

Article

Emergence of and Learning Processes in a Civic Group Resuming Prescribed Burning in Norway

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Abstract: Background: Coastal Norwegian heathlands have been regularly managed by burning for about 5000 years. This practice, supporting sustainable herbivore production, did, however, cease in the 1950s and was virtually absent for 60–70 years. Loss of biodiversity, increased fire hazard due to biomass accumulation and loss of visual landscape qualities recently propelled new interest in traditional landscape management. Loss of know-how makes this a dangerous activity. The present study focuses on the emergence and learning processes of a civic group established for resuming prescribed burning in Northern Rogaland in order to possibly assist similar initiatives elsewhere. Methods: Study of written information, interviews with core prescribed burners and participant observation have been undertaken. The topics at four annual prescribed burning seminars, arranged by the studied civic group, have been analyzed. Participant observation at civic group winter meetings, debriefing sessions and field work has also been undertaken. Results: Pioneers who, without guidance, resumed prescribed burning relied on experience gained as part-time firefighters and relations to farming, in particular sheep grazing. Building good relations with local fire brigades and support by local and regional environmental authorities (especially the local agricultural advisory office) enhanced the practice. Short weather window, assembling a big enough burner group on the working days, as well as possible liability issues were identified as challenges. They were self-taught through “learning by doing” and open to new technologies/artifacts, i.e., leaf blowers for fire control. Their use of artifacts, together with supporting the fire brigades during a wildfire, strengthened their group identity. A connection to academia improved the focus on safe and effective prescribed burning through deeper insight into the physical parameters that govern burning in the terrain. Conclusions: The study provides valuable insight into favorable preconditions and possible key personnel for resuming prescribed burning in other areas in Norway and elsewhere. Content and teaching methods for a possible future standardized prescribed heathland burning course are suggested.

Keywords: prescribed burning; heathlands; *Calluna vulgaris*; learning processes; civic groups; sustainable sheep grazing

1. Introduction

Understanding and accepting the role of fire in ecosystems may be culturally influenced. Evidently, fire was used by the Vikings [1], Indigenous Americans [2] and Aboriginal Australians [3] as a form of landscaping and controlling biomass accumulation. Fire ecologists [4,5] and paleoecologists provide evidence about the continuity of both natural and anthropogenic burning events through the Holocene in the Mediterranean area [6,7]. However, attitudes to fire’s role in ecology started becoming negative since the 1930s.

Leenhouts [8] estimated that only 10% of area is burned within the USA in the 20th century compared to the pre-industrial period. In California, this ratio is 5–6% [9]. Fire aversion has resulted

in biomass accumulation in all areas where the climate and nutrient conditions supported growth. Reduction of grazing activities is also part of the picture.

However, since climate change has resulted in a longer fire season [7,10,11], the wildfire losses have increased dramatically in the whole world. In 2015, the U.S. Forest Service spent more than 50% of its budget on fire suppression compared to 16% in 1995 [12]. Reexamination of existing policies and re-introduction of the notion of resilience, involving controlled biomass reduction, are ongoing processes. Concerns about red-listed species, mainly birds who depend on open landscapes, also suggest prescribed burning [13]. Areas with reduced vegetation create a barrier providing a good chance of firefighting when a wildfire occurs. Prescribed Fire Councils are active [14] in performing land restoration and informing the public about the difference between “good fires” that should be supported, and “bad fires” that must be extinguished. The level of activity varies greatly throughout the USA, with a strong hold in the Southeast.

Within the EU, the five southernmost Mediterranean countries (Portugal, Spain, France, Italy and Greece) have experienced devastating fires, categorized as “megafires” [15] during the first two decades of the 21st century. Forest fire fatalities in the EU in the 2000–2017 period counted 611 lost lives, i.e., on average, 34 per year [15]. The situation developed to unprecedented losses during 2018 with 102 fatalities in Greece [16], and a further increase in the amount of fires in 2019 [17].

The conclusion of the EU “EFIRECOM” project is that “without prevention, extinction is impossible” [15]. The Fire Brigades claim that “To prepare for megafires, we don’t need more resources, we need better managed landscapes” [15]. Despite this situation, prescribed burning as a means of wildfire prevention/control is highly controversial in this region. The practice is prohibited in Greece, while Portugal, France and some regions in Italy and Spain have developed regulations and criteria for prescribed burning [18,19].

In Norway, preservation of the heathlands as a valuable habitat has, to a large extent during the last decade, gained public support. Public awareness of the problem was raised after the severe sub-zero temperature wildland-urban interface (WUI) fires in January 2014 in abandoned and overgrown heathlands [20]. The first of these fires resulted in the highest number of lost structures during a single fire in Norway since 1923. Additionally, the unusually warm summer in 2018, where 2079 fires occurred [21], influenced public opinion in favor of prescribed burning. Another aspect influencing public opinion is the increased abundance of ticks, often associated with Lyme disease [22], which are believed to perish upon burning.

Prescribed burning is a short-term risk-imposing but long-term risk-reducing activity. Managed heathlands represent a low-fuel-content barrier in wildland fires, and thus reduce societal WUI risk. Ascoli and Bovio [23] studied normative documents dealing with fire and forests in Italy, where landscape management with prescribed fire was addressed. Fire hazard reduction was mentioned most often as the motivation, i.e., in all the studied documents. In almost 30% of the documents, grazing management was mentioned. Habitat restoration was mentioned in 22% of the documents while landscape conservation, firefighters’ training, research studies and other motivations were respectively mentioned in 21%, 17% and 10% of the documents.

The present article examines how prescribed burning of heathlands has been resumed in Northern Rogaland, Norway, after being obsolete for 60–70 years. While regularly managed heathland is not very fire-prone, resuming degenerated heathland is much more challenging. Groups of people have to cooperate in order to achieve safe and effective burning. Thus, informal civic groups among farmers emerged. The study covers the development of a prescribed burner civic group, with mainly farmers as members, for a decade, from 2009 to 2020.

The main research questions are:

1. How did the particular prescribed burner civic group acquire necessary competence (and confidence) to perform burning sessions?
2. Which factors enhance and which factors impede the practice of prescribed burning as a way of heathland management?

3. Which learning processes were prevalent in resuming the activity, and how can they inform future standardized courses?

