

# **The Beat of the Mountain: A transdisciplinary rhythmanalysis of temporal landscapes**

## **Abstract**

This article discusses how studying rhythms can help us better understand and manage spatiotemporal tensions in social-ecological landscapes, highlighting the potential of rhythmanalysis as a tool for crossing scientific and methodological borders. The empirical material is from a study of human and non-human users and uses of the highly valued Dovrefjell mountain area in Norway, with particular attention to the much-debated Snøheim Road. We take an in-depth view of three different, but interrelated, rhythms at Dovrefjell and discuss how intervening through rhythms can be a fruitful way to approach landscape management. By simultaneously ‘listening’ to different rhythms, this approach helps us to understand and reduce spatiotemporal tensions between social, cultural and ecological uses of a landscape.

**Keywords:** landscape, rhythmanalysis, interdisciplinarity, wild reindeer, recreation, land management, Dovrefjell, Norway

## **1 Introduction**

Researching, as well as managing, highly complex and multidimensional social-ecological processes is challenging. But just as a music producer lays out the different recorded tracks on the master control and mixes them into a synchronised whole, researchers and managers engaged with social-ecological systems should be provided with methods enabling them to work across traditional boundaries in exploring and managing different interests and knowledges jointly and simultaneously. In the present paper we take seriously DeLyser and Sui’s (2013) arguments that rhythmanalysis has such a potential.

We aim: (a) to examine three rhythms at the highly valued mountain area Dovrefjell in Norway and their interactions, in order to better understand the challenges of wild reindeer management; (b) to discuss how rhythms and their interrelations can be a fruitful approach in applied landscape management; and (c) to elaborate on the potential of rhythmanalysis as a tool for crossing scientific and methodological borders in social-ecological studies.

Three crucial observations can be made when examining the spatiotemporal landscapes of Dovrefjell, and essentially there is a rhythm to each of them. First, throughout history the landscapes of Dovrefjell have served many different purposes. How different groups of people have valued and utilised Dovrefjell has changed in synchronicity with socio-economic changes and wider discursive changes in society, activating environmental, cultural, symbolic, and economic values (Daugstad, Svarstad, & Vistad, 2006).

Second, just before the weather from the west brings snow to the Dovrefjell, one of the few remaining European wild reindeer herds moves from its summer grazing areas in the west to the eastern side of the mountains (Strand, Flemsæter, Gundersen, & Rønningen, 2013). Here

the animals can find food under the thin and dry snow cover during winter. The herd moves again when spring comes and the snow layer melts and uncovers the rich soils of the western areas. This seasonal movement cycle between east and west is considered to be crucial for the conservation of wild reindeer.

Third, at the same time as the wild reindeer start their seasonal movement from west to east, the hiking season reaches its peak in these areas (Gundersen, Mehmetoglu, Vistad, & Andersen, 2015). At this altitude, the mountains are only attractive for the average hiker for a short period of time in late summer or early autumn. The area's attractiveness to hikers increased significantly after the controversial reopening of Snøheim tourist cabin in 2012 at the foot of the famous peak Snøhetta. Most tourists reach this area by the Snøheim Road, a 14 km gravel road that cuts across the wild reindeer migration route and connects the tourist cabin with the main highway over Dovrefjell.

This article's analysis of spatiotemporal relationships at Dovrefjell is influenced by Henri Lefebvre's concept of rhythmanalysis (Lefebvre, 2013). Our rhythmanalysis is based on an interdisciplinary study integrating the seasonal rhythm of the wild reindeer, the cyclical rhythm of hikers and tourists, and the linear rhythm of the recurrent devaluations and revaluations of the mountain resources, including how people perceive natural rhythms in different times and spaces (cf. Bunkse, 2004). Other significant rhythms such as those of the weather and the vegetation layer, as well as the circadian rhythm, are also addressed.

We present the conceptual framework and the study area, before we go more into the particularities of three vital rhythms of Dovrefjell. Thereafter we discuss the polyrhythms of Dovrefjell, crossing disciplinary divides.

