image: Marina Tonkopeeva)

Modern reindeer herding districts in the Nordic states could be understood as state-defined administrative units with the responsibility for managing internal issues. These states' herding management strategies are envisaged to increase self-governance through the introduction of internal management plans.

In implementing the regulatory reform, the process of developing and approving internal management plans has proved challenging (Turi, 2016). For example, two out of three winter pasture districts in Western Finnmark declared unable to develop internal management rules since *siida* land rights were not clarified. For Western Finnmark, a central policy priority was reducing the number of reindeer to achieve what had been defined as ecological sustainability (Reindriftsforvaltningen, 2013). The establishment of grazing borders between *siidas* is seen as an instrument toward achieving that goal, as commented by the reindeer husbandry director of the County Governor of Western Finnmark to local media NRK Sapmi (31 October 2014): "…This is imperial for the goal of sustainable reindeer husbandry ... an important prerequisite for achieving a total number of reindeer which is adapted to the pasture foundation so that *siidas* have predictability concerning which pastures they may use." While grazing borders might be seen as a means to increase administrative predictability, i.e., a way to simplify and make the reindeer husbandry sector more manageable for the state, such simplifications diminish the room for reindeer herders' Indigenous traditional knowledge of reindeer, pasture, and climate (Johnsen & Benjaminsen, 2017; Johnsen et al., 2017).

The administrative boundaries developed by the state administrative system reduce reindeer herders' flexibility on snow-covered grazing land, weakening their adaptive capacity (Tonkopeeva et al., 2023). This leads to forced adaptation in reindeer herding and might also increase the level of conflicts in winter pasture areas.

8.7 Sámi Reindeer Husbandry and Social-Ecological Resilience

This chapter focuses on resilience thinking viewed through the lens of reindeer herders' traditional knowledge. Traditionally, nomadic reindeer husbandry in Western Finnmark is a human-ecological system strongly coupled with herders' specialized traditional knowledge about individual reindeer, pasture, and environment (Eira et al., 2023). The concept of a social-ecological system emphasizes that humans are part of nature; we stress that herders are an essential part of the reindeer herding ecological system (Rockström, 2013). Social-ecological systems are interwoven systems of human societies and ecosystems (Rockström, 2013; Berkes, 2023).

With the new governance model, the role of the coupling mechanisms might have been reduced; the ability to deal with socio-economic stress and new climate shocks while maintaining stability and structure in the herding community has later become challenging (Johnsen et al., 2023). It is clear today that the top-down productivity policy model adopted by the government for reindeer husbandry in Norway failed to holistically utilize herders' traditional nomadic cultures and knowledge. Moreover, it did not consider the country's regional differences in reindeer husbandry. Erosion of traditional knowledge and assimilation in Sámi reindeer husbandry (Eira et al., 2018) might affect the social-ecological resilience to external changes. All available knowledge, including Indigenous, is important to build resilience in reindeer husbandry. As stated in the Ottawa Traditional Knowledge Principles (2015), knowledge of Indigenous peoples "enhances and illuminates the holistic and shared understanding of the Arctic environment" (Arctic Council Permanent Participants, 2015).

Further constraints to nomadic reindeer herding include lands divided by fences on the winter grazing pastures. Fences might be a further indicator of a sedentary lifestyle. Soviet reindeer researcher P. Vostryakov, who visited Norway several times in the 1960s, reported in 1968, the transition of Sámi reindeer herders to a sedentary lifestyle. In the book *Reindeer Husbandry in Norway*, Vostryakov wrote that according to Norwegian experts, "it was not easy to teach the former Sámi nomads to use houses and property correctly, to transit to a sedentary way of life" (cited from Mathiesen et al., 2023). Further, he described that the transition of the Sámi reindeer herders to settled life began relatively long ago. At first, it was spontaneous, but later it continued with the intervention and participation of the state. The transition was required due to the country's general technical and cultural progress, the need to intensify reindeer herding, and the state interests (cited from Mathiesen et al., 2023).

Flexible management of reindeer husbandry is a critical component of adaptive capacity (Tyler et al., 2007; Wesche & Armitage, 2010; Hovelsrud & Smit, 2010; Marin et al., 2020). Transformation, erosion, and loss of resilience affect the ability of Indigenous peoples to self-organize. Self-organization requires the best available knowledge, both scientific and traditional-based knowledge. Indigenous and local knowledge are fundamental to Indigenous resilience, but various other factors,

including decolonization and self-determination, are also crucial as enabling conditions. Indigenous and local knowledge can increase the range of available command to solve problems and provides the basis for adaptive capacity. Accumulating knowledge, when shared in networks, enables social learning, leading to social memory, which is vital for remembering responses to past disasters (Berkes, 2023).

The Norwegian Reindeer Husbandry Act of 1978 can be considered a shock: the new law did not incorporate traditional knowledge, and it forced changes that the herders were not prepared for, such as changes in the internal governance model, which could have affected the number of reindeer (Eira, 2012). How Indigenous peoples understand, cope with, and adapt to climate change-related events and other disaster shocks is of universal interest because such Indigenous resilience also informs climate change adaptation in general. However, Indigenous environmental knowledge and understanding have been impacted by colonization. Hence, Indigenous resilience requires decolonization, empowerment, and decision-making responsive to local needs and concerns (Berkes, 2023). A critical first step toward enhancing resilience is understanding the social, behavioral, and ecological processes already building (or eroding) resilience in the Arctic (Huitric et al., 2016).

