Crofting and Muirburn in Scotland

Cathy Smith, Leverhulme Centre for Wildfires, Environment and Society, Royal Holloway University of London, April 2024

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Contents

1. Introduction

Fire use has a long history in the management of Scotland's landscapes, though we have a limited picture of how it has evolved through time. It is likely that people used fire in landscape management in the Mesolithic and Neolithic, for purposes that may have included creating habitat for game, promoting certain plant species, and clearing vegetation for access and swidden agriculture[1]. It has also been used for pastoral reasons since at least the Bronze Age, to promote fresh growth for grazing livestock[2]. It is likely that pastoral burning intensified after the Highland Clearances, in association with more widespread and intensive sheep grazing[3]. From approximately the 13th to 19th centuries, 'paring and burning' was used to prepare land in the uplands for cropping, which involved cutting the surface layer of peat, burning it, and spreading the ashes on the ground[4]. By the mid-19th Century, fire was also in widespread use in the driven grouse shooting industry, to maintain habitat for grouse in upland areas[5].

[1] Bishop, R.R., Church, M.J. and Rowley-Conwy, P.A., 2015. Firewood, food and human niche construction: the potential role of Mesolithic hunter–gatherers in actively structuring Scotland's woodlands. *Quaternary Science Reviews*, *108*, pp.51-75; Davies, A.L. and Tipping, R., 2004. Sensing small-scale human activity in the palaeoecological record: fine spatial resolution pollen analyses from Glen Affric, northern Scotland. *The Holocene*, *14*(2), pp.233-245; Pyne, S.J. 1997. *Vestal fire: an environmental history, told through fire, of Europe, and Europe's encounter with the world.* University of Washington Press.

[2] Davies & Tipping "Sensing small-scale"; Dodgshon, R.A. and Olsson, G.A., 2006. Heather moorland in the Scottish Highlands: the history of a cultural landscape, 1600–1880. *Journal of Historical Geography*, *32*(1), pp.21-37; Smout, T.C., MacDonald, A.R. and Watson, F. 2007. *History of the native woodlands of Scotland 1500-1920*. Edinburgh University Press; Tipping, R., Davies, A., McCulloch, R. and Tisdall, E., 2008. Response to late Bronze Age climate change of farming communities in north east Scotland. *Journal of Archaeological Science*, *35*(8), pp.2379-2386; Whittington, G. and McManus, J., 1998. Dark Age agricultural practices and environmental change: evidence from Tentsmuir, Fife, eastern Scotland. In C.M. Mills and G. Coles (Eds.) '*Life on the edge: human settlement and marginality'*, pp. 111-120. Oxbow Books.

[3] Dodgshon & Olsson "Heather moorland in the Scottish Highlands".

[4] Fenton, A. 1970. Paring and burning and the cutting of turf and peat in Scotland. In A. Gailey and A. Fenton (Eds.) "*The Spade in Northern and Atlantic Europe*", pp. 155-193. Ulster Folk Museum, Queen's University of Belfast Institute of Irish Studies; Pyne "Vestal fire".

[5] Lovat, S.J.F.B. et al. 1911. *The grouse in health and in disease: being the final report of the Committee of Inquiry on Grouse Disease*. Smith Elder and Co; Pyne "Vestal fire".

The term 'muirburn' has been used to describe pastoral burning on moorland and heath since the Medieval period[6], and was later also applied to burning for grouse moor management. In contemporary muirburn regulations it is defined as 'the setting of fire to, or the burning of, any heath or muir'[7], and this is the focus of this report. In Scottish Gaelic, the term 'falaisg', or similar, is used to refer to moorland and heath burning[8]. Today, those practising muirburn include grouse estate managers, hill farmers and crofters.

Crofting is a form of small agricultural land holding, usually held in tenancy, dating to the Highland Clearances. Crofters usually also have grazing rights to a common grazing area shared by multiple crofters. Crofting is exclusively practiced in the Highlands and Islands of Scotland and concentrated on the West and North coasts and the Islands. By contrast, grouse estates practising muirburn are concentrated in the East and South of Scotland (especially in the Cairngorms and Borders). Compared with grouse estates, very little attention has been given to fire use by crofters, neither in research nor public debate surrounding recent changes to the muirburn legislation. This is unfortunate, because the conditions under which crofters practice muirburn are different in terms of the desired outcomes and patterns of burning, social structures surrounding burning, landscapes in which burning takes place, and financial resourcing.

Crofters are not alone among smallholder farmers in Western Europe in practising pastoral burning, which has been documented for instance in Ireland[9], France[10], Spain[11], Portugal[12] and Italy[13]. Yet, in much of Western Europe, pastoral fire use has declined significantly in recent centuries, following strict regulations and prohibitions on burning, rural abandonment and the loss of communal land management[14]. Where it persists, the stigma and potential illegality associated with the practice have often made it secretive, reducing the transmission of fire knowledge and meaning that fires are more likely to be started by individuals and less likely to be tended until extinguished.

Until 2024, regulatory control of muirburn in Scotland was relatively minimal when compared with other countries in Western Europe, many of which have had complete bans or regulations

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[6] Craigie, W., Aitken, A. J., Stevenson, J. A. C., and Watson, H. D. 1993. A dictionary of the older Scottish tongue from the twelfth century to the end of the seventeenth. Aberdeen University Press.
[7] *Wildlife Management and Muirburn (Scotland) Bill* 2024 (as passed). Available at: https://www.parliament.scot/-/media/files/legislation/bills/s6-bills/wildlife-management-and-muirburn-scotland-bill/stage-3/bill-as-passed.pdf.
[8] Am Faclair Beag: https://www.faclair.com/
[9] Carroll, M.S., Edgeley, C.M. and Nugent, C., 2021. Traditional use of field burning in Ireland: History, culture and contemporary practice in the uplands. *International Journal of Wildland Fire*, *30*(6), pp.399-409.
[10] Coughlan, M.R., 2013. Errakina: pastoral fire use and landscape memory in the Basque region of the French Western Pyrenees. Journal of Ethnobiology, 33(1), pp.86-104; Dumez, R., 2010. *Le feu, savoirs et pratiques en Cévennes*. Éditions Quæ; Métailié, J.P., 2006. Mountain landscape, pastoral management and traditional practices in the Northern Pyrenées (France). In M. Agnoletti (Ed.) *The conservation of Cultural Landscapes*, pp. 108-124. CAB International; Métailié, J.P., Daupras, F. and Faerber, J., 2020. «Back fire»: the current place of burning practices in the rural landscapes of the Pyrenees from pastoral management to ecological debate. *Quaderni storici*, *55*(2), pp.343-368.
[11] Fernández-Giménez, M.E. and Fillat Estaque, F., 2012. Pyrenean pastoralists' ecological knowledge: documentation and application to natural resource management and adaptation. *Human Ecology*, *40*, pp.287-300.
[12] Oliveira, E. and Fernandes, P.M., 2023. Pastoral burning and its contribution to the fire regime of Alto Minho, Portugal. *Fire*, *6*(5), p.210.
[13] Ascoli, D. and Bovio, G., 2010. Tree encroachment dynamics in heathlands of north-west Italy: the fire regime hypothesis. *iForest-Biogeosciences and Forestry*, *3*(5), p.137; Mathews, A.S. and Malfatti, F., 2024. Wildfires as legacies of agropastoral abandonment: Gendered litter raking and managed burning as historic fire prevention practices in the Monte Pisano of Italy. *Ambio*, pp.1-12.
[14] de Oliveira, E., Colaço, M.C., Fernandes, P.M. and Sequeira, A.C., 2023. Remains of traditional fire use in Portugal: A historical analysis. *Trees, Forests and People*, *14*, p.100458.; Coughlan "Errakina"; Fernández-Giménez and Fillat Estaque "Pyrenean pastoraslists' ecological knowledge"; Mathews and Malfatti "Wildfires as legacies"; Pyne "Vestal fire"; Uyttewaal, K., Prat-Guitart, N., Ludwig, F., Kroeze, C. and Langer, E.R., 2023. Territories in Transition: how social contexts influence wildland fire adaptive capacity in rural Northwestern European Mediterranean areas. *Fire Ecology*, *19*(1), pp.1-25.; Valese, E., Conedera, M., Held, A.C. and Ascoli, D., 2014. Fire, humans and landscape in the European Alpine region during the Holocene. *Anthropocene*, *6*, pp.63-74.

significantly limiting burning. Scotland has had laws limiting muirburn since 1401[15], though these likely saw very limited enforcement in the Late Medieval and Early Modern periods. The early laws made it illegal to burn between the end of March and time of the corn harvest in the Autumn, or to burn standing wood. These rules remained largely unchanged into the twenty-first century. Before 2024, muirburn was regulated under the Hill Farming (Scotland) Act of 1946. This made it illegal to burn between 16th April and 30th September, between one hour after sunset and one hour before sunrise, without informing landowners and neighbouring land occupiers at least seven days in advance, or without sufficient people and equipment to control the fire. In addition to the regulations, the Muirburn Code, last revised in 2017, lays out best practice guidelines for burning[16].

