17 Case study: reindeer husbandry plans – "Is this even monitoring?"

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Introduction

As demonstrated in earlier chapters, there are widely varying types and applications of monitoring. This chapter provides an insight into the somewhat non-conventional monitoring programme termed Renbruksplan (RBP; in English, reindeer husbandry planning). Even though RBP is founded on many of the common monitoring methodologies described in earlier chapters, RBP did not start out as a monitoring programme and is often not recognized as such. RBP also lies outside the common national reporting systems. It has also sometimes been seen as an example of community-based monitoring, where the Sami reindeer herders, as Indigenous people and as the significant "knowledge holders" (Wilson et al. 2018), are carrying out the data collection and driving the demand towards its outcome (see chapter 2).

This chapter describes the history and development of this programme, how methods were developed and used, and some of the results, impacts, and contributions to land use decisions, management, and policy.

We start this chapter by providing a short background about Sami reindeer husbandry as a land use system, to give context to the RBP effort. To understand the situation for reindeer husbandry today, some background of the historical perspective and how the interpretation of legal rights for the Sami people has changed over time is needed (Mörkenstam 1999; Brännlund and Axelsson 2011). Sami life and culture are in many ways centred on reindeer and the reindeer husbandry system (Text box 17.1) and thus is the focus of this programme. Reindeer husbandry has existed in various forms for millennia (Aronsson 1991) and throughout the 19th century was encouraged and privileged by the government of Sweden as the best-suited land use form in northern Sweden (Cramér and Ryd 2012). Reindeer husbandry as a land use system originated from the taming of a few reindeer for milking, as draft animals, and as decoys to attract wild reindeer (Björklund 2013), from which it gradually moved towards the land use system we see today. The formation of a formally organized reindeer husbandry system became necessary to increase production capacity in response to an increased government tax burden (Cramér and Ryd 2012).

Today, reindeer husbandry represents a land use system that ultimately depends on the implementation and consequent footprint of other land uses such as infrastructure development, mining, and energy exploitation or specific forestry activities that affect lichen conditions, the key winter food source for reindeer (P. Sandström 2015; P. Sandström et al. 2016). In strict monetary terms, all of these competing land uses are more significant than reindeer husbandry. As all these other land use systems expand and intensify, the hope and

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Text box 17.1: Sami reindeer husbandry

The reindeer husbandry system constitutes an extensive, complex, and unique land use form carried out by the Indigenous Sami people across Sapmi, an area covering northern Sweden, Norway, Finland, and parts of the Kola Peninsula in Russia. There are also more than 20 other indigenous groups across the Russian north and Mongolia who depend on reindeer husbandry (Oskal et al. 2009). With seasonal grazing lands connected via annual long-range migration routes, reindeer constitute the last remaining large ungulate migrations in the Northern Hemisphere (Vors and Boyce 2009). The reindeer husbandry system is also the only enduring grazing system of semi-domesticated or domesticated animals that still use their native range and seasonal movement patterns to access and use grazing resources in the same or similar way as its native ancestor species. Maintaining such a land use system today offers both challenges and opportunities for managers as well as for policymakers.

Reindeer husbandry in Sweden is allowed on 55% (constituting a 22.6 million ha area) of the land base, including 49% of the productive forest lands, more than 40% of the standing forest volume, and 99% of the alpine biomes (P. Sandström et al. 2016). Because no part of the reindeer husbandry area is set aside exclusively for reindeer husbandry, it is always carried out in conjunction with other land uses. The reindeer husbandry area is divided into 51 reindeer herding communities (in Swedish, *sameby*). A reindeer herding community constitutes a large geographic area usually stretching from the mountains in the west to the Bay of Bothnia in the east. A reindeer herding community is also an administrative and financial organizing association for the Sami reindeer herders' companies. Many reindeer herding communities are further divided into *siidas* (winter groups), each containing one or several reindeer herding companies.

