



HAL
open science

Negotiating (with) Fire: Contemporary Fire Domestication in Swedish Sápmi

Sarah Cogos, Lars Östlund, Samuel Roturier

► **To cite this version:**

Sarah Cogos, Lars Östlund, Samuel Roturier. Negotiating (with) Fire: Contemporary Fire Domestication in Swedish Sápmi. *Journal of Ethnobiology and Ethnomedicine*, 2021, 41 (4), pp.499-516. 10.2993/0278-0771-41.4.499 . hal-03669621

HAL Id: hal-03669621

<https://hal.science/hal-03669621>

Submitted on 16 May 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

NEGOTIATING (WITH) FIRE: CONTEMPORARY FIRE DOMESTICATION IN SWEDISH SÁPMI

Sarah Cogos^{1,2*}, Lars Östlund¹, and Samuel Roturier²

In Sweden, fire management is driven by nature conservation objectives through both regeneration burning, used as a soil preparation method in forestry, and conservation burning in protected forests, aiming to reintroduce fire as an ecological process necessary for the preservation of biodiversity. The burning strategy affects Indigenous Sami reindeer herders who use commercial and protected forestlands as pastures for their reindeer. Fire can have ambivalent effects on reindeer pasture depending on where it occurs. Yet, Sami herders are currently not included in the planning process of burning but for a consultation by forest owners occurring late in the process. In this article, we interpret fire management as a system of fire domestication, understood as continuous interactions between humans and fire. To describe the modalities of contemporary fire domestication, our study draws on semi-structured interviews carried out with Sami reindeer herders, forestry planners, conservation managers, and burning practitioners in different localities of the northernmost counties of Västerbotten and Norrbotten. We show how the domestication of fire involves a dual negotiation process: a negotiation with fire during the burning process, and a negotiation about fire between Sami herders and forest managers. Burning practitioners conceive fire as an agent rather than a tool, able to produce unique effects in forests and increase their naturalness, which they must steer in order to reach desired ecological results. Through the negotiation of the use of fire, fire domestication stimulates new interactions between Sami herders and forest managers, and constitutes a possible common ground from which new forms of collaboration could emerge. Our study reaffirms the hybrid nature of fire, both natural and cultural, resulting from negotiations with and between the human actors of the domestication system.

Keywords: *fire domestication; boreal Sweden; Sami reindeer herding; forest management*

Introduction

Since they domesticated fire about 1.5 million years ago (Gowlett 2016), humans on every continent have continued to develop fire control techniques with a variety of goals (Bowman et al. 2011; Coughlan 2013; Pyne 2012; Scott et al. 2016). However, according to Bowman et al. (2011: 2224), there is still “little understanding of [the] interplay between humanity, fire, and the Earth

¹ Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, 90183 Umeå, Sweden

² Université Paris-Saclay, CNRS, AgroParisTech, Ecologie Systematique et Evolution, Orsay, France

*Corresponding author (sarah.cogos@protonmail.com)

system.” In scientific literature, contemporary interactions between humans and fire are almost exclusively designated by the term “fire management” (see, for example, Bowman et al. 2004; Butz 2009; Mistry et al. 2005; Petty et al. 2015), while “fire domestication” is confined to the pre-historical process through which hominins learned to control fire (Bowman et al. 2011; Gowlett 2016). However, we argue that the domestication framework allows aspects of these interactions to be studied that are not addressed within the “fire management” framework. To Fayol (1949), whose work predates the management concept and theory, “to manage is to forecast and plan, to organize, to command, to co-ordinate and to control.” Thus, “management” steers the attention to aspects related to social organization and strategic action in a utilitarian perspective. In contrast to the management framework, the domestication framework allows us to address questions such as, what are contemporary interactions between humans and fire and how do people who view fire differently interact?

In the case of plants and animals, anthropology has questioned domestication as an “achieved, datable, and localizable historical process,” and proposes instead that it be viewed as “an action that is necessarily continuous, renewed on a daily basis, and nurtured” (Digard 1988:30)¹. Stépanoff and Vigne (2018) reaffirm how domestication is an “ongoing process.” Probably because fire is a non-biological phenomenon, unlike plants and animals, it has not been included in the recent debates about domestication. Nevertheless, the domestication of fire can also be considered a continuous process, updated over time, and depending on goals and representations specific to each society and members of that society at a given time.

Scholars in a variety of disciplines have also brought to the fore the “mutuality of domestication,” especially in the case of animals (Cassidy 2007). Through the domestication process, domesticated beings undergo modifications in terms of their physiology, morphology, behavior, and sociability, but so do their domesticators (Stépanoff and Vigne 2018). Some authors define domestication as a symbiosis (Cassidy 2007; Ingold 1974; O’Connor 1997) or as a coevolutionary process (Cassidy 2007; Stépanoff et al. 2017). This can be relevant for understanding human–fire relationships, considering the tremendous effect of fire domestication on the evolution of hominins, as well as the intertwined effects of anthropogenic and non-anthropogenic factors in fire regimes (Gowlett 2016). Furthermore, domestication is a social process. According to Digard (1988:48), “by producing and consuming domestication, humans both create and express social relations, ideas, etc.” Thus, domestication both reflects and influences the social relations that take place between the human actors within the domestication system.

Based on these assumptions, we suggest that fire domestication can be equated to a negotiation process in two senses. Broadly, negotiation has been defined as “a situation in which independent actors seek, through discussion, to end a disagreement, a conflict of interest, or an open conflict, by developing a solution that is acceptable for all” (Touzard, 2006:72). Ingold (1974:525) draws a connection between domestication and a form of negotiation when he describes the “pastoral man–deer adaptation” as “transactional.” In the same way, we suggest that fire domestication firstly implies a negotiation *with* fire on the part of the human actors who seek to manipulate fire, which is considered as being active in the negotiation. Secondly, fire domestication implies a negotiation *about* fire, between different groups of human actors concerned about the use of fire and its impacts in their environment.

In this article, we define negotiation as a process of interactions between two actors or two groups of actors in which they establish a dialogue in order to assert their respective interests or express their agency. We illustrate this dual negotiation process through the case of contemporary fire domestication in boreal Sweden.

After decades of fire suppression and exclusion, advances in ecological sciences that occurred in the 1970s led the scientific community worldwide to recognize fire as an ecological perturbation essential to the functioning of ecosystems and biodiversity conservation (Brown et al. 2004; Driscoll et al. 2010; Krebs et al. 2010). Over the last few decades, controlled burning techniques have been developed across the world, principally to restore fire-prone habitats, preserve biodiversity, and prevent fire hazards (Brockett et al. 2001; Eloy et al. 2019; Fernandes et al. 2013). In Sweden today, controlled burning represents an issue for nature conservation, as fire is considered as an ecological disturbance necessary for the preservation of biodiversity and the boreal forest structure and composition, as well as for forest production to only a minor extent (Halme et al. 2013; Kuuluvainen 2002).

Controlled burning raises an important issue for Indigenous Sami reindeer herders. They have faced a continuous decrease of winter pasturelands since the 1950s, partly due to forest exploitation and fire suppression and exclusion (Berg et al. 2008; Sandström et al. 2016). Through centuries of colonization, Sami reindeer herders lost their land governance rights and only received a right to use the land for herding (Brännström 2017; Norstedt 2018). They are dependent on decisions taken by forest owners for the management on their pasturelands. The consultation process, enshrined in the Swedish Forestry Act in 1979, requires forest owners to consult Sami reindeer herding communities before implementing any encroaching forestry measure, including controlled burning (Swedish Forestry Act 1979). These consultations represent potential arenas of negotiation about controlled burning between Sami herders and forest owners.