In March 2024, the Wildlife Management and Muirburn (Scotland) Bill was passed, replacing the regulations under the Hill Farming (Scotland) Act. The Bill was developed in direct response to the Independent Review of Grouse Moor Management (or 'Werritty Review') commissioned by the Scottish Government in 2017 to assess the sustainability of grouse estate management, the findings of which were published in 2019[17]. As such, while it was acknowledged that the muirburn element of the Bill would affect crofters, they were given little attention throughout its development. Besides regulating muirburn, the Bill includes various measures banning the snaring and trapping of animals on grouse moors and introduces a licensing for grouse shooting. It thus responds to concerns about animal welfare and debates around the concentration of land ownership in Scotland, alongside considerations about environmental sustainability. As regards muirburn, the Werritty Review concluded that there is mixed evidence about its implications for wildfire risk, biodiversity, and greenhouse gas emissions (especially from peatlands), and recommended tightening regulation of the practice as a precautionary measure. Note that definitions of 'wildfire' vary, but for the purposes of this report, I use the term to refer to any uncontrolled fire.

The Wildlife Management and Muirburn (Scotland) Bill introduces a licensing requirement for all muirburn and bans burning on peatland (defined as land with peat deeper than 40cm) for reasons other than environmental restoration, wildfire risk mitigation or research. All muirburn practitioners will also need to have taken an approved muirburn training course, and abide by the Muirburn Code, giving the Code stronger legal backing than it has had to date. The Bill also alters the legal muirburn season to run from 15th September to 31st March. Pre-existing rules around notifying landowners and neighbours, not burning after sunset, or near roads remain largely unchanged. At the time of writing this report, many details regarding implementation of muirburn licensing remain vague, though the Bill makes clear that licenses will be attached to a specific piece of land and be valid only for specific muirburn purposes. It is unclear how long licenses will be valid, whether landowners or tenants will have responsibility for license applications, and what licenses and training courses will cost. It is also unclear how peat depth will be assessed for the purposes of the regulations, and by whom.

In this research I aimed to provide a first overview of muirburn by crofters, examining why and how the practice is carried out today, changes to the practice in living memory, and the possible implications of the new muirburn regulations for crofters. In this report I draw on interviews with 24 crofters from Sutherland, Skye and Lochalsh, and Lochaber, and 5 other people who work

[15] The Records of the Parliaments of Scotland to 170, 1401/2/15
[16] Muirburn Code: https://www.nature.scot/sites/default/files/2021-06/Guidance%20-%20The%20Muirburn%20Code%20-%20Accessible%20pdf.pdf
[17] Werritty et al. 2019. Grouse moor management review group: report to the Scottish Government. Available at: https://www.gov.scot/publications/grouse-moor-management-group-report-scottish-government/documents/

with or alongside crofters. I carried out these interviews in September and October of 2023, when the Wildlife Management and Muirburn (Scotland) Bill was at Stage 1 in Parliament. The research was funded by the Leverhulme Trust (under grant RC-2018-023) and carried out with guidance from the Scottish Crofting Federation (SCF) and the Scottish Fire and Rescue Service (SFRS). I intend to conduct some archival research in 2024 and draw this historical research together with the findings presented here, in a peer-reviewed article.

2. Research methodology

I carried out 20 interviews involving a total of 29 research participants in September and October 2023 and January 2024. 15 interviews took place one-on-one, and, for the convenience of the participants, I conducted five group interviews, three with two participants, one with three participants and one with five participants. Participants were recruited via contacts of SCF and SFRS, from among the attendees at two muirburn workshops convened by SCF, SFRS and myself, and through snowballing.

I chose geographical focus areas for the research based on recommendations from SCF and SFRS. These were crofting areas where muirburn is thought to be very limited, where muirburn is thought to be common, or they were areas with a high incidence of wildfire in recent decades, based on SFRS data. To help to maintain the anonymity of the research participants they are linked here only to the broad local government district in which they live and/or work (based on the 1975-1996 local government district boundaries). Two participants were based in Sutherland, 15 in Skye & Lochalsh, 11 in Lochaber, and one worked covering the Highland region more broadly.

Of the research participants, 24 were crofters, two were hill farmers with land bordering crofting areas, and the remaining three had other connections to crofting (Table 1). Some crofters interviewed also had other professional connections to crofting. Note that most crofters have multiple occupations. The occupations listed in Table 1 are only those most relevant to the research and are left vague to ensure the anonymity of the research participants. 21% of participants were female and 79% male. 24% were aged 30-49, 41% aged 50-69 and 34% aged 70 or older.

I carried out the interviews in-person, and, based on the participants' preferences, either in their homes, workplaces, in public spaces, or walking on croft or common grazing land (this being the case for six interviews). One interview was conducted online. The interviews lasted between 25 minutes and three hours. The interviews were semi-structured - conversations were generally free-flowing, but I covered a standard list of questions (in no particular order) in every interview with a crofter (Appendix 1), while tailoring the questions slightly differently to the non-crofter participants. I recorded all interviews and transcribed them for qualitative analysis.

Table 1. List of research participants. Geographical regions are based on former Scottish local government district boundaries (1975-1996). Level of detail under 'occupation' is intentionally vague to ensure anonymity of participants.

Participant number	Interview date	Age bracket	Gender	Occupation	Region
P1	10/09/2023	70+	Male	Crofter	Sutherland
P2	11/09/2023	70+	Male	Crofter, also worked with crofters in another professional capacity in the past	Sutherland
P3	13/09/2023	30-49	Male	Crofter	Skye & Lochalsh
P4	13/09/2023	30-49	Male	Crofter's son, works for a Land Trust	Skye & Lochalsh
P5	13/09/2023	70+	Male	Crofter	Skye & Lochalsh
P6	13/09/2023	50-69	Male	Crofter	Skye & Lochalsh
P7	13/09/2023	50-69	Male	Crofter	Skye & Lochalsh
P8	13/09/2023	30-49	Female	Crofter, also works with crofters in another professional capacity	Skye & Lochalsh
P9	15/09/2023	30-49	Male	Crofter, also works with crofters in another professional capacity	Skye & Lochalsh
P10	15/09/2023	30-49	Female	Crofter	Skye & Lochalsh
P11	16/09/2023	70+	Male	Crofter	Skye & Lochalsh
P12	20/09/2023	70+	Male	Crofter, also worked with crofters in another professional capacity in the past	Skye & Lochalsh
P13	20/09/2023	50-69	Male	Crofter	Skye & Lochalsh
P14	22/09/2023	70+	Male	Crofter	Skye & Lochalsh
P15	22/09/2023	50-69	Male	Crofter	Skye & Lochalsh
P16	24/09/2023	30-49	Male	Crofter	Skye & Lochalsh
P17	24/09/2023	50-69	Male	Hill farmer	Skye & Lochalsh
P18	27/09/2023	50-69	Male	Crofter	Lochaber
P19	27/09/2023	50-69	Male	Hill farmer	Lochaber
P20	28/09/2023	50-69	Female	Crofter	Lochaber
P21	28/09/2023	50-69	Female	Crofter	Lochaber
P22	28/09/2023	70+	Male	Crofter	Lochaber
P23	29/09/2023	70+	Male	Crofter	Lochaber
P24	29/09/2023	70+	Female	Crofter	Lochaber
P25	02/10/2023	70+	Male	Crofter	Lochaber
P26	02/10/2023	50-69	Male	Crofter	Lochaber
P27	02/10/2023	50-69	Female	Crofter	Lochaber
P28	03/10/2023	30-49	Male	Scottish Crofting Federation council member	Lochaber
P29	12/01/2024	50-69	Male	Employee of Forestry & Land Scotland	Highland region

3. Results

3.1 Desired and undesired outcomes of burning

This section examines the potential outcomes of burning that influence crofters' decisions about whether to practice muirburn. More practical or logistical issues that may influence decisions about burning are covered in sections 3.2 and 3.5.