## 2 Conceptualising rhythms

Linguistically, rhythm originates from the Greek *rhythmus*, meaning 'regular flow or movement' (Caprona, 2013). *Temporality* is vital for rhythms, and Lefebvre (2013) identifies two kinds of rhythms: cyclical rhythms of returning, though generative, intervals; and linear rhythms which represent a timed flow of information or events. While the former is a well-established, everyday understanding of rhythm, the latter has gained increasing attention in social science research, especially in studies analysing the interplay between different *nested* rhythms (cf. Paiva, 2016), temporal elements that together with others form polyrhythms, which might or might not be perceived as a whole. Another categorisation of rhythms is based on a separation between metrical and non-metrical, or in musical terms divisive vs. additive rhythms. While much music, dance and seasonal or circadian rhythms in nature have an underlying metrical level and can be divided into equal units, other timed sequences are added to one another in a linear flow without a metrical reference. Newer understandings of rhythm pertain, for example, to both the *combination* of different elements in a temporal assemblage and to a *feeling of rhythm*, as in a poem, as distinct from measurable rhythms. Defining rhythms 'with dogmatic epistemology misses its objects' (Mels, 2004b, 3).

Studies of rhythms in social science involve the temporal organisation of space and highlight rhythm-making processes in both society and nature as vital for shaping as well as understanding our surroundings. Rhythms can be socially produced patterns, such as institutional processes, customs or synchronised habits, or natural patterns, such as climate and weather changes, animals' migration patterns and tidal movements. Different rhythms, also across the nature-society divide, can influence or be dependent on each other.

Analysing rhythms enables us to see beyond individual things, images, objects or actions and see their interplay. Rhythmanalysis opens up a myriad of possible uses and approaches, and there is a growing body of literature on spatiotemporal rhythms, including both anthologies (e.g. Edensor, 2010; Mels, 2004b) and journal special issues (Henriques, Tiainen, & Väliaho, 2014; Shilling, 2013). Recent studies have investigated the synchrony or asynchrony between different rhythms, exploring such as conflicting rhythms (e.g. Brown, 2012; Lager et al. 2016; Spinney, 2010), how rhythms and polyrhythms shape experiences and practices (e.g. Edensor, 2011; Marcu, 2017; O'Reilly, 2004; Terkenli, 2005, Vannini and Taggart, 2015) and rhythms' embeddedness in landscapes (e.g. Jones, 2006; Pungas, Oja, & Palang, 2005). Rhythms in urban spaces has particularly been subject to many studies (e.g. Kärrholm et. al, 2015; Osman and Muliček, 2017; (Schwanen, van Aalst, Brands, & Timan, 2012; Vergunst, 2012). Most of the literature is based on qualitative ethnographic studies.

While Lefebvres conceptualization of rhythm has been influential, it has also been subject for criticism as it is claimed to lack enough analytical purchase to be fully employed as an exhaustive analytical framework for time-space studies (e.g. Crang, 2001; Reid-Musson, 2017; Shilling, 2013; Simpson, 2008; Wunderlich, 2013). Simpson (p. 824), for example, asks for a more "heuristic understanding of rhythmanalysis" where rhythms are less treated as objects and more as emergent relationships. However, although Lefebvre's work can be regarded as an unfinished project, we believe, in line with Edensor (2011, 190), that it is nevertheless a good place to start thinking about rhythm, and importantly, "sufficiently open to adapt and expand notions of rhythm."

In his book *Rhythmanalysis*, Lefebvre (2013) suggested an approach with a transdisciplinary character, which has the potential to connect multiple scales and domains, and combine qualitative and quantitative analyses (DeLyser and Sui, 2013). Interdisciplinary research projects often suffer from one of two pitfalls. In the search for ways to work together across boundaries, the strengths and expertise contributed by each of the involved disciplines or scientific traditions might become blurred. Alternatively, scholars from different disciplines end up working side by side, without really adding a new layer of analysis that ties together their different knowledges. DeLyser and Sui highlight rhythmanalyses as an inventive cross-disciplinary approach to bridge methodological gaps, and argue for further developing rhythmanalysis at the intersection between disciplines and scientific frameworks. Evans and Franklin (2010), Jones (2010), Thorpe (2015) and Rantala and Valonen (2014) have studied the interplay between humans and geological rhythms, and Ratamäki and Salmi (2015) and Prieto de la Fuente (2015) study human-animal interactions. However, studies that have taken up the challenge of jointly analysing natural and sociocultural rhythms, and not at least