Currently there are about 240,000 reindeer in Sweden, a number that has remained relatively constant over the last decades, distributed among 4598 reindeer owners, working full time or part time as herders (Sametinget 2021c).

prospect for a balanced and functioning coexistence alongside reindeer husbandry are continually and increasingly challenged. Of particular concern, because it overlaps entirely with reindeer husbandry, are the intensification and expansion of forestry into areas not previously impacted by modern forestry practices (Text box 17.2). Initiatives and discussions to mitigate the conflict between reindeer husbandry and forestry have been going on for a long time. The need to find a balance between the impacts of forestry and the needs of reindeer husbandry was addressed as far back as 1954 at a meeting in Jokkmokk (Skuncke 1955). At this meeting, reindeer herders expressed concerns about future negative impacts from forestry on grazing resources and the need to address issues with a landscape perspective. Since then, the need for a knowledge-based dialogue, supported by maps and field inventories in various forms as tools towards solutions, has been put forward (e.g. Heikka 1981). Reindeer herders have long expressed their needs for such tools to support planning and negotiations in relation to the forest industry and more recently in relation to other ongoing land uses; hence the development of the RBP programme.

Text box 17.2: Impacts of forestry on reindeer husbandry

Forestry and reindeer husbandry each represent two extensive and overlapping land use forms. On these lands, forestry is the prioritized and dominant land use system because of its economic importance. As the demand for forest products has increased and modern forestry practices have intensified and spread into new areas, the negative impacts on reindeer husbandry have been amplified. Forestry affects reindeer husbandry in several ways. First and most important, modern forestry has profound impacts on mat-forming (*Cladina* spp. or *Cladonia* spp.) and arboreal lichens (e.g. *Bryoria fuscescens* and *Bryoria fremontii*), which are pivotal key winter grazing resources (P. Sandström et al. 2016). Much of the conflict and dialogue between reindeer husbandry and forestry revolves around management of lichen forests. Other negative impacts include the densification of forests, which, in addition to having negative effects on ground lichen growth, also inhibits reindeer, as well as herders' ability to move through the forest landscape. Forest regeneration after harvest usually begins with soil scarification, which removes ground vegetation cover, with consequent effects on ground lichen (Roturier and Bergsten 2006; Roturier 2009). The impacts of timber harvests on canopy cover also affect the conditions of the snow cover. Even though forestry can cause such negative impacts, it is no doubt technically possible to adapt forest management practices to the needs of reindeer husbandry while maintaining profitable forestry operations (Roturier 2009; Korosuo et al. 2014; Lundström 2016). However, many of the identified solutions such as increased levels of cleaning and thinning and gentler soil scarification methods have not yet been broadly implemented. Lack of implementation of such solutions is partly connected to the forest sector's poor understanding of reindeer use of grazing areas and the movement patterns of the reindeer. Solutions are also held up because of drawn-out consultation procedures (P. Sandström et al. 2003; C. Sandström and Widmark 2007; Roos et al. 2022). After 70 years of modern forestry practices, forestry is still seen as a threat to future reindeer husbandry. However, at the same time, if correctly carried out, forestry could be the saviour, because thinning and cleaning of dense young forests is essential for the ground lichen resource. Hence, there is a need for programmes such as the RBP to contribute data and knowledge to highlight key issues so that they can be better addressed.

The story behind Renbruksplan

The birth and naming of the Renbruksplan process stems from a meeting in a reindeer herder's kitchen in a Malå reindeer herding community (for definition, see Text box 17.1) in 1998. A discussion between reindeer herders and Swedish Forest Agency (SFA) personnel around how reindeer husbandry could match the forestry sector's well-established strategic forest planning tool, *skogsbruksplan*, led participants towards a matching reindeer herder's tool, *Renbruksplan*. Until then, the forestry sector put forward data and maps during consultation meetings, whereas reindeer herders could only present their point of view in words.

The first official RBP working meeting, organized in 2000, included representatives from the two reindeer herding communities of Malå and Vilhelmina Norra, personnel from SFA, the Swedish Board of Agriculture, the County Administrative Board of Västerbotten, and the Swedish University of Agricultural Sciences (SLU). During the first meetings of the original RBP group, the overarching goals of the process were defined to provide and improve the basis for (a) operational reindeer herding and (b) consultations with other land uses. The initial focus was on forestry as the "other" land user.