Our main objective in this article is to analyze contemporary fire domestication in boreal Sweden and to describe the negotiation processes *with* fire and *about* fire that it implies. We address this objective through an ethnographic inquiry based on semi-structured interviews with Sami reindeer herders, forestry planners, conservation managers, and independent burning practitioners, carried out in different localities of the northernmost counties of Sweden from 2017 to 2020. This study also draws on the interdisciplinary backgrounds of the authors, covering the fields of ethnoecology, forest ecology, and forest history, as well as their lengthy experience in Swedish Sápmi, and aims to respond to unanswered questions about the nature of fire domestication in the Northern European context.

Methods

A Brief History of Fire Domestication in Boreal Sweden

It is commonly believed that the Indigenous Sami people, who historically lived off a combination of hunting, fishing, gathering, and reindeer herding, were averse to fire because it destroyed the reindeer winter pastures, mainly composed of reindeer lichens (Granström and Niklasson 2008). This supposed aversion to fire is supported by historical written sources that report the conflicts between Sami reindeer herders and southern settlers who progressively colonized

northern Sweden from the sixteenth century. The settlers used fire to create pasture for their cattle, thus destroying the reindeer winter pastures, sometimes deliberately (Granström and Niklasson 2008; Pyne 2012). However, some studies suggest that the Sami might have used fire to enhance winter reindeer pasture (Hörnberg et al. 1999, 2018). Indeed, without fire, lichen-rich forests tend to become denser and more nutrient-rich over time, favoring the growth of moss and ericaceous dwarf shrubs that eventually outcompete the ground reindeer lichens (Ahti and Oksanen 1990; Miller 1996; Nilsson and Wardle 2005). The Sami may also have used fire to enhance reindeer summer pastures (P.-J. Perttu, pers. comm. 2019).

In Sweden, like in the rest of the Western world, the turn of the twentieth century marked an unprecedented break in the history of fire domestication, when forest managers made the choice to exclude fire from the environment to preserve silvicultural resources, in the context of industrialization (Niklasson and Granström 2000; Östlund et al. 1997; Zackrisson 1977). However, during the same period, the role of fire in boreal forest regeneration was debated in the forestry sector. Regeneration burning (in Swedish, *byggbränning*) experiments were carried out in Sweden as early as the 1890s, consisting of burning clear-cut areas to encourage forest regeneration. These experiments led to the use of burning as a forestry practice on a large scale in the 1950s and 1960s (Cogos et al. 2020; Granström 1991; Holmgren 1959). From the 1970s, regeneration burning was superseded by mechanical soil preparation, with fire remaining virtually absent from the boreal forest for two decades (Granström 1991; Östlund et al. 1997).

Since the 1990s, efforts have been made to restore fire into the environment (Halme et al. 2013; Östlund et al. 1997). Fire reintroduction is encouraged by various environmental policies, including the Forest Stewardship Council certification that requires forestry companies to “burn an area equivalent to 5% of the regeneration area on dry and mesic forest land over a five-year period” (FSC Sweden 2010). Fire reintroduction is achieved through regeneration burning in productive forests and through conservation burning (in Swedish, *naturvårdsbränning*) in protected areas, which involves burning standing forests to promote nature conservation by reintroducing fire as an ecological function.

Debates about the use of fire for forestry between herders and foresters at national and local levels began as early as the 1920s and increased in the 1950s, fostering what later became formal “consultations” (Cogos et al. 2021). During the consultations with forest owners, herding communities are represented by one or more herders charged with asserting the interests of the community. Controlled burning ceased to be a subject of dispute in the 1980s and 1990s, as the technique was replaced by mechanical soil preparation, but it became contentious again since the late 1990s in the context of the consultation process, when controlled burning was reintroduced in forest management. While in forestry law the consultation area was limited to the “year-round herding” areas, i.e. lands above the “cultivation line”, where the Sami can conduct reindeer herding the whole year (see Figure 1), the Forest Stewardship Council certification extended the consultation area to the entire herding area, including the lower conifer forestlands, corresponding to winter grazing lands for the Sami.

Study Area

The area of interest (Figure 1) corresponds to the lower forestlands extending from the Scandinavian mountain range to the coast of the Baltic Sea, composed of commercial forestlands and protected forest areas. The area includes fire-adapted Scots pine (*Pinus sylvestris*) forests that are prone to fire, while Norway spruce (*Picea abies*) thrive in forest patches not subjected to fire. The area also contains a smaller component of deciduous trees, mostly birches (*Betula pendula*, *B. pubescens*). The ground vegetation is mainly feather mosses and ericaceous dwarf shrubs in moist to mesic forest types, and ground reindeer lichens (*Cladonia* spp.) in dry forest types.

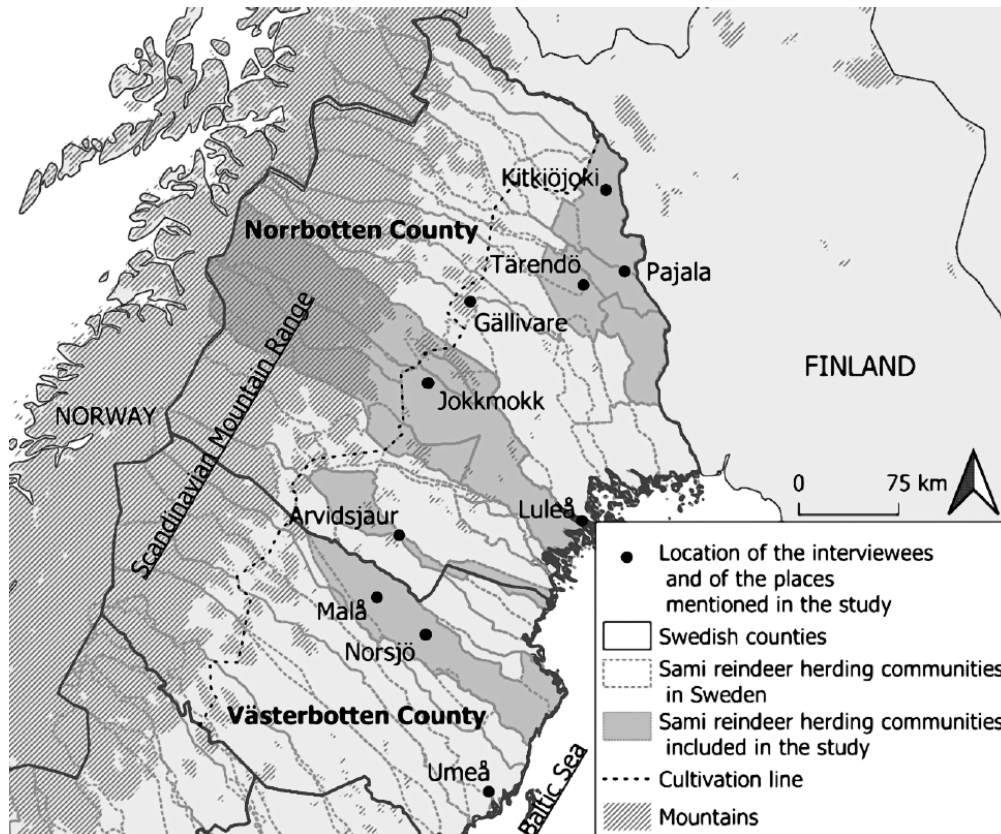


Figure 1. Location of the interviewees and of the different places mentioned in the study, within the counties of Norrbotten and Västerbotten. The Sami reindeer herding communities of the herders interviewed are indicated in dark grey. The Cultivation line (dotted black line) delineates year-round reindeer grazing lands on the western side, from winter grazing lands on the eastern side. Source: the authors.