Possible findings may inform other parts of Norway, Europe, USA, Europe and South Africa, in ways to develop safe and effective heathland prescribed burning groups. In addition, the learning process undertaken by the studied group can provide valuable insights towards the development of a standardized course in Norwegian heathland restoration by prescribed burning. The article is a contribution to the domain of learning in the context of civic groups, in order to perform safe environmental management and sustainable agriculture.

2. Northern Atlantic Heathlands and Their Legal Protection Status in Norway

2.1. Succession of Unmanaged Norwegian Heathlands

The heathland is a type of ecosystem dominated by dwarf shrubs, with the *Calluna vulgaris* L. prevailing, abundant in cooler oceanic climate areas, such as the Atlantic coast of Western Europe. These areas are characterized by relatively small differences between June and January mean temperatures, e.g., 12 °C in June and 2 °C in January for Western Norway, and precipitation relatively evenly distributed throughout the year [24]. The heathlands were previously regularly managed for herbivore, mainly sheep, production. The *Calluna vulgaris* plants undergo changes as they pass from pioneer phase (establishment and growth), to building phase (bushy, productive, vigorous flowering), mature phase (shoot production, but decreased growth), and degenerated phase (central branches die) [25,26]. Each phase may last from five to ten years, dependent on soil characteristics and the density of the stands. The plants are most suitable for grazing during pioneer and building phases, while during the mature and degenerate phase wood production increases, diminishing their pasture value. Dwarf Shrub Heath is characterized by vegetation that has $\geq 25\%$ cover of plant species from the heath family (*ericoids*) or dwarf gorse (*Ulex minor*) [27]. When unmanaged, other species such as grass, bracken and juniper intrude, and finally alter the coverage to the extent that the area is “uncharacterized”. It is estimated that only 10–15% of the European heathlands present during the 18th century still exist today [28]. The best-managed heathland in Europe is the Scottish upland heath, at heights above the agricultural land and below the montane zone, at about 600 m above sea level [29]. The Hill Farming Act (1946 and 1985) [30] states prescribed burning as an activity permitting the use of marginal farming areas, combined with habitat conservation for grouse and deer. Estimated coverage of upland heath in Scotland is 21–31% of the land area, making the habitat a stronghold in Europe.

The northernmost one-third of Europe’s coastal heathlands are located in Norway, mostly present in coastal lowlands. The habitat has had a continuous history of management from ancient times, i.e., from 4000 B.C., through year-round grazing by Old Norse breed sheep [31]. Regular burning with intervals of about 15–20 years were common depending on the growth [1,32]. However, in modern times, the Old Norse Sheep population was reduced to 1000 animals in 1970, all living on the islands of Austevoll municipality. During the last 15 years, the breed has been reintroduced in several farms in coastal Norway, and is now counting about 30,000 animals [33]. In the county of Rogaland, evidence of regular burning cycles dates 5000 years back in time. However, this practice, supporting sustainable herbivore production, seized in the 1950s and was locally absent for about 60–70 years.

Land abandonment has resulted in degenerated heathlands and overgrown vegetation, as shown in Figure 1. These photos were taken from the same spot within a time span of 34 years.



(a)



(b)



(c)

Figure 1. Extreme successional development from (a) 1975, (b) 1993 to (c) 2019 at Bygnes, Karmøy, Norway (N 59.298, E 5.295). (Photos by Arnt Kvinnesland. Reproduced with permission).

2.2. Legal Protection of Heathlands

The EU Habitat Directive (Council Directive 92/43/EEC of 21 May 1992) [34] requires protection of heathlands in the EU-member countries. The EU Habitat Directive does not have legal force in Norway, but still influences administrative decisions. The Norwegian Nature Diversity Act 2009 [35] §52 states that selected habitats which:

1. have a development or condition that makes the habitat threatened;
2. the nature type is important for one or more priority species;
3. the habitat has a significant proportion of its prevalence in Norway, or
4. there are international obligations related to the nature type

shall be protected.

The Act further states in §52: “When selecting a natural habitat where active management or other types of measures are a prerequisite for safeguarding the habitat type, the state shall present an action plan to safeguard the nature type” [35].

In 2015, the most valuable coastal heaths were assigned the status as *selected natural habitat* [36], and put under the auspices of the Norwegian Environmental Agency (NEA). This makes the authorities an important stakeholder in protecting the heathlands: “Coastal heaths are classified as very important (Site A) or important (Site B) by the Ministry of Climate and Environment. By coastal heathland is meant hilly and mainly treeless areas in an oceanic climate, dominated by dwarf shrubs, mainly heather (*Calluna vulgaris*) formed through clearing of forest, and conditioned by long term grazing and burning, and sometimes mowing [36].”

The Ministry of Climate and Environment (MCE) has accepted burning as a method to manage heathlands. This implies that the Fire Brigades have to address the activity.

2.3. Notification Process Required by the Fire Brigade and Liability Issues

Atlantic heathland in Norway exists in five counties, of which Rogaland is the southernmost. There are three fire brigades covering the area: Rogaland Fire and Rescue, Haugesund Fire Brigade and Haugaland Fire and Rescue. The latter extends somewhat north of the border of Rogaland, as some municipalities north of Haugesund chose to join the particular intermunicipal fire brigade. Most heathland burning in Norway is conducted within the jurisdiction of those three fire brigades. Therefore, the activity is clearly addressed on their websites, offering information, and an application scheme for conducting “area burning”. Outdoor burning is generally prohibited from April 15th to September 15th. The Fire Brigade requires an application (filled in an available scheme on the fire brigade’s site) to be delivered at least 4 weeks prior to the planned burn. Detailed information about the area, risk considerations, number of crew, leader, and their experience and knowledge about the area must be provided.

A special note has to be given to the fire brigade the day of the burn, as well as to the 110 fire emergency call center, i.e., equivalent to the US 911 call center. The fire brigade can prohibit the burn when they perceive the weather conditions, weather forecast or other conditions as being adverse. As an example, prescribed burning was prohibited during the spring months of 2020 due to the COVID-19 pandemic.

Since management of the heathlands through prescribed burning is an activity which implies short-term enhanced risk, liability issues may arise. *Florida’s Revised Prescribed Fire Law: Protection of Responsible Burners* [37] provides the best legal protection for prescribed burners, as a court must demonstrate that the burner has been “grossly negligent” in order to be prosecuted.