crossing disciplinary divides, are scarce. The potential for studying nature-society relations, and human-animal polyrhythms in particular, combining qualitative and quantitative data seems thus to be unfulfilled.

Rhythmanalyses is a way to study, or in Lefebvre's terms 'listen to', different spatiotemporal practices simultaneously without necessarily valuing or giving priority to one more than others. Analysing polyrhythms by searching for relations between different rhythms in terms of patterns of synchrony or asynchrony makes it possible to reveal arrhythmia as well as how arrhythmia can be avoided through adjusting one or more of the rhythmic elements. Lefebvre (2013) terms the latter 'intervening through rhythms'.

### 3 Studying Dovrefjell

Dovrefjell holds strong environmental, cultural, symbolic and economic values and meanings. Traces of human subsistence linked to reindeer hunting in this mountainous area date back 9000 years, and today the region is an even more vital habitat for wild reindeer (*Rangifer tarandus tarandus*), which has both cultural and ecological importance. Norway holds approximately 90 percent of the remaining population in Europe, and has an international responsibility for maintaining its habitat (Strand et al., 2013). The herd at Dovrefjell represents the origin of the entire native reindeer population (Røed et al., 2014), and a large part of its habitat is protected.

The controversial Snøheim Road is at the centre of attention in this article (Figure 1). The Snøheim Road was originally a track used by cattle drovers, later a cart road to the former Reinheim tourist cabin, and then developed into a road suitable for heavy military vehicles but also used by hunters, mountain livestock grazers, hikers and tourists (Daugstad et al., 2006). The Snøheim Road is a potential barrier to the seasonal movement of the wild reindeer, and its future is hotly disputed.

An interdisciplinary research project (2008–2017) was carried out to identify ways of balancing human uses and the protection of wild reindeer populations, and specifically to provide recommendations for the future management of the Snøheim Road (Gundersen et al., 2017; Strand et al., 2013). Researchers from different disciplinary traditions have worked together, and authorities as well as stakeholders with conflicting interests have taken part by cofunding the project and serving on an advisory steering group. The knowledge produced has already been applied in planning and management initiatives (Kaltenborn, Hongslo, Gundersen, & Andersen, 2015). The comprehensive methods used in the study, comprising qualitative and quantitative data, have been presented in detail elsewhere (e.g. Flemsæter, Rønningen, & Holm, 2013; Gundersen et al., 2017; Panzacchi et al., 2016; Strand et al., 2013), and are therefore only briefly described here. Notably, the interdisciplinary approach has enabled us to extract spatiotemporal data from three separate studies and subject it to a transdisciplinary analysis, focusing on the rhythms and polyrhythms of this distinctly temporal landscape.

Figure 1. Map of the core of the study area in the Dovrefjell-Sunndalsfjella national park, including the Snøheim Road (Snøheimvegen). Reindeer movements are derived from 41 GPS collared female reindeer given position every 3 hour in the period of February 2009 to October 2017.

### 3.1 The Discursive Rhythms of Dovrefjell

As consciously or unconsciously repeated, overt or covert modes of structuring and reproducing the world, symbols, maps, and metaphors also tend to encourage particular dominant rhythms and routine ways of organizing human space and actions, while excluding, controlling or masking the rhythms of others (Mels, 2004b, p. 6).

