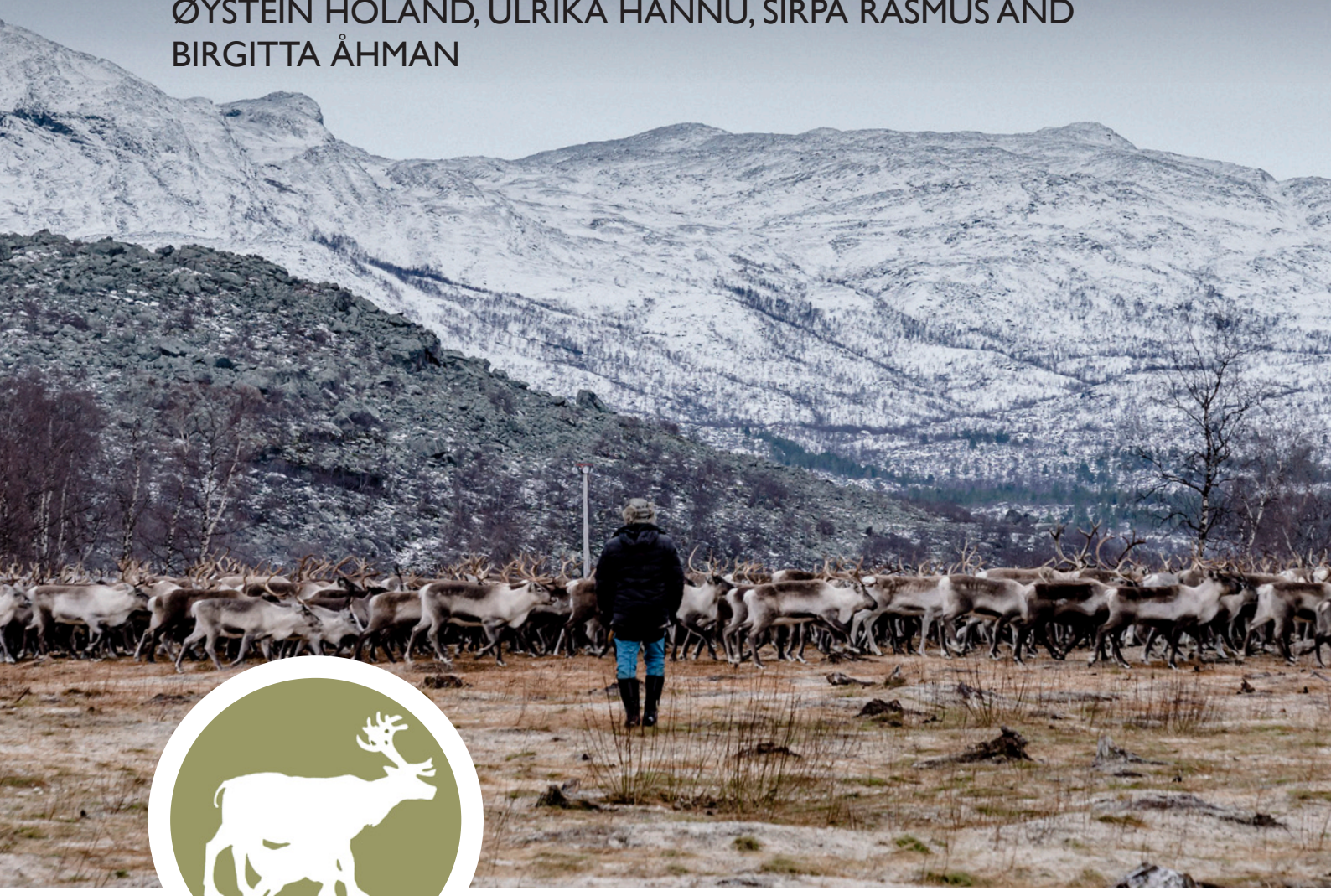
ENGLISH

Challenges and conditions for reindeer husbandry

IN NORWAY, SWEDEN & FINLAND

ØYSTEIN HOLAND, ULRIKA HANNU, SIRPA RASMUS AND BIRGITTA ÅHMAN

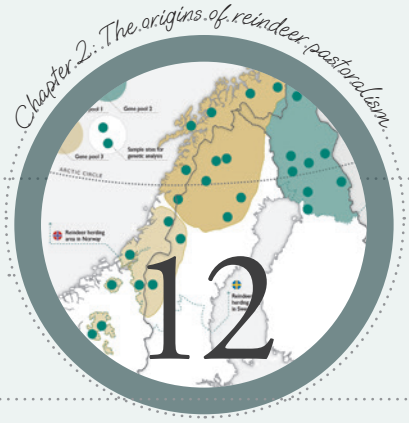


RANGIFER REPORT

Research, Management and Husbandry of Reindeer and other Northern Ungulates

Rangifer Report, No 24, 2024

Contents



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PREFACE

This report is based on the book *Reindeer Husbandry and Global Environmental Change – pastoralism in Fennoscandia*, which was published in 2022 and is the result of previous and new research compiled in a joint Nordic project in 2016–2021 called Reindeer husbandry in a Globalizing North (ReiGN), which was funded by Nordforsk. The book describes differences and similarities between reindeer husbandry in Norway, Sweden and Finland and the environmental and social challenges faced by herders.

The report describes how reindeer pastoralism is affected by climate change and the continuous loss of reindeer grazing lands linked to other external factors that altogether create challenges for the practice. It describes reindeer husbandry from the perspectives of different research fields. Each chapter lists one or more sources and links to the book Reindeer Husbandry and Global Environmental Change – pastoralism in Fennoscandia, which is freely accessible online (https://doi.org/10.4324/9781003118565) and contains more details on the topic.

The report has been published in Norwegian, Swedish, Finnish and Northern Sámi, and intended for reindeer herders and others involved in reindeer husbandry, as well as landowners, authorities and policymakers affected by or dealing with issues related to natural resource management, climate and environmental issues or other matters affecting reindeer husbandry. The English version was produced to reach out to a broader international audience and is available for download from Rangifer's website (http://rangiferjournal.com) and is also printed in a limited edition.

We hope this report will shed light on the importance of and need for viable reindeer husbandry in Norway, Sweden and Finland in the future. For that to happen, we need a discussion on what reindeer husbandry is and wants to be, about the rights it involves and also about what "sustainability" really means.

We would like to thank all the primary authors for their chapters in the Routledge book for their input and comments. Further, we thank the Sámi Reindeer Herders' Association of Norway (NRL), Swedish Sámi National Association (SSR) and the Reindeer Herders' Association in Finland for their comments. However, we wish to point out that the authors are fully responsible for the content and any errors or uncertainties in the report. This report was funded by Nordforsk. We also thank the Swedish University of Agricultural Sciences (SLU) and the Norwegian University of Life Sciences (NMBU) for their support with this work.

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PHOTO: JONAS VANNAR

1

From wild reindeer hunting to modern reindeer husbandry

This introductory chapter gives a historical overview of important ecological, socioeconomic, political and cultural processes and events that have affected reindeer husbandry in Norway, Sweden and Finland. The chapter gives a background to understanding how reindeer herding interacts with and is affected by various external forces. This provides a foundation for how to tackle the challenges faced by herders. The chapter also provides a brief overview of modern reindeer husbandry in the three countries.

REINDEER PASTORALISM IN TRANSITION

Long before modern reindeer husbandry developed, hunter-gatherers used semi-domesticated reindeer as transport animals and decoys to attract wild reindeer. In the 16th and 17th centuries, a small scale, nomadic form of Sámi reindeer pastoralism evolved, where semi-domesticated reindeer were used primarily as a means of transport, but also provided products such as milk, meat, leather, tendons, bones, etc. Various economic, social and ecological pressures in the 18th and 19th centuries changed herding practices, which became increasingly large-scale, with larger herds and longer migrations. The timeline below (figure 1.1) shows important ecological, socioeconomic, political and

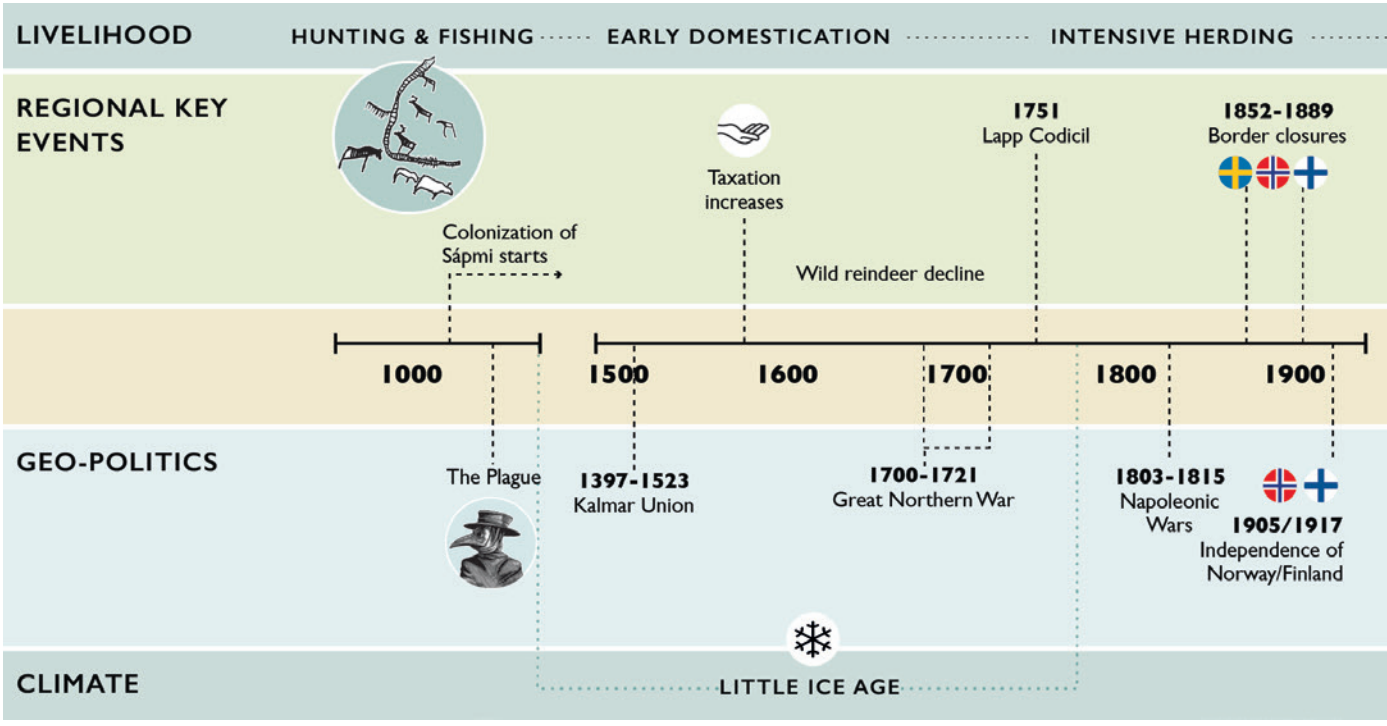


Figure 1.1: Key ecological, socioeconomic, political and cultural forces and events from wild reindeer hunting to modern reindeer husbandry.

cultural processes and events from national to global level that led to the transition from wild reindeer hunting to modern reindeer husbandry.

Early reindeer pastoralism was not confined by national borders. Many reindeer herders migrated with their herds along the river valleys, between winter grazing lands towards the Gulf of Bothnia and summer pastures in the mountains and along the northern Atlantic coast. Towards the end of the 19th century, however, reindeer herders had to adapt to the gradual closing of borders between countries, even if agreements such as the Lapp Codicil of 1751 granted them some freedom of movement. But the agreement could not secure them access to summer pastures in many areas in Norway. Many reindeer-herding families with winter grazing lands in Sweden and summer pastures in Norway were forcibly relocated during the early 20th centuries, and many Sámi herders in Finland were transitioned to seasonal grazing in forested areas.

The expansion of agriculture, forestry, and other land users in the north, further encroached on grazing lands. This led to regulation of reindeer herding through laws and regulations that placed time and space constraints on the herders. Only in recent years have reindeer herders been granted stronger rights. However, now the need for natural resources for the "green transition" is increasing, which is putting renewed and magnified pressure on reindeer grazing lands.

We are living in an era of rapid change. The effects of climate change are already visible, and the loss of biodiversity is rapid, accelerated by the effects of expanded land use. Global agreements are being implemented to meet these challenges. These agreements affect national politics, eventually resulting in local consequences. Reduced use of fossil fuels has been traded for a greater use of renewable energy sources such as wind, solar and hydropower as well as bioenergy sources. This transition requires extensive infrastructure investments, which occupy significant areas of space. Northern land regions have significant natural resources and are also sparsely populated. Today, wind farms are being built, mineral assets are being assessed and new mines are opening, and heated debates are underway about how the forests should be utilised. Despite the fact that reindeer grazing lands are already heavily im-

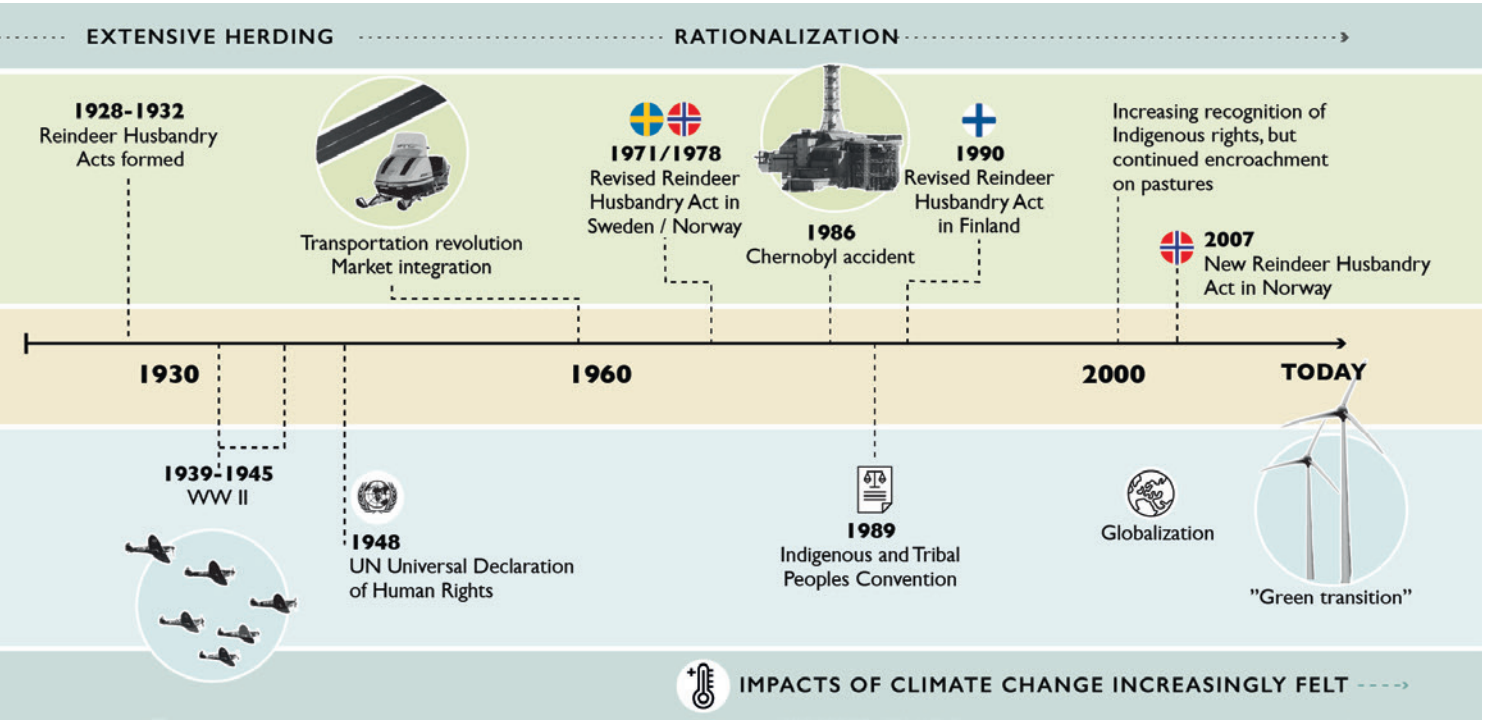


Figure 1.1 Cont'd.

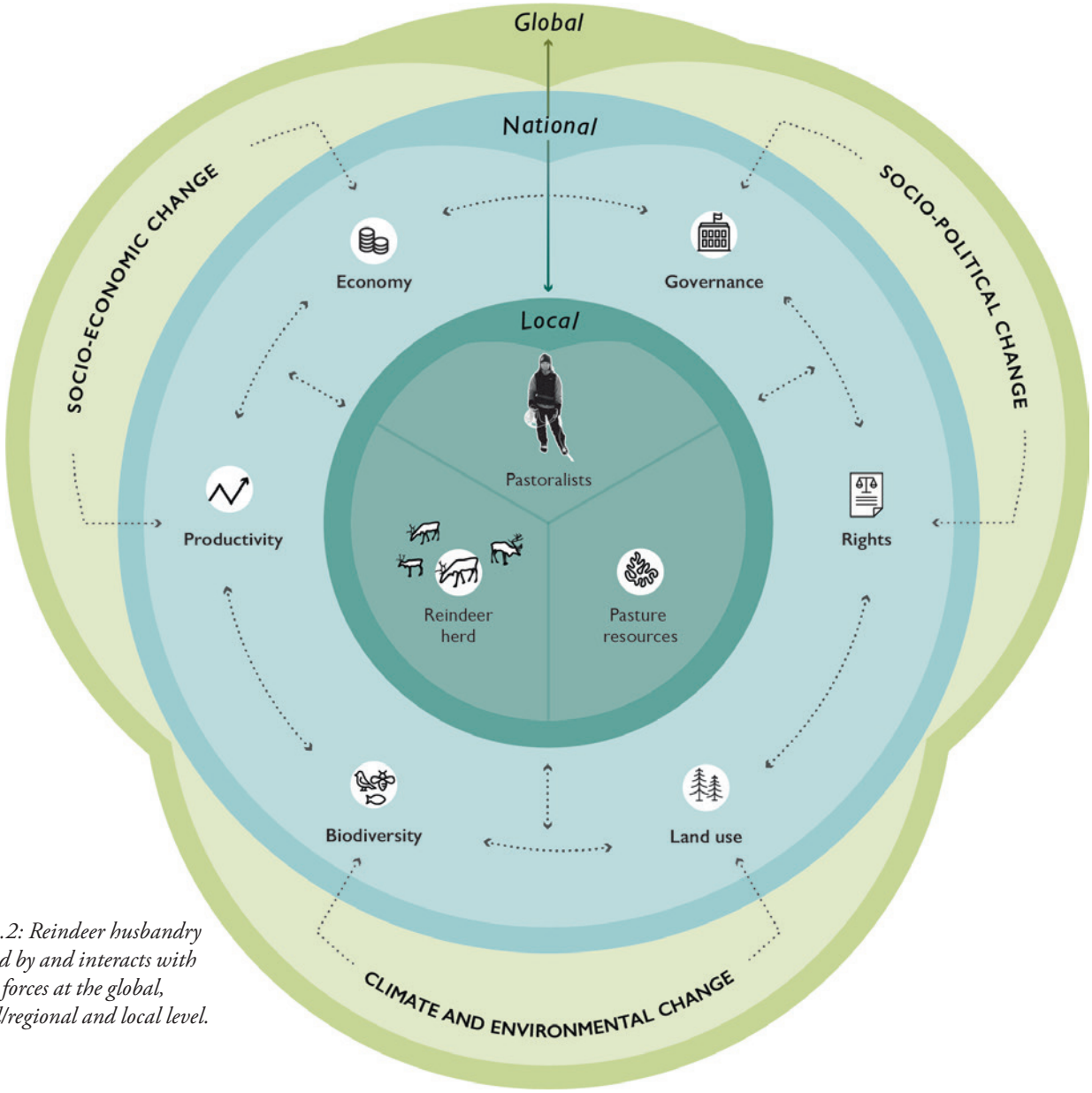


Figure 1.2: Reindeer husbandry is affected by and interacts with external forces at the global, national/regional and local level.

pacted by climate change and previous land use, they are considered to be an important part of the global and national solution to the climate crisis. The future of reindeer husbandry will depend to a great extent on the herders' ability to develop strategies to tackle these challenges. It is therefore crucial to understand how this production system is impacted by these different external forces (figure 1.2).

MODERN REINDEER HUSBANDRY IN NORWAY, SWEDEN AND FINLAND

There are currently about 200,000–250,000 semi-domesticated reindeer in each of the three countries Norway, Sweden and Finland, with the greatest number in the north (figure 1.3). There are about 3,300 reindeer owners in Norway, 4,600 in Sweden and 4,300 in Finland. The vast majority of reindeer owners in Norway and Sweden are Sámi, while in Finland both etnic Finnish and Sámi practice the livelihood. In all countries, reindeer husbandry is central to the culture.

Reindeer herding areas cover 30–50% of each country's surface area and the use varies seasonally (figure 1.5). However, not all land is functional for reindeer grazing, even if there are grazing rights associated with it. In Sweden and Norway, the right to reindeer grazing in the majority of these areas is reserved for the Sámi population. In Finland, only part of the reindeer management area (13 northernmost herding districts) belongs to the Sámi homeland area.

In all three countries, reindeer herding is divided into administrative districts where the size of the areas and the number of reindeer within each area varies significantly depending on the landscape, historical boundaries and administrative decisions (figure 1.4).

The ecological and historical background of the use of designated lands for reindeer grazing differs between the three countries. Currently, there are three primary reindeer grazing and migration strategies (figure 1.5).

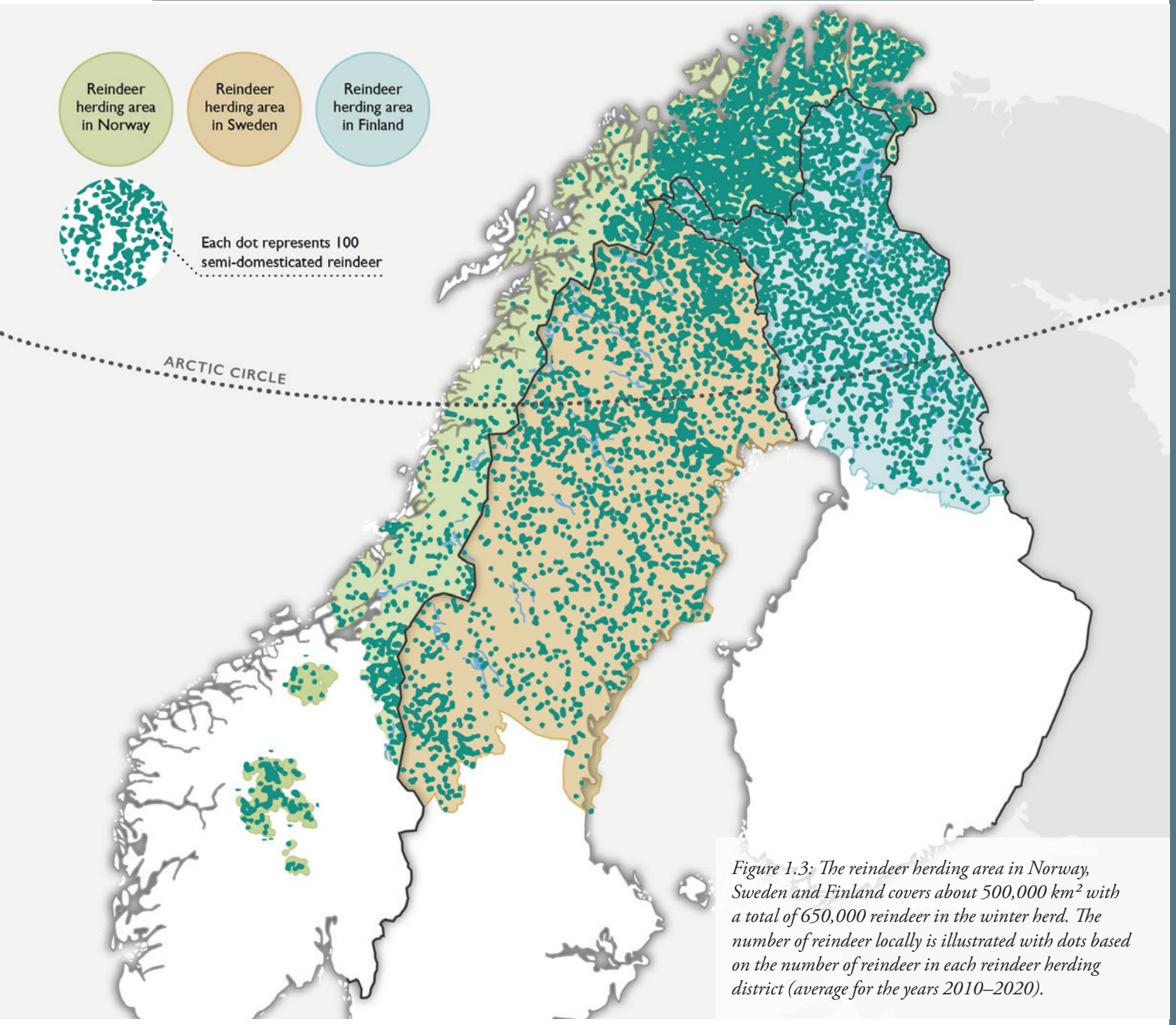


Figure 1.3: The reindeer herding area in Norway, Sweden and Finland covers about 500,000 km² with a total of 650,000 reindeer in the winter herd. The number of reindeer locally is illustrated with dots based on the number of reindeer in each reindeer herding district (average for the years 2010–2020).

- seasonal migration between summer grazing lands in the mountains or on the Atlantic coast to winter grazing lands in the taiga or tundra (Sweden and Norway),
- more stationary year-round grazing in taiga or mountain areas (Sweden and Finland).
- seasonal migration between summer grazing lands in the inland and winter grazing lands at the Atlantic coast (Norway),

Norway

In Norway, the Sámi reindeer herding area is divided into 82 districts (reinbeitedistrikt in Norwegian) (figure 1.4). In Finnmark in the north, the reindeer migrate between the summer pastures at the Atlantic coast and the winter grazing lands in the inland. In Troms, reindeer herders have their herds on islands year-round, while other districts do short migrations between coastal grazing and winter grazing lands farther inland. The winter grazing lands in the area are heavily affected by the ocean climate and are often inaccessible due to deep snow or hard ice crust. In mid-Norway in Nordland and Nord-Trøndelag, the reindeer graze in the inland mountains, often close to the Swedish border, and in the winter grazing lands along the Atlantic coast or in the lowland, where it rains more often and the snow cover is thin. In the southern part of the reindeer herding area, in Sør-Trøndelag and Hedmark, most of the reindeer migrate to winter

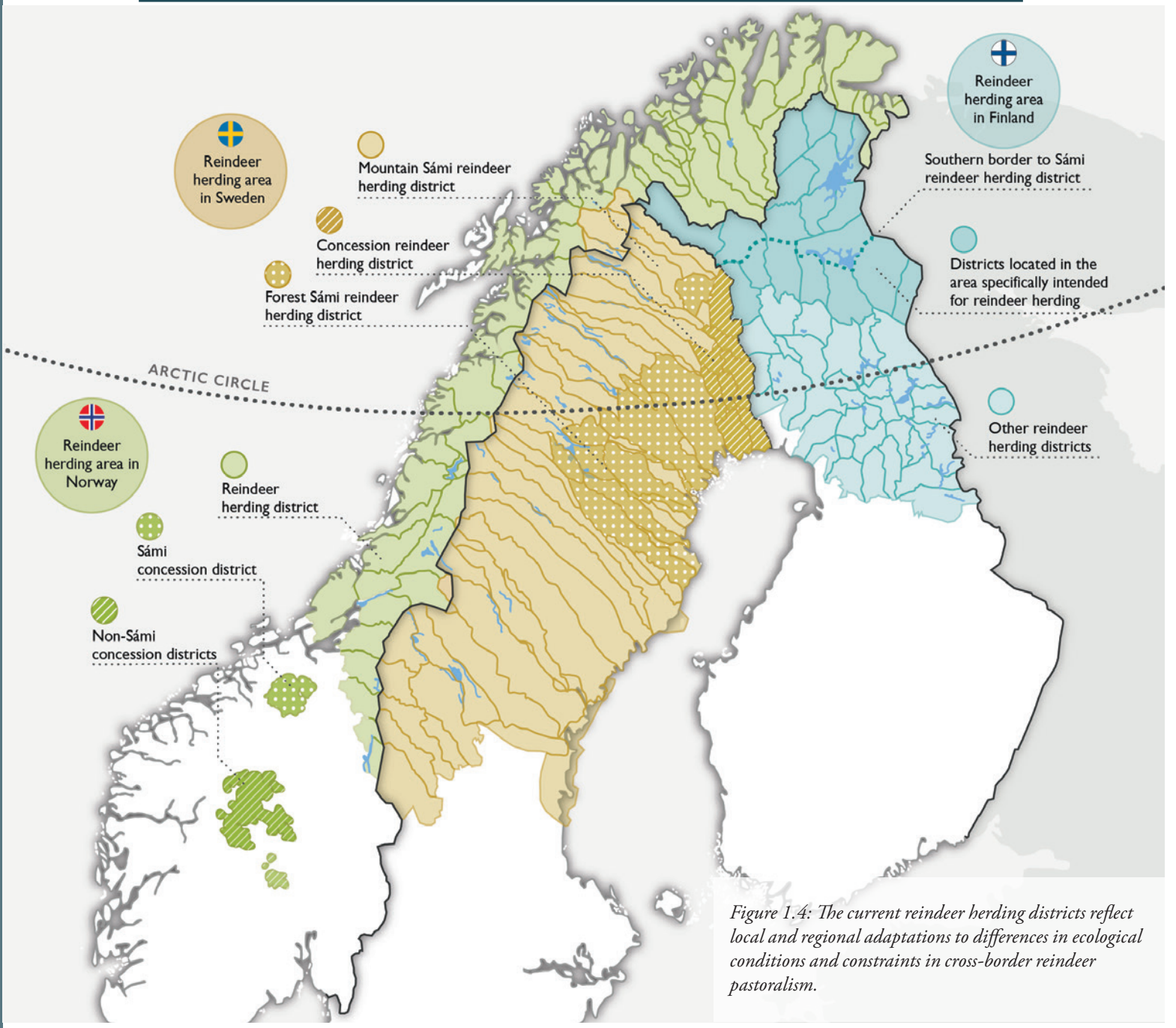


Figure 1.4: The current reindeer herding districts reflect local and regional adaptations to differences in ecological conditions and constraints in cross-border reindeer pastoralism.

grazing lands in the Femunden region near the Swedish border, which generally has little snow and good access to food. Four reindeer herding districts are run by non-Sámis in concession areas in the mountain chain in the southernmost parts of the reindeer herding area next to wild reindeer areas.