3.1.1 Improving grazing

The role of fire in improving grazing areas for livestock was mentioned in all interviews with crofters and was emphasised as the primary reason for burning. Crofters described how fire removes rank vegetation (heather and grasses), and how subsequent regrowth in the same year and for several years subsequently is more palatable to livestock: 'It's very simple. It's food makes milk, milk makes fat ... the more you can burn, the more of the sheep can graze on proper grass. The more grass they eat, the more milk they produce for lambs, the more you're going to get for those lambs, often, when you sell them. It's a very simple exercise' (P5). One crofter described how the blackness of the soil after burning draws heat which helps rapid regrowth. Burning small areas regularly keeps livestock using all parts of the grazing area, spreading the grazing load, and avoiding overgrazing in certain parts of the landscape.

Many crofters emphasised that burning is particularly important for improving grazing where the grazing regime is dominated by sheep, rather than cattle. This is because sheep are more selective grazers and will not graze on older vegetation. Several crofters said that grazing by cattle means they do not feel the need to burn, while others said that the presence of cattle means they choose longer intervals between fires than they would if grazing with sheep only. This likely reflects different levels of stocking intensity.

Several crofters highlighted wider benefits of sustaining grazing value in crofting areas. For one, the increased availability of food for livestock on the common grazing means less need to 'use inputs that come from other areas' (P9). Another crofter stressed the value of crofting, and in particular their sheep stock club, in sustaining the local community: 'Now, the sheep stock club, it employs maybe like 50 different folk in various ways, it makes sure that there's an animal feed store that, it's got a good turnover ... fencing materials, shepherds, gatherers, vets ... and that's a whole different type of sustainability, you know, it's, it's community sustainability, not just a shiny green label' (P10).

One non-crofter participant cautioned about a need for more research on the long-term effects of burning on soil fertility, and therefore grazing value. There is a possibility that, while burning provides short-term grazing value, in the longer term, the runoff of ashes, and emissions from fires are reducing the availability of nutrients and trace elements to plants in what are already nutrient-poor ecosystems.

3.1.2 Improving access

The value of burning in improving access to common grazing areas was mentioned in 30% of interviews with crofters. Access is improved for crofters themselves: 'When you don't burn it just gets rank... It becomes extremely difficult to walk through. It becomes extremely difficult and dangerous to go through it with a quad bike cos you can't see what's in front of you' (P15). Access is also improved for other users of the landscape, including tourists and livestock.

3.1.3 Reducing wildfire risk

In 47% of interviews with crofters, participants mentioned that regular controlled fire use reduces the risk of wildfire and makes it easier to control intentional fires. Some participants described how burning creates fire breaks in the landscape, where the progression of fire is halted: 'where there is regular burning, that regular burning forms a natural fire break. And the fire will just quite simply go out when it runs out of fuel' (P1). Others described how burning reduces fuel loads (the amount of flammable vegetation in the landscape), and thus reduces fire intensity and rate of spread: 'if you're burning something that was burned, I don't know, seven, ten years ago, it kinda skips along, the intensity's not there' (P25).

3.1.4 Controlling ticks

Tick control was mentioned as an outcome of burning in 24% of interviews with crofters. Crofters described two mechanisms by which burning reduces the risk posed by ticks to people. Some mentioned that fire directly burns ticks. Others described how sheep act as 'tick mops' and suggested that burning encourages sheep to graze a wider geographical area, bringing them into contact with more ticks.

3.1.5 Implications for biodiversity

Outcomes of burning for biodiversity were mentioned in 41% of interviews with crofters. In most cases, crofters mentioned positive outcomes. Some mentioned benefits for certain bird species; game birds like grouse, or wading birds like greenshank or golden plover. Others described how burning promotes a greater diversity of herbaceous plants, as compared with a landscape dominated by rank heather: 'You're getting all these nice, wee, delicate, herbaceous plants growing. A wee tormentil, you know, and all that's been, not entirely, but largely smothered out with sort of monoculture heather' (P10).

Several participants mentioned negative outcomes of burning for biodiversity. One mentioned negative outcomes for other bird species, such as hen harriers, and for reptiles. One non-crofter participant cautioned about lack of knowledge about the effects of burning on biodiversity, particularly on invertebrates that play a role in nutrient cycling. They also mentioned plant species that are very sensitive to fire, such as juniper. One crofter weighed up counterfactuals, suggesting that, while burning may have benefits under a grazing regime dominated by sheep, more biodiverse landscapes may be possible under other management regimes involving less or no fire use, such as grazing with cattle, or regenerating native woodlands.

3.1.6 Tradition

Tradition was mentioned in 24% of interviews with crofters. In most cases this was discussed in unfavourable terms, with participants saying that other crofters unduly deem tradition a sufficient reason to burn: 'Probably some people would call it a tradition. I think it's a bit ridiculous to call it a tradition... It's not, you know, it's not like, not like doing a bloody dance for the rain or something like that ... Some people will say we should be doing it, because we've always been able to do it. I think that's a terrible argument. The argument should be that we should be able to do it because it's a useful land management tool' (P9).

3.1.7 Other positive outcomes of burning

Several other positive outcomes of burning were mentioned in just one or two interviews. One participant described how in the past fire was used to clear a surface for stacking peats on the hill. One crofter described how burning reduces cases of yellowses (a disease caused by

excessive consumption of bog asphodel) among lambs, because it means that there is more alternative forage available. One felt the more open landscape created by burning is more aesthetically pleasing to tourists. Another mentioned that the more open landscape makes it easier to shoot foxes for fox control. One crofter described how burning can be a useful tool for the initial removal of vegetation before woodland regeneration, or for vegetation control in the early stages of regeneration. Finally, two participants mentioned burning as an enjoyable experience: 'it also appeals to that kind of pyromaniac element in folk, you know, I mean, there's no doubt a good falasgair's good crack' (P13).

3.1.8 Risk as a barrier to burning

Most participants mentioned risks associated with burning, but in 53% of interviews with crofters, participants explicitly mentioned that risks stop themselves or other crofters from carrying out muirburn, either completely, or in certain parts of the landscape. High fuel loads associated with limited grazing and infrequent burning, making it harder to control fires, were a risk factor mentioned by some crofters. Others mentioned proximity to at-risk features such as forestry plantations or housing: 'you're dicing, well literally playing with fire here, because you can't, you don't know where it's gonna go and the last thing you want is to go straight into the, the plantation'(P14). Some specifically mentioned fear of prosecution or lack of insurance as barriers to burning: 'One of the earliest [grazings] committee meetings I sat down to and I said, you know, "let's have a plan, let's have a muirburn plan". The rest of the committee, it was just "No!". "Oh". "We'll be up in court. We'll be up in court. No way. Absolutely no way." So, there, there has been no organised burning in the 30 years' (P1).

3.1.9 Expansion of bracken

In 29% of interviews with crofters, participants mentioned that burning is not a good control measure for bracken, and that fire encourages its spread: 'There is no point burning bracken, because it just comes in, I think, stronger' (P14).