The shifting spatiotemporal relationships between landscape and moral valuations at Dovrefjell, expressed through both deliberative and material practices, are striking (Flemsæter et al., 2013; Gundersen et al., 2017). These landscape dynamics can be understood as a linear discursive rhythm of changing geographical visions, or modes of representation (cf. Mels, 2004a), which have been an integral and vital part of the coproduction of Dovrefjell as a whole. Shifting images of nature and resources have been patterned by symbolic as well as formal modes of representation, correlating with shifting 'worldviews' (cf. Buttner, 1982). We highlight five expressions of such discursive moral considerations:

During the early twentieth century, the *modernization* of the young nation included building sufficient infrastructure. The north-south railway across Dovrefjell opened in 1921, and the main road running parallel to the railway later received European Highway status (E6). Massive hydropower developments undertaken during the 1950s provided the financial basis for the building of the modern, industrialized Norwegian welfare state. In 1953 three lakes were regulated for hydropower production at Dovrefjell, forming the dam Aursjøen, with associated infrastructure such as gravel roads, power lines, and lots of landfill. With gravel roads extending deep into the mountain areas, private cabins and recreational infrastructure followed.

Responding to the country's rapid occupation during World War II, Norwegians agreed that the country needed to strengthen its *military* capacity. Dovrefjell was scarcely populated and was seen as highly suitable for an artillery range (Bonsak, 2005). From 1959 until they were shut down in 2005, intensive military activities left substantial traces in the landscape. In 1959 the tourist cabin Snøheim, built for recreational purposes by the Norwegian Trekking Organisation, was taken over by the military, and the road into Snøheim was upgraded to accommodate heavy vehicles.

*Nature protection* came to the fore during the 1960s and 1970s, and a national park was established in 1974. The main goal was, and is still, to protect the habitat of the wild reindeer

herd. Surrounding the park are several other categories of protected areas. After the closure and relocation of the artillery range, the area was incorporated into the surrounding conservation area. At present a massive nature restoration project is taking place, removing all traces of military activity.

Starting in the late 1880s, the urban upper class introduced recreation to Dovrefjell and elsewhere and eventually established a systematic national focus on nature protection and environmentalism (Breivik, 1978). During recent decades, strong urbanisation and a rising standard of living have opened remote areas such as Dovrefjell to recreational uses by a broader range of the population (Rønningen and Flemsæter, 2016). This nature-based rural development has increased pressure on natural resources. The Snøheim tourist cabin is now back in the hands of the Norwegian Trekking Organisation and currently attracts many hikers. The newly established Viewpoint Snøhetta closer to the highway also draws many visitors. Today the landscapes of Dovrefjell are presently mainly represented as an area for *recreation and nature consumption*.

Throughout history, humans have influenced fluctuations in the wild reindeer population at Dovrefjell through shifting hunting and nature management practices. Between 1900 and 1950, the herd was small due to a lack of systematic management and subsequent over-harvest depleting the population. Herd size rebounded and reached a peak in the 1960s, leading to starvation and death. Drawing lessons from overgrazing, which still affects the vegetation layer, environmental authorities shifted management strategies. Local management bodies were established and knowledge-based sustainable harvesting of wild reindeer with a stable population size over time became the main goals (Bråtå, 2001).

This brief historical overview shows that successive revaluations Dovrefjell have had major impacts on the landscape and landscape practices. Crucially, decisions taken in the past based on the valuations and worldviews existing at that time have been changed in line with entirely different purposes. There are currently heated debates about the future use and protection of Dovrefjell in general, and the Snøheim Road in particular. These debates demonstrate not only that moral values are reflected in the landscapes of Dovrefjell but also that these changing landscapes in turn affect people's notions of right and wrong and, crucially, who is entitled to delineate right from wrong (Flemsæter et al., 2013). These recurring discursive revaluations interact with and shape the landscapes of Dovrefjell in a dynamic, rhythmic pattern containing shifting moralities, practices and materialities.