Sweden

In Sweden, reindeer husbandry is divided into 51 reindeer herding districts (sameby in Swedish) (figure 1.4), which have year-round pastures where the reindeer can roam all year, and winter grazing lands where the reindeer can only be from 1 October to 30 April. There are 33 long and narrow mountain herding districts stretching along the river valleys, with summer grazing in the mountains in the west and winter grazing in the forested areas towards the Gulf of Bothnia. Ten forest herding districts use grazing lands in the forest areas year-round. In addition to this, there are eight concession districts, which rotate between different year-round pastures in the forest along the Finnish border (figure 1.4). The inland winter grazing lands are generally characterised by relatively cold, snowy winters, while the areas near the Gulf can be affected by the coastal climate and temporarily milder weather in the winter. The reindeer are moved between seasonal grazing lands on foot or by truck, depending on accessible migration paths between grazing lands.

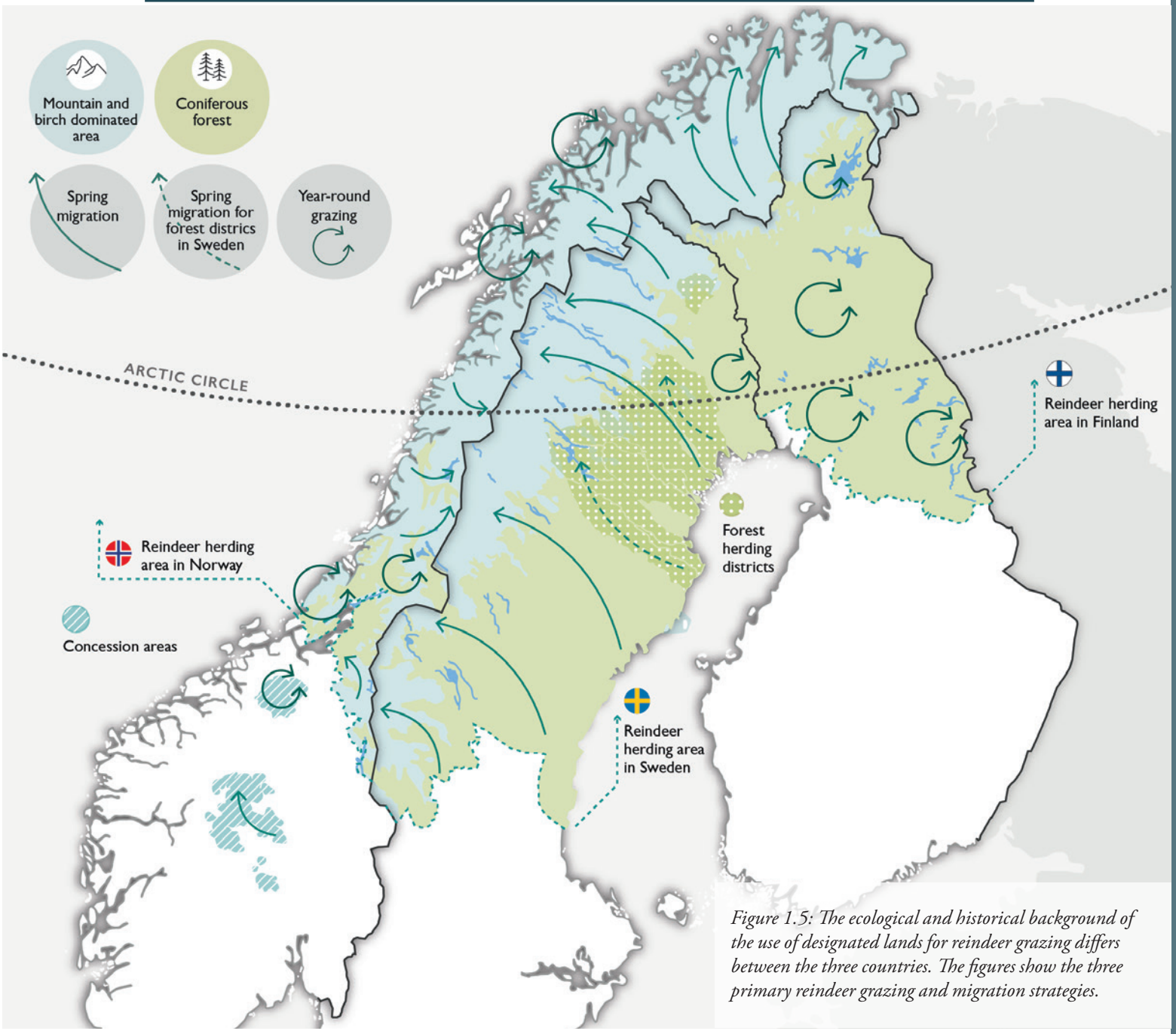


Figure 1.5: The ecological and historical background of the use of designated lands for reindeer grazing differs between the three countries. The figures show the three primary reindeer grazing and migration strategies.

Finland

The reindeer herding area in Finland is divided into 54 reindeer herding districts (paliskunta in Finnish) (figure 1.4). The 13 northernmost herding districts belong to the Sámi homeland area. The southern and central parts of the reindeer herding area consist of a combination of coniferous forest and bogs, while the northern part is dominated by tundra and mountain birch forest. The herding practice in the southern part is stationary, and the reindeer in the relatively small herding districts generally move freely between summer and winter grazing lands. In the larger districts further north, the reindeer are herded between defined summer and winter grazing areas. Many reindeer herding districts fence off the grazing lands.

Source of text and figures in chapter 1:

Holand, Ø., Horstkotte, T., Kumpula, J. & Moen, J. 2022. Reindeer pastoralism in Fennoscandia. Chapter 1 in book*. pp. 7-47. https://doi.org/10.4324/9781003118565-3

*T. Horskotte, Ø. Holand, J. Kumpula & J. Moen (eds.) *Reindeer husbandry and global environmental change – pastoralism in Fennoscandia.* Routledge, London. https://doi.org/10.4324/9781003118565

2

The origins of reindeer pastoralism

In Fennoscandia[1], reindeer herding is associated with the Sámi population, and recurring debates have focused on when, why and how the practice arose. One theory is that reindeer were domesticated a few thousand years ago east of the Ural Mountains in the southern part of the Siberian taiga and spread from there to other regions. Another theory is that reindeer were domesticated on several occasions in different parts of Eurasia. The current semi-domesticated reindeer in Fennoscandia can be divided into two gene pools: the Norwegian/Swedish and the Finnish. In addition, the Norwegian/Swedish populations have a distinct northern and southern gene pool.

THE GENETIC STRUCTURE OF EURASIAN SEMI-DOMESTICATED REINDEER

Analyses based on genetic markers from 25 places in Eurasia show a clear genetic difference between Fennoscandian and Russian semi-domesticated reindeer (figure 2.1A). The difference probably reflects historical and evolutionary events and indicates that the reindeer populations in the two regions have different origins, which supports the theory that the animals were domesticated in several locations. With a more detailed genetic division, also based on microsatellites, the Fennoscandian population still makes up a distinct group, while the Russian population can be divided into three smaller groups (figure 2.1B). Thus, the semi-domesticated reindeer in Fennoscandia are a genetically specific group, most likely descended from a different original population than those in Russia, and a unique genetic type within Eurasia, with the preservation and management responsibility that comes with such a status.

THE DEVELOPMENT OF REINDEER PASTORALISM IN FENNOSCANDIA

The origin and development of reindeer pastoralism has been discussed many times, and many researchers believe that Sámi communities transitioned from hunting to reindeer herding between 1550 and 1750 due to an increase in taxation, expanded trade connections and the introduction of firearms, which led to a decline in the number of wild reindeer. Others have emphasised the social tensions that arise in the hunting economy with the division of quarry, which favoured the introduction of an alternative system of individually owned reindeer. Archaeologists state variously that the growth of nomadic reindeer pastoralism can be dated back to the Viking Era, or to the 9th to 13th centuries, or even as early as the beginnings of Christianity. Regardless of what led to the transition, the debate has continued as to whether the rapid growth of semi-domesticated herds was based on the import of a new domesticated type of reindeer to Fennoscandia, or if it was primarily due to the Sámi adopting methods that made it easy to tame and start domesticating[2] locally occurring wild reindeer.

[1] Fennoscandia is a geographic term that is used to describe an area in northwestern Europe. The area includes the Scandinavian Peninsula (Norway and Sweden) and Finland, as well as the Kola Peninsula and Russian Karelia. However, in this report it is used to refer solely to Norway, Sweden and Finland

[2] Domestication (in contrast to taming an animal, which means making it accustomed to humans) means selective breeding of animals to change their genetic makeup so that each generation better matches the humans' goals. We use the term semi-domesticated to distinguish the degree of domestication and dependency on humans from fully domesticated livestock.

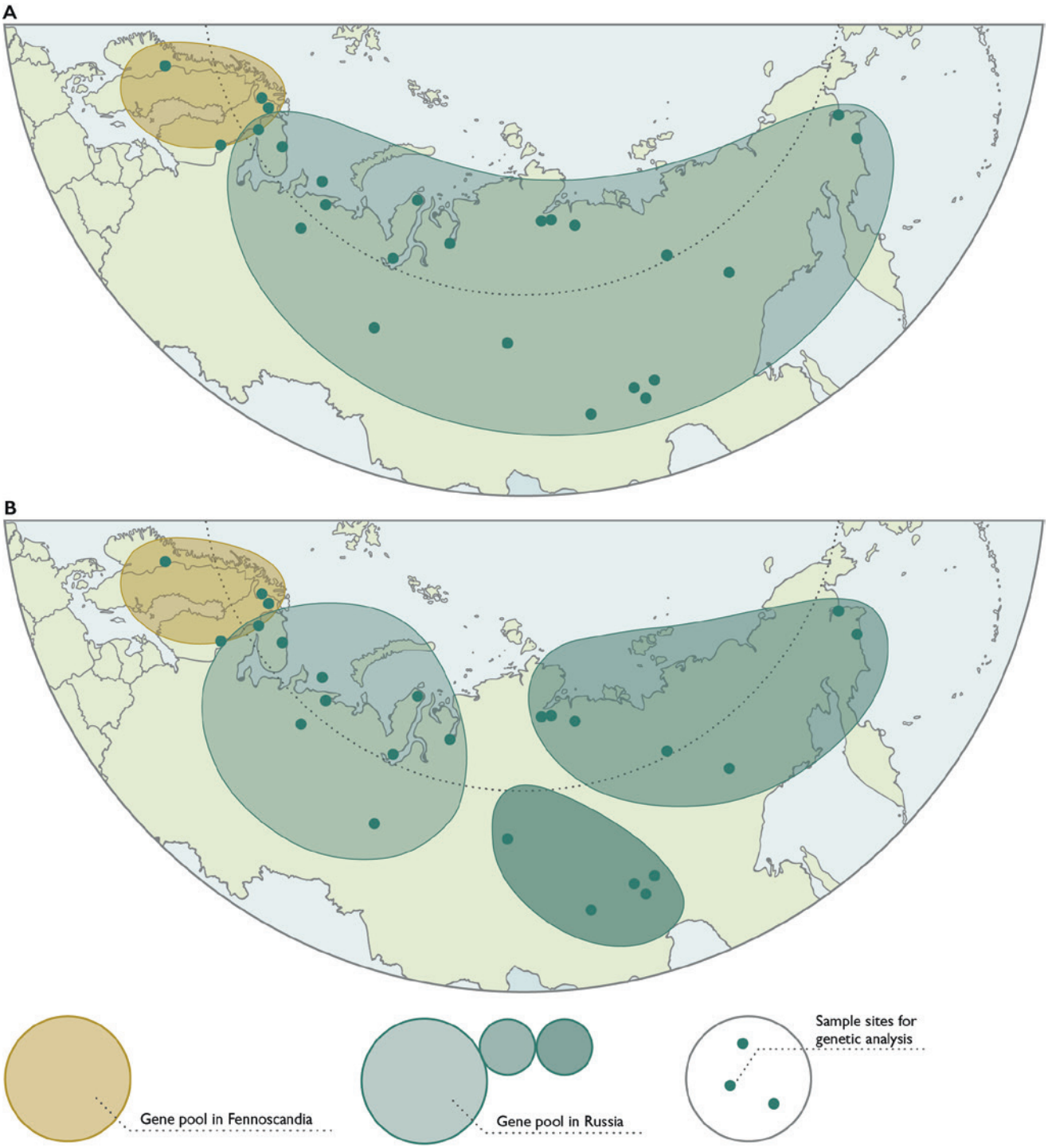


Figure 2.1: Genetic classification of semi-domesticated reindeer in Eurasia based on samples from 25 reindeer herds (marked with dark green dots). The top image (A) shows the genetic differences between semi-domesticated reindeer in Fennoscandia and Russia. The lower image (B) shows a more detailed division with one clear group in Fennoscandia and three groups in Russia: a north-western, north-eastern and a southern group.

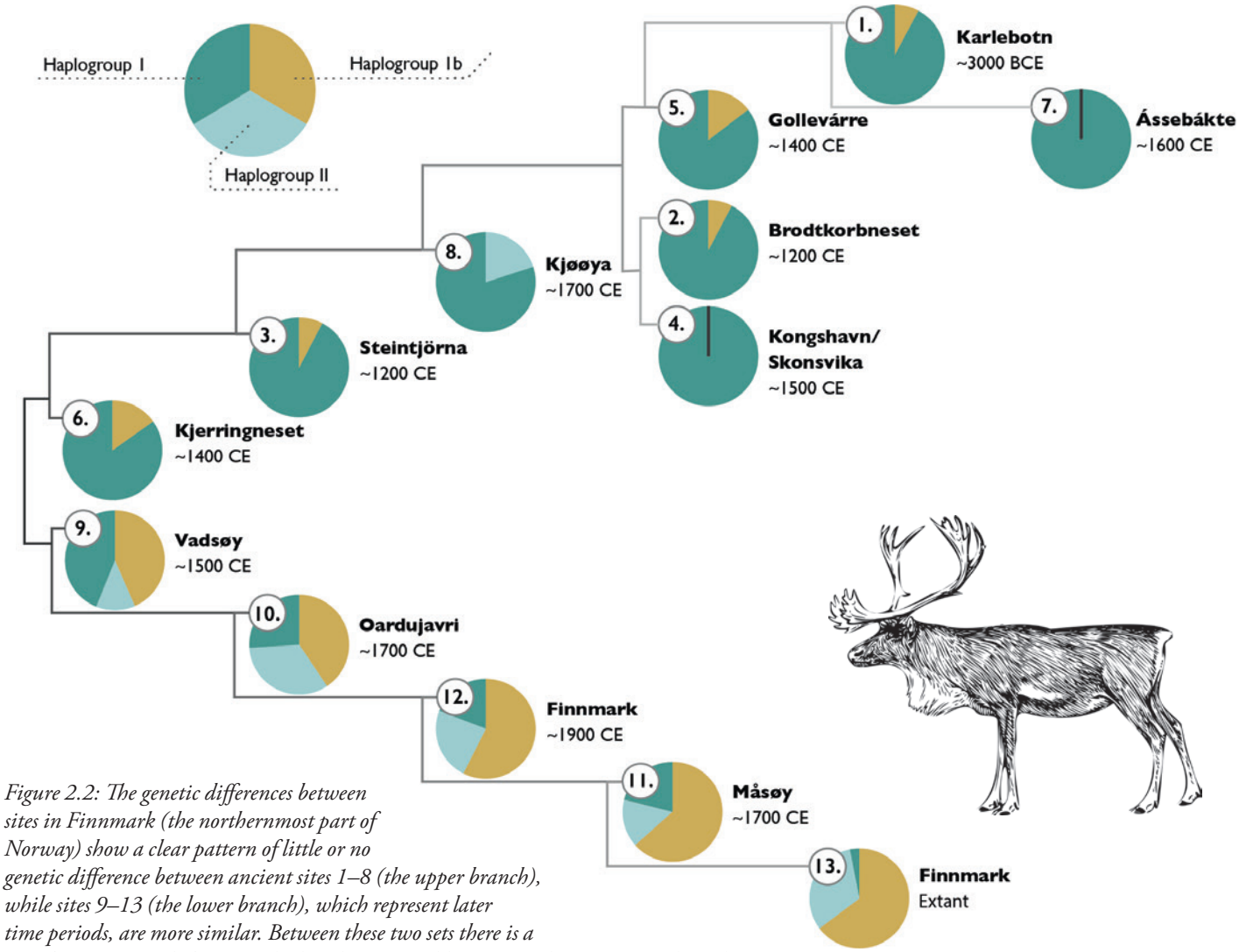


Figure 2.2: The genetic differences between sites in Finnmark (the northernmost part of Norway) show a clear pattern of little or no genetic difference between ancient sites 1–8 (the upper branch), while sites 9–13 (the lower branch), which represent later time periods, are more similar. Between these two sets there is a significant genetic difference, which indicates a sudden genetic change over a relatively short period. This coincides with the Sámi people's transition from primarily hunting and gathering to large-scale reindeer herding, indicating that the rapid genetic shift was closely associated with the commencement of nomadic reindeer pastoralism.

More recent genetic studies of archaeological finds have helped to explain the origins and spread of domestication. Studies of archaeological and extant reindeer from Finnmark have shown genetic changes linked to the transition from the hunting society to reindeer herding. Researchers have analysed mitochondrial DNA, which is passed down unchanged along the maternal line, making it an ideal genetic marker for the study of demographic processes and to provide clues to the early history of domestication. Different, closely related, versions of mitochondrial DNA – haplotypes – represent genetic lines preserved through generations of mothers. By comparing haplotypes in reindeer from 5,000-year-old archaeological sites with those from the Middle Ages and later sites up to modern reindeer, research shows that the reindeer in northernmost Norway (Finnmark) have gone through a massive genetic exchange since the Middle Ages. This genetic transition is characterised by a significant loss of older haplotypes along with the introduction of new ones (figure 2.2).

The archaeological samples show signs of a reindeer population with high genetic variation and a relatively homogeneous genetic structure (figure 2.2) until the late Middle Ages, which indicates that herds were relatively large. However, the analyses show a major genetic loss after this time, which indicates that the populations of wild

Painting of the "Little Ice Age" by Girardet

reindeer declined and were split up, either before or during the first phases of the Sámi transition to reindeer herding. Fewer and more scattered wild reindeer herds allowed reindeer herding to take hold and the semi-domesticated herds to expand quickly. Throughout Russia, too, the reindeer herding grew rapidly during the the 18th and 19th centuries. This may indicate a more general driving force, such as the start of the Little Ice Age, with the coldest interval between the 17th century and the mid-19th century. Reindeer are well adapted to cool summers and cold winters, and larger semi-domesticated herds may have led to greater human mobility, which facilitated the hunt of wild reindeer. It is possible that the decline in wild reindeer populations in Fennoscandia did not come before, but rather followed the population expansion of semi-domesticated reindeer, although local political, social and economic factors may have been influential as they iniciated reindeer herders to keep large herds. The difficulties with having large herds of both wild and semi-domesticated reindeer in the same area may have further reduced or fully outcompeted the wild reindeer population.

The genetic shift in the maternal lines of the Finnmark reindeer was characterised not only by the loss of genetic variation, but also by the replacement of haplogroups, which is clusters of closely related haplotypes, from different maternal lines. Haplogroup I dominated the historical material, but became rare and has nearly disappeared from today's semi-domesticated reindeer, while the opposite was true for haplogroup II (figure 2.2). The most common haplotypes in haplogroup II among today's semi-domesticated reindeer did not exist at all in the older specimens.

Thus, the transition to nomadic reindeer herding seems to have been based on a limited number of individuals in the maternal line, which in part seems to have come from elsewhere. The rapid growth of herds from the 17th century on may have facilitated the development of a unique reindeer type based on a small number of imported reindeer. Where these animals came from is an exciting question. The absence of the characteristic haplogroup II in reindeer from medieval and earlier sites in Finnmark (figure 2.2) indicates that the reindeer colonised from the east. This is also consistent with the declining occurrence of this line from east to west among the current semi-domesticated reindeer population in Fennoscandia Likely areas of origin of the wild ancestors of these reindeer may have been in the current taiga areas of Scandinavia or western Russia. Today, these are habitats for the wild Finnish forest reindeer that live in Finland and north-western Russia. The Finnish forest reindeer of today are descended from a previous large population whose geographical distribution probably covered the northern part of Finland and western Russia. The population died out in Sweden in the early 19th century and somewhat later in Finland, but recovered later when individuals were introduced to Finland from Russia and some have drifted into Finland along the Finnish/Russian border.

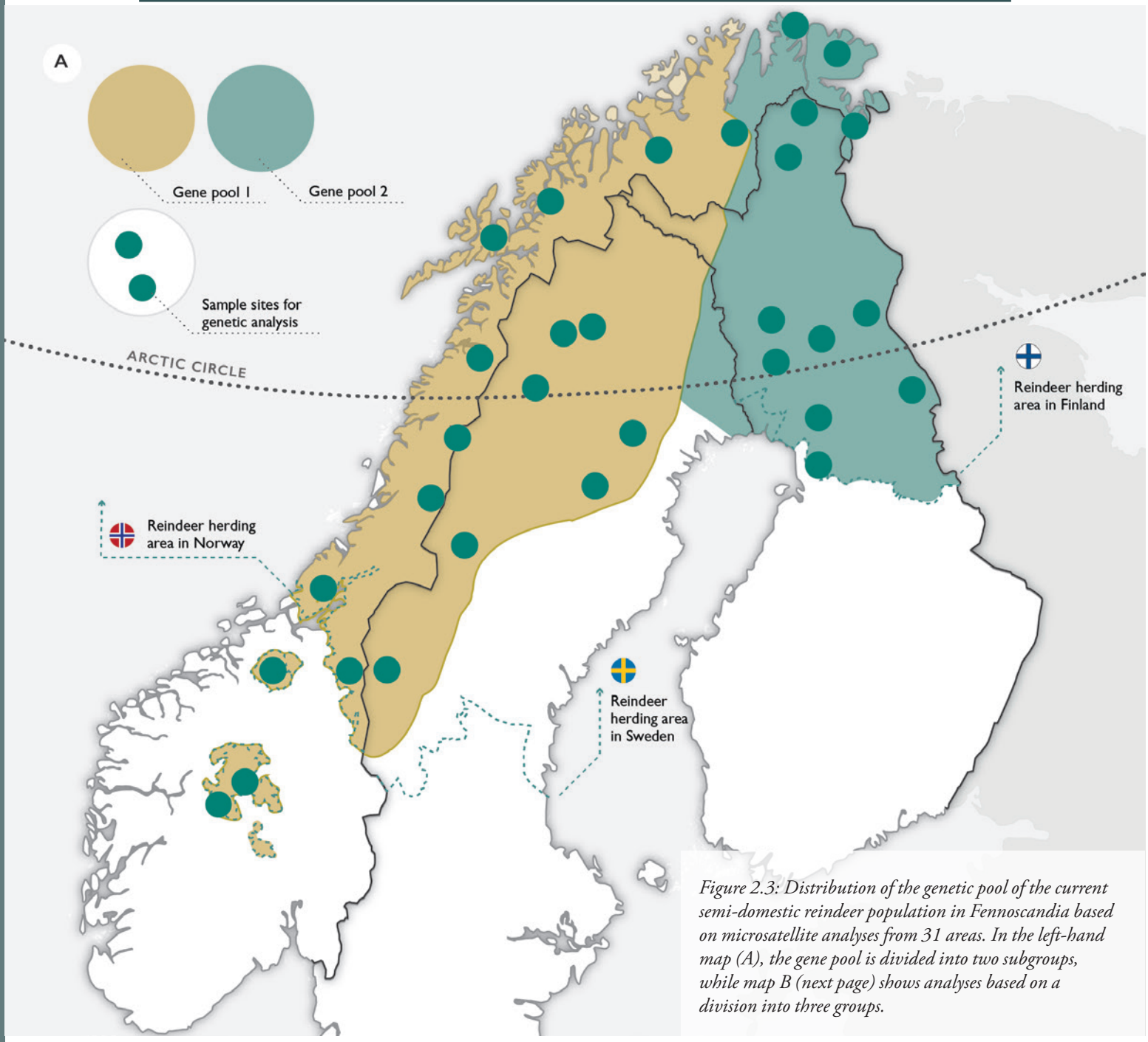


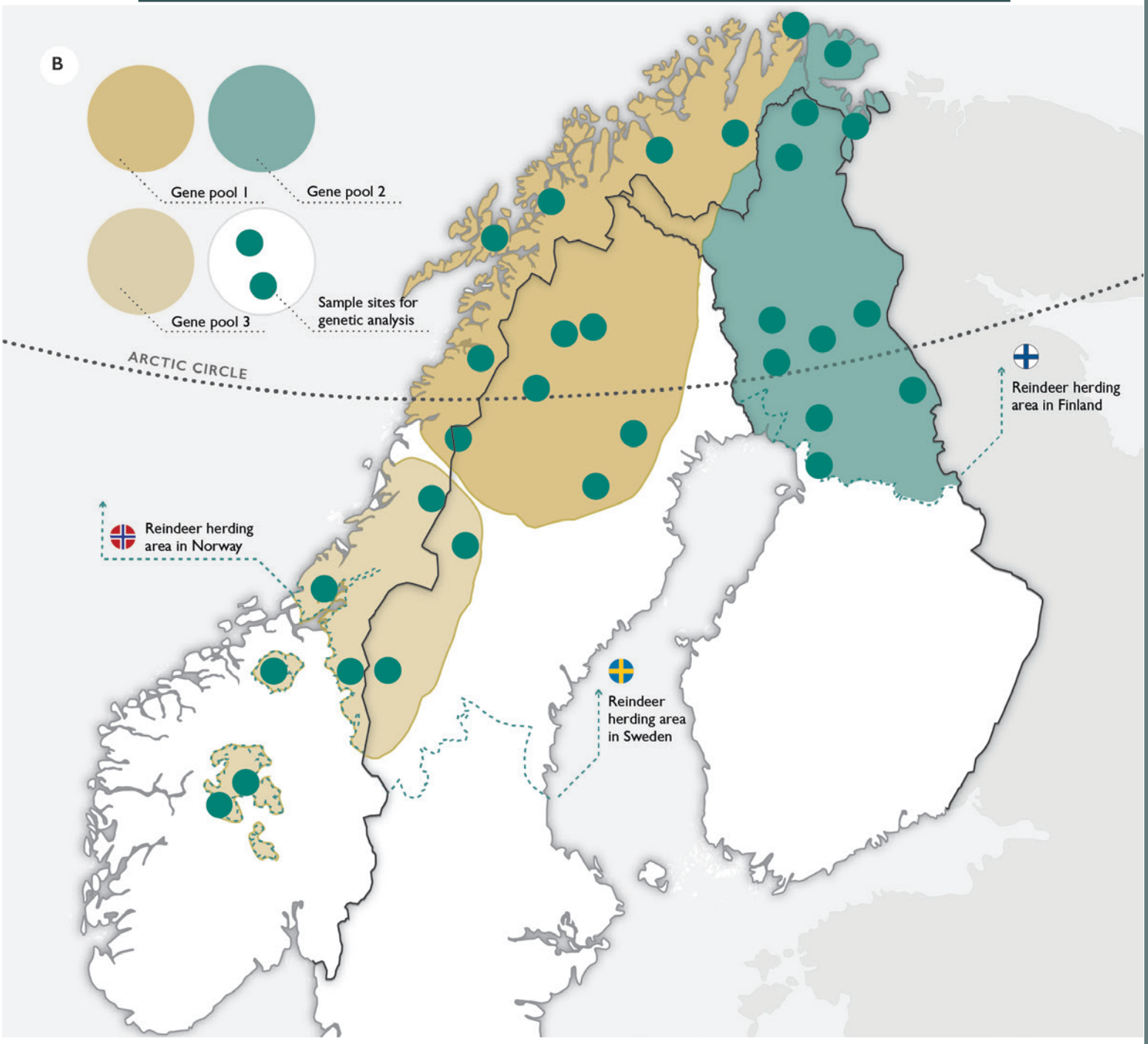
Figure 2.3: Distribution of the genetic pool of the current semi-domestic reindeer population in Fennoscandia based on microsatellite analyses from 31 areas. In the left-hand map (A), the gene pool is divided into two subgroups, while map B (next page) shows analyses based on a division into three groups.