In Norway, there are no laws addressing the liability issues if a prescribed burn develops into a wildfire and causes losses, and no case has been tried in the court. This means that liability issues in Norway, associated with prescribed burning, still must be clarified. Though the status of legal protection of the burners in case of loss of control in prescribed burning in Norway is still unclear, *Florida’s Revised Prescribed Fire Law* seems to influence police attitudes.

2.4. Funding Schemes in Norway as a Result of Legal Protection of the Heathlands

The Norwegian Environmental Agency is, through the Biodiversity Act 2009 [35] and the selection of the Heathland as a Protected Nature Type in 2015 [36], an important stakeholder in the heathland preservation process. The intention to protect the heathlands has resulted in funding regimes, mainly administrated through the regional counties. The County's environmental administration's subsidy scheme for endangered habitats, funding for activities enhancing landscape qualities in terms of view (where prescribed burning is suggested as an accepted tool), as well as other, less specified available funding ("SMIL-midler": Special Environmental Measures in Agriculture) has enabled funding for land owners, civic groups and associations (for example, Landowner Associations, Farmers' Leagues, Old Norse Sheep Owner Association etc.) to safely resume the heathland management. Funding is necessary in order to acquire equipment, protective gear, arrange meetings to recruit potential prescribed burners and to increase public acceptance of regular burning.

For well-preserved heathland (appraised as A, B and newly also C), a small annual sum per acre is awarded to the farmer/landowner.

3. Theory

3.1. Civic Groups

Voluntary organizations have historically had a strong position in Norway. Currently, the trend is a decline in number of associations with an ideological or political focus. There is, however, stability in the number of associations focusing on sports and culture (mainly for children and youth). An increase in the number of associations focusing on local welfare (parks, playgrounds in the neighborhoods) and local environmental issues can also be observed. Nationwide, hierarchically built associations, characterized by large numbers of passive members, seem to appeal less to young people. Decentralized forms of organizations with specialized focus, linked to local issues, culture and identity are becoming more central. Such organizations focus on participation and activity, and have a weaker ideological basis compared to traditional organizations [38–40]. This phenomenon may be connected to the individualization and de-ideologization of the society in general [41].

A civic group of prescribed burners may be considered as a *community of practice* [42]. However, the concept is a framework that focuses on the social dimensions of learning; the community of practice seen as a social learning system. Several of the characteristics involved in the notion of community of practice are also tangible to characteristics in the concept of civic groups [43].

Research shows that participants in voluntary organizations (including emergency management organizations) are motivated by learning, and the ability to live out their ideas [44]. Among the main reasons for participation, e.g., value-based, learning, socialization, self-esteem, and labor market, only the latter is generally changing much with age, mostly for young participants. Learning is the most important parameter for all ages, along with value-based reasons for participants above 45 years of age. Learning something through hands-on experience is generally known as highly motivating [45].

Prescribed burner groups are characterized by features appreciated in today's voluntary organizations. This may contribute to an increase in the number and distribution of such groups, and create activity to restore the heathlands in several areas along coastal Norway.

3.2. Adult Learning Styles/Theoretical Approach to the Learning Processes in Adult Civic Groups

Restoring degenerated heathland by prescribed burning is challenging. Groups of people therefore cooperate, as informal civic groups among farmers emerge, and gain experience as they practice. The study by Tough [46] about adult groups building their own knowledge and skill through a series of self-planned and self-directed learning episodes, motivated by responsibility for a task, is applicable.

Kolb's learning circle, Figure 2, [47] is also a tool to analyze the highly experiential learning process. It combines experience, reflection, conceptualization, and active experimentation and is, therefore,

a suitable instrument. The process of conceptualization also requires theoretical understanding and involves learning theories viewing learning as acquisition [48].

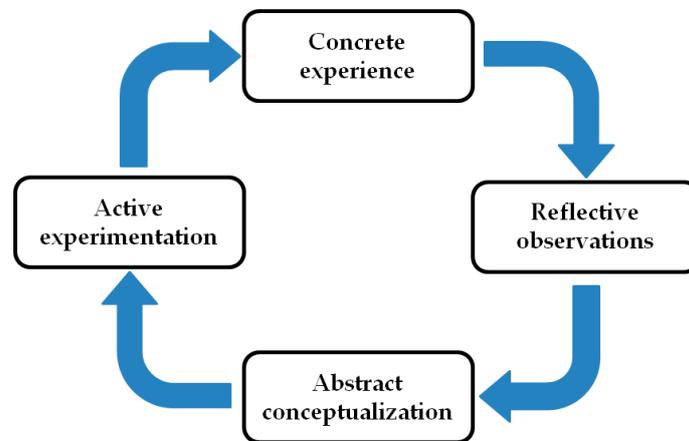


Figure 2. Sketch of Kolb's [46] learning cycle visualized.

Since experience will always vary within a civic group, the theoretical framework developed by Lave and Wenger [49] on situated learning, legitimate peripheral participation, applies well. However, the notion *community of practice* [42], also mentioned in Section 3.1, underlines the importance of learning as a social process, through the participation in common activities and using common artifacts. The practical burning is conducted by the group, while the learning takes place both in each individual and in the group. Thus, the approach of Sfard [50] on two metaphors for learning and the dangers of choosing just one, is fully applicable.

4. Research Methods

Written communications in the local press, addressing prescribed burning as a way of landscape management (2009–2020) were studied.

Semi-structured live interviews [51,52] were performed with the most experienced burners and one person from the agricultural advisory office, who offered crucial support throughout the development of the prescribed burner group. The aim was to reveal their learning process, challenges, and concerns, as well as successes through the years they had been active in the group. The interviews, therefore, qualify as “expert interviews”, where information on one particular field should be gathered and systematized. The semi-structured interviews involved questions about each person's:

1. motivation to commit themselves to the activity;
2. special triggers that affected the motivation;
3. getting started;
4. special challenges; or
5. perceived successes.

A summary of each interview will be given in the next section.

Participant observation was conducted during:

1. civic group winter meetings where plans for burning sessions in the spring were developed (2015–2019);
2. evaluation sessions (2016–2019), also after a prescribed burn that developed into a wildfire,
3. participation at open annual seminars arranged by the civic group in cooperation with the WNUAS, 2016–2019; and
4. participation in a burning session (February 2020).