Ethnoecological Fieldwork

This study is an ethnographic investigation involving semi-structured interviews carried out by the main author of this article between 2017 and 2020 in different locations in the counties of Norrbotten and Västerbotten (Figure 1) with 24 Sami reindeer herders, including one woman; nine forestry planners including one woman; five conservation managers, including one woman; and two

independent forestry entrepreneurs who conduct controlled burning. They were of all ages, from people in their twenties to over eighty years old. The interviewees were identified either through their function within organizations of interest (forestry companies, County Administrative Boards, reindeer herding communities) or through another interviewee. They were not selected according to any criterion except for their function.

Sami reindeer herders practice reindeer herding in forestlands located in the northern half of the country and owned by forestry companies, the state, or private owners. The herders interviewed belonged to 11 of the 51 Swedish Sami reindeer herding communities (Figure 1). All communities undertake seasonal migrations between winter grazing lands in the conifer forest, where the reindeer feed on reindeer lichen, and summer grazing lands in the alpine tundra or forestlands. The communities included in this study were selected for the past and current burning activity in the area: the Tårendö area is locally known for its continuous history of burning by forest owners since the nineteenth century, which continues today. The Malå area is the place where forest manager Joel E. Wretling experimented with regeneration burning from the 1920s to the 1950s (Cogos et al. 2020). As for the Jokkmokk area, it constitutes the ground fieldwork for previous studies about the interactions between fire and reindeer pasture (see Cogos et al. 2019; Roturier et al. 2017).

The forestry planners interviewed worked either for private forestry companies or for the National Forest Company. They were in charge of planning the controlled burnings for their management area. Conservation managers worked either for forestry companies or for the county administrative boards, where they were in charge of planning nature conservation measures, including conservation burning. In this article, a “burning practitioner” refers to an individual who is in direct contact with fire through regeneration or conservation burning and works for a forestry company, the county administrative board, or independently.

The interviews were conducted in Swedish, recorded and fully transcribed by the main author of this article. They covered a range of subjects, from the burning technique to knowledge transmission issues and effects of fire on the boreal forest, as well as the interactions with other actors about the use of fire. The interviews were analyzed qualitatively, following an inductive approach: the themes that were common to the interviews were identified and the interviews were divided and classified according to those themes. The similarities and divergences between the interviewees relatively to those themes were analyzed.

Results and Discussion

Uses and Techniques of Contemporary Fire Domestication in Northern Sweden

Regeneration Burning in Commercial Forestry

Interviews with burning practitioners allowed us to understand both the dynamics of knowledge transmission relating to the burning technique and the principles of the technique itself. Regeneration burning has been used over several decades in northern Sweden since the first experimentations in the late 1800s, and relies on past and new techniques (Figure 2). As they explained, today’s burning practitioners were able to learn from retired practitioners who were still alive in the 1990s, when burning came back into fashion. The current technique is thus directly inherited from the regeneration

burning era that lasted until the 1960s. Contemporary burning practitioners have also refined their technique through practice. Moreover, a few training courses were developed in the late 1990s in northern Sweden. Although the tools and equipment have evolved since the 1960s, the underlying principles of regeneration burning remain the same today.

Initially, forest regeneration after burning relied on Scots pine seed trees that were left in the stand after logging (Wretling 1948). Currently, regeneration after burning mostly occurs as a result of planting or sowing. Burning is mainly undertaken in mesic to dry stands with ground vegetation composed of mosses and ericaceous shrubs. Burning reduces the vegetation on the clear-cut site, which would otherwise compete with pine seedlings. As explained by burning practitioners, the technique avoids the need to clear the stand in the early years of regeneration. Burning also perturbs the soil by increasing the fertility and favors the growth of seedlings for several years after burning. Though recognized as an efficient forest regeneration measure by burning practitioners, regeneration burning is nowadays mainly advocated for nature conservation purposes.

The choice of the stand to burn is driven by a compromise between the safety of the practitioners and risk to the adjacent forest stands, as well as the economic costs and benefits for the stand's regeneration. The burnt stand ideally is surrounded by natural (water bodies, mires) or pre-existing artificial (roads) fire barriers. For this reason, forestry companies often prioritize burning on forest islands among mires or islands in lakes. In the case of islands, burning is cheaper than other silvicultural techniques that require the transportation of machines over wetlands. In terms of size, the stand must be large enough to reduce the cost per hectare of fire operations, but small enough to ensure the safety of the burn. According to Westerberg (1997), 10 ha is the minimum size needed to keep the costs per hectare small. Stands burned through controlled burning between 2011 and 2015 in Sweden were 12 ha on average (Ramberg 2017).

The burning process extends over a period of several years, to take necessary preparatory steps ensuring the safety and the efficiency of the actual burning. First, the stand must be logged, taking account of future burning: the logging debris must be removed from the edges of the clear-cut; firebreaks must be created one or two years before the burning by digging trenches along the edges of the stand that do not present natural fire barriers; anthills must be burned one year in advance, because they can smolder for several weeks after a fire and present a risk of re-ignition. Burning can be carried out one or two years after logging, once the logging debris and ground vegetation have dried sufficiently, and before fresh vegetation starts to grow again.

During the burning year, the practitioners closely monitor the weather forecast throughout the summer in order to identify a suitable day. This mainly depends on the humidity and wind conditions. On the burning day, a burning leader is designated to supervise and coordinate the team, usually composed of about ten workers. The burning technique used corresponds to the "strip head fire" technique. It consists of successively igniting parallel fire lines. The first line is ignited parallel to one of the firebreaks such that the prevailing wind blows the flames back towards that firebreak. The fire progresses slowly over the clear-cut in parallel strips against the wind. This technique provides opportunities to control the propagation and intensity of the fire. The fuel is progressively combusted so that, when a new fire front reaches the preceding one, it dies out from a lack of fuel. As a result, this technique does not usually require water to extinguish the fire. However, a system of water pumps

connected to a water source and a network of hoses is always present at the burning site in case of accidental ignitions in adjacent forest stands due to flying sparks. Burning practitioners can also wet the logging debris and brushwood along the edges of the stand that appear less safe. Nowadays, some burning practitioners use thermal cameras to detect fire sources and some use helicopters to monitor the progress of the burning and to damp down the stand if necessary. Once the burning is completed, the stand must be watched day and night until the risk of re-ignition has passed.



Figure 2. Regeneration burning with seed trees in 2009. The visible fire line follows a gravel road, which is a good firebreak (photo credit: Lars Östlund).

Conservation Burning: Restoring a Natural Process

Conservation burning draws on a dual heritage combining a technique based on regeneration burning and principles from ecological sciences. Even before its formalization as a nature conservation technique, in Sweden, forestry companies used to burn small patches of standing forest in combination with regeneration burning. The conservation burning technique draws on research by fire ecologists who helped develop methods and training courses for Swedish forest managers (Granström 2001; Niklasson and Granström 2000). First applied by forestry companies, conservation burning was then implemented by county administrative boards in northern Sweden. The Västerbotten and the

Norrbotten county boards planned their first conservation burnings in the late 1990s and in 2012, respectively.