TODAY'S SEMI-DOMESTICATED REINDEER

So what has impacted the genetic structure and variation of today's Fennoscandian semi-domesticated reindeer? To examine this, researchers analysed genetic material from reindeer from 31 reindeer herding districts in Norway, Sweden and Finland (figure 2.3).

The genetic structure of the Fennoscandian semi-domesticated reindeer herds reveals significant variation both within and between the districts. This indicates that many animals contribute to breeding and therefore inbreeding is low. Despite the relatively large genetic variation, there were also significant genetic differences between the populations. The analyses revealed two distinct gene pools (figure 2.3A), one that was dominant in Finland and one jointly in Norway and Sweden, with the exception of the northernmost and eastern herds in Norway, which shared a gene pool with the Finnish reindeer. In addition to this general pattern, the shared Swedish-Norwegian gene pool could be divided up into a southern and a northern part (figure 2.3B).

The early nomadic Sámi reindeer pastoralism in Finland may have spread from northern



Sweden and Norway to the Käsivarsi region in northwestern Finland in the early 17th century, from which large-scale herding gradually spread to other regions. In the 17th and 18th centuries, there was also frequent trade and transport of reindeer between Finnish reindeer herders and indigenous peoples in the nearby eastern region. In those days, reindeer herding was common on the taiga in what is now the Arkhangelsk Oblast and the Republic of Karelen on the eastern side of the current border between Finland and Russia. The import of particularly strong draught reindeer of eastern heritage from Finland to eastern Finnmark might explain the shared genetic pattern we see today between these areas. One key factor for the shared Swedish-Norwegian gene pool may have been herds primarily used for transportation, household use and milking.

The clear genetic difference between the herds in Finland compared with Sweden and most of Norway (figure 2.3A) was probably also affected by the border closure between Russia/Finland and Norway in 1852, which was followed by the border closure between Russia/Finland and Sweden in 1889. In the early 19th century, seasonal migrations were extensive, with tens of thousands

of reindeer migrating between the four countries. After the borders were closed, these migrations became impossible, which had a major effect on reindeer herding. The dissolution of the Swedish-Norwegian union in 1905, however, does not seem to have had any genetic consequences, despite the fact that Swedish reindeer herders until recently have lost access to important grazing areas along the Norwegian coast.

Socio-ecological driving forces behind today's genetic structure

Instead of following national borders, the reindeer in Norway and Sweden are divided into a southerly and northerly gene pool, which reflects trans-border social and ecological relationships.

Besides the national differences, there are socio-cultural variations within the Sámi community, which are represented by the Sámi languages. The cultural boundaries do not follow the national borders, as most of the Sámi languages are older and are spoken in more than one country; they have different delimiters than the national borders. Sámi belongs to the Fenno-Ugric languages and can be divided into three main types: Eastern Sámi, which is mainly spoken on the Kola Peninsula and in some parts of northeastern Finland; Central Sámi, which is spoken in northern Finland, Sweden and Norway; and Southern Sámi, which is spoken in the southern parts of Norway and Sweden (figure. 2.4). Northern Sámi is a part of the Central Sámi language type and is the most widely spoken Sámi language.

Analyses of diffeent models to explain the three-parted genetic structure gives that the genetic division of the Fennoscandian semi-domesticated reindeer is associated with nation-states (Norway, Sweden and Finland), ethnicity (Sámi versus non-Sámi) and language, in which language group is definitely the best factor to explain the reindeer's genetic grouping (figure 2.3B). In Norway in particular, the genetic grouping of reindeer matches the traditional language boundaries, where Southern Sámi dominates in the area of the southern genetic pool and Central Sámi dominates the area where we find the northern genetic pool. This shows that reindeer husbandry in the Fennoscandian countries is closely associated with the Sámi as a culture.

> ***"The genetic structure of the Fennoscandian semi-domesticated reindeer herds reveals significant variation both within and between the reindeer herding districts."***

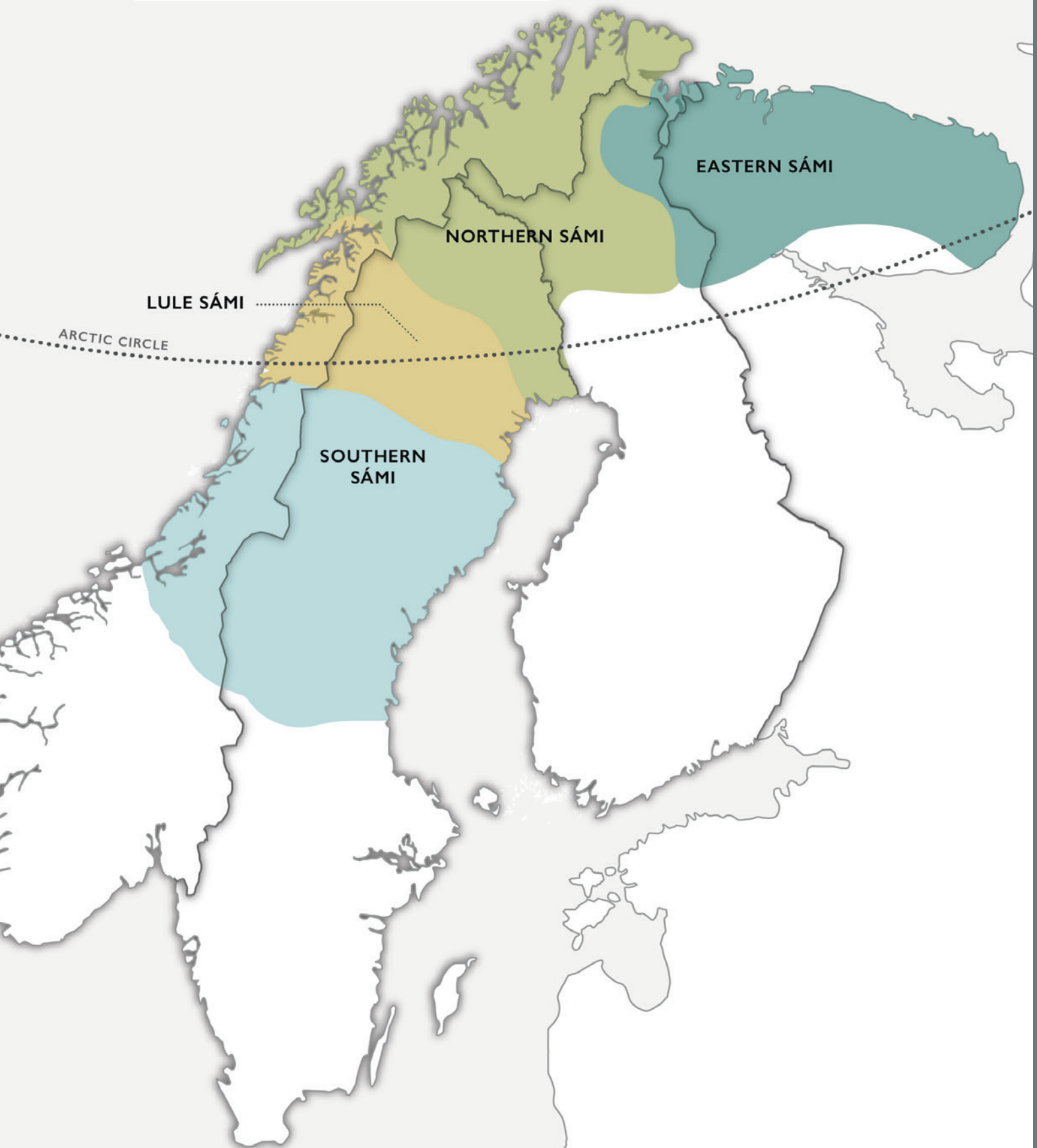
Studies have not been able to determine any obvious differences in reindeer husbandry practices that coincide with the two genetic subgroups of reindeer in Sweden and Norway. Rather, different methods seem to be ecological rather than genetic adaptations. Even if one might expect certain genetic adaptations as a response to differences in the environment, the genetic structure seems primarily to reflect the past and how reindeer herders have traditionally worked together across borders.

Source of text and figures in chapter 2:

Røed, H., Kvie, K.S. & Bårdsen, B.-J. 2022. Genetic structure and origin of semi-domesticated reindeer. Chapter 2 in book*. pp. 48-60. https://doi.org/10.4324/9781003118565-4

*T. Horskotte, Ø. Holand, J. Kumpula & J. Moen (eds.) *Reindeer husbandry and global environmental change – pastoralism in Fennoscandia.* Routledge, London. https://doi.org/10.4324/9781003118565

Figure 2.4: The Sámi language can be divided into three major language groups: Eastern Sámi, Central Sámi, and Southern Sámi. Eastern Sámi is spoken on the Kola Peninsula in Russia and the eastern part of Finland; Central Sámi is spoken in Finland, Norway and Sweden (Northern Sámi in all three countries, Lule Sámi in Norway and Sweden) and Southern Sámi is spoken in Norway and Sweden.



3

Reindeer pastures

The wild reindeer that lived in northern Europe in the past migrated between different habitats and landscapes depending on climate, terrain and available forage. Early reindeer herding evolved as a nomadic lifestyle based on the animals' natural migrations. Since then, the use of grazing land has always been adapted to the landscape and the needs of the reindeer. In recent decades, external pressure on grazing lands has increased and competition from other land users has grown more intense. Pasture loss is considered the greatest threat to the future of reindeer husbandry.

HOW REINDEER USE THE PASTURES

Reindeer are adapted to the arctic and sub-arctic climate. They migrate seasonally in herds, returning to the same or nearby pastures year after year. Their choice of grazing areas can be understood as layers of behavioural decisions in time and space, from choosing the region depending on the season to selecting the most nutritious part of an individual plant. Reindeer are in constant movement as they graze through the landscape. In summer they choose the most nutrient-rich, easily digestible vascular plants, while in winter lichens (in particular the Cladonia species) dominate the diet. During the snow free season, they need to fill up their energy stores for the austerity of winter. During all seasons, it is important that the reindeer are able to graze in peace so they can get enough energy and nutrients. The behaviour of the herded reindeer and actions of the herders vary according to the animals' reproduction cycle, season, herd structure and access to grazing land (figure 3.1). In general, the large-scale migration and choice of regional areas are mainly decided by the herders, while the reindeer choose the shorter movements within seasonal pastures and grazing areas. Thus, the definition of functional reindeer grazing land is a multidimensional concept in time and space. The herders' decisions to move on to a new pasture are well integrated with the reindeer's behaviour and it is hard to know who really takes the decision. The ability to graze in peace and choose the best grazing area for the season is crucial for reindeer herding and the animals' survival and reproduction.

PASTURES UNDER PRESSURE

Disturbances and barriers

The strategy of migrating between seasonal pastures makes reindeer sensitive to changes in the landscape. Barriers in the landscape prevent migration; industrial activities such as mines, hydropower and wind power often create such barriers. The strategy of living in large herds makes it easier for the reindeer to discover and flee from predators, but it also makes them more sensitive to disruptions (noise and movement) caused by people or industrial activity. Such disruptions can scare off the reindeer from an area, or cause them to avoid it. They can also drown out natural sounds, making it harder to discover predators, which might also cause the reindeer to avoid such areas.

The ability to herd the reindeer between different pastures and the animals' freedom to move about are particularly important when the weather or external disruptions change the grazing conditions. Barriers such as trafficked roads, power lines, dense forest plantations or unstable and uncertain ice conditions in regulated rivers and lakes create additional work for reindeer herders and make it more difficult and dangerous for humans and animals alike to move through the landscape. When areas are partially or completely separated by these barriers, the herders need to reorganise their use of

the land. Losing a migration path between seasonal pastures often means a need to move the animals by truck. In some cases, bridges and other structures have been built to allow reindeer to cross roads or pass other obstacles. Such passages must be carefully planned in collaboration with the reindeer herders and positioned in strategic locations in order to be useful. Due to the expense, there are not many such passages as yet.

Reindeer are known to avoid mining areas, where the roads are heavily trafficked and there is a regular human presence. In the Ivalo reindeer herding district in northern Finland, the reindeer avoided areas closer than 1.5 kilometres from gold-panning sites in the summer, when human activity was greatest. A study from Finnmark in Norway showed that reindeer presence decreased by 35 per cent within 1.4 kilometres of an open-pit

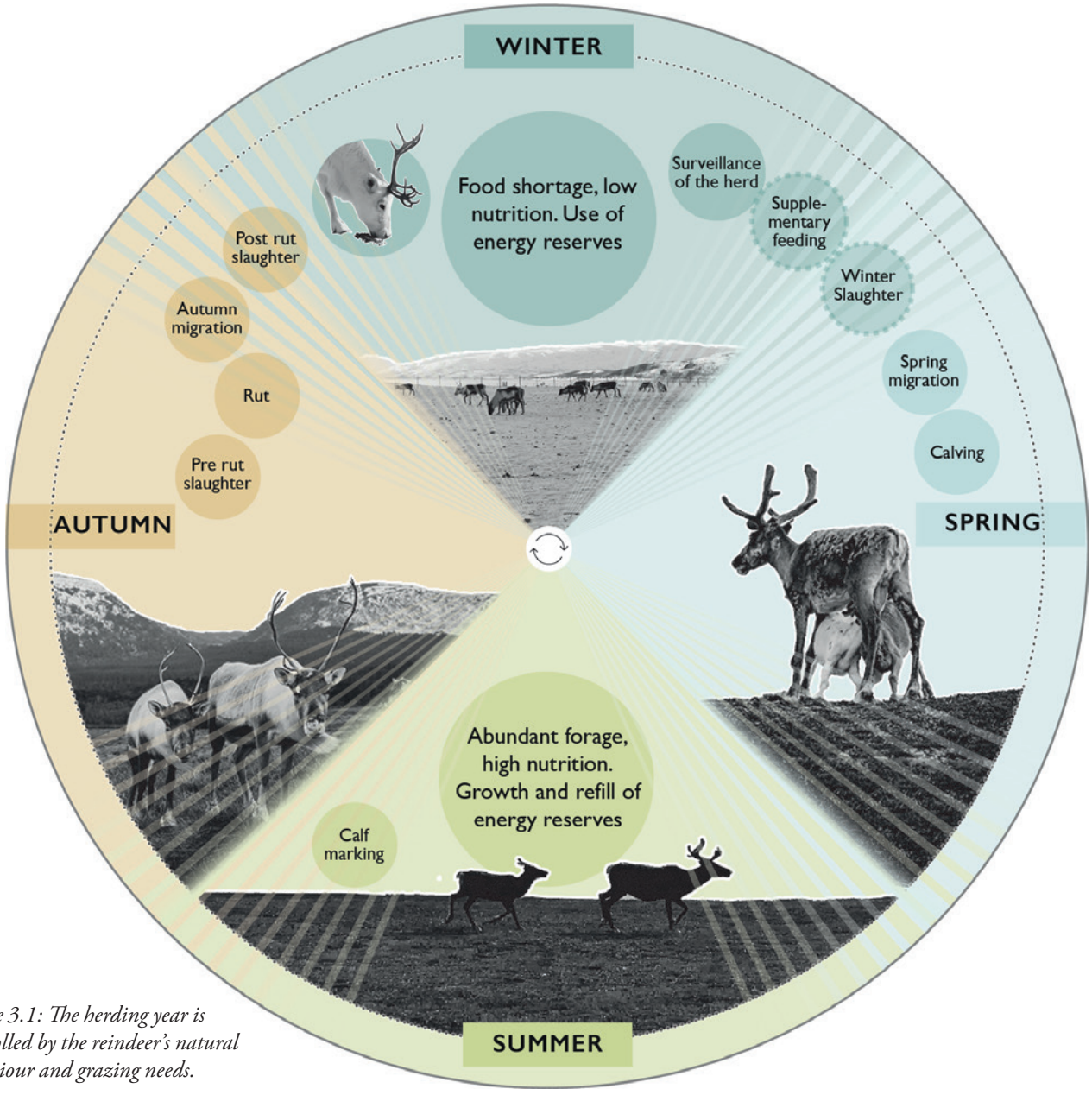


Figure 3.1: The herding year is controlled by the reindeer's natural behaviour and grazing needs.

mine during high-activity periods. In Malå herding district in Sweden, data spanning over a 10-year period shows that reindeer avoided an area near the Kristineberg underground mine during the snow-free season.

Wind turbines create noise and visual disturbances. Reindeer migration paths can be cut off during the construction of a wind farm, causing them to avoid the area. Several studies also show that once the wind turbines are running, the reindeer stay out of visual contact with the turbines, foraging more on lands where the topography obscures the turbines. In open landscapes in Norway, the zone of influence of wind turbines can reach as far as 13 kilometres.

Reindeer are particularly sensitive to disturbances during the post-calving period and in early summer. The least effect of human interference is observed in late summer, when the reindeer are more concerned about avoiding biting insects and parasites than humans. How different forms of land exploitations affect reindeer depends on the area, and local studies are needed to be able to understand the effects.

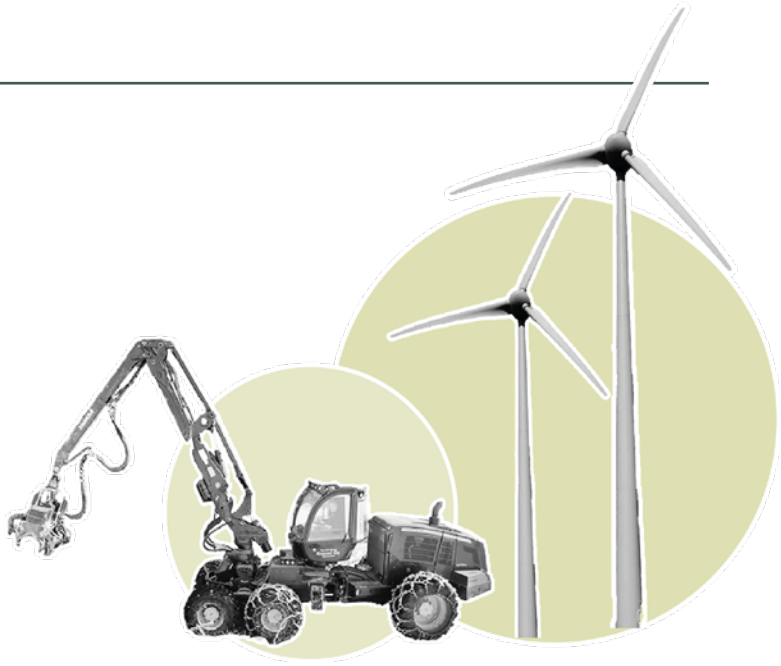
Losses and fragmentation

All land development causes a direct loss of grazing land at the development site, and the operations can also fragment the landscape with roads and other installations. For example, northern Sweden's biggest open-pit mine, the Aitik copper mine, is about three square kilometres, but its total physical footprint in the landscape is about 50 square kilometres. Mining can also affect the terrestrial lichens; for example, dust from the mines and mine roads can prevent lichen growth. Markbygden is Sweden's biggest land-based wind farm, which is planned to have 1,100 turbines on 450 square kilometres. When completed in 2025, the area will have nearly 800 kilometres of roads.

The Norwegian government has recently presented an ambitious plan to expand many wind farms in Finnmark, with the aim of electrifying the giant receiving and processing plants for natural gas on Melkøya outside Hammerfest. This will have a negative effect on the use of summer forage resources for many reindeer herding districts.

With the expansion of hydropower, key environments along rivers and lakes that were once calving sites, late spring pastures or migration pathways are now under water. But the reindeer's habitat loss may far exceed the area of land that was submerged. For example, herders from the Sámi area of Finland report that the construction of the Lokka and Porttipahta reservoirs in the late 1960s flooded some 11 per cent of their area, but the de facto loss of key grazing lands was up to 25 per cent. The reindeer had to learn new migration routes. Similarly, reindeer herders in Sweden and Norway have been forced to make major changes in their activities due to the expansion of hydropower.

The single biggest impact on the reindeer's access to both terrestrial and arboreal lichens in Sweden and Finland is forestry. Various forestry methods have changed the age structures and composition of the forests over time, with direct consequences for the access to lichens, which in turn negatively affects the viability of winter pastures for the reindeer. Until the mid-20th century, forestry involved selective removal of the largest trees, which didn't have a significant effect on the lichens. However, the practice of stand harvesting – clear-cutting followed by soil scarification – was introduced in the 1950s and has become the primary type of forest management.



This has led to a substantial decrease in old-growth forests in favour of young, dense plantation forests, which makes for less functional pastures, limiting the reindeer herders' options to adapt to current circumstances. The result is higher grazing pressure on the remaining pastures.

This change in the composition and structure of the forests has drastically reduced the amount of terrestrial and arboreal lichens. In the Swedish reindeer herding area, the proportion of forest with high lichen cover decreased by 71 per cent between 1953 and 2013. In the Sámi area of northern Finland, there was a 44 per cent drop between 1995 and 2018. When trees are felled, it eliminates the habitat for arboreal lichens. It takes at least 60 years for these lichens to come back in a rejuvenated forest, and 140–200 years before they are established in enough quantity to be considered a good food source for reindeer. The current growth time of 90–120 years in northern Sweden and Finland is not long enough for sufficient regrowth of arboreal lichens (the most important being the *Bryoria* and *Alectoria* species).

No matter what natural resources are used – renewable or not – the cumulative exploitation of land in the reindeer herding area decreases the area that is available for grazing.

Cumulative effects

The effects of competing land use on reindeer herding, including pasture loss, fragmentation of the landscape, barriers and other disturbances, cannot be viewed in isolation. Rather, all these factors interact and are also affected by previous hydropower, forestry and agricultural interventions. These create cumulative effects, which can be described in a variety of ways, depending on what is being affected. Cumulative effects on how reindeer and the herders can use the land are a measure of the total effects of all other land users in a region. These effects can enhance each other and lead to a greater problem than any of the problems alone (figure 3.2).

Cumulative effects are often difficult to predict and communicate. They can also be added to social and cultural effects to create an overall picture of how reindeer herding is impacted. The effects of other land use can furthermore be compounded by climate change and the increasingly common extreme weather or snow conditions that determine the reindeer's access to food. Thus, what is suitable land for reindeer can differ significantly from year to year. The occurrence of predators is yet another factor that can compound the effect of other disturbances. The loss and fragmentation of pastures severely limit the herders' ability to respond to climate change, disturbances and predators by finding alternative pastures. All together, this leads to the reindeer not using the pastures optimally and not having sufficient time to graze. This in turn gives them less time to build up energy stores in the summer and to sustain them over the winter.

"Cumulative effects are often difficult to predict and communicate. They can also be added to social and cultural effects to create an overall picture of how reindeer herding is impacted."

Reindeer grazing

The reindeer have an impact on the forage resources, either directly by browsing or indirectly by trampling and fertilising with faeces and urine. The animals' impact on the vegetation varies

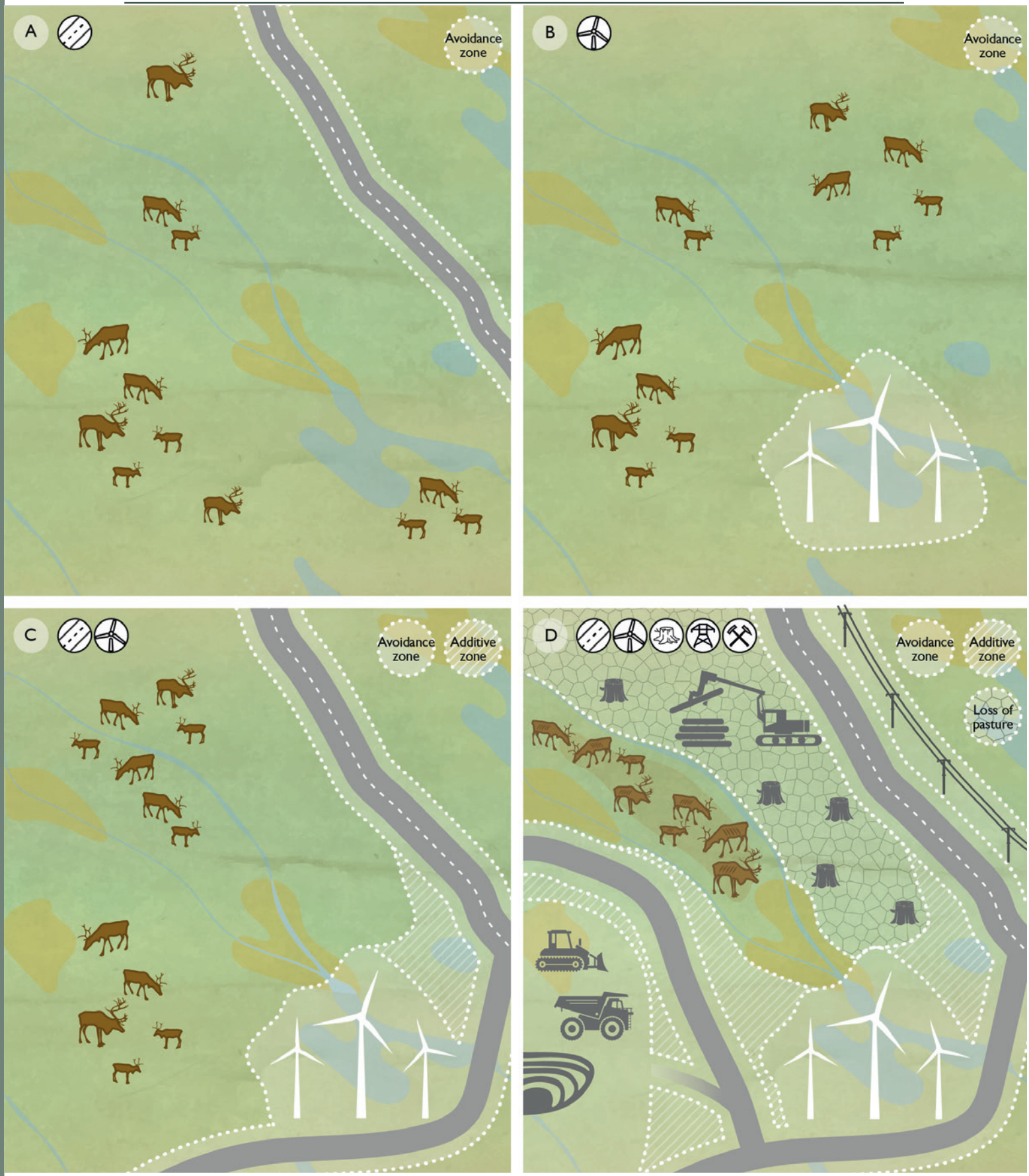


Figure 3.2: Images A and B show individual disturbances where the reindeer can choose the best pasture based on weather and snow conditions for most of the area, but avoid the zone around the road and wind farm. Image C shows how a wind farm and a road have a greater combined effect: the road had to be widened and the areas merge together through an additive zone. Image D shows how several disturbances together have forced the reindeer into a small remaining area.

Figure 3.3: Extent of hydropower (2021), shown here as affected lakes and watercourses in the Fennoscandian reindeer herding area.

with the season, weather, soil conditions and type of vegetation. Grasslands benefit from grazing because the reindeer provide fertilisation, whereas terrestrial lichens generally decline in the case of heavy grazing, while they grow best when the lichen mat is grazed moderately. In some habitats, grazing can also reduce competition from vascular plants, which promotes lichen growth.

The reindeer's effect on terrestrial lichens must be understood in relation to the animals' access to land and the intensity of other land use. The balance and migration between seasonal pastures impacts the relationship between herd size and the quantity of terrestrial lichens. More reindeer often results in less lichen, but this varies over time because it is affected by environmental factors such as the snow cover. The reindeer's trampling on snow-free lichen-rich land is particularly harmful during warm summer months, as dry lichens are easily damaged. This is a challenge for many reindeer herding districts in the southern part of the Finnish reindeer herding area, where it is not possible to separate the use of land into summer and winter pastures. The reindeer stay in the forest year round, resulting in low lichen growth compared with areas that are only grazed in winter.

