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Ground lichen development and consultation between reindeer husbandry and forestry

The past, present and future of *samråd* in Sweden

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Cover:

Photo from my home desk window, where most of the thesis was written. The forest that continues into the horizon has been managed by me, my father, my grandfather and his father, under the shifting forest policy focus of the 1900s and 2000s. The closest reindeer coral is four kilometres away. The pines can be the best friends of both the ground lichen and the forest owner.

Foto från skrivbords-fönstret där avhandlingen till största delen har skrivits. Skogen som sträcker sig upp mot berget till horisonten har jag, min far, min morfar och hans far brukat under 1900- och 2000-talets föränderliga skogspolitiska fokus. Fyra kilometer bort finns närmaste renhage. Tallarna får representera marklavens såväl som skogsägarens bästa vän.

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Ground lichen development and consultation between reindeer husbandry and forestry: The past, present and future of *samråd* in Sweden

Abstract

Samråd has long been the policy instrument for consultation between forestry and reindeer husbandry in Sweden. Natural pasture-based reindeer husbandry is crucial to the Sami culture, and ground lichen is the key winter grazing resource for the reindeer, while forestry has great economic significance. In recent decades the volume and denseness of the forest have significantly increased, contributing to a strong decline in lichen-abundant forest. The aim of this thesis is to investigate what could contribute to a more balanced development of the two key resources, timber and ground lichen, taking its departure in *samråd* as the instrument for consultation.

Results show that reindeer husbandry's expectations regarding *samråd* have differed from forestry's, and that *samråd* has mainly become an instrument for information exchange. Analysis of Swedish National Forest Inventory data shows that ground lichen cover declined by 57% from 1993 to 2015, while there was no declining trend from 2015 to 2023. Results also show that a significant increase in lichen cover could be possible using conventional forestry methods adapted in timing and intensity. Scenario analyses were used to show how lichen habitat could increase in the future through specific forest management strategies, and also showed the resulting decrease in economic output for the forest company.

The thesis discusses reasons why this new knowledge might not be implemented. These include that consensus in *samråd* is voluntary, the reindeer herders have low levels of influence and power, and the decisions governing *samråd* are made at a higher level. Implementing the results of the thesis in the forest companies' strategic planning could to some extent replace *samråd* and guarantee a certain lichen habitat development. However, this is not likely in today's context, and might require changes in areas such as legislation, certification, or international/national societal pressure.

Keywords: boreal forest, forest management, reindeer husbandry, consultation, environmental policy, indigenous land use, voluntary policy instruments, knowledge, *samråd*, Sweden

Marklavsutveckling och samråd mellan renskötsel och skogsbruk: Dåtid, nutid och framtid för samrådet i Sverige

Sammanfattning

Samråd har länge varit det policyinstrument som använts mellan skogsbruk och renskötsel i Sverige. Den naturbetesbaserade renskötseln är grundläggande för den samiska kulturen, och marklav är en nyckelresurs för renarnas vinterbete, medan skogsbruket är viktigt för den nationella ekonomin. De senaste decennierna har volymen och tätheten av skogen ökat mycket, vilket har bidragit till en kraftig minskning av den lavrika skogen. Syftet med denna avhandling är att undersöka vad som kan bidra till en mer balanserad utveckling av dessa två nyckelresurser, lav och träd, med utgångspunkt i samrådet som instrument för kommunikation.

Resultaten visar att renskötselns förväntningar på samrådet har skilt sig från skogsbrukets, och att samråd främst har blivit ett informationsutbyte. Analyser av riksskogstaxeringsdata visar att marklavstäckningen minskade med 57% i renskötselområdet under 1993-2015, men 2015-2023 fanns ingen trend. Resultaten visar att skogsbruk med konventionella metoder som anpassats i tidpunkt och intensitet kan bidra till en ökning av marklaven. Med hjälp av scenarioanalyser visar vi att det går att definiera en ökning av lavhabitat genom anpassad skötsel, och hur det minskar den ekonomiska vinsten för skogsbruket.

Avhandlingen diskuterar anledningar till varför denna nya kunskap kanske inte kommer att implementeras i verkligheten. Anledningarna ses främst som att konsensus i samråden är frivilligt, inflytandet från renskötseln är lågt, att skogsbruket har ett maktövertag och att besluten som skapar utrymmet för samråden fattas på en annan högre nivå. Att implementera resultaten i skogsbolagens strategiska planering skulle till viss del kunna ersätta samråden och garantera en viss utveckling av marklaven. Det är dock inte troligt att det inträffar i dagens kontext, utan skulle kunna behöva föregås av förändringar till exempel i lagstiftning eller i certifiering, alternativt i ett ökat tryck från samhället nationellt eller internationellt.

Nyckelord: boreal skog, skogsskötsel, renskötsel, samråd, miljöpolicy, frivilliga policyinstrument, kunskap, Sverige

Dedication

Till Dagmar och Aldor

Contents

List of publications

This thesis is based on the work contained in the following papers, referred to by their Roman numerals in the text:

I. Roos, U., Lidestav, G., Sandström, S., Sandström, P. (2022). *Samråd*: an institutional arrangement in the context of forestry and reindeer husbandry in northern Sweden. International Forestry Review, 24 (3), 441-457. https://doi.org/10.1505/146554822835941878

II. Roos, U., Adler, S., Lind, T., Sandström, P. Ground lichen cover and response in relation to forest characteristics and reindeer grazing in Sweden 1993-2023. (submitted manuscript)

III. Eggers, J., Roos, U., Lind, T., Sandström, P. (2024). Adapted forest management to improve the potential for reindeer husbandry in Northern Sweden. Ambio, 53(1), 46-62. https://doi.org/10.1007/s13280-023-01903-7

IV. Roos, U., Keskitalo, E. C. H., Sandström, S. The state of knowledge in the forest sector about reindeer husbandry issues. Can knowledge contribute to better consultation? (submitted manuscript)

Papers I and III are reproduced with the permission of the publishers.

The contribution of Ulrika Roos to the papers included in this thesis was as follows:

I. Developed the research idea together with co-authors, collected and analysed the main part of the material, wrote large parts of the manuscript with support from co-authors.

II. Developed the research idea together with co-authors, participated in data collection and analyses, wrote the manuscript with support from co-authors.

III. Developed the research idea together with co-authors, developed the reindeer husbandry-adapted forestry scenarios together with co-authors, participated in workshops with stakeholders, wrote parts of the manuscript.

IV. Developed the research idea together with co-authors, designed and conducted the survey, analysed the statistical survey data, wrote main part of the manuscript with support from co-authors.

Ulrika also contributed in developing and writing the FORMAS application, which have funded the main part of the thesis work. She also contributed to the following publications:

- Sandström, P., Sandström, S., Roos, U. & Cronvall, E. (2023). Case study: reindeer husbandry plans–"Is this even monitoring?". In: Monitoring Biodiversity Routledge, pp. 333-348. https://doi.org/10.4324/9781003179245-17
- Horstkotte, T., Sandström, P., Neumann, W., Skarin, A., Adler, S., Roos, U. & Sjögren, J. (2023). Semi-domesticated reindeer avoid winter habitats with exotic tree species *Pinus contorta*. Forest Ecology and Management, 540, p. 121062. https://doi.org/10.1016/j.foreco.2023.121062

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Abbreviations

RHC	Reindeer Herding Community
RHA	Reindeer husbandry area
RHP	Reindeer husbandry plan
FSC	Forest Stewardship Council
CCG	Central Consultation Group
SSR	Swedish Sami Association
NFI	Swedish National Forest Inventory
GAM	Generalised additive model
GAMM	Generalised additive mixed model
SI	Site index

1. Introduction

Globally, the increasing pressure on indigenous peoples' lands have been acknowledged (IPBES 2019). For land use decisions to be sustainable and socially acceptable, for example in forest governance management, the participation of indigenous communities in these decisions is necessary. However, the possibilities for the communities to have an influence, and for the diversification of forestry methods are limited by the large-scale industrial forest exploitation model and the property rights regarding the boreal forest (Teitelbaum et al. 2023).

In northern Sweden, indigenous Sami reindeer (*Rangifer tarandus*) herders have used the same lands as modern forestry has since its introduction about a century ago (Berg 2010). Today, the pastoral reindeer husbandry system[1] is under pressure from many land uses (Skarin & Åhman 2014; Österlin & Raitio 2020; Harnesk 2022; Stoessel et al. 2022), and the consequences are worsened by a changing climate (Harnesk et al. 2023). Modern forestry affects reindeer husbandry negatively, primarily through a reduction in lichen, which is the key winter grazing resource (Kivinen et al. 2010; Sandström et al. 2016). This development illustrates a trade-off in relation to the increased wood production as a key resource for forestry (Skogsdata 2018). A balanced development between certain values in forestry (Kimmins 2011) has been promoted through the Swedish forestry model, in which the production and environmental goals are equal (Appelstrand 2007). There is a clear trade-off between wood production and other aspects of sustainable forest management such as reindeer husbandry,

[1] The reindeer husbandry system is an extensive, complex, and unique land use form practiced by the Indigenous Sami people across Sápmi, an area covering northern Sweden, Norway, Finland, and parts of the Kola Peninsula in Russia (Horstkotte et al. 2022a; Sandström et al. 2023)

and better suited policy instruments are needed for a more equal balancing of these different aspects (Eggers et al. 2019).

Generally, the indigenous influence over natural resources in Sweden is low (Larsen 2018); and consultations, or *samråd* in Swedish, are used for negotiation between reindeer husbandry and forest owners (Widmark 2009b). These local *samråd* have been described as a tool for co-management (Sandström & Widmark 2007b) and as an institutional arrangement to ease the land-use conflict (Widmark 2009a). However, they have also been treated as a collaborative policy instrument (Löf et al. 2022) and have been found insufficient, mainly due to the uneven power relations between the actors (Widmark 2009a). Another reason for this insufficiency is an institutional imbalance whereby local-level interactions are expected to solve problems that in fact originate at the political or institutional level (Keskitalo 2008).

The pastoral reindeer husbandry is an important carrier of the Sami culture (Sandström 2015; Moen et al. 2022), and national (SOU 2006:14) and international inquiries and reports have criticised the weak Sami influence on land-use rights in Sweden (Council of Europe 2018, OECD 2019, UN Human Rights Committee 2016). The survival of this land-use form is seriously threatened today, with modern forestry posing one of the greatest threats (Horstkotte et al. 2022b). Therefore, further knowledge is needed about how forestry's negative impact on reindeer husbandry can be reduced, and regarding the potential of *samråd* for easing the land-use conflict.

1.1 Aim and research questions

My aim is to investigate and analyse what might contribute to a more balanced development of ground lichen as a key resource for reindeer husbandry, and wood production as a key resource for forest owners. Here, an unbalanced development is understood as an increase in one resource at the expense of the other. I will consider aspects involving both lichen production in relation to forestry methods and planning, and the limitations and possibilities entailed by *samråd* as a policy instrument that influences the development of the resources.

Research questions:

1. How has *samråd* worked historically and into the present as an instrument for influencing the development of the key resources between reindeer husbandry and forestry? Papers I and IV
2. How has forestry affected ground lichen as a key resource for reindeer husbandry, and how can the negative effects on ground lichen be reduced? Paper II
3. What constitutes a reindeer husbandry-adapted forestry, and how can its effects on the key resources of forestry and reindeer husbandry be estimated? Paper III
4. What is the role of knowledge in the *samråd* situation? Paper IV

2. Outline of the thesis

Taking its departure in the unbalanced development of the key resources, this thesis has a longitudinal perspective, which is described in more detail in Chapter 3 and Figure 1. Chapter 3 connects the development of *samråd* to the development of the key resources, namely ground lichen and timber, and places the appended papers along this timeline. The past century's development of *samråd* is described in Paper I, and the ground lichen development since 1993 in Paper II. Paper III focuses on future development, simulating the effect of reindeer husbandry-adapted forestry for a 50-year time horizon, while Paper IV has a present focus on forestry's perceptions of the role of knowledge in *samråd*. Chapter 3 (*Samråd*) starts by describing the crucial role lichen plays in reindeer husbandry, and notes the lichen development as a main reason for why *samråd* is needed. A summary of earlier research on *samråd* and ground lichen is followed by a description of how I will study *samråd*, taking my departure in the research gap and in my research area, forest management.

In Chapter 4 (*Theoretical framework and operationalisation*) I will go through the theoretical framework that I will use to understand and analyse the potentials and limitations that *samråd* entails as a policy instrument, in order to relate my results to its implementation. Chapter 5 (*Material and method*) starts by presenting the multidisciplinary perspective of my thesis and an overview of the methods used. Next, I describe the case study as the research method and the specific case that *samråd* between reindeer husbandry and forestry presents, and briefly, the context of the two land users. The ethical considerations of the study are then discussed, followed by the materials and methods for each paper. In Chapter 6 (*Paper*

summaries), the main results are presented paper by paper. *Findings and discussion* (Chapter 7) starts with the main findings for each research question as well as a discussion of achievement of aim, and continues with the discussion and conclusion. The contributions and possible implementations of new knowledge from the thesis are discussed, as well as limitations and considerations regarding the results. Finally, based on the results, the possible futures of *samråd* and the ground lichen development are discussed.

With a multidisciplinary approach, my thesis spans both the natural science-based aspects of the conflict between reindeer husbandry and forestry (Papers II & III) as well as the social science-based questions that can be asked about the deficiencies and potentials of *samråd* (Papers I & IV).

3. Samråd

To be specific about the particular form of consultation that I am studying, which is legislated in the Swedish Forestry Act[2] (hereafter Forestry Act) and part of the Swedish Forest Stewardship Council (FSC) certification[3], I will henceforth use the Swedish term *samråd* [4]. I start this chapter by describing the role that ground lichen plays in reindeer husbandry, and the lichen development as a main reason why *samråd* is needed. I will then describe the development of *samråd*, since it was introduced in this context in 1923.

3.1 The development of *samråd* and continuous decline in ground lichen

Ground lichen is the most important winter grazing resource for reindeer, and is considered the critical bottleneck resource for reindeer husbandry in Sweden. Natural pasture-based reindeer husbandry is an important carrier of the Sami culture (Sandström 2015; Moen et al. 2022), with seasonal migrations between summer grazing grounds in the west and winter grazing more to the east as a cornerstone (Horstkotte et al. 2022a). However, the loss of grazing grounds in recent times, along with other factors, has caused a need for increased winter feeding of reindeer. This possible forthcoming transition towards a system based on supplementary feeding is placing at risk the traditional land-use system as a whole (Åhman et al. 2022), as well as the

[2] Skogsvårdslagen (1979:429)

[3] The Forest Stewardship Council (FSC) issues a certification, an assurance that a product has been produced or processed according to a certain standard (Johansson, 2013). FSC is a politically independent member organisation that represents environmental, social and economic perspectives (FSC 2024-08-20), and whose international principles and criteria are adapted to the national standards of specific countries.

[4] Further elaborated on in Section 4.1.

traditional knowledge connected to the land as part of the Sami cultural heritage (Horstkotte et al. 2020).

One reason for the loss of grazing grounds is modern forest management, which among other things results in denser forests. Extensive data on forest development, available through the Swedish National Forest Inventory, shows that between 1955 and 2016 the timber stock increased from 788 million m^3 to 1 200 million m^3, an increase of 52%[5] (Skogsdata 2018). At the same time as the forest resource has grown, the ground lichen resource has declined. Forests classified as lichen-abundant (lichen cover >50%) declined from 1.4 million hectares in 1955 to 0.4 million hectares in 2016, representing a 71% decline (Sandström et al. 2016).

Figure 1 shows the development of the lichen and timber resources since 1955, as well as key events in the development of *samråd* since 1923. The figure also places the study periods of the appended papers of the thesis along the timeline.

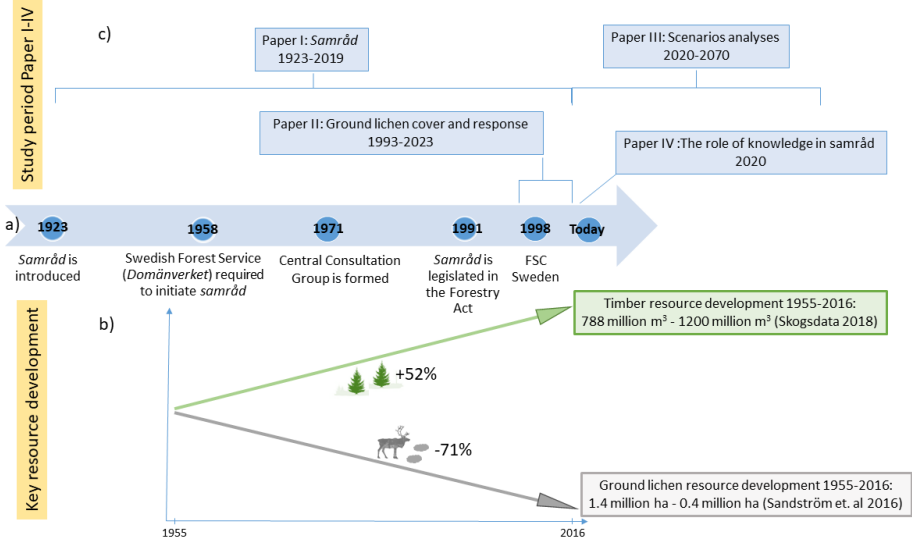

Figure 1. Schematic figure illustrating the longitudinal perspective of the thesis, with the development of *samråd* (a), the unbalanced development of the key resources of ground lichen and timber (b), as well as the study periods of appended papers (c).

[5] Productive forest land in the RHA.

Forestry and reindeer husbandry have parallel property rights to the same land (Brännström 2017).[6] Local *samråd,* as a tool for deliberation between the two land users, was first mentioned in written sources in 1923 (Skuncke 1955)[7]. The overarching goal of the forest policy in the early 1900s was to create timber producing forestry, and further to support the industries with raw materials. The forestry and wood processing industries were of great importance to the national economic interest, and production, rationality, efficiency and mechanisation were guiding principles (Appelstrand 2007). From the 1950s, intensive forestry with more large-scale methods was used (Östlund et al. 1997). By this time, reindeer herders' concern over forestry's impact on the reindeer pastures had increased[8], primarily connected to its impact on lichen as the most important winter grazing resource for the reindeer. To increase the knowledge and understanding between the two land users, a comprehensive education course was held for representatives of reindeer husbandry and forestry in 1954. The course was primarily based on research about lichen growth, the impact of reindeer on forest management, and the impact of forest fertilizers on reindeer-grazing resources 1923 (Skuncke 1955). From 1958, the Swedish Forest Service (Swe. *Domänverket*)[9] was required to initiate *samråd* with reindeer herding communities[10] (RHCs) and the Lapp administration[11] when planning forestry activities that would affect reindeer husbandry (Royal decree 21.11.1958, CCG minutes 1971-11-03[12]).

[6] The reindeer-herding right is a civil right, protected as property in Chapter 2, Section 15, of the constitutional Instrument of Government and Article 1 of the First Protocol to the European Convention on Human Rights. The legal relationship between property owner and reindeer herder is regulated primarily through the Forestry Act and the Reindeer Husbandry Act.

[7] The term *samråd* was first mentioned in this context in 1923, in a circular letter issued by the Swedish Forest Service (Swe. *Domänverket*) (Skuncke, 1955).

[8] The Minister of Agriculture was communicated in November 1950, concerning the termination of clear-cutting and the burning of clear-cuts at winter-grazing areas, as well as the subject of reimbursement to the reindeer herders for their losses (Annotation from SSR dated 1972-12-14, SO 8/72).

[9] The state-owned forests, today owned by Sveaskog, were previously owned by the Swedish Forest Service (Sjöstrand 2016).

[10] A reindeer-herding community (in Swedish *sameby* or earlier *lappby*, in some literature and documents called a Sami village) represents both a large geographical area and an administrative and financial association of Sami reindeer-herding companies. It is usually organised in winter groups (*siida*), which may consist of one or several reindeer-herding companies (Holand et al. 2022).

[11] *Lapp* being the historical Swedish word for Sami, the Swedish Lapp Administration (*Lappväsendet*) was organised under the county administration; see Lantto (2013).

[12] Minutes from the meeting of the Central Consultation Group for Reindeer Husbandry and Forestry (CCG).

In 1971, the *samråd* duties of the Lapp administration were transferred to the individual RHCs through the new Reindeer Husbandry Act. Simultaneously, the national-level Central Consultation Group for Reindeer Husbandry and Forestry (CCG) was formed, with the task of investigating how the two actors affect each other in order to find consensual solutions and propose measures. This primarily meant promoting an extended direct *samråd* procedure, discussing conflicting interests, organising education courses for representatives and promoting inventories of reindeer-grazing lands (CCG minutes 1981-07-21). The CCG has been reconstituted several times, but is still active in 2025.

Since as early as 1958, the role of the Swedish Forest Agency (hereafter Forest Agency)[13] has been to facilitate the state of affairs between forest owners and reindeer herders (SOU 1968:16). They also interpret the Forestry Act, and in 1982 their general advice concerning forestry's consideration of reindeer husbandry was published. During the 1980s and 1990s, the Forest Agency conducted three evaluations of the *samråd* procedure (Skogsstyrelsen 1987; Skogsstyrelsen 1992; Skogsstyrelsen 2001). They have been the convener for the CCG, and in 1987 were present at about half of the local *samråd*. In the two decades that followed, their engagement in local *samråd* seems to have been replaced by FSC acting as a mediator.

In 1991 it was legislated that the RHC would have the opportunity to take part in *samråd* on year-round grazing grounds (figure 4) (Brännström 2017)[14], while still today the opportunity to take part in *samråd* on winter grazing grounds is only a recommendation in the Forestry Act. The legislation regarding *samråd* is briefly presented in Text Box 1 on the next page, together with the two paragraphs regulating the minimum level of consideration towards reindeer husbandry and the general advice connected to these issues.

[13] The national authority in charge of forest-related issues.

[14] According to §20 in the Forestry Act, in the year-round areas and in the mountainous woodland there is an obligation to give the RHC in the area an opportunity to take part in consultation before a clear felling or before a felling for the construction of a forest road. However, this does not apply to forestry units with less than 500 hectares of productive woodland in which the harvested area is smaller than 20 hectares; in mountainous woodland, the corresponding harvested area is 10 hectares. If an area of specific importance to reindeer husbandry is affected, one should always allow the RHC to take part in consultation.

Text Box 1 - *Samråd* in the Forestry Act
(2022, my translation)

The paragraphs covering reindeer husbandry in the Forestry Act are, briefly:

20§ - Before clear fellings within the year-round reindeer-grazing area, affected RHCs should be offered the opportunity for consultation.

31§ - In forest management, the adaptations which are obviously necessary for considerations in regard to reindeer husbandry should be made regarding the size and location of harvest sites, regeneration measures, leaving groups of trees, and the construction of forest roads. When planning and implementing the measures, the aspiration should be that affected RHCs have yearly access to continuous grazing areas and the necessary vegetation within areas for the gathering, migrating and resting of the reindeer.

13b§ - Within the year-round reindeer-grazing area, clear felling is not allowed if

- the amount of grazing resources is so affected that it affects the possibility to keep the allowed number of reindeer, or
- it makes the usual gathering and migration of the reindeer herd impossible.

The recommendations in the general advice connected to the paragraphs are, briefly:

20§ - Consultations should be documented yearly, and briefly cover a planning horizon of three to five years for the consultations.

31§ - In the RHA, yearly consultations should also be offered outside the year-round grazing area between RHCs and forest owners with large properties and recurring forestry measures.

31§ - For clear felling operations there are recommendations concerning the avoidance of concentrations of cutting areas, extra consideration on migration routes including difficult passages and resting areas, no clear-felling in working corrals, co-planning for extended access to areas with tree lichens, leaving groups of trees for the dispersal of tree lichens, gentle soil scarification and co-planning of forest road constructions.

Since 1998, FSC certification has been obtained by the large private forest companies as well as the state-owned company Sveaskog, with certification including broader customary rights to reindeer husbandry (Johansson 2013). During the same time, the alternative certification PEFC[15] was obtained by other forest owners. The FSC certification required that *samråd* be offered at the winter grazing grounds as well, that further considerations be made to reindeer husbandry, and that the guidelines of the Forestry Act be followed. While the frequency of *samråd* increased after the introduction of FSC, the influence of reindeer husbandry on current and future forest planning and management was still low (Johansson 2013).

It can be noted that both the legislation and FCS standard include the phrasing 'offered the opportunity for' (my translation) *samråd*. It is not stipulated to what extent the parties should reach consensus. However, the FSC standard from 2020 includes the statement that *samråd* should be conducted 'in good faith'[16]. For a further description of what is written in the latest FSC standard, see Text Box 2 below. However, my empirical data for Paper I covers 1923-2019, and that for Paper IV covers 2020; thus, this standard had not been implemented by then. The period thereafter and the possible future of *samråd* are taken up in the discussion of the thesis.

For compliance with the requirements concerning *samråd*, the Forest Agency has the role of supervising whether the Forestry Act is being followed, while auditing the FSC certification is a way to assure that the requirements in the standard are followed[17]. The Reindeer Husbandry Plan

[15] PEFC is the *Programme for the Endorsement of Forest Certification*. The Swedish forest owners' associations, as well as other forest owners such as the Swedish Church, are certified by PEFC. Compared to FSC, PEFC allows more regional variations, and has been criticised for having a lower standard of environmental concerns and more focus on production aspects (Appelstrand 2007). The standard requires *samråd* on the year-round grazing grounds according to the law, but not on the remaining RHA (PEFC 2024). Today, most companies that are certified by FSC are also certified by PEFC.

[16] 'In good faith (Swe: *i god anda*): Good faith implies that the parties make every effort to reach an agreement, conduct genuine and constructive negotiations, avoid unjustified delays in negotiations, respect agreements, and give time to discuss and settle disputes and disagreements' (FSC 2020).

[17] In the system for follow-up connected to certification, it is possible to file complaints against a forest company. This can lead to a corrective action, whereby several of these could potentially lead to the loss of the certificate. However, FSC Sweden has previously been questioned as to why no forest company has lost its certificate, despite repeated major corrective requirements from audits (Johansson, 2013). Meanwhile, it can be noted that the environmental aims are more pronounced in the standard than are aims related to reindeer husbandry. The transparency of these complaints, corrective actions and audit results is also an issue of relevance for the support of the voluntary policy instrument.

Text Box 2 - The participatory planning process (*samplaneringsprocess*, previously *samråd*) according to the 2020 FSC National Forest Stewardship Standard of Sweden, my summary:

Active participation in good faith is required of both parties for the process to be carried out. In brief, the process should cover management activities for the coming five to seven years, such as final fellings and regeneration measures, but should have a landscape perspective and include cumulative effects. Affected RHCs should be invited to take part in the participatory planning process. The process should seek common solutions so that the land can be used by both parties. At a first participatory planning meeting, measures are sought to reduce the negative impacts and allow for the management activity to be carried out. If the parties cannot agree on a solution, a second meeting can be held or a field visit made as an alternative, or in addition, to this. Minutes are taken from the meetings, including the opinions of the RHCs, and should be approved by both parties. The RHC representatives can choose not to give consent, if their rights are threatened in a way that would disable reindeer herding. If the parties do not agree as to whether the management activity makes reindeer husbandry impossible and no adaptations are possible, they can call for mediation to help them agree on a solution. If they are still not in agreement after mediation, a review through a dispute resolution can be called for, in which they review whether all steps in the participatory planning process have been fulfilled. If the parties still do not agree, the forest company can either raise the management activity again once the forest grazing conditions have changed, or carry out the activity without the consent of the RHC, under certain special terms (FSC 2020).

(Swe. *Renbruksplan,* RHP)[18] also serves a monitoring function regarding the lichen resources. The Forest Agency conducted follow-ups of *samråd* and forestry's consideration of reindeer husbandry between 2011 and 2015 (Jordbruksdepartementet 2010), although the results are not publicly available. Since 2016 this work has been given low priority, and since 2020

[18] With inspiration from forest management plans, reindeer husbandry plans have been developed since 2000, as a tool and a basis for dialogue, consultations and negotiations with other land users. These plans consist of four parts: mapping, field inventories (including lichen, the main grazing resource), Global Positioning System (GPS) data from reindeer, and a Geographic Information System (GIS) compilation of other land use forms. They thus contain reindeer herders' mapping of important grazing lands, and a system for the vegetation classification of reindeer-grazing types (Sandström et al., 2023; Sandström, 2015).

it has not been prioritised (Skogsstyrelsen 2023). The routines, guidelines and knowledge level at the agency have been found to be insufficient in relation to its tasks concerning the supervision and exercise of authority concerning forestry's consideration of reindeer husbandry (Fjellgren Walkepää 2018); however, since 2018 improvements have been made regarding knowledge levels, routines and supervision (Grånemo 2019). The extent to which the management activities agreed on at *samråd* are actually carried out in reality has only been briefly investigated (Essman & Essman 2024).

The focus in this thesis is the *samråd* between the large forest companies and RHCs. As *samråd* is a part of the forest companies' planning process, it was noted as early as 1982 as well as thereafter that the decisions that determine the room for negotiation at the local *samråd* are made at a higher level in the company structure (Lantbruksstyrelsen 1984; Keskitalo 2008). Typically, these decisions are forest management strategies and felling volumes that the local forestry representatives have to consider when conducting the tactical planning[19] that *samråd* is traditionally a part of (Söderholm 2002).

Especially since 2006, there is a body of scientific knowledge about *samråd*, while there are also many non-peer-reviewed reports from this period, and earlier, on the relationship between reindeer husbandry and forestry (Hemberg 1998; Hemberg & Skogsvårdsstyrelsen 2001; Jougda 2003; Eriksson & Moen 2008; Jougda et al. 2011; Berggren & Lindberget 2012; Esselin 2012; Berggren 2015; Skogsstyrelsen 2023). In the following section I will review the main scientific sources regarding *samråd*, starting with an introduction of how forestry affects ground lichens and reindeer husbandry.

[19] The tactical planning uses the goals from the strategic planning to make a harvesting plan for smaller units of land for five to ten years in future. In long-term – or 'strategic' – forest planning for the forest resource, the time horizon is often at least one forest rotation. The aim of the strategic planning is to determine general strategies for the forest management and harvest levels as well as regeneration measures, and a consideration of nature values over time. Conflicting goals, common in forest management, can be addressed in the strategic forest planning (Öhman 2001). Typically, the strategic planning is done centrally and the final decisions are made by the executive management on the companies' boards. The tactical planning is done by planners in the regional district or planning department (Ulvdal et al. 2023).

3.2 Previous research on *samråd* and ground lichen

In Sweden, research on the relationship between forestry, reindeer husbandry and ground lichens has been conducted since the 1950s (Corkill 2009).

Dense forest which limits the available light on the forest floor affects ground lichens negatively (Jonsson Čabrajič et al. 2010), and the densification of Swedish forests in recent decades is a reason for the decline in the lichens (Kivinen et al. 2010; Sandström et al. 2016). Between 1953 and 2013 there was a 71% decline in the area of lichen-abundant forest in the reindeer husbandry area (RHA, figure 4) (Sandström et al. 2016). Forestry also affects ground lichens negatively through soil scarification (Roturier & Bergsten 2006; Tonteri et al. 2022), fertilisation (Olsson & Kellner 2006; Strengbom & Nordin 2008) and planting of the exotic tree species *Pinus contorta* (Horstkotte et al. 2023). On the other hand, thinning and harvest can have a positive effect by creating lighter conditions on the forest floor (Boudreault et al. 2013; Lafleur et al. 2016; Coxson & Sharples 2024). Fragmentation of the forest landscape has negative effects, as reindeer are dependent on continuous grazing areas during winter. Access to ground lichens can be hindered by harvest residues from fellings and thinnings, and mobility can be affected by things like soil scarification and the establishment of dense *Pinus contorta* stands (Horstkotte et al. 2023).

Reindeer grazing can be both negative (Akujärvi et al. 2014; Kumpula et al. 2014) and positive (Uboni et al. 2019) for lichen cover. But a similar decline in lichen-abundant forest outside, compared to within, the RHA (Figure 3) has been found in Sweden (Sandström et al. 2016), demonstrating that reindeer grazing is not a major reason for the decline here.

The future impact of forest management on ground lichens has been studied through scenario analyses in Finland (Miina et al. 2020) and in Sweden (Korosuo et al. 2013). For a study area in the central part of the county of Västerbotten, Sweden, an economically optimised forestry, a reindeer pasture-adapted forestry and a business-as-usual forestry were compared. Results showed that a continuation of the current forestry approach would lead to a continued decreasing trend in lichen area; however, implementing continuous cover forestry and increased pre-commercial thinning may halt the decrease, and even lead to a future increase, in reindeer pasture area. This would result in losses of approximately 5% of the net present value of the forestry in a 100 year future (Korosuo et al. 2013). In a similar study, Horstkotte et al. (2016) found a reduction in revenue levels by

approximately 20% over a 100-year period for reindeer-husbandry adapted forestry, compared to continued current forestry. The recovery time for ground lichen is relevant in relation to the earlier lichen decline in Sweden, and the annual linear growth rate for reindeer lichen has been seen be around 5 mm globally (McMullin & Rapai 2020), while for Swedish conditions it might be slightly lower (Helle et al. 1983; Cronvall et al. 2025).

Besides the negative impact on ground lichens, modern forestry also means other problems for reindeer husbandry. During snow conditions that make ground lichen unavailable to the reindeer, tree lichen is a highly important food resource. Tree lichens, which depend on forests with trees over 60 years old, have declined over the last century due to modern forestry's rotation periods of 70–100 years (Horstkotte et al. 2011).

Earlier research has found that *samråd* as an institutional arrangement is not a sustainable, stable co-management system, as land-use conflicts still occur. The main reasons for this are: the limited lichen resources, the historic land-use development in northern Sweden, and the fact that the legal framework has varied due to changing objectives in forest policy. Another reason for the shortcomings of this institutional arrangement is the uneven power relations and economic inequality between reindeer husbandry and forestry (Widmark 2009a). Improvements for *samråd*, suggested by Sandström et al. (2006), included defining the concept, implementing a landscape perspective, a better basis, more knowledge, economic implications of the *samråd* process, and mechanisms for conflict resolution. Allowing a longer time frame for planning and involving the reindeer herders earlier in the forest companies' planning process were also identified as areas for improvement. Widmark (2009) has studied the optimal level of influence by the reindeer husbandry on forestry: from a societal perspective it should ideally be weak, in order to maximise the sum of the two sectors' net present profit. One reason for this conclusion is that the *samråd* procedure is time- and resource-consuming for both parties (Widmark, 2019; Widmark & Sandstrom, 2012). In another study (Sandström & Widmark 2007), although reindeer herders believed that their influence had increased between 1985 and 1998, most of them still considered *samråd* a forum for information, while the forest companies felt that it had a major impact on the forestry planning. In other words, the land users had contrasting views about the reindeer herders' influence in the planning process. The forest companies graded the RHCs' influence higher than RHCs themselves did; however,

both actors graded the possible influence of RHCs higher than what their influence actually was at the time. Knowledge was identified, by both sectors, as the most important criterion for improving *samråd*, and trust as the second most important. Knowledge was referred to by a forestry representative as a 'solid foundation for cooperation', and an RHC representative stated that '[if] we understand each other's industries, we can find common solutions'. Material and results were other important criteria for improving *samråd* (Sandström & Widmark 2007). The transaction costs[20] of *samråd*, due to the interdependence between reindeer husbandry and forestry, were unevenly distributed between the two land users, being higher for the reindeer husbandry. Suggested improvements for bringing about more evenly distributed costs were increased knowledge among the stakeholders about each other, knowledge about the resource, clarification of the intended function of consultations, planning perspectives and conflict resolution. Changes in planning perspective were highlighted as a suggestion for improvement, more specifically carrying out *samråd* earlier in the forest companies' planning process, which would affect the transaction costs for both actors (Widmark 2009a; Widmark & Sandstrom 2012).