O'Brien et al. (2009) discussed that Sámi reindeer herders in Norway had been given considerable autonomy through international conventions and within the Norwegian constitution and human rights laws. Nonetheless, reindeer herding is highly regulated and governed by national legislation that imposes a production-oriented agricultural model on traditional herding systems (Tyler et al., 2007). Although Norway's governance of Sámi reindeer husbandry focuses on autonomy and rights, it fails to utilize the knowledge that underpins the herders' livelihoods, such as maintaining diversity in reindeer herds (Tyler et al., 2007). Historically, many policies of Arctic nations have eroded and restricted self-organization. The ability of people to self-organize underlies resilience in the Arctic. Such erosion of this ability was found in cases recently studied in the Arctic (Huitric et al., 2016; Rocha, 2022) and might apply to Sámi reindeer husbandry in times of rapid climate change (Hanssen-Bauer et al., 2023a, b; Stith et al., 2023) and loss of grazing land (van Rooij et al., 2023), and the danger of tipping points might be more pronounced (Moen et al., 2023; Wunderling et al., 2023; Tonkopeeva et al., 2023).

The most critical action in enhancing resilience in reindeer husbandry is maintaining and developing nomadic reindeer pastoralism in the Circumpolar North and their Indigenous knowledge base. Some regions of reindeer husbandry are close to their tipping points, have already experienced a loss of adaptive capacity, and consequently reached their tipping point (Mathiesen, 2023; Tonkopeeva et al., 2023). According to Maria Pogodaeva, "Reindeer husbandry today is no longer the foundation in some regions of the circumpolar civilization of the Indigenous peoples of the Russian Federation and has practically been lost" (Mathiesen, 2023, p. 6). The reason is that since the penetration of other peoples into the respective territories in the sixteenth century, reindeer herding nations have never been treated as equal partners. Other nations made decisions that destroyed their traditional way of life: forced transition to a settled way of life, destruction of small settlements, separation of children from their

parents, deprivation of ownership of reindeer through collectivization, and loss of traditional knowledge, language, and culture (Mathiesen et al., 2023).

When a system of reindeer husbandry has lost its adaptive capacity and consequently reached its tipping point, it is described as a sharp or abrupt change in the climate variables or biological variables where one after the tipping point often enters a state that one cannot say in advance what will happen (Tonkopeeva et al., 2023). In 1935–1936, catastrophic poor winter grazing conditions due to warm weather with high precipitation as snow affected the Sámi reindeer husbandry in the village of Sirges (Sirkas), Sweden, when half of the reindeer died of starvation, and the reindeer herders had to start fishing on the lakes to survive. The fish provided income, so the herds could be rebuilt (Päiviö, 2006). Such tipping points and regime shifts in reindeer husbandry are also discussed by Moen et al. (2023). They may occur when external drivers push a system to an alternative system state, characterized by different feedback than in the original state. Using the lenses of tipping points and regime shifts, Moen et al. (2023) discussed reindeer husbandry as a social-ecological system, highlighting the inseparability of humans, reindeer, and the environment and conceptually exploring the macro-level of emergent phenomena, such as abrupt changes to the livelihood.

Furthermore, extensive infrastructure development in the grazing lands can affect the future socio-ecological tipping points due to an expected increase in holiday cabins, energy wind and water plants, power lines, mines, petroleum terminals, roads, and urban developments (van Rooij et al., 2023). Infrastructure development in the calving ground can seriously impair the ability of reindeer to use the spring and summer pastures. Model studies show that 50% of the original biodiversity in the calving grounds is already lost (van Rooij et al., 2023). The calving ground is the part of the seasonal spring pasture where most female reindeer stay during calving. The most valuable calving land is a gently rolling tundra without steep riverbanks and situated precisely where competition for land exists (van Rooij et al., 2023).

The structural and rational practices of Sámi reindeer husbandry in Western Finnmark increased the proportions of females to as high as 90–95%. They were followed by an increase in the total number of reindeer in Western Finnmark. Furthermore, a regression analysis based on data from 1981–2018 showed a negative correlation between a high percentage of females and calf production in Western Finnmark (Degteva et al., 2023). Paradoxically, the modernization of Sámi reindeer husbandry in Finnmark, with almost 100% more calves born compared to before the reforms, failed due to increased competing land use combined with industrial development in the calving grounds. It is therefore worth noting that the use of terms like “overgrazing” has been debated within a reindeer herding context: unlike the dominant point of view blaming irresponsible reindeer herders for the depletion of pastures, Pilyasov and Kibenko (2023) see the problem as an institutional one – the result of public policies that created wrong incentives for reindeer herding entrepreneurs in recent decades. It would be immoral to assign the solution to the problem of overgrazing only to the most politically weak participant in the conflict – the private reindeer herd (Pilyasov & Kibenko, 2023).

In March 2017, Dolgan reindeer herder Roman Tuprin from the Republic of Sakha (Yakutia) visited a reindeer herd nearby Guovdageaidnu. Looking at the quality of the reindeer, he asked: "Why did the Norwegian state leave Sámi reindeer herders to live with such bad pastures?" Yet three years prior to this, in 2014, the Intergovernmental Panel on Climate Change (IPCC) concluded that protecting grazing lands would be the most important adaptation measure for reindeer herders under climate change (IPCC, 2014).