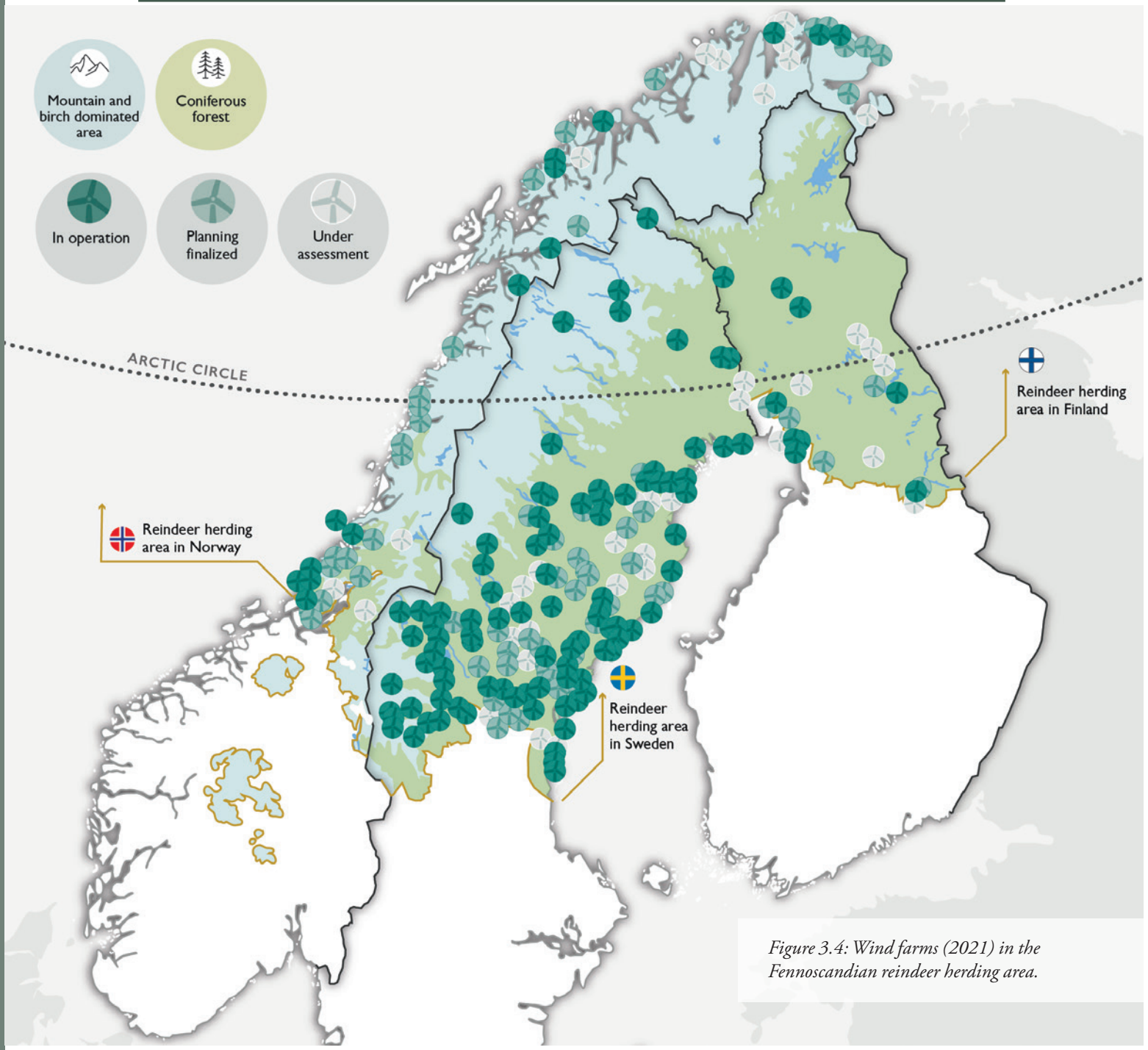


Figure 3.4: Wind farms (2021) in the Fennoscandian reindeer herding area.

In recent years, climate change has caused increased shrubification of the tundra, which threatens both the reindeer's access to high-quality fodder and biodiversity. However, reindeer browsing can hold shrubification in check, promoting the quality of the pastures and biodiversity. This in turn benefits the albedo effect[3], slowing the warming of the climate.

[3]The albedo effect denotes that different surfaces reflect light and heat differently. White, snow-covered surfaces with little shrubbery increase the albedo effect, so more heat from the sun is reflected back to the atmosphere.

Effects of climate change

The tree line is inexorably creeping upwards in many reindeer herding areas as an effect of the warmer climate. This means that open alpine pastures are shrinking, which will make summer grazing more difficult for the reindeer. Climate change affects reindeer pastures differently in different seasons. Earlier springs and longer, warmer growing seasons may increase the quantity of vascular plants, but at the same time reduce their nutritional value. Warmth benefits vascular plants, which can lead to a decline in lichens on the ground due to competition. A warmer climate

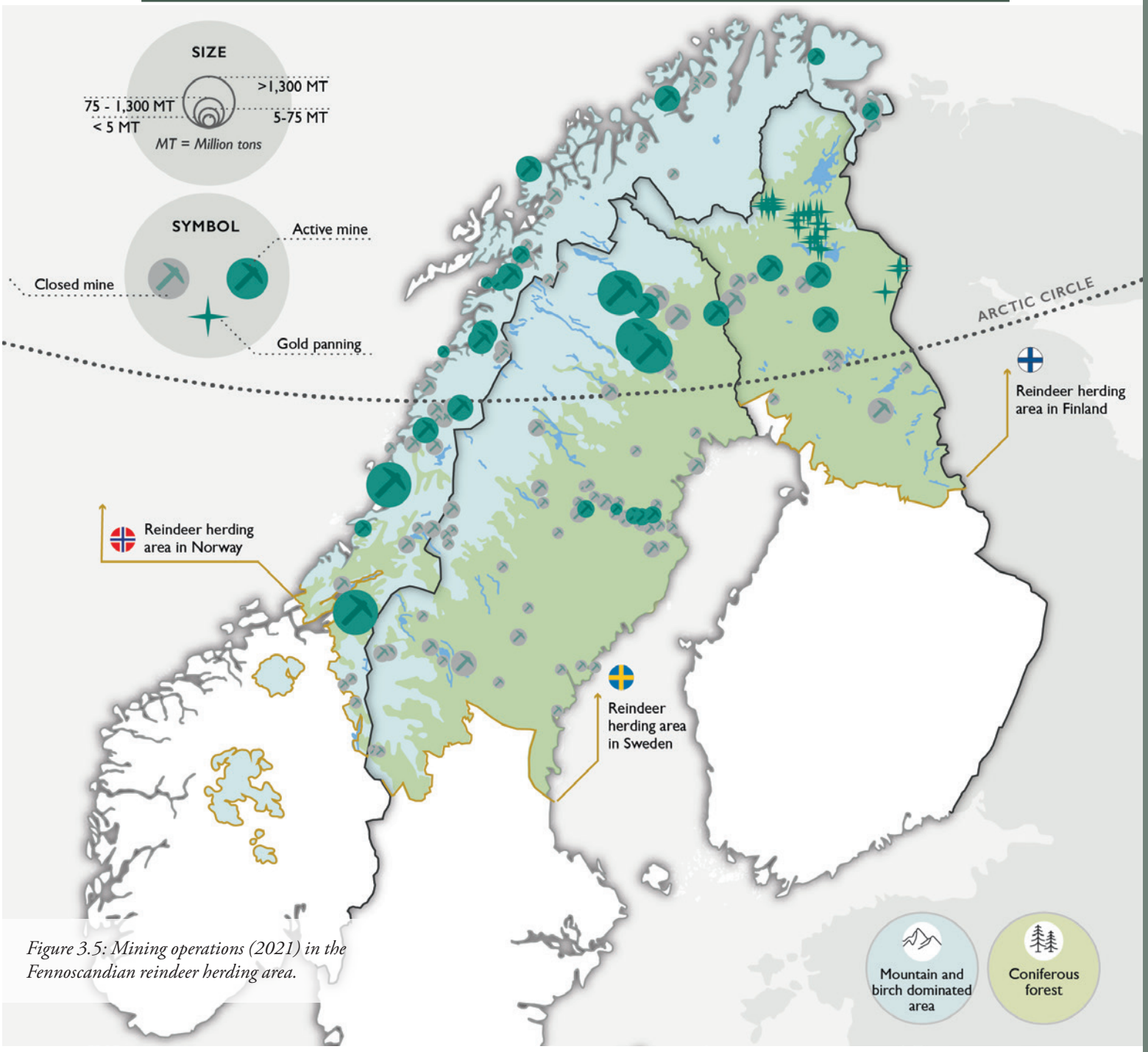


Figure 3.5: Mining operations (2021) in the Fennoscandian reindeer herding area.

can also negatively impact the amount of lichen in forests as trees grow denser and less light filters in. This effect is enhanced by a winter climate with more snow, making it harder for the reindeer to reach the lichens.

Pastures can be improved

The forestry industry could contribute to greater access to both terrestrial and arboreal lichens by adapting its forest management, but this would require compromising on their productivity levels. However, more thinning, particularly of young trees, could benefit both lichen growth and wood production, as would continuity forestry without clear-cutting. Avoiding soil scarification and spreading lichen fragments after felling on dry soils promote faster re-establishment of lichens.

Crossings and migration routes between pastures are vital for reindeer herding. Passages in strategically important locations can facilitate passage over roads and other barriers in the landscape. Leading the migration along prepared routes can help to reduce disturbances from road traffic.

Lichens can re-establish on lands previously used for mining if lichen fragments are distributed on site,

whether by natural or artificial means. The choice can be made per site, taking into account that it can take at least 30–50 years before a productive lichen mat forms. Residual metal pollutants can, however, be a challenge to the re-establishment of lichens.

Rotating between pastures and ensuring that the reindeer do not graze in lichen-rich areas when the ground vegetation is not protected by snow allows the forage resources to recover. Changing grazing areas by season and weather conditions is a traditional method among reindeer herders. But it is becoming increasingly difficult to rotate pastures when other land users are removing so much of the pasture land. Pasture rotation is particularly limited in parts of Finland, where many reindeer herding districts have small grazing areas and fences limit their flexibility for seasonal rotation. Shrinking forage resources force the herders to use all available pasture lands, leaving little or no opportunity for the lichen-rich areas to re-establish.

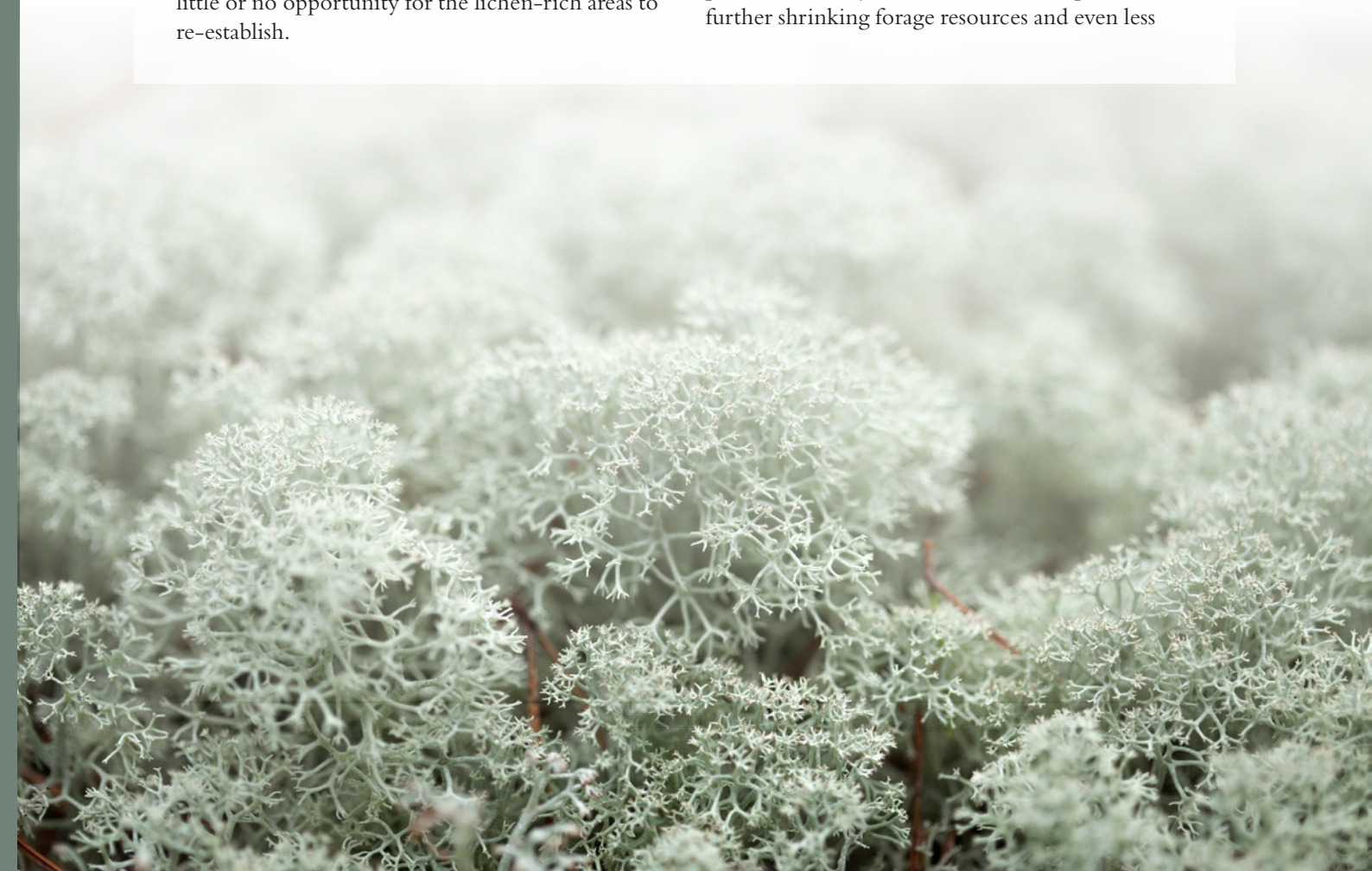
"Avoiding soil scarification and spreading lichen fragments after felling on dry soils promotes faster re-establishment of lichens."

Assessment of pasture quality

Reindeer impact on winter forage resources is a topic that gives rise to conflicts, especially in Finnmark in Norway, but also in Finland. There are continuing debates between reindeer herders, researchers and national authorities about the "optimal herd size".

Number of reindeer and low slaughter weights, in combination with the status of the lichen mat, are often used as indicators of "overgrazing", which is questionable because the link to forage resources is complicated by the variations in weather that are characteristic in northern climates. High grazing pressure must also be assessed based on the effects caused by the loss of pastures to other land users, which leads to more frequent and intense use of remaining pastures.

If no measures are taken to regain and restore lost pastures, this may lead to a downward spiral with further shrinking forage resources and even less



ability for reindeer herders and other land users to coexist. Feeding and transporting reindeer by truck can compensate for the lack of natural food sources and suitable migration routes in the short term. This can ameliorate urgent crises, but the underlying problem of encroachment on pastures and shrinking forage resources remains unsolved.

THE ROLE OF LAND-USE PLANNING

Coordinated land-use planning, taking into consideration all the variations of reindeer foraging conditions in time and space, would provide a more long-term solution. However, this solution may prove difficult due to the imbalance of power between reindeer herders and policymakers. For example, consultations between reindeer herders and forestry representatives have been criticised for coming in too late in forestry planning, giving the herders little room to negotiate and low likelihood of achieving consensus. Differences in status and power between reindeer herders and other land users can also make it difficult to reach agreements. The same power imbalance can also affect what knowledge is included in assessments of how different incursions are expected to affect the reindeer. This limits opportunities to find alternative ways to manage natural resources and counter climate change, which is described in more detail in chapter 6.

Source of text and figures 3.1, 3.3, 3.4 and 3.5 in chapter 3:

Skarin, A., Kumpula, J., Tveraa, T. & Åhman, B. 2022. Reindeer behavioural ecology and use of pastures in pastoral livelihoods. Chapter 3 in book*. pp. 63-75. https://doi.org/10.4324/9781003118565-6

Horstkotte, T., Kumpula, J., Sandström, P., Tømmervik, H., Kivinen, S., Skarin, A., Moen, J. & Sandström, S. 2022. Pastures under pressure. Effects of other land users and the environment. Chapter 4 in book*. pp. 76-98. https://doi.org/10.4324/9781003118565-7

*T. Horskotte, Ø. Holand, J. Kumpula & J. Moen (eds.) *Reindeer husbandry and global environmental change – pastoralism in Fennoscandia*. Routledge, London. https://doi.org/10.4324/9781003118565

4

Climate adaptation opportunities

In the past few decades, the Arctic and Subarctic has warmed up faster than other areas of the Earth, particularly in winter. This is likely to continue at about the same rate in the coming decades, while the warming rate after the mid-2000s will depend on how greenhouse gas emissions develop. How can reindeer herders adapt to a warmer, more humid and more extreme climate, and what limitations do they face?

EFFECTS OF A WARMER AND WETTER CLIMATE

Long autumns and early springs in many areas force reindeer herders to adapt key events, such as their seasonal migrations (figure 4.2). If the autumn comes late, with little snow, the reindeer must be rounded up using all-terrain vehicles, drones or helicopters instead of snowmobiles. Unfrozen bogs and thin ice on lakes and rivers can further hamper efforts to round up the herd and migrate between pastures. Snow cover on unfrozen lichen heaths can lead to mould in the lichen mat. Mould can produce toxic substances and lead to poisoning and the loss of reindeer, especially calves.

Warmer winters are expected to lead to long snowless periods, which could improve foraging opportunities for the reindeer. But this would also mean more and longer periods of temperatures around 0°C when the snow thaws and freezes repeatedly, and when rain might fall on snow-covered pastures, which can risk encasing the vegetation in ice, making it inaccessible for the reindeer. Reindeer herders deal with these challenges in different ways, based on local grazing conditions, reindeer herding systems and cultures. For example, in Norway, reindeer herders in some herding districts might have to reverse their grazing rotation. Previously, coastal pastures became ice-bound more often than inland ones; now the coastal areas are often snow-free while the inland is more likely to become ice-bound. However, coastal grazing lands are fragmented and shared with many other types of land use.

In Sweden, reindeer herders might need to migrate to lichen-rich grazing grounds earlier to avoid the risk of them becoming inaccessible later in the winter. A rugged landscape can lead to good overall grazing conditions, which may diminish the effects of harsh weather events. Depending on snow conditions, reindeer can be moved, for example, to wind-swept locations with less snow, or to forested areas with softer snow and arboreal lichens. A deep layer of snow, even if it is soft, makes it harder for reindeer to access food, because they have to dig deeply to reach the vegetation. They also sink into the snow when they walk, which costs extra energy. In particularly difficult grazing conditions, reindeer tend to spread out as they search for food. This demands more active herding and monitoring from the herders to prevent traffic accidents and losses to predators or reindeer straying away. This in turn makes snowmobiles and other technical equipment more important.

In a warmer climate, spring pastures in the mountains could be used even in winter. However, Swedish reindeer herders emphasise that this strategy is not sustainable in the long term because the forage in these lands is needed during the

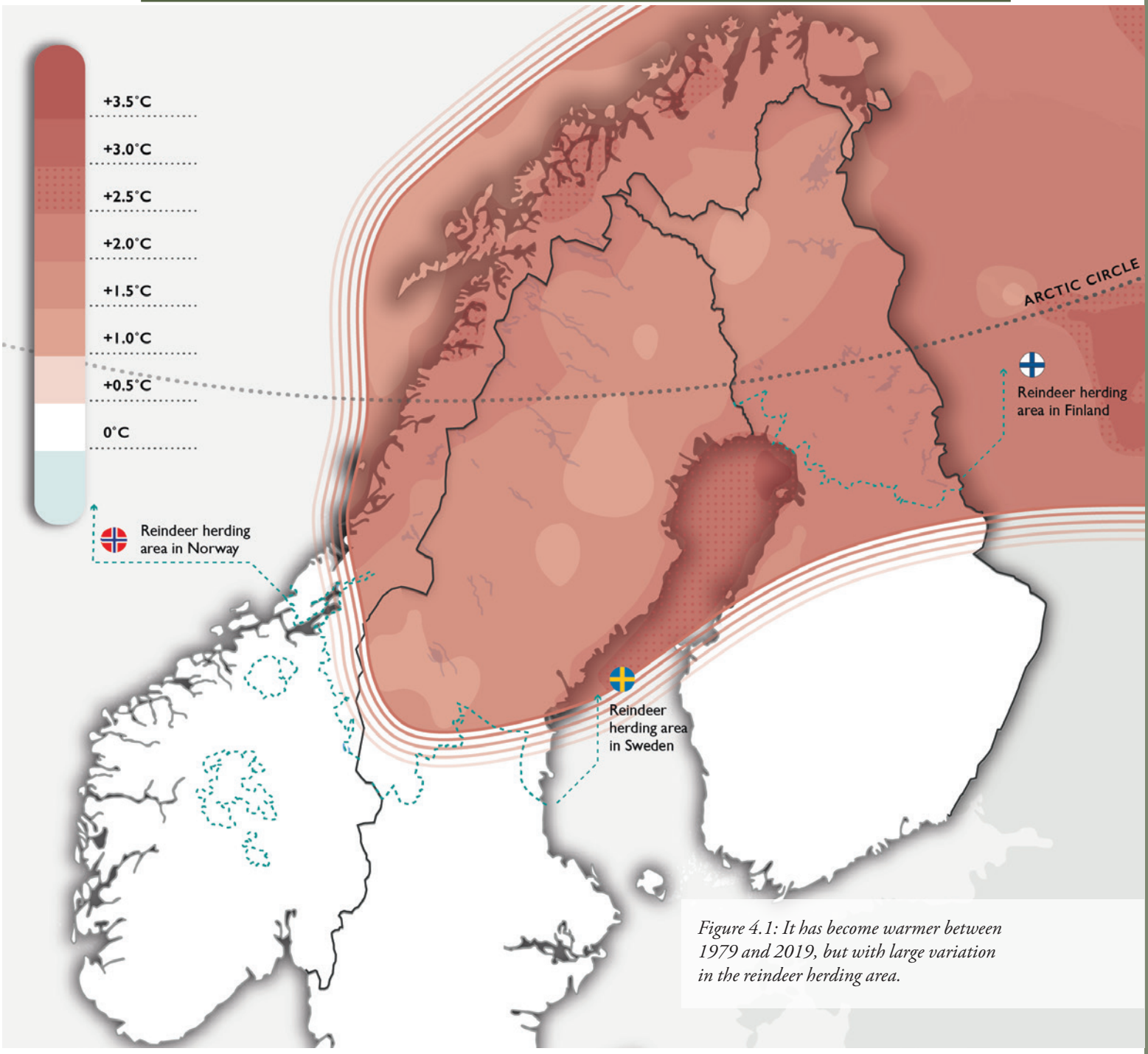


Figure 4.1: It has become warmer between 1979 and 2019, but with large variation in the reindeer herding area.

calving period. A warmer, wetter summer climate will result in a longer growing season and greater plant production, but the quality of forage plants, which are vital for the reindeer to gain weight and body reserves for the upcoming winter, will probably decrease. In addition, a warm summer climate will result in more insect harassment and heat stress for the reindeer, which will disturb their grazing peace.

POSSIBLE ADAPTATIONS TO CHANGED GRAZING CONDITIONS

Reindeer herders have always tried to help the reindeer access food when necessary, for example by felling lichen-rich trees. However, they currently have to provide supplemental feeding much more extensively in order to manage the changed winter conditions and increased external pressure on the lands. These two factors have increased the need for supplementary feeding in all three countries, but especially in Finland. In Norway and Sweden, many reindeer herders feel that large-scale, recurring supplementary feeding is not a desirable strategy, but rather risks increasing the animals' vulnerability in the long term. In Finland, a majority of herders, especially from herding districts in forested regions report that changed winter conditions have increased the need

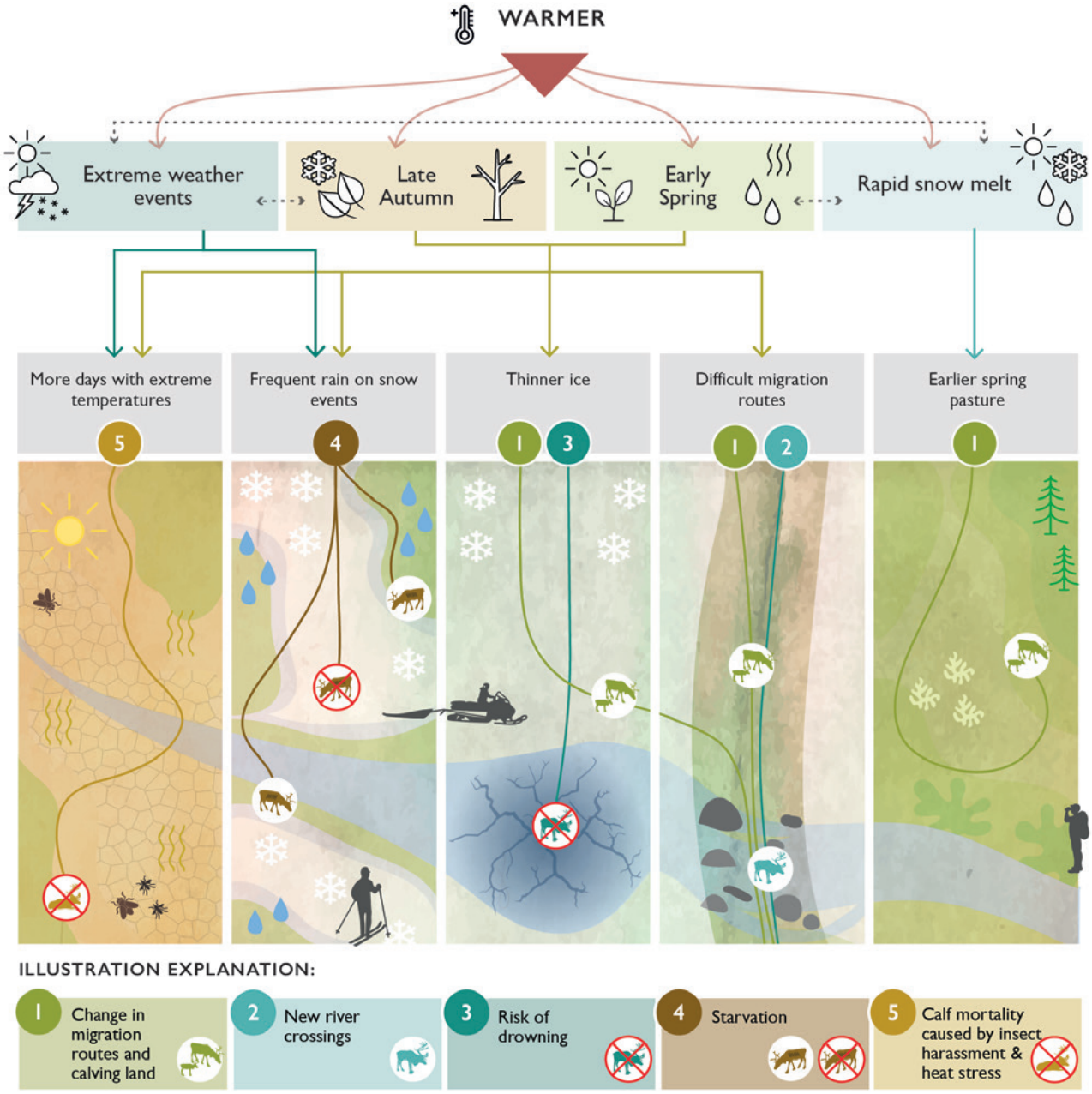


Figure 4.2: Climate change will result in higher temperatures, greater precipitation and more extreme and unpredictable weather. This is expected to have major consequences for the development, availability and use of seasonal pastures, which in turn will affect the reindeer's physical condition and the herd's production potential. Conditions related to seasonal migration will also become more difficult and may lead to losses. This makes flexible and alternative migration routes and calving sites important to ensure climate adaptation.

for supplementary feeding. At the same time, the warmer weather has made it increasingly difficult to maintain good hygiene in the enclosures and thus keep the reindeer healthy (see chapters 8 and 9).

An early thaw and start to the growing season helps the reindeer to recover after the winter and is particularly beneficial to cows and their newborn calves. Supplementary feeding can end sooner, which reduces expenses, but an early spring can also create problems. In Sweden, reindeer herders have reported that an early thaw can force them to move the reindeer to their spring pastures earlier, because it is harder to keep the herd together when the snow disappears. At the same time, a spring pasture at a higher elevation might have a delayed thaw due to greater quantities of snow in the late spring. This means the herders need to keep the reindeer penned up and keep feeding them supplementary fodder until the thaw. In several mountain areas in Norway, it has been observed that spring green-up actually comes later now,

probably due to the larger winter snowfalls. With an early spring in coastal winter grazing areas in Norway, the reindeer herders are forced to move their herds to the spring pastures in the mountains to avoid conflicts with agriculture, but then they risk difficult snow conditions in the mountains.