### ***3.2 The rhythms of wild reindeer***

Wild reindeer are more or less constantly on the move searching for different resources in the harsh mountain environment. The herd requires a large area in order to fulfil nutritional requirements, and within the cycle of a year they have separate calving areas, summer grazing areas, and winter grazing areas, as well as relatively stable movement corridors between them. To map the wild reindeer's land use pattern, and to single out *where* and *when* the animals are accessing resources that are particularly vulnerable to human uses, we

collected GPS locations from a selection of animals over a nine-year period (2009–2017), applied computer-aided habitat selection models to estimate the effects of human disturbances, and carried out in-depth exploration of selected focal areas, incorporating different kinds of knowledge, including local knowledge. We observed clear seasonal variations in the herd's use of space, and the relatively long time frame of the study enabled us to study movement patterns over several seasons, reducing the uncertainty of the data (Jordhøy, Strand, Sørensen, Andersen, & Panzacchi, 2012; Panzacchi, Van Moorter, Jordhøy, & Strand, 2013; Strand et al., 2013).

First, the analyses of the habitat selection models demonstrated that, on a general level, roads and tourist cabins have a direct negative effect on the use of old large scale migration corridors, and features such as power lines and private cabins have an indirect negative effect connected to the human activity they generate (Panzacchi et al., 2013; Panzacchi et al., 2016). Infrastructural development have led to several fragmentations of the herd. The hydroelectric power dam Aursjøen separated the Snøhetta reindeer into eastern and western herds, and the main highway gradually separated the Snøhetta herds from the Rondane (south-east) and Knutshø (north-east) herds. Development of infrastructure and related human activity has thus created barriers for the wild reindeer.

Second, the in-depth mapping of the spatiotemporal movement of the wild reindeer uncovered a seasonal shift in the land use pattern. Despite annual variations, the main pattern seems to be recurrent. The Snøhetta mountain range lies in the central part of Dovrefjell, and while the areas to its west are influenced by coastal weather systems coming from the west, the eastern side has a much drier, inland climate. The reindeer are now separated into eastern and western herds, and no movement between them was observed. The eastern herd, which is the focus in this article, displays a circular, seasonal movement pattern around the Snøhetta mountain range. In summer, the animals use areas in the west with rich grazing resources, and when the winter approaches they move via the northern areas to the eastern side, which has thick lichen layers covered by a thin coating of dry snow (Jordhøy et al., 2012). For the calving season in the spring the herds return to the western areas again, seeking areas as remote and as undisturbed by human activity as possible.

The eastern reindeer herd in the Snøhetta area must cross two main barriers: marked trails along the axes Kongsvoll-Stroplsjødalen-Reinheim; and the Snøheim Road. The reindeer crossed over the marked trail from Kongsvoll and the Snøheim Road all year around, but the crossing frequency is low in April, May, June and July. August and September have the highest crossing frequency, when the animals are approaching winter grazing areas in the eastern part of the Snøhetta area. This coincides with the period of high intensity tourism traffic on the Snøheim Road (Figure 2).

Figure 2. Reindeer crossing (n=334) and visitor use (n=175551) of the Snøheim road (in percent) during the year done by 41 GPS collared reindeer females and automatic counter, 2009-2017.

The reindeer cross the road in the daytime and only very rarely at night, as they have the same circadian rhythm as humans (Figure 3). They cross with equal frequency every day, while recreational visits are most frequent on weekends (Figure 4).

Figure 3. Reindeer crossing (n=334) and visitor use (n=175551) of the Snøheim road (in percent) during a day done by 41 GPS collared reindeer females and automatic counter, 2009-2017.

Figure 4. Reindeer crossing (n=334) and visitor use (n=175551) of the Snøheim road (in percent) during the week done by 41 GPS collared reindeer females and automatic counter, 2009-2017.

Figure 5. Crossing (n=334) of the Snøheim road, depicted as the shortest distance between two point as interval of 3 hours GPS position, done by 41 GPS collared reindeer females, 2009-2017.

### ***3.3 The rhythms of recreational visitors***

Recent developments in outdoor recreation show diversification in the modes of nature engagement in mountain areas (Flemsæter et al., 2015; Gundersen et al., 2015). Dovrefjell has been a popular area for outdoor recreation for many years, and the number of visitors has grown annually, stimulating local businesses.