Because we knew that mapping would be central to our approach, the tools brought to the first meeting included printouts of recent satellite images, plastic overlays, and coloured pens. In general, at this first meeting, it was clear that the reindeer herders were the experts on reindeer husbandry and everybody else there knew very little about this. However, each one of the participants brought some new knowledge to the meeting. A mutual learning process, later termed *co-production of knowledge* (P. Sandström 2015), started immediately. Initially, the group had no specific working strategy or a clear final product in mind. Instead, the approach and methods were developed in a stepwise fashion where we iteratively invented, evaluated, and re-invented our strategies (Poudyal et al. 2015). The reindeer herders' mappings of seasonal grazing areas for each of the eight seasons of the well-established cycle of the reindeers' year were a central part of the process (Manker and Pehrson 1953; P. Sandström et al. 2003). For each local portion of each of the pilot reindeer herding communities, we used collared pens to delineate the most important grazing lands with the initial focus on the forested winter grazing areas. We produced plastic overlays with coloured mappings of important grazing areas and delivered these to the County Administrative Board of Västerbotten to be digitized. However, interpreting mappings and digitizing the drawings was not a simple task. This working practice was soon rejected. We realized that instead it was necessary for the Sami reindeer herders to digitize and describe their grazing lands themselves. Consequently, we developed the first version of a custom-made geographic information system (GIS), named RenGIS (in English, ReindeerGIS). RenGIS v1.0 was developed in the standard commercial ArcView 3.0 GIS environment. As the number of participating reindeer herding communities increased from the original 2, then to 6, later to 10, and finally to today's 50 reindeer herding communities, the need for an even more specific and custom-made tool became clear. Also, in response to the increasing number of users, license costs for a commercial GIS platform became too high, prompting us to convert the RenGIS system to the programming environment of TatukGIS, resulting in the current freeware RenGIS v2.0 currently in use (TatukGIS 2014). RenGIS is now freely available to all users (Sametinget 2022).

What is a Renbruksplan?

As participating reindeer herding communities' specific needs became clearer, separate sections of the RBP work process crystallized. All sections were not part of an original plan of the programme but emerged from iterative development and testing together with participating reindeer herding communities. Currently, we divide the monitoring programme into the following four sections:

- Reindeer herders' mappings of important grazing lands.
- Reindeer herders' field inventories.
- The collection and use of Global Positioning System (GPS) data from reindeer.
- The compilation of all other land use forms and available land cover data.

All information from each of these sections is created, analyzed, and visualized in RenGIS.

The work in each of these sections was preceded by the development and refinement of a number of common definitions and terminologies. Together with participating reindeer herders, we developed a common general division of the reindeers' grazing year. We also developed common terminologies for reindeer grazing lands. We divided the grazing lands into three main types: (a) general grazing areas representing the total seasonal grazing lands; (b) core areas, or important grazing land within general grazing areas; and (c) key areas, situated within core areas and of greatest importance to reindeer. Additionally, we divided and defined common vegetation classes as reindeer grazing types (P. Sandström 2015). Training involving reindeer herders and organized by personnel from SLU preceded all data collection, with a specific focus on coordinating work and maintaining common ground between all different reindeer herding communities and their data collection teams. During the 22 years of operation, 400 Sami reindeer herders from all reindeer herding communities have participated, contributed, and been involved in trainings in RenGIS, satellite image interpretation, field inventory techniques, forestry, drone use, and GPS. These training sessions have played central and necessary roles for each operational component of the process. Each session was focused less on teachings by experts but instead more on peers teaching peers (co-production of knowledge). The session organizers seldom delivered and instructed completely tested components. Instead, trainings consisted of continually testing and developing prototypes and learning from each other's experiences. Together we evaluated and improved the processes iteratively over time (Poudyal et al. 2015). Such mutual learning and mutual development have guided the project's efforts concerning improvements of most sections and components. In fact, most of the ideas regarding improvements of existing modules and the invention of new modules originate from these learning opportunities. The presence of Sami reindeer herders, researchers, as well as the programmer of RenGIS during all of the trainings ensured the tight connection between identified needs and production of new modules into RenGIS.

In the following paragraphs, we describe each of the four sections of the RBP.

Reindeer herders' mappings of important grazing lands

The first, and maybe the most central, section of the RBP monitoring programme is the delineation and description of important seasonal grazing lands into grazing types (key, core, and general grazing area). The Sami reindeer herder with the most knowledge of each specific, local area carries out the mapping by digitizing in RenGIS.