PHOTO: CJ UTSI

ADAPTATIONS HAVE THEIR LIMITS

Reindeer herders have managed varying and detrimental weather conditions for centuries through traditional knowledge and skills. To deal with rapidly changing conditions, they are seeking new knowledge and solutions as a complement to traditional methods. Some examples include promoting increased knowledge about reindeer health and disease, new technological innovations like mobile slaughterhouses and the use of drones and tracking collars. Some solutions could also be useful in co-planning with other land users; however, this requires equal arenas for collaboration and influence, which do not currently exist. Rapid change also creates circumstances that have never been experienced before, which demand brand-new approaches and innovations.

Adapting to change means testing alternative solutions to maintain or develop reindeer herding in a desired direction. Although there are measures that support reindeer husbandry in the short term, they can also result in undesired consequences, which lead to greater vulnerability in the longer term, set the stage for future conflicts and have a negative impact on cultural, ecological or economic aspects. Changes in use of some seasonal pastures can jeopardise the quality of the forage in other seasons, for example. Some technological solutions can lead to a loss of knowledge and skills, and intensive supplementary feeding can affect the reindeer's behaviour and health, imperilling the whole concept of reindeer herding as a nature-based production system. Adaptation must be viewed from a holistic perspective and formulated based on a desired future for reindeer herding, from the herders' perspective.

There are also biological limits to adapting reindeer herding. Reindeer physiology, reproduction cycle and behaviour set limits, even if the animals are highly flexible, as is typical of species in seasonal, unpredictable environments. Reindeer herders emphasise that they must work according to the biological rhythm of the reindeer, rather than fighting against the animals' instincts. Lack of time, manpower or resources also affects the ability to adapt. Options are extremely dependent on the available land and variations in topography and vegetation. In many reindeer herding areas, grazing lands are shrinking, access to alternative pastures has disappeared and growing populations of predators further limit opportunities to find feasible solutions. Therefore, adaptations must be discussed in a broader context than just climate change.

NEED FOR COMPREHENSIVE, LONG-TERM SOLUTIONS

To a large degree, adaptation of reindeer herding is limited by sociopolitical factors and competing land use. Reindeer herders have limited opportunities to influence decision processes as to how land is managed, and therefore the conditions for their own adaptations. To avoid increasing the existing inequality between players and rights holders, established power structures and relationships need to be reassessed and balanced.

Although the Norwegian, Swedish and Finnish governments all accept the threat of climate change and the challenges faced by reindeer herding, there are still no political solutions for managing the structural element of adapting the practice.

> *"Therefore, adaptations must be discussed in a broader context than just climate change."*

National action plans for reindeer herding usually emphasise technological solutions or compensation systems rather than what the reindeer herders identify as long-term strategies, such as restoring and protecting grazing lands. Financial compensation is important for the reindeer herders to survive demanding circumstances, but is not a long-term solution to the conflicts that exist between reindeer herders and competing land users. In addition, it is difficult to assess the effect of financial support because the various actors (reindeer herders, authorities, other land users) perceive the problems and potential solutions differently.

For example, the Swedish government's strategy for the Arctic region expresses an intention to boost knowledge about Sámi businesses, including reindeer herding, and to find necessary paths to climate adaptation. While underlining the importance of intact ecosystems (such as functional calving sites, migration routes and connections between seasonal pastures), the same government strategy emphasises the importance of developing mining operations and expanding wind farms on the same lands – without specifying how these conflicting goals will be managed. The Finnish climate adaptation plan also presents suggested measures for alleviating the negative effects of climate change on reindeer herding, including maintaining migration paths and the diversity of pastures, and considering reindeer herding in the legislation that controls planning of land use. However, there are no concrete tools for doing so. Similarly, Norway's Arctic strategy emphasises the contribution of reindeer husbandry to value creation and the importance of maintaining reindeer herding in parallel with other types of land use, but without specifying how this will be done.

The governments' adaptation policies often seem to focus solely on symptoms. Underlying conflicts in goals are left out, and usually so are the needs and perspectives of the reindeer and their herders. Thus, policymakers place a significant burden on reindeer husbandry as a whole as well as on individual herders. What is needed instead are deliberate, proactive adaptive measures backed up by political support. This requires an honest, equal dialogue about desired adaptive strategies and opportunities to earn a living in reindeer herding, and what choices can lead there. Adaptations to changes require flexibility and joint strategies, which are sustainable not only financially and environmentally but also culturally and socially. Succeeding at this will shape the future of reindeer herding for decades to come.

Source for text and figure 4.1 in chapter 4:

Rasmus, S., Horstkotte, T., Turunen, M., Landauer, M., Löf, A., Lehtonen, I., Rosqvist, G. & Holand, Ø. 2022. Reindeer husbandry and climate change. Challenges for adaption. Chapter 5 in book*. pp. 99-117. https://doi.org/10.4324/9781003118565-8

*T. Horskotte, Ø. Holand, J. Kumpula & J. Moen (eds.) *Reindeer husbandry and global environmental change – pastoralism in Fennoscandia*. Routledge, London. https://doi.org/10.4324/9781003118565

5

Impact of predators

The number of large carnivores in Fennoscandia has varied over the centuries that reindeer herding has been practised. Once nearly hunted to extinction, large carnivore populations have increased dramatically in the past 50 years, primarily as an effect of national laws protecting them and limiting hunting. International conventions and directives regulate the administration of this in the individual countries. The consequence has been an escalation in losses of reindeer and disturbances of reindeer herding.

LARGE CARNIVORES ARE FOUND THROUGHOUT THE REINDEER HERDING AREA

All large carnivores – wolf, lynx, wolverine, brown bear and golden eagle – create major problems for reindeer husbandry. The wolf is considered the most efficient predator of reindeer and is the hardest for herders to manage. In addition to its ability to kill many reindeer, the wolf's hunting method breaks up and scares the herd away, which creates a lot of extra work for the herder. The wolf population in the reindeer herding area is strictly regulated in all three countries. Despite this, wolves exist and reproduce in parts of the reindeer herding area (figure. 5.1), where they have the potential to cause substantial damage.

Lynxes are found throughout the reindeer herding area (figure 5.2), where reindeer are often their primary prey; however, to a lesser degree in areas where roe deer are abundant, offering an alternative prey. A survey in the Sarek region of northern Sweden, where lynxes ate almost exclusively reindeer, showed that a female lynx with cubs could kill an average of six reindeer a month. Research also shows that lynx in general choose to take calves rather than adult reindeer.

Reindeer are the primary food of wolverines (figure 5.3) in the reindeer herding area. Wolverines are not the effective hunters that wolves and lynxes are, and often eat remains from other predators' kills. However, if the surface of the snow is hard enough to bear the wolverine's weight, but not the reindeer's, the wolverine can be a very effective hunter and kill many reindeer.

Brown bears (figure 5.4) mainly cause losses of reindeer during the calving period. Research from two forest reindeer herding districts in northern Sweden showed an annual average mortality of 11 reindeer calves per bear within the calving area.

Table 5.1: Presence of large carnivores in the reindeer herding area in Norway, Sweden and Finland (estimated number of individuals, except for golden eagle, where the figure shows mating pairs). The figures ,which are approximate, are extracted from several official sources and reflect the years 2016–2020.

	Norway	Sweden	Finland	Comment
Wolf	Sporadic	10-50	10-20	Great variation from year to year
Lynx	200	700	100	
Wolverine	250	700	100-150	
Brown bear	At least 100	2000	300	Norway: minimum number
Golden eagle	500	350	400	Nesting pairs

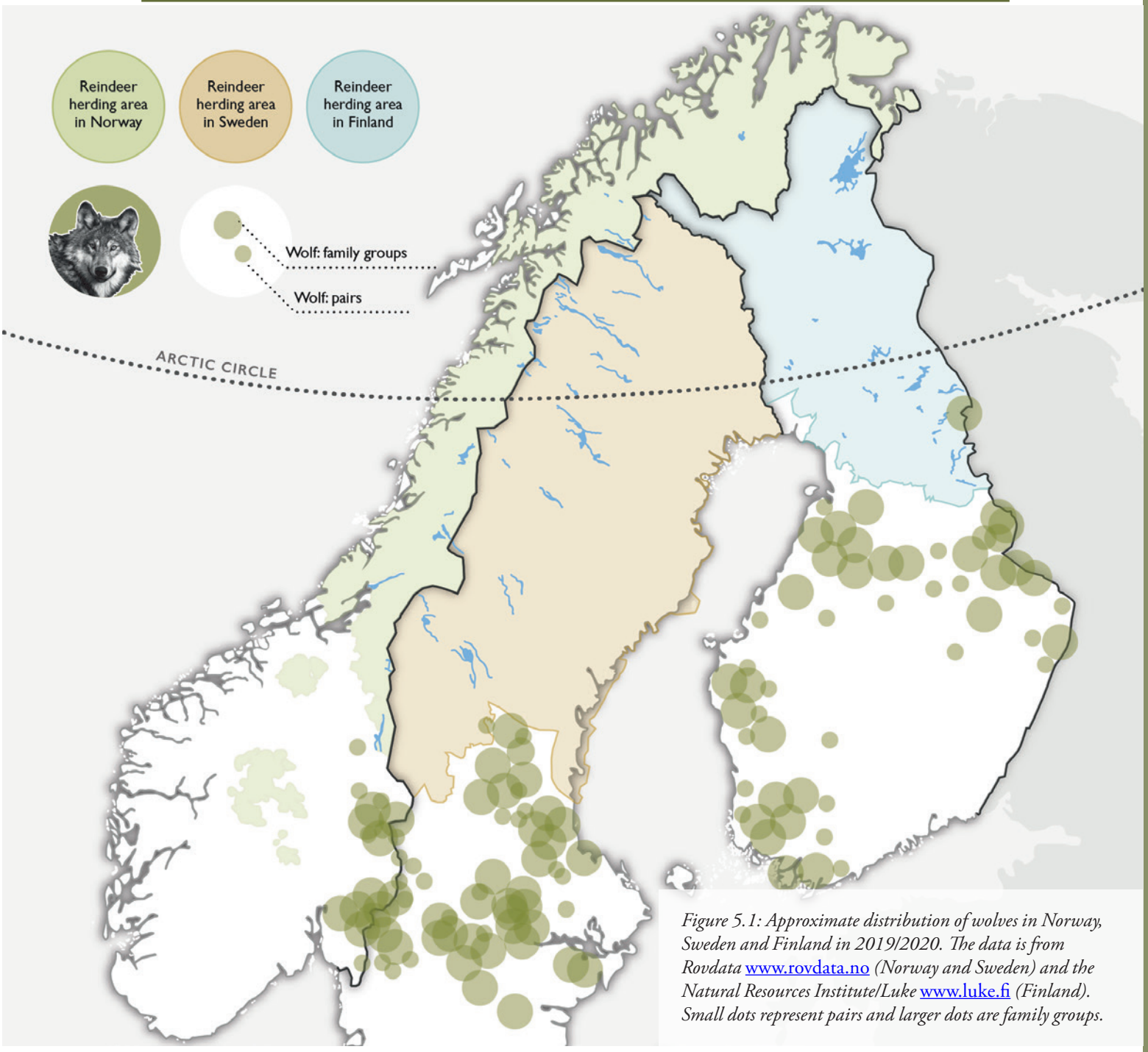


Figure 5.1: Approximate distribution of wolves in Norway, Sweden and Finland in 2019/2020. The data is from Rovdata www.rovdata.no (Norway and Sweden) and the Natural Resources Institute/Luke www.luke.fi (Finland). Small dots represent pairs and larger dots are family groups.

With the number of bears in the area, this means that totally around 600 calves per year may have been killed in the two districts. The killing almost completely ended shortly after the last calves were born. Similar research results have been found in Finland. Ongoing studies from mountain herding districts in Sweden show that bears can kill many reindeer calves in tundra areas as well. Bears can also kill adult reindeer around the calving period and later in autumn before going into hibernation.

Golden eagles (table 5.1) primarily take newborn calves, but they have the capacity to kill also adult reindeer. Lightweight calves are at higher risk of being killed by eagles than heavier ones. The age and condition of the mothers can play a role because young, lighter-weight females tend to have lighter calves. In addition, young females have less experience of protecting their calves from eagles. White-tailed eagles frequently occur in the reindeer herding area, but their capacity to kill reindeer is unknown.

DIFFERENCES IN COMPENSATION SYSTEMS

In all three countries, the state compensates reindeer owners for lost animals. The compensation systems are meant to minimise the financial losses to reindeer

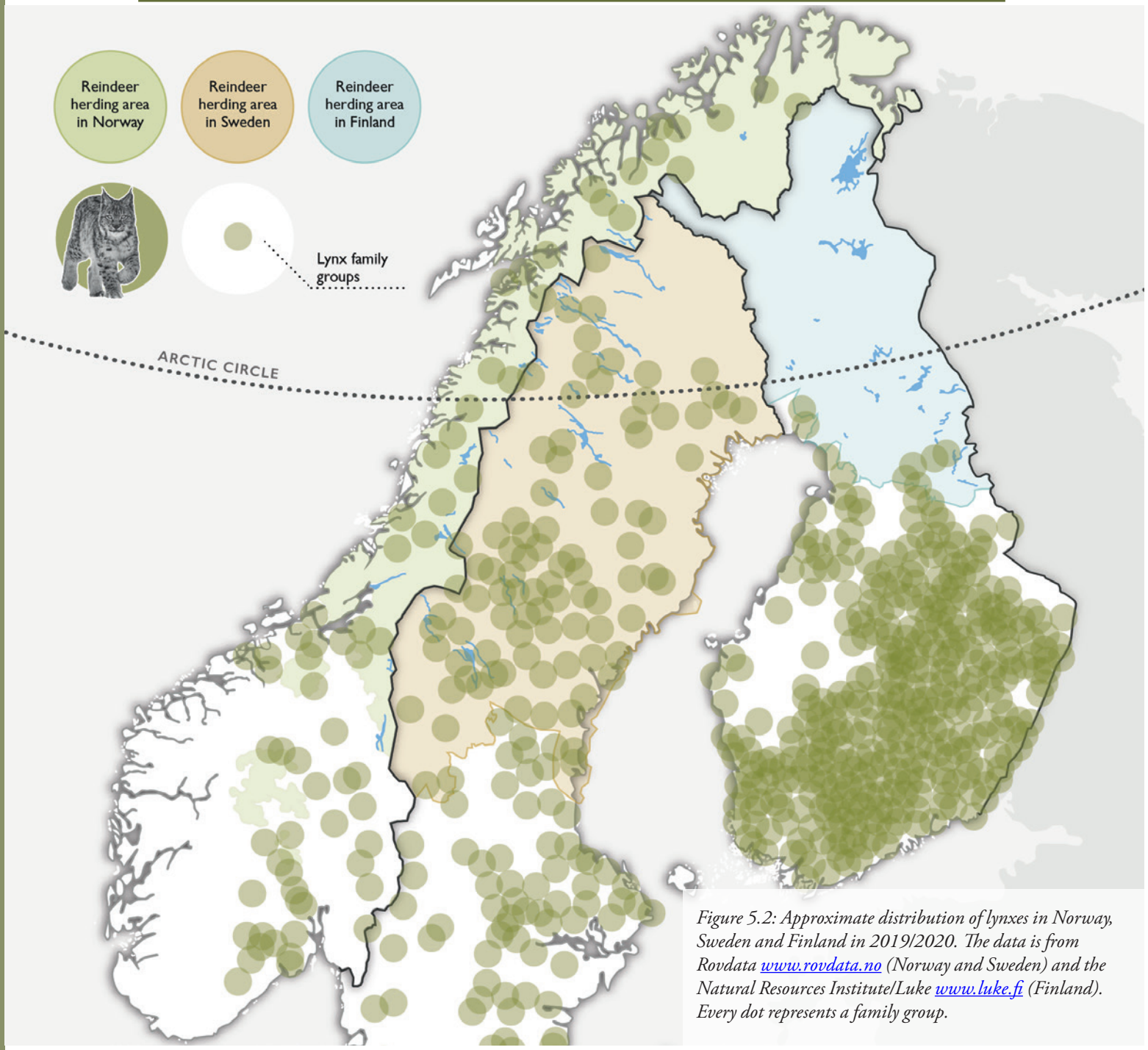


Figure 5.2: Approximate distribution of lynxes in Norway, Sweden and Finland in 2019/2020. The data is from Rovdata www.rovdata.no (Norway and Sweden) and the Natural Resources Institute/Luke www.luke.fi (Finland). Every dot represents a family group.

herders while maintaining viable large carnivore populations, but the systems differ widely between countries. In Finland and Norway, the compensation is based on the number of dead reindeer found and assessed to have been killed by predators. For the past 25 years, Sweden has had a compensation system based on how many large carnivores there are in each reindeer herding district and an estimation of how many reindeer each predator kills.

In Norway, compensation is paid for recovered cadavers from reindeer that has been killed by predators. The Norwegian Nature Inspectorate or a person authorised by that body must confirm that the reindeer was killed by a large carnivore. In addition, reindeer owners can apply for compensation for reindeer that have been killed and not found, on condition that they were lost in an area and during a time where there were documented losses to predators. In such cases, a deduction is made for the risk of death due to other causes than predation. In recent years (2017/18–2021/22), reindeer herders have applied for compensation for around 70,000 reindeer annually, but been compensated for less than 21,000. In Norway, lynx, wolverine and golden eagle are more or less equally responsible for the compensated losses, while the compensated losses due to

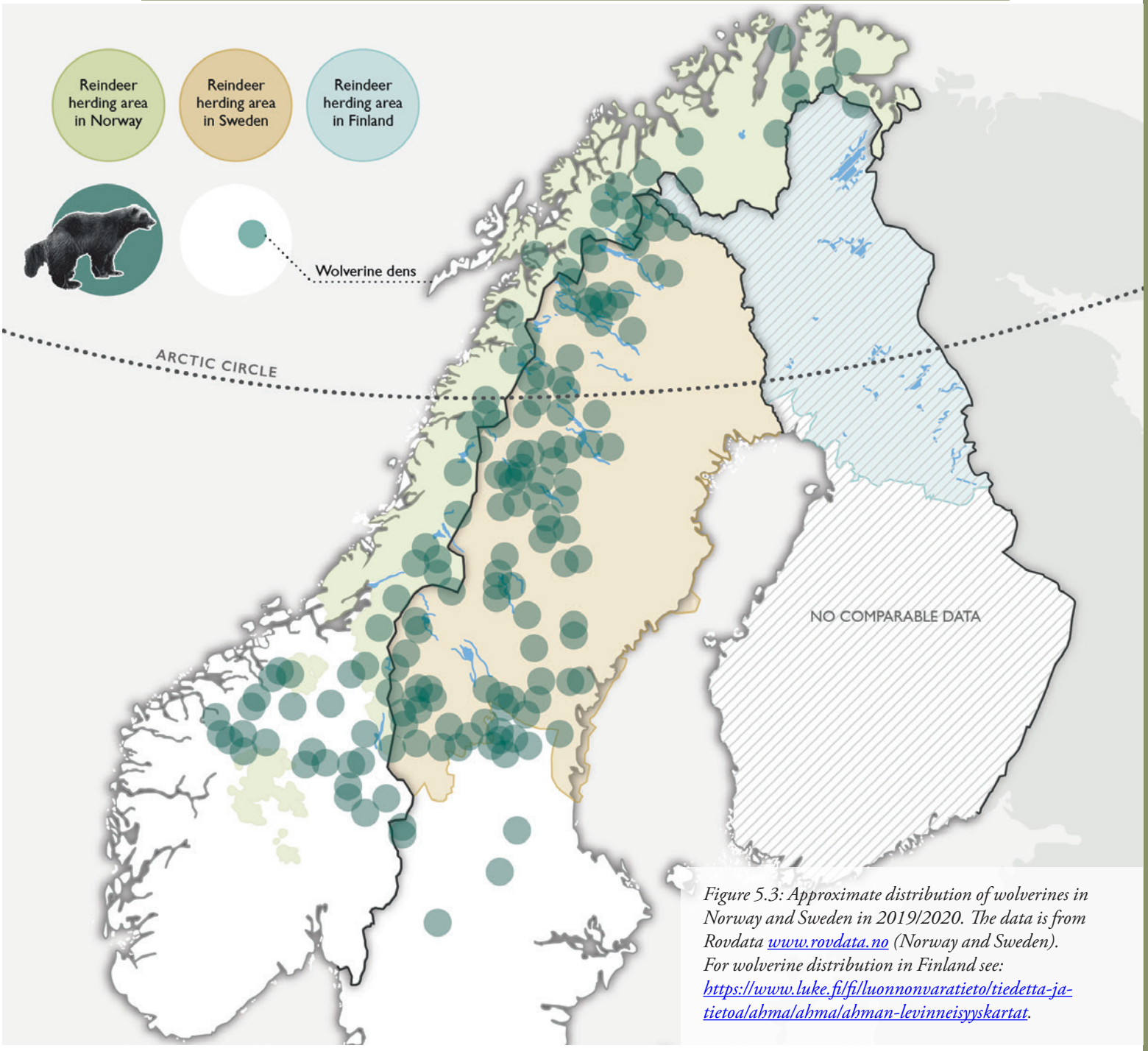


Figure 5.3: Approximate distribution of wolverines in Norway and Sweden in 2019/2020. The data is from Rovdata www.rovdata.no (Norway and Sweden). For wolverine distribution in Finland see: https://www.luke.fi/fi/luonnonvaratieto/tiedetta-ja-tietoa/ahma/ahma/ahman-levinneisyyskartat.

wolf and brown bear are small. The compensations are paid out by the County Governor directly to the individual reindeer herder, who can also be compensated for expenses, inconveniences or damages related to the reindeer loss. In the 2017/18–2021/22 period, the compensation for reindeer losses to predators has amounted to NOK 81–105 million per year (https://rovbase.no/erstatning/rein).

Because the Swedish compensation system is based on the number of large carnivores within the respective districts, there is no systematic and quantitative documentation of predator-killed reindeer. A government investigation from 2012 estimated the number of reindeer killed by predators in Sweden to be somewhere between 19,500 and 72,500 per year. The large range is due to variations in the number of large carnivores and the uncertainty as to how many reindeer each predator kills. Research indicates that every family group of lynx or wolverine reduces the number of reindeer available for slaughter by an average of 100. With the number of lynxes and wolverines in the reindeer herding area in Sweden, this corresponds to about 25,000 fewer reindeer to slaughter each year. This is in addition to losses caused by other predators. This corresponds quite well to a calculation model comparing the actual

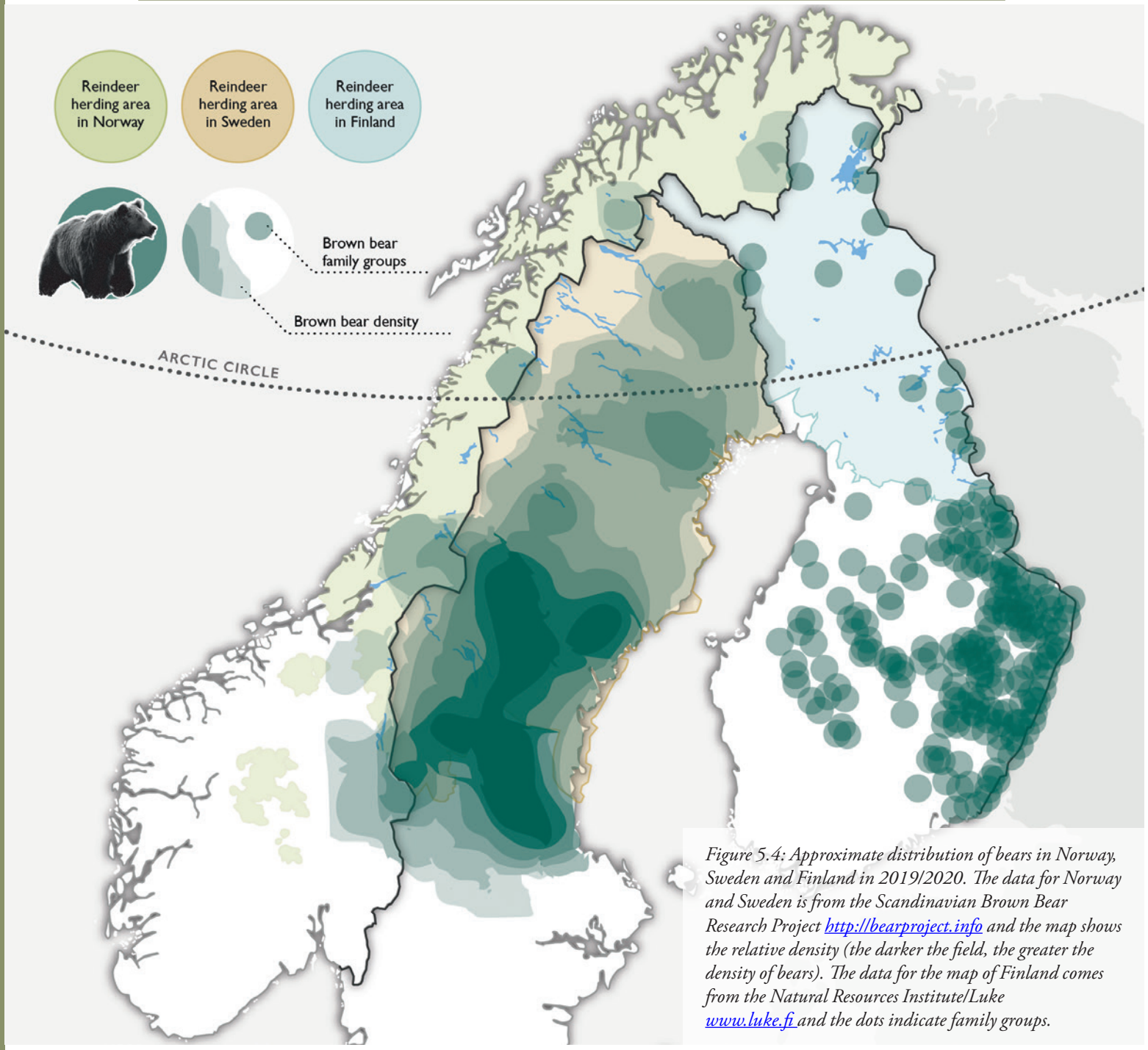


Figure 5.4: Approximate distribution of bears in Norway, Sweden and Finland in 2019/2020. The data for Norway and Sweden is from the Scandinavian Brown Bear Research Project http://bearproject.info and the map shows the relative density (the darker the field, the greater the density of bears). The data for the map of Finland comes from the Natural Resources Institute/Luke www.luke.fi and the dots indicate family groups.

number of reindeer at round-up and slaughter with what would be expected without losses to predators. According to estimates using this model, the annual loss of reindeer to predators reaches 10–20 per cent of the number of reindeer in the winter herd in many herding districts (if the total loss in Sweden was 10 per cent of the winter herd, this would equal to about 25,000 lost reindeer per year). Compensations for wolf, lynx and wolverine are based on annual inventories of each species. A documented reproduction of wolves currently (in 2023) pays SEK 500,000, while each reproduction of lynx or wolverine pays SEK 200,000. The mere presence of each species pays a lower amount. For bear and golden eagle, compensation is paid in relation to the district's total area, irrespectively of the actual numbers of the species in question, and the sums are low (totalling about SEK 1.6 million for bear and SEK 1 million for golden eagle per year). The Swedish Sámi parliament manages the compensation, paying out funds to the herding districts, which in turn distribute them internally or use them for shared expenses. This emphasises the central role of the Sámi parliament in the administration of reindeer husbandry in Sweden, in contrast to Norway and Finland. In recent years (2013–2020), the total compensation to

reindeer husbandry in Sweden for losses to predation has amounted to about SEK 50 million per year (www.sametinget.se/statistik/rovdjur).

In Finland, losses due to predation were quite low until about 1990. Since then, losses have steadily increased. The year 2020 was one of high losses, with a total of 5,965 predator-killed reindeer being found. However, the reported number is a minimum level and the real figure might be significantly higher. Damages vary between regions and are greatest in the south-eastern reindeer herding area; however, losses are also great along the rest of the border to Russia and in the northernmost reindeer herding area. Compensation is paid out for reindeer found that are assessed to have been killed by predators. These finds must be reported to the municipality for compensation to be paid. To compensate for the large number of predator-killed reindeer that are never found, the authorities compensate every found cadaver as 1.5 times the calculated value of the found reindeer. An additional compensation is also paid for the loss of reindeer calves from birth until the autumn round-up. A separate compensation is paid for reindeer killed by golden eagles, based on the number of golden eagle territories and successful hatchings. The compensation is either provided to the reindeer owner or to the reindeer herding district. In the past decade (since 2012), the total compensation for losses to predators in Finland has amounted to EUR 6–10 million per year (annual statistics are published in the journal *Poromies*).