The recommendations for participant observation described by Blevins [53], Fangen [54] and Wolcott [55] were adapted. Thus, the prescribed burner group was studied in the natural environment for their activities as the group developed.

5. Results and Discussion

5.1. The Prescribed Burner Group Participants and Organization

In 2012, the group had 10 active members, which increased to 20 to 25 active members in 2015. In 2019, the group consisted of 35 to 40 persons, mostly males aged 19 to 72 years old. Most of them are farmers, and most of the farmers have sheep. They have a practical focus in their approach and like using motorized equipment. During a meeting coffee break, they may typically assemble a new leaf blower. The learning and socialization processes in the group are tightly interwoven [42,49].

They were used to “reading” the landscape and the weather forecasts, but not in combination with fire. They are therefore eager to learn more about fire-related topics, and welcome fire safety scientists, firefighters as well as ecologists and biologists, as members of the group. However, there is a distance between the farmers and “the others” (non-farmer individuals), with the two subgroups seemingly not fully intermixed.

Informal structure, with some leading personalities (mostly justified through commitment and competence), dynamic boundaries (in addition to farmers and land owners, biologists, social science researchers and fire brigade members are also welcomed), and cultural meaning (resume an ancient practice) are important characteristics of the group. The use of artifacts, (equipment for starting fire, and equipment to control the fire) are necessary to “make the efforts of the civic group visible in the restored terrain”. Thus, their shared achievements become a part of their identity in a community of practice [42,43]. The prescribed burner groups operate at the edge of voluntary contingency management organizations, as they perform an activity which, among others, reduces long-term fire disaster risk. In August 2019, “Haugaland Lyngbrannreserve” was formally established as an association.

5.2. Description of and Main Findings from the Document Study

There are mainly three groups of documents available, i.e., (i) documents related to the project “See Haugalandet”, (ii) documents related to burning around a hut “Kringsjå”, see Figure 3, belonging to the local International Organization of Good Templars (IOGT) and (iii) documents covering the development of a wildfire (Hetlandsbrannen) in 2019, which started when prescribed burning got out of control.

(i) “See Haugalandet” is an initiative by the environmental authorities and municipalities to enhance visual landscape qualities. The initiative focuses the funding primarily to areas where lake, river or sea views would appear, and prescribed burning was recommended as one of the possible methods for achieving the previous view conditions. The “See Haugalandet” project delivered a final report, summarizing the activities, and the media coverage of most of the activities, from 2008 to 2012 [56]. The included articles are generally positive to prescribed burning. They welcome the improved view (and hopefully, fewer ticks), given that the prescribed burning is performed safely.

(ii) The “Kringsjå” hut (English: “Look-around” or “Panorama”), is located on a hill above the town of Haugesund. Since all distant view from Kringsjå had been lost due to an overgrown forest, the organization performed local deforestation. An association specifically connected to Kringsjå (“The friends of Kringsjå”) built a barn for sheep, and a farmer whose land had been expropriated started a company (Kringsjå Samdrift AS), and introduced Old Norse Sheep, combining services to the landscape and the visitors. The sheep owner started regular prescribed burning to prevent another cycle of succession. Their efforts initially met some resistance in the local press, mainly as a result of complaining citizens, who disliked the “blackened landscape, with dead junipers” [57]. Recent media coverage is mostly informative prior to prescribed burning to inform the public and prevent

unnecessary calls to the fire brigade when smoke is observed. Some hints to the burning practice being an ancient technique introduced long before the Viking Age creates a contemplative mood in the reader, who is likely to turn positive towards this practice.

(iii) Media coverage of a wildfire (Hetlandsbrannen) in April 2019, which started as a prescribed burn, was mostly factual, as the fire brigades and prescribed burners together fought to control the flames. Interaction between wind direction, speed and local topography created surprises, for example, fire moving north, in spite of wind forecasted from the north [58]. There is not even subtle accusation for the incident, which threatened some huts, and destroyed an electricity transformer station. The issue was followed up with a new article a couple of days later (the 15th of April) [59], with an interview of one of the most experienced prescribed burners in the area. The article mainly stresses the fact that judicious burning cannot always guarantee control. An overview of the state of the heathlands in Haugalandet is also given. It stresses that if the estimated remaining 100,000 acres is to be managed with burning each 10th year, the yearly burned area must, more or less, double what the civic group has burned on average during each of the recent years, i.e., 4000–5000 acres.



Figure 3. Kringsjå Old Norse Sheep, Haugesund, Norway. (Photo by the organization Kringsjås venner. Reproduced with permission).

Summarizing the information available in the abovementioned publications, one may conclude that public attitudes to prescribed burning are fairly positive in the area of Haugalandet. No skepticism appeared after the Hetland fire in 2019. While smoke management seems to be a concern in the US [14,37], it does not seem to be an important issue at Haugalandet.

5.3. Description of and Main Findings from Winter Meetings

The main aim of the winter meetings was to create a tentative plan for burning sessions during the coming spring. The location was intentionally alternated to create ownership to the different groups of farmers. School buildings or remote prayer houses not currently in regular use were typical meeting places. The farmers could inform each other whether they considered burning on their land, and could discuss which section of their property one should prioritize. Mentioning the intention was an indirect invitation for help with performing the burning session. During the last four years, these discussions became more “professional” and were often accomplished with studying detailed maps over the considered areas. The suggestions were summed up in a list to assess the feasibility of the total need, and then made an early notice to the fire brigade about possible prescribed burning activity during the following spring.

As the size of the group increased during the years, the character of the winter meetings was also altered. In addition to the early focus on communicating to each other about interest in burning on their own property, elements of an introductory course in prescribed burning for newcomers were included. In this way, the group started to produce elements that may comprise a future course. These will be presented in Section 5.8.

A summary of the previous season's activities also became a part of the first winter meeting, including the number of managed acres, number of sessions, number of participants in each, etc. All last season's sessions could be discussed and evaluated during winter meetings, on the initiative of any present participant, but the organizer of the meeting could focus on some sessions, often supported by UAV (unmanned aerial vehicle) videos of the prescribed burn. The videos mainly showed situations that developed as intended. They had an educational purpose, in addition to remembrance of the activity of the previous season. If no big incidents occurred, no cold debrief, or evaluation of particular burning sessions was arranged. Burns that became out of control (but managed by own resources, without the involvement of the fire brigade) were also presented and discussed to share learning points. There was a no-blame culture in the group, at least in the organized sessions.