All delineation was done through on-screen digitizing, using the most up-to-date satellite images as background (P. Sandström et al. 2003; P. Sandström 2015). The specific delineation was then discussed and readjusted in consultations with other local experts from each *siida* (winter group). Through this process, each local area was mapped for each of the eight reindeer grazing seasons but with specific initial focus on the forested winter grazing areas. Mappings for each local area were subsequently merged to cover the entire grazing lands for each season. Finally, the digitized material for each season was merged to cover the entire reindeer herding community (Figure 17.1).

The delineation of important grazing lands has grown from a modest pilot project in two reindeer herding communities to cover the entire lands of 50 reindeer herding communities, representing an area of 225,000 km^2 and spanning more than half of

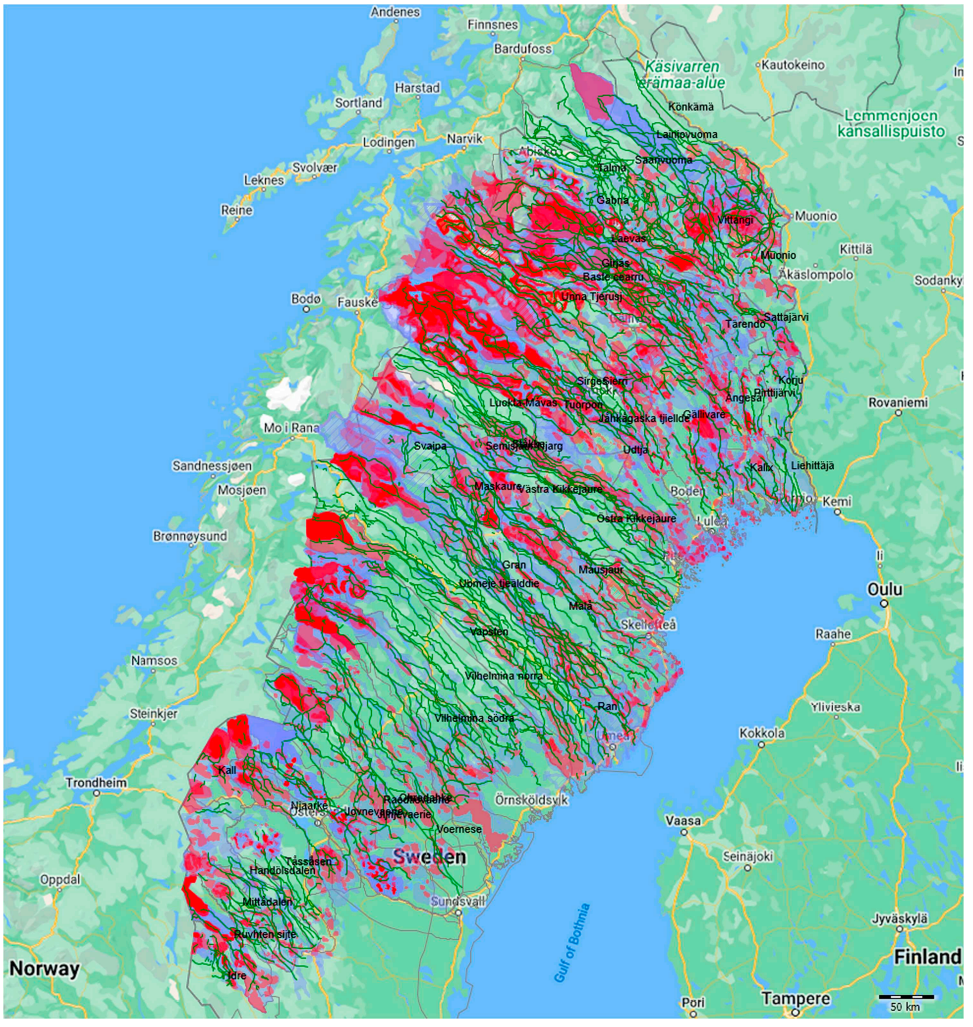

Figure 17.1 The combined map describing the reindeer herders' mappings of important seasonal grazing lands for 50 out of the 51 reindeer herding communities in Sweden for all grazing seasons. Key areas are shown in red, core areas in blue, general grazing areas as see through and reindeer migration routes are shown as green lines. Data and mapping compiled and visualized from RenGIS.

Sweden's land area (P. Sandström 2015). Today nearly 10,000 key areas have been digitized and described, with the large majority situated in the boreal forest.