RHPs[18] have been developed since 2000, as a tool and a basis for dialogue, consultations and negotiations with other land users (Sandström 2015; Sandström et al. 2023). An RHP can serve as a bridge between Western academic knowledge and herders' indigenous knowledge, and has improved the understanding of how forestry and reindeer husbandry affect each other and contributed to a more knowledge-based dialogue. However, the power relations between the actors has not changed (Sandström 2015). On the other hand, it has been shown that as a participatory mapping tool for mitigating the land-use conflict, RHPs can also contribute to reproducing specific representations of, and responses to, the conflict that perpetuates existing power imbalances and inequalities (Löf et al. 2025). It has also been found that transaction costs were driven by RHPs, however in different directions for the two actors whereby the costs for forest companies decreased while those for the RHCs increased (Bostedt et al. 2015; Widmark 2019). In another study, based on material from 2010 and 2011 it was found that according to the participants' perceptions, no conflict resolution was conducted during *samråd* as the consultations have no legal power but only

[20] The costs of information, coordination and enforcement (Bromley 1991).

serve an advisory role for forest management. It was also found that the use of RHPs at *samråd* made the process more time-consuming and costly; however, they resulted in more negotiation power for the RHCs in consultations (Widmark 2019).

According to Hagsgård (2016), the legislation regarding forestry's consideration of reindeer husbandry is not applied as it was originally intended by the legislator, with the Forest Agency shouldering the main responsibility for it. The RHCs do not have influence over the land use, and *samråd* tends to involve information rather than dialogue. It is up to the Forest Agency to design regulations for *samråd* and to actively participate. Brännström (2017) investigated the legal relationship between reindeer husbandry and forestry, finding that it is in many respects unclear. The fact that the relationship between the two rights holders is largely regulated in the general advice is not compatible with the requirements in the Swedish Constitution regarding private property rights. As the historical actions of the Swedish state have created a complex legal situation, the state has a responsibility to solve the conflict of interest that exists today. The legal framework regulating the property rights vs. the reindeer-herding rights has several deficiencies, and needs to be updated according to existing judgements. Governmental inquiries (SOU 1968:16; SOU 2006:14) have proposed strengthening the legal position of the reindeer husbandry, but due to strong resistance this has not been done. Additionally, Sweden has been criticised for not giving the Sami people enough influence (Council of Europe 2018, OECD 2019, UN Human Rights Committee 2016).

Löf (2014) illuminates the deficiencies in the overall Swedish land-use governing system relating to reindeer herders' influence. Further, Horstkotte (2013) discusses governance in relation to path dependencies, with a possible solution involving transferring authority from centralised government to local cooperative decision-making, which would foster power sharing and social learning in order to negotiate trade-offs between the interests of forestry and reindeer husbandry. He also emphasises the need to recognise that current forest management is only one of many options, and that raising the biological and cultural significance of boreal forests is fundamental to ensuring the cultural survival of Swedish reindeer husbandry. Moen and Keskitalo (2010) also discuss path dependencies in this regard, specifically in relation to forestry being characterised by low flexibility and low resilience due to highly optimised harvesting methods, noting that this

situation has been created by key political decisions. Further, they illuminate the importance of increasing coordination among sectors and developing further incentive structures for coordination at the local level. The authors also discuss the possibility that forest certification offers for institutionalising requirements for consultations beyond those of the legislative demands.

In the latest FSC National Forest Stewardship Standard of Sweden (FSC 2020), the term *samråd* is replaced with *samplaneringsprocess* (Participatory Planning Process) as a part of implementing the principle of Free Prior and Informed Consent (FPIC) for the indigenous people referred to in the standard. The new process includes enhanced information-sharing and mechanisms for mediation and dispute resolution, and includes writings on active participation in good faith (Text Box 2; FSC 2020; Teitelbaum et al. 2021). Although this could mean increased influence for the reindeer herders, there is still a need for a future effective collaborative process (Teitelbaum et al. 2023). Irrespective of the new terminology of the updated FSC standard, *samråd* is still the prevailing concept in Swedish legislation and in PEFC[15], the other forest certification in use.

Keskitalo (2008) has highlighted that the conflict between the two land users originates from multi-level governance, even though it is manifested at the local level. Decisions, such as the production goals of forest companies and regulations governed by policy/market/international actors, are made at another level than the local one. Therefore, a focus on the local context, such as possible improvements to the *samråd* process, will be too limited (Keskitalo 2008). The conflict, as part of a multi-level governance system, is also characterised by multiple aims. The power distribution has continued to be in favour of forestry, due to the differences in economic significance on a national level, and the multiple aims can contribute to giving forestry – as the economically more powerful party – an even stronger role. Keskitalo et al. (2016) also acknowledge the role of disagreements over the framing of the problem as a reason for the conflict, and as an epistemological barrier. Similarly, differing views regarding which decision-making and rights principles should apply constitute institutional and systemic barriers (Keskitalo et al. 2016).

The overall governance of reindeer husbandry in the Nordic countries is analysed by Löf et al. (2022), in which they highlight the development of soft instruments as a response to competing sectoral legislation that does not sufficiently recognise herding objectives or consideration of reindeer

herding. Soft instruments include dialogue and information, such as *samråd*, and the use of these can be problematic under the unclear and asymmetrical conditions that characterise much of the land-use interaction between reindeer husbandry and other land users. The competing and interacting sectoral systems also place reindeer husbandry in a subordinate position in relation to other land users, and collaborative instruments such as *samråd* lack regulations considering procedures and outcomes. The authors consider these collaborative instruments weak, and believe that they fail to protect both the pastures and the reindeer-herding rights (Löf et al. 2022).

In the Forest Agency's reporting of the government assignment 'The state show the way in sustainable forestry in the RHA' (Skogsstyrelsen 2023), the need for political decisions is emphasised concerning what extent of forest management should be considered sustainable in relation to reindeer husbandry. The Forest Agency also acknowledges that the legislation will have to be updated in conjunction with the UN Declaration on the Rights of Indigenous Peoples, and other UN declarations that Sweden has signed. According to the current legal status, the Forest Agency does not make adequate trade-off decisions between reindeer husbandry and forestry interests. An absurdity of today's legislation is mentioned: reindeer herders have no say in, and no right to appeal, decisions about consideration of reindeer husbandry according to §31, even though they are very much affected. The authors suggest that the state forest management adopt a more proactive approach to the long-term needs of reindeer husbandry (Skogsstyrelsen 2023).

3.3 The knowledge gaps and perspectives addressed in my thesis

Based on the described previous research, this thesis takes a multidisciplinary, longitudinal perspective. Figure 1 illustrates the longitudinal perspective; that is, the history of *samråd* in relation to the development of the key resources. While earlier studies have focused a great deal on the process of *samråd*, I use the outcome – more specifically, the development of ground lichen – as a starting point to evaluate the implementation of *samråd*. Taking my departure in the review of earlier research as described above, the knowledge gaps that I aim to fill through my research questions are described in this section. Considering the long-

term development of the key resources for reindeer husbandry and forestry, there is a knowledge gap when it comes to its connection to the development of *samråd* (Paper I). Earlier, the history of *samråd* has been studied from 1984 (Widmark 2009b); but the period before that, from 1923, has not been previously described. The lichen resource development (Sandström et al. 2016) in relation to the timber resource development (Skogsdata 2018) is also illustrated in Figure 1. Considering the lichen resource development, earlier studies have only focused on changes in the area of bottom-layer classes of lichen cover. However, these categories miss all the variation *within* these bottom layer classes, namely the respective changes in lichen cover between 0 and 25%, 25 and 50%, and 50 and 100%, as these earlier studies only take into consideration the changes *between* these classes. Further knowledge about long-term lichen cover change in relation to forest characteristics is also urgently needed in order to develop reindeer husbandry-adapted forestry, and our novel lichen cover data, used in Paper II, is excellent for this purpose. There is also an urgent need for knowledge development regarding future adaptations for forestry that considers the needs of reindeer husbandry while also maintaining high wood production (Paper III). Earlier studies on future-adapted forest management (Korosuo et al. 2013; Horstkotte et al. 2016; Miina et al. 2020) have not evaluated the effects of management practices for an entire winter group area, or all aspects of necessary considerations towards reindeer husbandry. Considering the decline in lichen cover since the 1950s, and the areas with lost lichen coverage, this is crucial. Finally, different areas for improvement of the local *samråd* have been suggested in earlier studies. A main area for improvement that has been mentioned, in 1954 as well as later, is the role of increased knowledge between the actors involved in *samråd*. However, considering the power imbalance between the two actors, I problematise the role that increased knowledge can play in this sense (Paper IV), as well as the limitations and possibilities the local *samråd* presents.

The multidisciplinary perspective is connected to forest management as my doctoral education subject. As defined in the syllabus for the doctoral education, the subject area covers ‘how the forest, as a limited resource, can be used to produce commodities such as timber and biodiversity, taking into account economic, environmental, social and cultural considerations. Within the subject forest management, biological, geographical, technological, statistical and financial theory and methodology are used.’ I consider forest

management to be a part of natural resource management, and as such subject to environmental policy. Environmental policy is interdisciplinary, in which economic theory can be used to understand policy instruments, but only in conjunction with natural science, technology and other social sciences. Natural resource management is necessary for a sustainable future, not least considering the population growth in the world (Coria & Sterner 2011). Forest, historically an important resource, has been impacted by multiple areas and objectives for use (Keskitalo 2017).

As defined in the syllabus for the doctoral education, forest management embraces different resources in the forest than solely trees and wooden raw material. Differing views on what outputs are to be expected from the forest, for example in terms of reindeer pastures or wooden raw material, might require trade-offs. Management of a limited resource, and a resource for which there is competitive pressure, requires policy decisions to be sustainable. As a maximisation of the timber resource production will decrease the space available for reindeer husbandry, I will also include policy aspects in my thesis. Thus, I will also use additional methods than merely 'biological, geographical, technological, statistical and financial theory and methodology', as mentioned above.

Considering the conflicting goals between the two land users, I will explore *samråd* from not only an ecological-forestry perspective and a planning and knowledge perspective but also a policy perspective. However, considering my positioning and background, I will not conduct a full-fledged policy analysis of *samråd* as an instrument, but will make use of policy instruments and implementation theory as a theoretical framework to examine how my natural science-oriented results can be implemented. I will have a special focus on the relationship between *samråd* and the development of the key resources. In particular, I will focus on ground lichen as the bottleneck and key resource for reindeer husbandry, and on what might contribute to an increase in lichen cover, regarding not only the technical forest management aspects but also those involving planning as well as policy and knowledge. This thesis will thus contribute by offering a new multidisciplinary and longitudinal perspective, adding policy aspects to the forest management perspective and connecting the lichen resource development to *samråd* as a policy instrument.

4. Theoretical framework and operationalisation

4.1 Understanding *samråd*

The meaning and development of the concept *samråd* are relevant in relation to the influence of the reindeer herders in *samråd,* especially considering the concept's meaning when it was introduced in this specific context. Previously, the meaning of *samråd* has often been seen in relation to Arnstein's theory on influence in decision-making (Arnstein 1969).

As a tool for negotiation between the two land users, consultation can be translated into Swedish as either *samråd* or *konsultation*, the latter of which has a different meaning than *samråd* - more like 'asking for advice' (SAOL 2015). Arnstein's Ladder of Citizen Participation is a classic framework in which eight rungs illustrate the degree of influence that stakeholders can have in decisions (figure 2, Arnstein 1969; Varwell 2022). In relation to *konsultation, samråd* can be placed closer to a higher rung on the Ladder of Citizen Participation (Arnstein 1969; Sandström & Widmark 2007). The concept of *samråd* has been used at least since the 1600s (cf. Wänström 2009). In relation to another type of *samråd*, Wänström (2009) describes the historical conditions behind the parties entering *samråd* with differing expectations regarding influence and dialogue. Today the concept is broadly used and can mean different things in practice, but the meaning of *samråd* when it was introduced in the context of relations between reindeer husbandry and forestry can similarly be significant for the original intent and purpose of the institutional arrangement and the participants' expectations.

Over time, the concept's meaning and use in practice have changed. *Samråd* has long been used as a mechanism for enabling government decision-making and public policy, in which two or more state agencies are

obliged by law to confer with each other in various matters. It can also entail a forest owner being obliged to confer with the Forest Agency before a defined action can be executed. In 1988, *samråd* was legislated in Sweden's Planning and Building Act (SOU 2001:89), with the purpose of increasing citizens' influence. A decade later in 1998 *samråd* was added to the Environmental Code, but at this time the primary purpose was to gather public opinion and knowledge before decisions were made. *Samråd* is used in many other public contexts, but looking at these two recent examples in practice (the Planning and Building Act and the Environmental Code), the meaning of the concept seems to have shifted downwards on the Ladder of Citizen Participation between 1988 and 1998 in these cases.

Degrees of citizen power	Citizen control	Have-not citizens obtain the majority of decision-making seats, or full managerial power.
	Delegated power	
	Partnership	Enables the have-nots to negotiate and engage in trade-offs with traditional powerholders.
Degrees of tokenism	Placation	Simply a higher level of tokenism, with the ground rules allowing the have-nots to advise while allowing the powerholders to retain the continued right to decide.
	Consultation	Levels of tokenism that allow the have-nots to hear and to have a voice. When these are proffered by powerholders as the total extent of participation, citizens may indeed hear and be heard; but under these conditions they lack the power to insure that their views will be heeded by the powerful. When participation is restricted to these levels, there is no follow-through, no 'muscle', and hence no assurance of changing the status quo.
	Informing	
Non-participation	Therapy	Levels of nonparticipation that have been contrived by some to substitute for genuine participation. Their real objective is not to enable people to participate in planning or conducting programmes but rather to enable powerholders to 'educate' or 'cure' the participants.
	Manipulation	

Figure 2. Arnstein's Ladder of Citizen Participation, a typology in which each rung corresponds to the extent of citizens' power in decision-making (adapted from Arnstein, 1969).

Considering Arnstein's Ladder of Citizen Participation as a framework for *samråd* (previously used by, e.g., Widmark (2009) and Sandström and Widmark (2007)), this framework takes its departure in the idea that the process of *samråd* can be improved, allowing the reindeer herders to gain more influence. However, for instance, Löf et al. (2022) have found that dialogue and information such as *samråd* are weak instruments and fail to protect both the pastures and the reindeer-herding rights. Therefore, I will henceforth take note of this, discussing my results in relation to the limitations of and possibilities offered by *samråd* as a policy instrument. I

will discuss how the instrument has served to balance the resources between the two land users, considering the trade-off between the aims of wood production and lichen development, and the last century of unbalanced development. I will also discuss the potential that *samråd* offers for balancing the resource development in the future, and the factors influencing this potential.

My theoretical framework thus has a particular focus on voluntary policy instruments, which I relate *samråd* to. In the following section I will define a policy instrument and describe what can influence the implementation of such an instrument in general. This will provide the basis for looking at *samråd* as a past, present and future instrument for negotiation between reindeer husbandry and forestry. I will also operationalise the theoretical framework behind the context of *samråd* between reindeer husbandry and forestry.

4.2 Policy instruments

Policy instruments are the means chosen for achieving policy goals (Chandler & Atkinson 1983), also often known as governing tools (Ali, 2012). In evaluation of public policy, the concepts of efficiency, effectiveness and equity are commonly used. These can be defined as: effectiveness – 'the extent to which the policies are achieving the benefits they are supposed to achieve…'; efficiency – 'the extent to which they are keeping costs down…'; and equity – 'the extent to which their benefits and costs are spread among those that are affected…' (Nagel 1986). In my analysis of *samråd* I will not consider efficiency or equity, instead focusing on the effectiveness of policy implementation through *samråd* as a policy instrument. Consequently, I will look into whether it is currently achieving the benefits it is supposed to achieve.

Implementation of policy can be described as what explains the gap between policy decision and action. The triad of the understanding-willingness-ability of the actors, or 'implementers', is considered important for the implementation of policy. It concerns the extent to which the implementers understand the meaning of the intervention that is to be implemented, the extent to which they want to implement the intervention, and the extent to which they have the ability (e.g. the resources) to implement it. Finally, the context of the implementation – including the origin of the

intervention to be implemented, other parallel interventions and actors, and review of and feedback on the implementation – is also an important factor (Vedung 2016).

Implementation science deals more specifically with the gap between scientific findings and their implementation (Vedung 2016). In *samråd* this can be related to the general emphasis on increased knowledge as an important factor for improving *samråd*, which I will come back to later.

Other important aspects for policy implementation are the role that unclear interventions play in the implementation, history as part of the context of the implementation, and the role of framing as part of the problem formulation that leads to the intervention (Vedung 2016).

Policy instruments can be used, for example, by a state to effect change, through either regulative, economic or information measures (Vedung 1998; Appelstrand 2007).

Examples of regulatory instruments are prohibitions, impositions, permissions and fees. Even though some regulations and compliance with them can seem to be a given, the very existence of a law is not enough for it to change the behaviour of a population. Instead, there are a number of factors that influence and limit how successful the state will be in affecting people's behaviour. The three basic conditions for rules to be effective are considered to be knowledge, comprehension and motivation (Appelstrand 2007).

Economic instruments are 'softer' than the regulatory instruments. Historically in Sweden, economic instruments have been synonymous with taxes and fees, but there has been a shift in recent decades towards market-based instruments that give the actors more freedom. The goals are set by the state or, for instance, the EU; but how to reach the goals is up to the actors, often companies. An example of this is the trading with emission rights (Appelstrand 2007).

For the use of regulatory and economic instruments to be effective, information about the instruments is often necessary. However, information can also be seen as an instrument in itself (Appelstrand 2007).

4.2.1 Voluntary and environmental policy instruments

'Soft law', or voluntary policy instruments, have no legal power and are flexible in the sense that they can be formed to suit the specific operations at hand. They are often developed in cooperation, at horizontal levels and in

networks, apart from hierarchical structures, and their implementation is often done through standards, certifications, labelling, guidelines, evaluations, comparisons and accounting requirements. Reporting and audits are often basic but voluntary requirements. Voluntary instruments can in some cases be seen as imperative, when the monitoring, comparisons and follow-ups work in the sense of 'name, blame and shame' (Appelstrand, 2007).

Policy instruments are often used to achieve goals in environmental (Segerson 2013) or resource management (Ali 2012). Thus, *samråd* between reindeer husbandry and forestry can be considered an example of a policy instrument for resource management.

Further, as a voluntary policy instrument, *samråd* can be seen as an example of soft steering as part of a shift from government to governance[21] (Jordan et al. 2013) in Swedish forest policy (see Ch. 4.2.1), and today it is mainly applied according to the FSC certification criteria (see Ch. 5.2). Certification can be a complement or alternative to legislation that can be seen as the middle ground between command-and-control regulation and self-regulation (Appelstrand 2007). FSC certification is a voluntary private governance system, in which a non-governmental actor has taken the lead in policymaking as part of a move from government towards governance; this is recognised by Cashore et al. (2004) as the most advanced case of non-state market-driven private authority.

4.3 What influences instruments' implementation

Many factors can influence the implementation of voluntary instruments. The 'understanding' part of implementation (from the understanding-willingness-ability triad) is highly related to information and knowledge. The institutional process and the context in which an instrument is implemented offer an example of another factor which influences implementation, including both formal structures and social rules as well as power structures (Keskitalo, 2022). Support from an underlying existing or threatened regulatory structure can be important (Appelstrand 2007 & Segerson 2013), as can the reporting and audits that are often part of certification systems, as

[21] *Government* has been described as 'widely seen as state-led governing via the "command-and-control" instrument of regulation (i.e. laws)' (Jordan 2013:156) and *governance* as 'rel[ying] instead on horizontal forms of societal self-coordination' (Jordan 2013:156).

well as comparing and follow-ups. This can also be coupled with media reporting, which can stand alone or together with political and societal pressure from, e.g., NGOs to support the policy instrument. As knowledge has been considered so crucial for the implementation of *samråd* (e.g. Skuncke (1955) and Sandström and Widmark (2007)), the next section describes the role that information plays in the implementation of voluntary policy instruments, as well as different understandings of knowledge.

4.3.1 Information and knowledge

Information can be an important part of implementing a voluntary instrument, for instance by aiming at increasing knowledge or changing attitudes and/or actions among actors. Similar to the implementation science mentioned earlier, the disproven 'linear model of scientific knowledge' (hereafter linear model of knowledge) illuminates the potential that increased knowledge has for influencing policy or actions. How produced knowledge makes it to the next step, as a basis for decisions by policy-makers and practitioners, is a crucial component in this disproven model (cf. Beck, 2011). In the linear model of knowledge, decisions are based on scientific information without being altered by the policy process or practical considerations, which is seldom the case in reality. This can explain why scientific recommendations are sometimes not followed. An example of this is climate scientists who critically ask why their recommendations are not followed by political actors or society as a whole (Keskitalo 2022).

There are different understandings of knowledge. The linear model of knowledge can be seen as an assumption in which knowledge is apolitical and a given, and should therefore be of interest to all who come in contact with it. In this sense, the theory of ideal communicative rationality can be mentioned. This assumption can be seen as related to Jürgen Habermas's idea of an ideal situation. Communicative rationality assumes that in a communication situation, e.g. a dialogue or dispute, the only legitimate force is a good argument (Han 2002), and that a communication process would deliver the most 'correct' political judgement possible and lead to a consensus on values. Hence, interactions are egalitarian and free from deception, power and strategy. Among the rules that Habermas set up for this ideal communication are that participants must abandon their interests and commit to consensus development, and that they must not be hindered by power perspectives or resources (Keskitalo 2021). This is seldom the case in

real-life situations, including the *samråd* situation between forestry and reindeer husbandry.

The contrasting Foucauldian understanding of knowledge builds not on the ideal situation but on reality, in which knowledge is related to power (Dreyfus & Rabinow 2014) . Knowledge is established in the context of, and to support, power, and all decision-making and development of knowledge is impacted by power and interest. Power is always present in people's interests, affecting them in relation to authority as well as in language in regard to what can be said and what cannot. Also, communication is always influenced by one's previous understandings and the ways of understanding the world that one has been schooled in. Better knowledge will not necessarily lead to change, and it cannot be assumed that learning will take place automatically or in all situations. Therefore, it is important to understand what knowledge people are receptive to, or even what incentives can be provided, rather than assuming that knowledge exchange or learning will necessarily occur (Keskitalo 2021).

Cook and Wagenaar (2012) highlight something highly relevant to the case of reindeer husbandry and forestry, in which a common conception has been that if we learn from each other we will make adequate considerations. The authors say that it has sometimes been taken for granted that participation will lead to the accumulation of knowledge and skills, while it has not been specified how active participation results in knowledge:

> …by putting knowledge forward as the major, privileged, or exclusive way of relating to the world, we overload it. We leave out the whole living, experiencing, interacting, embedding material and social environment that often gives rise to what we know in the first place and without which it simply wouldn't make sense to us. It forgets—and in fact dismisses as irrelevant—the fact that knowledge is at all times embedded in a particular practical context, and emerges from our active engagement with some particular slice of the world. (Cook & Wagenaar 2012)

As mentioned earlier, previous studies (Sandström & Widmark 2007b; Widmark & Sandstrom 2012) have suggested that increased knowledge is important for supporting *samråd*. However, in the context of power and institutions described earlier that *samråd* is a part of, it is reasonable to ask to what extent increased knowledge can actually influence *samråd*. It is

relevant to consider who has the power to ask the questions, and the influence to prioritise which knowledge is produced (Sarmiento Barletti & Larson 2019) [22]. Framing can be seen as relevant to implementation theory; and the framing of the problem between reindeer husbandry and forestry can be seen as having been similar over the years, mainly having been controlled by the forest companies as the more powerful actor (Widmark 2009a). This also relates to bureaucratic inertia, whereby people in organisations tend to do as they have always done. In particular, if a certain powerful actor has long dominated the framing of a problem and its solutions, these patterns, perspectives and unreflected habits will be effectivised and routinised, which can prevent a change in implementation (Vedung, 1998).

Monitoring to gather knowledge (c.f. Bjärstig et al. 2014), for instance about resources, can be a basis for accountability such as reporting and audits. Common tools for complying with policy instruments include monitoring such as inspections, and enforcement such as penalties and fines. Self-reporting is another example. However, informal regulation through community pressure can be especially important for voluntary policy instruments (Sterner & Coria 2013). 'Naming and shaming' refers to the public scrutiny of and reputational damage to individuals or companies, with effects that can go beyond penalties imposed by law (Oniwinde 2024). Environmental monitoring, reporting, comparisons and follow-ups can be crucial for the strength of environmental voluntary policy instruments, and serve as the basis for naming and shaming. Further, media reporting contributing to community pressure is an example that can motivate actors like companies to act in line with policy goals and voluntary policy instruments. In relation to forestry's consideration of reindeer husbandry, compliance tools include the supervision of whether the Forestry Act is followed and FSC auditing and accreditation (Halalisan et al. 2023).

4.3.2 Institutional context

It has been suggested that institutional theory is relevant in influencing the success of implementation of instruments. Institutions are the basis of both formal and informal governance systems (Young 2017; Keskitalo 2021), and

[22] A demarcation concerning other knowledge systems besides the dominant global scientific one (Durie 2005; Watson-Verran et al. 2005) used in this thesis is the local and indigenous knowledge that has been passed on over generations. Currently growing in legitimacy, this is an important source of learning and understanding (McDonagh et al. 2020), but is not addressed in this thesis.

at the most general level can be defined as 'constellations of rules, decision-making procedures, and programs that define social practices, assign roles to the participants in such practices, and govern the interactions among the occupants of those roles' (Young et al. 1999). Institutions have been defined as constraints of individual behaviour, as normative structures, and as cognitive models for understanding the world (Vatn 2005). The context of an instrument's implementation can encompass not only formal structures but also social rules in a social setting, which are nested within formal and informal power structures that enable some actions and limit others (Keskitalo 2021).

Institutions constrain policy change (Béland 2009), particularly due to their naturally possessing stable features, for instance rules and norms. Change through instruments will also depend on how the forces that sustain institutions are influenced. Who is expressing the need for change, how the issues of change are framed, and what other issues these changes are competing with are examples of this. To understand the context in which an instrument is to be implemented, knowledge of the 'system' and its formal and informal institutions, as well as power dynamics and arrangements, is crucial. The power dynamics in relation to who benefits from and who loses due to certain changes – as well as the history and how well certain rules, institutions or discourses are embedded in society, especially among powerful actors – are important determinants for change (Keskitalo 2021). In summary, an institutional understanding of possibilities for change mainly implies that 'one needs to focus on understanding the existing environment of institutions with their embedded contexts and assumptions, and not least the driving forces and the complex, interlocking motivations and incentives' (Keskitalo 2021:49).

It is crucial to understand the context of power dynamics in which a policy instrument is implemented (Keskitalo 2021). The limited power of reindeer herders to influence final decisions in *samråd* has previously been described as a rung on Arnstein's (1969) Ladder of Citizen Participation (Sandström & Widmark 2007b). The unequal power relations are influenced by differences in both financial resources (Widmark 2009; Widmark 2019) as well as technical skills and strengths. The forest companies have historically asserted their national significance in terms of export value and as an employer, compared to the relatively small reindeer husbandry sector (Lantbruksstyrelsen 1970).

It has been suggested that the different kinds and scales of power inequalities in participatory processes are based on different characteristics, such as political, resource, technical and epistemological (e.g. the power to determine what 'acceptable' knowledge entails) (Sarmiento Barletti & Larson 2019). Similarly, Partzsch (2017) has presented the prism of 'power and responsibility for change', in which power plays an important part in shaping the world and is exercised by influencing, forming and constituting ideas and intentions.

Related to scales of power are the organisational decision levels governing *samråd* at the forest companies. Here, the power to make long-term strategic decisions is situated at a higher level than where *samråd* is actually held, which means that the reindeer herders' participation does not give them the possibility to influence these decisions. In the following section I will first operationalise the policy objectives of *samråd*, followed by a section on the different levels governing *samråd.*

The objectives of samråd

The overarching forest policy in Sweden since 1993 has involved the production and environmental goals, with equal importance. However, the production-oriented forest policy left a strong legacy among forest owners (Lindahl et al. 2017), which can be seen as a production norm. The Forestry Act states that the forest is a renewable resource that is to be sustainably managed to yield a good revenue, while maintaining biodiversity and considering public interests. In the Forestry Act, it is clear that the production and environmental objectives are treated with the same dignity. However, the relationship between the production objective and the case of forestry's consideration of reindeer husbandry is more unclear.

Since the introduction of the Reindeer Grazing Act, ideas about parallel land use and coexistence have guided the land-use governance between reindeer husbandry and other land users. The underlying logic has been that reindeer husbandry must give way to societal development, with the adaptation of reindeer husbandry seen as the solution and with the limits to coexistence left undefined. Rather, coexistence is a prescribed outcome of the collaborative instruments (Löf et al. 2022).

The institutional arrangement of *samråd* can be seen as a way for the legislator to handle the multiple aims (cf. Keskitalo *et al.* 2016) and competing sectoral legislation (cf. Löf *et al.* 2022) in the relationship between reindeer husbandry and forestry. Hydén (1984) has previously

described this approach as governing intervening norms or cases. This is useful for understanding the legislated *samråd* as part of the Forestry Act. Here, the legislator does not take a stand on how the conflict should be solved but rather leaves this to the administrative system, to a practice to be developed among the implementing actors. Solving the conflict is then institutionalised into the administrative system (cf. Brännström 2017). Hydén motivates why the legislator does not take a stand regarding how the conflicting goals should be solved with reference to the 'reflexive right': the prevalent approach in this context is to refer to the issues as being so technical and complicated that it is difficult to even state solutions to the problem in the legislation, citing a need to not lock the legal development by stating 'what a societally acceptable solution entails from one time to another' (Hydén 1984, my translation). The balancing of interests should be done by the practitioners, and the function of the legislation is to bring together the affected interests (Appelstrand 2007).

Reindeer husbandry often lacks clear policy objectives on a national level, other than a broad focus on sustainability. In Sweden, the goal is for reindeer husbandry to remain an ecologically, economically and culturally long-term sustainable practice[23]. In 1988, a suggestion by for the goal of *samråd* was 'the long-term goal of balancing the use of the forest ecosystem resources between forestry and reindeer husbandry'[24]. Today, however, the goal of *samråd* is not stated in either the legislation or the FSC standard. Rather, the notion of coexistence seems to be the underlying assumption.

There have been efforts to agree on joint visions for forestry's consideration of reindeer husbandry, with the aim of securing the access to continuous grazing lands. A working group began addressing this in 2016, but as they were not able to agree on these visions the dialogue between the actors was cancelled in 2017 (Skogsstyrelsen, 2023).

The different levels governing samråd

Similar to the multiple aims, multiple organisational levels also characterise the institutions surrounding *samråd,* with *samråd* regularly governed by

[23] 1999/2000:MJU9; SOU 2001:101

[24] Minutes from Central Consultation Group, dated 1988-08-30, my translation.

higher-level company aims and characterised by multi-level governance[25] (Keskitalo 2008; Keskitalo et al. 2016). Also, when Nils Arell (Lantbruksstyrelsen 1984) describes the relationship between the 'small' reindeer husbandry and the 'great' forestry interests, he introduces the concept of different logical levels. He describes how the forest companies have an advantage in that they can easily switch, or refer, to another logical level in the argument, for example referring to reasons such as employment, requirements from the government, or demands for raw material from the forest industry as motivation for certain forestry practices. An example of this is stressing the impossibility of refraining from final fellings; with this reference to fixed demands for harvesting levels from the forestry side, almost all the room for negotiation that would frame the local *samråd* has now been mortgaged. The other party can then ask themselves what there is to negotiate about, when the harvest level is set and the fellings can at most be subject to marginal changes in time and space.

To be more specific, the different levels can be exemplified in the structure for planning and decision-making in the forestry organisations. The organisational structure of the major forest companies follows the general levels of the hierarchical structure of planning (Courtney 2001). Different parts of the organisations are responsible for the different stages of planning. Strategic[26] forest planning is done centrally, with the final decisions being made by the executive management on the companies' boards. Tactical planning is done by planners in the regional districts or forest management departments, while the production leaders do the operational planning[27] in the districts or production departments (Ulvdal et al. 2023). *Samråd* has traditionally been held at the tactical forest planning stage (Söderholm 2002). Here, the decisions made at the strategic stage limit the available room for negotiation during *samråd* at the tactical planning stage. This is because the

[25] Multi-level governance, defined as the participation of different actors at different levels in decision-making, aims to serve as a term for this complexity, including subnational, national and supranational – as well as private and non-governmental – interests (Marks & Hooghe 2004).

[26] In long-term, or 'strategic', forest planning of the forest resource, the time horizon is often at least one forest rotation. The aim of the planning is to determine general strategies for the forest management and harvest levels, regeneration measures and consideration of nature values over time. Conflicting goals are common in forest management and can be addressed in the strategic forest planning (Öhman, 2001), as in the example of reindeer husbandry and forestry.

[27] The tactical planning uses the goals from the strategic planning to make a harvesting plan for smaller units of land, for five to ten years in future. Operational planning is short-term and schedules the actual forest operations, like harvesting, from a month to about a year ahead of time (Öhman, 2001), also taking into account the demands for timber delivery.

harvesting levels that the tactical planning should deliver are set at the strategic level, hence allowing the planning at *samråd* to only negotiate about the locations of final fellings rather than the amount of harvest.

In summary, the personnel involved in *samråd* is at a lower organisational level than those taking the strategic decisions that determines the long-term forest management strategy. This contributes to the limitations of *samråd* as a policy instrument.

4.4 Samråd as a voluntary policy instrument

In summary, from the judicial perspective, forestry's consideration of reindeer husbandry can be considered voluntary to the extent that the wording 'offered the opportunity for' (20§) does not oblige the forest companies to listen to the reindeer herders' opinions at *samråd*.

As described in earlier sections, offering the RHCs *samråd* is not voluntary. But considering the results of the *samråd* in the forestry actions is to some extent voluntary, according to both the law[28] and the FSC standard, and there is no absolute veto right for the reindeer herders concerning planned forestry measures. When it comes to the outcome of *samråd* and the reindeer herders' influence, *samråd* can be seen as a voluntary policy instrument.

Considering *samråd* between reindeer husbandry and forestry as a policy instrument, there are factors at different societal levels that influence the outcome. This outcome can include actual forestry measures following the local *samråd*, or the development in the long term of the timber/lichen as key resources (strategic level). The state has not taken a stand regarding how to solve the conflict; a reason for this could be, as described by Appelstrand (2007) and Hydén (1984), the fact that the legislator does not want to lock the legal development and take a stand as to how to solve conflicting goals.