NEGATIVE EFFECTS IN THE SHORT AND LONG TERM

Reindeer herders state that the presence of large carnivores has several harmful effects on reindeer herding, beyond the killing of reindeer. Herds are scattered, the reindeer's grazing is disturbed, the best pastures can be impossible to use, the reindeer's body condition deteriorates and calving is disrupted. The presence of large carnivores also make it harder to control the herds and to gather and move the reindeer to round-up sites.

Predators also negatively affect the herd's productivity by changing the age structure of breeding animals (mainly adult females), which reduces calf production. This also impacts the ability to select the best breeding animals. In the long run, this could jeopardise the sustainability of reindeer husbandry. Unpredictability has increased for the herders, while their sense of independence has decreased. Regularly finding their animals killed by predators is a physical and mental strain that affects the reindeer herders' families and social lives negatively.

If the losses of reindeer are great enough, the herd may reach a threshold where the number of calves that survive to adulthood is too low to replace the number of adult reindeer that die or become too old to reproduce. This will eventually cause the herd to collapse, which actually happened in one Swedish reindeer herding district when a group of herding families, a *siida*, lost not only calves but 18 per cent of its adult females every year. This scenario is becoming increasingly common in Norway as well, particularly in many reindeer grazing districts in the Nordland county, due to major losses to predators over time. The preventive measures used today are fencing and supplementary feeding of reindeer or constant guarding. Areas with many large carnivores are avoided, which leaves potential forage resources unutilised. It is almost impossible to protect the reindeer effectively when there is no snow leaving tracks from the animals, and can even be difficult in winter because the predators often hunt at night. To facilitate their work, some reindeer herders have begun using modern technology, such as GPS tracking collars on the reindeer, drones or wildlife cameras, which can provide more overview

over reindeer–predator interactions and help herders to locate killed reindeer.

The management of large carnivores is crucial to reindeer husbandry both locally and on the whole. Regardless of compensation levels, it is impossible to pursue reindeer herding rationally if losses are too big. However, large carnivore management is primarily concerned with maintaining the carnivore populations.

Norway ratified the Bern Convention in 1986, which is a commitment to protect sustainable populations of all large carnivores. In 2011, the Norwegian parliament settled on a "Carnivore Agreement", delegating administrative rights from the state to regional large carnivore committees. These have a mandate to take decisions regarding hunting as long as the population goals are reached. They are responsible for management plans, which aim to reduce the risk that large carnivores and domesticated livestock are in the same area (so-called "clear zoning"). However, despite this, there are large overlaps between areas for reindeer and areas prioritised for large carnivores. There are controversies about the size of these areas as well as about the instruments for documenting the number of large carnivores in Norway. Reindeer herders and sheep owners also point out the difficulties of maintaining these zones due to topography and other factors that affect the animals' movement pattern and behaviour. The increased tension in large carnivore administration came to a head at the Sámi Reindeer Herders' Association of Norway general meeting in 2023, where the meeting encouraged reindeer owners who were part of the large carnivore committee to step down.

Sweden and Finland are limited by EU's Habitat Directive in their management of predators. Sweden has management plans for all large carnivores. Damage-based hunting can be granted for any of the large carnivore species in the event of severe damage. Quota-based hunting permits are issued within the reindeer herding area for bear, lynx and in some cases wolverine, but strict regulations apply. The Swedish Environmental Protection Agency has an overall responsibility, but can delegate decisions on hunting quotas to the county administrative boards. Nature conservation organisations often appeal hunting permits, and in many cases they are repealed. In 2013, the Swedish Parliament decided that no reindeer herding district should have to lose more than 10 per cent of the number of reindeer in the winter herd to predation, and that measures were to be taken if that level is exceeded. However, that decision has been applied only to a limited extent so far.

In Finland, some hunting of large carnivores is permitted; however, based on strict criteria. Management plans are important tools for managing large carnivores, and policies for the reindeer herding area differ from the rest of the country. Damage-based hunting of wolf, lynx and brown bear can be issued without quotas, while there is an annual quota for wolverine provided that the terms in the EU's Habitats Directive and Finnish hunting legislation are carefully considered. The bear population is primarily legislated through quota-based hunting. There is also limited licence-based hunting of lynx.

UNSATISFACTORY SOLUTIONS

In summary, reindeer herding operations are heavily affected by the presence of large carnivores. At the same time, reindeer are a key source of food for these animals. Reindeer herders must constantly manage the presence of predators and try to minimise losses of reindeer. Their traditional, experience-based knowledge is crucial, but often insufficient when rapid environmental changes, especially increasing encroachments and climate change, gradually reduce the space for adaptation.

Compensation systems aim to facilitate the coexistence of reindeer herding and large carnivores. In general, reindeer herders accept the ecological and cultural role of large carnivores and tolerate their presence on condition that reindeer losses are not

too great and are reasonably compensated. Although the compensation systems differ between countries, none of the systems is considered satisfactory and all have their benefits and drawbacks. A general criticism is that more reindeer are killed than the owners are compensated for. Reindeer herders also state that the value of a killed reindeer is set too low and that there is no compensation for indirect expenses, or that the number of predators is underestimated. In addition, there is frustration among herders who feel that their voices are not heard and their experience-based knowledge is not respected in large carnivore management.

There are tensions not only in Fennoscandia but also globally between groups that feel it is important to preserve large carnivores and local communities that live close to and are affected by predation. From this perspective, the Fennoscandian reindeer herding area is a textbook example. The large carnivores here share their habitat with free-grazing livestock (reindeer) and the people (reindeer herders and their families) whose livelihood depends on those animals. However, it may very well be that the measures and compromises implemented so far have not worked from a conservation perspective for the carnivores, nor from the perspective of preserving the livelihood of the reindeer herders. What is clear is that the conservation goal for the carnivores must be balanced against humans' livelihood and welfare. Ecological sustainability and biodiversity – in which semi-domestic reindeer and large carnivores both play a central role – demand that the economic and social sustainability of reindeer herding must not be sidelined. Otherwise, international commitments to biodiversity may come into conflict with the rights of indigenous peoples as set out in various UN conventions (e.g. ILO convention 169, which has been signed and ratified by Norway but not yet – in 2024 – by Sweden and Finland).

PHOTO: CJ UTSI

Source of text and figures in chapter 5:

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*T. Horskotte, Ø. Holand, J. Kumpula & J. Moen (eds.) *Reindeer husbandry and global environmental change – pastoralism in Fennoscandia.* Routledge, London. https://doi.org/10.4324/9781003118565

6

Governance

In Norway, Sweden and Finland, the governance of reindeer husbandry by the states is separate from matters of Sámi culture, language and Indigenous Rights, even though the right to use the land for reindeer grazing is a part of Indigenous Rights. While in Finland reindeer herding is not an exclusive Sámi right, all three nations recognize that reindeer husbandry is an integral part of Sámi culture and a constitutional right. Despite this, it is a fundamental problem that the governments frame reindeer husbandry primarily as a business and an "interest" rather than a rights issue. Legislation and governance are fragmented and the perspective of reindeer herders is barely represented, which leads to the governments largely focusing on their own interests rather than those of the reindeer herders.

FRAGMENTED STATE-BASED GOVERNANCE

In Norway, reindeer husbandry is regulated by the Ministry of Agriculture and Food, while Sámi matters are under the Ministry of Local Government and Regional Development. In Sweden, the Ministry of Culture is responsible for Sámi issues, while the Ministry of Rural Affairs and Infrastructure handles reindeer husbandry. In Finland, Sámi issues (including the right to self-government) are regulated under the Ministry of Justice, while the Ministry of Agriculture and Forestry is responsible for reindeer husbandry. The interaction between the governing system's ministries and policy sectors is limited, both in practice (due to the division between different ministries and administrative units within the ministries) and formally (due to different sectorial regulations such as mineral laws, forestry laws, etc.). In all three countries, the administration fragments and divides the different aspects of reindeer herding, such as culture, lifestyle and livelihood, and the connection to land and rights. This division differs from the reindeer herders' own understanding of the practice and limits what problems, solutions and visions are embraced by the administration.

A striking similarity between the countries is that reindeer husbandry as a policy field is viewed almost entirely as a business activity. Linked to this is an ideal of rationalisation, which is particularly visible in the Norwegian and Finnish administration.

For example, in the past 40 years, the Norwegian government has implemented various regulations that have instituted major organisational changes to reindeer husbandry. The goal was to reshape Sámi reindeer herding into a market-oriented, economically efficient business, while keeping it environmentally sustainable. This was followed by a strife towards modernisation and a perception that too many reindeer and herders will lead to overgrazing and poor economy. However, the 2007 Act on Reindeer Herding gave the reindeer owners a greater degree of self-government.

Similarly, the administration of Finnish reindeer husbandry is based on the perception that it should be a full-time occupation, and it is better to have fewer herders with larger herds, so that they can support themselves better, economically. The legislation understands poorly the widely used strategy of a diversified livelihood that combines smaller scale reindeer herding with other operations and incomes. Indeed, government regulations and financial incentives push for more reindeer per herder, a development that is also promoted by EU policy.

The governments' idea as to what "good" reindeer husbandry is has changed over time. In Sweden,

for example, the goal in the early 20th century was to keep reindeer herding as "traditional" as possible, while from the 1970s on, "good" reindeer husbandry became synonymous with rationalisation and profit. The governments' goal for reindeer husbandry has primarily been financial, including when the goal is described in terms of sustainability. This reinforces the role of the reindeer herders as stakeholders – the same as other entrepreneurs – rather than recognising them as rights holders. This in turn has major consequences for the possibility to negotiate with other land users.

THE IDEA OF SUSTAINABLE REINDEER HUSBANDRY

The administration systems in Norway, Sweden and Finland all have the stated goal of sustainability for their reindeer husbandry policy. Sustainability has three dimensions: ecological, economic and cultural sustainability. However, all three countries place a strong focus on the economic dimension and rational, profitable methods for the reindeer herders. This idea of "sustainable reindeer herding" does not take into account many of the most important challenges that reindeer herders face. In Norway's legislation, the connections between the three pillars of ecology, economy and culture are clearly stated. Ecological sustainability – specifically the number of reindeer in relation to forage resources – is presented as the foundation of economic and cultural sustainability. Yet the goals set by the government take little consideration of the complex realities of reindeer herding, striving instead towards rationalisation.

"The governments' idea as to what 'good' reindeer husbandry is has changed over time. In Sweden, for example, the goal in the early 20th century was to keep reindeer herding as 'traditional' as possible, while from the 1970s on, 'good' reindeer husbandry became synonymous with rationalisation and profit."

The Finnish reindeer husbandry law describes ecological sustainability in terms of the "carrying capacity of winter pastures", and thus assumes that reindeer herding is based entirely on natural grazing grounds (without any supplementary feeding). The effects of other land use are not included, and the description of sustainability ignores the fact that most herding districts are already forced to use supplementary feeding because they no longer have access to enough natural winter pastures due to land loss and fragmentation by other competing land use.

Swedish legislation has a vision of reindeer husbandry as ecologically, economically and culturally sustainable in the long term. The description of how the ecological goals will be achieved recognises the fact that the production capacity of and ability to use grazing grounds are affected by other land users and by changed environmental conditions (including climate change). However, there are no instruments or arenas in the administrative system that sufficiently highlight and allocate responsibility to navigate land use conflicts between herders and other actors.

In both Norway and Finland, a frequently proposed "solution" has been to reduce the number of reindeer, citing ecological sustainability. This brings up the question, for whom is this a solution and what understanding of the problem is it based on? This focus on regulation of herd size does not consider the fact that there is an external pressure from competing land users, and places the entire responsibility for the condition of the grazing grounds on the reindeer herders.

MAXIMUM NUMBER OF REINDEER AS A GOVERNING INSTRUMENT

Reindeer husbandry is governed in a detailed, largely top-down way. In all three countries, the authorities set a maximum permitted number of reindeer for each herding district. Regulations differ in terms of how much influence and involvement the herders have in the decisions, what knowledge the decisions are based on and how the decisions are applied in practice.

The Finnish Reindeer Husbandry Act states that the Ministry of Agriculture and Forestry sets a maximum number of reindeer for each reindeer herding district for a 10-year period, so that the number of reindeer does not exceed "the sustainable production capacity of winter pastures". However, the legislation does not consider the effects of other land use on reindeer pastures, although this has increasingly been included in negotiations in recent years. This makes it questionable whether "the carrying capacity of the winter grazing areas" can be considered a relevant regulatory instrument. The maximum number of reindeer is set based on lichen pasture inventories and negotiations with the herding communities. Finnish authorities mainly use financial incentives as governing instruments by withdrawing financial support if the decided maximum number of reindeer is exceeded.

In Norway, the Reindeer Husbandry Board sets the maximum number of reindeer for each district, after reporting from and dialogue with each district. Regulating the number of reindeer, along with financial incentives to improve meat production, are regarded as important tools for securing national policy goals of a rational market-oriented business. There is also a goal of protecting pastures from overgrazing, so the regulation of reindeer numbers is based on estimates of the districts' carrying capacity. However, paradoxically, while reindeer herders in several districts in Finnmark have been forced to reduce their herds in recent years to protect the pastures, the authorities have permitted mining of minerals and expansion of wind power in the same areas. Some researchers and reindeer herders also claim that the government's use of indicators like the reindeer's slaughter weight to oversee ecological sustainability is bypassing the reindeer herders' experience-based knowledge on the reindeer and the herd, and that it leads to misinterpretations of the grazing situation.

In Sweden, the government regulates the number of reindeer via the County Administration Boards, which set the maximum number of reindeer for each herding district. In contrast to Finland and Norway, it is rare for the authorities to actively make changes to this number, and the public discussion on numbers of reindeer is less intense. As a result, the maximum number of reindeer is not as strictly upheld in Sweden as it is in Finland and Norway and the figure is rarely adjusted. Indeed, for most districts the maximum allowed number of reindeer has remained the same for the past 50 years.

Many different goals have influenced national policy and regulations on the maximum number of reindeer. First of all, particularly in Finland and Norway, ecological sustainability is cited as a primary reason for regulating herd sizes. But the process of setting criteria for ecologically sustainable herd sizes and use of pastures is complex and many question its validity. Secondly, since the 1960s and 70s, there has been a political goal to rationalise reindeer husbandry in these countries. Swedish policy was based on an economic rather than a cultural approach, which generally benefited reindeer owners with large herds. In Norway, the rationalisation policy promoted standardised herd structures, slaughter strategies and "optimal" numbers of reindeer. In Finland, its EU membership since 1995 has pushed reindeer husbandry towards larger herds and more meat

production, while EU membership has had little effect on reindeer husbandry in Sweden and in Norway, as a non-EU member.

In the past century, it has also been a goal to control the potential damage that reindeer grazing can cause to forestry and agriculture, by regulating herd sizes and controlling seasonal use of pastures. However, the situation has changed, and now there is greater recognition of the needs of reindeer husbandry and the effects that other land use has on pastures and grazing conditions. Nonetheless, reindeer herders and other actors often have differing views on reindeer numbers. It is still common for government employees to suggest regulation of reindeer numbers to manage conflicts between reindeer husbandry and other forms of land use, including forestry, urbanisation, mining, large carnivore management and renewable energy.

Policy decisions on reindeer husbandry often prioritise results from research over the reindeer herders' experience-based knowledge. In Finland, discussions of reindeer numbers are heavily influenced by science-based inventories, especially regarding lichen biomass. On the other hand, it has become increasingly clear that it is extremely difficult to define a constant "optimal" number of reindeer based on ecological, economic, socio-cultural or other factors. Clearly, the knowledge of the reindeer herders is needed for the dialogue on reindeer numbers to become meaningful.

PHOTO: C. UTSI

SOCIAL NETWORKS, NORMS AND KNOWLEDGE

Internal regulations within and between reindeer herding groups are necessary to ensure that the practical labour and use of forage resources works. The actions of reindeer herders are not only based on external factors, but also on how individuals can work together. This collaboration occurs through internal organisation, with shared norms and knowledge systems developed over time.

Traditional institutions of reindeer husbandry – *siida* and *tokkakunta*

Social networks are built and maintained through family ties, friendships and collaboration. Through social networks, people create mutual trust, share knowledge and provide financial or social support, which makes it possible to manage problems or adapt to changes together. Within these networks, norms and practices are the foundation of how indigenous groups and others with nature-based livelihoods use and understand their traditional lands and waters, both materially and spiritually. Norms are culturally bound, informal rules consisting of beliefs, thought models and perceptions, rather than clearly stated rules. Norms affect individual actions, collaborations and expectations, such as what behaviours are approved and not approved. Relationships between people, lands and the reindeer herding system are all embraced in the traditional institutions of the reindeer herders, like the Sámi *siida* or the Finnish *tokkakunta*.

The *siida* is a unit in which reindeer herders manage the relationship between the herd, available workforce and the use of grazing resources (Fig. 6.1), often based on familial relationships or other bonds. Non-Sámi reindeer herders in Finland have similar local units based on neighbourhoods or family ties. The *siida* is a unit that existed before the states implemented any regulations to govern reindeer husbandry. Households and families in a *siida* live and migrate together and share the benefits and expenses of herding individually owned reindeer on shared pastures. The land use of a *siida* is based on trust in neighbouring siidas and interaction between the composition of the herd, the reindeer's behaviour, the weather and topography. The structure and size of a siida (people and reindeer) can vary between seasons and years, depending on shifting access to grazing resources. Groups that make up a large siida on summer pastures can break up into smaller groups during a migration or on winter pastures.

Even if the organisation and function of the *siida* has changed over time, its basic principles remain relevant today. Yet, the recognition of the *siida* in national legislation varies between the three countries. In Norwegian legislation, *siida* and *siida* units are legal terms alongside reindeer herding districts. In Sweden and Finland, the only legally recognized units are the herding districts (*sameby* and *paliskunta*, respectively). There is no legal recognition of *siida* or *tokkakunta*.

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IN VARIOUS SÁMI LANGUAGES

Siida	*Sijdda*	*Sïjte*
NORTHERN SÁMI	LULE SÁMI	SOUTHERN SÁMI

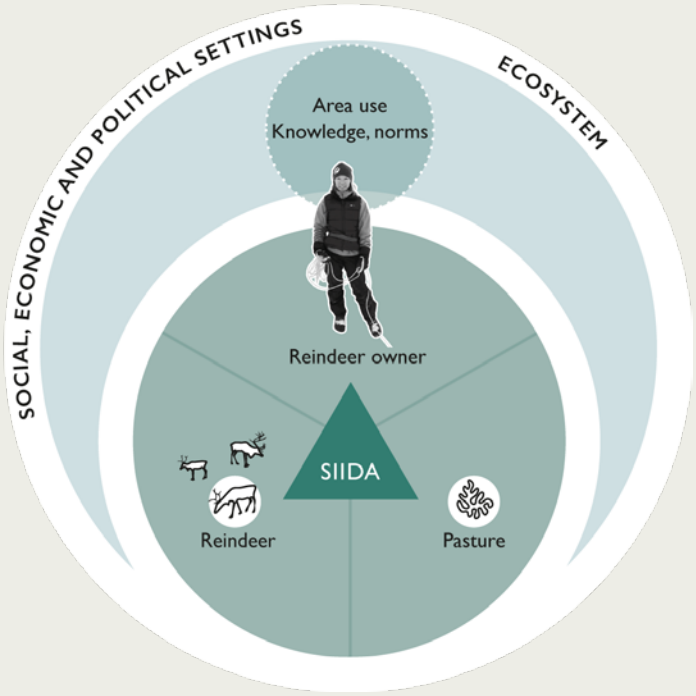

Figure 6.1: Conceptual diagram of a siida. The siida interacts with the surrounding social, economic and political environment and related ecosystems, including migration routes and the reindeer's habitats.

Knowledge systems

Traditional knowledge systems include languages, skills and practices developed through experience and passed on through generations. Because they are continuously tested against observations and new experiences, they are adaptable and often described as place-specific ways of life.

The Sámi languages are integral parts of traditional Sámi knowledge (*árbediehtu*, "inherited knowledge" in Northern Sámi) and tools for knowledge transfer. The need to identify and communicate important situations and phenomena has created a rich vocabulary around reindeer behaviour, appearance and age, as well as around weather and snow-related conditions. Specific terms describe mutually dependent phenomena, such as the term *guohtun* (Northern Sámi), which describes the relations between vegetation, snow cover and the reindeer's behaviour, which together determine the accessibility of the forage resource to reindeer in time and space. Correspondingly, Finnish reindeer herders have their specific terminology, often originating from Sámi.

Practices, norms and traditional knowledge create the social relationships between reindeer herders and are important to how they can respond to unpredictable environmental conditions. Rapid climate change, increased extraction of resources, growing predator populations and legal constraints make it difficult for reindeer owners to maintain internal relationships. Recognition of customary rights and traditional knowledge in national laws and international agreements could turn this trend around.

WEAK COLLABORATION INSTRUMENTS BENEFIT COMPETING LAND USE

Over time, tools have been developed to facilitate dialogue and exchange of information, with the ambition to reduce conflicts between reindeer herders and other land users and interests. Even if these tools can be useful in specific cases, they work poorly under unclear and unequal conditions. There are unclear rules for collaboration, including dialogues and consultations, both for how they are to be conducted and what results are expected. The result is that politically and economically stronger stakeholders often get the upper hand over reindeer herders.

The administration of reindeer husbandry is coloured by history. The first reindeer grazing laws were not established to protect the rights of reindeer herders, but to control and limit reindeer herding in order to give settlers and businesses an opportunity to establish in traditional Sámi lands. The logic was that reindeer herding had to give way to societal development. Reindeer husbandry administration has been based on ideas of shared land use and postulated coexistence. Dialogues and consultations are conducted from the perspective that reindeer husbandry can coexist with the planned business, instead of first doing a impact assessment to determine whether this is really the case. Large carnivore management and natural resource planning are based on similar assumptions. According to Metsähallitus/Forststyrelsen (a state-owned enterprise) in Finland, forestry, tourism and reindeer herding can be pursued on the same lands with joint agreements.

Reindeer herders' current participation in planning regarding land use issues, such as environmental impact assessments and permit procedures, takes a lot of time and resources but doesn't guarantee meaningful influence. Preventing the establishment of some new land use development projects means, at best, temporarily slowing increased competition for land use. The dream of coexistence is part of the explanation as to why land use planning and permit procedures usually lack a satisfactory assessment on the cumulative impacts on reindeer pastures and reindeer herding. This is striking, considering that impact assessments have long been seen as key instruments in other aspects of environmental consideration.

Due to the wide-ranging, multi-faceted land use that reindeer herding requires, there must be much clearer regulation on collaboration with competing land interests. The impacts of encroachments, disturbances, increased losses to predators and rapid climate change must be managed jointly to give a fair image of the true effects of various encroachments and to ensure that the basic needs and rights of reindeer herding can be assured.

WHEN STATE BASED GOVERNANCE FAILS – WHAT REMAINS?

When public administration doesn't work, there are other ways of gaining influence. One is to use legal proceedings as a tool to gain recognition and protection for the rights, land and livelihood of reindeer herders. Other methods are protests and using international media campaigns to agitate and apply external pressure on the countries and governing systems. There is also international criticism from UN bodies, which drives the countries to increase the influence of the Sámi and the reindeer herders.

National courts also have the potential to implement political change. One recent example is the Girjas case (2019), where the Girjas Sameby sued the Swedish Government regarding the right to grant hunting and fishing rights on the herding district's year-round lands. There is, however, a downside to legal proceedings and mobilising international support: Court trials run counter to

the principles of good governance and practice and have also resulted in an escalation of conflicts between reindeer herders and the local community, and an open questioning of reindeer herders' rights. It has also led to a surge in expressions of hate and racism against the Sámi and reindeer herders. An equally recent example is the Fosen case in Norway (2022). Although the Norwegian Supreme Court determined that the establishment of this large wind farm on traditional reindeer herding land is in breach of Sámi human rights, the government hesitated to take action. This led to extensive protests and debates as to whether the country is still subject to the rule of law. Today, intentional agreements between the two involved *sijtes* (management groups) and the government have been signed. However, the implementation of these still remains to be seen.

GOVERNANCE MUST BE BASED ON THE GOALS OF THE HERDERS

Clearly, there is a perception gap between reindeer herders and government administration as to what the key issues are and how to manage them. The major policy solutions often place all responsibility on the herders and promote short-term and step-by-step measures rather than more thorough, long-term change. An example is financial compensation for supplementary feeding and for damages in relation to climate impacts and predation. The instruments of governance typically focus on adapting reindeer herding, not spotlighting and counteracting the negative effects of competing land use on the conditions for reindeer herding.

In other words, administration and governance consist of problem formulations and solutions defined by other stakeholders than the reindeer herders themselves. This limits the potential for discussions that take into account the herders' actual needs, goals and visions. As a consequence, the reindeer herders have to find their own solutions, while at the same time many of them must pay a high price, for example in the form of increasing conflict levels.

One underlying cause of this systematic failure is that the governing systems do not embrace all

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aspects of reindeer herding. All three countries' governments seem to base their administration on a description of reindeer herding primarily as a business activity, and one "interest" among others. Instead, it is important to distinguish between securing the reindeer herder's livelihood and having profit as a primary goal. Reindeer herders often emphasise that good livelihood is about maintaining a good life, healthy herds and natural pastures. The primary goal is not financial profit.

NEED TO REINTERPRET "SUSTAINABLE REINDEER HUSBANDRY"

The stated goal of the governments' administration of reindeer husbandry is to create the conditions for sustainability. But the question is whether it is possible to improve the governmental administration of reindeer herding at all based on the visions and solutions that have been applied thus far. Perhaps other administrative methods and practices are required, which re-examine the notion of what is to be governed, and by whom?

From the perspective of the three countries, sustainable development is usually connected to "ecological modernisation" and the idea of producing more with fewer resources. The main goal is to overcome ecological and economic limitations, primarily through technological development. This image of sustainable development supports a hopeful notion of coexistence and win–win solutions, where no one is left behind. But the complexity and conflicts embedded in the idea itself are monumental. Sustainability is not a clear concept; it not only creates, but also conceals conflicting goals. Because different stakeholders have different definitions of sustainable development, one group can use the term to justify solutions that may be unjust and unsustainable to others. As long as the governments' administration sidelines the knowledge and experience of reindeer herders, the conflicts, disputes and declining legitimacy will continue. A renewed effort must be made to redefine reindeer husbandry as a political sphere and challenge the current perception of what reindeer husbandry is and can be, as well as what sustainability might mean. This requires that herders themselves have significantly more influence than it is the case currently.

"Perhaps other administrative methods and practices are required, which re-examine the notion of what is to be governed, and by whom?"

Source of text and figure in chapter 6:

Horstkotte, T., Heikkinen, H.I., Warg Næss, M., Landauer, M., Forbes, B.C., Risvoll, C. & Sarkki, S. 2022. Implications of norms and knowledge in customary reindeer herding units for resource governance. Chapter 7 in book*. pp. 133-149. https://doi.org/10.4324/9781003118565-11

Löf, A., Raitio, K., Forbes, B.C., Labba, K., Landauer, M., Risvoll, C. & Sarkki, S. 2022. Unpacking reindeer husbandry governance in Sweden, Norway and Finland. Chapter 8 in book*. pp. 150-172. https://doi.org/10.4324/9781003118565-12

Sarkki, S., Ivsett Johnsen, K., Löf, A., Pekkarinen, A.-J., Kumpula, J., Rasmus, S., Landauer, M. & Åhman, B. 2022. Governing maximum reindeer numbers in Fennoscandia. Chapter 9 in book*. pp. 173-187. https://doi.org/10.4324/9781003118565-13

*T. Horskotte, Ø. Holand, J. Kumpula & J. Moen (eds.) *Reindeer husbandry and global environmental change – pastoralism in Fennoscandia.* Routledge, London. https://doi.org/10.4324/9781003118565

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7

Reindeer pastoralism as a livelihood

The practical aspects of reindeer husbandry differ geographically and from one herder to another. Reindeer owners choose their strategies based on their own purposes and goals, as well as their ecological, economic and social conditions. In this chapter, we focus on reindeer herding as an economic activity and what strategies can give the best production and economic outcome. However, reindeer owners rarely, if ever, have economic yield as their top priority. Social and cultural aspects are often at least as important when deciding which strategies are best for the individual reindeer owner and for the herding district.

THE GOAL OF THE REINDEER OWNER DETERMINES THE SIZE AND COMPOSITION OF THE HERD

The reindeer herd represents the herder's and the family's capital and investment for the future. In the past, reindeer owners strove for big, robust herds with a large proportion of older animals. Because they lived in a subsistence economy, there was no need to maximise the slaughter. The herders depended on having many strong, tame reindeer, especially castrated males for transports. In areas where the females were milked, this also affected the herd composition. If there were many good grazing years in a row, the herds could grow large. Sometimes this could lead to the pastures being too heavily grazed and reindeer losing body condition. In the longer term, fewer females would have calves and reindeer would even starve to death.