We can identify distinct rhythms among the visitors. Almost every visitor needs to be transported to the area by car, bus or train and arrive at the main entrances to the area, and start hiking from there. Most visitors follow designated infrastructure of marked trails and tourist cabins with associated facilities, such as information signs and bridges. Most of the visitors hike a day-trip (75 percent) and end by their car in average five hours later. Automatic counters (n=48) in the study area showed that approximately 82 percent of the visitors used marked paths. Hikers outside marked paths are typically local users, wilderness and adventure seekers, and people who are hunting, fishing, or picking berries or mushrooms. Measuring the spatiotemporal patterns of these hikers is more challenging than for those using designated infrastructure, because they start the trip outside the major entrances and use a larger area.

The volume of visitors in the 48 localities measured by automatic counters showed large variations. July, August and September see the highest number of visitors, approximately three quarters of the annual total. The volume at these entrances varied from 400 visitors



passing in and/or out to 25,000 visitors during the three summer months, with an average of approximately 1600 visitors.

The most commonly used marked path, from Kongsvoll to the tourist cabin Reinheim (and Snøheim), illustrates the hikers' rhythm (Figure 6). Almost all visitors were either walking during the summer or skiing during the winter, and they followed either the marked paths or ski tracks through the valley. The pulse is quite similar from one year to another, and most visitors come in late June, July, August and September; there are significantly fewer visitors in October through April. People start their trips at different times, although people mainly enter the national park before midday and leave in the afternoon and evening (data not shown). The intensity of use is highest on weekends.

Figure 6. Number of visitors (n=175551) daily passing an automatic counter at the main entrance by the Snøheim road, July 2006-October 2017.

The Snøheim Road has many similarities to the Kongsvoll-Reinheim axis, both in terms of potential use and location. During the period 2006–2012 everyone who paid a fee was allowed to drive their private car on the Snøheim Road. The road is always closed from October to June, so there were three hectic months with continuous car traffic during the day. This pattern of access led to a recreational land use that covered most of terrain along the road. In 2012, as a test initiated by the research project, a shuttle bus was established and private cars were prohibited. The bus ran five times a day with no stops between Hjerkind and Snøheim. Most people visited the Snøheim cabin at the end of road and then hiked towards the top of Snøhetta. Both the use of the road and the spatial footprint of the hikers changed significantly (Figure 7). We identified a considerable change in visitors' profile. Local people continued to use their private cars to a large extent, but some took the shuttle bus (Strand et al., 2013). Rhythms changed along three dimensions; first, the intensity of use during the day became more concentrated in five periods; second, the spatiotemporal pattern changed from dispersed and scattered hikes in the terrain along the road to being concentrated around the marked trails from Snøheim at the end of the road; and third, visitors were no longer predominantly local, but included many tourists from outside.

Figure 7. GPS tracked visitors at the Snøheim road during summer season. On top data from 2011 when all visitors used private cars (n=351 groups of visitors), and below allocated data from the year of 2012, 2013 and 2016 when all visitors used shuttlebus (n=859 groups of visitors).

#### 4 The polyrhythms of Dovrefjell

The rhythms of the wild reindeer and the recreational visitors can be categorized as cyclical rhythms, as certain temporal patterns occur repeatedly and can be divided into more or less equal units in a metrical system. The rhythm of the long-term sociocultural devaluations and revaluations of Dovrefjell over time, however, is linear and non-metric. As Mels (2004a, p. 6) put it, this kind of rhythm is ‘connected to particular discourses, geographical imaginations and modes of representations’.

We will now zoom in on the *polyrhythms* tied to the Snøheim Road, and discuss how arrhythmia both can be revealed and avoided. At the outset of the research project, the authorities presented three alternative futures for the road: removing it as part of the ongoing nature restoration project; keeping the road and letting it be open for traffic; and keeping the road but regulating its use. The first alternative had actually been adopted in 1999, but the decision was contested, and our transdisciplinary research group was expected to illuminate the consequences of each alternative and provide research based advice for the future management.