A resilient social-ecological system may have a high diversity of landscapes, native species, and crop species and varieties, as well as a diversity of economic opportunities and livelihood options for its inhabitants. The diversity of options provides insurance and the ability to cope with, absorb, or adapt to change (Berkes, 2023). Resilience thinking deals with sustainability dynamics and helps operationalize the feedback-related adaptive elements of complex adaptive systems. In practical terms, resilience is common sense: it is about options and flexibility.

References

Aagnes, T. H., & Mathiesen, S. D. (1994). Food and snow intake, body mass and rumen function in reindeer fed lichen and subsequently starved for 4 days. *Rangifer, 14*, 33–37.

Aagnes, T. H., & Mathiesen, S. D. (1996). Gross anatomy of the gastrointestinal tract in reindeer, free-living and fed baled timothy silage in summer and winter. *Rangifer, 16*, 31–39.

Aagnes, T. H., Sørmo, W., & Mathiesen, S. D. (1995). Ruminal microbial digestion in free-living, in captive lichen-fed, and in starved reindeer (*Rangifer tarandus tarandus*) in winter. *Applied and Environmental Microbiology, 61*(2), 583–591.

Arctic Council Permanent Participants. (2015). *Ottawa traditional knowledge principles*. Available at: https://www.arcticpeoples.com/knowledge#indigenous-knowledge. Accessed 26 Oct 2021.

Barboza, P. S., Bennett, A. F., Lignot, J. H., Mackie, R. I., McWhorter, T., Secor, S., Skovgaard, N., & Sunset, M. A. (2010). Digestive challenges for vertebrate animals: Microbial diversity, cardio-respiratory coupling, and dietary specialization. *Physiological and Biochemical Zoology, 83*(5), 764–774.

Berkes, F. (2023). *Advanced introduction to resilience* (Elgar advanced introductions) (p. 224). Edward Elgar.

Bøe, U.-B., & Jacobsen, E. (1981). Fôringsforsøk med ulike typer fôr til rein. *Rangifer, 1*, 39–43.

Bøe, U.-B., Gundersen, N., Sletten, H., & Jacobsen, E. (1982). Fôropptak, pH og melkesyre i vomma hos rein under overgangsfôring med kraftfôr tilsatt buffer og fett. *Rangifer, 2*, 31–38.

Clune, S., Crossin, E., & Verghese, K. (2017). Systematic review of greenhouse gas emissions for different fresh food categories. *Journal of Cleaner Production, 140*, 766–783.

Cocchietto, M., Skert, N., Nimis, P. L., & Sava, G. (2002). A review on usnic acid, an interesting natural compound. *Naturwissenschaften, 89*(4), 137–146.

Degteva, A., Okotetto, E., Slepushkin, I., Romanenko, T., & Mathiesen, S. D. (2023). Reindeer husbandry trends: Nenets Autonomous Okrug and Western Finnmark. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer.

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 in Yamal peninsula, Yamal-Nenets AO, Russia (MS thesis). University of Tromsø.

Eira, I. M. G., Oskal, A., Hanssen-Bauer, I., & Mathiesen, S. D. (2018). Snow cover and the loss of traditional indigenous knowledge. *Nature Climate Change, 8*(11), 928–931.

Eira, A. J., Eira, I. H., & Sara, P. O. (2021). *Wind power development at Storheia in Fosen reindeer husbandry district*. Additional note for reinforcement economic calculation (16 pp.). Stiftelsen Protect Sampi. In Norwegian.

Eira, I. M. G., Turi, E. I., & Turi, J. M. (2023). Sámi traditional reindeer herding knowledge throughout a year: Herding periods on snow-covered ground. In: S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences. Springer*. https://doi.org/10.1007/978-3-031-17625-8_4

Forrest, S. (1997). *Territoriality and state-Sámi relations*. University of Northern British Columbia.

Glad, T., Barboza, P., Mackie, R. I., Wright, A.-D. G., Brusetti, L., Mathiesen, S. D., & Sunset, M. A. (2014). Dietary supplementation of usnic acid, an antimicrobial compound in lichens, does not affect rumen bacterial diversity or density in reindeer. *Current Microbiology, 68*, 724–728.

Gunderson, L. H., & Holling, C. S. (Eds.). (2002). *Panarchy. Understanding transformations in human and natural systems*. Island Press.

Hamnes, A. J. (2007) *Evaluering av lokalprodusert gresspellet som fôr til rein og effekt av melassetilsetning* (in Norwegian) (MSc thesis). University of Tromsø. https://munin.uit.no/handle/10037/1183

Krarup Hansen, K. (2012). *Methane emissions from reindeer. Do reindeer-fed lichens emit less methane than reindeer on a pelleted-feed diet?* (MSc thesis). UiT – The Arctic University of Norway, Tromsø. https://munin.uit.no/bitstream/handle/10037/5153/thesis.pdf

Krarup Hansen, K., & Oskal-Somby, B. (2023). Adaptation to the future climate in Sámi reindeer husbandry: A case study from Tromsø, Norway. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry (Springer polar sciences)*. Springer.