[28] For the *samråd* stipulated by law, in the year-round reindeer-grazing areas it is up to the Forest Agency to grant or deny permission for final felling, taking into consideration the consent or non-consent of the RHC.

5. Material and method

5.1 A multidisciplinary approach

The most common view is that knowledge is a *justified true belief* (derived from Plato) (Johansson 2016). Considering my multidisciplinary approach, it is important to grasp the different understandings of knowledge, and the different views of it as based in qualitative and quantitative science.

Epistemology concerns theories of knowledge; in other words, how knowledge is derived. In the social sciences, a distinction is generally drawn between epistemology and ontology, with ontology instead focusing on questions of reality. While ontology is concerned with what we know about the world, epistemology addresses how we can know it (Kant 2014). Considering different epistemologies is useful, particularly in interdisciplinary research, in which different disciplines can have different conceptions of what constitutes knowledge, how it is produced and how it should be applied. For example, in social-ecological research, this can contribute to a more integrated understanding (Miller et al. 2008).

Related to this is the difference between qualitative and quantitative research approaches, which 'stem from two entirely different ontological and epistemological perspectives representing two distinct worldviews' (Slevitch 2011). A qualitative method can be defined as follows: 'A scientific method is qualitative if and only if it aims at the classification of phenomena with respect to categories containing an explicit, or implicit, intentional component' (Johansson 2016). In contrast, a quantitative approach is based on the ontological position that objective reality exists independent of human perception, and the methodology can be described as experimental or manipulative. Objectivity and generalisation are underlying methodological

principles, as is statistical analysis, with sample size being critical in quantitative research.

Similarly, the distinction between the cultural[29] and natural sciences is that they use essentially different methods. The central activity of the cultural sciences is interpretation, for example of texts, events, actions etc., and interpretation always contains a subjective element based on the interpreter's prior understanding and background. In contrast, in the natural sciences objectivity is possible, in the sense that two researchers can agree on an observation irrespective of their backgrounds (Slevitch 2011).

The general model of empirical research is suitable for both quantitative and qualitative research. It can be defined as an organised, systematic and logical process in which empirical information is used to answer questions or test hypotheses (Punch & Punch 2003).

Forming and using theories is a basic component in the social sciences, in order to understand specific components of society. Social theories are often built on or derived from multiple cases, but the complexity of society as a system also means that multiple theories exist. Different theories rely on assumptions regarding the social system, which will vary greatly between the theories (Keskitalo 2021).

Interdisciplinary, transdisciplinary, cross-disciplinary and multidisciplinary science are all varieties that span over disciplines and/or involve engagement with non-scientific actors. A need has emerged to rethink cultures and practices of knowledge production in order to address the challenges of today, such as climate change and natural resource management (Felt et al. 2013).

As *samråd*, as well as the relationship between and the socio-ecological system of reindeer husbandry and forestry (Horstkotte 2013), have components that are suitable to address with both natural science and social science methods and approaches, I use both qualitative and quantitative methods in my thesis (Table 1).

[29] Including the social sciences and the humanities (Kagan 2009; Pskhu & Murga 2018).

Table 1 Overview of methods, materials and main objective as stated in each paper

Paper	Method	Material/Respondents	Main objective
I	Literature analyses and qualitative data analyses through coding	Minutes from Central Consultation Group, grey literature, other secondary sources	Examine and analyse the evolution of *samråd* between 1923 and 2019
II	Statistical analysis and modelling, generalised additive modelling and generalised additive mixed modelling	Data from the National Forest Inventory 1993-2023	Analyse how forest characteristics can predict lichen cover and change
III	Scenario analyses	Data from reindeer husbandry plans and the forest companies' management strategies	Define reindeer husbandry-adapted forestry and compare the effects of this with those of current forestry in a 50-year future
IV	Survey	Participants in an education course on reindeer husbandry plans	Problematise the need for increased knowledge and examine forestry representatives' views of relevant knowledge in *samråd*

5.2 Case study

A case study can be defined as an intensive study of a single unit with the aim of generalising across a larger set of units. While it can be regarded as a method (Gerring 2004), some scholars argue that it is neither a method, nor a methodology, nor a research design (VanWynsberghe & Khan 2007). The case study method is best understood as a way of defining cases rather than a way of analysing them (Gerring 2004). A case study can involve collecting several datasets concerning the case at hand, and a challenge can involve the large volumes of data as well as a temptation to veer away from the research focus (Heale & Twycross 2018).

According to Thomas and Myers (2015), how a case study is defined depends on the research discipline. Ways of understanding a case study can entail, for instance, studying the complexity that is involved in real-life situations, or studying many factors in few cases rather than few cases in a larger number of populations. The significance of an analytical frame is also highlighted: a case study needs to be a case *of something,* which will then constitute the study's analytical frame. Additionally, the introduction of the terms *object* and *subject* can further enhance the understanding of the case study. *Object* can be exemplified as a 'practical, historical unit', while *subject* is the 'theoretical, scientific basis' or the analytical frame. 'Case studies concern an understanding of how and why something may have happened' (Thomas & Myers 2015).

In Paper I, to get a thorough understanding of *samråd*, we explore it since its introduction in 1923 through to 2019, regarding the practice and interpretation of the two land users. The understanding of the concept and the development of the practice is relevant in relation to the unclear purpose of *samråd*. In Paper II, as forestry's impact on ground lichen is the main underlying reason for why *samråd* is needed, we conduct an in-depth analysis of how forestry has affected ground lichen in northern Sweden in the period 1993-2023, in order to find ways to reduce the negative effects. In Paper III, reindeer husbandry-adapted forestry is then applied to a specific study area in the boreal forest of Västerbotten, with the simulation of a scenario analysis for a 50-year future (2020-2070) in order to explore consequences in terms of the outputs of timber production, the economic output for the forest owner and the lichen habitat. Finally, in Paper IV, we conduct an in-depth analysis of a suggested main factor for improving *samråd*, to investigate the role of knowledge in *samråd*, from the perspective of the forest companies. For Paper III, the specific study area is Vardofjällsgruppen in Vilhelmina Norra RHC in Västerbotten in northern Sweden. For Paper II, the study area is the RHA and the area directly south of it, limited by *Limes Norrlandicus* (Wastenson et al. 1996). We include the area south of the RHA to be able to analyse the effect of reindeer grazing. For Papers I and IV, the case study area is the Swedish case of *samråd*. The study area for Papers II and III is shown in Figure 3.

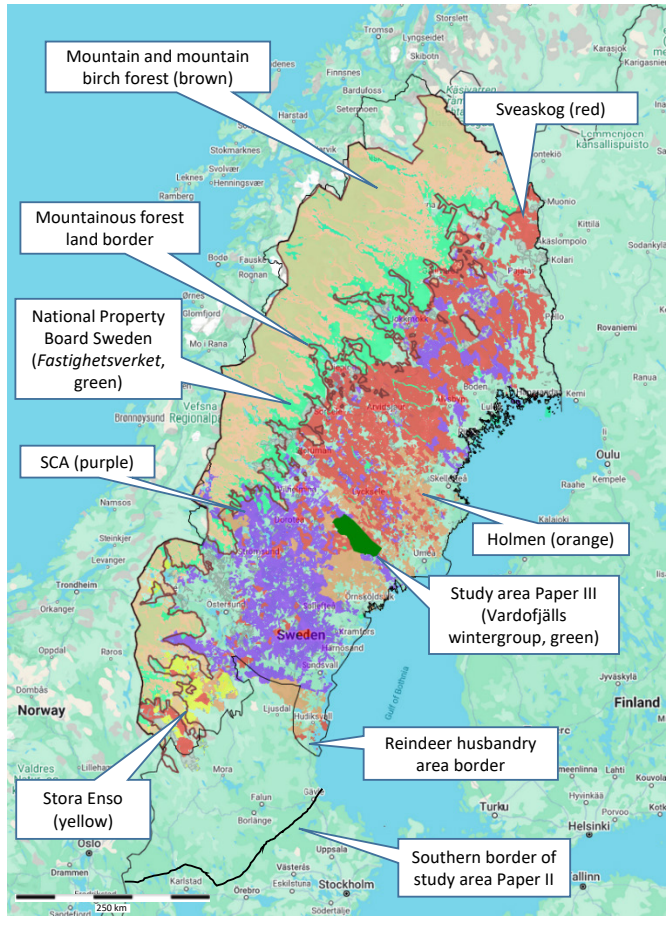

Figure 3. Map of northern Sweden with the study area for Papers II and III, the mountainous forest land border, and the forest owned by the state and the four largest forest companies in the reindeer husbandry area. Data and mapping from RenGIS.

5.2.1 Samråd as a case study

As mentioned earlier, *samråd* is a specific institutional arrangement, in a context that is characterised by power inequalities and unclear legal relationships. For about a century, *samråd* has been an expected approach to handling the conflicting goals of the two land users, with ground lichen being the main underlying resource. *Samråd* has been introduced as a collaborative tool, based on ideas about participation, shared knowledge and understanding. However, I do not understand *samråd* in this way here, as

much of the earlier research has focused on how the tool itself as well as the process can be improved. Instead, I base my understanding on *samråd* being a soft policy instrument, which means that improvements to the process have a limited ability to change the outcome, and that it is rather the factors surrounding *samråd* that determine the outcome.

As this is a case study, the transferability to the implementation of other similar instruments related to *samråd* may be limited due to the highly specific conditions surrounding *samråd*, not least regarding the relationship between the two land users. However, even though the case study might make only a limited contribution to the further understanding of policy instruments in general, for the further understanding of *samråd* as a specific case it is crucial that it be regarded as a policy instrument. In other words, I will use theory by applying it to this specific situation, rather than having the goal of actually contributing to theory. Below I will further describe the two land users and the Swedish context.

The reindeer-herding right (Swe. *renskötselrätten*) is an exclusive right held by the Sami people in Sweden[30]. There are about 4 600 reindeer owners in Sweden, and about 1 000 people working with reindeer husbandry (Sametinget 2024-08-13). Forestry in the RHA employs approximately 4 300 full-time workers, 40% of whom are self-employed and typically work part-time for the small private land-owners (Skogsstyrelsens statistikdatabas 2021). Forestry and the forest industry contribute greatly to the overall economy of Sweden, not least considering the export value of forest products, which was about 9% of the country's total export value in 2023 (Kommerskollegium & SCB 2025). While forestry has much greater economic significance, reindeer husbandry is crucial for the indigenous Sami people and their culture (Sandström 2015; Moen et al. 2022).

In the RHA, 27% of the forest below the mountainous forest land border is owned by private forest companies, while 26% is owned by the state (or state-owned company) and 47% by small private land-owners (Sandström et al. 2016). Often, the small private land-owners owning forest does not have to offer RHCs the opportunity to participate in *samråd*, due to the legislation in the Forestry Act[31]. This makes the *samråd* with the forest companies and

[30] Reindeer husbandry by concession can be allowed in specific areas and cases, with the reindeer owned by non-Sami members of an RHC. However, the right to pursue reindeer husbandry by concession still belongs to the Sami, who holds the permission for the concession (Reindeer Husbandry Act (1971:437)).

[31] If the forestry unit comprises less than 500 hectares of productive forest land, the RHC does not have to be offered the opportunity for *samråd* for final fellings comprising less than 20 hectares, or 10 hectares in

the state more important to the RHCs. The four largest forest companies in Sweden are Sveaskog, SCA, Stora Enso and Holmen. The state owns 82% of mountainous forest in the RHA, while the remaining 18% is privately owned (Sandström et al. 2016). The forest in the RHA owned by the state as well as that owned by the private companies is shown in Figure 3.

Swedish forestry is based on even-aged stand management, and largely delivers raw materials to the forest industries. The industries have developed towards larger units, and towards higher efficiency in the logistics of the flow of raw material (Agestam et al. 2022). This is linked to the forest companies' planning process, which is typically divided into strategic, tactical and operational phases, with *samråd* traditionally being held in the tactical phase (Söderholm 2002).

Only Sami who are members of an RHC have the right to pursue reindeer husbandry[30]. An RHC is both a geographical area for the reindeer herding as well as an administrative and economic organising association for the reindeer-herding companies. There are 51 RHCs in Sweden. Thirty-three of these are mountain herding communities, using the mountains as summer grazing grounds and migrating to winter grazing grounds in the boreal forest. In the ten forest RHCs, the reindeer graze and migrate within the forested areas throughout the year. Therefore, *samråd* is more important for forest RHCs compared to mountain RHCs. In addition, there are eight concession RHCs[30], whose reindeer herding is similar to the forest reindeer-herding practices (Horstkotte et al. 2022a). The RHCs and the year-round grazing grounds are shown in Figure 4. Since the 1990s the total number of reindeer has remained stable at around 225 000, with 280 000 in the winter herd before spring calving (Sametinget 2024-08-13); this can be compared to the period 1900-1990, when the herd fluctuated around 225 000, with some peaks and declines to around 300 000 and 150 000 (Moen & Danell 2003). Thus, the reindeer numbers in Sweden have not declined overall in recent decades, even though the ground lichen resource has.

mountainous forests, of productive forest land within the forestry unit. However, the RHC must be given the opportunity to participate in *samråd* if the felling affects forests of particular importance to reindeer husbandry, such as those that are abundant with tree lichen, resting pastures, working pastures or migration routes, or if the felling is adjacent to other clear-cuts or regeneration forest that together with the planned felling exceeds 20 hectares, or 10 hectares in mountain forests, within the forestry unit. For forestry units larger than 500 hectares of productive forest land, the parties can agree on corresponding relief at the *samråd* (my translation, SKSFS 2015:3).

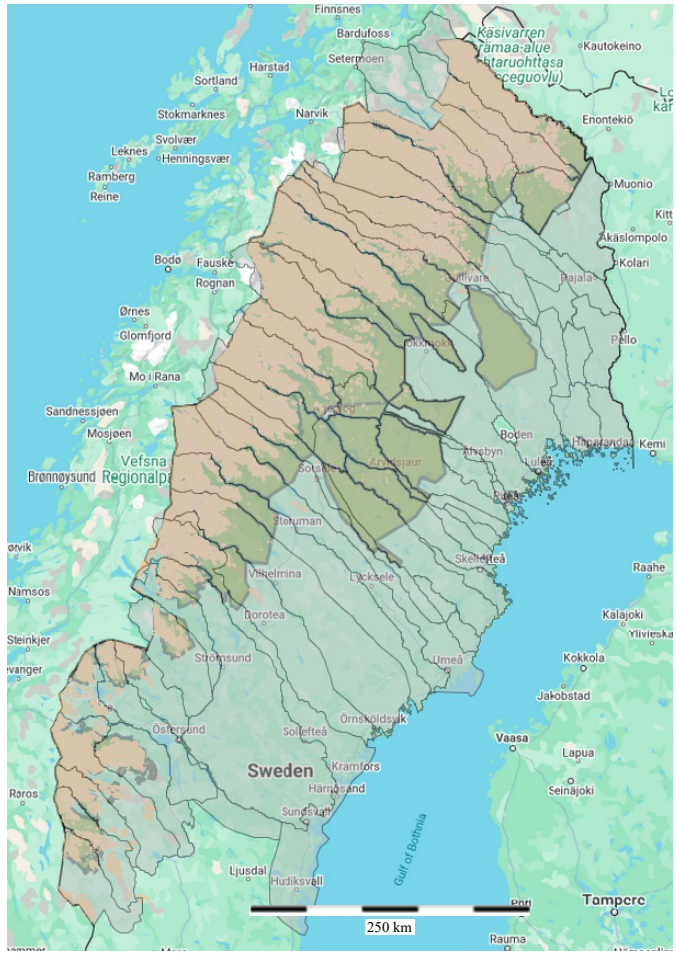

Figure 4. Map of the reindeer husbandry area of Sweden. In the western part, year-round grazing grounds are shown with mountain and mountain birch-area (brown) and forested area (green). The forested year-round grazing grounds are subject to legislated *samråd*. Lines illustrate boundaries of the 51 reindeer-herding communities covering both year-round and winter grazing grounds. Data and mapping from RenGIS.

As reindeer are migratory herd animals, the reindeer-herding year has been divided into and described as eight seasons. These seasons are briefly generalised, with a focus on migration and winter grazing, as follows: late winter with migration to calving grounds; spring with calving season; early summer; summer with calf marking and summer grazing in the mountains, or for the forest reindeer mainly in forests and on mires; late summer with the start of slaughtering season; autumn with the start of migration to the

early winter ranges; and finally winter, starting with arrival at the winter pastures around Christmas. The mountain herding communities can migrate from the coast of the Bay of Bothnia to the mountains in the west along the river valleys, sometimes by foot and sometimes by truck, while the forest reindeer migrate over smaller distances within the boreal forests (Holand et al. 2022). The migration pattern of the reindeer underlines the importance of continuous grazing grounds, with possibilities to migrate both on a more local scale, depending on snow, ice and climate conditions (cf. Roturier & Roué 2009; Horstkotte 2013), as well as the more long-range seasonal migrations. During the course of the year, the reindeer make use of grazing grounds in the forest just below the mountains and along the migration routes, where resting pastures are crucially important, as well as at the different winter pastures (Jougda 2003). During winter, the reindeer graze the ground lichen, digging through the snow (Roturier & Roué 2009). If logging residues cover the ground, the reindeer can be prevented from reaching the lichen beneath them (Helle et al. 1990). Winter grazing is generally recognised as the bottleneck in reindeer husbandry, when the reindeer often lose weight and rely on their fat reserves (Skarin et al. 2022). This is why *samråd* is so important to the RHCs. For the forest reindeer, *samråd* concerning forests where the reindeer can spend the summer season is also critical (Arell 1981). Therefore, *samråd* is of especial significance to the forest RHCs.

The case study area of Paper III covers part of a mountain RHC, the winter grazing grounds of Vilhelmina Norra RHC. This area exemplifies a winter group[32] area, the wintering lands of the winter group Vardofjällsgruppen. The RHCs are organised into different winter groups, which distribute the herding work based on mutual agreements, often between close relatives. This balances the relationship between herders and herd size according to pasture resources and protects their range and grazing rights, in relation to other winter groups' territories (Holand et al. 2022).

5.3 Ethical considerations

Research involving humans always requires ethical considerations. It can involve restrictions, legal requirements or permits connected to the data

[32] In some of the Sami languages: *siida, sijdda, sɪ̈jte*

collection. It can also entail establishing a 'contract' with the studied community, transparency about the research purpose, confidentiality for participants, and consent from the people involved in the study (Bell 2006). More specifically, participants need to be aware that their participation in the study is voluntary, and that they can withdraw without unfavourable consequences; informed consent involves these rights to refuse participation and to withdraw. If a participant is guaranteed anonymity, this means that they cannot be identified by any of their responses. When anonymity is not possible, research subjects should be guaranteed confidentiality. In this case it is possible for the researcher to identify the different respondents, but the researcher promises that their identity will not be revealed in any report, paper or public forum. It is also important that the participants be given information about the study before data collection, to help them decide whether or not to participate. Relevant information includes the study's purpose, who is conducting it, expected outcomes and who will benefit from its results (Bhattacherjee 2019). Responsible ethical research insures that participants are safe from harm and protected from unnecessary stress. In contrast, unethical research almost always leaves participants and researchers feeling vulnerable and exposed in negative ways (Cacciattolo 2015).

Research involving indigenous people like the Sami requires specific ethical considerations. These can involve the inclusion of indigenous knowledge and research methodologies, awareness of indigenous research principles, as well as relating to the concepts 'knowledge', 'decolonisation', 'research' and 'indigenisation'. It is important to be mindful of the cultural interface when we are working with indigenous and Sami studies, and it can be a tool, serving as both a mirror and a lens (Keskitalo et al. 2021). This also relates to how and by whom problem representations and solutions are formulated (cf. Löf et al. 2022). Further, it can be important to consider power relations and reciprocity, as well as relationships with the community members (Keskitalo et al. 2021).

The Sami Parliament's definition of Sami research includes research carried out in consultation with Sami people. In Paper III we consulted representatives from the RHC in the study area. Also, in Paper IV, a few Sami may have responded to the survey as invitees to the education course. The Sami Parliament has four overarching principles in their strategy regarding Sami research: Sami self-determination; de-colonised Sami

research; responsible research and economic resources; and investments in infrastructure (Sami parliament 2025). In my research, the background and prioritisation of the thesis subject's relevance as well as the identification of the impact of the research on the Sami community are important aspects. Also, participating RHCs received economic reimbursement for their consultation for Paper III.

Research on indigenous people, as well as about Sami society, has increased over the last 30 years. In early research the Sami population was considered an object, in line with the social climate and views at the time. Therefore, SSR as well as other indigenous organisations have developed their own guidelines for collaboration and research in order protect their culture and society, as well as to gain increased influence, control and power in this aspect. In the guidelines for research and project collaborations with Sámiid Riikkasearvi (SSR, Swedish Sami Association), SSR emphasises the requirements that researchers have relevant prior knowledge about Sami society and that the starting point for collaboration and research be values that are in line with SSR's mission and values (SSR 2019).

Research ethics in general is about balancing legitimate interests, one of which is that of knowledge. Privacy and protection against various forms of harm and risk of harm are other examples. This raises questions about the handling of privacy-sensitive material, what the researcher can promise participants, and who owns the research material. Beyond the researcher's everyday reflection on the content of one's own research from an ethical perspective is the legislation, including the requirement that certain research must be ethically reviewed and approved by the Ethical Review Authority before it can be carried out (Vetenskapsrådet 2025). Research involving humans or information about humans may be subject to this legislation as it often involves medical research, but other research that involves particular risks in this aspect is also subject to it. The legislation contains aspects involving especially vulnerable persons, information and consent, and the handling, storage and screening of research data. Historical research is also subject to the legislation if it can reveal information about individuals who are alive today, even if the information is available in public records or archives (Görman 2023).

In my thesis and the appended papers, Sami people are not involved in such a way that ethical review is necessary. This is because we have no sensitive personal data in our research. For Paper III, we requested consent

from the RHCs and the forest companies to use their geographical area as a study area, as well as to use their data from RHPs and forest register data as a basis for the study. We also started the project by inviting the participants to a digital meeting and informing them about the purpose and methodology of the study. We adapted the collaboration so that it would be as efficient and consume as little of the participants' time as possible. We held digital or physical meetings or workshops for all stages of the research process: planning the scenarios; anchoring the method; and presenting and discussing the preliminary and final results. For workshops/meetings that required the reindeer herders to dedicate a whole day, they were economically reimbursed for their participation. Considering the working method in relation to de-colonised Sami research we consider that, rather than studying the reindeer herders, we have been doing research together with them, as with the participating forest companies.

In Paper IV, the principles of transparency, confidentiality and consent in the survey were handled as follows. On the first page of the digital survey, participants were given information about the purpose of the survey and informed that it was part of a research project. They consented to participate by submitting the survey, which was voluntary. Additionally, they were informed about the handling of data according to GDPR[33], their right to have their answers deleted, and the storage and archiving of the data. They were also provided with contact information for questions about the survey.

5.4 Materials and methods for appended papers

In the following, I will describe the materials and methods used for Papers I-IV.

5.4.1 Literature analyses and thematic analyses (Paper I)

The main data source for Paper I is all the minutes we were able to gather from the Central Consultation Group (CCG) meetings, from the start of the group in 1971 to 2019. This comprised minutes from 69 meetings, totalling 1 563 pages. In the early part of the period, the records are not yearly. The minutes were analysed using qualitative data analysis.

[33]General Data Protection Regulation

Coding is the starting point in most qualitative analysis of social science data (Bryman 2009). In Paper I the minutes from the CCG meetings were carefully scrutinised, and coding for the analysis was developed over time. We specifically developed codes for representation and procedures in, and issues and outcomes of, *samråd*. We also searched for expressions and statements in which the meanings of *samråd* were explicitly discussed, noting coherence and differing views as well as changes over time.

Science is not value-free (Lekka-Kowalik 2010), and the researcher's preconceptions will always involve a risk of leading them onto the wrong tracks when using qualitative methods. A way to decrease this risk is for two or more researchers to be involved in the planning and/or implementation of a project (Jensen 1991). In analysing the CCG minutes we did not re-code each other's material as a 'safety check'; however, there were two of us who, continuously during the coding, discussed the developed categories.

In regard to the material used, much of it represents the reality described by the secretaries' at the Forest Agency who were responsible for documenting the CCG meeting minutes (previously *Lantbruksstyrelsen*) as well as the conferences in 1970, 1976 and 1982. This might have affected how well the respective argumentation from reindeer husbandry and forestry has been represented, considering that the preconceptions of the secretary primarily involved forestry.

5.4.2 Statistical analyses and modelling (Paper II)

For Paper II, we used data from the Swedish National Forest Inventory (NFI) from 1993-2023. The purpose of the NFI is to follow up on the state of and changes in the Swedish forest, regarding aspects such as land use, trees, vegetation and soil. The novelty of our material is that we use data on reindeer lichen cover, which the NFI continuously measured in integer square meters (Fridman et al. 2014), instead of the categorical lichen cover classes estimated in percentages (<25%, 25-50% and >50%) used in earlier studies (Sandström et al. 2016; Horstkotte & Moen 2019; Uboni et al. 2019). We also use lichen height data, collected by the NFI since 2018. A co-author analysed the changes in ground lichen height in relation to reindeer grazing (within and outside the RHA), as well as lichen coverage in relation to reindeer grazing and forest characteristics.

For the analysis of lichen cover within and outside the RHA, we used a generalised additive model (GAM, Hastie & Tibshirani 1990). A GAM is a

regression method, commonly used for analysing ecological and environmental data (Zuur et al. 2007). When data shows a non-linear relationship, an alternative is to apply a smoothing method such as a GAM. When parametric models like linear regression or general linear models give a poor fit, non-parametric techniques like a GAM are likely to give better results. Here, smoothing curves are used to model the relationship between the response variable and the explanatory variable. In the context of a GAM, a 'smoother' is a flexible function that fits a gentle, curving shape to data rather than a straight line like in standard linear regression. The shape of the curve is not determined by a given number of parameters provided by a data analyst, but is instead optimised following the data. The risk of overfitting was handled by restricting the number of knots in a careful inspection of model residuals and predictive capacity. Additive modelling is a useful data analysis tool for visualising the relationship between a response variable and multiple explanatory variables, 'to let the data speak'. Ecological data is often 'noisy', and (generalised) additive modelling may be the only available tool that can give useful results (Zuur et al. 2007). For the analysis of lichen cover within and outside the RHA, we found no linear relationships and therefore a GAM was the available alternative. However, for the analysis of lichen cover change in relation to forest characteristics we used a general additive mixed model (GAMM, Wood 2017), which allows for auto-correlation and multiple variances in the data (Zuur et al. 2007). The analysis of lichen cover change in relation to forest characteristics was done using data from NFI sample plots that had been visited and inventoried at least three times during the study period. The novelty in the material is that every sample plot was re-inventoried two to four times between 1993 and 2023, and that changes in the total lichen cover of the plots can be analysed in relation to forest characteristics. In contrast, earlier studies have used the plot data to estimate mean values of forest characteristics over many sample plots, which have been related to the lichen cover classes divided into percentages of bottom layer coverage (0-25%, 25-50%, 50-100%).

5.4.3 Scenario analyses (Paper III)

For illustrating the long-term effects of different trade-offs, landscape level scenario analysis can be a useful tool. Scenario analysis can also be used to evaluate different forest management practices, assess potential future developments and provide valuable input for forest governance and decision-

making at different levels (Eggers 2017). It can be used to explore possible, plausible and preferable futures (Bengston et al. 2012). More specifically, it is a common way to analyse and compare outcomes of forest management practices (Peterson et al. 2003). In Sweden, scenario analyses using the decision support system (DSS) Heureka are used for nationwide forest impact analysis and for policy support, and it is also used by all large and many medium-sized forest owners for long-term forest planning (Lämås et al. 2023). In Paper III, we used Heureka PlanWise (version 2.18.3.0) (Lämås et al. 2023) to explore three different forest management scenarios with different considerations made to reindeer husbandry.

Scenario analyses can also be used to build shared understanding, e.g. through the participation of a diverse group of people in a systemic process of collecting, discussing and analysing scenarios (Peterson et al. 2003). In developing our scenarios for Paper III, we consulted representatives of the forest companies and the RHCs in the specific study area, although at separate meetings for the two land users. At the first meeting, the reindeer herders presented their 'dream scenario' for the study area. An example of an adjustment that was made following the consultation with the forest companies was that we first suggested a reference scenario based on conventional, economically optimised methods. However, the consulted forest companies felt that the reference scenario should rather represent the actual current forest management in the area, in which considerations were already made to reindeer husbandry based on *samråd*. The final results of the study were also presented and discussed with the representatives.

An important factor involves what assumptions you use in the DSS. We based our indicators for the reindeer husbandry-adapted scenarios on earlier studies (Jonsson Čabrajič et al. 2010; Horstkotte et al. 2011; Boudreault et al. 2013; Sandström et al. 2016; Horstkotte & Moen 2019; Horstkotte & Djupström 2021; Rikkonen et al. 2023) as well as our own analyses from the NFI data that was available at SLU (Paper III, Appendix).

A disadvantage with our method is that Heureka does not offer the possibility to simulate ground vegetation growth, such as lichens, meaning that we could only measure lichen habitat, based on site factors and forest characteristics. Therefore, is important to keep in mind the time aspect for lichen growth from a lichen restoration perspective. Also, an important factor for the results in terms of economic output as net present value (Faustmann 2018) is the discount rate that is used. When the Forest Agency values forest

properties it uses a discount rate between 2.5 and 2.8%, with the lower rate typically used in northern Sweden (Hansson et al. 2016). We used 2.5% as the discount rate in our study. Changed prices due to changes in market demands would also change the economic output; for example, higher demand and a higher price for pulp wood would make the difference smaller between current and reindeer husbandry-adapted forestry.

An advantage to using Heureka PlanWise as a tool for visualising the effects of a reindeer husbandry-adapted forestry is that it is used by the forest companies in their actual long-term planning. This makes the method and the indicators easily transferrable to be used in practice.

5.4.4 Survey (Paper IV)

Paper IV is based on a survey among participants registered for an education course on RHPs. In survey studies, it is possible to use both qualitative and quantitative approaches.[34] The survey process can be divided into three steps: data collection; analysis/processing; and interpretation. All three steps can use qualitative/quantitative approaches in different combinations, and this is almost always the case when using survey as a method. In this regard, scale types for data collections are of interest. In a qualitative approach, a nominal scale is often used to categorise and find patterns in the material. Numerical comparisons between different values on a nominal scale are not possible, for example in the case of different sexes on a nominal scale. An ordinal scale can be ranked as having more or less of a certain property. However, the steps on the scale cannot be said to have a certain size, for example in the case of the ECTS grading system of A, B, C, D, E, FX and F. On an interval scale, the data is ordered into a hierarchy with equal steps in between, but with no given zero-point; the Celsius scale is the most common example of this. In contrast, the quotient scale is an interval scale with a fixed zero-point, which allows for adding, subtracting and multiplying as well as dividing when processing the data (Trost 2007; Johansson 2016).

In Paper IV we use a combination of a qualitative and quantitative approach, which offers the possibility not only to draw conclusions on the population in general but also to find explanations for them. In order to calculate a mean value to enable comparisons between both different questions as well as the same question before and after the education course,

[34] For definitions of qualitative and quantitative methods, see Section 5.1.

a quotient scale is used for many of the questions. In this way, we can say how the participants' knowledge varies between different subjects and how it has changed due to the course. However, in some cases in the analyses we have presented the results as representing an ordinal scale. By allowing the possibility to give free-text answers, we can also analyse the course participants' reasoning and reactions.

Questions about sample, population and dropout are often crucial in survey design and analysis. A sample is a smaller subset drawn from a larger group, in which the larger group is the population. In the case of Paper IV, the survey was sent to all participants registered for the course. The target group was officials active in issues regarding the relationship between reindeer husbandry and forestry not only at the forest companies, but also the Forest Agency and other actors primarily involved in *samråd*. Some reindeer herders also participated. The digital survey was distributed via a link in an email. Thus, it was not distributed to a sample of participants but rather to the whole population of participants. When it comes to dropout, of the 92 registered participants, 88 started the survey and 64 finished all questions. For the second survey after the course, 68 participants started the survey and 38 finished all questions. One participant registered late and only got the second survey, bringing the total number of participants to 93 for the second survey. We have not analysed the dropout group in relation to those who finished the survey, considering the high response frequency.

The survey was distributed by the service provider Netigate. A unique link was sent to every participant, which enabled reminders to be sent to those who had not answered. A respondent-unique ID was connected to the answers; this was not connected to the email address of the respondent, however, which meant that it was not possible in the analyses to connect specific answers between the first and second surveys.

The respondents were informed that the survey was part of a research project. They were also informed about the handling of data according to GDPR, their right to have their answers deleted, and the storage and archiving of the data.

The free-text responses were coded by a co-author under themes that were developed inductively in relation to the responses to specific questions in Survey 2.

6. Paper summaries

This chapter presents the respective situation, main results and conclusions from the four appended papers.

6.1 Paper I - *Samråd*: an institutional arrangement in the context of forestry and reindeer husbandry in northern Sweden

In Paper I, we asked how *samråd* has been interpreted by the actors (reindeer husbandry and forestry) and how the practice of *samråd* has evolved over its almost hundred years of implementation. We considered the national level of the CCG to serve as a proxy for the local *samråd*, as regional reporting was standard at every meeting. *Samråd* was discussed in relation to participatory planning and power in order to provide a thorough understanding of the concept. We examined how the concept and practice of *samråd* have evolved with respect to understanding and mutual consideration. Power inequality is one of the shortcomings of the institutional arrangement. *Samråd* in relation to power was discussed with a focus on the transformative potential in relation to overall issues of functioning coexistence and sustainability.

Regarding representation at the CCG meetings, results showed that the number of forestry representatives doubled over the period 1971-2019, mainly at the expense of authority representatives. We interpret this as corresponding with forestry being the dominant and more powerful actor. Regarding issues taken up at CCG relating to the procedure of *samråd*, we found that documentation, information well in advance, the involvement of the Forest Agency and how well *samråd* worked in the different regions have been recurrent issues. Other recurrent issues raised in relation to *samråd*

include reindeer negatively affecting forestry and methods for assessing this, economic compensation to reindeer husbandry for lost grazing resources, landscape perspective and mapping, follow-up on forestry's consideration in regard to reindeer husbandry, and different forestry measures such as soil scarification, pre-commercial thinning, thinning, fertilisation and planting of *Pinus contorta*.

Our results show that no common, unambiguous understanding has been reached concerning the concept of *samråd* or its expected outcomes, when it comes to the long-term goal of balancing the use of the forest ecosystem resources between forestry and reindeer husbandry. Forestry sector representatives believe that *samråd* is constructive and has increased in importance, while reindeer husbandry representatives believe that *samråd* has increasingly come to involve simply receiving information from the forestry sector. Reindeer herders experience a lack of influence. Training efforts for the parties and the development of RHPs as a tool for *samråd* have facilitated *samråd*, and the implementation of the FSC standard in 1998 clarified the *samråd* procedure. However, the overall conditions for reindeer husbandry have not improved.