The studies of wild reindeer habitat selection models demonstrated that roads have significant disturbing effects on the animals’ migration patterns (Panzacchi et al., 2013; Strand et al., 2013). Adding to that, a group of stakeholders with a nature conservationist perspective were arguing for the removal of the road for the benefit of “undisturbed” nature as well as the wilderness experience (Daugstad et al., 2006). Thus, from a perspective focusing on the rhythms of the wild reindeer, there were certainly many reasons why researchers should support the complete removal of the road.

From the perspective of the rhythms of the recreational visitors, while disregarding the wild reindeer movement patterns, the second alternative would have been a reasonable choice. The Snøheim cabin and Snøhetta mountain attract many visitors, and without the road the use of the mountain area would be sharply restricted. The trip to Snøhetta would require a two-day hike, and the rest of the area would be less accessible to most people. Results also showed that the area between Hjerkin and Snøheim would be more used by recreationists for hiking if the road were open and unregulated. By removing the road, hikers would be more likely to use the area between Hjerkin and Snøheim and less likely to use the area beyond Snøhetta.

Recreational visitors share space with wild reindeer in late summer when the animals are moving to their winter habitat. In principle, the hikers’ rhythm disturbs that of the wild reindeer. In such situations, a common management tool internationally is restrict recreational use during critical time periods for wildlife (Manning, 2011). But such restrictions are highly controversial in Norway, where both formal and informal regulations ensure public access rights to private as well as public land. Therefore, we needed to search for other ways of harmonising these rhythms and avoiding encounters between people and

reindeer. We could use existing or new infrastructure and attractions to guide people to areas that are less important for the wild reindeer. A second option would be to reduce the time when people's and animals' spatiotemporal uses overlap.

To avoid establishing long-term barriers for the wild reindeer, the adjustment of hikers' movement patterns needs to be sustainable. Thus, crucially, the rhythm analysis needs to incorporate the long-term recurrent changes in the social and political contexts that landscape management takes place. We need to look beyond the present, learn from the past and prepare for the future. Management solutions ought to be robust, outlasting changing social and political contexts. A third level of knowledge in the rhythm analysis is therefore gained when the spatiotemporal analysis is complemented by the discursive rhythms and recurring moral revaluations of the landscapes of Dovrefjell. By viewing the present use and management of Dovrefjell in a historical perspective, it is obvious that moralities, and the related land use decisions, are influenced by the intellectual, moral or cultural climate of an era. What is prioritised at one time, such as the military installations that followed after the war, is seen as inappropriate at another, when military uses were seen as incompatible with a 'natural' landscape. Material changes in a landscape influence how a landscape is valued later, in a different societal context. Moreover, institutions, such as protection areas, management bodies and interest groups, and arenas where stakeholders can meet, discuss issues, and exchange knowledge, are also expressions of moral considerations reflecting a specific time period (Flemsæter et al., 2013). The power of some moral valuations can be prolonged through institutional arrangements rooted in a different era. This situation might, on one hand, lead to an institutional imbalance in power relations as new challenges for landscape management emerge, but, on the other, institutional arrangements that outlast recurring discursive revaluations of landscapes might be the key to establishing robust and sustainable management solutions that are capable of handling change.

For the management of the Snøheim Road, this suggests the establishment of arenas and institutions where stakeholders, managers and researchers across interests, responsibilities and disciplines meet and share and develop knowledge. To build on Mitchell's (2000, 139) terms, actors should be offered equal opportunities to 'author' the landscape. These could be formal and permanent bodies, or project-based groups connected to research or planning processes, but arenas could also emerge as a result of recreational infrastructure developments, such as the shuttle bus and attractions that have been developed to pull people to the fringe of the most vulnerable areas. On board the bus and at attraction sites, environmental authorities might inform about the wild reindeer and other natural and cultural values, and explain the reasons behind management measures. For management solutions to be stable through shifting times, arenas should be set up for long-term communication and cooperation in which authorities, stakeholders with conflicting interests, and researchers participate. The interdisciplinary approach to the complex must not be confined to specific projects, but rather become an integral part of everyday landscape management. Landscape management authorities therefore need to retain highly qualified and creative staff who are comfortable operating in dynamic social and political environments.