Krarup Hansen, K., Sundset, M. A., Folkow, L. P., Nilsen, M., & Mathiesen, S. D. (2018). Methane emissions are lower from reindeer-fed lichens compared to concentrate feed. *Polar Research*, 37. https://doi.org/10.1080/17518369.2018.1505396

Hanssen-Bauer, I., Benestad, R. E., Lutz, J., Vikhamar-Schuler, D., Svyashchennikov, P., Førland, E. J., Mathiesen, S. D., Eira, I. M. G., Turi, E. I., Oskal, A., Pogodaev, M., & Tonkopeeva, M. (2023a). *Reindeer husbandry adaptation to the changing arctic volume 1 comparative analyses of local historical and future climate conditions important for reindeer herding in Finnmark Norway and the Yamal Nenets Autonomous Okrug Russia* (pp. 187–222). Springer International Publishing.

Hanssen-Bauer, I., Benestad, R. E., Lutz, J., Vikhamar-Schuler, D., Svyashchennikov, P., & Førland, E. J. (2023b). Comparative analyses of local historical and future climate conditions important for reindeer herding in Finnmark, Norway and the Yamal Nenets autonomous Okrug, Russia. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry. Springer polar sciences*. Springer. https://doi.org/10.1007/978-3-031-17625-8_8

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics, 4*, 1–23.

Hovelsrud, G. K., & Smit, B. E. (2010). *Community adaptation and vulnerability in Arctic regions*. Springer.

Huitric, M., Peterson, G., Rocha, J. C., Carson, M., Clark, D., Forbes, B. C., Hovelsrud, G. K., Mathiesen, S. D., Perl, A., & Quinlan, A. (2016). What factors build or erode resilience in the Arctic? In M. Carson & G. Peterson (Eds.), *Arctic resilience report 2016* (pp. 96–126). Stockholm Environment Institute. https://oaarchive.arctic-council.org/handle/11374/1838

IPCC. (2014). *Climate change 2014: Synthesis report* (Contribution of working groups I, II, and III to the fifth assessment report of the intergovernmental panel on climate change).

Istomin, K., & Dwyer, M. J. (2010). Dynamic mutual adaptation: Human-animal interaction in reindeer herding pastoralism. *Human Ecology, 38*(5), 613–623. https://doi.org/10.1007/s10745-010-9341-3

Istomin, K. V., Laptander, R. I., & Habeck, J. O. (2022). Reindeer herding statistics in Russia: Issues of reliability, interpretation, and political effect. *Pastoralism, 12*, 19. https://doi.org/10.1186/s13570-022-00233-9

Jacobsen, E., & Skjenneberg, S. (1972). Forsøk med ulike fôrblandinger til rein: fôrverdi av reinfôr (RF-71). Norges landbrukshøgskole. *Meldinger, 58*(34), 1–11.

Jacobsen, E., & Skjenneberg, S. (1975). Some results from feeding experiments with reindeer. In J. R. Luick, P. C. Lent, D. R. Klein, & R. G. White (Eds.), *Proceedings from the first international reindeer/caribou symposium* (pp. 95–107). University of Alaska.

Johnsen, K., & Benjaminsen, T. A. (2017). The art of governing and everyday resistance: "Rationalization" of Sámi reindeer husbandry in Norway since the 1970s. *ACTA BOREALIA, 1-26*, 2017. https://doi.org/10.1080/08003831.2017.1317981

Johnsen, K. I., Eira, I. M. G., & Mathiesen, S. D. (2017). Sámi reindeer governance in Norway as competing knowledge-systems: A participatory study. *Ecology and Society, 22*(4), Article 33. https://doi.org/10.5751/ES-09786-220433

Johnsen, K. I., Eira, I. M. G., Mathiesen, S. D., & Oskal, A. (2023). 'Leaving no one behind' – Sustainable development of Sámi reindeer husbandry in Norway. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_3

Josefsen, T. D., Aagnes, T. H., & Mathiesen, S. D. (1996). Influence of diet on the morphology of the ruminal papillae in reindeer calves (*Rangifer tarandus tarandus L.*). *Rangifer, 16*, 119–128.

Landauer, M., Rasmus, S., & Forbes, B. C. (2021). What drives reindeer management in Finland towards social and ecological tipping points? *Regional Environmental Change, 21*, 32.

Landbruks-og Matdepartmentet. (2009). *Klimautfordringene – Landbruket en del av løsningen*. St. Meld. Nr. 39 (2008–2009). https://www.regjeringen.no/no/dokumenter/stmeld-nr-39-2008-2009-/id563671/

Larsen, J. N., Anisimov, O. A., Constable, A., Hollowed, A. B., Maynard, N., Prestrud, P., Prowse, T. D., & Stone, J. M. R. (2014). Polar regions. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate change 2014: Impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the fifth assessment report of the intergovernmental panel on climate change* (pp. 1567–1612). Cambridge University Press.

Leem, K. (1767). *Beskrivelse over Finmarkens Lapper, deres Tungemaal, Levemaade og forrige Afgudsdyrkelse, oplyst ved mange Kaabberstykker: med anmaerkninger*. GG Salikath.

Lenvik, D. (1990). Flokkstrukturering: tiltak for lønnsom plassering og ressurstilpasset reindrift. *Rangifer Special Issue, 4*, 21–35.