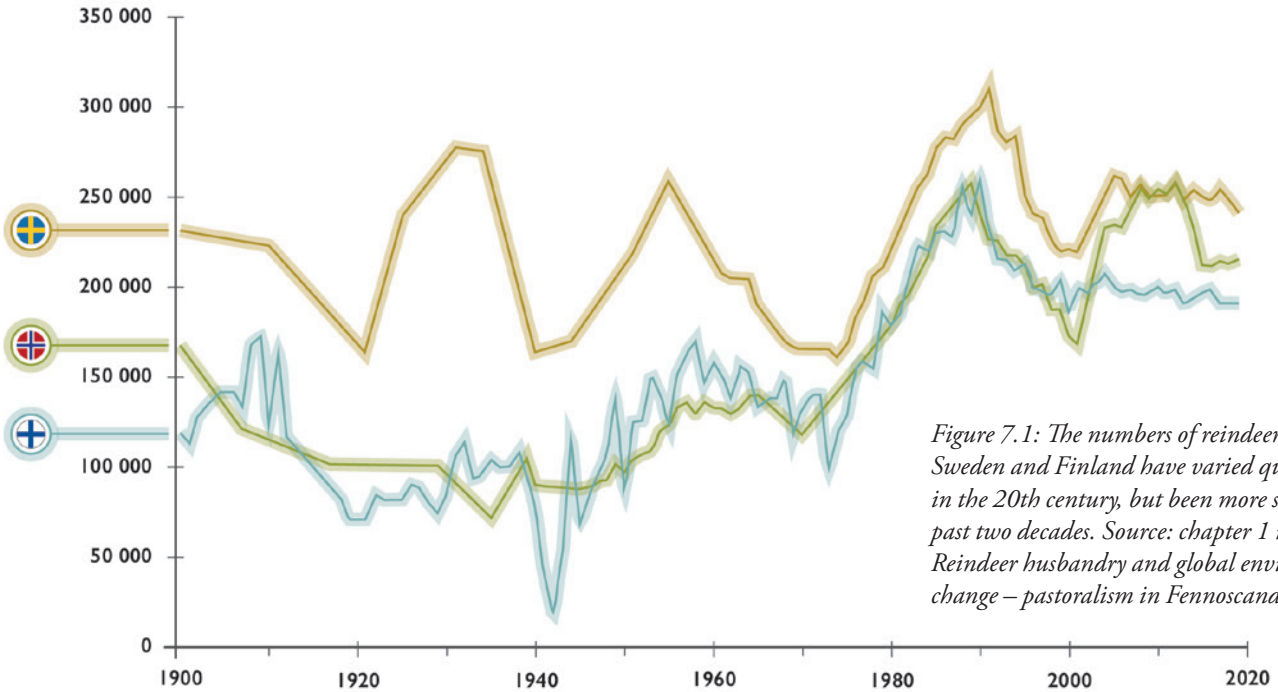

Figure 7.1: The numbers of reindeer in Norway, Sweden and Finland have varied quite widely in the 20th century, but been more stable in the past two decades. Source: chapter 1 in the book Reindeer husbandry and global environmental change – pastoralism in Fennoscandia.

In addition, reindeer numbers could drop due to extreme winter conditions, often exacerbated by outbreaks of disease. Today, reindeer owners depend on meat production, and this is reflected in the size and composition of the herd as well as the slaughter and breeding strategies.

Vital and productive reindeer herds depend on suitable grazing lands with sufficient forage at all times of the year, and they need to be able to move between different pastures depending on the season and weather. Herd composition is important for making the best use of the lands, but also depends on the reindeer owner's goals.

NEW IDEAS TO BOOST PRODUCTIVITY[4]

By the late 1930s, Soviet researchers were recommending changes to herd composition to increase meat production. They proposed restructuring the herd to have a higher proportion of breeding cows, and they recommended slaughtering calves. These ideas reached Fennoscandia in the late 1950s, first Finland, where many reindeer owners were well familiar with raising other domestic animals.

The Sámi in southern Norway developed a reindeer herd structure and slaughter strategy that combined their traditional methods with new ideas about optimal production in balance with access to forage. They adjusted the sex balance and age structure of the herds in the 1970s and early 80s (figure 7.2). Controlled selection of breeding animals improved the body condition and weight of the reindeer and ensured that most females were able to calve at 2 years of age and continue to calve annually up to an advanced age (10–12 years). They increased the proportion of adult females in the winter herd, selecting the best female calves by weight. They were even more selective about male calves, keeping only about 20 per cent over the winter. This restructuring was stimulated by a bonus for slaughtered calves, which was introduced in 1977 and resulted in the strategy spreading to many districts in Norway.

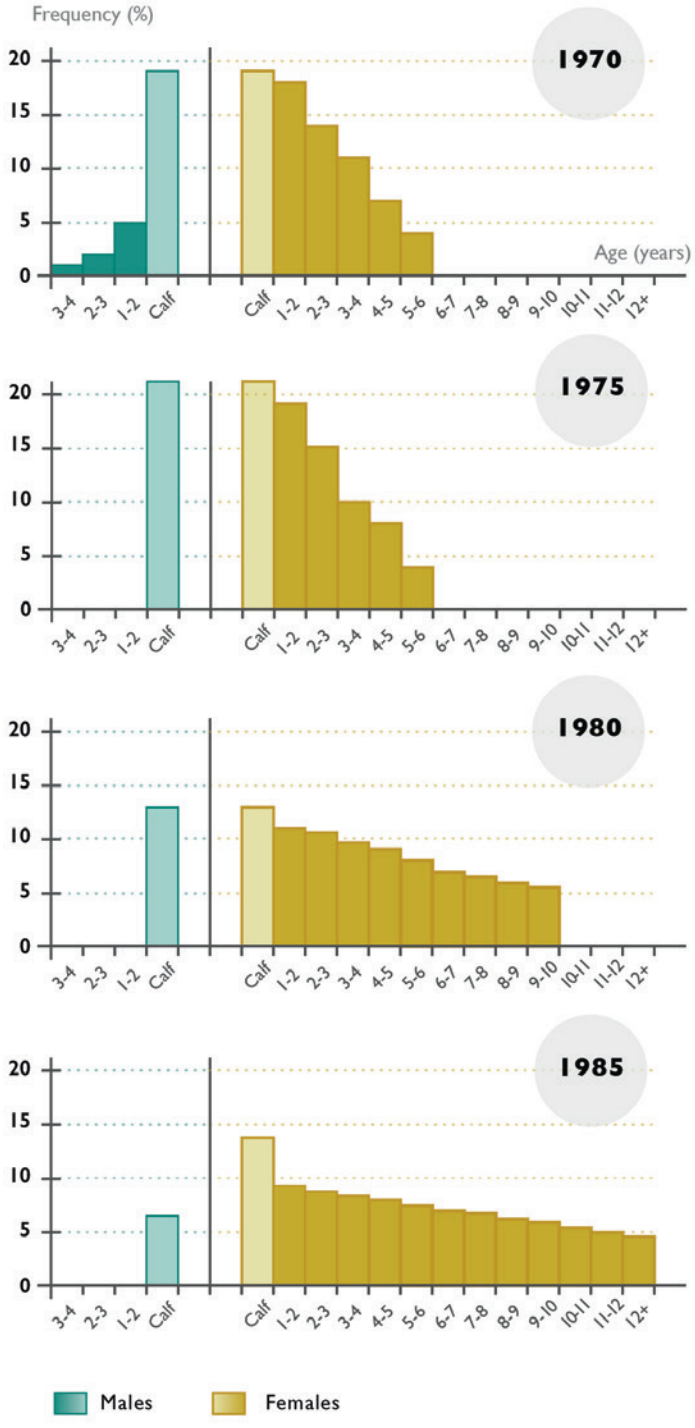

Figure 7.2: A gradual change in the sex and age structure of the winter herd occurred in Gåebrien sijte between 1970 and 1985 in order to increase productivity.

[4] Productivity here is a relative figure, for example kilograms of meat produced in relation to the number of animals in the winter herd or the available grazing area, while production refers to the quantity actually produced.

On the Swedish side, in Ruvhten Sijte (Jämtland county), a programme of individual marking and selection began in the 1980s, which is still running. Research showed that the autumn weight of the calves was in part genetic, and selecting by weight produced clear results. Further, simulations have shown that even with a low proportion (about 7%) of breeding males in the herd, genetic variation was not lost as long as the herd size remained greater than 2,000 individuals. Data collected since 1969 from an experimental herd in Kutuharju (northern Finland) has confirmed that the age and weight of the mother has a significant impact on the birth weight and survival of the calf. The mother's ability to care for her calf is also very important, and females that are successful with their first calf usually remain successful mothers for the rest of their lives.

According to a Finnish study, reindeer herders considered the selection and optimisation of the herd composition as critical in reindeer husbandry. Calf slaughter was generally applied, with the aim of controlling the age and sex distribution of the herd, and thus increasing productivity and profitability. The strongest calves were saved at the autumn slaughter to improve the vitality of the herd for future generations. The most important selection criteria were calves' health, vitality, size and muscle mass, while temperament was regarded as less significant.

ADJUSTING THE HERD TO FORAGE RESOURCES

With a herd size in balance with the forage resources, nearly all females over 1.5 years have the capacity to produce and raise a calf every year. Thus, the calving result[5] and the calves' summer survival are good measures of how well the herd size is adapted to the forage resource. However, variations in weather conditions affect access to forage, especially in winter, and therefore influence the calving result. Spring and summer weather may also directly or indirectly affect the calf summer survival. In addition, predation can substantially reduce survival. The condition of the lichen mat is another key factor to assess, because lichens are a dominating food resource in winter, when available. Excessive grazing pressure can quickly reduce lichen biomass and this resource may take many years to recover.

Balancing the herd size to available food resources requires herding and slaughter strategies and a well composed herd at the herding group (*siida*) level. However, individual reindeer owners may have their own goals and strategies, which can affect the productivity. Potential effects of pasture encroachments and disturbances from other types of land use must also be considered, because different sex and age groups react differently to disturbances. This varies seasonally and is also linked to the reproductive status of the females.

REINDEER MEAT PRODUCTION IN THE THREE COUNTRIES

While these figures varied widely in the past, the number of reindeer and the production of meat has remained relatively stable in all three countries for the past decade (figure 7.1). Finland's production is higher than Norway's and Sweden's, both in total and in relation to the number of reindeer in the winter herd and the land area (see table 7.1). This may be due to the extensive use of supplementary feeding in winter in Finland, which ensures high fertility, pregnancy, calving percentages and calf survival even when grazing is poor. Supplementary feeding is not used as extensively in Sweden and Norway, although it is gradually increasing in both countries. Norway has greater productivity (defined as kilograms of meat per animal in the winter herd and per area) than Sweden (table 7.1). This can be explained in part by a higher proportion of females in the winter herd and a greater focus on calf slaughter in Norway (table 7.1). Further, Sweden's low production per square metre might be related to the fact that a greater proportion of the potential grazing area is not accessible due to other land use. Much larger populations of large carnivores compared with the other two countries also contributes to the low productivity in Sweden (see chapter 5).

[5] Refers to the number of viable calves born. The measured calving result at calf marking or in autumn can be dramatically affected if there are significant predation losses or very poor weather conditions around calving.

Table 7.1: The composition of the winter herd and the slaughter distribution of calves/females/males (C/F/M), as well as the total annual production of reindeer meat (carcass with bones), and productivity measured as kilograms of meat relative to the winter herd size and the size of the Reindeer herding area , in Norway, Sweden and Finland (see fig. 1.3). Note, however, that the size of the Reindeer herding area indicates the boundaries on the map, not how much land is actually available to the reindeer, and that this can vary between countries. Average for the years 2010–2020.

Country	Winter herd	Slaughter	Production and productivity of reindeer meat		
	C/F/M	*C/F/M*	*Total (tonnes)*	*Kg per winter animal*	*Kg per km²*
Norway	16/78/6	79/10/11	1 526	6.8	10.5
Sweden	24/68/8	70/20/10	1 366	5.5	6.0
Finland	15/78/7	76/16/8	1 957	10.2	17.4

IMPACT OF CLIMATE CHANGE ON PRODUCTION

The ongoing climate change is expected to lead to snowier and more unpredictable winters. Warmer weather also means that it will rain on snowy ground more often, which leads to ice formation, preventing reindeer from accessing the forage on the ground. This increases the herders' reliance on supplementary feeding in winter to keep reindeer from starving, sometimes to death, which happened in some areas in the difficult winter of 2019/2020. However, extensive winter feeding can change the animals' natural grazing behaviour over time, making them less able to survive solely on natural pastures year round. Frequent ice crusts can also have consequences for herd composition, because strong animals (including bulls and steers) in good conditions can more easily break the ice and thus survive when younger and weaker reindeer may die.

The negative consequences of climate change are magnified by the fact that the reindeer's movement and grazing patterns are disturbed by other land use. A warmer climate can also have some positive effects, such as a shorter winter and a longer growing season. This can give the reindeer opportunity to feed and build their muscle and fat reserves in the summer, which gives them, especially the calves, better chances of surviving a harsh winter. Warmer summers may, on the other hand, reduce the nutritional quality of the pasture and are expected to increase insect harassment, which stresses the reindeer and reduces their growth.

The animals' mating and calving behaviour has developed in parallel with their migration patterns, choice of food and the social structure of the herd. Mating takes place during a short period in late September or early October and the calving is timed 2-3 weeks before the vegetation begins to flourish in the spring. With climate change, i.e. earlier spring green-up, there is a worry that this timing will no longer match up.

However, studies from Finland indicate that increasingly warm weather may lead to the reindeer calving earlier. From 1970 to 2015, the calving date shifted to an average of seven days earlier. This coincided with less precipitation, reduced snow

cover in April and warmer temperatures in April and May. This maintained the balance between calving and the arrival of spring, which indicates a plastic response to the changes in spring weather. However, there were greater differences in calving dates between females, meaning that the overall calving period became longer.

A stochastic environment has induced a wide variety of adaptations in the reindeer. If climate change continues, it might lead to lasting genetic changes over time. To manage future variation in the environment, it is important to maintain enough genetic variation among the reindeer when selecting individuals for future breeding.

CONSEQUENCES OF NEW TECHNOLOGY

The snowmobile revolution of the 1960s and ATVs somewhat later transformed reindeer herding. More recently, GPS tracking collars and drones have been introduced to facilitate daily monitoring. Virtual fences have the potential to improve the guarding of free-ranging animals. Remote-controlling of reindeer herds in real time can alleviate conflicts with other land users and reduce losses to predation, but at the same time risk eliminating the close contact between the reindeer and the herder. Supplementary feeding in winter can strengthen that bond, but extensive feeding will have consequences for breeding, because it may deprioritise survival traits that are adapted to the natural environment.

New technology brings additional costs and consequences to the management of the reindeer herd. The need for greater slaughter revenues and larger reindeer herds is increasing, while the demand for manpower is decreasing. This is in line with the authorities' goals of rationalising production and can lead to less diversified reindeer husbandry. Herders also worry about the risk of losing traditional knowledge, as seen in the heated debate about compulsory implementation of ID tagging of reindeer in Norway. However, new technology and innovations could create new types of business, within e.g. meat processing or manufacturing of new niche products.

FUTURE REINDEER HUSBANDRY FROM A PRODUCTION PERSPECTIVE

The size and composition of the herd and the slaughter and breeding strategies are related, and reflect the owner's aims and goals. These can change over time, due to natural, social and economic conditions and available technology. The national governments have applied regulations and subsidies, aiming to rationalise reindeer husbandry by stimulating meat production and integrating reindeer products into the market. Financial support is particularly prominent in Norway, where the government annually negotiates the sizes and allocations of funds with the Reindeer Herders' Association (NRL). In Sweden and Finland, too, reindeer husbandry is financially supported to some degree (in Sweden primarily through price support for slaughtered reindeer and in Finland via EU subsidies for live reindeer). This has affected herd composition, slaughter strategies and numbers of reindeer.

A reindeer herd that is adapted to the forage resource and dominated by productive females contributes to low mortality in the winter herd, a high proportion of calves in the summer and therefore many calves that can be slaughtered in the autumn. Many owners follow this strategy and take into account factors that contribute to high productivity. But the size of the herd, as well as its sex and age composition, can have a value in itself for the owner, which does not have to be consistent with optimisation of meat production. This is reflected in differences between reindeer herding districts and also between reindeer owners within the districts.

Land loss – especially winter pastures – human disturbances and high predation reduce production and increases costs. These risk factors magnify the reindeer herders' dependency on supplementary feeding in winter, which can result in new management strategies.

ECONOMICALLY OPTIMAL REINDEER HUSBANDRY

Slaughter strategies, the use of pastures and the extent of supplementary feeding vary between

and within the countries. Differences in methods are often adaptations to local conditions, so what is financially optimal management of the herd and pastures can vary (figure 7.3).

A key aspect for productivity in a reindeer herding system is how the reindeer use the grazing land. The winter lichen pastures are considered to be a limiting factor for growth and productivity in many reindeer herds. For the herd to produce optimally, there must be a sustainable dynamic between lichen growth and the reindeer's need of forage in the long term.

"Land loss, especially winter pastures, human disturbances and high predation reduces production and increases costs."

The economic outcome depends on both running and fixed costs and the price of reindeer meat, and thus varies over time and between the countries. This impacts which slaughter strategy is the most optimal financially. State subsidies can also affect this, by reducing the costs per reindeer or increasing the revenue per kilo of meat.

In all three countries, reindeer husbandry is largely based on calf slaughter and having a small proportion of adult males in the winter herd (table 7.1). Economic models show that this strategy is the most profitable in most cases. State subsidies in Sweden and Norway also promote calf slaughter. High predation pressure (or high mortality caused by disease or traffic) can change the optimal slaughter strategy and will sometimes reduce the advantages of calf slaughter. Lower meat prices, higher costs or a change in types of support can also change the optimal strategy from calf slaughter to slaughter of adult reindeer.

Economic models show that it is generally more profitable for reindeer husbandry to rely on natural pastures in an undisturbed environment than on extensive supplementary feeding. In Norway and Sweden, seasonal migration between grazing lands is most common. This protects valuable lichen resources from overconsumption in snow-free periods. However, pasture rotation is more difficult to arrange in small, fragmented grazing areas. When rotation systems cannot be used, it can be financially wise to permit the lichen mat to be depleted and rely more on other forage plants or supplementary feeding. For example, in the southern part of the Finnish reindeer herding area, intensive forestry has permanently reduced the availability of lichen, and reindeer herding relies instead on recurrent supplementary feeding. Model simulations indicate that this is a rational strategy in this situation. In addition, Finnish government subsidies benefit larger herds and supplementary feeding.

The choice between intensive supplementary feeding and the sole use of natural pastures also depends on external economic factors, especially fodder prices. In varying winter conditions, it can be economically optimal to feed the reindeer only in extreme winters, when weather and snow conditions make it extra hard for the reindeer to access natural forage.

Economically optimal solutions can thus vary depending on various ecological and economic factors. Indeed, different conditions require different strategies for slaughter, herd structure, feeding and pasture management. Models indicate that many of the differences in reindeer husbandry that we see between countries and regions are economically rational adaptations to local conditions.

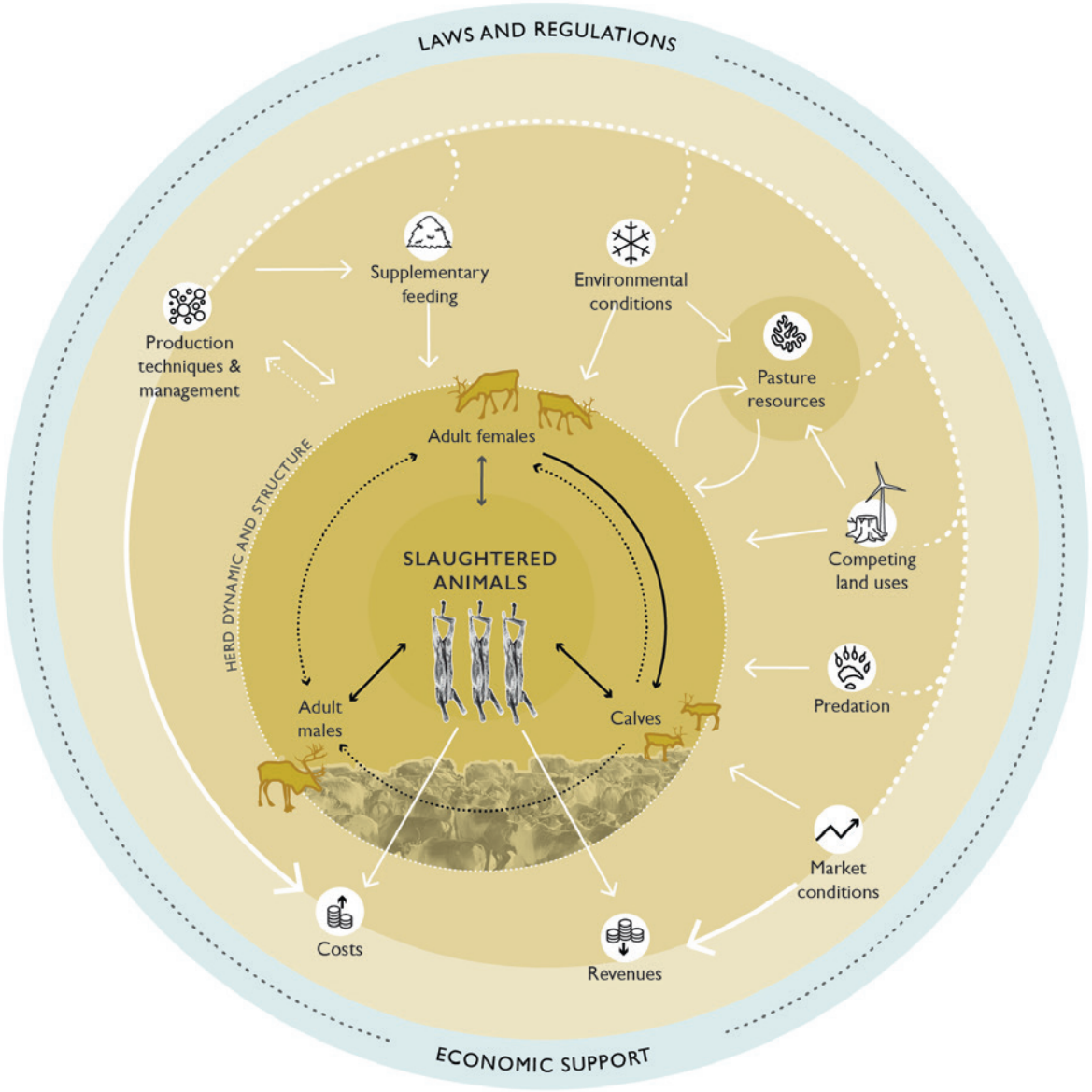

Figure 7.3: The reindeer herd is impacted by a dynamic interplay between several environmental factors and other external factors, as well as internal agreements. The reindeer owner's slaughter outtake (in the middle) depends on, and also determines, the size and composition of the winter herd. All this together impacts production costs and revenues.

Source of text and figures 7.2 and 7.3 in chapter 7:

Holand, Ø., Mäki-Tanila, A. Kvalnes, T., Muuttoranta, K., Paoli, A., Pietarinen, J., Weladji, R.B. & Åhman B. 2022. The productive herd. Past, present and perspectives. Chapter 10 in book*. pp. 191-210. https://doi.org/10.4324/9781003118565-15

Pekkarinen, A.-J., Kumpula, J., Holand, Ø., Åhman, B. & Tahvonen, O. 2022. Bioeconomics of reindeer husbandry in Fennoscandia. Chapter 11 in book*. pp. 211-231. https://doi.org/10.4324/9781003118565-16

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HERD STRUCTURE AND PRODUCTION

Based on the age and sex distribution of the reindeer herd, we can run simulations and estimate how different herd structures affect production. Figures 7.4 and 7.5 show two possible versions based on the sex distribution that is presently found in reindeer husbandry, A) with a relatively high proportion of males (20%) and a relatively low proportion of females (60%), and B) with a small proportion of males (5%) and a large proportion of females (80%). Slaughter outtake and the proportion of calves in the winter herd are adapted to maintain the number of reindeer and the herd structure over time.

The calculations show that the herd with more females produces more calves (as expected) and therefore more reindeer to slaughter (figure 7.5) However, the production is heavily impacted by reindeer losses (e.g. due to predation). Here, the calculations have included two different levels of mortality. With high mortality, there are small differences in production output between herds A and B (table 7.2). The calculations also show that with the high mortality, it is more or less impossible to maintain herd structure B.

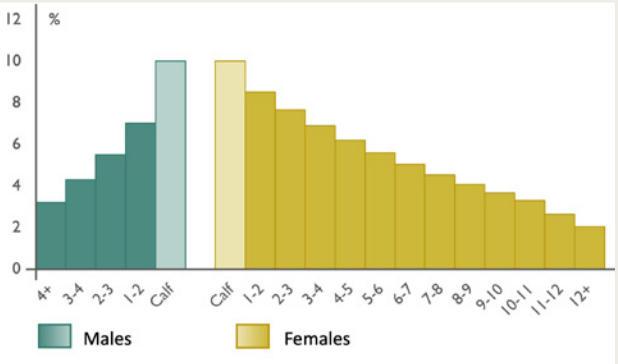

Figure 7.4: Reindeer herd A, where an equal number of male and female calves are retained and the winter herd consists of 20% males (green bars), 20% calves (lighter bars in the middle) and 60% females (yellow bars).

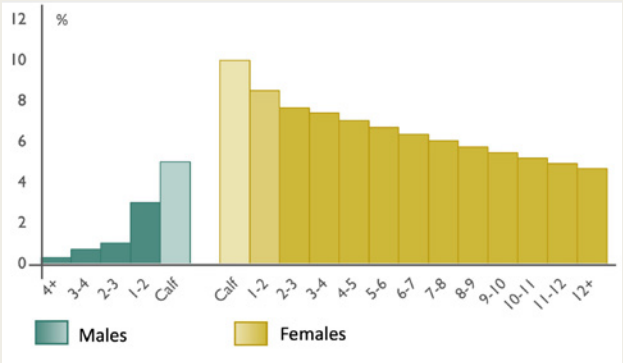

Figure 7.5: Reindeer herd B, where the majority of male reindeer are slaughtered and the winter herd consists of 5% males (green bars), 15% calves (lighter bars in the middle) and 80% females (yellow bars).

Low mortality

- Of females over age two, 80% have calves in autumn.
- Calf survival from the first to the second autumn is 95%.
- Annual survival of older reindeer is 98%.

High mortality (due to e.g. predation)

- Of females over age two, 60% have calves in autumn.
- Calf survival from the first to the second autumn is 85%.
- Annual survival of older reindeer is 95%.

Table 7.2: Calculated slaughter outtake in a winter herd with 1,000 reindeer (after slaughter)

	Number slaughtered	% calves slaughtered	Total slaughte-red in tonnes*
HERD A			
Low mortality	386	55%	11.2
High mortality	244	45%	7.6
HERD B			
Low mortality	504	84%	12.1
High mortality	330	85%	8.0

**based on average slaughter weights according to statistics from the Sámi parliament in Sweden*

8

Supplementary feeding of reindeer

Supplementary winter feeding of reindeer has increased in recent decades. One main reason is the combined effects of climate change on snow conditions, making it harder for the reindeer to access the winter forage, along with the loss of land to other types of land use. Altogether, there is an increased risk for situations when there is not enough natural winter forage, making supplementary feeding the only solution to provide the reindeer with enough food. Supplementary feeding is also used in other situations that are not directly linked to a lack of natural forage, for example to facilitate handling or protect reindeer from predators. However, feeding is both costly and laborious and may also lead to health risks for the animals.

FEEDING - MORE COMMON WITH TIME

As long as humans have kept reindeer, they have probably used supplementary feeding to some extent. During hard winters, reindeer herders have cut down branches from lichen-rich trees or tried to facilitate the animals' digging for food on the ground. The current form of supplementary feeding was triggered by several difficult winters in the 1960s and 70s, when hundreds of reindeer died of mass starvation. This increased the use of hay for winter feeding in much of the Finnish reindeer herding area, while at the same time, grain-based fodder for reindeer started being developed in all three countries.

Finland

As a result of the negative impact of forestry on terrestrial and arboreal lichens, winter feeding became a regular part of reindeer husbandry in Finland in the late 1980s. It developed in combination with small-scale farming in the southern parts of the Finnish reindeer herding area and then spread to the north. The fact that reindeer herders grew their own hay and had experience of feeding other livestock facilitated the development of feeding practices for reindeer. A helpful factor was that farmers got state compensation for leaving their fields fallow, but were still allowed to cut grass and produce hay and silage on those fields for feeding reindeer. This was further stimulated by subsidies when Finland joined the EU in 1995. As a result, many fields and meadows in the Finnish reindeer herding area are used to produce hay for reindeer.