3.2 Crofters' fire use in practice

This section focuses on fire use as it was described to take place today. Section 3.5 covers differences between fire use today and in the past.

3.2.1 The decision to burn

Most burning by crofters takes place on common grazings. In some cases, the decision to burn at a given time and place is taken by a grazings committee, while in other cases, individual crofters or groups of crofters make the decision more informally. Burning is more likely to be organised by a grazings committee where there are more active shareholders on a grazing, and especially where shareholders are organised into sheep stock clubs, as is quite common on Skye especially.

Key factors that determine the right time and areas to burn include the season, weather conditions, state of the vegetation, and availability of people to help control the fire. These factors are covered in more detail in the following sections. Generally, this combination of factors makes burning difficult to plan far in advance, with burning often taking place opportunistically. In the words of one participant: 'We'd had a grazings committee meeting the day before. It was like "well we'd better do this, the weather's good", and all that, so we just went and did it' (P12). And as another participant described: 'I notice that a lot up our end, that it's

half five, and the boy's coming home from work ... it's been dry for a few days, and it's like "we need to get something burnt"' (P7).

3.2.2 Seasonality

All crofting participants favoured burning in late Winter and the first half of Spring, with January mentioned as a good month in which to burn in one interview, February in five, March in nine, April in five, May in one and June in one. This part of the year is preferred because it precedes most of the spring growth, such that regrowth can still take place that year, and because weather conditions are most likely to be favourable. Several participants mentioned that burning earlier in this period means the ground is slightly damper, making it safer.

In four interviews, crofters mentioned preferring to burn before ground nesting birds are nesting. Several mentioned the legal restriction on burning after mid-April. Several also said they align the timing of burning with certain parts of the annual cycle of sheep farming. For one participant, the best time to burn is when 'you've got your sheep gathered in for scanning anyway- we normally scan at February time ... And that makes it easier, you know, if you are wanting to do a burn, there's no sheep that are gonna get caught up in this if it does take off' (P10). For another, February is best because 'the sheep should be early in lamb then, so they're not going to get too stressed, they're still fairly fit to get about the place and, they, they know what's going on, they sort themselves out' (P13).

3.2.3 Suitable weather conditions

All crofting participants agreed that burning requires very specific weather conditions, and that there are generally few suitable weather windows each year. Several days of dry weather are needed for vegetation to be sufficiently dry, with the necessary length of the dry spell dependent on how wet the conditions have been beforehand. On the other hand, too long a spell of dry weather can make the vegetation too dry to easily control the fire. Several participants mentioned that icy or frosty conditions can be useful because they make fire control easier.

Participants agreed that wind direction and speed are also very important. The best wind direction depends on various factors including the location of fire breaks and features that are at risk of burning (e.g. forestry plantations), and the typical weather that certain wind directions tend to bring: e.g., 'easterlies tend to obviously be dryer than westerlies' (P13). Most crofters agreed that it is too dangerous to burn in strong winds, with some preferring no wind, and other preferring light winds.

Several participants emphasised the uncertainty associated with the weather. It is best to burn in steady wind, but there is always a risk of unexpected changes in wind direction and speed. Several crofters discussed occasions where they had lost control of fires due to unexpected changes in wind conditions. One participant mentioned that weather forecasts and wildfire risk warning systems are useful, but that the very localised nature of weather in the Scottish Highlands means that they can be unreliable.

Two participants mentioned burning after dark, one because there are limited hours of daylight in the Winter, and the other because conditions tend to be cooler and the wind calmer.

3.2.4 Frequency of burning

Many crofters said that they would ideally prefer to burn smaller areas of the landscape every one to three years, with patches of the landscape being burned on timescales ranging from about five to 20 years. Yet, for various reasons discussed in Section 3.5, crofters only appeared

to be following a regime like this in practice in four interviews. Some participants said that their common grazing land has not seen any fire on long timescales ranging from 12 to 50 years.

Several crofters discussed factors that determine the ideal return interval for fire in each part of the landscape. One factor is the stocking levels, and ratio of sheep to cattle. Burning is required less frequently where there are more livestock, and especially where there are more cattle. Another factor is the rate of regrowth of the vegetation, which varies greatly with a host of other factors such as topography and aspect.

3.2.5 Burning team and equipment

The number of people involved in burning varies. Very few crofters described burning on their own, but several mentioned that this is done by others in cases where there are few active crofters on a common grazing, or people fear litigation: 'The unfortunate thing where you don't have a terribly, an active, grazing committee, is that you can get individuals just striking off by themselves, pun intended' (P9). In 11 interviews crofters described burning in a small team of people, typically two to three, which might include family members or neighbouring crofters: e.g., 'there's only like three ... of the shareholders that are active, myself and my two brothers and generally we're the ones that will do the burning' (P11). In three interviews crofters described burning as part of larger teams of six or more, all in cases where common grazing shareholders are organised into sheep stock clubs, which often employ additional helpers for certain activities in the farming calendar e.g., 'we have a squad of about six guys that come in and gather the hill for us, work the sheep. So, it's the same guys' (P13).

Many crofters agreed that it is usually difficult to gather enough people for good control of burning. This is partly due to changes in crofting demographics and the nature of 21st century life and work, which will be covered further in section 3.5. It is also linked to the very limited weather and time windows in which burning takes place. As one crofter suggested 'because the weather window's short, it can't be just like a specialised job that a few people on, like Skye did, because if they were gonna be doing it, they'd need to be everywhere' (P8).

Few participants mentioned burning using specialist equipment. Several mentioned having beaters on hand when burning, one mentioned using a pressure washer, and one a leaf blower.

3.2.6 Patterns of fire on the landscape

Many participants said they would ideally burn small areas of the grazing area each year or every few years to sustain good grazing year on year and keep livestock moving to different parts of the landscape. This also makes fires easier to control: 'you need to burn sections to slow it down, and when it does get away you've got some control when it reaches bare ground' (P26). But in practice, for various reasons covered further in Section 3.5, it is common for burning to take place less frequently and covering larger areas of land.

Many crofters mentioned using fire breaks, either natural or human made, to control the spread of fire. These fire breaks include land that has recently burned, rivers, ditches, the sea, or stony ground. Two participants said that they specifically make fire breaks in advance of burning. The positioning of fire breaks in the landscape influences where crofters choose to start a fire: e.g., 'to make it easy for yourself you go between two burns and it's going in a strip straight up the hill' (P26). The choice of where to start a fire is also influenced by the positioning of landscape features that are at risk of burning, such as forestry plantations or housing.

In some cases, certain bits of ground may be burned more often out of convenience. One participant described the burning practices of some crofters in their area: 'it's the same bits that always get burned and it's the bits close to the road' (P12).

Participants were divided as to their preference of burning direction relative to the wind, with crofters in five interviews preferring to burn with the wind (head fire) and in six preferring to burn against the wind (backing fire). Various reasons were given for these preferences. Some mentioned that backing fire moves slower, removing rank vegetation more completely, while head fire will 'burn the tops off the heather but it doesn't ... go for long enough to burn the really woody stems' (P12). Some described how backing fire is easier to control and 'if you're beating it, you've not got the smoke in your face' (P26). Those preferring head fire mentioned that the faster, lighter burn achieved is less likely to cause damage e.g., to peat, especially in areas with high fuel loads, and that it is easier to predict where the fire will go, allowing them to channel the fire towards fire breaks such as rivers or the sea.

3.2.7 Other considerations when burning

Several participants mentioned the need to account for topography when burning, since fire can move very quickly upslope: 'You think, 'oh, the winds blowing that way', and then all of a sudden, the fire hits a slope and it goes in the opposite direction to the wind. So yeah, you have to, you have to watch. If you're at the bottom of a slope usually it just burns straight up it, you know. And that can be- it can go quite quick' (P15).

Two participants said that burning should not take place on Sundays: 'I'm on the Isle of Skye, and it's still quite Presbyterian. Nobody likes to see a fire burning on a Sunday. So, most of us try and put it out long before then' (P15).