The conclusion based on the interdisciplinary analysis of the polyrhythms of Dovrefjell was to transport visitors by bus from Hjerkind to Snøheim, with a limited number of departures per day, and reducing other traffic by car, bike or foot to a minimum, provided long-term arrangements for communication and knowledge exchange between stakeholders, a predictable and long-term organisation of the shuttle bus and unequivocal responsibility for maintaining the road. In this scenario recreational visitors can easily access the mountain, and the wild reindeer movement corridor is sustained. Moreover, management solutions founded so clearly on different branches of knowledge have a better chance of gaining legitimacy from multiple stakeholders with conflicting interests, and the prospects for establishing robust and long-term arenas for communication and cooperation between actors that can handle societal changes improves.

The three rhythms are separate systems that could have been researched and managed individually and independently. But they overlap the same geographical space, and temporally they are interdependent and interact in complex ways. Approaching the polyrhythmia and arrhythmia of these relationships has yielded an understanding of the human–animal interface, which otherwise would have been obscured.

Rhythm analyses add new perspectives to landscape research. It focuses on the dynamics and pluralism in landscapes much in the same way as the literature on ecosystem services. However, where the ecosystem service approach face severe challenges as an integrative framework (Setten and Brown, 2018), rhythm analyses not only provides a better understanding of landscapes as a whole and their nature-society relations, but suggests a shift in landscape management perspectives from each distinct landscape element to the interface *between* them. Managing landscape through an understanding of its polyrhythms, and preventing arrhythmia, incorporates liveliness of landscapes and supports landscape management aiming to balance different interests, needs and values. It supports therefore the prosperous branch of literature that draws upon Mouffe's (1999) ideas pertaining to "agonistic pluralism" to show how conflicts may be progressively handled in landscape management. Conflicts between stakeholders are often connected to conflicting rhythms (Cresswell, 2010), producing hierarchies of acceptable human and animal mobility. Thus, people's engagements with rhythmic landscapes, and related ascriptions of meaning, might reinforce or unsettle existing power geometries (cf. Mitchell, 2003). Conceptualising interference in landscapes through polyrhythmia and arrhythmia enables us to handle complexity and better understand nested rhythms in miscellaneous timespaces. Hence, a key to understand and manage temporal landscapes is to address their polyrhythms.

## **5 Intervention through rhythms**

Lefebvre (2013) argues that a rhythm analyst is capable of listening to places and landscapes as one listen to music. Just as the music producer is adjusting the character and relative volume of the different tracks in a music recording, landscape managers might be in a position to intervene through rhythms in order to balance conflicting interests and reconstruct

polyrhythms in spatiotemporal landscapes. In social-ecological systems, as well as in music, dominant rhythms might efface others, producing imbalance and asynchrony. The struggle to gain power over other interests, where research produced in disciplinary silos are used by different stakeholders as deliberative weapons, as each asserts claims to truth and moral acceptability, might result in large gaps between different interests, domination by some interests, and a state of arrhythmia.

The interdisciplinary research project at Dovrefjell demonstrates the potential of rhythm analysis as a tool for crossing scientific and methodological borders. Our conclusions are based on knowledge gained from different disciplines and sciences and, importantly, they are drawn from a joint analysis *combining* qualitative and quantitative data. Understanding the spatial *and* temporal rhythms of this landscape and the degree to which the different rhythms are synchronous or asynchronous enabled us to adjust the polyrhythm by concentrating limited interventions to the *interface* between different rhythms.

Intervening through rhythms can be a fruitful approach to the management of landscapes and other complex social-ecological systems. By understanding the polyrhythms of a landscape, researchers and managers are better able to cope with and, to some degree, reconcile spatiotemporal tensions between social, cultural and ecological uses and valuations of a landscape. A better understanding of the interrelations of spatiotemporal structures in a landscape enhances society's capacity to sustain highly valued socio-ecological systems.

## Acknowledgements

## References

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