Summarizing, the winter meetings play a crucial role in the functioning of the group. Planning of the next season is the main goal, see Figure 4, but elements of a course in prescribed burning are included. Experience from the previous season is shared, and some incidents/near misses are analyzed and evaluated. However, time delays of several months may diminish the learning potential.



Figure 4. Participants at a January 2020 prescribed burning meeting studying maps for planning local burning sessions when the weather would allow for safe and efficient burning.

5.4. Description of and Main Findings from the Hetland Wildfire Evaluation Session

Short description of the events during the Hetland fire: One of the prescribed burning sessions became out of control and developed into a wildfire at N 59.343, E 5.401, 13 April 2019. The plan for burning had, according to the procedure, been approved by the fire brigade and the plan was followed. The burning should culminate on a rocky area falling steeply to the sea at N 59.3412, E 5.3990, while being kept under control from both the side flanks. The wind, due to the onset of the sea breeze, increased in strength and turned 180°. It pushed burning dead litter (small branches and old pinecones lying on the ground) outside an edge, sloping steeply downwards to the sea. At some height, and unknown to the prescribed burners, there was a narrow ledge full of dry leaves, acting as a fuse and directing the fire incline upwards and beyond the safe black defense lines. This changed the situation dramatically. The fire brigade was alerted. However, the area is roadless and the fire brigade did not find ways to intervene efficiently before the fire reached dirt roads. The prescribed burner group had immediately started acting as a voluntary group of wildland firefighters. They also called for

support from other prescribed burners who turned out on foot to assist in the wildfire management. As prescribed burners were used to manage fire in the landscape without water, they established new defense lines and burned suitable places to create safe black areas, thus protecting huts which otherwise would have been threatened. It is considered that this tactic saved three huts from the approaching wildfire.

However, the fire did reach an area with electricity wiring, where the trees below had been cut years ago so as not to touch the cables and were left on the ground. These old dry logs and branches sustained combustion well and the leaf blowers were not suitable for extinguishing fire in these materials. An aluminum cable melted and fell down, threatening two prescribed burners. The material loss was limited to the wiring and an electricity transformer (property of the local electricity company).

The fire brigades and the Civil Defense participated in the response and in watchkeeping, ensuring the fire would not blow up again. The fire brigade Incident Commander expressed to the local newspaper “They [the prescribed burners] have a lot of expertise and are a good team together with the firefighters” [59]. He also expressed: “The wind tricked us, and it was burning in two directions. Although it was blowing from the north, it was burning towards north. It may have something to do with the terrain.” This shows how challenging it is to perceive the influence of wind for a particular location.

Evaluation session of the Hetland fire: The evaluation meeting was arranged three weeks after the Hetland fire. A thorough description of the timeline for the process that changed the prescribed burn into the Hetland fire and the succeeding response was held by one of the most experienced prescribed burners, who also had the lead when the prescribed burn got out of control. The atmosphere in the meeting was friendly, but muted mood was indubitable. The burning had been well planned, and conducted according to the plan, but the vegetation and topography regardless surprised them. The response was physically exhausting with members of the group inhaling much smoke, until the backup group of prescribed burners arrived, and the fire brigade could assist. No personnel were injured and there was no loss of material assets with emotional value, e.g., homes or huts. The loss of the electricity transformer did, however, become a mental burden. Questions about liability were raised.

The discussions were generalized, as to which conditions generally lead to near misses, and whether one has to avoid weather conditions which can make an eventual wildfire challenging to manage. (Requiring dry weather some days before the burn, and rain right afterwards will narrow the weather window even more). Deeper insight into vegetation combustibility and elements of meteorology was called for and the issues were put on the agenda for the autumn seminar in 2019.

Summarizing, one may say that the ignition mechanism converting the prescribed burn into a wildfire was odd, highly unlikely, and very difficult to foresee. However, the resulting wildfire was challenging for the responders to extinguish. Though the main wind direction was forecasted, local topography influenced conditions and created an unexpected fire development. However, the practice of leaving dead branches and trunks below the power lines is highly questionable since any wildfire may then destroy the wiring. This could be a learning point for the electricity company.

The fire brigades may address the possibility to transport responders by boat earlier, and fight fire without fire trucks in remote and roadless coastal areas. Prescribed burners cooperated well with the Civil Defense and fire brigade, controlling the wildfire.

5.5. Description of and Main Findings from the Annual Seminars 2016–2019

The annual seminars have been arranged at the Haugesund campus of the Western Norway University of Applied Sciences since 2016. The seminar series soon became a success. Members of the civic group, personnel from the fire brigades, students (studying Fire Safety Engineering), personnel from the local environmental authorities and academic staff were the main participant categories. The seminars exposed the civic groups and their achievements for the local society, in a semi-academic manner, thus increasing their credibility. A common feature of all four seminars held was a session with groups of farmers working on detailed maps of their own properties, under guidance from an

ecologist focusing on how to combine safe regular burning with future improved grazing conditions. It was always well understood by the prescribed burners that they needed to have a good relationship with the fire brigade, even though they would be denied burning on some occasions. This was, among others, expressed by always inviting local fire chiefs and other personnel from the fire brigade as speakers in the annual seminars.

Main focus in the 2016 seminar: Experiences from fire brigades participating in prescribed burning, and benefits in fighting wildfires if they have created areas with reduced biomass.

Main focus in the 2017 seminar: Defense fires as a firefighting technique in terrain. The fire brigades again held lectures and discussed how practices from heathland burning affected their attitude (and perhaps the need) to operate with fire as a means of extinguishing fire to a greater extent than they had done previously.

Main focus in the 2018 seminar: Wildfire risk from unmanaged heathlands. The Directorate of Civil Protection expressed anxiety about the degenerated *Calluna*-dominated landscape, increasing wildfire risk, and called for preventive measures advocating prescribed burning. Challenging responses in unmanaged heathlands experienced elsewhere in Norway were presented [20].

The 2019 seminar focused on parameters that may lead to loss of control of a prescribed burn, as well as liability issues in case of loss of control. The background for the chosen focus was the Hetland fire, described above, but also another wildfire which occurred a few days after the Hetland fire, in the municipality of Sokndal, Rogaland, 100 km to the south of Hetland. (Another, less experienced, prescribed burner group had been operating on April 13th).