Forestry's position as the dominant and more powerful actor is demonstrated in the increasing share of forestry representatives at the CCG, and in the fact that the procedure of *samråd* between forestry and reindeer husbandry does not meet the reindeer herders' expectations with respect to negotiations, trade-offs, and shared decision power. This expectation can be related to the meaning of the concept in the local democratic culture, as well as its lexical definition. In addition, goals for lichen-rich forests with respect to forestry practices and non-sustainable levels for the survival of reindeer husbandry have not been discussed. The idea of coexistence, although never specifically defined or realised, seems to assume that forest industry and reindeer husbandry will sufficiently consider each other's interests and claims by staying properly informed. Finding this balance corresponds with the general Swedish forest strategy of 'freedom with responsibility'. In this regard, the wording of the considerations and adaptations in the Forestry Act is crucial (SFS 1979:429, §31). However, the lack of definitions and clarifications of these considerations has frequently resulted in a focus on final felling, soil scarification, *Pinus contorta* plantation and fertilisation. A major shortcoming in this regard, even though it has been an issue since 1971, are the limited methods for a systematic evaluation of the

considerations as well as of the trends regarding the amount and distribution of key resources. Thus, the shortcomings even after decades of *samråd* can be seen in the trends of the key resources at stake. These confirm the concerns and observations voiced by reindeer husbandry representatives in the CCG regarding exceedingly limited possibilities for sustainable and balanced coexistence.

Samråd assumes that reindeer husbandry and forestry should coexist and learn from each other, and thereby make adequate considerations. However, this arrangement ignores the fact that the power relations between the parties are not equal, and further assumes that the dominant party would voluntarily give up power (Sandström & Widmark 2007b). Our main conclusion is that the power has remained with the forest industry, and that without a clarification of how the total amount of the key resources within the common ecosystem can be secured, a sustainable and balanced coexistence between forestry and reindeer husbandry will be hard to achieve.

6.2 Paper II - Ground lichen cover and response in relation to forest characteristics and reindeer grazing in Sweden 1993-2023

In Paper II, we investigated the lichen cover and height changes in northern Sweden, and searched for factors in forest characteristics which explain these changes. First, we compared the overall change in lichen cover for the area within the RHA, to the part of northern Sweden directly south of it. The two areas have similar forest conditions (Paper II, Appendix), but no reindeer grazing takes place in the southern area. We found declining trends both within and outside the RHA between the years 1996 and 2015, and no trend thereafter. The total lichen cover change in 1996-2021 was 58% within and 40% outside the RHA. The similar trends outside and within the RHA indicate that reindeer grazing is not a major factor behind the lichen decline. In contrast, we found a significant difference in the mean lichen height, which was 3.9 cm within and 7.2 cm outside the RHA[35], showing the effect of reindeer grazing.

Because of the similar change in lichen cover within and outside the RHA, the results were based on combined data from both areas. For forest

[35] The mean weighted lichen height over the years 2018-2023

aged 40-80 years, we found that a forest age over 50 years and a basal area over 16 m^2/ha reduced lichen cover, while a canopy cover between 40 and 60% increased cover.

Descriptive data from the analysed revisited sample plots showed that a lichen decrease was more common than no change or an increase over the study period, for all age classes of forest. However, relative to the other age classes, a lichen cover increase was most common for plots that had been clear-cut over the study period. Of the plots that had been clear-cut, 41% had an increase in lichen cover while 48% had a decrease (n=141).

Because of the large total decline in lichen cover over the study period, we also investigated explaining site variables for lichen cover, for instance as a basis for possible restoration measures where the ground lichen had disappeared. To this end, we analysed lichen cover data from 1993-1997, for which we had a much larger sample of plots with lichen cover compared to the end of the study period due to the total lichen cover decline. Significant variables explaining lichen cover in 1993-1997 were proportion of pine (>48%), site index (<19), wetness index (<10.3) and basal area (<15 m^2/ha). There was a negative effect for a basal area over 30 m^2/ha; however, basal area as explanatory variable had a very low explained deviance. Of the total explained deviance (37.2%), proportion of pine explained 59.4%, site index 34.5%, wetness 4.4% and basal area 1.8%.

Our results support previous findings that there are good possibilities for increasing lichen cover through adapted forest management. A basal area below 16 m^2/ha at lichen habitat, determined by site index and wetness index, will increase lichen cover for forest in the age class of 40-80 years. Lichen cover increase has primarily occurred in clear-cut forest and forest <40 years of age between 1993 and 2023. A suggestion for future studies is an examination of how forest management measures for these age classes can predict lichen cover change. The results of this study can contribute to a further knowledge basis for policy decisions, forest management planning and local *samråd* between reindeer herders and forest companies in order to increase and restore lichen cover.

6.3 Paper III - Adapted forest management to improve the potential for reindeer husbandry in Northern Sweden

In Paper III, we asked how a continuation of current forest practices would affect conditions for reindeer husbandry. We contrasted this by asking how much reindeer husbandry-adapted forestry could improve conditions for reindeer husbandry. The effects of different forest management practices were compared in relation to wood production, economic output for the forest owner and area of lichen habitat. Our analysis and comparisons were carried out for the period 2020-2070.

We built scenarios for a study area of 161 454 hectares in the RHA. Cooperating forest companies in the area provided stand-based information as input data regarding forest conditions for the scenarios, and the actual current forest practices were used for the business-as-usual scenario. We defined two different scenarios with reindeer husbandry-adapted forestry, one focusing on ground lichen and the other on both ground and tree lichen. The main adaptations made in the ground lichen scenario were: maintenance of low basal area in pine-dominated forests with a site index (SI) of 12–20 on dry or mesic sites; adapted pre-commercial thinning and thinning; careful or no soil scarification on ground lichen habitat and natural regeneration on the least fertile sites; removal of *Pinus contorta* stands in important grazing areas[36]; no fertilisation; and finally, maintenance of good visibility in reindeer corridors and 10% left as retention patches at final fellings. In the ground and tree lichen scenario, the main additional adaptations to tree lichen were an increase to 20% retention patches in stands larger than 9 ha. Also, continuous cover forestry was added as a management strategy for uneven-aged spruce forest on 2.2% (2 496 ha), and prolonging the minimum final felling age by 30% was added as a management strategy for even-aged spruce forest on 10.5% (12 148 ha) of the study area.

We found that when current forest practices were continued, the area with ground lichen habitat decreased by 52% between 2020 and 2070, from the present 27% of potential ground lichen habitat to only 13% at the end of the

[36] At *Pinus contorta* dominated stands in a reindeer corridor, key or core grazing area - Remove and replace with Scots pine when *Pinus contorta* is 30 years old, maintain low basal area in Scots pine forest, At *Pinus contorta* dominated stands with SI≤20 on dry and mesic sites - Remove and replace with Scots pine when *Pinus contorta* is 55–60 years old, maintain low basal area in Scots pine forest

period. With reindeer-adapted forestry, the area with potential ground lichen habitat increased by 22% (from 27% to 35%). The forest area with adapted management for reindeer husbandry was 62% of the total productive forest area, of which 27% was pine forest with an SI of 19-20. Net revenues were 10% lower for the ground lichen scenario compared to the continuation of the current forestry.

The results from Paper III are only a limited example from a specific geographical region, but can serve as an example of how to use the system in specific regions or for a larger geographical area. Linked to the possible generalisation of the results is an analysis of the representativeness of the study area compared to the RHA as a whole. The study area had a larger share of young forest and a lower mean age compared to the RHA as a whole. The implications of this in generalising the results would be a greater potential to achieve lichen habitat through forest measures, without overly negative economic consequences. Therefore, the difference in net present value would likely be higher if the starting point were a forest with a higher mean age. This is because the negative economic consequences of a lower basal area would be greater in a mid-aged or mature forest, compared to a young one. The economic effect of a higher mean age on the ground and tree lichen scenario would probably have been higher, as the majority of the adaptations in this scenario were done at final fellings. Besides age, many other parameters would have to be considered in generalising the results – mainly the area of *Pinus contorta* and pine-dominated forest with SI 12-20 for the ground lichen scenario and, for the ground and tree lichen scenario, also the area of spruce forest and the area in question for final felling during the study period.

6.4 Paper IV - The state of knowledge in the forest sector regarding reindeer husbandry issues. Can knowledge contribute to better consultation?

In Paper IV, we problematised the historic long-term demand for increased knowledge as an important measure for improved *samråd*, investigating: i) the perceptions of participants from the forest sector regarding relevant knowledge related to samråd and, in relation to this, ii) the role of the RHP as a tool for facilitating samråd. A survey was conducted among participants at this education course, arranged by the Sami Parliament, with the main

invitees being forest employees working with *samråd*. The answers were analysed in relation to the framing of knowledge, views on relevant knowledge and different types of knowledge.

Framing is a concept that describes how knowledge can be understood and formed differently among divergent groups and interests. Further, framing highlights how a problem can be formed or expressed differently by different groups.

Results show that most of the participants regarded their general knowledge about reindeer husbandry as neither poor nor very good, and the specific areas in which they perceived that they had the most knowledge involved ground lichens and the basic conditions and rights of reindeer husbandry. The representatives expressed a great need for increased knowledge about reindeer husbandry, RHPs and the impact of forestry on reindeer husbandry, and perceived that they had mediocre previous general knowledge in these areas.

Since 1954, the notion of a need for more knowledge can be noted in the material regarding coexistence and consultation between reindeer husbandry and forestry. In 2004, both the RHCs and the forest companies regarded knowledge as the most important criterion for improving consultations (Sandström & Widmark 2007). According to our results, in 2020 the forest company representatives regarded knowledge as the second most important criterion and trust as the most important.

Results from Paper IV show that a major challenge in the forestry representatives' work with reindeer husbandry issues was the relationship between the objectives of the two sectors, which was graded a median 5 on a scale with integer numbers from 1 (no challenge) to 6 (serious challenge). This is in contrast to earlier results from 2007, in which both RHCs and forest companies found objective (defined as 'the two stakeholders hav[ing] the same objective on how the forest resource should be managed' (Sandström & Widmark, 2007, 32)) to be a less important criterion for improving *samråd* than knowledge, trust, result and material. In relation to the study mentioned earlier there is also an indication that the reindeer herders' influence at *samråd* has increased since then, according to the forest representatives' perceptions.

The free-text responses of the survey revealed that the education course had offered different content than the participants had expected. It had provided too little 'factual' knowledge regarding RHP; how it was, and could

be, used; and issues of perceived relevance to forestry. In contrast, participants felt that there had been too much content on basic conditions and rights of reindeer husbandry, including the negative effects of modern forestry on reindeer husbandry.

We interpret the discrepancy between the expected content of the course among the forest representatives on the one hand and the actual content designed by the Sami Parliament on the other as a result of different framings of knowledge. Thus, the forestry representatives' framing of the underlying problem in the relationship between reindeer husbandry and forestry differed from that of the course organizer. The different understandings of what knowledge is and which knowledge is relevant at specific levels problematise the historic long-term general demand for increased knowledge as an important measure for improving *samråd*. In their free-text responses the course participants conveyed that they expected a focus on how to promote cooperation, and highlighted the importance of physical meetings for enabling discussion and exchange of thoughts. This can also be related to the historic emphasis on knowledge and understanding as a means for improving the very process of *samråd*. On the other hand, the course organizer addressed the underlying issues of rights distribution and basic rights between the two land users. These issues are determined at another level than the one represented by the participants at the course, which may be a reason why they did not find this part of the course relevant. It also exemplifies the different framings of relevant knowledge between the two parties.

7. Findings and discussion

In the following chapter I will first summarise my findings in relation to Research Questions 1-4, and then discuss my findings in relation to my aim.

7.1 How has *samråd* worked historically and into the present as an instrument for influencing the development of key resources between reindeer husbandry and forestry? Papers I & IV

Results from Paper I show that no common, unambiguous understandings have been reached concerning the concept of *samråd* or its expected outcomes. Although all parties agree in principle that it should be more than simply a forum for providing information, reindeer herders experience a low degree of influence, and forestry has persisted as the dominant actor. Over time, there has been a lack of definitions and clarifications regarding the considerations from forestry towards reindeer husbandry in relation to the key resources. Although this has been an issue for decades, the methods for systematically evaluating the considerations, as well as the trends in the amount and distribution of lichen as a key resource, seem to be limited.

Thus, *samråd* as an instrument does not seem to have safeguarded the development of the key resource for reindeer husbandry over the period 1923-2019, in relation to the timber development. A main reason for this seems to be that the power has remained with the forest industry. Also, there is a need for clarification regarding how the total amount of the two land users' key resources within the common ecosystem should be secured.

According to the theoretical framework of the thesis, another reason why *samråd* has not safeguarded the lichen development seems to be that *samråd* can be considered a weak policy instrument, lacking sufficient supporting

factors. While it can be seen as an imperative instrument in the sense that the forest companies have to offer it according to legislation, its outcome – the level of consideration of the needs of reindeer husbandry – can be regarded as voluntary. Even though the *samråd* process is defined in detail by FSC, including procedures and instances for handling cases in which the prescribed process has not been followed, the outcome and minimum level of consideration are not defined by FSC or the legislator. A stipulated minimum level of consideration could be a possible way to secure the key resource development.

The power asymmetries between the two land users also seem to have resulted in a forestry-oriented framing of what knowledge is relevant and sought-after, regarding for instance the resource development in relation to how the dialogue and cooperation can be improved (Paper IV). However, as discussed in relation to the linear model of knowledge, new knowledge seems to have a limited possibility to alter the outcome of *samråd,* since knowledge does not automatically alter actions or policy, but is rather influenced by power.

7.2 How has forestry affected ground lichen as a key resource for reindeer husbandry, and how can the negative effects on ground lichen be reduced? Paper II

Results from Paper II confirm earlier findings of a decline in ground lichen as a key resource for reindeer husbandry. Between 1996 and 2021, the total lichen cover of the RHA declined by 58%. Basal area was a main explaining factor for the lichen cover change, and considering the general increase in basal area in the forests of northern Sweden in recent decades (Paper II, Appendix), results indicate that forestry can be considered a main reason behind the lichen cover decline. However, the declining lichen trend levelled out between 2015 and 2023 both within and outside the RHA. To reduce the negative effects, measures for preventing dense forests with a basal area over 16 m^2/ha for forests aged 40-80 years are important in lichen habitat. Lichen habitat can be defined as forest with mainly pine[37], a site index <19 and a wetness index <10.3. In other words, mid-aged pine forests that are relatively

[37] Pine >48% of volume.

dry and not highly productive should be kept quite open. This can be accomplished primarily through more intense thinning and pre-commercial thinning than is practised in conventional forestry.

While the densification of Swedish forests seem to have affected ground lichen negatively, we found that forestry measures can affect lichen coverage positively. Of the sample plots in the data, an increase in lichen cover was primarily found at those that had been clear-cut during the study period. Consequently, forestry can also have positive effects on lichen coverage. It is important to further investigate what determines whether forest regeneration measures have a positive or negative effect on ground lichen cover. Such measures can include soil scarification methods and treatment of residues from logging.

7.3 What constitutes a reindeer husbandry-adapted forestry, and how can its effects on the key resources of forestry and reindeer husbandry be estimated? Paper III

In the ground lichen scenario of Paper III, we exemplify what reindeer husbandry-adapted forestry could entail. In addition to the consideration of ground lichen, it also includes specific considerations regarding visibility in reindeer corridors, and leaving retention patches at final fellings to allow for tree lichen dispersal from them. The main adaptation in the ground lichen production-focused management strategy was to maintain a low basal area through adapted plantation, pre-commercial thinning and thinning, and to increase minimum felling age and pile up harvest residues. This was applied in pine-dominated forest on dry and mesic sites, with a site index of 12-20. Also, further adaptations were made at *Pinus contorta* stands. Examples of other adaptations that were made include no fertilisation, careful or no soil scarification on ground lichen habitat, natural regeneration on the least fertile sites and 10% left as retention patches at final felling.

For our example study area, scenario analyses for a 50-year future showed that future forestry with adaptations to reindeer husbandry could increase the area of lichen habitat by 22%. These adaptations came with a decreased profit of a net present value for forestry that was 10-13% lower than continuing the current forestry, which would have resulted in a 50% decline in lichen habitat.

Results show how scenario analyses can be used as a method for estimating the long-term effects of reindeer husbandry-adapted forestry on the key resources of forestry and reindeer husbandry. The effects of different forest management strategies are compared in relation to wood production, economic output for the forest owner and the area of lichen habitat. The results also provide an example of how a continuation of current forest practices can negatively affect the development of ground lichen.

7.4 What is the role of knowledge in the *samråd* situation? Paper IV

Since as early as 1954, the notion of a need for more knowledge can be noted in the material regarding coexistence and consultation between reindeer husbandry and forestry (Sandström & Widmark, 2007; Skuncke, 1955; Paper I). Results from Paper IV show that in 2020, forestry representatives engaged in *samråd* considered knowledge to be the second most important factor for *samråd*, and trust the most important. Thus, knowledge was considered less important than trust in this study than in one from 2007 (Sandström & Widmark 2007). About half (54%) of our participants felt a need to increase their general knowledge about reindeer husbandry issues, while 64% stated that their employer wanted them to increase their knowledge. Previous general knowledge about reindeer husbandry varied. The main source of knowledge about reindeer husbandry came from contact with reindeer herders. Lack of a knowledge base regarding reindeer husbandry for forest planning was not perceived as a great challenge in *samråd*. The need for different types of reindeer husbandry-related knowledge was perceived to be fairly high, and highest for the parts connected to the RHPs, which indicates an interest in factual knowledge. Seventy percent believed that a planning tool that shows changes in lichen availability as a result of different management strategies (as in Paper III) would be helpful in facilitating *samråd.* The free-text responses revealed a dissatisfaction among participants with the knowledge provided about the historical negative impact of forestry on reindeer husbandry, as well as 'injustices' in the past[38]. More knowledge about the 'forestry side' and how to increase cooperation and dialogue was also requested.

[38] As expressed by a respondent, my translation.

Results highlight the role of different framings of knowledge in *samråd*. The framing of the problem of reindeer husbandry vs. forestry differed between the course organizer and the forestry representatives. The different understandings of what knowledge is, and which knowledge is relevant at specific levels, problematise the historic long-term general demand for increased knowledge as an important measure for improving *samråd*. Considering Habermas's and Foucault's understandings of knowledge related to power, and the linear model of knowledge, I conclude that the role of knowledge in *samråd* seem to have been overestimated over the years – mainly due to the uneven power balance between the actors. Also, educating and informing the forestry representatives who are active at the local level of *samråd* seems to offer few possibilities for enacting actual change, as long as the strategic decisions are made at a higher level.

7.5 Achievement of aim and my contributions

In regard to my aim, reindeer husbandry-adapted forestry could contribute to a more balanced development with an increase in ground lichen in relation to wood production, according to scenario analyses from Paper III. A way to achieve this is could be through strategic decisions about reindeer husbandry-adapted forestry based on scenario analyses being made at a higher level than the local *samråd*. However, probably, for this to happen there would be a need for a great deal of support from other factors as well. How my results can contribute to facilitating these decisions and the implementation of *samråd* as a policy instrument will be further elaborated on below.

In relation to previous studies, my results contribute by suggesting an understanding of how *samråd* has developed since its introduction in 1923 (Paper I). Similar to earlier studies (Sandström & Widmark 2007; Widmark 2009a), the power asymmetries were found to be a reason for why reindeer husbandry finds itself on the losing side, regarding the key resource development. Also similar to earlier studies, it was found that changes to the institutional framework are needed regarding, for example, legislation and policies at the national and organisational levels. An important finding was the need for clarification concerning how the total amount of key resources within the common ecosystem can be secured. Further, the findings involving lichen cover change in relation to forest characteristics (Paper II)

were similar to those from earlier studies (Horstkotte & Moen 2019; Uboni et al. 2019; Tonteri et al. 2022). However, the levelling of the lichen cover decline in 2015 was a new and unexpected finding. While the results from Paper III were in agreement with those from earlier studies (Korosuo et al. 2013; Horstkotte et al. 2016; Miina et al. 2020), we conducted a more thorough assessment of the effects of extensive considerations at a whole winter group area, which has not been done at this scale before. We used the RHP data as a basis, and made considerations, for instance, in reindeer corridors and such as removal of *Pinus contorta* stands, considerations that have not been made in earlier studies. We also developed new lichen indicators that are more specific than in earlier studies, which can easily be used in regular forest management planning, making it possible to assess the impact of management choices on the lichen potential. Hence, using the RHP as a basis for the scenario analyses was a novelty, as were the developed lichen indicators. The findings from Paper IV deviate from previous studies (Sandström et al. 2006; Sandström & Widmark 2007), regarding the earlier emphasis on increased knowledge as an important factor for improving *samråd*. Rather, I conclude that the role of knowledge in *samråd* seem to have been overestimated in the past, and that framing of knowledge is relevant in this regard. The relevance of the new findings from Papers II and III, however, should be considered in relation to the limitations of *samråd* as a policy instrument and how it is connected to its implementers' understanding, ability and willingness.

Considering the contribution of my results for the implementation of *samråd* as a policy instrument, evaluating the effectiveness of policy means looking into whether it actually achieves the benefits it is supposed to achieve (Nagel, 1986). In this regard, the lack of objectives for *samråd* and coexistence between reindeer husbandry and forestry is problematic for the evaluation; not least considering *samråd* as a policy instrument, with policy instruments being the means chosen for achieving policy goals (Chandler & Atkinson 1983).

I consider *samråd* to be a weak policy instrument due to the absence of supporting societal and political pressure, media reporting, monitoring and follow-up, and no threatening regulatory structure to support it. Thus, seeing *samråd* as a policy instrument allows me to understand why its effect has been limited. Crucial for implementation, especially of weak policy instruments, is the implementing actors' understanding, willingness and

ability (Vedung, 1998), in which understanding refers to the participants' understanding of what is expected of them as well as their comprehension of the meaning of rules and regulations. Here, the unclear objectives of *samråd* would be a problem for the actors' understanding of its very purpose, which has also been noted in previous studies (Widmark & Sandstrom 2012). In the following sections I will relate my results to increased understanding, ability and willingness. To enable a more balanced development of the key resources, there seem to be a need for all of these three factors to be increased. In other words, for instance, implementing reindeer husbandry-adapted forestry in strategic planning would require not only an understanding of but also an ability *and* a willingness for this among the decision-makers at the forest companies. Considering the power relations between the two actors and the economic consequences that implementing reindeer husbandry-adapted forestry seem to have on forestry, the supporting factors surrounding the *samråd* policy instrument would probably need to increase in strength for this to be likely to actually happen.

Related to not only understanding but also willingness and ability is the fact that reindeer husbandry-adapted forestry only encompasses silvicultural methods that are already in use by the forest companies today.

7.5.1 Understanding

My results can contribute to an increased understanding of what forestry considerations that would be needed in order to change the long-term development of the lichen resource (Paper III). Additionally, more detailed knowledge of how forestry affects ground lichens (Paper II) contributes to increased understanding regarding cost-efficient considerations that can be made to reindeer husbandry.

My results can also increase the understanding of the power perspective between reindeer husbandry and forestry, the past and present institutions of *samråd* connected to the long-term development of the key resources, and what could contribute to or limit the possibilities *samråd* offers for changing the development.

Increased understanding among the different implementers in the institutional system of *samråd* can be important. However, for change to be possible, understanding needs has to be accompanied by ability and willingness. Increased understanding among the decision-makers at the forest companies is the most obvious example, but among policy-makers

such as the decision-makers at FSC, this understanding could also, for example, allow for extended requirements for *samråd* in the next FSC standard. However, this would depend on the institutional conditions and power relations, for instance political pressure to increase the considerations made to reindeer husbandry. One way to implement my results would be to adopt a requirement of a minimum level of consideration in the FSC standard; an example of this could be that the total ground lichen cover would not be allowed to decrease for any RHC.

7.5.2 Ability

The ability to enact a change in the output of *samråd* can be connected to the different levels for decision-making at the forest companies. *Samråd* is, and has historically been, part of the tactical forest planning at local or regional level. However, this tactical planning relies on decisions made at a higher level, concerning general forest management strategies and long-term goals for the output. The tactical planners at *samråd* have simply not had the ability to make decisions that can alter the long-term opposite development of the key resources. Similarly, the RHCs have not been able to influence the long-term development due to the level of *samråd*. Rather, decisions about trade-offs between the two key resources would have to be made through policy decisions and/or strategic planning decisions by the forest companies' boards. The ability for this has been strengthened through the demonstration of the scenario analysis tool. Decisions at the strategic level can have the potential to contribute to a changed long-term development of the key resources, through the adoption of certain adapted forest management strategies. We also show that the possible ability that the companies can have to make considerations that would increase ground lichens, as the forestry methods would be the same as the conventional ones, but with different timing and intensity. However, as these considerations would have a negative effect on the economic profit of forestry it would be dependent on other factors, not least willingness in combination with ability.

More specifically, the use of scenario analyses demonstrates the possibility to estimate the outcome of strategic planning in terms of lichen habitat and wood production/net revenues. Scenario analysis could be used as a tool by forest companies to incorporate the needs of reindeer husbandry into their long-term forestry planning. This could be done through the inclusion of the reindeer herders' tool for strategic planning, namely the

RHP, but would require a change to the factors that are normally included in the forest companies' strategic planning. As the *samråd* procedure is time- and resource-consuming for both parties (Widmark, 2019; Widmark & Sandstrom, 2012), adopting a certain long-term management strategy with considerations made to reindeer husbandry could to some extent increase the ability to replace the local *samråd*. However, local adaptations will always have to be considered. While local *samråd* involves negotiation about single stands, strategic decisions could deal with management strategies for the whole company's property, and policy decisions could affect all forest companies in the RHA. Similarly, while local *samråd* primarily deals with management activities concerning the coming year, strategic and policy decisions would cover a longer time frame. Carrying out *samråd* earlier in the forest companies' planning process has previously been suggested, for instance by Widmark and Sandstrom (2012), but was found to affect the transaction costs for both sectors.

Similarly, scenario analysis could also serve as a tool for policy-makers, strengthening their ability to make informed decisions. Scenario analyses can illustrate effects and facilitate decisions about trade-offs between goals, which in this case would be the development of the key resources. Trade-offs include those adaptations to reindeer husbandry that limit the long-term production of the key resource in terms of wooden raw material that generates economic profit.

However, to make use of this ability as described above, the implementers' willingness would be key. Changing the factors supporting *samråd*, for example through international conventions on indigenous rights, could contribute to increased willingness.

7.5.3 Willingness

Factors that can increase the willingness to implement reindeer husbandry-adapted forestry are discussed earlier as factors supporting the policy instrument, including aspects such as societal and political pressure, media reporting, monitoring and follow-up, and a threatening regulatory structure.

To increase willingness, motivation among implementers would need to be increased. Feedback, such as follow-up, can increase this motivation. In this regard, I find supervision, transparency and accountability, as a basis for media reporting, to be important supporting factors for the policy instruments. Monitoring can also be an important supporting factor for

voluntary policy instruments, and in recent decades the Forest Agency has made some attempts and carried out initiatives related to monitoring of the considerations made to reindeer husbandry (Paper I, Skogsstyrelsen, 2023). The forest companies have also made some of their own attempts at follow-up regarding considerations (Paper I). However, the extent to which the management activities agreed on at *samråd* are actually carried out has only been briefly investigated (Essman & Essman, 2024).

The Forest Agency has suggested that the status of the minutes from *samråd* should be strengthened as a basis for follow-up on considerations (Skogsstyrelsen, 2023). A thorough follow-up on considerations following *samråd* could serve as the basis for developing routines at the forest companies based on good and bad examples, but could also point out the role of FSC and the Forest Agency when it comes to monitoring and transparency. In relation to future *samråd*, in which adaptations and measures for reducing the negative impacts might increase – for instance pre-commercial and commercial thinning – this is urgent. Results from monitoring and follow-up on considerations could serve as important support in increasing the willingness to make considerations to reindeer husbandry in *samråd*.

How increased knowledge will not increase willingness

As described earlier, increased knowledge is a factor with the potential to support the implementation of a policy instrument, even though the expectations in this regard seem to have been too high in the case of *samråd*. Increased knowledge has the potential to change attitudes and/or actions among actors; however, increased knowledge will not automatically lead to increased willingness. My analysis rather relies on the theory of the disproven linear model of knowledge, supporting the fact that increased knowledge over the years has in fact not been enough to influence the development of the key resources between the actors. The fact that the power has remained with forestry also seem to have influenced the requested knowledge production. In the *samråd* situation, there seems to have been a view that 'if we can only sit down together, we'll learn from each other' (Paper I). In light of Habermas's and Foucault's understandings of communication and knowledge, the power relations between the actors, as well as the interests and attitudes and existing 'paths' or 'logics' that delimit what we focus on and learn (Eagly & Kulesa, 1997), will limit the 'automatic' learning in the *samråd* situation. This is also related to

Johansson's (2013, 55) conclusion in the context of *samråd*: '"However, respondents from reindeer husbandry argued that high participation, transparency and responsiveness in stakeholder consultations (input legitimacy) do not imply that the long-term results are in the best interest for reindeer husbandry (output legitimacy).'

At the 1976 conference on 'Modern forestry's effects on reindeer husbandry', head of the Forest Service (today Sveaskog) Folke Rydbo said that '[Regarding] the arguments about how much more or less lichen there will be after one or the other forest measure, the participants here are beginning to know [them] quite well at this point' (my translation from the Swedish). He continues shortly thereafter, stating that 'reindeer herding as a business is obviously in a condition of crisis', and asks to what extent supplementary feeding has actually been tried. Further, he raises the question of a lack of knowledge about each other's conditions, and suggests mutual education (Lantbruksstyrelsen, 1976, 10-12). This illustrates that it is not a lack of knowledge that has been the problem, as the ground lichen has radically declined since then despite this thorough knowledge; neither does it seem to be a result of insufficient *samråd* meetings and a lack of trust, knowledge and material (cf. Sandström & Widmark, 2007), as local *samråd* simply does not have the ability to control the long-term development of the key resources. To summarize, the reason for the decline in both tree and ground lichen as a key resource for reindeer husbandry do not seem to have been a lack of knowledge about the negative impacts of forestry. The reason rather seems to be a lack of willingness.

7.6 Strengths, limitations and considerations of the results

Below I will consider the main strengths, limitations and considerations regarding the results of the appended papers.

For Paper I, a strength of the study is the extensive body of material covering the time period of the CCG (1971-2019). However, for the period before 1971 the sources were quite few, although some were very elaborate (e.g. Skuncke 1955). The paper draws conclusions about local *samråd*, based on the assumption that the minutes from the CCG meetings can be used as a proxy. We have not considered local variations, which judging from the material could have been possible, as regional reports were standard

procedure at the meetings. Also, as mentioned earlier, the material is produced by representatives from the forest authorities, which could mean that the reindeer herders' perspective is not represented as well as that of the forest companies. Further, the predominance of members at the meetings representing forestry might have further amplified the voice of the forestry side.

For Paper II, the strength is the extensive body of NFI data, covering northern Sweden for the period 1993-2023. One of the considerations to be made involves the small and differing sizes of the sample plots (radius 5.64 m for bottom layer, 10 m for site productivity and 20 m for other factors), which would give edge effects and make the data sensitive to variations. A limitation in the data is that information on, for example, the method of soil scarification is not available; nor is a total record of all thinning and pre-commercial thinning. Another limitation is that the prevalent use of conventional forestry methods would mean that the data more or less only contains results concerning how production-oriented forestry affects ground lichen. Ideally, the data would also contain sample plots with reindeer husbandry-adapted forestry. For example, as pre-commercial thinning to low stem numbers is not generally applied in production-oriented forestry, we could not analyse the effect of this on lichen cover. Also, a significant consideration to take into account is the time aspect of lichen cover change: as growth conditions for lichen change, it should be considered that the growth response is not immediate. We have not included this effect in the analyses.

For Paper III, crucial for the results in terms of economic output of the different scenarios are the management strategies used, and the proportion of land where reindeer husbandry adapted forestry measures are used. To insure that all potential lichen habitat was included in the scenarios adapted to ground lichens, we included forest with a site index up to 20. However, considering the results from Paper II, reindeer husbandry-adapted management should be recommended on SI<19, so in Paper III pine forest with SI 19–20 could have been considered 'other forest' with standard clear-cut forestry, which would then have given a higher economic output for the ground lichen scenario. However, the change in lichen habitat would also have been very different, with a much lower increase than in our simulation. The higher the site index the larger the production loss, due to not using the forest's full growth potential because of harder pre-commercial thinning or

thinning for reindeer husbandry consideration. Hence, the relatively high site index makes the production loss greater in comparison to more low productive areas. In our case study area, pine-dominated forest on dry and mesic sites with an SI 19–20 was 27% of the total area. If we had excluded these site index classes from the reindeer husbandry-adapted management, the area for standard clear-cut forestry would have increased from 38% to 65%. According to NFI data, of all lichen-abundant/-moderate forest[39] in the RHA in 2016, only 4%/1% was found on SI 19. For SI 20 there was 0% of both lichen-abundant and lichen-moderate forest (Paper III; Supplementary material).

It should also be noted that the situation for reindeer husbandry in general is dependent on the lichen development on all forest land. The scenario analysis in Paper III involves forest land in which the area owned by the state and the two largest forest companies in the study area represents 72% of the forest land. This can be compared to 53% of the non-mountainous forest in the RHA being owned by the state and all forest companies (Sandström et al. 2016). Even though *samråd* can also be held on the forest land owned by small private land-owners, this shows the importance of the lichen development in the state- and company-owned forest.

When discussing economic output from Paper III, an important consideration is also that we only take into account the economic consequences for the forest owner. The economic consequences of a further decrease in ground lichen on reindeer husbandry in terms of, for example, increased supplementary feeding has not been accounted for. To evaluate this, many values such as ecosystem and 'cultural' services connected to the reindeer husbandry would have to be accounted for.

A strength in Paper IV, is the large number of respondents, representing different parts of the RHA. A consideration regarding the respondents is that not all of them were employees of a forest company. However, the questions regarding *samråd* were only answerable by those who answered that they actually worked with *samråd*. However, it should be noted that all the free-text answers do not have to represent the view of a forest company employee. Also, a limitation in the material is that it was not possible to connect specific answers between the first and second surveys, which would have increased the potential to analyse the answers.

[39] Bottom-layer class categories 'lichen-abundant' (50-100% coverage) and 'lichen-moderate' (25-50% coverage).

7.7 The future of the key resources

Different future developments of the key resources are illustrated in Figure 5, based on the results from Paper III. Even though this development is only an example from a specific study area under certain preconditions, this can serve as a possible future for the state- and company-owned forest area in the RHA.

Depending on choice of forestry strategies, the future development of ground lichen habitat ranges from a decline of 52% to an increase of 22%. It is hard to predict what the future development will look like; many uncertain factors, such as the institutional context, will be important for determining the development. However, the willingness of the implementing actors seem to be a key factor. Willingness can be affected by the factors supporting the policy instrument, such as societal and political pressure, media reporting, monitoring and follow-up, and a threatening regulatory structure.

If there is willingness, the results from Paper III provide a good example of what strategic planning, which could partly replace the local *samråd*, might achieve. Using this tool, it could be possible to guarantee a certain development of the ground lichen, which has long been needed, considering how the local *samråd* has not safeguarded the reindeer pastures. Also, it could be seen to ensuring compliance with what is stipulated in contemporary legislation and guidelines: that all owners of and stakeholders in the land within the RHA must safeguard and respect the grazing rights as defined in the Swedish Constitution (SFS 1974:152, Chapter 2, §10), the Reindeer Grazing Act (SFS 1971:437) and the Swedish Environmental Code (SFS 1998:808).