Linnaeus, C. (1737). *Flora Lapponica*. Amsterdam.

Mackie, R. I., Aminov, R. I., Hu, W., Klieve, A. V., Ouwerkerk, D., Sundset, M. A., & Kamagata, Y. (2003). Ecology of uncultivated *Oscillospira* species in the rumen of cattle, sheep, and reindeer as assessed by microscopy and molecular approaches. *Applied and Environmental Microbiology, 69*, 6808–6815.

Marin, A., Sjaastad, E., Benjaminsen, T. A., Sara, M. N. M., & Langfeldt Borgenvik, E. J. (2020). Productivity beyond density: A critique of management models for reindeer pastoralism in Norway. *Pastoralism, 10*, 9. https://doi.org/10.1186/s13570-020-00164-3

Mathiesen, S. D. (1999). *Comparative aspects of digestion in reindeer: Digestive adaptations in reindeer on South Georgia and in northern Norway (Rangifer tarandus tarandus) and in Svalbard reindeer (Rangifer tarandus platyrhynchus)* (Tromsø Dr. philos. Thesis). University of Tromsø.

Mathiesen, S. D. (2023). Reindeer husbandry in the circumpolar north. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_1

Mathiesen, S. D., Rognmo, A., & Blix, A. S. (1984). A test of usefulness of a commercially available mill "waste product" (AB-84) as feed for starving reindeer. *Rangifer, 4*, 28–34.

Mathiesen, S. D., Mackie, R. I., Aschfalk, A., Ringø, E., & Sundset, M. A. (2005). Chapter 4: Microbial ecology of the gastrointestinal tract in reindeer – Changes through season. In W. Holzapfel & P. Naughton (Eds.), *Microbial ecology of the growing animal: Biology of the growing animals Volume III* (pp. 73–100). Elsevier Press.

Mathiesen, S. D., Alftan, B., Corell, R. W., Eira, R. B. M., Eira, I. M. G., Degteva, A., Johnsen, K. I., Oskal, A., Roue, M., Sara, M. N. A., Skum, E. R. N., Turi, E. I., & Turi, J. M. (2013). Strategies to Enhance the Resilience of Sámi Reindeer Husbandry to Rapid Changes in the Arctic. In *Arctic Council Arctic Resilience Report (ARR), interim report to the Arctic Council Ministerial Meeting in Kiruna, 2013* (pp. 100–112). Stockholm Resilience Centre and Stockholm Environmental Institute.

Mathiesen, S. D., Aikio, P., Degteva, A., Romanenko, T., & Tonkopeeva, M. (2023). Historical aspects of cross-border cooperation between Nordic and Soviet experts in reindeer husbandry. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer.

Moen, R., Olsen, M. A., Haga, Ø. E., Sørmo, W., Utsi, T. H. A., & Mathiesen, S. D. (1998). Digestion of timothy silage and hay in reindeer. *Rangifer, 18*(1), 35–45. https://doi.org/10.7557/2.18.1.1444

Moen, J., Forbes, B. C., Löf, A., & Horstkotte, T. (2023). Tipping points and regime shifts in reindeer husbandry: A systems approach. In T. Horstkotte, Ø. Holand, J. Kumpula, & J. Moen (Eds.), *Reindeer husbandry and global environmental change pastoralism in fennoscandia* (Vol. 14, pp. 265–277). https://doi.org/10.4324/9781003118565-20

Nergård, E. R., Griffiths, D., Moe, L., & Mathiesen, S. D. (2010). *Reindeer castration: Can re-introduction of an old method help herders to adapt to climate change?* IPY OSC. Abstract.

Nilsson, A., Olsson, I., & Lingvall, P. (1996a). Comparison between grass-silages of different dry matter content fed to reindeer during winter. *Rangifer, 16*, 21–30.

Nilsson, A., Olsson, I., & Lingvall, P. (1996b). Evaluation of silage diets offered to reindeer calves intended for slaughter. I. Feeding of silage and barley from September to March. *Rangifer, 16*, 129–138.

Norwegian Official Report. (1972). The regional plan for Northern Norway (NOU 33,72).

O'Brien, K., Hayward, B., & Berkes, F. (2009). Rethinking social contracts: Building resilience in a changing climate. *Ecology and Society, 14*(2), 12. [online] URL: http://www.ecologyandsociety.org/vol14/iss2/art12/

Olsen, M. A. (2000). *Microbial digestion in reindeer and minke whales* (PhD thesis). University of Tromsø. isbn 82-7589-102-7.

Olsen, M. A., & Mathiesen, S. D. (1998). The bacterial population adherent to plant particles in the rumen of reindeer (*Rangifer tarandus tarandus*) fed lichen, timothy hay or silage. *Rangifer, 18*(2), 55–64.

Olsen, M. A., Aagnes, T. H., & Mathiesen, S. D. (1997). The effect of timothy silage on the bacterial population in rumen fluid of reindeer (*Rangifer tarandus tarandus*) from natural summer and winter pasture. *FEMS Microbiology Ecology, 24*, 127–136.

Oskal, A., Turi, J., Mathiesen, S., & Burgess, P. (2009). *EALÁT. Reindeer herders voice: Reindeer herding, traditional knowledge and adaptation to climate change and loss of grazing lands* (Arctic Council Sustainable Development and Utilization Working Group EALÁT-Information Ministerial report). International Centre for Reindeer Husbandry and Association of World Reindeer Herders.