Currently, in Sweden, conservation burning is principally advocated by environmental policies for nature conservation purposes. Main objectives are to preserve or restore a forest landscape conceived as natural and to promote biodiversity in standing forests. The idea that disturbances disrupted by humans, like fire, should be reintroduced or restored to preserve ecosystems is directly inherited from the paradigm shift that occurred in ecological sciences in the 1970s (Clewell and Aronson 2013; Krebs et al. 2010). Conservation managers who are in charge of conservation burning are trained in forestry schools where such understanding of ecosystem functioning is disseminated. Specifically, conservation burning is used to counteract the phenomenon of “sprucification” currently observed in the boreal forest, that is, an increase in Norway spruce in forests historically dominated by Scots pine, partly due to fire suppression. At the forest stand level, the objective is to obtain variation in the forest structure and composition with a mixture of dead and living healthy and damaged trees. Tree damage favors the production of resin in the trees and eventually the production of “silver wood,” that is, long-lasting dead wood. Furthermore, fire scars resulting from the fire form substrates for some fungi and insects. Burning affects the forest soil and its vegetation by removing shrub and moss cover and burning part of the humus layer.

The choice of suitable stands for conservation burning is guided by a compromise between safety and benefits in terms of nature conservation. This compromise entails a paradox, as the stands that are the safest and easiest to burn often have a smaller probability of being affected by forest fires, as in the case of islands within mires, while forests that tend to burn more frequently, such as dry pine forests, may be less safe to burn.

As for the burning technique, the principles of conservation and regeneration burning are identical in terms of safety precautions and burning processes. Both use the strip head fire technique. However, the ecological objectives associated with conservation burning imply technical adaptations that differ from regeneration burning. For example, since the variation obtained in the forest structure depends heavily on the state of the stand before burning, some forestry measures can be prescribed in advance to create such variation by felling trees or creating clearings. Compared to regeneration burning, burning a standing forest entails technical constraints as well. The fuel on the ground may be less abundant compared to a clear-cut stand, as there is no logging debris, while the ground vegetation may dry less easily because of the tree cover. Suitable conditions for burning are less controllable and less easy to attain.

Negotiating With Fire

The “Pilotage” of Fire

Whether for regeneration or conservation goals, burning involves direct contact with fire during which burning practitioners must demonstrate their ability to domesticate fire so that it can achieve desired effects. However, the use of fire can give rise to situations that escape the control of practitioners, who must constantly renew the terms of the negotiation in order to reach their objectives. Swedish burning practitioners we interviewed used the verb *styra* (to drive, conduct, steer) to describe their actions towards fire during the burning process. They do not seek to confine fire, but

rather to direct its inherent properties and effects. As a technique, burning can be equated with a type of technical action termed “pilotage” by some authors (Larrère and Larrère 2018; Ribet 2011), which refers to the art of orienting natural processes to obtain desired results.

Steering fire relies on an ability to anticipate how it will behave and its effects in the area where it is present. One conservation manager explained that he could “read the intensity [of the fire] or predict how it will behave depending on how the forest looks.” Animal metaphors were omnipresent in the burning practitioners’ way of speaking about fire. Burning practitioners explained that they had to be able to predict fire’s ability to “jump over,” “crawl over,” and “creep underneath” to reach a nearby forest stand, or “run up in the trees.” For one of them, the burning team should always be ready to “hunt” the fire. Thus, burning practitioners must understand how fire spreads in order to “keep the fire under control” or “hold it back” when it constantly seeks to escape, like a wild animal would do. Ribet (2005), who worked with pastoralists in the French Pyrenees, likened the culture of fire to an ethology of fire. She highlighted the analogy between a herd looking for new grass to feed on and a fire looking for vegetation to burn and fuel to consume (Ribet 2011).

Drawing similarities between fire and an animal reveals how, to burning practitioners, fire is not simply a tool but rather an agent, as suggested by Ribet (2011) in the case of French pastoralists. This was obvious in the discourse of one burning practitioner in particular who, to describe the behavior of fire during the burning of a mountain slope, recounted how “the fire want[ed] to go up.” He recounted how, once, they had a “war” with a fire that escaped, and how “all the rules you have made for yourself can be spoiled by the fire.” Despite the technical system they deploy in order to anticipate and control fire behavior, burning practitioners must still face its unexpected moves and act accordingly in the moment. Regarding the possibility that wildfires may increase in the future, this same burning practitioner said: “fire is one of our colleagues nowadays.” In the perspective of the burning practitioners we interviewed, fire is an agent that they must contend with in order to reach their own objectives.

Fire is an agent that burning practitioners must *negotiate with*. When fire practitioners personify or animalize fire, they acknowledge the agency of fire and the need to compromise with it. This negotiation is achieved through the technical skills of the practitioners and their knowledge of fire behavior. Practitioners seek not only to keep the fire under control but also to modulate its behavior and make it act according to their own objectives. During regeneration burning, practitioners are able to control the progress of the fire by redistributing the fuel loads and controlling the ignition pattern by burning in strips. As long as there is fuel to consume, the fire moves forward. Keeping the fire moving is actually necessary to keep the fire alive, as one burning practitioner explained: “in a forest, the fire moves all the time. If it does not move, it dies out.” Conversely, a fire that is allowed to spread through a stand with continuous fuel will be impossible to “master.” One burning practitioner explained: “the more we ignite, the longer distance we ignite, the more intensive it becomes.” Burning practitioners regulate the timing and the pattern of ignition of the fire lines in order to control the speed, the intensity, and the movement of the fire. Steering the intensity of the burning is particularly important so as to obtain the desired effects on the soil. For example, in regeneration burning, the fire must be strong enough to burn dwarf shrubs, like bilberry (*Vaccinium myrtillus*), or burn the roots of species that would compete with the pine seedlings, like heather (*Calluna vulgaris*). In conservation

burning, steering the intensity is important in order to ensure that the fire behaves in a heterogeneous fashion across the stand and brings about varied effects on the forest, such as the percentage of trees that are killed by the fire.

The negotiation with fire also involves the adaptation to and manipulation of the elements that drive the behavior of fire, including, chiefly, the wind. The wind accelerates and steers the movement of fire. Burning practitioners must understand what types of wind will allow them to keep control of the fire, the ways to orientate ignitions depending on the wind direction, and the ways to adapt the progress of the burning if the wind turns. One of them compared these skills to “having a sailboat.” Through their understanding of the processes at play during burning and the interactions between fire, fuel, wind, oxygen, and smoke, experienced burning practitioners can even steer these elements:

I cannot say that it is easy, as it has to do with the weather and the wind, but you can pull the fire. You can also turn the wind, here and there, with fire. It craves a lot of oxygen, so when you set the fire, if you have a difficult firebreak, you set the fire, perhaps 100 meters away from the firebreak, so that it starts pulling the wind from the firebreak. Then you don't have to stand in the wind (forestry entrepreneur, Tärendö, 2020).

Thus, burning is not simply about fire management: it implies a direct and physical contact with fire, involving the bodies of burning practitioners, who enter in a negotiation with fire through their technical skills. Such interaction is better encompassed by the domestication framework, compared to a focus on management aspects only.

Fire as an Agent of Naturalness

According to the conservation managers we interviewed, one main objective of conservation burning is to “restore the natural phenomenon of fire” or to “regain a natural process.” In the field, conservation burning is advocated as a tool to increase the “nature value”—an ecological indicator used by conservation and forestry managers in Sweden—of forests that are characterized by a history of recurrent fires. For conservation managers, burning can increase the nature value by creating or preserving forest structures or “substrates” that favor fire-dependent species and, thus, biodiversity.