Reindeer herders' field inventories

For most monitoring programmes, field inventorying constitutes the core of the programme. However, with the RBP programme, the actual field inventory work is just one section of the entire programme. As mapping of important seasonal grazing lands was carried out, the need to support and strengthen these mappings with field inventories became apparent.

Figure 17.2 View from within a key grazing area, where the reindeer grazing type is classified as lichen-rich pine forest. Each delineated key grazing area contains information from field inventories and a description by the reindeer herder. This area is described as "rich in trees with pendulous lichen in rolling terrain and with large variations in canopy cover providing good grazing even during periods with difficult snow conditions".

Credit: Photo by Per Sandström.

Partly developed out of the protocol used in the Swedish National Forest Inventory (Fridman et al. 2014) with respect to variables and inventory methods, we developed a specific vegetation classification system for reindeer grazing types (Sametinget 2017; Figure 17.2). We further adjusted this protocol and definitions of grazing types according to recommendations from reindeer herders.

Currently we have developed and implemented four different field inventory protocols. These include an inventory system for (a) forest lands, (b) wetlands, (c) mountain areas, and most recently (d) ground lichen. We have also developed specific inventory manuals (Sametinget 2017) and inventory instruction films to support the work (Sametinget 2021a). All field inventories were carried out by local reindeer herders from each respective area and reindeer herding community. Field inventory trainings organized by SLU preceded all inventory work.

Our first developed inventory protocol covering forest lands was launched in 2001. The objectives were to visit, estimate, and measure field inventory plots and document information to safeguard future re-inventories and, in some cases, by placing lichen cages as described in Figure 17.3. However, in addition, one objective was for the herders to gain additional overall and general knowledge about each visited delineated grazing area and to add such information for each mapped area (Figure 17.2). This was especially important because most of the inventories were carried out on winter grazing lands, previously mostly only visited by the herders when the ground was snow

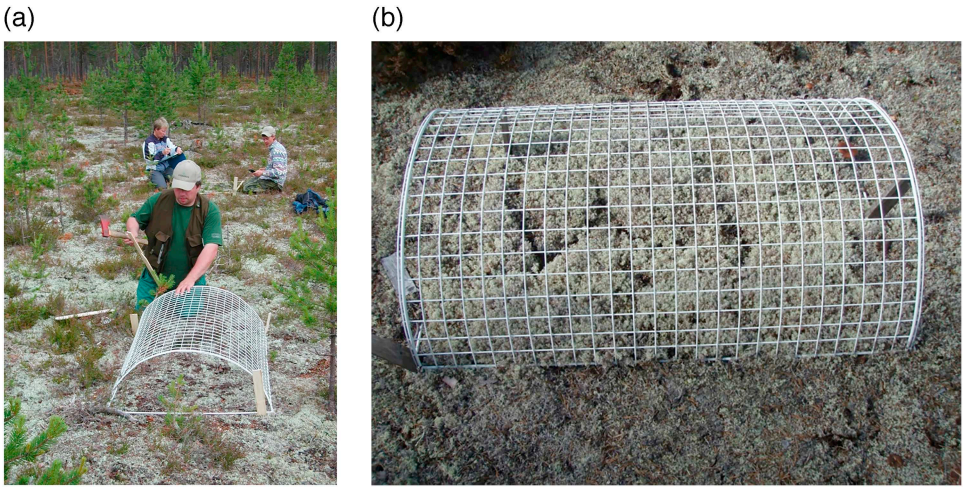

Figure 17.3 As part of the RBP grazing land inventory system initiated in 2001, we placed a series of lichen cages in the field to be able to follow lichen growth over time: (a) an overview of the field plot and (b) a 1.5m × 1m lichen cage.

Credit: Photos by Per Sandström.

covered. Another objective of the field visits was to improve herders' satellite image interpretation skills further, because the field visits served as additional ground truthing. Finally, the field visits gave the reindeer herders' specific information for final adjustments of the boundaries of the delineated important seasonal grazing areas. Consequently, the effort to map important grazing lands became closely linked to the effort of the field inventory. General information on each delineated grazing area gained during field visits was subsequently added into RenGIS. Such field-based and specific information for each grazing area can be especially important to support and strengthen the dialogue and land use negotiations with the forest industry as well as other land users.