Paine, R. (1994). Social construction of the 'tragedy of the commons' and Saami reindeer pastoralism. *Acta Borealia B, 2*, 3–20. 159.

Päiviö, N. J. (2006). Sirkas sameby: om av beitekatastrofer Ottar. (259)10-17.

Palo, R. T. (1993). Usnic acid, a secondary metabolite of lichens and its effect on in vitro digestibility in reindeer. *Rangifer, 13*, 39–43.

Pilyasov, A. N., & Kibenko, V. A. (2023). The phenomenon of entrepreneurship in reindeer husbandry in Yamal: Assessment of the situation, paradoxes, and contradictions. In S. D. Mathiesen,

I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_10

Regional Plan for Northern Norway/Norwegian Official Report NOU 33, 1972,

Reindriftsforvaltningen. (2013). https://www.stortinget.no/nn/Saker-og-publikasjonar/publikasjonar/Innstillingar/Stortinget/2012-2013/inns-201213-307/?lvl=0

Reinert, E., Aslaksen, I., Eira, I., Mathiesen, S., Reinert, H., & Turi, E. (2009). Adapting to climate change in Sámi reindeer herding: The nation-state as problem and solution. In W. Adger, I. Lorenzoni, & K. O'Brien (Eds.), *Adapting to climate change: Thresholds, values, governance* (pp. 417–432). Cambridge University Press. https://doi.org/10.1017/CBO9780511596667.027

Reinert, H., Mathiesen, S., & Reinert, E. (2010). Climate change and pastoral flexibility. *Political Economy of Northern Regional Development, 1*, 189–204.

Rocha, J. C. (2022). Ecosystems are showing symptoms of resilience loss. *Environmental Research Letters, 17*(2022), 065013. https://doi.org/10.1088/1748-9326/ac73a8

Rockström. (2013). *Arctic Council. 2013* (Arctic Resilience interim report (2013)). Stockholm Environment Institute and Stockholm Resilience Centre.

Rønnow, C. (1948). *Om kastrering hos de renskotande folken med sarskild hansyn till rennomadismen i Sverige*. FOLK-LIV 1948–1949.

Rumyantcev, N. A. (2015) *Timpton Evenki of southern Yakutia. History and the modern time*. Pechatnyi Dvor

Salgado-Flores, A., Hagen, L. H., Ishaq, S. L., Zamanzadeh, M., Wright, A. D. G., Pope, P. B., & Sundset, M. A. (2016). Rumen and cecum microbiomes in reindeer (*Rangifer tarandus tarandus*) are changed in response to a lichen diet and may affect enteric methane emissions. *PLoS One, 11*(5), e0155213.

Sara, E., Mathiesen, S. D., Olsen, M. A., Aagnes, T. H., & Schelderup, I. (1996). *Gras som krisefôr til rein/Rássi heahttefuodarin bohcuide* (pp. 1–14). Reindriftens fagråd, Forskningsformidlingen, Universitetet i Tromsø.

Skjenneberg, S. (1965). *Rein og reindrift* (325pp.). A.S. Fjellnytt.

Skjenneberg, S., & Slagsvold, L. (1968). *Reindriften og dens naturgrunnlag*. Universitetsforlaget.

Skum, E. R., Turi, J. M., Moe, L., Eira, I. M. G., & Mathiesen, S. D. (2016). Norwegian: Reinoksens og kastratens rolle i reinflokken [The role of the buck and the castrate in the reindeer herd]. In T. A. Benjaminsen, I. M. Gaup Eira, & M. N. Sara (Eds). Norwegian: *Samisk reindrift. Norske myter* [Sámi reindeer pastoralism. Norwegian myths] (pp. 129–142). Fagbokforlaget.

Stith, M., Corell, R. W., Magga, R. M., Kaiser, M., Oskal, A., & Mathiesen, S. D. (2023). Ethics of knowledge production in times of environmental change. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_6

Storeheier, P. V. (2003). *Food intake and forage utilization in reindeer during winter* (PhD thesis). University of Tromsø. isbn 82-7589-139-6.

Storeheier, P. V., Mathiesen, S. D., Tyler, N. J. C., & Olsen, M. A. (2002a). Nutritive value of terricolous lichens for reindeer in winter. *The Lichenologist, 34*, 247–257.

Storeheier, P. V., Mathiesen, S. D., Tyler, N. J. C., Schjelderup, I., & Olsen, M. A. (2002b). Utilization of nitrogen and mineral-rich vascular forage plants by reindeer in winter. *Journal of Agriculture Science, 139*, 151–160.

Storeheier, P. V., van Oort, B., Sundset, M. A., & Mathiesen, S. D. (2003). Food intake of reindeer in winter. *Journal of Agricultural Science, 141*, 93–101.

Sundset, M. A., Cann, I. K. O., Mathiesen, S. D., Præsteng, K. E., & Mackie, R. I. (2007). Novel rumen bacterial diversity in two geographically separated sub-species of reindeer. *Microbial Ecology, 54*, 424–438.

Sundset, M. A., Kohn, A., Mathiesen, S. D., & Præsteng, K. E. (2008). *Eubacterium rangiferina*, a novel usnic-acid resistant bacterium isolated from the reindeer rumen. *Die Naturwissenschaften, 95*, 741–749.