Forestry planners working for forestry companies are also concerned about the role of fire in maintaining ecosystem functioning and species richness. One of them believed that fire suppression and exclusion had jeopardized the “normal functioning” of areas with a history of forest fires, thus endangering fire-dependent species. Beyond the economic benefits, forestry planners praise regeneration burning for its “natural” character:

I think that it is the best soil preparation method, because it is natural. It is nature's own way of helping it [the forest] to grow (forestry entrepreneur, Tärendö, 2020).

In forests where burning is impossible for practical reasons—too expensive or too risky—conservation managers sometimes recommend “fire-mimicking measures.” Such measures can consist of mechanically removing spruce trees or inducing their death by ringbarking, burning individual pine

trees to trigger resin flow, or clearing the stand. However, some conservation managers question whether this results in “the same ecological effects” and “the same nature conservation benefit” as obtained with fire. For the biologist at the Norrbotten county administrative board who we interviewed, fire has a unique effect that cannot be reproduced with machines:

Fire creates a structure than can be difficult to mechanically reproduce, I believe. What I observe when I follow up after fires is that fire is so random. It does not produce a homogeneous pattern: it creates patches that might not be affected at all, but only a few meters away, the fire has burned very intensely and burned everything. And this random pattern is very hard to create with machines (biologist at the Norrbotten county administrative board, Luleå, 2020).

To her and other foresters we interviewed, fire transforms the forest landscape and structure in ways that humans cannot fully reproduce. A burning practitioner affirmed: “the point is that it should burn. What burns burns, what does not burn is left; this is natural too.” Because it exceeds total human control, fire confers a natural quality on the resulting landscape. The art of burning, and the subtlety of the negotiation with fire, rely on the ability of burning practitioners to control fire sufficiently to prevent it from escaping, but not to the extent that fire cannot exert its own agency and create its unique effects in nature. As Stépanoff and Vigne (2018) note, domestication involves a “continuum of interactions between control and autonomy.” By conserving the opportunity to express its own agency, fire resolves the paradox, expressed by some foresters, of increasing naturalness while being artificially induced by humans. Even controlled in the framework of conservation and regeneration burning, fire is seen as an agent of naturalness in forest management. Although forest managers themselves use the terms “natural” and “artificial” to speak about fire, fire domestication actually blurs the divide between the “natural” and the “artificial.”

Negotiating Fire: Sami Reindeer Herders Challenge Fire Domestication

The Terms of Negotiation: Burning for Reindeer

We now discuss how fire domestication also involves a negotiation *about* fire, between forest managers (including forestry planners and conservation managers) and Sami reindeer herders. According to some forest managers, reindeer herders hold a negative view of all forestry activity and are opposed to any forestry work conducted on their herding lands, including burning. One forestry planner considered that reindeer herders are usually “a bit skeptical” about burning. One conservation manager considered that reindeer herders were generally opposed to burning, and he viewed the consultations with reindeer herding communities as the biggest barrier to controlled burning.

Sami herders are well aware of the role of fire in the boreal forest, to maintain reindeer lichen pastures in the long term and thus for the next generation, based on their own experience, inherited knowledge and scientific input. For example, some Sami place names associate fire and good reindeer winter pasture (Cogos et al. 2019). Nevertheless, they do see reasons for opposing burning of stands with even the smallest amount of ground or arboreal lichen. They know that fire destroys reindeer lichens for several decades before they can re-establish. Given the general declining state of lichen

pastures, it is essential for them to preserve any available lichen pasture to ensure the possibility of carrying out reindeer herding for the current generation of herders, especially in some areas where the pasture condition is much degraded. They consider that the negative effects lasting for several decades resulting from the destruction of existing lichens would jeopardize their ability to pursue reindeer herding today, which to them overrides possible benefits in terms of reindeer pasture for future generations.

Most of the herders we interviewed are not opposed to burning when it does not concern important pasturelands with already-existing reindeer lichen. Reindeer herders observe that some pine forests historically rich in ground reindeer lichen include tree scars from old forest fires, yet moss and ericaceous dwarf shrubs have now taken over. Some herders, therefore, view burning as a means to remove competing species and allow the lichen to establish. Furthermore, to reindeer herders, regeneration burning presents benefits compared to the most disturbing mechanical soil preparation measures carried out by forestry, such as harrowing. Reindeer tend to gather on burned fields in the summer because the trampled ashes deter the insects that harass them. While this effect of burning disturbed the movement pattern of the reindeer and the herders' traditional herding system in the 1950s-60s when regeneration burning was at its peak (Cogos et al. 2021), it is viewed positively by herders today. Burning also favors the growth of summer pasture for a few years, such as the grass *Deschampsia flexuosa*. Additionally, burning preserves the structure of the ground and removes the logging debris, which otherwise complicates the movement of the herders across their herding lands and prevent the reindeer from accessing the pasture. Thus, herders regularly propose burning in places where it would benefit reindeer pasturelands. A forestry planner in charge of the consultation recalled:

I have quite large spruce forest areas where the herder included in the consultation said: 'When you are done, throw a match, it will be very good.' He said that there was nothing for the reindeer there, neither epiphytic lichen nor ground lichen. He said that it could not be worse (forestry planner, Gällivare, 2020).

In some cases, the Sami propose conditions that lead burning practitioners to adapt the burning technique. For example, they sometimes water the lichen patches before burning so that they persist through fire. If the planned burning is located near calving habitat, reindeer herders sometimes ask to delay the burning until autumn when the calving period is over.

Negotiations undertaken between Sami herders and forest managers about burning, during the consultations, can lead to compromises. In some cases, reindeer herders can make burning a condition for accepting other forestry measures, such as clearcutting. In other cases, negotiations can lead forest managers to include other parameters in their fire management strategy. In the case of regeneration burning, as the technique is usually not necessary for forest regeneration anymore, and is applied by forestry companies mostly to meet FSC requirements, forestry planners usually accept the suggestions of herders. In the case of conservation burning, the exclusion of lichen-rich forests from the possible stands to burn can go against conservation principles, as these forests are more prone to fire, making them a logical choice for conservation managers. Moreover, this constraint narrows the options of possible stands to burn, which can present difficulties for reaching the FSC targets in some areas.

The Sami can make use of arenas other than the consultations to assert their interests in terms of burning. For example, at a seminar on the effects of conservation on reindeer herding organized by the Västerbotten County Administrative Board, and gathering forest managers from various companies, conservation managers, and reindeer herders from across Sweden, one herder described his role with the reindeer in the following terms:

I will talk about the needs of reindeer herding, or I rather want to say, the needs of the reindeer, which we, as reindeer herders, oversee and thus convey the word of the reindeer. The reindeer, as you understand, [is] a four-legged being that cannot speak Swedish. So, we try to mediate the needs and wants of the reindeer. Their needs in the past and their needs today. And we, as reindeer herders, we will pass on our traditional knowledge to both our descendants and government agencies. Our knowledge about the forest, about the needs of the reindeer for pasture, will also be shared. But the most important thing, I think, is to pass on the needs of the reindeer for pasture (reindeer herder, Umeå, 2020).

Martin (2016:71) reports similar words expressed during a political gathering by a representative of the Gwich'in, an Indigenous People of Alaska, whose livelihood partly depends on caribou hunting: "We must speak for the caribous, since they cannot speak for themselves." By translating the needs of the reindeer, Sami herders seek to preserve the integrity of the reindeer pasturelands. Later, during an interview, the same herder reflected on the role of the consultation process with reindeer herding:

Reindeer represent a threat to forestry. Forestry [managers] cannot do whatever they want, because they must reach an agreement with reindeer herders... So, it is also positive that they must consult reindeer herders and cannot do whatever they want in the forest (reindeer herder, Umeå, 2020).