The results from Paper III show what reindeer husbandry-adapted forestry could mean, and the consequences in terms of the output of the key resources as lichen habitat and net revenues for forestry. Although the net revenues would be lower in the reindeer husbandry-adapted alternative, the two sides of the joint ‘vision’ of the future forest might not have to be so far apart as it may first seem. Although forestry has been a reason behind the lichen decline, it can also be an important contributor to a lichen increase. Silvicultural measures such as pre-commercial thinning and thinning are

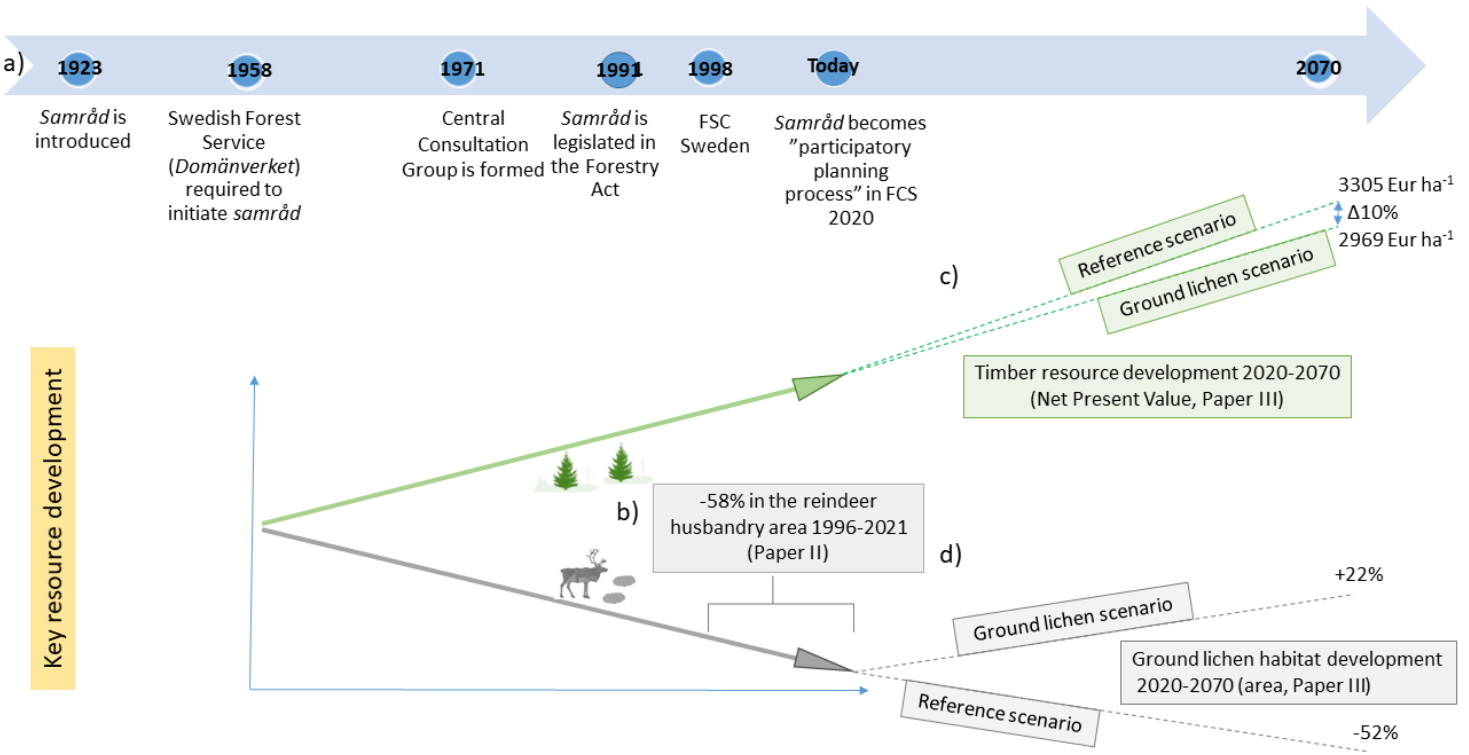

Figure 5. Schematic figure illustrating the longitudinal perspective of the thesis (a) and findings from Paper II (b). Dotted lines schematically illustrate the different outcomes of a continuation of current forestry in the study area, compared to adopting reindeer husbandry-adapted forestry, in terms of economic output for forestry (c) and area of ground lichen habitat (d).

crucial in this sense, with adjustments in timing and intensity compared to conventional forestry. Hence, our scenarios do not include new types of silvicultural practices. For the ground lichen scenario, 38% of the area was managed in the same way as for the reference scenario, demonstrating that current forestry can be continued in large parts of the forest while adaptations are made in areas with potential lichen habitat.

Related to the future of the resources, the levelling of the lichen decline since 2015 was a surprising result, and the possible reasons for this require some further discussion. There may be several reasons for the finding that the lichen cover decline levelled out; explanations can be sought not only in the specific forest management but also in aspects relating to power and knowledge. For example, could a reason for the levelling out of the decline be an indication of levelling power relations, and/or the result of *samråd* and reindeer husbandry-adapted forestry at the winter grazing grounds, following the introduction of FSC in 1993? Considering the response time of lichen growth in relation to changes in forest conditions, this could be possible. However, results from Paper II show that the levelling trend in lichen cover is even more distinct outside the RHA. This indicate that *samråd* or considerations made to reindeer husbandry are not a plausible reason for the levelling trend. Rather, general patterns in forest land use and forest characteristics could lie behind the results. Considering the increase and decrease in lichen cover for different age classes of forest in Paper II, a plausible reason could be changes in the age class distribution of the forests in northern Sweden. Although modern forestry has mainly affected ground lichens through a decrease in coverage, in some cases (e.g. felling areas with the right condition) lichen cover increased due to forestry operations such as clear-cuts. Following a long period of lichen cover decline, it is possible that equilibrium has been reached, whereby the areas with increasing lichen cover have balanced out the decrease in other areas – thus, one could say that the 'bottom has been reached' in the lichen cover decline. As the lichen-rich forest has shifted from occurring in all age classes to occurring primarily in forest aged 0-60 years (Sandström et al., 2016), and as the age class of 0-40 years represented 47% of the pine forest in northern Sweden in 1995 (Paper II, Appendix), there has been a great potential for lichen increase here. Another explanation could be that the densification of the forests has also started to level out, which we saw an indication of a levelling yearly increase

of the basal area from a mean value of 0.7% in 1995-2021 to 0.4% in 2015-2021 for northern Sweden.

Future studies could involve further research on how different forest regeneration measures, such as soil scarification in relation to ground vegetation, affect lichen cover. The reasons for the levelling out of the lichen cover could also be further investigated. The forest companies' technical and organisational aspects of planning and *samråd* for taking into account reindeer husbandry needs, linked to the operational forest measures may require further research. As it is largely unknown to what extent considerations agreed on at *samråd* are actually executed and carried out in practical forestry, the reasons for this – such as possible organisational obstacles related to internal communication and the rationalised production at the forest companies – are also unknown.

Finally, it should be noted that although ground lichen is the key winter grazing resource, many other aspects of resources and disturbances are significant for the future of the natural pasture-based reindeer husbandry. The area and quality of natural pastures is deteriorating, involving ground and tree lichen as well as other vegetation, due to forestry, other land uses and other external factors. At the same time, the possibility to utilise the pastures is affected by disturbances – such as predators, tourism, environmental factors and climate change . These factors make forestry's possibilities to positively affect the ground lichen development even more crucial to reindeer husbandry.

7.8 The future of *samråd*

As mentioned, my results contribute by providing an example of how strategic planning could partly replace the local *samråd*. However, this is dependent on policy decisions and the understanding, willingness and ability of the implementers, as discussed earlier. It seems to require a substantial change from the current situation for this new knowledge to be implemented. Considering the power asymmetries and what we have learned from my theoretical framework regarding implementation and the linear model of knowledge, at present this does not seem likely. However, parts can still be implemented in the local-level *samråd* as well, to serve as support in making cost-efficient forestry considerations to reindeer husbandry.

My empirical data on the participants' perceptions of *samråd* ends in 2020 (Paper IV). It remains to be seen whether the changed wording about the process in the FSC standard from 2020[40] will change the outcome of *samråd*. However, as in the past the reindeer herders have been satisfied with the process but not the outcome (Teitelbaum et al. 2023), the change in wording and specification of the process may seem redundant. Also, considering the soft nature of the policy instrument, and the fact that no other changes in the institutional context have been made, the effect of a change in the outcome is not highly likely. This seem to require stronger supporting factors, such as increased political pressure.

Measures for accountability – such as reporting through media, FSC audits and/or transparency in FSC mediation cases– seem to be a way to strengthen the instrument. There have also been initiatives over the years by the Forest Agency to follow up on considerations made by forestry to reindeer husbandry that could possibly have the same effect, if the results are transparent. As noted in Paper I, a systematic evaluation of the considerations as well as the trends of the amount and distribution of key resources could also enable accountability by the forest companies. Further research could also have a role in looking into the Forest Agency's possibilities and limitations in acting historically and in the future, when it comes to the interpretation of *samråd* in the Forestry Act.

In summary, what could enable or prevent a change in the outcome of *samråd*, compared to earlier? In my view, the main barriers to change are: the institutional context, with conflicting objectives and competing sectoral legislation; the normative structures, such as the production norm created by the legacy of forest policy; the power structures, with forestry as the more powerful actor, which is also related to the framing of the actual problem; and the institutional arrangement of *samråd* at the local organisational level. Factors that in my view could enable a change would be increased understanding, ability and willingness among the forest companies and policy-makers whereby increased willingness, for example, can be enabled by increased monitoring, inspection or enforcement, or increased community pressure.

[40] In which the term *samråd* is replaced with *samplaneringsprocess* (Participatory Planning Process).

7.9 Conclusion

With a longitudinal perspective, I have linked the past, present and future development of ground lichen, as the key resource for reindeer husbandry, to the development of *samråd*. Historically, *samråd* has not safeguarded a balanced development of the key resources for the two land users. My results show how forestry affects ground lichens, and how it could be adapted in order to reduce the negative impact on reindeer husbandry. Additionally, the results demonstrate a method for estimating the future effects of reindeer husbandry adapted-forestry compared to conventional forestry. This could serve as decision support for enabling a change in the future development between the two key resources. My results show a possibility for the inclusion of reindeer husbandry perspectives in strategic forestry planning.

A reason why *samråd* has had a limited influence on the development of the key resources seem to be that it has limited potential as a soft instrument. Although *samråd* appear to have contributed to increased knowledge, especially at the local level, the role and potential of increased knowledge in *samråd* seem to have been overestimated over the years. Decisions at a higher level seem to be needed, and this thesis contributes by offering examples of support for such decisions. This support could enable decisions of a quantifiable level of consideration made to reindeer husbandry, which could determine and guarantee a more balanced long-term development of the resources. However, these decisions seem to be dependent on understanding among the decision-makers, as well as their willingness and ability to make balanced trade-offs between the different goals of the two land users.

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Populärvetenskaplig sammanfattning

Under lång tid har skogsbruket och renskötseln haft samråd inför avverkningar. Medan skogsbruket är viktigt för Sveriges nationella ekonomi så är den naturbetesbaserade renskötseln grundläggande som bärare av den samiska kulturen. Marklav är det viktigaste vinterbetet för renen. Det produktionsinriktade skogsbruket har lett till tätare skogar, vilket är negativt för den ljusberoende marklaven. Sedan 1950-talet har den lavrika skogen minskat med över 70% samtidigt som virkesförrådet, summan av alla stående träds volym, har ökat med över 50%. Skogsbrukets nyckelresurs har alltså ökat med följden att renskötselns nyckelresurs minskat, vilket kan ses som en obalanserad utveckling. Min avhandling syftar till att undersöka vad som skulle kunna balansera utvecklingen av nyckelresurserna, med fokus på skogsbruksmetoder, planering och samrådets möjligheter som policyinstrument.

Resultaten visar att renskötselns förväntningar på samrådet har skilt sig från skogsbrukets, och att samrådet främst har blivit ett instrument för informationsutbyte. Resultat från analyser av riksskogstaxeringsdata visar också att lavminskningen i norra Sverige faktiskt planat ut sedan 2015, men orsakerna till det är osäkra och vidare forskning föreslås. Det finns dock goda möjligheter att anpassa skogsbruket så att marklaven ökar igen. De viktigaste åtgärderna är tidiga och hårda röjningar och gallringar på mager tallmark med förutsättningar för marklavstillväxt. Andra viktiga åtgärder för hänsyn till renskötseln kan vara avveckling av *Pinus contorta*, hård gallring i flyttleder, ingen markberedning på lavhabitat, naturlig föryngring på de magraste markerna, ingen gödsling och lämnade trädgrupper som hänsynsytor främst för hänglavsspridning. Utifrån dessa hänsynsåtgärder gjorde vi scenarioanalyser för ett studieområde i Västerbotten. Vi kom fram till att arealen med potential för marklav skulle kunna öka med 22% på 50

år, där den ekonomiska vinsten för skogsbolagen var 11-13% lägre jämfört med ett fortsatt konventionellt skogsbruk, som skulle minskat arealen med potential för marklav med 52%. I en enkätundersökning visade det sig också att uppfattningarna om vad som är relevant kunskap när det gäller samråd skilde sig mellan renskötseln och skogsbruket. Medan Sametinget tyckte att rättighetsfrågor och skogsbrukets påverkan på renskötseln var relevant, så tyckte skogsbruksrepresentanterna snarare att kartor och samebyarnas renbruksplaner var relevanta.

Resultaten i avhandlingen kan bidra med ökad kunskap om hur skogsbruket kan anpassas för att återställa och/eller öka marklaven. Ökad kunskap har också varit den viktigaste åtgärden som historiskt framhållits generellt för att förbättra samråden och relationen mellan skogsbruk och renskötsel. Dock kan ökad kunskap ha begränsad möjlighet att påverka samrådet, beroende på de olika uppfattningarna om vad som är relevant kunskap och maktförhållandena mellan de två parterna. Möjligheterna att påverka samrådet är också till viss del beroende av att samråden, som sker på lokal/regional nivå, redan är styrda av beslut från högre nivå i skogsbolagen. En möjlighet skulle kunna vara att metoden för scenarioanalys användes i beslutsfattandet, då skogsbolagens planering skulle kunna säkerställa en viss framtida utveckling av marklaven och kostnaderna för det skulle kunna bedömas i förväg. Det skulle kanske kunna ersätta samrådet till viss del och göra det möjligt för lagstiftare eller andra beslutsfattare att exempelvis instifta en tillåten nivå för minskning/ökning av marklav. För att det skulle kunna ske i verkligheten verkar dock förändringar behövas i de institutioner som idag styr förhållandet och maktfördelningen mellan renskötseln och skogsbruket, som lagstiftning eller certifiering. Ett annat alternativ skulle kunna vara ett ökat tryck från samhället på större hänsyn till den samiska markanvändningen. Även uppföljning, övervakning och rapportering för hur skogsbruket påverkar renskötseln skulle kunna vara viktigt. För att en förändring skulle vara möjlig kan både förståelse, förmåga och vilja hos beslutsfattare och implementerare/praktiker behövas, där mina resultat främst kan bidra till förståelse och förmåga.

Popular science summary

Samråd has long been the instrument for consultation between forestry and reindeer husbandry in Sweden. While forestry has much greater economic significance nationally, the natural pasture-based reindeer husbandry is crucial for the indigenous Sami people and their culture. The production-oriented forestry has resulted in denser forests, which is detrimental to the light-dependent ground lichen, the key winter-grazing resource for reindeer. Since the 1950s, lichen-rich forest has declined by more than 70% while the timber stock, the summed volume of all standing trees, has increased by more than 50%. The key resource for forestry has thus increased at the expense of reindeer husbandry's key resource, which can be seen as an unbalanced development. This thesis aims to investigate what could contribute to a more balanced development of the key resources, focusing on forestry methods, planning and the possibilities presented by *samråd* as a policy instrument.

Results show that reindeer husbandry's expectations regarding *samråd* have differed from those of forestry, and that *samråd* has mainly become an instrument for information exchange. Novel findings from analyses of forest inventory data show that the lichen cover decline in northern Sweden has actually levelled out since 2015, but the reasons for this are uncertain. However, technically, there is good potential for adapting forestry so that the ground lichen will increase again. The most important forestry measures are early and intense thinning and precommercial thinning at low productive pine sites with conditions for ground lichen growth. Further important adaptations to reindeer husbandry can include the replacement of *Pinus contorta*, intense thinning in migration routes, no soil scarification at lichen habitats, natural regeneration at the least fertile sites, no fertilisation, and trees left in retention patches primarily to allow for the dispersal of tree lichen. Based on these adaptations, we conducted a scenario analysis for a

study area in Västerbotten. We found that the forest with potential for ground lichen growth could be increased by 22% in 50 years, resulting in an economic output for forestry that was 11-13% lower compared to continued conventional forestry, which would instead decrease the area with potential for lichen growth by 52%. Results also highlight how perceptions of relevant knowledge for the relationship between reindeer husbandry and forestry seemed to differ between the two land users. While the Sami Parliament found knowledge about grazing rights and how forestry affects reindeer husbandry to be relevant, forestry representatives rather emphasised a need for factual knowledge such as maps and reindeer husbandry plans.

These results can contribute increased knowledge of how forestry can be adapted to make the ground lichen recover. Increased knowledge has also been the most important suggested measure for improving *samråd* and the relationship between reindeer husbandry and forestry over the years. However, increased knowledge seems to have a limited possibility to influence *samråd*, due to different perceptions of relevant knowledge and the power relations among the participants. Another reason could be that the local/regional *samråd* are already governed by decisions at a higher level at the forest companies. If scenario analysis were used as a tool in the decision-making, the forest companies' strategic planning could guarantee a certain future development of the lichen, and could estimate the cost of this in advance. This could to some extent replace *samråd*. It would also be possible for policy-makers to specify a certain accepted level for decline/increase in ground lichen. For this to happen in reality, however, changes would probably be needed in the institutions that govern the relationship and power distribution between reindeer husbandry and forestry, such as legislation or certification. Another alternative could be increased societal pressure regarding considerations towards Sami land use. Also, follow-up, monitoring and reporting about forestry's considerations towards reindeer husbandry could have an important role. For a change in the resource development to be possible, the understanding, ability and willingness among decision-makers and practitioners would be important.

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I

Samråd: an institutional arrangement in the context of forestry and reindeer husbandry in northern Sweden

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HIGHLIGHTS

- The concept of *samråd* is an institutional arrangement for deliberation and conflict mitigation between reindeer husbandry and forestry in Sweden.
- The understandings and expectations of *samråd* differ among actors in terms of procedure, issues, efficiency and outcomes.
- The shift from centralized *samråd* between authorities to a system with local *samråd* between land users has not undermined forestry's position as the dominant actor.
- As compared to the traditional understanding, a watered-down meaning of *samråd* has evolved where the *samråd* practice has merely become an instrument for information gathering.
- The development of participatory mapping suggests potential for new thinking about current power relations in *samråd*.

SUMMARY

In northern Sweden, forestry and reindeer husbandry overlap spatially and judicially. To mitigate conflicting objectives regarding land use, the concept of "*samråd*" has been introduced as a form of institutional arrangement of environmental politics. This study explores how stakeholders have interpreted this concept and corresponding processes from its first introduction in 1923 to 2019. Language, including the cartographic language, is regarded as a mean for argumentation. Results show that the understandings and expectations of *samråd* differ among actors in terms of procedure, issues, efficiency and outcomes. As compared to the lexical definition and understanding, the *samråd* practice has merely become an instrument for information exchange before decisions are made, rather than a functional arrangement for conflict mitigation. This ambiguity is in parallel to a deregulated forest policy and a watered-down meaning of *samråd* in public administration. However, the transformative potential of participatory mapping suggests a new way of thinking about power relations in land use matters within the framework of *samråd*.

Keywords: consultation, environmental politics, indigenous land use, participatory mapping, power

Samråd: un arrangement institutionnel dans le contexte de la gestion des rennes et de la foresterie en Suède du nord

U. ROOS, G. LIDESTAV, S. SANDSTRÖM et P. SANDSTRÖM

La foresterie et l'élevage des rennes se chevauchent judiciairement et dans l'espace en Suède du nord. Pour atténuer les objectifs conflictuels quant à l'utilisation des terres, le concept de '*samråd*' a été introduit en tant que forme d'arrangement institutionnel des politiques environnementales. Cette étude explore la manière avec laquelle les parties prenantes ont interprété ce concept et les processus lui correspondant depuis son introduction initiale en 1923, jusqu'à 2019. Le langage, langage cartographique inclus, est considéré comme outil d'argumentation. Les résultats indiquent que les compréhensions du *samråd* et les attentes qui lui sont liées diffèrent parmi les acteurs, en termes de procédure, des problèmes, de l'efficacité et des résultats. Comparé à sa définition lexicale et à la compréhension dont il est l'objet, la pratique du *samråd* n'est devenue qu'un simple instrument d'échange d'information avant les prises de décision, au lieu de l'arrangement fonctionnel d'une atténuation des conflits qu'il est censé incarner. Cette ambigüité existe en parallèle avec une politique forestière dérèglementée et une définition très délayée du *samråd* dans l'administration publique. En revanche, le potentiel transformatif de la cartographie participative suggère une nouvelle façon de penser aux relations de pouvoirs dans les questions d'utilisation des terres, au sein du cadre *samråd*.

Samråd: un acuerdo institucional en el marco de la silvicultura y la cría de renos en el norte de Suecia

U. ROOS, G. LIDESTAV, S. SANDSTRÖM y P. SANDSTRÖM

En el norte de Suecia, la silvicultura y la cría de renos se solapan espacial y judicialmente. Para mitigar los objetivos contradictorios en relación con el uso de la tierra, se ha introducido el concepto de "*samråd*" como un tipo de acuerdo institucional de las políticas medioambientales. Este estudio explora cómo las partes interesadas han interpretado este concepto y los procesos correspondientes desde su primera introducción en 1923 hasta 2019. El lenguaje, incluido el cartográfico, se considera un medio de argumentación. Los resultados muestran que la comprensión y las expectativas del *samråd* difieren entre los actores en términos de procedimiento, cuestiones, eficiencia y resultados. En comparación con la definición y la comprensión léxicas, la práctica *del samråd* se ha convertido en un mero instrumento de intercambio de información antes de la toma de decisiones, más que en un acuerdo funcional para la mitigación de conflictos. Esta ambigüedad funciona en paralelo a una política forestal desregulada y a un significado diluido del *samråd* en la administración pública. Sin embargo, el potencial transformador de la cartografía participativa sugiere una nueva forma de pensar en las relaciones de poder en materia de uso de la tierra en el marco del *samråd*.

Samråd mellan skogsbruk och renskötsel i norra Sverige

U. ROOS, G. LIDESTAV, S. SANDSTRÖM och P. SANDSTRÖM

I norra Sverige finns rätten att bedriva skogsbruk och renkötsel på samma marker. För att minska konflikterna mellan de två olika markanspråken har "*samråd*" tillämpats, vilket kan betraktas som ett miljö- och näringspolitiskt motiverat förfarande. Den här studien utforskar betydelsen av *samråd* för skogsbrukets och renskötselns sakägare från introduktionen 1923 fram till 2019. Resultaten visar att förståelsen och förväntningarna på *samråd* skiljer sig mycket mellan olika sakägare när det gäller såväl procedur som innehåll, effektivitet och utfall. Jämfört med den lexikala definitionen och betydelsen har *samråd* i praktiken endast blivit ett sätt för informationsutbyte innan beslut fattas, snarare än en fungerande konfliktlösningsmekanism. De skilda tolkningarna kan förstås i ljuset av avregleringen inom skogspolitiken och en allt mer urvattnad betydelse av *samråd* inom offentlig sektor generellt. Den transformativa potentialen i deltagande kartläggning visar dock på en framkomlig väg att etablera ett nytt tänkande kring hur maktrelationer i frågor om markanvändning kan hanteras inom ramen för *samråd*.

Rádedibme: institusjåvnålasj ásadus mij gåbtjå miehttseäládagá ja boahttsubargo vidjurijt nuorta Svierigin

U. ROOS, G. LIDESTAV, S. SANDSTRÖM ja P. SANDSTRÖM

Nuorta Svierigin gåbtjå miehttseäládak ja ällobarggo nubbe nuppev, bájkálattjat ja juridihkalattjat. Vaj duosstot ednamaddnij sierra ulmmevuojnojt, la vuohke "rádedibme" vuododuvvam degu biráspolitihkalasj institusjåvnnåásadus. Dat åtsådibme guoradallá anov hámevuohkáj ja dan prosessaj fert dåjmaddidje tjalmijs, dallutjis gå álgaduváj 1923 ja gitta 2019 rádjáj. Giella, ja aj kárttagiella, la vuojnedum degu argumentasjåvnå. Boados vuoset vaj dádjadibme ja vuorddemusá rádedibmáj adni nåv stuor sieradusájt doajmmij gaskan gå la gatjálvis jåhtuj, sisadnuj, doajmmafábmuj ja båhtusij. Buohtastahttemijn dajna lexikála tjielggidusájn ja anos la rádedibme dåssjå sjaddam vuohke diehtojuohkemij åvddål märrádusá válddeduvvi, farra gå doajmmis rijddotjåvda. Dal dát moattejuonakvuohta tjuovvu njuolggadisvuodadahttemav miehttsepolitijkan ja dav tjátjas anov rádedimes almulasj sektåvrån. Dán maŋemus ájge åvddånibme oassálasstem ájggomussaj degu aktisasj giellan, oajvvat ådå ussjolimvuogijt fámo aktavuoda hárráj. Ij le binnebuj le dárbo dajda riektá aktavuodajda dáj guovte ednamaddnij hárráj tjielggiduvvat.

Ráđđehallan meahccedialu ja boazodoalu gaskkasnuorta Ruoŧas

U. ROOS, G. LIDESTAV, S. SANDSTRÖM ja P. SANDSTRÖM

Nuorta Ruotas meahccedoallu ja boazodoallu leat badjálaga, eatnamiid ektui ja juridihkalačča t. Jus galgá unnidit riidduid daid guokte eanangeavaheddjiid gaskal, de konseapta "ráđđehallan" lea geavahuvvon, mii sáhttá gehčča t dego biras- ja eláhuspolitihkalaš motiverejuvvon meannu. Dát dutkan iská mearkkašumi *ráđđehallamis* meahccedoalu ja boazodoalu áššeoamasteddjiide álggaheami rájis 1923 gitta 2019:i. Boađus vuoseha ahte ipmárdus ja vuordámušat ráđđehallamiin rievdá sakka sierra áššeoamasteddjiid gaskkas mii guoská sihke meanu nugo sisdoalu, beaktilvuođa ja bohtosa ektui. Jus buohtastahttá dan leksikála meroštallamis ja mearkkašumis ráđđehallan praktihkas lea dušše gártan gaskaoapmin diehtojuohkinlonohallamii ovdal go mearrádus váldo, mihá buoret go doaibmi riidočoavdinmekanisma. Dát sierra dulkomat sáhttet ipmirduvvot meahccepolitihka heaitima čuovggas ja dan láivvaseappot mearkkašupmi *ráđđehallamis* almmolaš suorggis oppalačča t. Rievdadeaddji potensiála oassálastimis gártemis vuoseha goitge geainnu gos sáhttá beassat ovddos guvlui ásaheamis ođđa jurddašeami got fápmogaskavuohta áššiin got eanangeavaheapmi sáhttá gieđahallot *ráđđehallama* rámmaid siskkobealde.

INTRODUCTION

In the recently revised FSC National Forest Stewardship Standard of Sweden (FSC standard), the terms 'engagement' and 'participatory planning' are introduced to help identify and uphold the legal and customary rights of Sami reindeer husbandry (FSC 2020). Therefore, the previously applied concept of consultation, *samråd* in the Swedish language, (FSC 2010), is partly replaced by a more developed and specified procedure. Both approaches can be placed under the umbrella of "platforms for resource use negotiation", which according to Steins and Edwards (1999: 242) through collective action and shared learning has the potential to settle natural resource management problems involving multiple use and conflicting objectives. This study has its point of departure in the conflicting objectives and practices of forestry and reindeer husbandry in northern Sweden (see e.g. Sandström 2015). To what extent the change from the present procedure of *samråd* to 'engagement' and 'participatory planning' in the new FSC standard is merely a matter of semantic, or actually improves coexistence between these two spatially extensive land users remains to be seen.

A thorough understanding of the concept of *samråd*, will provide a solid basis for future comparative assessments of institutional arrangements for improved coexistence. In this study, we explore how stakeholders have interpreted the concept of *samråd* since 1923, when the term was first mentioned in a circular letter issued by the Swedish Forest Service (Skuncke 1955).

We choose 1923 as a starting point for our study, with a specific focus on the period since 1971, when *samråd* has been carried out between the respective reindeer herding communities (RHC)[2] and the forest owners, instead of between authorities. Moreover, involved stakeholders' understanding of the *samråd* concept and how the corresponding processes have developed can support the development of functional approaches and tools that promote coexistence of different land use practices. Therefore, we make use of the new way of thinking that the argumentative turn in policy analysis offers (cf. Fisher and Gottweis 2013), where language, meaning, rhetoric and values are key features in the analysis of policy-making and planning. We specifically acknowledge the "role of language in shaping our world in general and environmental policies in particular" (Behagel *et al.* 2019: 488).

In the current context, we acknowledge that the language and practice of mapping is a powerful mean of argumentation. The cartographic language represents ways of communication that can be descriptive, narrative, expository and persuasive, similar to written language (Tyner 2018). Following the dictum of "map or you will be mapped", many Indigenous peoples have made their own maps of their lands and of their land use. However, to be effective, these maps still "have to be able to play in state court systems and therefore have to look, feel, and taste like state-sponsored maps" (Wood 2010: 139).

Unlike most so-called multi-stakeholder initiatives and processes described and discussed in the international literature (see Sarmiento Barletti and Larson 2019), *samråd* is an old and extensively used concept in Sweden (Wänström 2009) and has been the dominant form of negotiations between Sami reindeer husbandry and forestry for almost a century. Between 1923 and 1971, the interests of the forest industry and those of the Sami reindeer husbandry were negotiated through two governmental administrations relying on the traditional notion of *samråd* where the Swedish Forest Service district represented the state forest management and the local Lapp Administration[1] represented the reindeer husbandry interest (Brännström 2017, Skuncke 1955). With the abolishment of the Lapp Administration in 1971, a devolution of authority took place, meaning that *samråd* should be carried out between the respective RHC and the forest owners. As a result, the RHCs gained direct access to the arena that the *samråd* represents, but this institutional arrangement does not seem to have sufficiently protected the rights of the reindeer herding sector (Sandström and Widmark 2007).

In general, the idea behind increased participation and decentralization of decision-making is to expand and strengthen the influence of local stakeholders. Although, it is commonly observed and reported that both government actors and other powerful actors resist giving up their control over processes and decisions that affect them (Arnstein 1969, Buchy and Hoverman 2000, Poudyal *et al*. 2015, Wood 2010). As a mean to follow and promote the development regarding conflict resolution, a Central Consultation Group for Reindeer Husbandry and Forestry (CCG) under the chairmanship of state authorities and representation of the two interest groups was established in 1971.

Samråd, when applied in community or environmental planning, can be considered a form of citizen participation (Castell 2016) comparable to consultation[3] in Arnstein's ladder of participation (1969). However, in the context of coexistence between forestry and reindeer husbandry, *samråd* is also about regulating property rights where two entities have equal legal claims to the same property (Brännström 2017). That is, the Sami land use rights and the forest owners' rights apply to the same property, which according to Brännström (2017), is similar to double ownership. The right to conduct reindeer husbandry is a user right, independent of

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[1] *Lapp* is the historical Swedish word for Sami, the Swedish "Lapp administration" [Lappväsendet] was organized under the county administration, see Lantto (2013).

[2] A reindeer herding community (in Swedish *sameby*, which in some literature and documents, e.g. the English version of the Swedish FSC standard, is called Sami village) represents both a large geographic area and an administrative and financial association for Sami reindeer herding companies.

[3] Consultation is the fourth rung of participation in Arnstein's ladder, where the have-nots are allowed to hear and be heard, but lack the power to insure that their views will be heeded by the powerful.

the right of ownership of the real estate. However, it is not limited in time and no lease is paid to the landowner. Yet, the legal relationship between the two sets of rights is far from clear, and some central components for regulating property rights are missing, such as mutual consideration and compensation in case of damages (ibid.). This ambiguity is significant because it affects forestry and reindeer husbandry in different ways since they are interested in promoting different outcomes of the forests, specifically timber and lichen respectively.

This paper examines how the concept and practice of *samråd* have evolved with respect to understanding and mutual consideration. In a study covering 1984 to 2009, Widmark (2009: 47), who uses the term consultation rather than *samråd*, claimed that "in addition to the absence of conflict resolution mechanisms, there is no clear, consistent definition of consultations", so it is up to "the stakeholders to establish the consultation framework", which in light of the uneven power relations and an overall forest policy emphasizing "freedom under responsibility"[4] contributes to the shortcomings of the current institutional arrangement. Thus, the practice of *samråd* between forestry and reindeer husbandry seems to suffer from one or more known power inequalities between stakeholders, where forestry is the dominant, and reindeer husbandry the weaker, stakeholder. These power inequalities, recognized in the literature on participatory development (Sarmiento Barletti and Larson 2019), are influenced by differences in financial resources (Widmark 2009, Widmark 2019) as well as in technical skills and strengths (Reed 2008, Sandström *et al*. 2003, Sandström *et al.* 2020b). Inequalities are further exacerbated by an informal precedence regarding who has had the last say and the prioritizing of certain forms of knowledge production (Cambou *et al.* 2021, Sarmiento Barletti and Larson 2019, Turunen *et al.* 2020). To counterbalance forestry's privileged position in relation to reindeer husbandry reported by Widmark (2009) among others, we agree with Behagel *et al.* (2019: 489) who suggests a practice-based approach in environmental policy that "allows detailed accounts of various types of political struggle and agency, locally embedded structures and routines, and the performative aspects of knowledge."

Considering *samråd* between forestry and reindeer husbandry as environmental politics, the issue of power has to be problematized and contextualized. In this regard, we apply Partzsch's analytical concepts of *power with*, *power to*, and *power over* and draw on Partzsch's call "to ask questions of the activity of power, of where, when and how environmental innovations allow for individual empowerment and coaction" (2017: 206–207).

Aim and scope

Against this background, this article examines how *samråd* has evolved since 1923, when it was first introduced as an institutional arrangement for resource use negotiations between forestry and reindeer husbandry. We are specifically interested in how the Sami RHCs have been engaged in the process and how their engagement has influenced the understanding of the concept as well as the outcome. Our specific analysis focuses on the following aspects: i) who has been involved and represented in *samråd;* ii) what are the perceptions and conditions of *samråd;* iii) what issues are raised; and iv) what changes can be observed both regarding representation and issues raised and how these changes have influenced RHCs. The findings of the *samråd* practice will then be discussed using Partzsch's understanding of power (2017), with a focus on the transformative potential in relation to overall issues of functioning coexistence and sustainability.