Based on requests from reindeer herding communities and other land users, SLU designed and implemented a ground lichen inventory programme as part of the overall RBP process during 2019. The goal with this inventory was specifically targeted towards producing high-accuracy ground lichen maps for each reindeer herding community. Both inventory data and produced lichen maps will provide important base information for future re-inventories, mapping efforts as well as land use consultations. This is especially important and sought after as a response to alarming reports of a 71% decline in the lichen-rich forests grazing type during the last 65 years (P. Sandström et al. 2016). Ground lichen, the key winter grazing resource for reindeer, has continually declined since the introduction of modern forestry methods during the 1950s and, consequently, inventory and mapping of this resource are much needed. However, because the ground lichen–rich forests have become so rare (according to P. Sandström et al. (2016), only 3.8% of the reindeer husbandry area remains), the National Forest Inventory, which is based on a random sample of field plots, provides too few lichen-rich plots. Consequently, we needed additional field data to produce high-accuracy maps even for

lichen-rich areas. This need paved way for the RBP ground lichen inventory and map production system, here described through the following five steps:

1 SLU produces a preliminary lichen map based on NFI data, satellite images, and lidar data (Swedish Forest Agency 2022b).
2 SLU organizes field training in lichen inventories for reindeer herders.
3 Based on the preliminary lichen map and balanced sampling methods, SLU delivers coordinates to reindeer herding communities for additional field plots to improve the preliminary lichen maps.
4 Reindeer herders carry out field inventories based on the SLU lichen inventory protocol and deliver field data to SLU.
5 SLU carries out the final classification and produces the final lichen map for each participating reindeer herding community.

The ground lichen mapping and field inventory effort now constitute important components of the RBP programme. The ground lichen, field inventory and mapping can be repeated in the future to map and monitor changes of this important key resource. Earlier efforts to map ground lichen using satellite image data in combination with field data from the Swedish National Forest Inventory (Fridman et al. 2014) showed promising results in terms of general classification accuracy (P. Sandström et al. 2003; Gilichinsky et al. 2011). However, new methods developed through the RBP programme provide higher classifications accuracies than earlier efforts.

To date, we have visited, measured, and photographed more than 10,000 field plots. Most of the field plots are located in identified and digitized pre-winter and winter key grazing areas. Currently, field data collection has moved to being carried out via a cell phone app (Sametinget 2021b). This allows data from field inventories to be entered directly into RenGIS in the field. Over time, the field inventories of forest lands initiated in 2001 have expanded into new areas and new reindeer herding communities. During 2020, three reindeer herding communities initiated re-inventories of their older field plots. Such information will provide critical baseline knowledge about changes in lichen cover in relation to both forestry activities that may have occurred since the first inventory as well as changes because of successional changes in the forests.

Real-time GPS data

The use of real-time GPS collars on reindeer has become commonplace in most reindeer herding communities since it was first introduced in a project between SLU and the Vilhelmina Norra reindeer herding community in 2006. General technical solutions for real-time GPS already existed and were used, for example, in moose research (Dettki et al. 2004). However, the introduction of real-time GPS into reindeer husbandry became the first example of a fully participating data user – the reindeer herder – taking full operational advantage of real-time GPS data.

The GPS collar consists of a GPS unit that records the position of the animal according to a schedule defined by the user. The collars also include a communication unit that transfers the positions via the cellular network. Positions are then transferred to a web server, where the positions can be viewed on the reindeer herder's cell phone or computer. Hourly updates from GPS-equipped reindeer have provided important support and allowed herders to reduce their use of snowmobiles, all-terrain vehicles (ATVs), and

helicopters; for example, during reindeer gatherings for calf markings, for slaughter, and during seasonal migrations. Adoption of the GPS technology has also reduced stress levels for reindeer and improved working conditions for the reindeer herders (Andersson and Keskitalo 2017). Nowadays, a herder's workday usually begins with checking the reindeer's movements since the day before on their cell phone or computer.

As important as the operational advantages, reindeer equipped with real-time GPS collars provide vital information for monitoring changes in reindeer habitat use over time, as data from GPS-equipped reindeer provide a continually feed of their positions into the system. Long-term data in the form of GPS positions, descriptions of reindeer habitat use, and reindeer movements have created an important data bank, used in numerous research projects, impact assessments, and environmental court cases (Skarin et al. 2015, 2018, 2021, 2022; Cambou et al. 2022). Because new GPS data are collected from many reindeer every hour, every day, the record of reindeer use has provided, and will continue to provide, valuable monitoring data. Furthermore, GPS positions from collared reindeer have helped herders refine and improve their delineation of important grazing lands. Currently we also use GPS data describing reindeer use to verify the quality of our lichen maps. Here older positions can show high reindeer use of areas now not in use by reindeer as the lichen have disappeared.