Still in the same vein, Martin (2016) recounts how the caribou have become ambassadors of the Gwich'in when opposing industrialization projects in Alaska. This dual movement in which Sami herders are spokespersons of the reindeer and the reindeer are ambassadors of the Sami can be viewed as a strategic position to assert the herders' interests in their negotiation with forest managers. However, it should also be understood in the light of the reciprocal responsibility that ties together humans and reindeer in the frame of reindeer husbandry. Ingold (1974:525) describes the domestication of reindeer as a "long-term contract of mutual advantage." Thus, reindeer herders have the opportunity to negotiate and even take advantage of burning to orientate it in their and the reindeer's interests. By doing so, they actively contribute to defining the location, the timing, the types of fire, and the purpose of burning, and to the current domestication of fire.

The Grounds for Negotiation: Shared Uncertainty and Experimentation

Because fire has been virtually absent from the Swedish boreal forest for more than a century, due to fire suppression, both Sami herders and forest managers face the difficulty of negotiating the use of fire while being uncertain of its long-term effects on the boreal forest and reindeer pasture.

Coming together around the question of burning, forest managers and reindeer herders become partners in experimentation. Indeed, during the consultation, the negotiations and debates about which stands to burn sometimes led to experimental setups designed to clarify doubts about burning and its effects. A forestry planner described how a reindeer herding community wanted his company to harrow a stand adjacent to a burnt and harrowed stand so that it could be used as a “reference” to “see how they would differ.” Another planner recounted his burning of a logged stand because “the reindeer herders wanted to test what would happen” compared to a stand on the other side of the road where there were no soil preparation measures after logging. One conservation manager recalled that some reindeer herders refused to let them burn a forest where there was a large amount of reindeer lichen but suggested burning another one with less lichen so that they could “see what happens in this case.”

Questions about burning can lead to participatory research projects. For example, reindeer herders, foresters from the Swedish National Forest Company, and one of the authors have collaborated in experiments with lichen pasture restoration after burning (Roturier et al. 2017). This project encouraged other forestry planners and conservation managers in northern Sweden to carry out similar experiments in their districts. This shared uncertainty places reindeer herders and forest managers on an equal footing and opens the way for collaboration that extends the simple consultation process.

The Limits of the Consultation as an Arena for Negotiation

The consultation is currently the main arena in which Sami herders can discuss the use of burning with forest managers. However, apart from individual and local initiatives, there is no formal or institutional way through which Sami herders can be involved in decisions related to the burning strategy. Indeed, they have not been included in the development of the controlled burning strategy at the national level nor at the regional level. While the Swedish FSC standard reinforced Indigenous Peoples’ rights by extending the obligation to consult Sami herders, the latter were not included in the Swedish FSC working group on fire restoration. The only consideration of Sami reindeer herding included in the 2010 Swedish FSC standard was the specification that “managers with landholdings within the reindeer husbandry area shall not use prescribed burning on lichen areas of importance to reindeer husbandry” (FSC Sweden 2010).

The fact that negotiations about fire are constrained to the format of consultations poses limitations for Sami herders. The limits of the consultation process have been pointed out by Sami herders and related in scientific studies (Larsen and Raitio 2019; Sandström and Widmark 2007; Sandström et al. 2006; Widmark 2006). According to many herders interviewed by Sandström and Widmark (2007), the consultation process was unsuccessful because they were included too late in the planning of the forestry measures. Reindeer herders we interviewed raised the same issue today about the planning of burning:

We are a hindrance when we come in too late. We are no hindrance if we have the opportunity to participate from the start, so that we can plan together. ‘Maybe this place you are considering is unsuitable, but this is a suitable place, can we do something here?’

‘ah we had not thought about that,’ maybe they say. Instead, we come in so late to the planning that they have already presented a plan to the National Board of Forestry. Then it is too late. And it is wrong. (reindeer herder, Kitkiöjoki, February 2020)

Moreover, negotiations about burning remain limited by the fact that forest managers are the ones who will eventually carry out the burnings, and are able to impose their own conditions based on technical justifications.

Sandström and Widmark (2007) showed that, in Sweden, consultations between reindeer herders and forest managers did not provide the basis for true co-management. Our research confirms that this is still the case today. Studying fire management through the lens of domestication allows revealing the multitude of interactions occurring between the humans and the non-humans at play, including negotiation processes. However, all actors of these processes are not included in the planning of fire management on an equal basis. Sami herders stress the need to implement actual collaboration between forest management and reindeer herding early in the planning of burns, instead of consultations that lead to a standoff late in the process, and to uneven power relations between Sami herders and forest managers.

Conclusion

Towards Fire Co-management in Sweden?

In boreal Sweden, burning represents a possible common ground between Sami reindeer herding and forest management, because forest managers are bound by obligation to burn, and reindeer herders, forestry planners, and conservation managers have common interests in the use of fire. Greater inclusion of Sami herders from the start of the planning process could guarantee that burning is mutually beneficial. Possible solutions for improvement of the consultation process have been proposed by scholars (Sandström et al. 2006; Sandström and Widmark 2007). In the case of fire management, some countries, including Australia, Venezuela, and Brazil, for example, have taken advantage of the fire restoration movement to implement cooperative fire management systems, which include Indigenous Peoples in the planning of the burning measures (Eloy et al. 2019; McGregor et al. 2010; Rodríguez et al. 2018; Russell-Smith et al. 2013). Sweden could take a leaf out of these attempts, of which benefits and drawbacks have been analysed, to develop its own collaborative fire management system together with Sami reindeer herding communities.

Sweden released a new FSC standard in 2020, which notes the importance of including Indigenous rights in forest management, and requires large forest owners to organize a “participatory planning process” with the reindeer herding communities (FSC Sweden 2020). However, the current modalities of such a process still perpetuate the situation in which Sami herders are asked to validate or veto decisions that have already been made, instead of being included in the whole planning process from the start. The guidelines provided by the 2020 FSC standard will most likely not guarantee greater inclusion of Sami reindeer herders in forest management, including the planning of controlled burnings. We argue that, in order to be truly democratic and collaborative, fire management, i.e., the actual planning and implementation of fire use, should be based on a deeper understanding of the fire

domestication system, which involves different groups of humans but also non-humans engaged in continuous negotiation processes.

Notes

¹All citations of non-English sources were translated by the authors.

Acknowledgements

We thank the Sami reindeer herders, the forestry planners, the conservation managers, and the forestry entrepreneurs interviewed for this work for their willingness to share their knowledge and points of view. This work was supported by the Carl-Göran Adelswårds stiftelse. Victoria Grace and Sees Editing Ltd corrected the written English.