Thus, reindeer in most of the Finnish reindeer herding area are regularly fed hay, silage and pellets in the winter. They are fed both in pens, where all fodder is provided by the herder, and on pastures where the reindeer can simultaneously graze natural vegetation. During harsh winters with a lot of snow and ice crust, supplementary feeding can last for

four or five months, while two to three months might be enough in better grazing situations.

Sweden and Norway

In Sweden and Norway, supplementary feeding is not as common as in Finland, and few reindeer herders regularly feed their reindeer for most of the winter. In Sweden, supplementary feeding has been common during migrations and round-ups, while this is less common in Norway. In both countries, the need for emergency feeding to prevent starvation has increased in recent years, both due to harsh winters and due to pasture loss. Risk for predation may also play a role, as herders might hesitate to let their reindeer use otherwise good pastures due to high presence of large carnivores and then prefer to feed the herd instead.

It is unusual in both Sweden and Norway that reindeer herders own farmland and can produce their own fodder. This means that they must buy all feed they use, and the high costs mean that many herders avoid large-scale supplementary feeding unless it is absolutely necessary to prevent starvation. Many also find it difficult to obtain suitable quality hay and silage, and prefer to rely solely on commercially produced fodder, even though the diet is less similar to the reindeer's natural food and generally causes more digestive problems.

FEED AND FEEDING METHODS

Commercial grain-based feed for reindeer is available from several animal feed producers. These feeds are manufactured in the form of pellets, with the same ingredients as feed concentrates for other ruminants, but in other proportions. Reindeer feed contains different types of grains, by-products from the sugar industry, some extra fat and protein and additional minerals and vitamins. Some feeds contain additives to prevent ruminal acidosis (see the section on health problems at the end of this chapter).

Silage and hay are also common reindeer fodder. Large-bale silage came in the 1980s and replaced a lot of the dry hay. The grass used to make silage is generally harvested earlier and therefore contains less fibre than hay, which is good for the reindeer. Reindeer lichens (*Cladonia* species) are used in limited amounts as a complement, often to get the reindeer accustomed to the feed and the feeding situation. Lichen is also the best feed to use if a reindeer has digestive problems.

NEGATIVE CONSEQUENCES AND RISKS

Supplementary feeding implies both hard work and high costs. It is not just the feed itself that costs money, but also the facilities, equipment, machines and fuel. Supplementary feeding costs can be one of the biggest expense items in some reindeer herding areas. In addition, it may have negative effects on the herder's health and safety, because of the heavy work.

There are also health risks to reindeer related to supplementary feeding. Many of these health problems are linked to poor adaptation of their digestive systems to a new diet; this is discussed in more detail below. Additionally, there is a risk of spreading infectious diseases when reindeer are kept penned up in a small area. Stress from handling can also increase the risk of impaired health. In addition to the direct effects, there are also potential long-term effects to the reindeer's grazing behaviour and to the reindeer husbandry system as a whole.

Feeding the reindeer on grazing lands can lead to greater pressure on the vegetation, and leaving excess silage or hay on the ground (i.e. seeds) can affect the species composition of the pasture. In time, this might lead to gradual shifts from oligotrophic forest to more nutrient-rich types.

FINANCIAL SUPPORT

As mentioned previously, reindeer herders in Finland can obtain EU subsidies to use their fields to produce hay/silage for reindeer. In Sweden, reindeer herders can apply for government support ("disaster relief") when snow conditions make it impossible for the reindeer to access natural forage on the pastures. This compensation can pay for up to 50 per cent of the feed costs. It has also become increasingly common for compensation to be paid for supplementary feeding when other types of land use, such as mines or wind farms, destroy reindeer grazing grounds.

The Norwegian government provides some financial support for supplementary feeding, for

example to reindeer herding districts that cannot use parts of their traditional winter pastures in Sweden since the previous reindeer grazing convention between the countries ended in 2005. Reindeer herders can also receive financial support for supplementary feeding to prevent losses due to predation. The reindeer herding districts in Norway also have their own catastrophe funds, which can be used for supplementary feeding in particularly harsh winter conditions.

REINDEER HERDERS' ATTITUDES TOWARDS SUPPLEMENTARY FEEDING

Reindeer herders see many problems related to supplementary feeding of reindeer. Among other things, they worry about the animals' health and well-being. High costs and greater workload, as well as difficulties in weighing expenses against the advantages of feeding, are other challenges. However, the herders focus particularly on the long-term effects of increased feeding on the reindeer husbandry system. They emphasise that reindeer husbandry must be based on the use of natural pastures to be ecologically, economically and culturally sustainable.

Further, herders see a risk of losing access to pastures if authorities, developers or society at large, with no understanding of reindeer husbandry, see supplementary feeding as a good substitute for natural pastures. Herders also worry about the risk of losing traditional knowledge, because knowledge about reindeer, nature and landscapes is learned through experience. If they must spend more time at the feed troughs than with the reindeer herd in the landscape, there is a risk that such knowledge won't be passed down to future generations. Another risk is that meat and other products from the reindeer will no longer be considered "nature-based" and "traditional" in marketing. Effects on the reindeer's normal grazing and migration behaviour and that the reindeer become too tame and not as vigilant are other risks they mention.

THE FUTURE ROLE OF SUPPLEMENTARY FEEDING

Winter supplementation has become an integral part of reindeer husbandry in many areas. Short-term feeding in specific situations rarely creates major problems and seems to be generally accepted by reindeer herders. The use of feeding in urgent situations where the reindeer risk starving due to extreme weather conditions has contributed to stabilising the reindeer population and maintaining productivity. The system of several months of feeding every winter is questioned by the herders because of the many risks mentioned above, but still viewed as the only solution for survival by many herders in areas where this practice in commonly used.

Researchers and reindeer herders alike have pointed out many times that the increased use of supplementary feeding is not a voluntary choice, but has been forced by external factors related to other land use, large carnivore policy and climate change. There is a risk that frequent use of supplementary feeding will create an undesired transition in the reindeer husbandry system that will be difficult to return from. Avoiding falling into this trap is a complex task that demands measures beyond the control of the reindeer herders. Rather, the effects of other land use and legislation should be carefully weighed, so they do not force reindeer herders into systematic supplementary feeding. At the same time, the challenge of a warmer climate is unavoidable, and supplementary feeding will continue to be necessary as a crisis measure.

HEALTH CHALLENGES LINKED TO A CHANGE OF DIET

Several of the health problems associated with supplementary feeding are due to the change of diet and that the microorganisms in the rumen[6] need time to adapt to the new feed. The reindeer is a selective ruminant and sensitive to dietary changes. It is crucial

[6] Reindeer are ruminants and have a unique ability to digest lichens. In the summer season, they eat grass, herbs and leaves. In winter their primary food is reindeer lichens (*Cladonia* species), and sometimes arboreal lichens, mixed with different shrub species.

CAUSES

- CLIMATE CHANGE (WINTER WEATHER)
- PREDATOR PRESSURE
- LOSS OF PASTURES (COMPETING LAND USE)

RISKS

- CHANGE IN FORAGING BEHAVIOUR
- WEAKEN GRAZING RIGHTS
- PRODUCTION IMAGE
- REINDEER HEALTH

CONSEQUENCES

- INCREASED COSTS
- INCREASED PRODUCTION
- INCREASED WORKLOAD
- LOSS OF KNOWLEDGE
- VEGETATION CHANGES

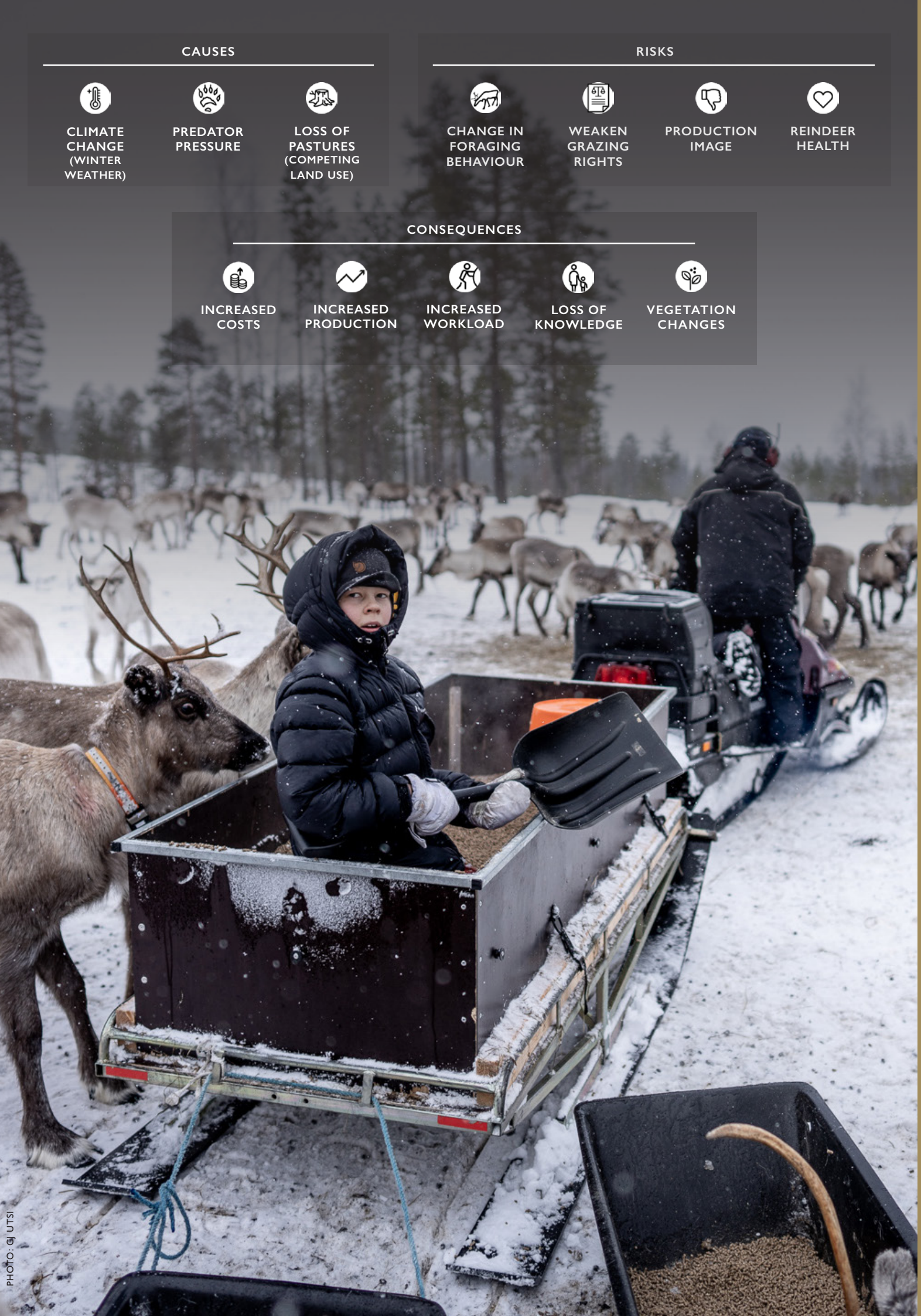

PHOTO: G UTSI

to adjust slowly to new feeds to avoid complications and disruptions in the digestive system. Other problems are associated with unsuitable fodder or poor hygienic quality of the feed.

Ruminal acidosis

In ruminal acidosis, digestion stops because the contents of the rumen have become too acidic. This is a serious, but relatively common condition when reindeer switch from natural forage to grain-based commercial reindeer feed (pellets). Grain contains easily digestible carbohydrates (mainly starches), which reduce the pH levels in the rumen when given in large amounts. This can result in the growth of lactic acid-producing bacteria, which makes the rumen content even more acidic and can lead to a general acidosis in the body, which is a life-threatening condition. Ruminal acidosis normally occurs in the beginning of supplementary feeding, usually within three weeks of start. Reindeer with the condition are often sluggish and have a poor appetite, increased thirst, distended belly and sometimes diarrhoea. The rumen contents become very liquid, which creates a sloshing sound from the belly. Severe cases of acidosis are difficult to treat. Early, mild cases can be treated with reindeer lichens or giving the reindeer liquid energy supplements with bicarbonate, which can neutralise the rumen content.

Diarrhoea

Diarrhoea is relatively common in the beginning when feeding with pellets, but has also been observed in reindeer that have been fed high-fibre forage. Diarrhoea due to a dietary change is usually temporary, but in severe cases must be treated. It can also be caused by bacterial infections in the digestive tract.

Wet belly

Wet belly is a condition that seems to be unique to reindeer. Sick animals start to sweat, making their coat wet under their belly and often down their legs, sometimes also on the neck. The reindeer can have an increased appetite and appear to freeze, huddling together when they lie down. The condition is linked to feeding and has been reported since the 1960s when research on supplementary feeding began. The reason for wet belly is unknown. Although the condition is linked to feeding, it does not seem to be associated with any specific type of feed. A commonly effective measure is still to change fodder.

Bloat

Reindeer can sometimes suffer from a severely distended belly during supplementary feeding. This happens when the rumen fills with gas or foam and the animal is unable to burp it up. The pressure in the belly increases rapidly and can inhibit breathing and blood circulation, which can be fatal. The probable cause is rapid intake of large amounts of high-energy feed.

Accumulation of grass in the belly

The reindeer's digestive system is not adapted to handle large amounts of fibre. The accumulation of undigested grass in the rumen is a well-known condition in reindeer that are primarily fed hay or silage. When the grass is not digested, the reindeer does not get enough energy and remains hungry, so it keeps eating. The reindeer risks dying of starvation even though its rumen is full of grass. In most cases, the condition can be reversed by giving the reindeer more easily digested feed.

Source for chapter 8:

Åhman, B., Turunen, M., Kumpula, J., Risvoll, C., Horstkotte, T., Lépy, É. & Eilertsen, S.M. 2022. Role of supplementary feeding in reindeer husbandry. Chapter 12 in book*. pp. 232-248. https://doi.org/10.4324/9781003118565-17

Tryland, M., Åhman, B. & Romano, J.S. 2022. Health and disease of semi-domesticated reindeer in a climate change perspective. Chapter 12 in book*. pp. 249-262. https://doi.org/10.4324/9781003118565-18

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9

Health and diseases in a climate perspective

Besides increasing the need for supplementary feeding, global warming itself can create health problems and diseases, both directly and indirectly. New pathogens may spread, not least through insects and other animals as carriers (so-called vectors) that have begun to expand further north as an effect of a warmer climate. Increased supplementary feeding can also promote infections. Even though reindeer are herd animals, feeding in pens leads to closer contact between animals, which facilitates the transmission of contagious diseases. Poor hygienic conditions at feeding can further increase that risk, especially for newborn calves and reindeer with weakened immune systems.

PATHOGENS THAT TRANSMIT BETWEEN REINDEER

Eye infections

Infectious keratoconjunctivitis (inflammation of the eye), in reindeer has been described as a multifactorial disease, and a plethora of microorganisms have been identified in the eyes of infected reindeer, including the reindeer herpes virus and bacteria such as *Chlamydia* spp. and *Moraxella* spp. Eye infections can strike individual animals, but also cause major outbreaks, usually among calves and yearlings. Such outbreaks have been associated with stress and supplementary feeding. The infection can affect one or both eyes, and often starts with increased tearing and discolouration under the eyes. The inflammation can lead to corneal ulcers, eye ruptures and permanent blindness. There is no effective treatment of the herpes virus, but antibiotics can be used to control secondary bacterial infections.

Orf parapoxvirus

Orf, or contagious ecthyma, is a disease caused by a parapoxvirus, which is found in ruminants all over the world. The disease has been diagnosed in free-grazing reindeer in all three countries. The virus can also cause painful skin lesions in humans who have handled infected animals. In reindeer, the disease is characterised by blisters and ulcers on the skin around the mouth and nostrils and in the mucous membranes of the mouth. In later stages, the animal may have difficulty eating, resulting in reduced body condition and emaciation. Currently there is no specific treatment for the disease, but antibiotics can be prescribed to control secondary bacterial infections.

Necrobacillosis

Necrobacillosis is caused by the bacterium *Fusobacterium necrophorum*, which is typically found in the gastrointestinal tract of ruminants, including reindeer. The bacterium exists in this environment, but it cannot pass through intact skin or mucous membranes. Abrasions and small wounds, caused by external factors, viral infections or teething in calves can open the door to the bacteria. Necrobacillosis primarily occurs as an infection in the hooves or the mucous membranes of the mouth. Recent outbreaks in reindeer have been linked to supplementary feeding in pens and the oral form of the disease has dominated. Necrobacillosis can also infect the rumen and lead to extensive lesions, which can be lethal even in animals that have not shown any clinical signs in their mouth.

Pasteurellosis

Pasteurellosis in reindeer is caused by the bacterium *Pasteurella multocida*, which is found in the throat and upper respiratory tract of many animal species. The

infection is transmitted via direct contact between animals and is known to cause disease in connection to stress – often severe pneumonia and sepsis ("blood poisoning") – and the reindeer unexpectedly dying without having shown any prior signs of illness.

PATHOGENS THAT ARE SPREAD BY VECTORS (PRIMARILY BLOOD SUCKING INSECTS AND TICKS)

Some arthropods, such as ticks and mosquitoes, live on reindeer as temporary blood-sucking parasites and can serve as vectors, transferring other parasites, bacteria and viruses to the reindeer.

Tick

The tick (*Ixodes ricinus*) is a vector of several diseases that are spread between animals and humans (zoonoses). Ticks feed on the blood from mammals and birds. Their distribution is currently expanding northwards and from coastal to inland areas. Ticks have been found on reindeer in Nordland county in Norway as well as in nearly all of the northerly municipalities in Sweden. The most well-known tick-borne disease is borreliosis (Lyme disease), which is caused by the bacterium *Borrelia burgdorferi*. A study of ticks in Nordland showed that 21 per cent of nymphs and 46 per cent of adult ticks carried *Borrelia* bacteria, indicating that reindeer are probably susceptible. Other tick-borne diseases that reindeer are susceptible to are anaplasmosis and babesiosis (which is a currently rare, but severe disease).

Deer ked

The deer ked (*Lipoptena cervi*) is a blood-sucking parasite that has primarily been found on moose and roe deer, but has expanded its distribution area northwards and is now found in the reindeer herding area in Finland. There are indications that attacks by this parasite can cause acute behavioural disturbances and stress in reindeer.

Mosquitoes and midges

Setaria tundra is a mosquito-borne nematode (roundworm). In Finland, there have been several outbreaks characterised by peritonitis and decreased body condition in reindeer. Bluetongue virus (BTV) is a viral disease that causes acute illness in sheep, but also infects other domestic animals and wild ruminants, even if they often don't show any symptoms. With the warmer climate, bluetongue has been documented in Sweden and Norway recently, but it does not seem to have affected reindeer yet. Schmallenberg virus (SBV) is transferred by biting midges and mosquitoes. It causes fever, diarrhoea and reduced milk production in dairy cows and can also cause stillbirths and deformities in other domestic ruminants. The virus is found in wild cervids in southern Europe, and SBV antibodies have been found in cervids in Sweden. Screenings of reindeer in Norway and Finland found no exposure to the virus.

PHOTO: CJ UTSI

Other parasites

Rumenfilaria andersoni is a roundworm that is found in the lymph nodes of reindeer and other cervids and as larvae in their blood. This parasite is transferred by blood-sucking insects, but not much else is known about its distribution and potential health effects on reindeer. The parasite *Onchocerca skrjabini* is also transferred by blood-sucking insects. The pathogen has been described in reindeer in Sweden and Finland. The adult parasites are often found in connective tissues around the joints, and serious infections have been associated with pustules in various organs and liver damage in reindeer.

The brainworm *Elaphostrongylus rangiferi* has slugs as an intermediate host. The incidence of these slugs may increase as the climate gets warmer. The reindeer can ingest infected slugs as they graze, and the larvae migrate from the reindeer's gastrointestinal tract to the central nervous system, where they develop into small filamentous worms. As they develop, the larvae can cause infections that result in weakness, paralysis in the hindquarters and unsteady movements.

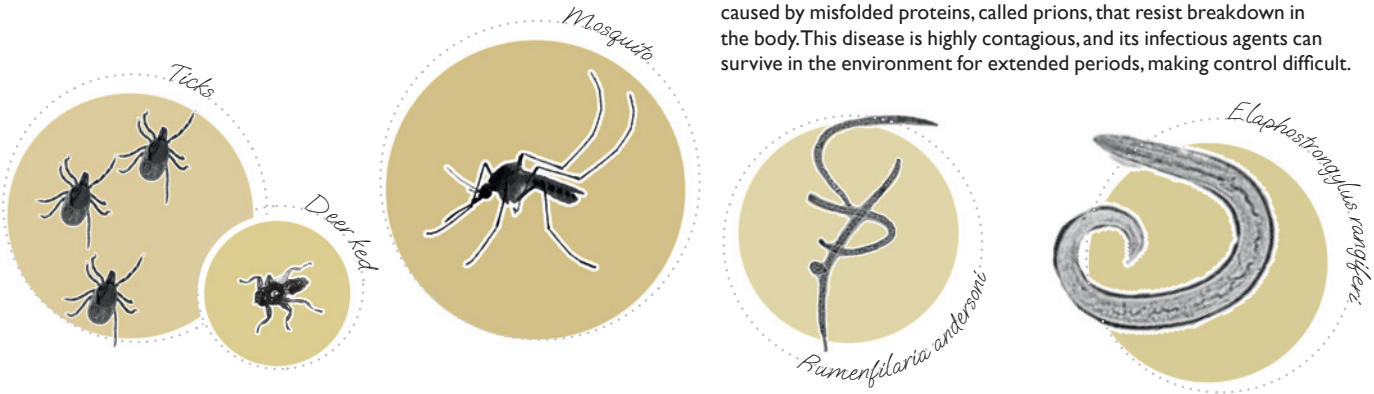
CHRONIC WASTING DISEASE

In the winter of 2016, chronic wasting disease[7] (CWD) was found in a wild reindeer herd in the Nordfjella wild reindeer area in southern Norway. This was the first documented case of the disease in cervids in Europe. Measures were implemented to prevent the spread of the disease to other wild reindeer areas and to the Filefjell reindeer herding district, which borders on the Nordfjella wild reindeer area, and to prevent the spread of infection to other cervids. The wild reindeer population in the area was decimated and a total of 19 animals were found with chronic wasting disease. In 2020, two animals with CWD were found in Hardangervidda, the biggest wild reindeer area in Norway. By reducing the population in Hardangervidda, and particularly older bulls, the authorities hope to get control of the disease. Chronic wasting disease is a threat to both wild and semi-domesticated reindeer. There are, however, better chances of monitoring and implementing measures against the disease within reindeer husbandry than among wild reindeer.

IMPORTANT TO FOLLOW UP REINDEER HEALTH AND DISEASE IN THE FUTURE

Climate change will impact the ecosystems and change reindeer husbandry. It is important to continuously follow these changes and monitor the effect they may have on the health of the reindeer in order to support reindeer husbandry in the future.

[7] Chronic wasting disease (CWD) is a fatal prion disease affecting deer, caused by misfolded proteins, called prions, that resist breakdown in the body. This disease is highly contagious, and its infectious agents can survive in the environment for extended periods, making control difficult.



Source for chapter 9:

Tryland, M., Åhman, B. & Romano, J.S. 2022. Health and disease of semi-domesticated reindeer in a climate change perspective. Chapter 13 in book*. pp. 249-262. https://doi.org/10.4324/9781003118565-18

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REFLECTIONS

Several of the trends and external pressures described in the chapters above risk driving reindeer husbandry past a tipping point and into a new regime. The gradual loss of pastures, which has been occurring for decades, is slow but still dramatic over time, since functional grazing land is the basis of the system, as for all pastoral systems. This makes it crucial to have a long-term perspective on sustainable reindeer husbandry. Besides pasture loss, climate change will cause further stress to both reindeer and herders. Although the herders and their families have so far shown a remarkable ability to adapt to changes in both social and ecological conditions, it will eventually be impossible to withstand all the emerging changes. Clearly, there are multiple factors pushing reindeer husbandry towards a new state. Pasture loss, greater predation pressure, encroachment from other land users, increasing emotional stress and lack of hope for the future can force reindeer herders into centralised and cost driven spirals, for example, where they are absolutely dependent on supplementation or the reindeer are kept corralled to protect them from predators.

Reindeer husbandry can adapt to several changes, but there are still limits to its flexibility. Pasture loss can be partially compensated with supplementary feeding – but only up to a point; after that, financial costs, lack of manpower or psychosocial stress may force reindeer herders to abandon the practice. Losses of reindeer to predation can become so great that it is not possible to maintain the herd. Furthermore, several adaptations can be very hard to reverse. For example, if reindeer herders give up the practice, traditional knowledge will disappear, and if pastures are not used, grazing rights can be repealed.

So, what can be done to reduce the risk of an unwanted transition of pastoral reindeer husbandry? Reindeer herders have always adapted their activities to internal and external changes, and they will continue to do so. Even though reindeer husbandry is characterised as "traditional", the internal identity of herders has not remained static. A fundamental part of the identity of the system entails freely roaming reindeer on natural pastures.. This requires stable social relationships within the herding district, secure access to grazing areas and functional working relationships with the outside world. These values must be reinforced, because they provide resilience, by maintaining the diversity of the pastures and ensuring mobility between pastures. Effective strategies demand structural, institutional and legislative changes, as well as a change in how we view sustainability and the role of reindeer herders – not primarily as one interest among many, but as the rights holders they are by law.

Today's global economy is based on the concept of economic growth. In the name of societal development and economic growth, reindeer owners have been forced to give up grazing grounds, hunting lands and fishing areas, which has undermined the Sámi culture. Land has been taken over by industries such as forestry, hydropower and mining, creating prosperity at the national level, but denying Sámi land rights.

Now, in the name of climate actions, investments in "green energy" are leading to more mines, wind turbines and other industrial development in reindeer herding areas. This time, land claims are made under the banner of "green infrastructure", the narrative being that

"The gradual loss of pastures, which has been occurring for decades, is slow but still dramatic over time, since functional grazing land is the basis of the system, as for all pastoral systems".

PHOTO: CJ UTSI

mines and "green energy" are necessary for the green transition.

Evidently, large steps must be taken to combat climate change. But the new wave of climate measures and green industrialisation appears the same to reindeer herders as the previous industrial development. The same power structures are still in play. And the new industrialisation is harder to argue against, because it makes the reindeer herders seem like climate-unfriendly luddites when they oppose the establishment of "green" industries that the governments view as necessary for the environment and sustainable development.

This report shows some of the consequences of reindeer herders' lack of influence and the imbalance of power between them and the authorities. There is a clear lack of consideration of the needs of reindeer husbandry in the current land and resource administration. In fact, the administration regulations and authorities' arguments reflect an unspoken assumption that reindeer husbandry would abuse the resources if the state did not manage them.

There is an urgent need to use the existing knowledge in the reindeer herding communities to find long-term sustainable solutions for land use and resource management, and culturally acceptable adaptation measures to manage climate change. This unused potential is being held back by unyielding state administrative systems. As long as this outdated view is embedded in national policy, it will remain impossible to achieve a truly working management model for reindeer husbandry. Indeed, we must ask – what is to be governed, for what and by whom?

Source for Reflections:

Moen, J., Forbes, B.C., Löf, A. & Horstkotte, T. 2022. Tipping points and regime shifts in reindeer husbandry. A system approach. Chapter 14 in book*. pp. 265-277. https://doi.org/10.4324/9781003118565-20

Larsson Blind, Å. 2022. Pathways for action. The need for Sámi self-determination. Chapter 15 in book*. pp. 278-288. https://doi.org/10.4324/9781003118565-21

Moen, J., Horstkotte, T., Holand, Ø. & Kumpula, J. 2022. Final Reflections. Chapter 16 in book*. pp. 289-292. https://doi.org/10.4324/9781003118565-22

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This report is based on the book *Reindeer Husbandry and Global Environmental Change – pastoralism in Fennoscandia*. The book is grounded in current research compiled in a joint Nordic project, ReiGN, funded by Nordforsk. It describes differences and similarities in reindeer husbandry in Norway, Sweden and Finland and how the practice is impacted by climate change, land encroachment and other factors that in combination create major challenges to reindeer husbandry.

The report describes reindeer husbandry and analyses the current reality from different scientific perspectives and disciplines. Genetics, reindeer behaviour and grazing activity, other forms of land use, the production, economy and management structure of reindeer husbandry are all factors that impact the complex internal and externally imposed dynamics of reindeer husbandry. The focus is on urgent challenges, particularly conflicting land use and the autonomy of reindeer herders, climate change and the high number of predators.

This report is intended for reindeer herders as well as landowners, authorities, policymakers and other stakeholders affected by or dealing with issues related to natural resource management, climate and environmental issues or other matters with relevance for reindeer husbandry. The Report can be downloaded from Rangifer's website (http://rangiferjournal.com).

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