As of 2022, about 35 reindeer herding communities use and manage their real-time GPS-collars and, over time, several thousand reindeer have been equipped with GPS collars.

Mapping of all other land uses

In 2001, the RBP team identified the need to include data about other land uses in RenGIS. In 2010, SLU received funds from the Sami Parliament to carry out the first compilation of other land uses and incorporate this into RenGIS. This compilation, updated every year, now represents the only custom-made and easy-to-use land use database of its kind. Compiled data originate from different state agencies for their respective geographic areas and responsibilities, including the Swedish Forest Agency, the Swedish Mining Inspectorate, the Swedish Energy Agency, the Swedish Meteorological and Hydrological Institute, the Swedish Board of Agriculture, the county administrative boards, the Swedish Land Survey, the Swedish National Heritage Board, and the Sami Parliament. Most of the data are publicly available but not compiled in one place and into one database. Having all of these data compiled in RenGIS provides a common basis for the analysis of land use issues and activities as both individual and cumulative impacts. These data have played a major role in numerous land use dialogues (Herrmann et al. 2014; Skarin et al. 2015, 2018, 2021, 2022). Being able to illustrate, visualize, and explain land use changes over time provides data for yet another component of the RBP programme.

Outcome and impacts of the Renbruksplan programme

Usually monitoring programmes constitute a field data collection component, whereas analysis and use of data is left to others. In the work with RBP, a significant aim of the programme was also to provide tools and opportunities for the data collectors – in our case, the reindeer herders – to also analyze, visualize, and communicate the compiled data and to illustrate changes over time. In this way, the RBP is also a tool for learning

and communication about the complex reindeer husbandry system within the reindeer husbandry collective as well as among other land users. This makes the RBP programme unique because the data collector, the data owner, and the data user, to some extent, is the same person.

The role of the tool – RenGIS in a monitoring programme

Visualizing and explaining the extensive and complex land use system of reindeer husbandry, with its long-range seasonal movements and large shifts in seasonal grazing lands, is best done using GIS-aided tools. To support communication about the content of the RBP, we custom-developed RenGIS as our tool for data collection, analysis, visualization, and dialogue.

RenGIS has become the tool used to analyze and illustrate landscape changes and shifts in habitat use over time and relate these to changes in vegetation composition and changes caused by other land users. It is important to understand that the RBP is not just a series of datasets that by itself support dialogue and planning and decision making. The RBP, through its communication tool RenGIS, only works to its full extent together with its presenter, the reindeer herder.

One important overall outcome of RBP and RenGIS is that they provide a platform for learning about reindeer husbandry. Numerous specifically developed modules in RenGIS, such as "play GPS-equipped reindeer movements", have been used in numerous public and professional meetings to communicate reindeer habitat use in relation to vegetation as well as other land uses (Skarin et al. 2021). Hence, there are several examples of how a co-produced RenGIS is more effective than tools developed outside the programme.

RenGIS is publicly downloadable from Sametinget (2022) with some common data available for all users. There are also some more specific data only available for the reindeer herding communities. In addition, each reindeer herding community owns and manage their own data, such as their digitized important grazing lands, field inventory data, and data from their GPS-equipped reindeer. Hence, this form of raw data from the RBP programme is not directly available for all. Instead, knowledge from such data is the common outcome of the programme.

Specific outcome and impacts

Data and knowledge from RBP communicated via RenGIS are well-established contributors to land use dialogues, negotiations, and consultations in Sweden. Data from RBP play a major part in governmental and non-governmental reports and strategies. Examples include the Swedish environmental objectives "A Magnificent Mountain Landscape" (Swedish Environmental Protection Agency [SEPA] 2014) and "Sustainable Forests" (SEPA 2013), the government commission "Follow-Up of the Attention to Reindeer Husbandry" (Swedish Forest Agency 2011), "Dialogue and Collaboration between Forestry and Reindeer Husbandry" (Swedish Forest Agency 2013), the Sami Parliament environmental programme *Eallinbiras* (Sametinget 2009), the Swedish Forest Stewardship Council (FSC 2010, 2020), the Swedish Sami Organization Forest Policy (SSR 2019), and "Indicators for the National Forest Programme of Sweden" (Swedish Forest Agency 2022a).