Finally, some crofters mentioned that they notify SFRS on the day of burning because this reduces the risk that SFRS attend the fire thinking it is a wildfire, usually following a call from a worried member of the public.

3.3 Learning to burn

The interviews highlighted that the body of fire knowledge among crofters combines knowledge passed intergenerationally between crofters with influences from other sectors and agencies. 11 crofters mentioned learning about fire from older family members, with some having gained experience of burning as young children: e.g., 'Ah, my dad showed me. I was doing it since I was six' (P20). Six crofters mentioned learning about burning from other crofters in their community. Two crofters had taken formal training courses in controlled burning, including courses organised by SAC Consulting and LANTRA. Three mentioned gaining knowledge of fire from gamekeepers, and two from staff of the former Forestry Commission.

3.4 Crofters' experience of wildfires

Wildfire was not the focus of this research and was not a topic included in my list of interview questions, but it came up frequently, nonetheless. In 80% of interviews, participants described specific incidents of wildfire that they had witnessed in their area. They discussed various causes of wildfires. In 13 interviews high fuel loads (high for various reasons covered in section

3.5) were mentioned as a driver of wildfires. In 12 interviews, participants mentioned wildfires accidentally having been started by tourists, or other members of the public, while wildfires caused by the escape of intentional fire use by crofters or others were mentioned in eight interviews. Participants mentioned particularly dry weather conditions driving wildfire incidents in five interviews.

Participants pointed to various effects of wildfires that they had witnessed. Several mentioned intense wildfires causing damage to peat or soil, with implications for vegetation, and grazing value: 'Usually what happens is it totally kills the heather. And the heather in a lot of places seems to actually keep the surface together. And obviously it can go into the peat... then after that it's pretty much black you know, it's just peat on the surface. A lot of times if it's been burned too hard as well, you get this kind of what looks really like nice clean grass from a distance, and then you go up and there's loadsa kinda gaps in between it ... it looks great, but it just doesn't seem to be of any grazing value to the livestock, they don't seem to do well at all. They'll go on it, they like it, but they don't seem to thrive on it, and then you look at it, it goes back pretty quick and then it takes ages for it, for it to come back' (P13).

Generally, wildfire effects on grazing value for crofting appear to be mixed. Sometimes, a wildfire can replicate the effect of controlled fire use for crofters, by clearing rank vegetation and promoting regrowth. Yet, where wildfires take place later in the year than controlled fire use would, regrowth can be limited in that year: 'this was in the middle of May-June, and by the time it recovered, you know, the season was quite well on you know' (P18). Moreover, where wildfires are large in extent, they leave behind large areas of even-aged vegetation, such that there is good grazing across the landscape for a limited time, but then 'for a couple of years the grazing wouldn't be there' (P23).

Some participants mentioned wildfires damaging features like fencing, forestry plantations or woodland regeneration areas. Some had also seen wildfires causing danger for road users, where smoke reduced visibility. Three knew of cases where crofters had been prosecuted or subject to insurance claims for causing wildfires, but most felt that this was very rare.

Three crofters described their involvement with fighting wildfires and/or providing local knowledge to the fire brigade to assist with firefighting. This was felt to have been more common in the past (1970-80s), when 'every man and his granny' was involved, and Forestry Commission staff also actively fought wildfire (P5), while today, people tend to see firefighting as the sole responsibility of agencies: 'there wasn't any other locals up and out on the hill with a beater. It was like "well that's a forestry thing, a fire brigade thing"' (P7).

3.5 Changes in fire use, their drivers, and implications

This section explores social, economic, and environmental factors that have driven changes in fire use by crofters in living memory. Taken together, these factors contribute to broad trends described by many participants towards less frequent burning, of larger patches of the landscape, by smaller groups of crofters or individuals, with greater wildfire risk.

3.5.1 Changing crofting demographics

Participants in 18 interviews described changes in the make-up of the crofting community that have affected muirburn. A change described by many participants is that ever fewer crofters actively keep livestock and use their common grazings: e.g., 'I saw the end of the era where

virtually every croft was individually lived on and worked. So, people would have one or two cows, so many sheep, use the common grazing extensively. We're now at the stage where there are so very few people ... that the people that are working crofts have got a number of crofts and maybe the use of a lot of other crofts where the shareholder, the crofting tenant, doesn't actually actively do anything at all, and may not live in the area ... There's virtually no cattle now. The sheep numbers have dropped very, very significantly, even since I took over as Clerk of the common grazing' (P1).

This reduction in the number of crofters keeping livestock was attributed to extensive hill farming becoming less financially viable (both due to changes in subsidies and the market value of livestock and wool), while it can be more financially viable to run other businesses, e.g., campsites, on crofts. It was also attributed to lack of enforcement of crofting regulation – technically, regulation decrees that crofters must live near, and actively work their crofts. It was also linked to the way in which the removal of land from crofting tenure is being allowed very freely. As one participant described: 'The Crofting Commission are not picking up on absentees, they're not picking up on people not cultivating the croft. And they're almost doing the opposite ... there's a particular croft I have in mind ... The new crofter has basically been in breach of regulations since the day they moved in because they've done nothing with the croft ... They are resident ... but they've basically been, like elsewhere, speculating, they've put in for house plots. They've got permission ... and now there's a de-crofting application' (P28).

Participants noted multiple ways in which the reduction in the number of active crofters has affected muirburn. One outcome is a reduction in grazing pressure on common grazings resulting in higher fuel loads, which makes muirburn riskier (see section 3.5.7). It also means that there is a smaller pool of people from which to draw a team large enough to carry out muirburn safely. Where common grazings have few active shareholders, Common Grazings Committees are also less likely to be active and play a role in organising muirburn collectively. Participants also described how burning in smaller teams or by individuals today is resulting in less transmission of fire knowledge between crofters.

Several participants also mentioned how the crofting population is aging, both because of the lack of financial viability of crofting and because it is very difficult for young people to acquire croft land unless they inherit it. Older crofters may be less able-bodied for the physical work of tending a fire. They are also less likely to manage the additional physical work involved with keeping cattle, with implications for fuel loads on common grazings. The aging of the crofting population also means that fire knowledge is not always being transmitted to the next generation. One participant also noted that there is generally less involvement of children today in agricultural practices like muirburn, because society is more risk averse. In the past, 'there wasn't that sort of like, "oh maybe not. You're a bit young to come to the hill and help with this and help with that, you know, in case you get hurt" (P7).

Several crofters who are part of sheep stock clubs (which own and manage herds collectively) noted that this model, particularly prevalent on Skye, has somewhat mitigated the pressures on crofting. Besides usually having more active shareholders, sheep stock clubs often have the resources to employ additional help and so are more likely to be able to gather sufficient people together to carry out muirburn safely. Sheep stock clubs are also more likely to have sufficient labour and collectively owned equipment to maintain larger herds of livestock including cattle, on their common grazings, keeping fuel loads lower.

3.5.2 Changing agricultural practice

Participants described various changes in agricultural practices that have affected muirburn. Participants in eight interviews described changes in agricultural subsidies that have driven changing in stocking. This included the introduction of stock reduction schemes where crofters were paid subsidies for reducing their sheep numbers, as well as other subsidy changes that have made it less financially viable to keep cattle. As one participant described: 'We couldn't live off the subsidies … You know, we have to put in our own money to keep the cattle, because it's just a thing, we want to keep the cattle going' (P22). Two participants also mentioned that in the past, even if they did not keep large herds of cattle, most crofters kept one or two 'house cows' (P7) to provide milk for the household, so there were cattle on most common grazings. Today cattle are not generally kept for this purpose and cattle grazing is concentrated on far fewer grazings. These changes in stocking – an overall reduction in grazing pressure, and trend away from keeping cattle—have resulted in increased fuel loads, making burning risker (see section 3.5.7).

Two participants described how apportionment of their common grazing areas (sub-division of the common grazing among crofters for their exclusive use) had changed the need to burn. Burning is not required on the apportioned land because grazing intensity is higher, and there is no longer the same level of mutual support available among crofters. Meanwhile, if some parts of the grazing remain in common, they have less users, so muirburn is less likely to take place.