Summarizing the four seminars, it is evident that the first three seminars (2016–2018) aimed at exposing the need for the practice for a broader audience, while strengthening the connection to the fire brigades, and their supervisory authority, the Directorate of Civil Protection. The 2019 seminar had a focus on learning as much as possible about the physical processes governing the development of fire in the terrain, as combustibility of biomass and the possible effect of wind shifts. Liability issues were also on the agenda. Since Norway lacks legal framework, the local police and a representative from an insurance company expressed their opinion about liability. The main learning points are presented in Section 5.8.

5.6. Description of and Main Findings from a Burning Session

The burning session was planned for a farm on the island of Karmøy, January 2020. A private dirt road led to the meeting point in the outback. The area had swampy parts and was surrounded by small lakes. The vegetation was quite humid. It was announced that this could be a suitable burn for newcomers. Fourteen persons participated. Five of them carried drip torches. Another five carried leaf blowers mainly for managing the burn by extinguishing but also for improving the air access to weakly burning heather, i.e., similar to fireplace bellows. The rest carried cameras. They tried to ignite the heather, which was too humid. A few junipers in an inclined area were then burned, but the fire did not spread. Then, the group moved to the steepest 15 m long slope and ignited junipers at the bottom of the slope. The fire stopped after having burned a few of the junipers.

Following the abovementioned, one of the newcomers walked higher up and ignited some more junipers. He was then standing above the fire he had just previously ignited. Eventually, the fire burned in a line upwards, and self-extinguished at the top. The vegetation was too humid to sustain further burning. Since the vegetation was rather humid, nothing dramatic happened to the daring prescribed burner, but the action was commented on at the succeeding debrief as “something we don’t do”, since fire (normally) spreads rapidly upwards in the slopes.

Summarizing, one may say that the weather window for safe and efficient burning may be quite short (a few days each year). This makes it difficult, both to manage safe burning and to make room for beginner courses. When doing prescribed burning on a large property, it may be an idea to leave some spots unburned for later practice burns and courses. Leaving an area of highly combustible degenerated *Calluna* to stand, e.g., facing south, surrounded by burned safe black areas, may be

beneficial for succeeding courses. It would then be much easier to find days where training sessions could be successful also in marginal conditions. The surrounding safe black areas from the previous prescribed burn will illustrate the importance of barriers. In generally good conditions for prescribed burning, selected areas of degenerated *Calluna* could also be spared for firefighting practice sessions. It is therefore recommended that sparing some small areas for future training sessions should be considered in the long-term prescribed burning area plans.

5.7. Main Findings from the Interviews

The most central prescribed burners along with one person working in the agricultural advisory office who supports the development of the civic group, were interviewed. Their occupational background, the main motivation and confidence to become a pioneer prescribed burner or giving support to this development are given in Table 1.

Table 1. Affiliation, source of motivation and learning/support process for the interviewees.

Interviewee	Affiliation	Source of Initial Motivation	Main Learning or Support Process
1	Teacher (agricultural vocational school)	Usefulness to students/future farmers	Self-taught; part-time firefighter
2	Farmer/sheep owner	Out grazing sheep, culture (ancient practice)	Self-taught; firefighter in the military service and industry
3	Farmer	Sustainability	Burned with interviewee 1; part-time firefighter
4	Assistant professor (university)	Reduce wildfire risk	Local fire brigade burning sessions as part-time firefighter
5	Sheep owner	Sheep and reduce wildfire risk	Self-taught; burned first with a friend who works in the fire brigade
6	Agricultural advisory office	Ecology/biodiversity/landscape	Introduced detailed maps; organized seminars; supported with applications

From Interviewee 1:

“A landowner I know, he owns a property on the Toftøy island, asked me if I could burn it for him. It had not been burned for about 50 years. I answered I probably could, if my students at the agricultural school joined.” To the question “How did you dare to perform a burn, having never burned before, and, in addition, have a class of teenagers joining?” He answered that he was a part-time firefighter and had joined responses involving wildfires. He divided the farmer’s property into eight sectors and has since then burned one sector each year as an exercise with the agricultural class. He considered it was useful for his students. “Farmers are often involved in responses when wildfires occur. If they have previous experience with a controlled fire, it may be an advantage for them in the future.” The 2007 prescribed burn at Toftøy island came out of control and resulted in a larger area than planned being burned. It was also burning during the night, i.e., violating the prescribed burning permission. The lessons learned from the 2007 Toftøy island wildfire are usually presented at seminars and courses for learning purposes.

From Interviewee 2:

When I was a 10 year old child, a wildfire on Boknafjellet burned for one week. No one attempted to extinguish it. It was in 1962. They accepted wildfires those days. I joined a prescribed burn on Toftøy organized by Interviewee 1 (the one where the fire got out of control) so the fire brigade came. I was surprised by the way they (the fire brigades) worked. They moved between large fire flame front bays (which would extinguish anyway when these flames converged), and it can be lethal to be caught in between. I had just come back to the district to take over my parents’ farm, after many years of career in the industry. I had been part of the industrial (fire) safety organization, as well as being a firefighter during the military service. So, I tried to calm everyone down,

and let them drink water. Later on, I joined a seminar in the project “See Haugalandet”, where prescribed burning was mentioned as a recommended way to get back the original landscape view. That inspired me to try prescribed burning at my farm. I now have several Old Norse Sheep, incredible animals. The fire brigade has a different competence level and different attitude now, after years with prescribed burning. Sometimes firefighters join in, as individuals. That is great.

From Interviewee 3:

I have always been concerned about sustainability and want to run my small farm in a sustainable way, as far as possible. Outdoor grazing sheep use a resource that otherwise is unused, so it is more sustainable to let them graze on the heathland than importing concentrated animal food. I also invite youth to the farm. This involves youth with special needs, or disadvantaged youth, in some way. They then experience this way of living with the nature. I joined the burn in Toftøy, i.e., the one that got out of control. It was my first time on a prescribed burn. I had previously been a part-time firefighter, so it was not scary for me. I have burned many times since then. I have also had the lead for several prescribed burns. Well, the most recent one was the one that developed into the Hetland fire, so, I don't “talk so loudly” in meetings after that incident.