We start by describing the overall context of the two overlapping land use practices, forestry and reindeer husbandry. Next, we introduce the concept of *samråd*, and describe how *samråd* in general has been applied in the context of forestry and reindeer husbandry both during 1923–1971 when *samråd* was held between authorities, and the decentralized period that followed after 1971. Throughout the article, we use *samråd* as the specific term for the concept in question, highlighting the distinction to the related Swedish word *konsultation*, which has a different history and slightly different meaning. Although, both terms usually are translated as "consultation", this translation can miss some of the understanding of the potential and limitation of the concept of *samråd*. With reference to previous studies, e.g. Widmark (2009) arguing for the need to clarify the definition of *samråd,* we problematize the concept, by comparing the lexical definition of *samråd* to how it is used in practice. Using minutes from an assembly with representatives of the two interests and associated authorities, we explore how the involved stakeholders have interpreted the concept and corresponding processes and how the practice of *samråd* have evolved from 1923 through 2019.

The context of land use in northern Sweden

In the northern half of Sweden, forestry and reindeer husbandry are the two major spatially extensive land use forms and are dependent on the same ecosystem (Brännström 2017, Sandström *et al.* 2016). Although trees are the key resource for the forest industry, terrestrial and arboreal lichens are the key resource for reindeer husbandry systems, as lichens can constitute up to 80% of the diet for reindeer (*Rangifer tarandus* L.) during winter (Heggberget *et al*. 2002). Thus, the extensive decline of ground lichen-abundant forests observed since 1955, is of major concern to reindeer herders (Horstkotte and Moen 2019, Sandström *et al*. 2016). There are several reasons for the lichen decline, but the simultaneous intensification of forestry activities resulting in a doubling of annual harvest volumes and an increased stocking within forest stands (*Skogsdata* 2018) are major contributing factors.

Forestry has always been of major importance to the overall economy of Sweden, and 49% of the productive

[4] The Swedish wording *freedom under responsibility* is sometimes translated with "freedom with responsibility", sometimes with "freedom-under-responsibility" (e.g. Widmark 2009).

forestlands and 41% of the standing volume are found within the reindeer husbandry area (Sandström *et al*. 2016). The land ownership below the border of mountain forests is distributed among state (26%), private forest companies (27%), and 86 500 individual small-scale forest owners (47%). The forest industry in the area employs approximately 4 300 full-time workers and 40% of these workers are self-employed and usually part-time workers for the small-scale forest owners (*Skogsstyrelsens statistikdatabas* 2021).

In comparison, reindeer husbandry is a small contributor to the overall economy of Sweden, although it is crucial for the Indigenous Sami people and their culture. There are approximately 4 600 reindeer owners, of whom 2 500 are also active reindeer herders, economically dependent on reindeer husbandry. All reindeer herders are organized in one of the 51 separately managed RHCs. Since the 1990s, reindeer numbers have remained stable – between 225 000 and 280 000 reindeer in the winter herd before spring calving (*Sametinget* 2021).

Whereas forestry is grounded in land ownership and regulated by the Forestry Act (SFS 1979:429), reindeer husbandry rights are based on prescription from time immemorial and customary law regulated by the Reindeer Husbandry Act (SFS 1971:437, SOU 2020:73). The Reindeer Husbandry Act gives a Sami who is a member of a RHC the right to use land and water for themselves as well as their reindeer within the reindeer husbandry area. The Sami are an Indigenous Finno-Ugric people who have historically inhabited Sapmi, which today is part of Norway, Sweden, Finland, and Russia (*Samiskt informationscentrum* 2021). Being culturally distinct from their neighbours, notably their language and the introduction of domesticated reindeer, the Sami have governed themselves even after being incorporated into the national states that emerged in the 14th century. However, as the state developed, the Sami's rights slowly eroded, especially after Sweden began promoting settlements in the Sami homelands in the 19th century (ibid.). By the time of the Reindeer Grazing Act of 1886 (the first legislation on Sami land rights), the Swedish state still had a clear view on Sami rights in relation to other land users, which was relatively favourable to the Sami.[5] Furthermore, contemporary legislation and guidelines clearly stipulate that all owners and stakeholders of the land within the reindeer husbandry area must safeguard and respect the grazing rights as defined in the Swedish Constitution (SFS 1974:152, Chapter 2, §17), the Reindeer Grazing Act (SFS 1971:437), and the Swedish Environmental Code (SFS 1998:808). In addition, in 1981 the Supreme Court ruled that Sami reindeer grazing rights were equal to property rights (NJA 1981). However, historically and compared to landowner rights, the Sami land use rights have diluted over time (Brännström 2017, Hahn 2000, Torp 2014). The Sami influence over legislative processes has been criticized as being weak, in both official inquiries and reports (SOU 2006:14), research studies (Löf 2014), and by international organizations (Council of Europe 2012, 2017, 2018, OECD 2019, UN Human Rights Committee 2016). In addition, the Swedish legal framework has not been updated in accordance with existing court decisions to support Sami rights (Brännström 2017).

Since 1993, Swedish forest policy embraces the idea of "freedom with responsibility" for the forest owner (Appelstrand 2012). By giving the forest owner the freedom to decide best forest management strategies while emphasizing their responsibility to consider other forest values (including reindeer husbandry), they are expected to make decisions in line with Sweden's forest policy goals, with the aim to decrease the general risk of conflicts. At the same time, the Swedish Council on Legislation has interpreted the Forestry Act and concluded that the government should not intervene in *samråd* on behalf of either reindeer husbandry or forestry, leaving the conflict resolution to the two parties (Widmark 2009). Therefore, the Swedish Forest Agency, which is the national authority in charge of forest-related issues, now has a limited role in the *samråd* process (SOU 2020:73).

In the wake of this new and deregulated forest policy, the adoption of independent third-party forest certification has also developed and been welcomed by the Swedish state (Johansson 2013). The majority of small-scale forest owners (< 5 000 ha) and their associations as well as the forest commons and the church in northern Sweden have not joined the Forest Stewardship Council (FSC) but have embraced the Programme for the Endorsement of Forest Certification Schemes (PEFC) (Lidestav and Berg Lejon 2011), as it has fewer demands concerning *samråd* with RHCs (cf. FSC 2010, 2020, PEFC 2016). However, the state-owned forests, which are managed by Sveaskog AB and the National Property Board Sweden, as well as the major private industrial forest companies have joined the FSC standard. The FSC standards of 1998, 2010, and 2020 require the certificate holder to engage in *samråd* with RHCs regarding proposed management measures on all forestlands in the reindeer husbandry area, whereas the Swedish Forestry Act only mandates using *samråd* for negotiating the access to the area where grazing is allowed year-round.

As previously mentioned, the revised FSC standard (effective October 1, 2020) also mandates large forest owners (> 5 000 ha) to invite RHCs to participate in the planning processes if they are affected by the following planned management activities: regeneration felling, continuous cover forestry in areas above the nature conservation boundary, the method for soil scarification, the choice of tree species, prescribed burning, the use of exotic tree species, fertilization, and road construction. The planning horizon is the next 5–7 years, and a landscape perspective is recommended. Before implementation of forestry operations, a participatory planning process according to principles of Free, Prior and Informed Consent (FPIC) is required, and the RHC is required to provide a current description of their land use. To review the proposed activities and their impacts, the land use information should be available in a GIS.

[5] The Sami property rights to their "taxation land" was according to Brännström (2017) similar to the taxed freeholder rights to their farmland in some areas at least until the middle of the 1700s.

The concept of *samråd*

In Sweden, *samråd* is a broadly used word and concept rooted in a local democratic culture since the 17th century (cf. Wänström 2009). By that time, Sami communities were already using the Swedish local court systems to settle land disputes and other internal matters (SOU 2006:14), so the concept of *samråd* would not have been alien to them. However, depending on the political and cultural context, *samråd* can mean different things in practice. In this respect, and from an argumentative perspective, it becomes relevant to consider how this particular concept has been understood and used regarding "the empirical and normative claims as they play out in policy argumentation and deliberation", and thereby also "inform the ordinary everyday language policy argumentation" (Fischer and Gottweis 2013: 426).

Swedish dictionaries and glossaries published by the Swedish Academy define *samråd* very specifically. According to the glossary (SO 2009), *samråd* is a formal deliberation that results in an agreed upon joint action. The verb form of *samråd* is defined as "to discuss (something)" and "to reach agreement on a position and action" (SO 2009). A 1964 dictionary entry defines *samråd*, the noun form, as a process of collectively making plans through consensus that results in an action and the verb form as to collectively plan, decide, agree, deliberate, discuss, consult, or confer (SAOB 1964). The most recent glossary presents an abbreviated definition: *samråd* is a deliberation and the corresponding verb is "to deliberate" or "to advise" (SAOL 2015).

Samråd has for long been used as a mechanism to enable government decision-making and public policy where two or more state agencies are obliged by law to confer with each other in various matters. In addition, *samråd* is used when a forest owner is obliged to confer with the Swedish Forest Agency before a defined action can be executed. In the context of forestry and reindeer husbandry, the *samråd* practice from the 1980s to 2007 has been evaluated by the Swedish Forest Agency and others (Sandström and Widmark 2007, *Skogsstyrelsen* 1987, 1992, 2001) with a focus on perceived outcomes, power relations within the procedure, and the prerequisites and problems involved. None of these evaluations have given attention to the dictionary definition, as the *samråd* practice seems more in line with the weaker concept of *konsultation*, which tends to be used in the context of asking for advice or an opinion. Furthermore, studies on *samråd* have also concluded that the definitions and instructions concerning *samråd* are vague and that the interpretation of the term lies with the dominant actor – i.e., the actor obliged to initiate *samråd* (Henriksson 2012, Widmark 2009).

Through the introduction of forest certification, *samråd* has become a requirement for meeting the standard set by the specific scheme. The 2020 FSC Standard defines *samråd* (consultation) as "[a] formal meeting between The Organization and affected stakeholders. Consultation is a type of engagement." (FSC 2020:83). Correspondingly, engagement is defined as:

> "[t]he process used by The Organization to inform about management activities and collect opinions from affected stakeholders and/or interested stakeholders, and to ensure that their concerns, desires, expectations, needs, and rights are considered in the forest management. The process for engagement is adapted to the participating parties" (FSC 2020: 85).

Information and dialogue are other types of engagement, but they are separate from consultation. There are detailed descriptions of what should characterize and be included in a good *samråd*, but the 2010 FSC Standard also states that the process primarily is intended for communication and not for making decisions (FSC 2010). This definition of *samråd* is kept in the revised 2020 FSC standard. However, the process of *samråd* has been replaced by a participatory process in the sections involving the Sami people and reindeer husbandry (FSC 2020).

MATERIAL AND METHODS

Different sources have been used to examine the evolution of the meanings and practices of *samråd*. To cover the period of centralized *samråd* (1923–1970), grey literature was examined such as the reporting from a 1954 joint course in forestry and reindeer husbandry (Skuncke 1955) and Official Reports of the Swedish Government (*Statens Offentliga Utredningar*, SOU) related to reindeer husbandry and/or forestry (all listed in References). After the change of authority in 1971 from the Lapp Administration to the individual RHCs, the primary source of the analysis of how the practice of *samråd* has evolved since then, are the minutes, notes and annexes of the Central Consultation Group for Reindeer Husbandry and Forestry (CCG). This consultation group, established in 1971 as an overarching national platform of relevant interests and parties (Figure 1), representing agriculture and forestry authorities, forestry/forest landowners, and reindeer herding communities and their national federation. The CCG has been re-constituted several times. However, their mandate has essentially been the same: 1) to advocate for an extended direct *samråd* procedure between representatives of forestry and reindeer husbandry; 2) to constitute a forum for discussion of conflicting interests between the two industries; and 3) to find forms of conflict resolution (e.g., education of representatives from both parties/interests and produce an agreed and shared factual basis). By inviting governmental investigators to the CCG-meetings, they have become an arena for dialogue with policy makers. Also, researchers have been invited to carry out specific investigations. Most of the CCG participants are also involved in local *samråd.* Thus, issues addressed at CCG meetings reflect everything from the potential impacts of new policies to the perceived effect of specific operational practices at a local level. Therefore, it can be argued that this material not only speaks to how the concept of *samråd* has been perceived and developed at the national level, but can also be considered an adequate proxy

for how the praxis has evolved at the local level. Furthermore, the documents provide insights into how the CCG representatives, in their role as intermediaries between policy and implementation, conceptualize *samråd* and its transformative potential in relation to overall issues of functioning coexistence between forestry and reindeer husbandry. In total, 1 563 pages from 69 CCG meetings, which to our knowledge have not been previously analysed, were carefully scrutinized regarding representation, procedures, issues, and outcomes. Furthermore, in the search for expressions and statements where the meanings of *samråd* were discussed explicitly, coherence and differing views were noted as well as changes over time. To gain a prior understanding of which conflicts between the two land use practices were likely to be displayed in the CCG documents, grey literature and other secondary data sources such as conference reports were reviewed (*Lantbruksstyrelsen* 1970, 1976, 1984) as well as previous evaluations of the *samråd* procedure carried out by the Swedish Forest Agency (*Skogsstyrelsen* 1987, 1992, 2001).

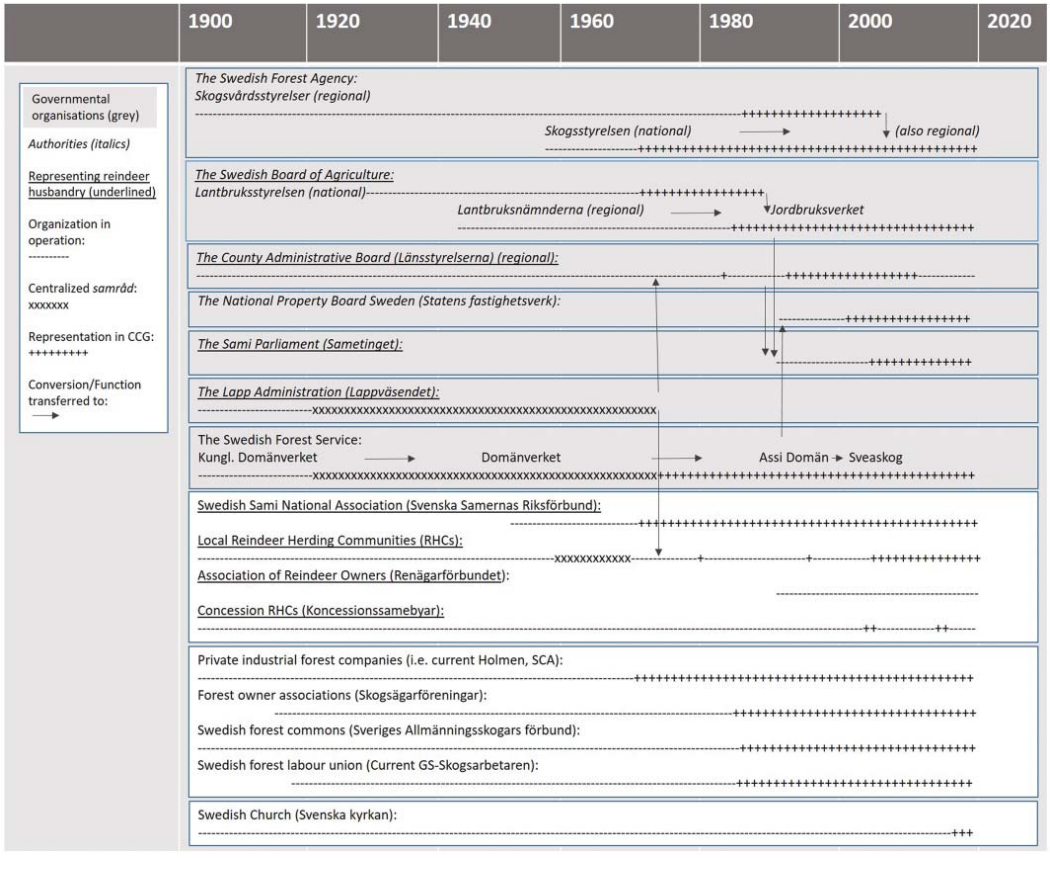
RESULTS

The results will be presented under the headings of representation, procedures, issues raised and outcomes, highlighting changes as well as coherence and differing views between forestry and reindeer husbandry.

Representation

A circular letter issued by the Swedish Forest Service to the local districts in 1923 (Skuncke 1955) stated that *samråd* should take place between the forest districts and the local Lapp Administration (civil servants appointed by the government) before performing controlled burnings as a regeneration measure. As the government considered the RHCs too weak to negotiate with more powerful land users, the state found it necessary to administer their rights (PROP 1971:51). In 1958, the Swedish Forest Agency was asked to facilitate the state of affairs between forest owners and the Sami.

FIGURE 1 *Actors involved in i) centralized samråd 1923–1970, and ii) the Central Consultation Group for reindeer husbandry and forestry (CCG) 1971–2019*



Additionally, a royal decree in 1958 to the Swedish Forest Service, the Swedish Forest Agency, and the County Administrative Boards required the Swedish Forest Service to initiate *samråd* with the Lapp Administration and local RHCs when planning forestry activities that would affect reindeer husbandry. Several Official Reports of the Swedish Government were published that investigated the current situation for the Sami people or reindeer husbandry (SOU 1927:25, 1936:23) or forestry (SOU 1946:41, 1964:7). However, the relationship between reindeer husbandry and forestry was not mentioned specifically until 1966 (SOU 1966:12) and stated that an established collaboration already existed between the Swedish Forest Service and the Lapp Administration. According to the SOU (1966:12), forestry plans should be discussed with the affected RHCs and these RHCs should be given ample opportunity to suggest adjustments. Two years later, another SOU (1968:16) suggested that this collaboration should be legislated and that the new Reindeer Husbandry Act should transfer the current power to make decisions from the Lapp Administration to the individual RHCs. This included internal decisions (e.g. distribution of grazing lands within the RHC) as well as external decisions (e.g. negotiations with competing land use parties). The goal was to increase RHC self-determination and this change in authority was contained in the new law that came into force in 1971 (SFS 1971:437). To manage the development and implementation of the decentralized decision-making, the CCG was established.

The frequency of CCG meetings and the number of participants increased substantially between 1971 and 2019 (Table 1), reflecting an increased awareness of the diversity of interests. Whereas the first meeting, held in November 1971, brought together three authority representatives, one reindeer husbandry representative, and one state forest representative, the meeting in February 2019 included five state authority representatives, six reindeer husbandry representatives, and eleven forestry representatives. From 1971 to 1983, there was a clear dominance of authority representatives, although the number of reindeer husbandry representatives only increased from one to three. Forestry interests also expanded by including forest industry, forest owner associations, and labour union interests.

In 1984, the forest commons were recognized as additional stakeholders and over the following twelve years (1984–1996) typically ten representatives of different interests participated in the meetings. The authority dominance was replaced by a dominance of forestry representatives, a trend that continued between 1997 and 2019. During this latter period, two additional forest landowners (the Swedish Church and the National Property Board of Sweden) were included as well as representatives of the Sami Parliament (authority) and the Association of Reindeer Owners. Thus, the typical number of meeting participants reached about 16 persons. The extended membership shows that there are different interests and opinions, even within forestry and reindeer husbandry, recognized by CCG by including representatives of e.g. small scale land owners, forestry workers and the Association of Reindeer Owners[6] as members.

Procedures

In the first three decades of *samråd* use, very little information was produced regarding the actual procedures except that the direct involvement of RHCs seemed to be minimal. Partly

TABLE 1 *Compilation of Central Consultation Group for reindeer husbandry and forestry (CCG) meetings by period and main category of interest (numbers and proportion of total), and invited speakers and observers*

	1971–1983	1984–1996	1997–2019
Recorded CCG meetings, total no.	7	21	41
Members representing authorities, total no.	25	59	148
Proportion of all CCG members	53%	27%	23%
Members representing reindeer husbandry, total no.	12	67	213
Proportion of all CCG members	26%	30%	33%
Members representing forestry, total no.	10	94	280
Proportion of all CCG members	21%	43%	44%
All members	47	220	641
In total	100%	100%	100%
Total number of invited speakers and observers by affiliation	Forestry 4 Reindeer husbandry 4 Research 1	Authority 74 Reindeer husbandry 5 Forestry 5 Research and education 7 Commissions 6	Authority 104 Reindeer husbandry 35 Forestry 21 Research and education 27 Commissions 9

[6] An organization for reindeer herders with focus on reindeer husbandry, not associated with the main Sami organization SSR (renagarforbundet.se).

as a consequence of this, a six-day course involving representatives of forestry, reindeer husbandry, and academia was organized in 1954 (Skuncke 1955). During this course, reindeer herders raised their concerns and demands directly with forestry representatives and vice versa. These discussions ended with a proposed resolution document that compiled the relevant considerations for reindeer husbandry interests, as well as suggested ways to ensure mutual learning (ibid.). Although the forestry representatives did not agree to any of the suggested adaptations to accommodate reindeer husbandry, several similar courses were organized in the following years. These developments anticipated the change towards a decentralized *samråd*. Similarly, conferences of representatives from forestry, reindeer husbandry, academia, and authorities to discuss "[t]he modern forest management impact on reindeer husbandry" were organized in 1970, 1976, and 1982 (*Lantbruksstyrelsen* 1970, 1976, 1984). During the 1982 conference, the governmental commission regarding the mapping of winter grazing land was discussed in terms of practical implementation and cost.

Although the introduction of a new Reindeer Husbandry Act (SFS 1971:437) and the corresponding decentralization of *samråd* to the local level can be considered to have made fundamental changes, no regulations were developed that provided practical advice and direction for the executive agencies. Therefore, the instructions in the 1958 royal decree to the Swedish Forest Service (November 21, 1958) remained a statement of good intent for the parties' understanding of the concept until 1982, when the Swedish Forest Agency published general guidelines for the Forestry Act regarding forestry considerations for reindeer husbandry interests (SKSFS 1982:2). Meanwhile, the CCG asked for clarifications regarding the application of *samråd* for non-public and individual landowners and suggested that the Swedish Forest Agency provide suggestions for how the Royal Decree of 1958 should be applied (1971-11[7]). A common agreement established during the first period of local *samråd* was that the affected RHCs should be notified well in advance so they can comment on the choice of logging areas before the logging plan is finalized (1971-11, 1972-05). *Samråd* should be organized as fixed annual meetings (1981-06) relying on map-based information showing planned forestry activities of final felling and the following operations, and these maps should be provided to the *samråd* participants in advance (1981-06). During *samråd*, the RHC should have the possibility to negotiate and make changes to planned forestry activities, and the parties should agree on the measures before any actions (1979-03). The outcome of each *samråd* should be documented, including the remarks of the RHC, and this document should be attached to the mandatory harvesting permit application to the Swedish Forest Agency.

To comply with the 1958 Royal Decree, later legislation, and the FSC certification Criteria and Indicators of responsible forest management, documentation of the local *samråd* has been considered crucial for the last half century. In 1979, it was suggested that the Swedish Forest Agency should always participate and keep minutes (1979-03, Table 2). Furthermore, a standard template for meeting minutes to ensure uniformity was discussed from 1979 to 2017 (1998-06, 2001-01, 2002-09, 2005-03, 2008-03, 2017-02). In particular, the Swedish Forest Agency representatives stressed the lack of information about consensus or conflicting opinions (2007-06) and the lack of plans that address reindeer husbandry (2000-10). In 2002 and 2007, a common minute template was put forth by the Swedish Forest Agency, but it was not generally implemented (2002-09, 2007-06). Thus, the varying quality of the minutes remained an issue during the 2010s (2011-11, 2015-02). In 2017, a project was proposed to develop a common digital *samråd* minute template and a communication portal (2017-02).

Another concern raised by the CCG was the different practices among forest companies. Therefore, both parties considered participation of personnel from the Swedish Forest Agency to be important as this would ensure the procedure is properly carried out (1985-02). Thus, a request for closer involvement by the Swedish Forest Agency in *samråd* has frequently been raised by both the reindeer husbandry and the forest industry (1994-10, 2001-10, 2006-09, 2009-03, 2010-10). However, during the last two decades, the engagement by the Swedish Forest Agency seems to have been replaced to some extent by the FSC Sweden National Office acting as a mediator (2012-08, 2013-08, 2019-02).

In line with the CCG instruction since 1984, a systematic regional follow-up of the *samråd* practice has been part of every CCG meeting. Until 1995, the Swedish Forest Agency did the reporting; after 1995, the parties did the reporting themselves. The statements regarding how well *samråd* worked, suggest that the reporting person/authority had a specific understanding of what *samråd* was or should be – i.e., essentially an administrative routine based on documents sent before meetings, planned forestry activities indicated on maps, and forestry activities properly documented (1992-10, 1993-10). In addition, reindeer husbandry representatives expected that the scope of *samråd* should include the entire reindeer husbandry area i.e., to also include winter grazing areas. In contrast, forestry representatives questioned this view in terms of an obligation and even questioned the customary law in certain areas (1985-02, 1986-03, 1989-09). There were also differing opinions regarding which forestry activities should be subject to *samråd* (1992-03), even though it was recommended that both forestry and reindeer husbandry activities that affect each other should be included (1988-08, 1992-03, 1993-10).

Issues raised

In the early 1950s, when clearcutting followed by soil preparation (e.g., prescribed burning) and sowing or planting was the dominant forest management practice, reindeer herders became concerned that forestry would negatively affect

[7] Minutes from the Central Consultation Group for reindeer husbandry and forestry (CCG) are referred to with year and month.

TABLE 2 *Frequent occurring issues in the Central Consultation Group for reindeer husbandry and forestry (CCG) minutes*

	1971–1983	1984–1996	1997–2019
Minutes from local consultations	x	x	x
Forest Agency's participation in local consultations	x	x	x
Forest certification			x
Follow-up of *samråd* practice		x	x
Compensation for loss of income etc. from forestry for participation in *samråd*			x
Final felling and succeeding regeneration measures	x	x	x
Damage to trees caused by reindeer	x	x	x
Follow-up on forestry-consideration to reindeer husbandry			x
Pinus contorta			x
Lichen inventories	x	x	x
Fertilization	x	x	x
Economic compensation for damage caused by forestry	x	x	x
Training efforts	x	x	x
Landscape perspective	x	x	x
Mapping and the importance of maps	x	x	x

lichen resources (Skuncke 1955). In 1966, a report concluded that forestry had little, and only temporary, negative impacts on reindeer husbandry and that lichen resources would not be hampered in the long term (SOU 1966:12). However, several later official reports (SOU 1979:55, 1983:67, 1989:41) concluded that modern forestry methods *did* negatively affect reindeer grazing areas. Thus, an overall and recurring issue reported in the CCG documents (Table 2) has been where, when, and how final felling and following site preparation should be done or not done (1972-05, 1988-05, 2002-03, 2003-10, 2006-03, 2013-02, 2016-02). Although the practice has developed towards methods aimed to reduce ground impact, site preparation has remained an issue for RHCs during the 2010s (2011-11, 2012-02, 2013-08, 2016-08, 2019-02). In the 1970s, RHCs raised concerns about cleaning and thinning less frequently. However, in 1996, RHCs demanded that these practices should also be discussed during *samråd* procedures (2013-02, 2016-08). Reindeer husbandry representatives have repeatedly raised concerns about fertilization practices (1984-08, 2011-11, 2012-08) and about the lack of input they have regarding these practices (2012-02). The use of *Pinus contorta* has also been frequently mentioned since the 2000s (2004-03, 2005-03, 2008-10, 2009-03, 2013-08, 2015-02, 2019-02), and as a cause of conflict and subject for mediation between the parties (2013-08, 2019-02). Among the few issues raised about reindeer husbandry negatively affecting forestry is the damage to seedlings/young trees caused by reindeer trampling, velvet shedding and snowmobiles. Since these issues were first mentioned in 1971, many studies have been initiated (1971-11, 1985-02, 1988-05, 1989-09, 1993-10, 1998-12), and methods for the assessment have also been brought up by the Swedish Forest Agency (1993-05, 2008-03). However, during the last decade no damage caused by reindeer has been discussed at the CCG meetings.

As forestry has a far greater negative impact on reindeer husbandry than reindeer husbandry has on forestry, RHCs have frequently raised the issue of compensation. During the 1970s and 1980s, compensation for reindeer killed by falling trees at felling sites has been discussed (1971-11, 1989-09). Later, compensation has been discussed for lost arboreal lichens (1985-05, 1988-05), lost grazing resources (2013-08, 2015-01, 2019-02, 2020-20), and impacts caused by site preparation and fertilization (2011-11). In 1984, the Swedish Forest Agency suggested that industrial forestry should compensate reindeer husbandry for damages caused by forestry activities (1984-08), but a year later the Swedish Forest Agency advocated that the compensation should be provided by the government (1985-05). Yet, after decades of discussions, no system of compensation for lost grazing resources caused by forestry activities has been put in place.

In 2008, the Swedish Forest Agency finally suggested follow-up of considerations for reindeer husbandry (2008-03), and the forest companies have presented their own system for reporting changes in management due to *samråd* (2011-11, 2015-02, 2017-02). However, the lack of statistics and variation in the documentation make it difficult to systematically evaluate to what extent agreements from *samråd* have been fulfilled (2015-02). A systematic evaluation would require inventories of reindeer grazing areas as already mentioned in the first instruction to the CCG in 1971. The effects on arboreal lichens (1983-8, 1998-1, 2015-02) and ground lichens (1973-10, 1990-10, 1997-2, 2013-02) by current forestry practices were discussed during all periods. This lack of agreement is the result of insufficient knowledge and methodology concerning arboreal lichen inventories (2008-03) and that forest companies and RHCs use different methods to

inventory ground lichen (2013-02). However, a common definition of gentle site preparation was adopted in 2013 (2013-08), and in 2019 special instructions for site preparation of lichen-rich ground were developed (2019-02).

Inventories, planning, and follow-up of forestry activities, including proposed and required actions taken for reindeer husbandry, are usually mapped according to the standard of each specific forestry company or management unit. While forestry's annual planning is based on treatment of many individual stands of different sizes and locations, reindeer husbandry planning is based on how reindeer herds move within and among large landscapes independent of stands or property boundaries. Thus, since the 1971 *samråd*, the RHCs have advocated for a landscape perspective rather than limiting the discussion to forestry issues at the stand level. To this end, the use of maps and the importance of mapping have been put forward by authorities, forestry representatives, and reindeer husbandry representatives as a way to facilitate and improve the *samråd* practice through improved mutual understanding. In fact, the number one item on the agenda of the first CCG meeting concerned compilation of all forest activities in a specific area – i.e., mapping (1971-11).

Outcome

Although the procedures and issues mentioned above are quite specific and tangible, others deal with approaches that are more fundamental to the concept of *samråd*, including the long-term goal to balance the use of the forest ecosystem resources between forestry and reindeer husbandry (1988-08). Most importantly, no common and unambiguous understandings have been reached concerning the concept of *samråd* or the expected outcomes. This is evident in the minutes as well as the evaluations carried out by the Swedish Forest Agency in 1985 and 1990 (*Skogsstyrelsen* 1987, 1992). According to the evaluations, whereas the forestry sector representatives believe that *samråd* are constructive and have increased in importance, reindeer husbandry representatives believe that *samråd* have increasingly come to be about receiving information from the forestry sector – i.e., they believe that *samråd* has become a forum for one-way flow of decisions. Reindeer herders pointed out the limited opportunities available to them to wield any substantive influence. To illustrate this, a few significant quotations are presented in Table 3.

Admittedly, all parties agree in principle that *samråd* should be more than just a forum for providing information about forestry activities, as *samråd* should also contain some measure of negotiation. However, no negotiation is possible about when and how *samråd* should take place because the Forestry Act (§ 20, §21 and §31) stipulates these issues. In addition, considerations to reindeer husbandry interests in terms of final felling and subsequent regeneration measures are solely evaluated by the Swedish Forest Agency. However, as expressed by the CCG chair (1997-06), *samråd* is about setting the level of ambition, the need for practical results, and the difficulty of finding solutions that satisfy both parties. Regarding the level of ambition, the CCG minutes indicate a higher level of consideration than stipulated in the Forestry Act – among other things that *samråd* should encompass the entire winter grazing area. Furthermore, considerations should also include fertilization and regeneration with the exotic tree species *Pinus contorta* and thinning in areas that are sensitive for reindeer husbandry (1998-12).

The need to learn from each other through education has been a frequent topic at CCG. Consequently, education was part of the first instruction to CCG in 1971. In addition, specific training efforts were identified and carried out in 1983, 1988, 1989, 1991, 1993, 1997, 2008, 2013, and 2020. Training topics include *samråd* skills, forestry knowledge for reindeer herders, and reindeer husbandry knowledge for foresters and authorities. In addition, it has been suggested that undergraduate and graduate programs in forestry should include more education about reindeer husbandry (2011-11, 2016-02).

In 1981 (1981-07), the CCG agreed to introduce and develop a mapping tool at that time called the "Jokkmokk model" to compile planned forest measures from the Swedish Forest Agency so each RHC would have an overview of all forest activities in the landscape. However, the "Jokkmokk model" was never fully implemented. Instead, paper maps of individual stands describing forestry activities, delivered from forest companies to RHCs, are still in common use today. These maps have repeatedly been criticized because they do not provide a landscape perspective of proposed forest activities. This limitation sparked a need for more efficient digital tools for land use mapping (1988-05) and contributed to the development of reindeer husbandry plans (in Swedish *RenBruksPlan*, RBP) initiated in 2000 (Sandström *et al*. 2003,

TABLE 3 *Examples of quotations from reindeer herding representatives in Central Consultation Group for reindeer husbandry and forestry (CCG), illustrating their experience of influence in local* Samråd

Quotation	Translation	Protocol nr. (page nr.)
"rennäringen har en svag förhandlingsposition"	reindeer husbandry have a week negotiation position	1994-10 (2)
"bolagen bara lämnar information vid samråden"	*samråd* is merely information from forest companies	2000-10 (3)
"samebyn hela tiden är i underläge"	RHCs are constantly underdogs	2008-10 (5)
"samebyarna bör få mera att säga till om"	RHCs should have more influence	2014-08 (3)
"skogsbruket kör över samebyar"	RHCs are ignored by the forest industry	2017-02 (5)
"det saknas mandat att göra förändringar"	lacking mandate to make changes	2018-08 (3)
"frustration för att man inte får gehör i samråden"	frustration for not being heard during *samråd*	2019-02 (6)

Sandström 2015). Over time, this comprehensive digital tool and model has developed to contain reindeer herder's mappings and field inventories of seasonally important grazing areas as well as positional data provided by several thousand GPS-equipped reindeer. The RBP also includes a comprehensive compilation of all other land uses. Furthermore, the RBP enables RHCs to import information provided by forest companies, such as planned forestry activities, into their system. Through the use of RBP, the land use needs of reindeer husbandry as well as the impacts of forestry activities can then be viewed with a landscape perspective and in relation to all other ongoing land uses.

Although continually developing, RBP has presently been adopted by 50 of the 51 RHCs in Sweden. However, the level of use of RBP during *samråd* varies (2004-03, 2006-09, 2019-02). Furthermore, an extension of the RBP to allow planning of forest management by the RHCs was suggested (2004-03). Documented shortcomings related to RBP include the RHCs not receiving the proposed forestry activities in digital form well in time to review them before *samråd,* and that forest companies sometimes lack information from the RBPs in their planning systems (2008-03, 2011-11, 2014-08). Consequently, RHCs are still calling for a dialogue based on a landscape perspective (2017-02).