In two interviews, participants described how the introduction of all-terrain vehicles (ATVs) had influenced muirburn in their lifetimes. They linked the reduction in time spent by crofters walking their common grazing areas to less local knowledge of the terrain among crofters, as is very important for planning and executing muirburn: 'If they would just stop for five minutes, get off their bikes … they just don't know what they're missing. They're missing something that they can't read in a book' (P5). They also linked the use of ATVs to a general reduction in willingness to do the kind of physical activity that is required to control muirburn.

3.5.3 21st Century life and work

In nine interviews, participants mentioned changes in life and non-croft work in their lifetimes that have affected muirburn. Several mentioned that people have less flexibility with their time than in the past, making it more difficult to gather a team of people together to burn in limited suitable weather windows: 'I think in the past like crofters' employment would tend to be a bit easier, like if you worked for like the Forestry [Commission], you might just say, "oh, it's a good day for burning, do you mind if I don't come today?", whereas now life is more official, and people need to apply for annual leave in advance, which often the weather windows don't work' (P8). Some participants mentioned how, while many crofters have always had jobs outside crofting, it is increasingly rare to be a full-time crofter. Part-time work also more commonly takes place away from the croft. These factors also make it more difficult to gather a team of people to carry out a burn.

Other participants alluded to more individualism and less community-spirit among crofters today than in the past, again making it more difficult to gather sufficient people for muirburn. Some participants described less communication between neighbours: 'Everything's secret, nobody tells one another, you know, you can't phone up and text someone saying, "we're burning today, watch your animals". People don't talk nowadays' (P22). Others described situations where people were less likely to provide mutual assistance to one another with

activities like burning: “A lot of times you don't have enough people … that can go out for the day, free of charge, to help on a fire … They want paid’ (P7).

3.5.4 Loss of support from state agencies

Many older participants described changes in support from state agencies that have affected muirburn. The Forestry Commission (now Forestry and Land Scotland) was the main agency mentioned. Participants in seven interviews said that the Commission historically provided staff to assist with muirburn and firefighting in crofting areas (this being remembered in the 1960s, 1970s and early 1980s), to ensure the safety of forestry plantations: ‘All the Woodmen were taught on firing. And if you wanted to burn anything … you'd say, “right, on Saturday if it's a good day, we're going to burn this hill”. “Right, no problem”. So, they'd all be out with their beaters and what have you, ready to go’ (P14). Crofters said that the loss of this support had made it more difficult to gather sufficient people to burn safely and made them more worried about burning near forestry plantations. An employee of Forestry and Land Scotland said this change was driven by a move towards mechanisation and reductions in staffing. It also followed a change in organisational policy not to risk liability for staff involvement with fire operations, and the perspective that fire users should be responsible for controlling their own fire use.

Five participants also described how the Forestry Commission was a major employer of crofters in the past (before the 1990s), but this is not the case today. This employment had implications for muirburn, in that Commission staff were (historically) trained in fire management, bringing this knowledge and skill into the crofting community. The Commission also had a specific policy towards crofting employees, whereby they were granted flexibility to tend to their crofts (see also section 3.5.3), as described by an employee of the organisation: ‘Crofters got special leave for crofting. “Crofting leave” it was called, you know. So, it's part of the culture up here that a lot of the crofters worked for us, and it was part of the whole culture that they still managed their crofts or farms whilst working for us and got time off to do that, particularly at lambing season, for example, or muirburn season’ (P29).

Six participants mentioned how the Forestry Commission had stopped mechanically cutting fire breaks to protect forestry areas in the 1990s. An employee of Forestry and Land Scotland gave several reasons for this change, including reductions in staffing, the high cost of maintaining fire breaks, and changes in the way plantations are structured that make them less at risk from wildfire, including a move away from even-aged stands, and towards inclusion of broadleaf woodland and open spaces within plantations. They also said that they had stopped cutting fire breaks because ‘the muirburn wasn't for us, so why should we pay for it? … we were almost admitting liability for any burning that got away if we were doing the swiping [creation of fire breaks] as well, because the swiping wasn’t on our land, it was outside our land’ (P29). Crofting participants did not seem aware of any reduced risk to plantations due to changes in their structure, and felt strongly that Forestry and Land Scotland should take more responsibility for protecting their plantations from fire: ‘They kept these breaks and then all of a sudden they seemed to go “ach, to pot with it, we're not doing it”, and then turn around and blame everybody else for burning their trees down’ (P17). Several participants described being less confident to conduct muirburn or stopping the practice entirely because of fear of possible risk to plantations that are not protected by fire breaks.

Besides discussion of the Forestry Commission, one participant mentioned that there is generally less on-the-ground support from Civil Service agricultural extension agents today than in the past, affecting all aspects of crofting.

3.5.5 Changes in public awareness and opinion of fire use

Changes in public awareness of fire use were mentioned in 14 Interviews. Many participants felt that the public is more disconnected from agriculture and land management than in the past, and most people do not understand why muirburn takes place: 'Just in my lifetime here ... it's more frowned upon to do the burning ... the least little whiff of smoke and people assume that you're doing something that's not correct' (P24). Several mentioned that fire was a contentious topic on local social media pages. Some linked increasing lack of local awareness of burning to increasing numbers of incomers in their areas.

Related to this, several participants described it being increasingly common for members of the public, assuming all fires are wildfires, to call SFRS when they see muirburn taking place (P17). Some participants felt that lack of public awareness, and the increased likelihood of SFRS attending muirburn mistakenly puts some crofters off burning completely. Others felt that this does not generally stop crofters burning.

3.5.6 Climate change

In 7 interviews, participants discussed changes in weather or climate that mean that the right weather conditions for burning are less common today. Four participants said they had experienced wetter conditions in Winter and early Spring making it more difficult to burn. One participant mentioned experiencing unusual periods of drought in Spring where it was too dangerous to burn. Two participants described greater extremes of weather, such that it is commonly too wet to burn or too dry to burn safely: 'It's getting drier and it's getting wetter. There's no in-between now' (P21).

3.5.7 Increasing wildfire risk

Many participants mentioned that changes in wildfire risk have made them more wary of burning than in the past. Participants in 16 interviews said that landscapes now contain more features to which fire may pose a risk, including forestry plantations, woodland regeneration areas, nature conservation areas, roads, and housing. This includes woodlands and plantations owned by crofters themselves (as was the case for three research participants). Some crofters described conducting muirburn less frequently, or stopping completely, because of worry about risk to such landscape features. Others described a need for greater control over fires: 'When I was a very small boy there wasn't any forestry. So, people were a bit kinda haphazard. They just lit it, and it went, you know, and it was fine, it would go out eventually somewhere. It didn't really matter' (P15). As described in Section 3.5.4, the way plantations are structured by Forestry and Land Scotland has changed since the 1990s, such that mature plantations are less at risk from fire, but crofter research participants did not generally seem aware of this. Several participants did mention that younger plantations and woodland regeneration areas are at greatest risk from fire.

Finally, 13 participants described how, due to the various drivers described throughout section 3.5 leading to reductions in grazing pressure and fire use, there are greater fuel loads in the landscape, making it more difficult to control fire: 'It is a riskier thing than people burning maybe 50 years ago was, because the fuel load is higher in a lot of places ... so what maybe could have been a burn that had a few people there and would have been totally under control will now need more people to get to where they used to be' (P8). The wildfire risk posed by high fuel loads seems to have a positive feedback effect, in that some crofters said it has driven them to burn less frequently or to stop burning altogether.

3.6 Perceptions towards muirburn legislation

3.6.1 The existing legislation and muirburn code

At the time of the interviews, muirburn was regulated by the Muirburn (Scotland) Regulations under the Hill Farming (Scotland) Act (see Section 1). In addition, the Muirburn Code sets out other guidance for burning that was, at the time of the interviews, not legally mandated (though it will now be given stronger legal backing under the Wildlife Management and Muirburn (Scotland) Act.