Sundset, M. A., Edwards, J. E., Cheng, Y. F., Sensosiain, R. S., Fraile, M. N., Northwood, K. S., Præsteng, K. E., Glad, T., Mathiesen, S. D., & Wright, A. D. G. (2009a). Molecular diversity of the rumen microbiome of Norwegian reindeer on natural pasture. *Microbial Ecology, 57*, 335–348.

Sundset, M. A., Edwards, J. E., Cheng, Y. F., Sensosiain, R. S., Fraile, M. N., Northwood, K. S., Præsteng, K. E., Glad, T., Mathiesen, S. D., & Wright, A. D. G. (2009b). Rumen microbial diversity in Svalbard reindeer, with particular emphasis on methanogenic archaea. *FEMS Microbiology Ecology, 70*, 553–562.

Sundset, M. A., Barboza, P. S., Green, T. K., Folkow, L. P., Blix, A. S., & Mathiesen, S. D. (2010). Microbial degradation of usnic acid in the reindeer rumen. *Naturwissenschaften, 97*, 273–278.

Sundset, M. A., Salgado-Flores, A., Wright, A. D. G., & Pope, P. B. (2013). The reindeer rumen microbiome. In K. Nelson (Ed.), *Encyclopedia of metagenomics*. Springer. https://doi.org/10.1007/978-1-4614-6418-1_664-1

Supreme Court judgment 11 October 2021, HR-2021-1975-S (Case No. 20-143891SIV-HRET, Case No. 20-143892-SIV-HRET and Case No. 20-143893SIV-HRET) Licence for wind power development on Fosen ruled invalid as the construction interferes with Sami reindeer herders' right to enjoy their own culture. https://www.domstol.no/en/enkelt-domstol/supremecourt/rulings/2021/supreme-court%2D%2D-civil-cases/hr-2021-1975-s/

Tonkopeeva, M., et al. (2023). Framing adaptation to rapid change in the Arctic. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_2

Turi, J. M. (2002). The world reindeer livelihood – Current situation, threats and possibilities. In S. Kankaanpää, L. Müller-Wille, P. Susiluoto, & M.-L. Sutinen (Eds.), *Northern timberline forests: Environmental and socio-economic issues and concerns* (pp. 70–75). Ko-lari, Finland.

Turi, J. M. (2009). EALÁT – A model for local competence building in the north. Introduction. In A. Oskal, J. M. Turi, S. D. Mathiesen, & P. Burgess (Eds.), *EALÁT reindeer herders' voice: Reindeer herding, traditional knowledge and adaptation to climate change and loss of Grazing land. Report 2:2009*. International Centre for Reindeer Husbandry. Fagtrykk Idé AS.

Turi, E. I. (2016). *State steering and traditional ecological knowledge in reindeer-herding governance: Cases from western Finnmark, Norway and Yamal, Russia* (PhD). Umeå University.

Turi, E. I., & Keskitalo, E. C. (2014). Governing reindeer husbandry in western Finnmark: Barriers for incorporating traditional knowledge in local-level policy implementation. *Polar Geography, 37*(3), 234–251.

Turunen, M., Soppela, P., Kinnunen, H., Sutinen, M.-L., & Marts, F. (2009). Does climate change influence the availability and quality of reindeer forage plants? *Polar Biology, 32*, 813–832.

Tyler, N., Turi, J., Sundset, M. A., Bull, K. S., Sara, M. N., Reinert, E., Oskal, N., Nellemann, C., McCarthy, J., Mathiesen, S., Martello, M., Magga, O., Hovelsrud, G., Hanssen-Bauer, I., Eira, N. I., Eira, I. M., & Corell, R. (2007). Saami reindeer pastoralism under climate change: Applying a generalized framework for vulnerability studies to a sub-arctic social-ecological system. *Global Environmental Change-Human and Policy Dimensions, 17*, 191–206.

van Rooij, W., Aslaksen, I., Eira, I. H., Burgess, P., & Garnåsjordet, P. A. (2023). Loss of reindeer grazing land in Finnmark, Norway, and effects on biodiversity: GLOBIO3 as decision support tool at Arctic local level. In S. D. Mathiesen, I. M. G. Eira, E. I. Turi, A. Oskal, M. Pogodaev, & M. Tonkopeeva (Eds.), *Reindeer husbandry* (Springer polar sciences). Springer. https://doi.org/10.1007/978-3-031-17625-8_9

Vostryakov, P. N., & Mezhetsky, A. A. (1968). *Olenevodstvo v Norvegii* [Reindeer husbandry in Norway] (50 pp.). (In Russian) Востряков П.Н, Межецкий А.А. Оленеводство в Норвегии. М. 1968.-50 с.

Walker, B., Holling, C. S., Carpenter, S. R., et al. (2004). Resilience, adaptability, and transformability in social-ecological systems. *Ecology and Society, 9*(2), 5.