References Cited

- Ahti, T., and J. Oksanen. 1990. Epigeic Lichen Communities of Taiga and Tundra Regions. *Vegetatio* 86:39–70.
- Berg, A., L. Östlund, J. Moen, and J. Olofsson. 2008. A Century of Logging and Forestry in a Reindeer Herding Area in Northern Sweden. *Forest Ecology and Management* 256:1009–1020. doi: 10.1016/j.foreco.2008.06.003.
- Bowman, D. M. J. S., J. Balch, P. Artaxo, W. J. Bond, M. A. Cochrane, C. M. D'Antonio, R. Defries, et al. 2011. The Human Dimension of Fire Regimes on Earth. *Journal of Biogeography* 38:2223–2236. doi: 10.1111/j.1365-2699.2011.02595.x.
- Bowman, D. M. J. S., A. Walsh, and L. D. Prior. 2004. Landscape Analysis of Aboriginal Fire Management in Central Arnhem Land, North Australia. *Journal of Biogeography* 31:207–233. doi: 10.1046/j.0305-0270.2003.00997.x.
- Brännström, M. 2017. *Skogsbruk Och Renskötsel På Samma Mark (in Swedish) [Forestry and Reindeer Husbandry on the Same Land]*. Unpublished Doctoral Dissertation, Umeå University, Umeå, Sweden.
- Brockett, B. H., H. C. Biggs, and B. W. van Wilgen. 2001. A Patch Mosaic Burning System for Conservation Areas in Southern African Savannas. *International Journal of Wildland Fire* 10:169–183. doi: 10.1071/wf01024.
- Brown, R. T., J. K. Agee, and J. F. Franklin. 2004. Forest Restoration and Fire: Principles in the Context of Place. *Conservation Biology* 18:903–912. doi: 10.1111/j.1523-1739.2004.521_1.x.
- Butz, R. J. 2009. Traditional Fire Management: Historical Fire Regimes and Land Use Change in Pastoral East Africa. *International Journal of Wildland Fire* 18:442–450. doi: 10.1071/WF07067.

- Cassidy, R. 2007. Introduction: Domestication Reconsidered. In *Where the Wild Things Are Now: Domestication Reconsidered*, edited by R. Cassidy and M. Mullin, pp. 1-26. Berg, Oxford, UK.
- Clewell, A. F., and J. Aronson. 2013. *Ecological Restoration, Second Edition: Principles, Values, and Structure of an Emerging Profession*. Island Press, Washington DC.
- Cogos, S., L. Östlund, and S. Roturier. 2019. Forest Fire and Indigenous Sami Land Use: Place Names, Fire Dynamics, and Ecosystem Change in Northern Scandinavia. *Human Ecology* 47:51–64. doi: 10.1007/s10745-019-0056-9.
- Cogos, S., S. Roturier, and L. Östlund. 2020. The Origins of Prescribed Burning in Scandinavian Forestry: the Seminal Role of Joel Wretling in the Management of Fire-Dependent Forests. *European Journal of Forest Research* 139: 393–406.
- Cogos, S., L. Östlund, and S. Roturier. 2021. Fire Management in the Boreal Forest of Swedish Sápmi: Prescribed Burning and Consideration of Sami Reindeer Herding During 1920–1970. *Environmental Management* 68:295-309. doi: 10.1007/s00267-021-01503-9.
- Coughlan, M. R. 2013. Errakina: Pastoral Fire Use and Landscape Memory In the Basque Region of the French Western Pyrenees. *Journal of Ethnobiology* 33:86–104. doi: 10.2993/0278-0771-33.1.86.
- Digard, J.-P. 1988. Jalons Pour Une Anthropologie de La Domestication Animale [Milestones for an Anthropology of Animal Domestication]. *L'Homme* 28:27–58.
- Driscoll, D. A., D. B. Lindenmayer, A. F. Bennett, M. Bode, R. A. Bradstock, G. J. Cary, M. F. Clarke, et al. 2010. Fire Management for Biodiversity Conservation: Key Research Questions and Our Capacity to Answer Them. *Biological Conservation* 143:1928–1939. doi: 10.1016/j.biocon.2010.05.026.
- Eloy, L., B. A. Bilbao, J. Mistry, and I. B. Schmidt. 2019. From Fire Suppression to Fire Management: Advances and Resistances to Changes in Fire Policy in the Savannas of Brazil and Venezuela. *The Geographical Journal* 185:10–22. doi: 10.1111/geoj.12245.
- Fayol, H. 1949. *General and Industrial Management*. Pitman. Boston, USA.
- Fernandes, P. M., G. M. Davies, D. Ascoli, C. Fernández, F. Moreira, E. Rigolot, C. R. Stoof, et al. 2013. Prescribed Burning in Southern Europe: Developing Fire Management in a Dynamic Landscape. *Frontiers in Ecology and the Environment* 11:e4-e14. doi: 10.1890/120298.
- FSC (Forest Stewardship Council) Sweden. 2010. *Swedish FSC Standard for Forest Certification including SLIMF Indicators*. FSC Sweden, Uppsala, Sweden. URL: <https://se.fsc.org/preview.fsc-forest-management-standard-for-sweden.a-772.pdf>
- FSC Sweden. 2020. The FSC National Forest Stewardship Standard of Sweden. FSC International Center, Bonn, Germany. URL: <https://se.fsc.org/preview.fsc-std-swe-03-en-the-fsc-nfss-of-sweden.a-1373.pdf>
- Gowlett, J. a. J. 2016. The Discovery of Fire by Humans: A Long and Convolved Process. *Philosophical Transactions of the Royal Society B: Biological Sciences* 371:20150164. doi: 10.1098/rstb.2015.0164.

- Granström, A. 1991. Elden i Människans Tjänst [Fire in the Service of the People]. *Skog Forsk* 4:6–12.
- Granström, A. 2001. Fire Management for Biodiversity in the European Boreal Forest. *Scandinavian Journal of Forest Research* 16:62–69. doi: 10.1080/028275801300090627.
- Granström, A., and M. Niklasson. 2008. Potentials and Limitations for Human Control over Historic Fire Regimes in the Boreal Forest. *Philosophical Transactions of the Royal Society of London. Series B* 363:2353–2358.
- Halme, P., K. A. Allen, A. Auniņš, R. H. W. Bradshaw, G. Brumelis, V. Čada, J. L. Clear, et al. 2013. Challenges of Ecological Restoration: Lessons from Forests in Northern Europe. *Biological Conservation* 167:248–256. doi: 10.1016/j.biocon.2013.08.029.
- Holmgren, A. 1959. Skogarna och deras Vård i Övre Norrland intill år 1930 [Forests and Their Value in Upper Norrland until Year 1930]. In *Sveriges Skogar under 100 år. En Sammanfattande Redogörelse över det Svenska Skogsbruket 1859–1959*, edited by G. Arpi, pp. 413–443. Kungl. Domänstyrelsen, Stockholm.
- Hörnberg, G., L. Östlund, P. Zackrisson, and I. Bergman. 1999. The Genesis of Two *Picea-Cladina* Forests in Northern Sweden. *Journal of Ecology* 87:800–814.
- Hörnberg, G., Josefsson, T., DeLuca, T. H., Higuera, P. E., Liedgren, L., Östlund, L., and I. Bergman. 2018. Anthropogenic Use of Fire Led to Degraded Scots Pine-lichen Forest in Northern Sweden. *Anthropocene* 24:14–29.
- Ingold, T. 1974. On Reindeer and Men. *Man* 9:523–538. doi: 10.2307/2801122.
- Krebs, P., G. B. Pezzatti, S. Mazzoleni, L. M. Talbot, and M. Conedera. 2010. Fire Regime: History and Definition of a Key Concept in Disturbance Ecology. *Theory in Biosciences* 129:53–69. doi: 10.1007/s12064-010-0082-z.
- Kuuluvainen, T. 2002. Introduction. Disturbance Dynamics in Boreal Forests: Defining the Ecological Basis of Restoration and Management of Biodiversity. *Silva Fennica* 36: 5–11. doi: 10.14214/sf.547.
- Larrère, C., and R. Larrère. 2018. *Penser et Agir avec la Nature: Une Enquête Philosophique [Thinking and Acting with Nature: A Philosophical Inquiry]*. La Découverte. Paris, France.
- Larsen, R. K., and K. Raitio. 2019. Implementing the State Duty to Consult in Land and Resource Decisions: Perspectives from Sami Communities and Swedish State Officials. *Arctic Review* 10:4–23. doi: 10.23865/arctic.v10.1323.
- Martin, N. 2016. *Les Âmes Sauvages: Face à l'Occident, La Résistance d'un Peuple d'Alaska* (in French) [*Wild Souls: In the Face of the Western World, the Resistance of a People from Alaska*]. La découverte. Paris, France.
- McGregor, S., V. Lawson, P. Christophersen, R. Kennett, J. Boyden, P. Bayliss, A. Liedloff, B. McKaige, and A. N. Andersen. 2010. Indigenous Wetland Burning: Conserving Natural and Cultural Resources in Australia's World Heritage-Listed Kakadu National Park. *Human Ecology* 38:721–729. doi: 10.1007/s10745-010-9362-y.
- Miller, D. 1996. Lichens, Wildfire, and Caribou on the Taiga Ecosystem of Northcentral Canada. *Rangifer* 12:197–207.