Among interviewees there was generally greater awareness and acceptance of the legal burning dates than the other elements of the existing legislation. Three crofters explicitly mentioned trying to follow the Muirburn Code themselves. Four said they felt the Code is not followed by many crofters. Some participants explicitly mentioned that they do not comply with certain regulations, where this is impractical. The requirement to notify neighbours and landowners came up particularly often, with some mentioning absentee landowners, and others the impossibility of predicting when burning will take place: 'How the hell can you advise people long in advance of when the weather conditions are going to be just right to burn one area? It's a question of, if you are going to burn, you get up one morning, and you see the wind is in that direction. It's right now. Going now' (P1). Two crofters mentioned burning after sunset: one because daylight hours are limited in Winter; the other because conditions are cooler and the wind generally calmer.

Only three participants had heard of cases of crofters being prosecuted for lack of compliance with the regulations. Several discussed reasons why prosecutions are rare. Some mentioned how it 'can be quite difficult to trace the source of ignition, or even if you get the source of ignition, who actually carried it out ... you would need quite a bit of forensic reporting and ... in an area like this, where's the resource or need to do it?' (P9). Some suggested that it is uncommon for members of the community to report others to the authorities, as in one case where a crofter who caused a wildfire was 'so well liked, and everybody knew- even the guy whose woodland got burned knew who it was. But luckily for him, his woodland was insured. Nothing more was said about it' (P12).

3.6.2 The forthcoming legislation

At the time of the research interviews, the Wildlife Management and Muirburn (Scotland) Bill was at Stage 1 in Parliament, so discussion focused on the legislation as introduced, which set out requirements for licensing, and proposed to ban burning on peat deeper than 40cm. At the time of writing this report, the Bill, including these elements, has been passed, but with changes at Stages 2 and 3 including explicit inclusion of training as a requirement for licenses and changing the legal burning season to start and finish earlier. At the time of the interviews, it was clear that training was likely to be a condition of licensing, so I did discuss this with participants, but I did not discuss the change in legal burning season.

In 11 interviews with crofters, participants felt that a ban on burning on peat deeper than 40cm would exclude burning on some or all of their common grazing. Only one crofter felt that this restriction would not apply to their grazing, and one was unsure. Many felt that low intensity, controlled, burning does not pose a risk to peat, and two said that fire poses less of a risk to deep peat, being moister than shallow peat. Several crofters posed concerns with how peat

depth would be measured. Some worried about the time it would take if they were required to take peat depth measurements themselves: e.g., 'it would take two or three days to do a hill like that' (P25). Others mentioned the variability of peat depth across their grazing areas, meaning that reliance on coarse data would be unreliable, taking accurate measurements would be very time-consuming, and people could potentially give an unrealistic picture of conditions by being selective about where to take the measurements.

Only two crofters were generally supportive of muirburn licensing, if designed to suit crofters. Most were wary of the additional bureaucracy that licensing would introduce, noting that compliance would be a burden for crofters, who generally work part-time and have far fewer financial and human resources at their disposal than other fire users in Scotland (e.g., grouse estates). Several also mentioned concerns about who would be responsible for license applications, noting that if landlords were responsible and refused to make an application then there was a risk that crofters were barred from burning.

Two crofters welcomed requirements for training, they themselves being worried about their capacity to burn safely in areas with high fuel loads. Most others, even if not opposed to training in principle, worried about the potential cost of the course, and likely need to travel for it: 'Practically, how does that work? Where are they holding these trainings? Who's carrying it out? Where's this resource coming from? I mean, we're significantly under-resourced in areas like this in almost all departments of life' (P9). Some also mentioned concerns that the courses would be tailored to grouse estates, not the crofting context.

In 13 interviews, participants said they thought that many crofters would not comply with the legislation, and would continue to burn, but do so more secretively. Participants felt that crofters would be less likely to stay and tend fires, and more likely to burn alone: 'Somebody might, just now, light it and stay with it to try and control it, two or three of you. Then you're not allowed to do it and you think "I need to burn this, so I'll just drop a match and I'll go home, and I'll just deny it was me that did it". And the place is so busy with campers and walkers anyway, you can easily say it must have been camper' (P15). In six interviews, participants said they thought that the new regulations would put some crofters and grazings committees off burning completely. Participants worried that these potential outcomes of the legislation – reductions in fire use, more individual and less well controlled burning practices—would increase wildfire risk, reduce the transmission of fire knowledge among crofters, and contribute to ongoing trends making crofting less financially viable.

Frequently, discussion of the legislation brought up more general feelings of disenfranchisement among crofters. These encompassed a sense that the local knowledge of crofters is not valued, and Government is disinterested in crofters' needs: 'If you mention crofting to Scottish Government ministers, they're not interested. It's almost like, if crofting came to an end next year, they honestly wouldn't care' (P4). Crofters also mentioned practical constraints in making their voices heard: ''I'm more a case of "I'll wait until it happens and then I'll see what I have to do", because I don't think I can influence it really, you know... well I don't have time to try and influence it. I mean, I'm the vice-chair of the local NFU [National Farmers Union] branch, but it's just, I don't have the time to read their papers for their meetings, yet alone anything else. So, it's like, yeah, it's like maybe that's for, for retired folk to get into' (P13). Others mentioned a lack of confidence being engrained more culturally among crofters and/or the Gaelic-speaking population more broadly: 'people are time-pushed and everything, but I think there's a slight confidence thing that people - you know, like, people working at a piece of common grazings should feel like they have the same value and status for their opinion to be

passed as somebody who's running a grouse moor on the East Coast. And that doesn't happen' (P8).

In reference to the Wildlife Management and Muirburn (Scotland) Bill more specifically, several participants mentioned how the Bill was explicitly aimed at grouse estates, and so did not consider how crofters' use of fire and needs differed. There was a sense that crofters struggle to know where to align themselves in the political debates surrounding the Bill. As one participant put it, in finding themselves targeted alongside grouse estates, 'there is a part of that's, that's class war, which is funny because you find crofters on the wrong side... it does get really tricky for... an organisation that – like SCF [The Scottish Crofting Federation] traditionally would be not really big palls with the landlords' (P8). Similarly, crofters struggle to align themselves with environmental campaign groups: 'The media often talk about, like, you know, "rewilding's good, and intensive agriculture's terrible" ... I think what happens in the Highlands is that people who are running actually low input, high nature value things, they associate themselves more with the agriculture ... So, they are getting all the negative messages, that – to be fair, the rewilders probably don't even have them in their thoughts... I think crofters feel quite attacked from all angles' (P8). Finally, several crofters deemed the new rules unfair or hypocritical, with the Government unwilling to tighten regulation of more environmentally damaging activities, such as flying, or development on peatlands: e.g., 'There's a proposal for another 200 wind turbines on Skye, all of which are on deep peat, and all of which will mean massive destruction of peatland. So why are those licences getting granted? If you're gonna make a rule, it can't be that the highest bidder can buy their way out of it. So, I don't know, I think people will see the hypocrisy there' (P7).

3.6.3 Views on alternatives to burning

Mechanical cutting can theoretically be used as an alternative to muirburn to promote fresh growth for livestock and reduce fuel loads. Only one participant had tried cutting heather, because they feared fuel loads were too high to burn. They had used a strimmer but had found this damaged the strimmer blade. Most others felt that mechanical cutting is not a viable alternative to muirburn for crofters. Some mentioned the cost of the machinery required, e.g., a flail mower, some the difficulty of operating such machinery on the uneven, rocky, and waterlogged terrain they graze: 'You would make an absolute mess of the bogs. You would roll your tractor goodness knows how many times. It wouldn't be safe to do it. Totally impractical' (P13). Some mentioned the time it would take to cut vegetation across their grazing areas, as compared with burning. Other participants discussed the fire risk posed by cut vegetation if not removed after cutting (this being impractical on large scales), or that thick piles of cut material limit the growth of vegetation beneath. Finally, one participant mentioned the damage that would be done to the peat if heavy machinery was used to cut firebreaks, as opposed to controlled burning.