Wesche, S., & Armitage, D. R. (2010). From the inside out: A multi-scale analysis of adaptive capacity in a northern community and the governance implications. In D. Armitage & R. Plummer (Eds.), *Adaptive capacity and environmental governance* (Springer series on environmental management) (pp. 107–132). Springer. http://link.springer.com.ezp.sub.su.se/chapter/10.1007/978-3-642-12194-4_6

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., Afshin, A., Chaudhary, A., Herrero, M., Agustina, R., Branca, F., Lartey, A., Fan, S., Crona, B., Fox, E., Bignet, V., Troell, M., Lindahl, T., Singh, S., Cornell, S. E., Srinath Reddy, K., Narain, S., Nishtar, S., & Murray, C. J. L. (2019, February 2). Food in the Anthropocene: The EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet, 393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

Wunderling, N., Winkelmann, R., Rockström, J., et al. (2023). Global warming overshoots increase risks of climate tipping cascades in a network model. *Nature Climate Chang, 13*, 75–82. https://doi.org/10.1038/s41558-022-01545-9

Epilogue

Svein D. Mathiesen

The smell of nature for me is the smell of reindeer
(Thor Heyerdahl)

In early September 1993, the world's reindeer herders gathered in Tromsø for the first time with participants from Russia, Finland, Sweden, Norway, and the USA. Preparations for the festival started in 1990, well and thoroughly carried out at the *Norske Reindriftssamers Landsforbund* (NRL) head office at Grønnegata 23. The September days were excellent, with clear blue skies, and the birch trees on the other side of the Tromsø strait were bathed in yellow-red colors for the nearly 400 reindeer owners. Many participants had received their first passports and were traveling for the first time. There were so many impressions. The opening of the festival was at the old Fokus cinema. Children from the various reindeer herding regions around the globe had made drawings for a separate children's drawing exhibition in Fokus, united by a reindeer herding theme. The atmosphere around the children's illustrations was at its best. Still, there was a lack of a person to officially open the children's drawing exhibition. Rumors had been going around all day that the Norwegian explorer and writer Thor Heyerdahl was in Tromsø, and we thought he was exactly the right person to open the exhibition (Fig. A.1).

Heyerdal had checked in at the SAS hotel in Tromsø, and with my newly acquired Nokia mobile phone, I sat in the car outside his hotel as the festival's practical coordinator and called his hotel room.

Thor's wife Jacqueline answered the phone:

– You will get to talk to Thor. He said he didn't want to participate in political activism.

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Fig. A.1 Reindeer herders from Russia, Finland, Sweden, and Norway with Thor Heyerdal in Tromsø, 1993. (Photo: Svein D. Mathiesen)

– Of course not, I replied. I told him that he should come to the *Fokus* cinema, open a drawing exhibition of Indigenous children from Siberia, and spread smiles and joy over the assembly.

He took two seconds to think and then answered:

– When will this happen, Mathiesen?
– In 10 minutes, I replied, I'm waiting outside the SAS hotel in a small gray *Honda Civic*.

Twelve minutes later, Jacqueline and Thor were sitting in my car on the way to the *Fokus* cinema in Tromsø. The entrance to the cinema was full of Indigenous peoples from all over the Circumpolar North with all their national costumes and an impressive display of children's drawings on the walls in the background.

An uproar broke out among the Russian Indigenous representatives: Thor Heyerdal! We had not announced that Thor Heyerdahl would participate, and the Russian participants started to cry and tremble. It was Heyerdahl himself who was supposed to be with the reindeer herders this time.

Evening at the *Fokus* cinema. Heyerdahl was well-known in Russia thanks to TV broadcasts: for a long time, his TV programs were the only content outside the Soviet Union people could watch. Guests at the *Fokus* were welcomed with reindeer tongue canapés and accompanying drinks – the atmosphere to be felt.

Heyerdahl took the microphone and said: **The smell of nature for me is the smell of reindeer.** Excited reindeer herders burst into a round of applause. Heyerdahl continued: "When I stood at my confirmation in Larvik in Norway in 1927, I received a reindeer skin sleeping bag as a gift from my father; it was good and warm and accompanied me like a friend on many trips to the forest and the mountains during my upbringing. Therefore, **any nature experience in this sleeping bag was linked to the smell of reindeer.** In it, I always survived, even if it was sometimes wet and cold.

Many years later, in late autumn 1944, I was parachuted with the Second *Bergkompani* from the Norwegian forces in Scotland to the east of Finnmark to support 114 Soviet Infantry Division in the liberation of Norway from Nazi Germany, continued Heyerdahl. We had extremely poor British equipment: very thin sleeping bags. That winter in East Finnmark was very cold, and when we landed with the parachutes, I immediately knew that if I were to survive, I would have to find a reindeer skin sleeping bag. I sought out the nearest Sámi reindeer herding family, who were still in their winter pastures with the reindeer herd and exchanged a good reindeer sleeping bag. I would have never survived this last war winter without this sleeping bag. And all of us probably could not have participated in the liberation of Finnmark. Since that winter, **the smell of nature has always been the smell of reindeer**; whenever I experience unique landscapes and nature worldwide, I always associate the impressions with the smell of reindeer."

Thor and Jacqueline Heyerdahl showed up at very short notice and stayed for the whole time with the reindeer herders at the *Fokus* cinema in Tromsø. In this way, they showed a deep respect for the reindeer owners and their knowledge of management of the High North that we have not seen since. The knowledge of survival lies deep in peoples' understanding of nature, experienced and passed on from generation to generation, as Thor Heyerdal expressed an example of practical resilience, or "common sense," of surviving a shock like the extremely cold winter.