From Interviewee 4:

I am a part-time firefighter in Sveio municipality. There, it is the fire brigade that conducts the prescribed burns, as a yearly exercise. As far as I know, it is the only place in Norway the fire brigade is doing that. The local farmers/landowners have to apply to the County for the funding. Then they transfer the necessary amount to the fire brigade to cover the cost for the exercise. This is a part-time fire brigade, so there is a cost for each person who participates. I have a small farm as well, and lately also I have started with some sheep. Not for sale, only for the family. I always join the fire brigade heather burning session, it is really fun! There was a wildfire in 2014, a few days after the huge fires in Flatanger and Frøya, and it was as dry here. But the fire hit an area that we had recently burned in a practice session, so it was quite easy to extinguish it at this recently managed area. That is why Sveio didn't become as “famous” as the other places.

From Interviewee 5:

I was six years old when I got my first sheep, and I have constantly had sheep since. That makes it nearly a lifetime. Our farm was turned into a residential area in year 2000, and the common outback was expropriated by the municipality. But the Kringsjø hut is here, so I started my own company (Kringsjø Samdrift) and the sheep could continue grazing on the same outback as previously. It is good for the landscape, and visitors love them. I burned heather first on a hill right above the hut together with a friend of mine who is a firefighter. That was in 2003. After that, I have joined others of the (prescribed burner) group several times, also during the Hetland fire. There, I had to escape to a land finger in a lake to avoid the flames. It spread really fast in cured grass. The fire brigade should have had some means to come to such areas by boat. And be able to fight fire without water. With some help, let's say half an hour or even one hour after we called for help, much could have been achieved. As the situation developed, it was the fire that reached the fire brigade (by reaching an area with roads), not opposite.

From Interviewee 6:

I work for the local agricultural advisory office. This agricultural advisory office applied for project funding for equipment as early as in 2007. The office then had brooms and ignition equipment, which the farmers could borrow. It was Interviewee 2 who came in and created a shared mindset ... that they could collaborate on this. Then even those who felt unsafe could start burning on their own land. He also arranged meetings to share experiences, where the different teams/farmers told each other how their burning had been. He is among the persons

who are able to take responsibility and organize. He runs a farm at Høie. He got together with neighbors, and they burned as a team, helping each other. The prescribed burner group have their own equipment now, and protective gear. Key people must take an interest in the problem and address it. Presentations about prescribed burning have also been held at the meetings of the Old Norse Sheep Owner Association, an important co-player. And the annual seminars at the University are important. A good number of firefighters, students and farmers gather there.

Summary of the interview findings: At the studied civic groups, all (five) of today's pioneer prescribed burners started without any form of guidance. They have then offered guidance to other members of the group. Participation in the fire brigades created the necessary familiarity with fire as a phenomenon, and to some extent, also fires in the terrain. They had a previous understanding of the need for biomass reduction to make suppression easier when wildfires eventually strike an area. Thus, a common feature for them all is the participation in part-time fire brigades or firefighter friends helping out, as well as some kind of knowledge and interest in sustainable farming and sheep grazing. All the interviewees now contribute voluntarily at informal courses or information meetings for groups who consider resuming the practice of prescribed burning in other areas. The participant lists reveal that both full-time and part-time firefighters are often present. This results in the sharing of competence and experiences and improves the possibility for cooperation in cases of major wildfires. Research also indicates that organizations such as the prescribed burner group may, when appropriate, include unaffiliated volunteers more easily than formal response systems [60].

5.8. Longitudinal Learning Processes in the Civic Group

A civic group of prescribed burners may be considered a *community of practice* [42], i.e., a social learning system, where the knowledge and skill level of individual members will vary with experience and commitment. As practical skills have to be combined with theoretical understanding in order to conduct safe and effective prescribed burning, both classroom sessions [48], and field sessions [49] were included. However, the extent of individual learning as acquisition may be subordinate to the situated learning in the field. Fulfilling Kolb's learning cycle [47] requires both approaches, as theoretical knowledge allows for conceptualization of experiences it is reflected upon.

The practical burning is conducted by the group, while the theoretical learning takes place both in each individual and in the group. Thus, the approach of Sfard [50] on two metaphors for learning and the dangers of choosing just one, is fully applicable. The group consists of adults, building their own knowledge and skill through a series of self-planned and self-directed learning episodes, in accordance with the observations of Tough [46] about the adult learning projects. The learning process is described in terms of the necessary background for committing oneself to the activity, practical skills, planning process, and implementation/directing of the process on the day of the burn.

Background: Knowledge about the benefits for the plants and wildlife (mainly red-listed birds) and the precautions required to support, and not destroy, such habitats is necessary. The support from the County Governor's Environmental Office creates a feeling of the participants being members of an important effort towards sustainable nature management. This may be an indication about the responsibility felt in this type of civic group, i.e., their role in restoring valuable historic heathland, and improving habitat for birds. Sustainable agriculture, with outdoor grazing sheep is the other pillar of the background, while the third one is societal safety, as future wildfires will become more manageable. Personal safety as to using protective gear and following instructions of the leader is also crucial. Members of the group, who also were part-time firefighters, contributed to develop functional and as safe as possible procedures.

Practical skills: The statement: "In order to learn how to burn heather, you have to burn heather", often expressed by prescribed burners, indicates that they value field experience. A crucial part of being a prescribed burner consists of the practical skills in igniting (physically easy; good attitudes and obedience to the leader required), and controlling/extinguishing fire (the first years performed with metal brooms; in recent years, with leaf blowers). The core group started burning 10+ years

ago by using propane torches to ignite, and metal brooms to control, the fire. Glowing material was swept back into the black. In the last three years, they have “discovered” the leaf blowers, which they claim, “helps a man to do the job of five” (equipped with brooms). The advice came from one person in the fire brigade (emergency department), who watched a video on YouTube about leaf blowers for extinguishment in the USA. The leader of the civic group purchased several models in the following days. During the first weather window for prescribed burning, they tried the efficiency of the different leaf blower models, comparing weight and comfort when carrying the equipment in the field. They concluded upon one particular fabricate, with operational weight of 12 kg plus 2 kg gasoline, and have purchased several of these. Personal safety is important, as a leaf blower has a “hurricane” wind speed and may blow objects, hitting fellow members if used too close to others.