Several participants looked more favourably on altered grazing regimes involving more cattle, and especially native breeds of cattle, as an alternative to muirburn. Some mentioned tools like electric collars, which can help to control cattle movements. All these participants also noted the additional time, equipment and physical ability required to work with cattle and thus the need for better support to make this a viable option for many crofters (see also section 3.6.4). One participant also mentioned the local knowledge required to understand the optimal grazing regime: 'A better grazing regime is always, is always an answer. But that's very difficult to achieve. I mean ideally you want a cattle and sheep balance... and it's very specific to where you are... this is why the likes of the stock clubs are very valuable, because the experience of like,

what the land will take, stocking density-wise and so on, it's handed down through, you know, institutionally' (P12).

3.6.4 Policy suggestions

Some participants made policy suggestions. Four felt that the Government should do more to practically enforce the existing Muirburn Code, though they did not necessarily feel licensing is the right means to achieve this. Many participants said that if mandatory muirburn training is to be introduced, crofters will require financial support to attend, and that training must be tailored to the crofting context.

Several participants suggested that crofters need better support to enable good burning practices: 'Incentivisation, rather than more legislation would have been the right way forward. Put the mechanism in place whereby we will follow best practice, if we're empowered to do so' (P4). Some mentioned tying well managed muirburn to subsidies, and others discussed financial support to enable local collaboration in burning: '[We need] funding for volunteers to collaborate with local fire crews to … carry out the muirburn itself. So that the retained volunteer fire crews, and the volunteer crofters in that area are paid a day rate to carry out your muirburn specifically. Doesn't have to be a lot of money … it'd surely be just as expensive as having this [licensing] scheme in force that then requires a lot of financial burden to administrate' (P9). One crofter suggested that for burning to be well managed there must be better general support for crofting as a livelihood: 'Fire can absolutely be a part of that toolbox really can't it? … We just need more young people, we need more energy, and that means crofting has to be a bit more financially viable' (P3). The same participant discussed the need for better enforcement of crofting regulations so that crofts with absentee crofters are made available to the next generation.

Some participants also discussed a need for better support for alternative management regimes, involving less muirburn, that also deliver 'public goods' (P3). Support for cattle grazing through subsidies and capital grants was mentioned in four interviews, while woodland regeneration was mentioned in two interviews. In the case of the latter, both participants discussed a need for government to better recognise the fire risk involved in the early stages of woodland regeneration and to put support in place for managing fuel loads, either through grazing regimes or controlled burning.

Some participants noted a need for more research to support muirburn policy, and fire use decisions by crofters. Two suggested a need for more accessible research on the effects of muirburn, including effects on grazing value in the short and long term. One crofter mentioned a need for more research to understand what crofters seek to achieve with muirburn, and how patterns of fire use differ in a crofting versus grouse moor management context. This participant mentioned a need to conduct such research in Gaelic, and to translate the Muirburn Code into Gaelic as part of making it more applicable to the crofting context: 'if what people are trying to do actively looks very different at the end of the day, it doesn't make sense that the same language has been, like, mangled to try and describe the two outcomes' (P8).

One participant also felt that there is a need for the Scottish Government to take increasing wildfire risk more seriously and increase funding to the Scottish Fire and Rescue Service.

4. Conclusions

This final section presents my thoughts towards policy based on the research. There are important uncertainties regarding implementation of the Wildlife Management and Muirburn (Scotland) Bill in a crofting context. First, crofters generally have limited financial resources at their disposal, which should be considered when determining what they are charged for muirburn licenses and training. Ideally there would be support schemes to enable access to muirburn training by crofters. Second, the social structures surrounding the management of common grazings differ, with varying levels of presence/absence by landowners, numbers of active shareholders and organisation by common grazings committees, and the potential organisation of shareholders into sheep stock clubs. This diversity makes it unclear who should have responsibility for making muirburn license applications for common grazings, be that individual crofters, landowners or common grazings clerks. Finally, the ban on burning on peat deeper than 40cm will affect at least some land on many common grazings. Again, given the diverse social arrangements governing common grazings, it is unclear who should be responsible for assessing peat depth. It is also unclear how the regulations will be implemented where peat depth is very patchy across a common grazing.

This research is a first step towards documenting why and how crofters practice muirburn, but there is a need for further research on this topic, especially carried out in Gaelic. The implementation of the new muirburn regulations, future revisions of the Muirburn Code, and design of muirburn training should draw on more evidence about the use of fire by crofters. There is also a need for more research to guide muirburn in a crofting context, examining e.g., the short- and long-term impacts of burning on grazing value. Existing UK research on the relationships between muirburn and wildfire risk, biodiversity and greenhouse gas emissions has mostly been carried out outside the crofting counties. Crofters would benefit from clear and accessible information synthesising the existing research and explaining where the uncertainties lie as regards the possible environmental and economic impacts of their fire use.

Most importantly, this research suggests that a regulatory approach focused on the practices of individual crofters, e.g., through licensing and training, is not necessarily the right policy approach to ensure that muirburn is carried out in compliance with the Muirburn Code. There are important structural conditions that shape the extent to which crofters can comply with the regulations and Code. For instance, because of the financial insecurity of crofting and poor enforcement of crofting regulation, the population of shareholders that actively graze livestock (and especially cattle) on common grazings is declining and aging. This is reducing the likelihood that muirburn is planned and carried out collectively and reducing the transmission of the knowledge and skill required to conduct muirburn safely. It also means that fuel loads are often higher, increasing the wildfire risk associated with burning. Muirburn therefore needs to be considered in the context of the reform of agricultural subsidies, and crofting regulation more widely. While the social and economic conditions under which crofters practice muirburn remain unchanged, there is a clear risk that the tighter regulations will exacerbate those cases of bad practice that do exist at present. Crofters that cannot or will not comply with the regulations will be more likely to burn secretively, as individuals, and without tending to the fire to ensure its control. This has the potential to exacerbate wildfire risk and reduce the transmission of important fire management knowledge and skill. Crofters need better support to enable muirburn to be carried out collectively, be that through subsidies, resourcing of common grazings committees, or financing to enable collaboration with agencies like the Scottish Fire and Rescue Service.

Finally, while common grazings continue to be grazed less intensively and predominantly by sheep, fire may be an important part of the picture to prevent high fuel loads, promote a more diverse vegetation structure, and sustain grazing. It might be that the picture is different for some common grazings in the future, with transitions to management regimes that require less fire use, such as more grazing by cattle, or regeneration of native woodland, but tightening the regulation of muirburn will not, in and of itself, bring about these transitions. If the Scottish Government wants to see more diverse management regimes on common grazings then it must better support crofters to provide them. There also needs to be far greater understanding and awareness of how muirburn may or may not be beneficial under different management regimes. For instance, muirburn may be a valuable tool to reduce fuel loads and wildfire risk around woodland regeneration areas in the early stages of regeneration, but less important once woodlands reach maturity.

Appendix 1: Interview questions

- How long have you worked this croft / lived/ worked in this area?
- What is the grazing regime like on your croft/ common grazing land?
- Why do crofters use fire?
- Where does burning take place in this area? Has this changed, if so, why?
- Do you / have you taken part in burning?
- If you have taken part in burning:
    - What is the best time of year to burn?
    - What weather conditions are best for burning?
    - How do you decide that you are going to burn on any given day?
    - What do you pay attention to when you burn? What is the best way to manage a fire?
    - How did you learn how to use fire?
- How is burning organised among shareholders on common grazings? Was this done differently in the past?
- How often does burning take place today? Has this changed, if so, why?
- Have there been any other changes affecting fire use?
- If there have been changes in fire use, what are the outcomes of these in the landscape?
- How do you think the public / other residents in your community feel about fire use?
- Do you know about the existing muirburn regulations and muirburn code? Do you think these are effective / useful?
- Do you know about proposed changes to the laws around muirburn? How do you feel about these?
- Are there alternatives to burning for the landscape outcomes that crofters require?