The first Swedish FSC standard was approved in 1998. It introduced an additional basis for the procedure of *samråd*, clearly stating that sending a letter to the RHC and asking for comments cannot replace a proper *samråd* (2005-03). The importance of face-to-face meetings based on documents that have been sent out well in advance and documented in accordance with minutes that clarifies what has been agreed or not agreed were stressed. Yet, the inability to agree on a standardized minute template and how it should be implemented indicates that *samråd*, both in terms of content and procedure, are very complex and that this complexity plays out differently at different levels and scales. Over time, the *samråd* practice has also become more complicated and resource consuming (i.e. time and money), which both forestry and reindeer husbandry representatives find frustrating (2018-08). New tools and technology, in particular the development and use of RBP, have meant that *samråd* are usually better prepared, but the overall conditions for reindeer husbandry have not improved.

DISCUSSION

The conducted examination of the *samråd* processes and issues has provided an enhanced understanding of how the sectors of forestry and reindeer husbandry have envisioned the concept, and its corresponding procedures. Despite the fact that the two interest groups, as well as rights holders, have different views regarding the issues that *samråd* should cover, what the process should look like, and not least the considerations to be given to each other's management activities, *samråd* still remains the overall form of institutional arrangement for deliberation. However, although introduced by governmental authorities and later through the Forestry Act, more recent implementations have been characterized by reduced presence and influence of authorities in favour of forest industry and forest authority representatives (Table 1). The overall consequence of this change in authority has been to reinforce the position of more powerful actors (i.e., forestland owners and forest companies) rather than to strengthen the influence of local stakeholders (cf. Arnstein 1969, Buchy and Hoverman 2000, Poudyal *et al*. 2015, Wood 2010). Reindeer herders' perceived lack of influence at *samråd* during our study period (Table 3) is paralleled by a 71% decline of lichen, the most important winter food for reindeer, and also the key resource at stake in the *samråd* processes (Sandström *et al.* 2016).

By viewing the results presented through the prism of "power and responsibility for change" as presented by Partzsch (2017: 200), the first three dimensions of *power over* – visible power, hidden power and invisible power – seem to be the most obvious ways of understanding the observed standstill in several *samråd* matters, procedures, and issues, whereas the fourth dimension – unconscious power – provides openings for "new thinking" towards an understanding of *power to* where "individual agents can provoke change and overcome structural constraints" (2017: 205). In the following section, we will discuss how powerful actors directly determine the actions of others (first dimension), the manifestation of power through some issues that do not make it on to the political agenda or are discarded before negotiations start (second dimension), and how power is exercised by means of influencing, forming, and constituting ideas and intentions (third dimension). Finally, the development of RBP and digital mapping will be discussed as expressions of the fourth dimension, where change can be introduced by "new thinking" that results in "self-empowering agents of transformation" – i.e., *power to* (Partzsch 2017: 199-200).

The shift from centralized *samråd* between authorities, explicitly acknowledging reindeer husbandry as the less powerful actor, to a system with local *samråd* between land users has not undermined forestry's position as the dominant actor. Among other things, this is indicated by the CCG composition, where forestry representation has increased considerably more than the reindeer husbandry representation. This trend seems to correspond with the reported unevenness of power distribution at local *samråd* by Sandström and Widmark (2007). Furthermore, the shift in representation resonates with trends of deregulation and reduced state intervention in general through what Appelstrand (2012) describes as new modes of governance in the Swedish forest sector. However, in contrast to the "successful example of the new orientation towards environmental management" in the Östra Vätternbranterna Partnership (Appelstrand 2012: 1), the procedure of *samråd* between forestry and reindeer husbandry does not meet the expectations of the reindeer herders with respect to negotiations, trade-offs, and shared decision power.

The reindeer herders' expectations of the *samråd* procedure draws on the traditional local democratic culture (cf. Wänström 2009), which also corresponds with the current lexical definition (SAOB 1964, SAOL 2015, SO 2009) and

matches what Arnstein (1969) defines as partnership[8]. However, our data shows that the practice of *samråd* is more similar to Arnstein's lower rungs of the participation ladder and Partzsch's second and third dimension of *power over* (2017). This agrees with Sandström and Widmark (2007) who found that reindeer herders have little power to influence final decisions. The seemingly paradoxical consequence of this approach may be due to a parallel development of *samråd* within the area of public participation. In 1987, the concept of *samråd* was introduced in Sweden's Planning and Building Act and the following year in the Municipality Act (SOU 2001:89) with the aim to increase the public's influence. In 1998, *samråd* was added to the Environmental Code with the primary purpose to gather public opinion and knowledge before decision-making rather than to support co-management. The opinion gathering may take different forms, as exemplified in a guide for planning of wind power plants published by The National Board of Housing, Building and Planning (e.g., consultation meetings, mailings, personal visits, telephone calls, and advertisements in the local press) (Boverket 2012). Thus, the watered-down meaning of *samråd*, as expressed in the Forestry Act, makes *samråd* an instrument for information gathering before decisions are made on forest management activities. More specifically, the Forestry Act only demands that the RHC shall be given the opportunity to participate in *samråd* on the area where grazing is allowed all year (§20), which excludes the important winter grazing areas where the majority of the productive forest lands are located. Additionally, the considerations and adaptations requested are those "which are obviously called for" with regards to reindeer husbandry (SFS 1979:429, §31). Therefore, it is not surprising that the understanding and expectations of *samråd* differ among actors and interests represented in CCG and that divergent views of the efficiency and outcome are frequently expressed in the minutes.

Despite clarifications made in the general guidelines in the Forestry Act issued in 1982, disagreements remain, regarding which forest management activities should be included in *samråd* as well as if the winter grazing areas should be included. Forestry, being the dominant actor, has been able to delay and prevent some issues from making it on to the agenda (i.e., second dimension of *power over*). Because the vast majority of forestry activities are ongoing in winter grazing areas and these areas constitute the bottleneck resource in reindeer husbandry, this touches on the very essence and purpose of *samråd* – namely, its conflict mitigating ability. Although in principle the CCG agrees that *samråd* should include measures of negotiation and adjustments of forestry plans according to proposed compromises, the reviewed CCG documents also show that RHCs affected by the proposed actions cannot influence decisions on an equal basis relative to forestry interests. Furthermore, the *Inquiry on Sami Rights* published in 1989 (SOU 1989:41) contained several proposals aimed to strengthen reindeer grazing rights, but these were never signed into law. There was also an effort to strengthen reindeer grazing rights in the proposed new Forestry Act (PROP 1990/91:3) by giving the Swedish Forest Agency the right to dictate forestry measures in important grazing areas, similar to what was suggested for areas of natural and cultural importance. However, the Council on Legislation argued that because the conflicting rights of reindeer husbandry and forestry belonged to different private actors, the government or agencies could not interfere on behalf of either. Instead, the finalised 1991 Forestry Act only stated that the forest industry should generally adapt their methods in areas considered to be of obvious value to reindeer husbandry, handing over the major responsibility to each forest owner (Brännström 2017). This law was further watered down in 2010 when forestry restrictions were abolished for land classified as difficult to regenerate (Brännström 2017).

In search of sustainable and balanced coexistence between forestry's claim to the timber resource and reindeer husbandry's claim to their rights-protected grazing areas, co-management arrangements have never been an option discussed by CCG. In addition, goals for lichen rich forests with respect to forestry practices and non-sustainable levels for the survival of reindeer husbandry have not been discussed. The idea of coexistence, although never specifically defined or realized, seems to assume that the forest industry and reindeer husbandry will sufficiently consider each other's interests and claims by staying properly informed. Finding this balance corresponds with the general Swedish forest strategy of "freedom with responsibility". In this regard, the wording of the considerations and adaptations in the Forestry Act are crucial (SFS 1979:429, §31). However, the lack of definitions and clarifications of the considerations has frequently resulted in a focus on final felling, site preparation, *Pinus contorta* plantation, and fertilization. A major shortcoming in this regard, although it has been an issue since 1971, is the limited methods for a systematic evaluation of the considerations as well as the trends for the amount and distribution of key resources. Thus, an indication of the shortcomings after decades of *samråd* can be seen in the trends of the key resources at stake. Here, research shows that forests classified as lichen abundant (lichen cover > 50%) have declined from 1.4 million ha in 1955 to 0.4 million ha in 2016, representing a 71% decline (Sandström *et al*. 2016). Simultaneously, there has been a significant decline in epiphytic tree lichens (Esseen *et al*. 2019). During the same period, forest statistics (*Skogsdata* 2018) show a substantial increase in annual final felling volume from 6 million m^3 to 13 million m^3 and the timber stock has increased from 788 million m^3 to 1 200 million m^3. Overall, these figures confirm the concerns and observations put forward by reindeer husbandry representatives in the CCG regarding exceedingly limited possibilities for sustainable and balanced coexistence. It also raises the issue of compensation, which has been brought up by RHC representatives since 1985 and problematized in the literature (Brännström 2017, Widmark 2009). The complexity of this issue is not only about who should be compensated for

[8] Partnership enables the citizens to negotiate and engage in trade-offs with traditional power-holders.

the loss of grazing areas, but also about the level and type of compensation. On the one hand, it can be argued that it is the responsibility of the state due to its previous actions resulting in the present parallel legal relationship and complex legal situation. Furthermore, according to the Swedish Constitution, it is the state's responsibility to promote the Sami's opportunity to strengthen their culture (Brännström 2017). On the other hand, forestry's infringement of reindeer husbandry rights makes it liable for the compensation. From an economic point of view, Widmark claims that "it is more profitable for forestry to compensate reindeer husbandry for lost grazing areas, instead of increasing consideration within consultations" (2009: 49). However, even if economic compensation supplements the cost of fodder, it does not help maintain the traditional form of reindeer husbandry practice and a Sami culture based on naturally occurring grazing resources (Widmark 2009).

The transformative potential of participatory mapping

The CCG meetings concluded that an increased use of maps through the introduction of GIS tools was needed. After some initial local attempts, two parallel strategies evolved with the explicit purpose to develop maps of the reindeer husbandry area (Vestman 2014). The first strategy, a consequence of the introduced environmental bill (SFS 1998:808), identifies reindeer husbandry as a National Interest (*Riksintresse*) and the County Administration Board became responsible for its documentation. Today, this responsibility falls on the Sami Parliament, and general maps of reindeer grazing areas, facilities, and movement routes are collected and updated in a public database, *iRenmark*. Using Partzsch's (2017) ideal types, this would be an example of the third dimension, *power over*, as even though the original data are delivered by the RHCs, the language, framing, purpose, as well as data remain under governmental control (Sandström *et al.* 2020b). The second strategy is based on participatory mapping and was initiated by two RHCs in 2000. The RHCs felt an imbalance in power relations when forestry companies presented their forest plans using maps, whereas RHCs could only respond orally about their land use needs (Sandström *et al*. 2003). Furthermore, the use of digital mapping tools would move the dialogue from a stand-based assessment to a landscape perspective, which has been highlighted by Sandström (2015) and are in line with the explanatory and pedagogic power of using maps as suggested by Wood (2010).

The combined participatory bottom-up and top-down approaches, established in the RBP concept, has produced maps that are made, owned, and controlled by RHCs but resemble professional or official maps, an arrangement that could explain why they have been successful (cf. Wood 2010, Sandström *et al*. 2020b). Individual reindeer herders have also reported that with a carefully produced RBP, they are perceived as more credible in discussions with forestry companies (Andersson and Keskitalo 2017) and in other planning processes (Sandström *et al.* 2020a). The technological know-how is in itself also a source of power (Anderson and Keskitalo 2017). Based on Partzsch (2017), it could be argued that the RBP process is an example of *power to* since the initiative came from the Sami community in response to an experienced uneven power structure (Sandström *et al.* 2003). However, funding for the effort as well as facilitation of the process were provided by the government and its agencies. Therefore, it could also be argued that this is an example of the fourth dimension of *power over* (Partzsch 2017), where the RBP became the "new thinking" responsible for initiating change in the power relations.

Before 1971, the government and its agencies used *power over* to regulate the conflict between reindeer husbandry and forestry. The revised SOUs make it clear that the government was going to continue to do so but using legislation and detailed regulations to induce a power shift in favour of reindeer herding. However, the government opted to delegate the practical decision power to the two actors involved, arguing that the two parties would act in a *power with* coactive way, and learning from each other, which would result in adequate considerations, creating a win-win situation (cf. Partzsch 2017). This belief was further strengthened after the concept "freedom with responsibility" was adopted, cementing a political and corporate discourse that argues that reindeer husbandry and forestry should co-exist. This arrangement, however, ignores the fact that power relations between the parties are not equal and assumes that the dominant party would voluntarily give up power (Sandström and Widmark 2007). *Power over* is often described as a situation with winners and losers (Partzsch 2017). Although *samråd* assumes negotiations will be conducted on equal terms, the unequal power balance ensures reindeer herders will be on the losing side of negotiations.

CONCLUSION

Although the meaning of *samråd* between reindeer husbandry and forestry has been watered down, the practice has become more inclusive and formalized. However, without a clarification of how the total amount of the key resources within the common ecosystem can be secured, a sustainable and balanced coexistence between forestry and reindeer husbandry will be hard to achieve. During the time period of our analysis, the lichen resources have decreased significantly at the same time as both timber harvesting and the timber stock has increased substantially. This situation illustrates that although the pretext is that negotiations should be conducted on equal terms, reindeer husbandry finds itself on the losing side. Our analysis suggests that power has largely remained with the more influential and economically stronger forest industry. Participatory mapping efforts to communicate the needs of reindeer husbandry and the distribution of the grazing resources can help equalize the positions during *samråd*. Nevertheless, to achieve the desired effects on the ground, corresponding changes of the institutional framework are required regarding, for example, legislation and policies at the national and organizational levels.

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III

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KUNGL. VETENSKAPS-AKADEMIEN
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RESEARCH ARTICLE

Adapted forest management to improve the potential for reindeer husbandry in Northern Sweden

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Abstract In northern Sweden, improvements of grazing conditions are necessary for the continuation of traditional, natural pasture-based reindeer husbandry. Ground and tree lichen constitute the main fodder resource for reindeer during winter but have reached critically low levels. Using a forest decision support system, we prescribe adapted forest management to improve the preconditions for reindeer husbandry and compare outcomes with the continuation of current forest management. We found that adapted management increases the forest area with ground lichen habitat by 22% already within 15 years, while a continuation of current management would result in a further decrease in ground lichen. Tree lichen habitat can be retained and increased in all scenarios, which is important in a changing climate. Compared to a continuation of current practices, adapted management with significantly improved conditions for lichen resulted in a decrease in net revenues from wood production by 11–22%.

Keywords Boreal forest · Forest management · *Rangifer tarandus* · Scenario analysis

INTRODUCTION

Balancing overlapping and competing land uses is challenging in most ecosystems globally, in part due to conflicting interests, imbalanced power relations as well as lack of knowledge regarding the long-term consequences of different land management options. Holistic landscape approaches that include people and communities as part of the landscape can provide the scientific basis for policy choices regarding ecosystem management (Garedew et al. 2009; Svensson et al. 2012). To understand impacts and facilitate planning among land users, scenario analysis can be a valuable tool in search of balanced and sustainable solutions (Eggers et al. 2019, 2022). We exemplify the common dilemma of multiple and conflicting land users operating in the same area in the northern half of Sweden, where reindeer husbandry and forestry have divergent objectives reflected in their forest use. Here, forest owners' primary objective is commonly wood production on their property, whereas reindeer herders are dependent on forests as a part of a pastoral landscape, where the main winter fodder resource for the reindeer is terrestrial and epiphytic lichen (Heggberget et al. 2002) (hereafter termed ground and tree lichen). The complexity of this dilemma is magnified by differing and competing views of what constitute landscape perspectives. In forestry, individual forest stands and property boundaries usually constitute the landscape in focus. In reindeer husbandry on the other hand, focus is on a much larger pastoral landscape that at times also spans several grazing seasons (Sandström 2015; Harnesk 2022). Furthermore, Roturier and Roué (2009) discuss the Sami word and concept *guohtun* that in addition to explaining the amount of grazing resources, also incorporates the distribution and accessibility of grazing resources. In this context, barriers caused by other land uses as well as snow conditions become important factors to consider.

Winter grazing and ground lichen in particular is recognized as the bottleneck resource in reindeer husbandry, while tree lichen is an especially important resource at times when snow conditions make the ground lichens inaccessible to the reindeer. Such winters, with difficult snow conditions, are becoming increasingly common under

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changing climate conditions, which further elevates the problem (Eira et al. 2013; Skarin et al. 2021; Rosqvist et al. 2022).

The pastoral reindeer husbandry system constitutes historical legacy, closely connected to the culture, tradition and well-being of the indigenous Sami people (Lundmark 2010). The Reindeer Husbandry Act (1971, p. 437) defines the exclusive rights for the Sami people to herd and graze their reindeer (*Rangifer tarandus*) on 55% of the Swedish land area, divided into 51 individual reindeer herding communities (RHCs). In this area, RHCs have the right to graze on all land regardless of ownership, and this grazing right is considered equal to ownership rights according to legal scholars (Hahn 2000; Brännström 2017). However, no areas are reserved exclusively for reindeer husbandry as other land uses always co-occur (Sandström 2015).

Industrial forestry started in northern Sweden during the 1850s (Östlund 1993; Widmark 2009), and has since then been transforming the forest landscape and changed the conditions for pastoral reindeer husbandry. One main objective of forest owners as well as forest policy has been to increase wood production. Forestry practice has changed from mainly uneven-aged forestry to even-aged forestry affecting almost all productive forests after the Second World War (Östlund et al. 1997; Lundmark 2010). Since then, the changed management has resulted in a continual densification of forests with higher growing stock, higher growth rates, increased harvest levels and larger areas of young and dense forests. The growing stock and harvest volumes have increased with more than 60% since the 1950s (SLU 2022). Forest regeneration has been intensified using soil scarification and planting. In combination with fertilization and plantation of Lodgepole pine (*Pinus contorta)*, this has led to a densification of forest stands, which is a major contributing factor to the ground lichen decline with 71% since the 1950 (Sandström et al. 2016; Tonteri et al. 2022; Horstkotte et al. 2023).

During the same period, tree lichen-abundant forests have also declined considerably as modern clear-cut forestry practices have become more widespread, causing significant shifts in age structure towards younger forests (Esseen 2019). As an example, tree lichen decline was estimated to 51% in a study area in the county of Norrbotten between 1926 and 2006 (Horstkotte et al. 2011). Furthermore, testimonies from reindeer herders state that both ground and tree lichen resources have reached a critical tipping point where traditional, natural pasture-based reindeer husbandry based on naturally occurring winter foods is severely threatened.

The pastoral reindeer husbandry system in Sweden includes migrations between and within seasonal grazing grounds. Similar to the pastoral system of the Sami people, an additional ca 20 indigenous groups practice reindeer husbandry across the Eurasian arctic, often overlapping with other land use forms such as forestry, mining, oil and energy exploration (Oskal et al. 2009). Of specific importance to the reindeer husbandry year are the spring migration to the calving grounds close to the summer grazing grounds, and the autumn migration back to wintering areas. The mountain RHCs migrate between the forestland and the mountains, while the forest RHCs migrate within the forestland. A functional wintering area for reindeer consists of a varied forest landscape that offers grazing opportunities at different weather and snow conditions (Roturier and Roué 2009; Harnesk 2022; Horstkotte et al. 2022). Besides the availability of lichen, important issues for reindeer herders include mobility through forests for both reindeer and herders, in particular along migration routes. The reindeer herders repulse Lodgepole pine plantations, as dense stands with low branches hinder the movements of both reindeer and herders, as well as reducing the occurrence of ground lichen (Horstkotte et al. 2023). In addition, intensive soil scarification can be a physical obstacle for the reindeer as well as destroying ground lichen areas (Roturier and Bergsten 2006; Svenska Samernas Riksförbund 2019).

The prerequisites for traditional, natural pasture-based reindeer husbandry are also threatened from other activities such as mining, wind power installations and other infrastructure extensions, in combination with climate change with altered weather and snow conditions (Sandström 2015; Fohringer et al. 2021; Skarin et al. 2021). Further stressors on the pastoral reindeer husbandry system are predators and tourism, and the combined effects of these cumulative pressures are occurring over large areas (Stoessel et al. 2022). However, forestry affects the largest area and directly the lichen resources. At the same time, forestry constitutes a land use activity Sami reindeer herders can influence and that could improve grazing conditions, if forestry practices are adapted to the needs of reindeer husbandry.

Together, private (SCA AB, Holmen Skog AB and several smaller companies) and state-owned (Sveaskog AB and the National Property Board) forest companies own and manage about half of the productive forests in the reindeer husbandry area (Sandström et al. 2016). Since 1923, some form of joint planning of forestry and reindeer husbandry has taken place through consultations (Skuncke 1955; Roos et al. 2022). Consultations in its present form have been legislated since 1990 (SFS 1979) and are mandatory for large forest owners (owning $>$ 500 ha) on the year-round grazing grounds (SKFS 2015). The authorities recommend also including winter grazing grounds in the consultations. All larger private forest companies and the state-owned forests are certified by FSC, where consultation is mandatory also on winter

grazing grounds (FSC 2020). At annually recurring consultations, each forest company presents their planned areas for final felling to the affected RHC. The consultations can also include regeneration measures, areas for fertilization, cleaning, thinning, planned forest roads and choice of tree species for regeneration. In separate reviews of the consultation procedures, Roos et al. (2022) and Widmark (2009) showed that the reindeer herders experience a lack of influence during consultations.

One way to improve the co-planning of forestry for timber production and reindeer husbandry would be to include the reindeer herders' landscape perspective into the forest planning process, as suggested at least since 1954 by Skuncke (1955). As the reindeer move in the landscape, they have different needs in different times of the year. However, in practice today, consultation is only carried out on the level of individual forest stands based on forest ownership. As forestry is the financially stronger actor, they have defined the content and level of the consultations (Roos et al. 2022). One way forward could be to explicitly include aspects important for reindeer husbandry into the forest planning process at the company level. The forest companies use decision support systems (DSS) for determining the long-term planning of harvest levels on their forestland (Nilsson et al. 2013; Ulvdal et al. 2022). The DSS is used to optimize the forest management in terms of economic return from forestry and non-declining timber flows. Aspects related to reindeer husbandry are largely treated by including a so-called planning reserve, i.e., a requirement that the amount of harvestable forest volume must always exceed the planned harvest volume. This requirement is meant to account for the uncertainty that the forest companies face regarding the outcome of the consultations. However, the extent to which management practices are adapted more specifically to the needs of reindeer husbandry, in terms of timing of thinnings and thinning grade, as well as cleaning, is very limited.

In previous studies, Korosuo et al. (2014) and Miina et al. (2020) showed that a continuation of current management practices would lead to a further decrease in ground lichen habitat. Horstkotte et al. (2016) showed that net present value was reduced by 10–11% between current management practices and adapted management in lichen-rich forests, but did not evaluate the effects of management practices on land with the potential to re-establish ground lichen if management is adapted to promote lichen growth. Hence, there is an urgent need to develop and agree upon new and adjusted forest practices. In particular, there is a need to identify management strategies that improve the availability of ground lichen and balance this with maintaining high wood production.

The aim of this study is to define and compare alternatives of forest management practices in terms of the outcomes for wood production and conditions for reindeer husbandry. In particular, we aim to answer the following research questions:

- How does the continuation of current forest practices affect conditions for reindeer husbandry in terms of habitat for ground and tree lichen and mobility across the landscape?
- How can reindeer-adapted forest management improve conditions for reindeer husbandry?
- What are the effects of the different forest management practices, in terms of wood production, production of lichen habitats and economic output?

We will do this by defining and comparing three different forest management scenarios for a large forest landscape in northern Sweden. The scenarios included a reference scenario continuing current management practices, and two scenarios with forest management practices that were adapted to the needs of reindeer husbandry. These scenarios were simulated in a forest decision support system for a time horizon of 50 years.

MATERIALS AND METHODS

Study area

The study area is located in the County of Västerbotten in northern Sweden, on the winter grazing grounds of Vilhelmina Norra RHC (Fig. 1). The entire RHC covers 14 400 km^2 where reindeer spend the snow-free seasons in western mountains and winters in the eastern coniferous boreal inland and coastal forests. The yearly movements of reindeer in the RHC can span more than 700 km from the west during summers, to the winter ranges in the east and back again via movement routes (reindeer corridors), which in part pass through our specific study area. The RHC is organized into different winter groups *(siida, sijdda, sijte)* and our specific focus area is on the wintering lands of the winter group Vardofjällsgruppen covering 161 454 ha (Fig. 1). The forest companies SCA AB, Holmen Skog AB and Sveaskog own 117 050 ha of forest (72%) of the case study area, of which 115 421 ha is productive forestland, i.e., having a potential mean annual increment of more than 1 m^3/ha/year. These companies provided stand-level information on management class, tree species distribution, site conditions, standing volume, age and basal area as input data for the analysis. Non-productive forestland is not managed, so we only considered the 115 421 ha of productive forests in the specific scenario analysis. The forest has a mean age of 52 years, with 70% of the area being younger than 61 years. The forest in the study area is thus younger compared to the

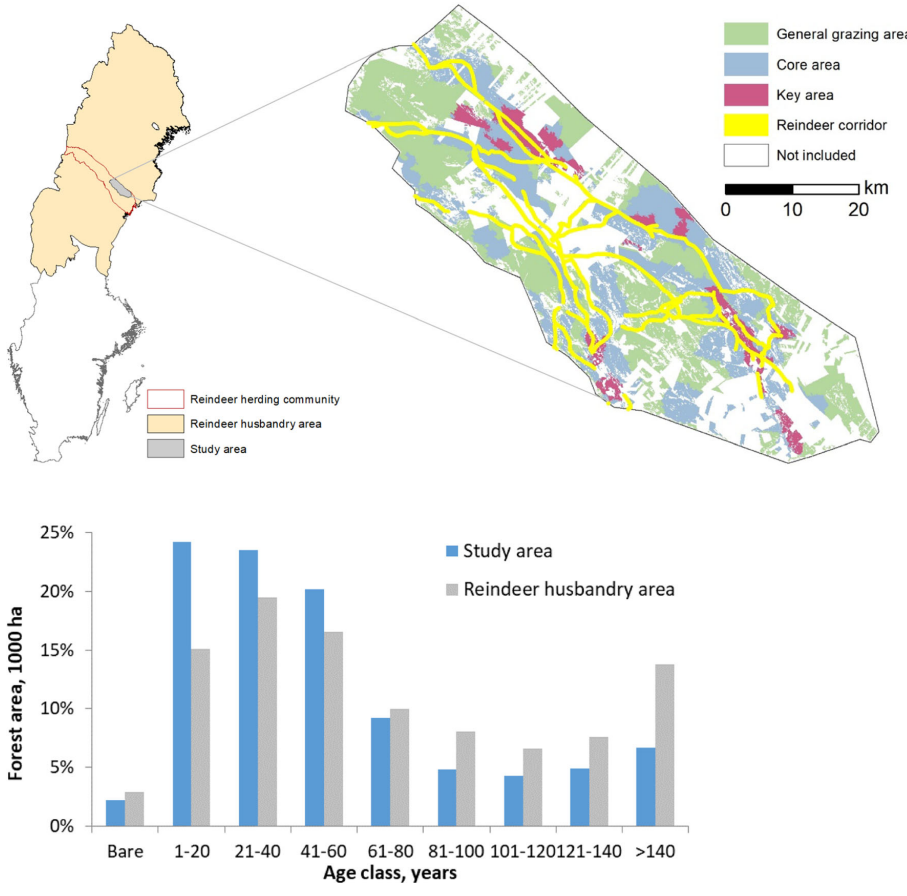

Fig. 1 Overview of the study area: Its location within Sweden (top left), the division of the productive forest in the study area owned by the three forest companies divided into core, key and general browsing areas connected by reindeer corridors (top right), and the age-class distribution (lower panel). The age-class distribution includes the productive forests owned by the three forest companies in the study area, compared with the reindeer husbandry area. Area not included in the analysis includes forest owned by other owners, and other land uses

average in the reindeer husbandry area (Fig. 1). The forest is dominated by Scots pine (*Pinus sylvestris*) with 65% of the growing stock, Norway spruce (*Picea abies)* 21%, birch (*Betula* spp.) and other broadleaved species 9% and Lodgepole pine (*Pinus contorta)* 5%.

In general, forests are managed for timber production using even-aged forestry, with stand-replacement cuttings followed by regeneration (mainly through planting after soil scarification), cleaning and one to three thinnings. Effective fire protection has eliminated fire as a disturbance factor. Till is the dominant soil type, with field layers including bilberry (*Vaccinum myrtillus*) and cowberry (*Vaccinum vitis-idea*). The forest floor layer is covered by leurocarpous mosses such as *Pleurozium schreberi* and *Hylocomium splendens* in mesic areas, while reindeer lichens (*Cladonia* spp.) dominate in drier parts. Especially during winters with difficult snow conditions, epiphytic tree lichens become especially important, including *Alectoria sarmentosa, Bryoria* ssp. and *Usnea* ssp.

Supported by our research team, Vilhelmina RHC has mapped and described habitat use and movement of reindeer across the landscape in their Reindeer Husbandry Plan (RHP), based on their expert knowledge and remote sensing techniques, further supported by GPS-data from reindeer (Fig. 1) (Sandström 2015). This division of grazing lands including key, core and general grazing areas is part of a dynamic and constantly updated process including new knowledge and changes in the landscape. Key areas contain

the highest quality grazing lands, crucial for reindeer husbandry. Core areas are important areas regularly used for grazing, usually surrounding key areas. General grazing areas surround key and core areas and often delineate the entire lands used by a winter group. Grazing areas are connected through reindeer corridors both within seasonal grazing areas as well as for longer migrations between coastal forests and the mountains (Sandström 2015; Sametinget 2022). In our analysis, we used a standard width of 600 m for the reindeer corridors.

Indicators for wood production and reindeer husbandry

To assess the impact of forest management on wood production and reindeer husbandry, we defined a number of indicators based on National Forest Inventory (NFI) data and earlier studies (Table 1).

According to NFI data (SLU 2022), the majority of lichen-abundant/lichen-moderate plots in the reindeer husbandry area (about 90%) were situated in Scots pine-dominated forests with a site index between 12 and 19 (Supplementary material Table S1), and on dry and mesic sites (98%) (Supplementary material Table S2). However, since such class boundaries are not exact we also include pine forest with a site index of 20 as our indicator to have the potential to maintain/colonize/re-colonize ground lichens. A basal area of 15 m^2/ha has been reported as optimal for lichen growth (Jonsson Čabrajič et al. 2010), abundance (Sandström et al. (2016) and decline (Horstkotte and Moen 2019). While ground lichen occur also in forests with higher basal areas, lichen occurrence declines significantly in forests with a basal area over 20 m^2/ha (Sandström et al. 2016). Therefore we use pine-dominated forests, with a basal area below 18 m^2/ha, on dry and mesic sites as an indicator for lichen habitat.

In forest stands older than 63 years, the presence of tree lichen becomes more common (Horstkotte et al. 2011; Horstkotte and Djupström 2021). As tree lichen disappear completely after clear-cuts, selective fellings and longer rotations are directly beneficial to increase potential tree lichen presence in the landscape (Rikkonen et al. 2023). At the same time, open stands with canopy closures below 70% often lead to a decline in tree lichen occurrence (Boudreault et al. 2013). Below this threshold, there is a risk for the lichen to dry out or to blow away by wind. Since simulations of canopy closure was not possible in the forest decision support system used in our study, we used a closure index based on the ratio between the actual forest volume, compared to the volume that would be optimal to fully use the wood production potential of the site. Based on a comparison of this closure index with canopy closure using NFI data, we chose 0.6 as threshold for the closure index.

Lodgepole pine-dominated stands are denser than domestic conifer stands (Bäcklund et al. 2018). Ground lichen cover was found to be lower in Lodgepole pine stands compared to domestic pine (Bäcklund et al. 2015) and the needle litter cover was more than three times greater (Nilsson et al. 2008). Also, Lodgepole pine-dominated forest aggravates the work for the reindeer herders, since the Lodgepole pine plantations are hard to pass through both for reindeer and herders (Svenska Samernas Riksförbund 2019). Therefore, the forest policy of the National Confederation of Swedish Sami states a zero tolerance against the planting of Lodgepole pine, and demands transformation of existing plantations to domestic species (Svenska Samernas Riksförbund 2019).

Table 1 Indicators used to assess the impacts of forest management on reindeer husbandry and on wood production

Indicator	Definition
Forest area with potential ground lichen habitat	Area of pine-dominated forest, site index 12–20, dry or mesic soil, basal area < 18 m^2/ha
Forest area with potential tree lichen habitat	Forest area with age > 60 years and a closure index ≥ 0.6
Forest area dominated by Lodgepole pine	Lodgepole pine has largest basal area or stem number among all species present in the stand
Density of forest in reindeer corridors	Basal area of trees within reindeer corridors (m^2/ha)
Harvest volume	Volume extracted from the forest, divided into sawlogs and pulpwood (m^3ub)
Net revenues from wood production	Gross revenue from timber and pulpwood minus costs for harvesting and silvicultural operations (EUR)
Annual area of thinnings, selections fellings and final fellings	Area (ha)
Net annual increment	Annual growth in tree volume, excluding natural mortality (m^3ob)
Growing stock	Tree stem volume above the felling cut. Includes bark and top of the tree, but not branches (m^3ob)

Scenario analyses and modelling framework

Scenario analysis is a useful method for exploring plausible futures (Bengston et al. 2012). Long-term scenario analyses are a common way to analyze and compare outcomes of forest management practices (Peterson et al. 2003). In this study, we defined three scenarios with different management practices based on consultation with representatives for the forest companies and the RHCs. The consultations even included in-depth discussions of the chosen indicators as well as preliminary results, allowing us to adapt the simulations according to the comments we received.

The scenarios were:

- Reference—Current forest management practices as defined by the forest companies.
- Ground lichen—Forest management practices with the objective to increase the area with ground lichen habitat and mobility of reindeer.
- Ground and tree lichen—Forest management practices with the objective to increase the area with ground and tree lichen habitat and mobility of reindeer.

The development and wood production of the productive forest in the study area for the three scenarios were simulated 50 years into the future, using the forest decision support system (DSS) for long-term analysis and planning of the forest landscape Heureka PlanWise (version 2.18.3.0) (Lämås et al. 2023). A simulation period of 50 years was chosen because it is the next decades that are decisive regarding the future of traditional, natural pasture-based reindeer husbandry, and because uncertainties regarding the tree layer development increase with longer time periods.

We simulated the development of the tree layer in 5-year time increments using a large set of empirical models simulating growth, mortality and ingrowth. Expected impacts of climate change on forest growth were accounted for by adjusting the empirical growth functions using the BIOMASS process-based vegetation model (McMurtrie et al. 1990) for the RCP4.5 radiative forcing scenario (Thomson et al. 2011) as modelled with the MPI-ESM model (Giorgetta et al. 2013). To account for the expected increased risk of disturbances due to climate change (Venäläinen et al. 2020), which is not covered by the vegetation model, we increased the sapling damage factors in young forest, and natural mortality in established forests, by 20% in the simulations. Models calculating cost for forest management and revenues from wood products is also included in the DSS. For individual trees, height growth in young stands is simulated (mean height < 7) (Fahlvik and Nyström 2006) basal area growth for established stands (mean height ≥ 7 m) (Fahlvik et al. 2014), and mortality (Elfving 2014). Heureka PlanWise also includes models simulating the effects of treatments such as pre-commercial thinning, thinning, final felling, regeneration methods, fertilization and climate change.