Once a new idea, e.g., leaf blowers for fire management, has been brought to the table, it is quickly tested and verified. The fast adaption of this new technology and new method clearly demonstrates the innovative capacity of the aforementioned civic group. During the last three years, leaf blowers have been presented at all meetings and debriefing sessions. When it was also proven valuable in firefighting, i.e., by controlling counter-firing at the Hetland wildfire, see Figure 5, it very much strengthens the group identity knowing that “with this equipment we can make a difference”.



Figure 5. Prescribed burners supporting the fire brigades to manage the Hetland fire, 13 April 2019, by a counter-firing approach using the recommended leaf blowers to control the intentionally ignited counter-fire. (Photo by Tor Andre Johannessen. Reproduced with permission).

Since carrying leaf blowers in difficult terrain is a challenge, usually this equipment is used by younger and very fit members of the civic group while the older members perform other tasks. This sharing of duties between the generations within the same group may also be very valuable for developing a sustainable approach to prescribed burning, which then may include all persons at 18+ years of age to 70+ years of age. Newcomers are involved when introduced to the artifacts for igniting or extinguishing the fire, while the more experienced members have responsibility to plan and direct the burning session. As the group performs several prescribed burns, they create a shared history of experience and learning.

The planning processes: Planning the event by visual inspection of the area to burn, in addition to using detailed maps is essential. Filling the mandatory application form required by the fire brigade involves answering several relevant questions, and that makes it a valuable part of the planning process. A risk analysis associated with possible threats to neighbors has to address all factors and include multiple plans, for possible changes in wind strength or wind direction.

The implementation process: To get the plan approved by the fire brigade is a form of “quality assurance”. When implementing the plan, the prescribed burn has some (i) static elements (the piece of land they have planned to burn, with the defense lines, natural or imposed), (ii) some quasi-static elements, (the humidity in the plants, affected by weather conditions the previous days and up to the last hours), and (iii) one highly dynamic element: the possible wind shifts. The dynamic elements require the leader’s attention during the burn, so one has to resonate into the logic of the fire and the terrain and start implementation in a very careful way. Ignition is performed along a barrier line, about 50 m long, close to a defense line (stone hedge, road, rocks, or an area stripped for fuel). This means that the fire can move away from the barrier line, as the available fuel is in this direction. Preferably, the burning should be conducted against the wind, the first time. The prescribed burners make sure no burning embers cross the barrier.

If the heathland has been burned during the last 10–15 years, the heather dominated by *Calluna vulgaris* will be about 30–40 cm high, and other species (trees, etc.), if any, are also small. This results in slow burning with small flames, especially in low wind, i.e., 2–3 m/s. The flame front is rather narrow, about 1 m, and moves in a line. Practically, there are no flanks. This is the ideal process for burning heathland. The area to burn should be rather limited, e.g., less than 10 acres at a time, and the process is slow. This gives small creatures in the habitat the possibility to escape the fire.

However, the semi-static element (Fuel Moisture Content in the plants) and the highly dynamic element (wind shifts) sometimes surprise the burners with unexpected difficulty. This may imply that the theoretical aspects needed in a future standardized course should have a main focus on these elements as suggested below.

5.9. Suggestions for a Future Prescribed Burning Course Curriculum

There are currently no formal courses in prescribed burning in Norway. It is, however, required by the Rogaland County to establish a course curriculum. The results from the present study may be valuable when defining a curriculum. The course content should include, but not be limited to, fire ecology of the heathlands and cultural heritage, fire spread characteristics of degenerated *Calluna* stands and other involved fuels, meteorology (wind and weather), topography, basic drying theory and general basic fire dynamics. The curriculum also needs to cover endangered species in the flora and fauna, how to plan and organize prescribed burning (including plan B and C), table-top map sessions and field inspection, personal protection gear, possible risk of exposed objects and risk situations, lessons learned and the need for backup plans and a backup force should that be required. Practice sessions in the field may integrate the theory and the field experience, and should be followed up by debriefing sessions. A certain number of field burns may be required before the course participants may be allowed to organize and perform prescribed burning, and they should, in the first burns, be assisted by more experienced personnel. Attitude is also extremely important, as the situation may develop into a severe wildfire challenge. Obedience to the leader, not igniting too long stretches and introducing novices in a pedagogical manner are also crucial skills in the field.

An initiative for a certification process for prescribed burners has recently been taken and may become a valuable way forward towards safe and effective restoration of the Norwegian heathlands.

6. Conclusions

Most people have and should have a barrier against igniting a fire for prescribed burning. Given the severe wildfire risk associated with degenerated *Calluna* stands, even in sub-zero temperatures [20,61], it is indeed required to have some basic fire safety knowledge before taking on the task to resume degenerated heathlands by prescribed burning. Upon supporting other regions to establish similar civic prescribed burner groups, it may therefore be recommended to focus on individuals who have a current or previous involvement in the fire brigades as well as an interest in sustainable farming.

The study revealed that a background as a (volunteer) firefighter and relations to farming and sheep production were characteristics of the pioneer prescribed burners. They took responsibility for their

own experiential learning including debriefing sessions, and mutually shared experiences along the way forward. Mishaps were used for learning purposes. They involved the fire brigades in meetings and seminars and sought support from agricultural agencies and academia regarding heathland ecology and fire safety. This has strengthened the focus on knowledge-based, safe and effective prescribed burning. They have also been open to new methods, e.g., leaf blowers for fire control, which has increased the shared focus on artifacts. They seek deeper knowledge in, e.g., basic meteorology, drying and fire dynamics, and have adapted to the requirements for protection of endangered wildlife. The focus on and commitment to several-thousand-years-old sustainable herbivore production traditions may likely be transferred also to other regions along the Norwegian coast.

To resume prescribed burning elsewhere, it is recommended to start with a meeting arranged by the local environmental or agricultural authorities, i.e., the agricultural advisory office. Farmers/sheep owners who are part-time firefighters could be invited to attend, since they have the potential to become core members of a future prescribed burner group. The local fire brigade (officers and constables) should also be invited. Among the speakers, there should preferably be fire chiefs from areas who have experienced benefits and challenges with prescribed burning or have handled challenging wildfires. A future course is expected to contain elements of sustainable agriculture, biodiversity, local risk assessment, air relative humidity and ignitability of biomass, and basic elements of meteorology. In the COVID-19 age, self-sustained food production will probably receive increased focus, which may assist in a development towards a more fire-safe society.

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