- Mistry, J., A. Berardi, V. Andrade, T. Krahô, P. Krahô, and O. Leonardos. 2005. Indigenous Fire Management in the Cerrado of Brazil: The Case of the Krahô of Tocantins. *Human Ecology* 33:365–386. doi: 10.1007/s10745-005-4143-8.
- Niklasson, M., and A. Granström. 2000. Numbers and Sizes of Fires: Long-Term Spatially Explicit Fire History in a Swedish Boreal Landscape. *Ecology* 81:1484–1499. doi: 10.1890/0012-9658(2000)081[1484:NASOFL]2.0.CO;2.
- Nilsson, M. C., and D. A. Wardle. 2005. Understorey Vegetation as a Forest Ecosystem Driver: Evidence from the Northern Swedish Boreal Forest. *Frontiers in Ecology and the Environment* 3:421–428.
- Norstedt, G. 2018. A Land of One's Own: Sami Resource Use in Sweden's Boreal Landscape under Autonomous Governance. Unpublished Doctoral Dissertation, Swedish University of Agricultural Sciences, Umeå, Sweden.
- O'Connor, T. P. 1997. Working at Relationships: Another Look at Animal Domestication. *Antiquity* 71:149–156. doi: 10.1017/S0003598X00084635.
- Östlund, L., O. Zackrisson, and a-L. Axelsson. 1997. The History and Transformation of a Scandinavian Boreal Forest Landscape since the 19th Century. *Canadian Journal of Forest Research* 27:1198–1206. doi: 10.1139/x97-070.
- Petty, A. M., V. deKoninck, and B. Orlove. 2015. Cleaning, Protecting, or Abating? Making Indigenous Fire Management “Work” in Northern Australia. *Journal of Ethnobiology* 35:140–162. doi: 10.2993/0278-0771-35.1.140.
- Pyne, S. J. 2012. *Vestal Fire: An Environmental History, Told through Fire, of Europe and Europe's Encounter with the World*. University of Washington Press, Seattle and London.
- Ramberg, E. 2017. *Bränder på Skogsmark i Sverige [Fires on Forest Lands in Sweden]*. Unpublished Doctoral Dissertation, Swedish University of Agricultural Sciences, Uppsala, Sweden.
- Ribet, N. 2005. La Maîtrise du Feu : un Travail en Creux qui Façonne les Paysages [The Mastery of Fire: A Work “En Creux” That Shapes Landscapes]. *Le Travail et les hommes: actes du 127e congrès du CTHS, Paris, CTHS* 32 :167-198.
- Ribet, N. 2011. Enjeux de Connaissance et de Reconnaissance des Compétences Techniques du Brûlage à Feu Courant [Matters of Knowledge and Recognition of Technical Skills of Stubble Burning]. *Forêt méditerranéenne* XXXII:277–290.
- Rodríguez, I., B. Sletto, B. Bilbao, I. Sánchez-Rose, and A. Leal. 2018. Speaking of Fire: Reflexive Governance in Landscapes of Social Change and Shifting Local Identities. *Journal of Environmental Policy & Planning* 20:689–703. doi: 10.1080/1523908X.2013.766579.
- Roturier, S., S. Ollier, L.-E. Nutti, U. Bergsten, and H. Winsa. 2017. Restoration of Reindeer Lichen Pastures after Forest Fire in Northern Sweden: Seven Years of Results. *Ecological Engineering* 108:143–151. doi: 10.1016/j.ecoleng.2017.07.011.
- Russell-Smith, J., G. D. Cook, P. M. Cooke, A. C. Edwards, M. Lendrum, C. Meyer, and P. J. Whitehead. 2013. Managing Fire Regimes in North Australian Savannas: Applying Aboriginal Approaches to Contemporary Global Problems. *Frontiers in Ecology and the Environment* 11:e55–e63. doi: 10.1890/120251.

- Sandström, C., J. Moen, C. Widmark, and Ö. Danell. 2006. Progressing toward Co-Management through Collaborative Learning: Forestry and Reindeer Husbandry in Dialogue. *International Journal of Biodiversity Science & Management* 2:326–333. doi: 10.1080/17451590609618153.
- Sandström, C., and C. Widmark. 2007. Stakeholders' Perceptions of Consultations as Tools for Co-Management — A Case Study of the Forestry and Reindeer Herding Sectors in Northern Sweden. *Forest Policy and Economics* 10:25–35. doi: 10.1016/j.forpol.2007.02.001.
- Sandström, P., N. Cory, J. Svensson, H. Hedenås, L. Jougda, and N. Borchert. 2016. On the Decline of Ground Lichen Forests in the Swedish Boreal Landscape: Implications for Reindeer Husbandry and Sustainable Forest Management. *Ambio* 45:415–429. doi: 10.1007/s13280-015-0759-0.
- Scott, A. C., W. G. Chaloner, C. M. Belcher, and C. I. Roos. 2016. The Interaction of Fire and Mankind: Introduction. *Philosophical Transactions of the Royal Society B: Biological Sciences* 371:8–8. doi: 10.1098/rstb.2015.0162.
- Stépanoff, C., C. Marchina, C. Fossier, and N. Bureau. 2017. Animal Autonomy and Intermittent Coexistences: North Asian Modes of Herding. *Current Anthropology* 58:57–81. doi: 10.1086/690120.
- Stépanoff, C., and J.-D. Vigne. 2018. *Hybrid Communities: Biosocial Approaches to Domestication and Other Trans-Species Relationships*. Routledge, New-York.
- Swedish Forestry Act (*Skogsvårdslagen*). 1979: 429. URL: <http://rkrattsbaser.gov.se/sfst?bet=1979:429>
- Touzard, H. 2006. Consultation, Concertation, Négociation. *Negotiations* 5:67–74.
- Westerberg, D. 1997. Bränning - Metoder och Kostnader [Burning – Methods and Costs]. *Skog Forsk.* 1996/ 97.
- Widmark, C. 2006. Forestry and Reindeer Husbandry in Northern Sweden – the Development of a Land Use Conflict. *Rangifer* 26:43–54. doi: 10.7557/2.26.2.187.
- Wretling, J. 1948. *Nordsvensk Hyggesbränning [Northern Sweden's Regeneration Burning]*. Svenska Skogsvårdsföreningens Förlag, Stockholm.
- Zackrisson, O. 1977. Influence of Forest Fires on the North Swedish Boreal Forest. *Oikos* 29:22–32.