The productive forest's stands were grouped by forest type, i.e., groups of stands with similar properties. The grouping differed between scenarios, both in terms of number and properties of groups. Each forest type was linked to one or more forest management strategies. Management strategies can differ in management regime (unmanaged, uneven-aged or even-aged management), or in how different management actions (such as regeneration, cleaning and thinnings) are performed. PlanWise simulates treatment schedules for each stand and management strategy, and finds the optimal combination of treatment schedules in the landscape using linear programming. In the optimization, a user-defined goal is maximized or minimized with considerations to constraints at stand, forest type and forest level. PlanWise can report results for many indicators such as tree species distribution, harvest volume distributed on assortments, growing stock, growth, mortality, biomass content, carbon in trees and soil, area of management activities as thinning and final felling, and costs and revenues.

Management strategies

The management strategies applied in the three scenarios were based on written and oral consultations with representatives for the three forest companies owning the majority of forestland in the case study area, and reindeer herders using the forests in the area for winter grazing. The consultations took place during the spring of 2021.

The forest companies delivered information on which part of the forest is set-aside for nature conservation, with or without management, and which part of the forest is assigned for selective fellings. These forest areas were managed in the same way in all three scenarios (Table 2). The remaining forest area was managed differently in each scenario (Fig. 2), as described in detail in the next sections. In all scenarios, an interest rate of 2.5% was used for the calculation of the net present value.

Reference scenario The forest that was not set-aside for nature conservation was managed with even-aged forestry (Table 3). The state-owned forest company Sveaskog stated they are phasing out Lodgepole pine in the area, thus their Lodgepole pine forests are regenerated with planted Scots pine. For the two other forest companies, planting Lodgepole pine is an option also in the future. Furthermore, fertilization is an option for all productive forest outside key and core grazing areas and has the vegetation type bilberry. No specific management consideration was made for reindeer corridors.

Table 2 Management strategies common in all three scenarios

Forest type	Forest area (ha)	Share of total area, %	Management
Forest set-aside for nature conservation, without management	7625	6.6	No management
Forest set-aside for nature conservation, with management	4690	4.1	Management aiming to improve nature values: thinnings that remove conifers and thus improve growing conditions for broadleaves
Forest assigned for continuous cover forestry	491	0.4	Selective fellings, implemented as thinnings from above

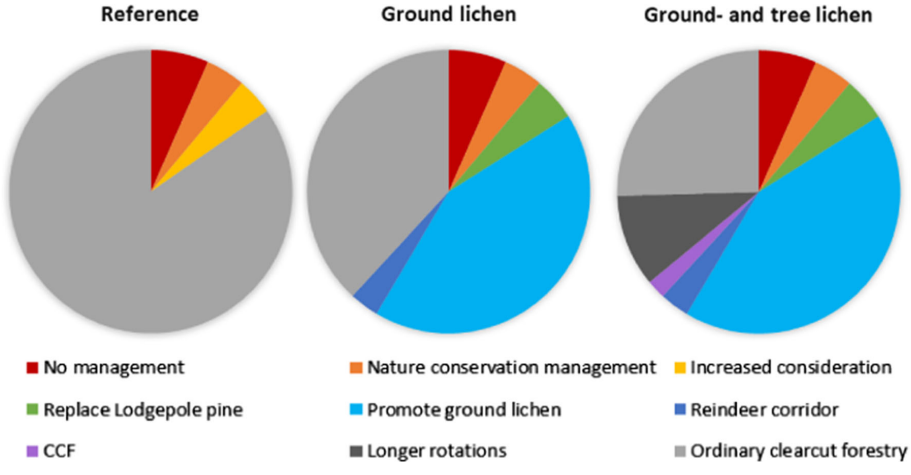

Fig. 2 Distribution of forest area assigned to different management strategies in the three scenarios

Table 3 Management strategies in the Reference scenario

Forest type	Forest area (ha)	Share of total area, %	Management
Forest assigned to management with increased consideration for other values	4896	4.2	Prolonged rotation period, natural regeneration, 40% broadleaves left in cleanings and thinnings
Other forest	97 719	84.7	Business-as-usual clear-cut forestry. Regeneration with plantation of Scots pine or Norway spruce, pre-commercial thinnings, up to 3 thinnings, final felling within 30 years of reaching the minimum final felling age. Regeneration with Lodgepole pine possible for SCA and Holmen, in areas currently dominated by Lodgepole pine, or situated outside key and core areas for reindeer husbandry and with bilberry vegetation type. Final felling of Lodgepole pine at 55–60 years of age and regeneration with Scots pine (Sveaskog). Fertilization possible outside key and core areas for reindeer husbandry, in forests with bilberry vegetation type

For all forest types except forest dominated by Lodgepole pine, 12% of the forest area was left as retention patches after final felling. In addition, three high stumps were left per ha in thinnings and final felling, and 10 retention trees in final fellings.

Ground lichen scenario The forest stands were grouped into forest types, and these types were assigned different management strategies (Table 4, Fig. 2). Lodgepole pine was removed and replaced with Scots pine. In reindeer corridors, key and core grazing areas Logdepole pine

Table 4 Management strategies applied in the different forest types in the Ground lichen scenario

Forest type	Forest area (ha)	Share of total area, %	Management
Forest dominated by Lodgepole pine in reindeer corridor, key or core grazing area	616	0.5	Remove and replace with Scots pine when Lodgepole pine is 30 years old, maintain low basal area in Scots pine forest (cleaning to 1200 stems, thinning curve ratio 0.65)
Forest dominated by Lodgepole pine, SI $\leq$ 20 on dry and mesic site	959	0.8	Remove and replace with Scots pine when Lodgepole pine is 55–60 years old, maintain low basal area in Scots pine forest (planting, cleaning to 1200 stems, thinning curve ratio 0.65)
Other forest dominated by Lodgepole pine	4128	3.6	Remove and replace with Scots pine when Lodgepole pine is 55–60 years old, manage Scots pine with standard clearcut forestry
Pine-dominated forest on dry and mesic sites, SI 12–16	3486	3.0	Maintain low basal area (natural regeneration, cleaning to 800–1000 stems, lower and upper thinning curve limits reduced by 35%), minimum felling age increased with 30%, pile up harvest residues
Pine-dominated forest on dry and mesic sites, SI 17–18	14 163	12.3	Maintain low basal area (plantation (1000 plants/ha), cleaning to 800–1000 stems, thinning curve ratio 0.65), minimum felling age increased with 20%, pile up harvest residues
Pine-dominated forest on dry and mesic sites, SI 19–20	31 372	27.2	Maintain low basal area (plantation (1000 plants/ha), cleaning to 1200 stems, up to 4 thinnings, thinning curve ratio 0.65), minimum felling age increased with 20%, pile up harvest residues
Reindeer corridors	3880	3.4	1200 stems/ha in planting and after cleaning, lower basal area by intensive thinnings (thinning curve ratio 0.8, minimum final felling age increased by 10%), pile up harvest residues
Other forest	44 012	38.1	Standard clearcut forestry. Regeneration with plantation of Scots pine or Norway spruce, pre-commercial thinnings, up to 3 thinnings, final felling within 30 years of reaching the minimum final felling age. No plantation of Lodgepole pine and no fertilization

stands were harvested at 30 years of age, in other areas, at 55–60 years of age.

In forests with potential for occurrence or re-establishment of ground lichen, i.e., in pine-dominated forests with a site index (SI) of 12–20 on dry or mesic sites, a management strategy was applied that maintained a low basal area throughout the rotation. On the least fertile sites, natural regeneration was applied, while on higher fertility sites, regeneration was through plantation following a careful soil scarification. No soil scarification was used with natural regeneration, to avoid negative effects of site preparation on ground lichens (Eriksson and Raunistola 1990; Roturier and Bergsten 2006). Cleanings and thinnings were adapted to allow for earlier and more intensive practices in terms of cut stems/volume, but in accordance with the legal regulations for forest management (SKFS 2015) (for details, see Table 4). We assumed an extra cost of 15%, added to the hourly harvester and forwarder cost, for piling up harvest residues in thinnings and final fellings so that they do not cover the ground lichen.

In the reindeer corridors, management aimed to keep an open forest through earlier and more intensive cleanings and thinnings, to allow for reindeer to move through the landscape and for the herders to monitor the reindeer during migration.

No forest fertilization was applied in this scenario. For all forest types except forest dominated by Lodgepole pine and forest set-aside for nature conservation, 10% of the forest area was left as retention patches at final felling. In addition, three high stumps were left per ha in thinnings and final felling, and 10 retention trees in final fellings.

Ground and tree lichen scenario The Ground and tree lichen scenario used the same forest management strategies as the Ground lichen scenario for all forest types except for other forest (last row in Table 4), and retention settings. Because local dispersal of tree lichen is limited in young stands (Dettki et al. 2000), the retention and creation of old, tree lichen-rich forest patches has been suggested to be an efficient strategy to promote tree lichen abundance. To support the dispersal of tree lichen, the size of retention patches left at final felling was increased to 20% of the forest stand in stands larger than 9 ha (Esseen 2019), as larger retention patches are more likely to retain tree lichen after the surrounding forest has been cut. Management of other forest was adjusted by adding continuous cover forestry as a management strategy for uneven-aged spruce forest on 2.2% (2496 ha), and prolonging the minimum final felling age with 30% for even-aged spruce forest on 10.5% (12 148 ha) of the study area.

Optimization

In the Reference scenario, net present value was maximized with a 2.5% interest rate, with the following constraints: Final felling volume was not allowed to decrease with more than 2% between consecutive periods, aiming for even final felling volumes. At the same time, final felling volume was not allowed to increase with more than 10% between consecutive periods. For Sveaskog, we applied a volume reserve of 2.8 times the final felling volume. That is, for each m^3 subject to final felling, there must be 2.8 times that volume in stands available for final felling, i.e., above the minimum final felling age. For the other owners, we applied an area reserve of 1.15: for each hectare subject to final felling, there must be 1.15 ha of area available for final felling. For the forest owned by SCA or Holmen, the annual area regenerated with Lodgepole pine was required to be between 1 and 3%. According to official statistics (Swedish Forest Agency 2022), between 0.04 and 0.3% of the productive forest area in northern Sweden has been fertilized annually during the last 10 years. We assumed that this will continue, resulting in the restriction that between 0.2 and 1.5% of the forest area would be allowed to be fertilized per 5-year period.

In the Ground lichen scenario, the optimization maximized the area with ground lichen habitat over time, i.e., the average over the planning horizon of 50 years. The ground lichen habitat was not allowed to decrease with more than 1% between consecutive periods. As in the Reference scenario, final felling volume was not allowed to decrease with more than 2%, or increase with more than 10%, between consecutive periods.

In the Ground and tree lichen scenario, we used the same optimization model as the Ground lichen scenario; with the addition that potential tree lichen habitat was not allowed to decrease over time with more than 1% between consecutive periods.

RESULTS

In the Reference scenario, the area with ground lichen habitat decreased steadily throughout the 50 year study period (2020–2070) (Fig. 3a), continuing the declining trend observed for the past 70 years (Sandström et al. 2016). The proportion of forests with ground lichen habitat decreased with 50%, from the present 27% of ground lichen habitat to only 13% at the end of the study period. On the other hand, the area with ground lichen habitat increased with 22% (from 27 to 35%) already during the first 15 years for the two lichen scenarios, and stabilized thereafter (Fig. 3b). Hence, the difference in the outcome for ground lichen habitat when comparing the Ground lichen scenario and the Reference scenario in 2035 shows 46% (35% vs 19%) more ground lichen habitat and at the end of the study period the difference was 60% more ground lichen habitat (33% vs 13%). For comparison, the forest area with adapted management for promoting ground lichen in both lichen scenarios was 49 000 ha, or 42% of the total productive forest area. Both lichen scenarios thus resulted in around 80% ground lichen habitat of the area managed for ground lichen. It is worth noting that results on the forest condition, including basal area, are reported for the middle of the 5-year period, before any management actions are performed. This can lead to conditions for

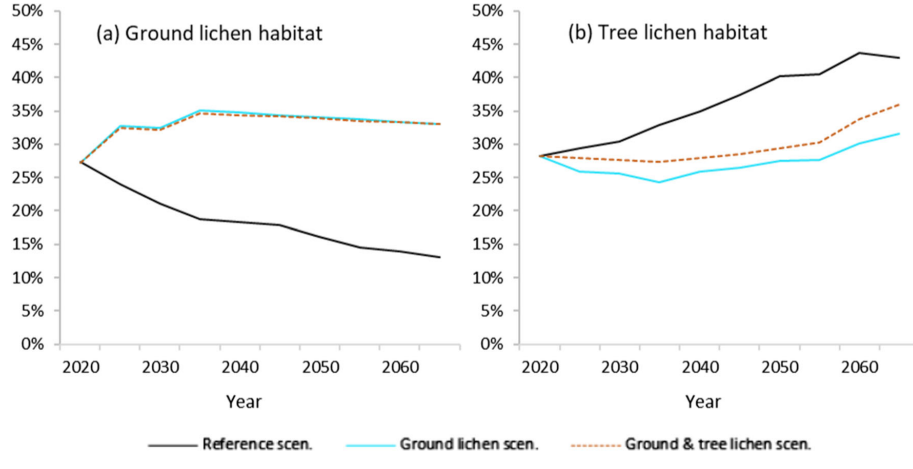

Fig. 3 Development of the proportion of forest area with potential for ground lichen (**a**) and for tree lichen (**b**)

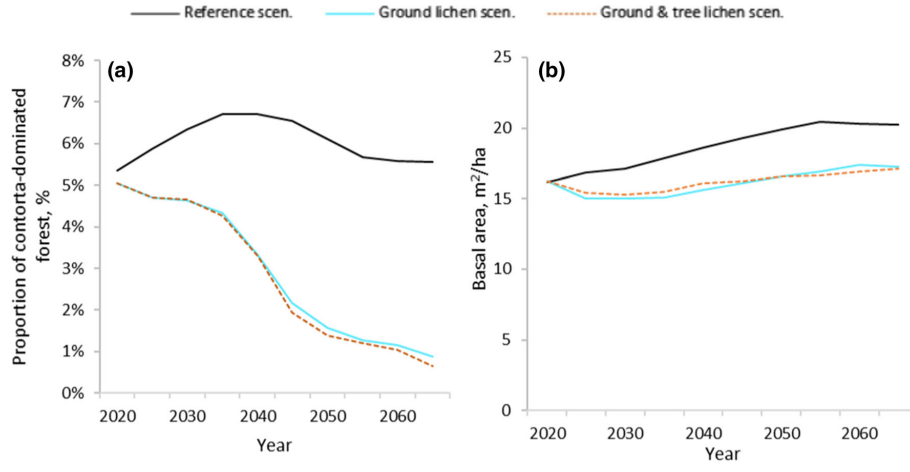

Fig. 4 Development of the proportion of forest area dominated by Lodgepole pine over time (**a**), and average basal area of forest in reindeer corridors (**b**)

the ground lichen indicator in terms of basal area not being met temporarily, for one 5-year period at a time.

The area with tree lichen habitat increased in the Reference scenario. In the Ground lichen scenario, tree lichen habitat decreased during the first 15 years, before starting to increase to levels slightly above the initial situation in the end of the study period (Fig. 3b). In the Ground and tree lichen scenario, tree lichen habitat remained stable for most of the study period, with an increase during the last 15 years. The mean age of forest classified as tree lichen habitat was 106 years in the beginning of the study period. The age remained stable initially and increased slightly to 110 years in both lichen scenarios, but decreased to below 100 years in the Reference scenario.

Lodgepole pine stands constitute 5% of the forest area in the beginning of the study period (Fig. 4a). The forest area of Lodgepole pine stands increased during the first 20 years in the Reference scenario, before returning to current levels. In both lichen scenarios, Lodgepole pine stands decreased steadily, down to less than 1% of the forest area after 50 years.

Average basal area in reindeer corridors was consistently lower, ranging between 15 and 17.5 m^2/ha, in the lichen scenarios, compared to the Reference scenario in which the average basal area increased over time, to more than 20 m^2/ha (Fig. 4b).

In the Reference scenario, the annual harvested volume of both pulpwood and sawlogs increased over time (Fig. 5a, b). Both lichen scenarios resulted in higher harvest of pulpwood volumes during the first 25 years, due to larger areas of and harder thinnings to promote ground lichen, and lower pulpwood volumes afterwards compared to the Reference scenario. On average over the study period, pulpwood harvest was highest in the Ground lichen scenario (148 000 m^3 $year^{-1}$), lowest in the Ground and tree lichen scenario (138 000 m^3 $year^{-1}$) and in between for the Reference scenario (144 000 m^3 $year^{-1}$). The harvest of pulpwood in the Reference scenario was markedly lower than in the lichen scenarios during the first half of the study period and higher during the second half. Volumes of sawlog harvest increased throughout the study period in all scenarios. From 2045 and onward, sawlog volumes stabilized in the Ground and tree lichen scenario, while it continued to increase in the Reference and Ground lichen scenarios. In the Ground lichen scenario, sawlog volumes were higher than in the Reference scenario during the first 10 years and lower during the remainder of the study period. The lower harvest volumes in the Tree and ground lichen scenario in the second half of the study period, compared to the two other scenarios, can be explained by the longer rotation periods applied in that scenario to promote tree lichen.

The annual area thinned was more than twice as high for the lichen scenarios compared to the Reference scenario throughout the study period (Fig. 5c). Consequently, this resulted in higher volumes of harvested pulpwood (Fig. 5a). The final felling area for the Reference and Ground lichen scenario followed similar trajectories, and ended up identical at the end of the study period. For the Ground and tree lichen scenario, the final felling area was lower and fluctuated more. The annual area of selection fellings was about twice as high in the Ground and tree lichen scenario while the Ground lichen scenario was about 50% higher than the Reference scenario throughout the study period.

Fig. 5 Development of annual harvested volume over time, distributed into **a** pulpwood and **b** sawlogs, and forest area annually subjected to thinning (**c**), final felling (**d**) and selection felling (**e**) in the three scenarios

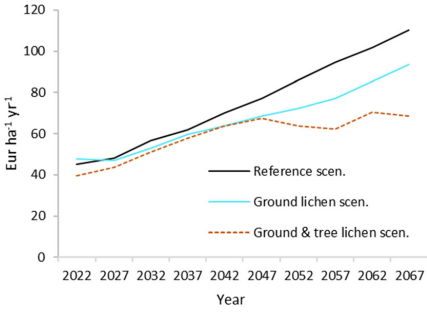

Fig. 6 Development of net revenues from wood production over time. 1 EUR = 10 SEK

Net revenues from wood production increased over time in all three scenarios (Fig. 6). The increase ranged from 74% in the Ground and tree lichen scenario, to 145% in the Reference scenario. Net revenues in the Ground lichen scenario were slightly higher compared to the Reference scenario during the first 5 years and very similar during the first 25 years. In the Ground and tree lichen scenarios, net revenues increased during the first 25 year before stabilizing. On average over the 50-year study period, net revenues were 11% lower in the Ground lichen scenario, and 22% lower in the Ground and tree lichen scenario compared to the Reference scenario.

Net present value (NPV) was highest in the Reference scenario, 3305 Eur ha^{-1}. In the Ground lichen and Ground and tree lichen scenarios, NPV was 10% (2669 Eur ha^{-1}) and 13% (2880 Eur ha^{-1}) lower compared to the Reference scenario, respectively. The discount rate was 2.5% and we assumed 1 EUR = 10 SEK.

Net annual increment (NAI) increased during the first 15 years in all three scenarios (see Fig. S1 in Supplementary material), from 3.8 to 4.2 m^3ha^{-1} $year^{-1}$ in the lichen scenarios, and 4.5 m^3ha^{-1} $year^{-1}$ in the Reference scenario. After 15 years, the NAI remained at same level in both lichen scenarios, while it continued to increase for another 20 years in the Reference scenario, to 4.8 m^3ha^{-1} $year^{-1}$. Growing stock increased in all scenarios as NAI exceeded the harvest level. The increase in growing stock was most pronounced in the Reference scenario (60% increase within the 50 year study period), and lowest in the Ground lichen scenario (43% increase).

DISCUSSION

We found that continued 'business as usual' forest management (the Reference scenario) would extend the past 70-years of decline of ground lichen habitat as our results for the Reference scenario show an additional 50% decline during the next 50 years. This represents an alarming trend, as today's amount of lichen habitat already is recognized as critically low (unified statement of hundreds of reindeer herders, and explicitly stated by local reindeer herders in our study area). Such continued negative effects on the lichen resources thus severely threaten RHCs possibility to carry out traditional, natural pasture-based reindeer husbandry. By applying management strategies aiming to increase lichen habitat, the area with ground lichen habitat increased with more than 20% compared with today. In the lichen scenarios, around 80% of the area managed for ground lichen fulfilled our defined habitat requirements for ground lichen, which is twice as much compared to the Reference scenario. After 50 years, the amount of ground lichen habitat would be 2.5 times higher in the lichen scenarios, compared to the Reference scenario.

The area of tree lichen habitat increased over time in all scenarios, apart from a slight decrease during the first decades in the Ground lichen scenario. The tree lichen habitat increased most in the Reference scenario, mostly due to the increase of relatively dense forests older than 60 years. While tree lichen can occur in forests younger than 60 years, it takes time before the tree lichen are abundant in the stand. This dynamic cannot be captured in the tree lichen indicator we applied. However, the majority of the forest classified as tree lichen habitat is considerably older than 60 years. In the Reference scenario, the mean age of the forest classified as tree lichen habitat decreased over time, while it increased slightly in the lichen scenarios. This means that although the area of tree lichen habitat increased most in the Reference scenario, the abundance of tree lichen does not necessarily follow the same trend. In the lichen scenarios, more than 40% of the forest area is managed to promote ground lichen habitat, hence maintaining a low basal area. Such open forests can discourage the development of tree lichen habitat requiring more closed canopies (Boudreault et al. 2013). This result illustrates the importance to adapt management based on the particular goals and conditions at each site. It is difficult to focus forest management on both ground and tree lichen within the same stand. Our results point at a clear dividing point to focus ground lichen considerations on pine forests younger than 80 years, with a site index up to 20 on dry and mesic soils and focus on tree lichen in other forests, such as older mixed species stands. Under a changing climate, tree lichen is becoming increasingly important. How this affects the prioritization between ground and tree lichen needs to be investigated in future studies.

In the Ground and tree lichen scenario, we promote tree lichen by managing spruce-dominated forests with continuous cover forestry (2.2% of the forest area) or prolonged rotations (10.5% of the forest area). This leads to a larger increase of tree lichen habitat compared to the

Ground lichen scenario, while remaining under the levels of tree lichen habitat reached in the Reference scenario. That is, the management adaptation to promote tree lichen in the Ground and tree lichen scenario did not fully compensate for the potential loss in tree lichen habitat caused by promoting ground lichen. However, the management measure to increase retention patches to 20% of the forest stand in the Ground and tree lichen scenario is likely to result in maintaining more tree lichens in these patches, compared to the smaller patch size of 10% in the other scenarios, in which tree lichen occurrence decreases during the first years after final felling due to wind exposure. The potential for dispersal and establishment of tree lichen in regenerated stands with these larger retention patches will probably be much greater compared to the other scenarios. Our modeling approach applying the tree lichen indicator cannot capture the spreading of tree lichen from older into younger stands.

The harvest volumes would increase and remain high in all scenarios. This is to a large part due to the present age-class distribution in the study area, with 70% of the forests younger than 60 years (Fig. 1b). It is, however, unlikely that the trend of increasing harvest volumes would extend much beyond the study period, in any of the scenarios. Economically, the lichen scenarios resulted in 10 to 13% lower NPV compared to the Reference scenario. This is mainly because of more thinnings (both in terms of area and proportion of harvest volume), which are more costly per unit harvested, as well as a lower harvest volume in the future due to lower growth levels. However, the annual net revenues increased in all scenarios over time. This means that the economic return for all scenarios will be higher in the future but on a lower level for the two lichen scenarios. It needs to be stressed that the economic results are limited to wood production, i.e., in this study, we made no attempts to assess the economic value of reindeer husbandry.

The differing snow conditions during winters require a landscape with varying and continuous forests, which offers grazing possibilities at all times (Horstkotte 2013). The results from the scenario analysis can be viewed on a map at different times, thus offering an opportunity to assess landscape patterns. The Ground and tree lichen scenario includes continuous cover forestry and prolonged rotation periods, resulting in more varied forests, with elements of multi-layered canopies, offering more diverse snow and grazing conditions than before. To what extent this improves conditions for grazing dynamics should be explored in future studies.

In the light of the legislatory framework and certification rules, forest companies already today are bound to consider reindeer husbandry. Measures are taken to meet the needs of reindeer husbandry, as reported by the forest companies in consultations informing the analysis. However, our results show that the measures applied in the Reference scenario are not sufficient even to maintain today's low amount of ground lichen habitat.

Today, many reindeer herders have been forced to switch to supplementary feeding during winter because of limited winter grazing resources. The problem of declining ground lichen resources is further accentuated through negative effects due to climate change and consequent poor and icy snow conditions. Declining lichen resources in combination with difficult snow conditions has led to an unwanted shift away from traditional, natural pasture and natural food-based reindeer husbandry. This constitutes a threat to the persistence of traditional, natural pasture-based reindeer husbandry (Uboni et al. 2020). Hence, a continued "business as usual" forest management reducing the remaining ground lichen habitat even further cannot be seen as an option if the pastoral reindeer husbandry as a basis for the Sami culture is to remain.

Importantly, the adjustments in forest practices in the lichen scenarios do not include new types of silvicultural practices. Instead, adjustments are more related to the timing and intensity of the silvicultural practices that are carried out, which warrants for a relative ease of implementation of the proposed adjustments. In medium to long-term, prescribed burning may have the potential to stop ground lichen decline at landscape scale (Roturier et al. 2023). However, we did not include the effect of prescribed burning as our modelling approach does not allow us to simulate the effects sufficiently well. In addition, there are many practical, regulatory and economic hurdles constraining the implementation of prescribed burning to an extent that would make a difference for lichen availability.

Our results are comparable with those of other studies. Miina et al. (2020) developed a model for predicting ground lichen cover and applied it to evaluate three management scenarios, finding that ground lichen cover decreases in all of them. However, none of the scenarios made specific adaptations to promote lichen habitat. In another study area, Horstkotte et al. (2016) demonstrated a decrease in harvests and revenues of approximately 20% over 100 years when prioritizing reindeer grazing over timber production. Korosuo et al. (2014) found that a continuation of business-as-usual management would continue the decreasing trend in ground lichen area, while implementing continuous cover forestry and precommercial thinnings would halt the decrease and lead to a future increase in the reindeer pasture area to an approximate loss of 5% of net present value for forestry. However, the ground lichen indicator used was less specific, and tree lichen were not included in the study.

Instead of a model predicting the occurrence of ground or tree lichen (Miina et al. 2020), we used simple indicators that are easy to apply in regular forest management

planning. The indicators do not predict occurrence, but instead the potential and availability of habitat suitable for lichen occurrence. Thus, our indicators do not account for the time it takes for lichen to establish, nor disappear. For example, exceeding the basal area condition of the ground lichen indicator in a forest stand for only a few years is unlikely to lead to the disappearance of the ground lichen. The advantage of the simplicity of the indicators is that they can be easily used in the forest planning of forest companies or other forest owners, allowing them to assess the impact of their management choices on the lichen potential.

Our results naturally depend on the current state of the forest and can only be generalized to landscapes with similar conditions. However, the chosen indicators and management scenarios are of high relevance also outside our case study area. The lichen indicators and management scenarios have already been used to inform several stakeholder meetings, including meetings organized by the Swedish Forest Agency. We therefore expect that study results can contribute to alleviating the conflict between reindeer husbandry and forestry. This has been possible due to established networks and close contacts with relevant stakeholders throughout the research process. The consultations with RHC and forest companies also helped to identify knowledge gaps and further research needs.

Other positive aspects for biodiversity and recreational values likely accompany adjusting management practices based on the needs of reindeer husbandry. For example, replacing the exotic Lodgepole pine with native Scots pine will benefit biodiversity (Kärvemo et al. 2022). A larger variation in management strategies, including continuous cover forestry and prolonged rotation periods has been shown to benefit multiple forest values including biodiversity and recreation (Eggers et al. 2018, 2019; Eyvindson et al. 2018; Duflot et al. 2021). Likewise, more open forests and forest canopies benefit both ground vegetation diversity (Hedwall et al. 2013) and recreational values. On the other hand, the lower tree growth in the lichen scenarios leads to lower carbon sequestration in living tree biomass compared to the Reference scenario. Future studies should explicitly include indicators for biodiversity and other forest values to study the effects of management aiming at increasing lichen in a wider context.

Climate change is already affecting tree growth (Appiah Mensah et al. 2021), and the impact of a changing climate is expected to increase over time along with rising global temperatures (Lindner et al. 2014). Our analysis accounted for the expected increase in tree growth due to a warmer and longer vegetation period, and an increase in mortality due to disturbances. However, how climate change will play out is highly uncertain, and water limitation may negate the growth-enhancing effect of rising temperatures (Belyazid and Zanchi 2019). Therefore, forest management also needs to focus on promoting resilient forest ecosystems. More research is needed on how climate adaptation can be combined with adaptation to other forest values and uses, including reindeer husbandry and wood production.

CONCLUSIONS

The results of this study can be used to propose and develop a system to support and improve co-planning between reindeer husbandry and forestry with a long time perspective at the landscape scale. We demonstrate a new and improved basis for planning and decision-making on a long-term, which can enable well-informed decisions for a more balanced co-use of the forest. Our results can be used to develop management guidelines to substitute the yearly, stand-based, 3- to 5-year time horizon consultations of today, with an agreement on management guidelines promoting lichen. Applying our proposed system can over time save time for both parties. The heavy burden of the time-consuming consultations have been an issue brought up by RHCs as well as forest companies (Roos et al. 2022). In addition, our results offer a way to put the cards on the table concerning the "costs and benefits" connected to an adapted forest management. Above all, our results can improve conditions for the continuation of the traditional, natural pasture-based reindeer husbandry.

Sami reindeer husbandry is in dire need of improved conditions in winter grazing areas after the last 70 years of declining grazing resources. This is especially critical when also considering increasing pressures from climate change, predation and all other land use forms. Our results show that a continuation of today's forestry practices would result in further decreases in ground lichen habitat far below today's already critically low levels. Such declines would constitute a threat to traditional pastoral reindeer husbandry. Tree lichen habitat, on the other hand, can be retained and increased in all scenarios, and may become more important in a changing climate. The forest management strategies proposed to improve conditions for reindeer husbandry present a potential way forward. These strategies result in a 22% increase in ground lichen habitat, with a decrease of 10–13% in net present value from wood production. While the effect on the harvest of sawn timber is relatively minor, pulpwood harvest volume are more affected. Earlier and more intense cleaning and thinning of pine forests to make them more suitable for ground lichen, resulted in a larger volume of pulpwood harvest during the first decades, compared to current practices, and lower pulpwood volumes in the latter half of the study period. In practice, the proposed adapted management strategies are largely part of traditional silvicultural measures, but with

changes to the timing and intensity of the measures. Therefore, we assess the technical challenges to implement these adapted strategies to be relatively minor. Our study can provide knowledge where forestry can constitute either a threat to the future of traditional, natural pasture-based reindeer husbandry or where forestry can provide a promising future towards significantly improved conditions for reindeer husbandry.

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Declarations

Conflict of interest The authors declare no conflict of interest.

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Ambio

Electronic Supplementary Material

Title: **Adapted forest management to improve the potential for reindeer husbandry in Northern Sweden**

Authors: Jeannette Eggers, Ulrika Roos, Torgny Lind, Per Sandström

Table S1: Percentage lichen cover on pine-dominated[1] productive forest land of total ground layer from the National Forest Inventory (municipalities in the Reindeer Husbandry Area, average 2014-2018)

Site Index, m (Scots pine H_{100})	>50% lichen cover	25-50% cover
10	1	1
11	1	0
12	4	2
13	4	9
14	7	12
15	18	12
16	14	27
17	17	21
18	21	6
19	4	1
20	0	0

[1] Scots pine >65% of basal area, or stem number in young forest <7 m height

Table S2: Percentage of lichen cover (>50% lichen cover, 422 193 ha and 25-50% lichen cover, 572 310 ha) per soil moisture class from the National Forest Inventory (productive forestland, municipalities in the Reindeer Husbandry Area, average 2014-2018).

Soil moisture class	>50% lichen cover	25-50% lichen cover
Dry	33	18
Mesic	66	80
Mesic-moist	2	2
Moist	0	0
Wet	0	0

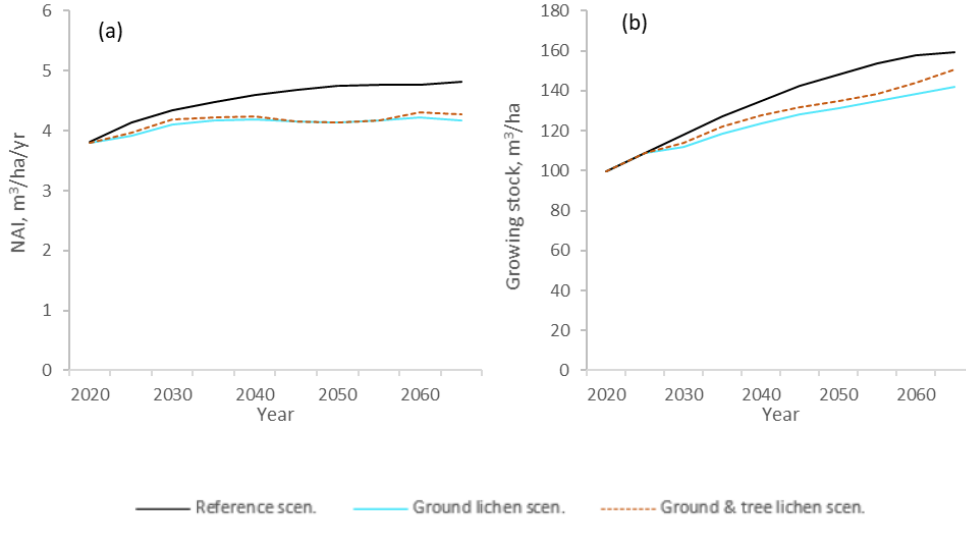

Figure S1. Development of net annual increment (NAI) (a) and growing stock (b) over time.

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This thesis analyses the voluntary policy instrument of consultation, or *samråd* in Swedish, between reindeer husbandry and forestry. With a longitudinal and multidisciplinary perspective, the thesis investigates what could contribute to a more balanced development of the key resources for the two land users, focusing on ground lichen development, potential effects of a reindeer husbandry-adapted forestry, the development of *samråd* over time and the role of knowledge in *samråd*.

Ulrika Roos received her doctoral education at the Department of Forest Resource Management, Swedish University of Agricultural Sciences (SLU). She received her BSc in Biology at Umeå University in 2007 and her MSc in Biology at Linköpings University in 2008.

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