Data and knowledge from RBP have played central roles in the analysis of impacts from wind power developments (Skarin et al. 2015, 2018, 2021, 2022), forestry (Korosuo et al. 2014; Lundström 2016), climate impacts (Löf et al. 2012), mining (Herrmann et al. 2014), infrastructure development (P. Sandström et al. 2020), and cumulative impact assessments (Arctic Monitoring and Assessment Program 2017; Kløcker Larsen et al. 2020), as well as in several court cases (see e.g. Cambou et al. 2022; Skarin 2022). Furthermore, data from RBP play a central role in a number of ongoing research projects.

Conclusion

Initiated in 2000, the RBP programme can now be considered a long-term monitoring programme. Starting as a modest pilot project in two reindeer herding communities, with some initial funding from the Swedish Board of Agriculture, the programme has grown significantly to inventory and map more than half of Sweden's land area. Since 2005, the programme has received funding through earmarked money in the Swedish national budget, first via the Swedish Forest Agency and lately via the Sami Parliament. The work has been carried out by more than 400 data collectors and data users and contributes knowledge to planning and decision making from local to national scales. Furthermore, data and knowledge from the programme can contribute data for monitoring landscape changes, impact assessments, research projects, policymaking and strategic planning.

For Sami reindeer husbandry, the RBP programme plays an important role in explaining, maintaining, and incorporating the complex and geographically extensive reindeer husbandry system into the context of other land use systems. Thus, the RBP programme can be seen as a challenging real-life test case for advanced, sustainable landscape management. The challenges span geographic scales that range from single grazing patches to half of the land area in Sweden and can provide a stronger basis for sustainable landscapes as well as for the continuation of an ancient indigenous land use system.

Many of the environmental monitoring programmes described in this book provide key component data within large national data depositories. Here the RBP programme differs significantly, because some of the data remain with the data producer and thereby data owner. However, the RBP programme still provides important information that contributes towards better understanding of environmental change, as well as support to planning, decision making, and policy development. Though not recognized at the initiation of the RBP programme, one focus of the work has become to provide a broader interdisciplinary understanding among all land users. We recognize the reindeer husbandry system as a suitable indicator system for sustainable landscapes and sustainable land use. Hence, the RBP monitoring programme can provide knowledge to address and resolve important and complicated land use issues.

Key messages

- RBP can serve as an example of both a non-conventional and a community-based monitoring programme.
- A programme initially introduced as community-based mappings supported through field measurements has developed into providing the basis of the more conventional monitoring system to document changes at local and landscape levels.

- Specific components such as GPS tracking of reindeer have provided advanced possibilities for habitat monitoring.
- The RBP programme is unique because it was initiated and carried out by community members and the compiled information is owned and used by community members. There are both challenges and advantages with this arrangement.

Study questions

1 Can reindeer husbandry plans be seen as an example of monitoring? Why or why not?
2 Can you see any problems with the reindeer husbandry plans as a monitoring programme in relation to:
    - Monitoring as a support for policymakers?
    - Fields of conflicting interests?
3 How are the reindeer husbandry plans related to social/human understanding of monitoring?

Further reading

Sandström, P. (2015) *A Toolbox for Co-production of Knowledge and Improved Land Use Dialogues – The Perspective of Reindeer Husbandry*. Doctoral Thesis, Acta Universitatis Agriculturae Suecicae–Silvestra.

Sandström, P., Granqvist Pahlén, T., Edenius, L., Tømmervik, H., Hagner, O., Hemberg, L., Olsson, H., Baer, K., Stenlund, T., Brandt, L.-G., et al. (2003) Conflict resolution by participatory management: remote sensing and GIS as tools for communicating land use needs for reindeer herding in northern Sweden, *Ambio* 32(8), 557–567. https://doi.org/10.1579/0044-7447-32.8.557

Provide thorough descriptions of the RBP programme 12 years apart.

https://www.sametinget.se/renbruksplaner presents all components of the RBP programme including working manuals and instructive films (Accessed November 22, 2022).

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