Vegetation fires in South Wales: public and stakeholder perceptions

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This thesis is my own work and is the result of my own independent study. It has not been submitted for any other part of my degree assessment at Swansea University nor has any element of it been submitted for a qualification or published externally. Any third-party involvement in this study is declared in the acknowledgements and all secondary sources of information has been acknowledged fully in footnotes and references. A bibliography of all Literature used in the work has been provided.

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Abstract:

Globally, wildfires are becoming more costly to extinguish and fire seasons are getting longer. In South Wales there have been over 75,000 wildfires over the last 20 years, with the vast majority of these being human-caused. The aim of this research was to determine and analyse the public's and stakeholders' perceptions of the risk from wildfires in this region. Understanding these is important as they help to shape public policy. Data was obtained through questionnaires, face to face in Tonypandy, a densely populated rural area, and Cardiff, a large City, and also via online surveys from across Wales. In addition, in-depth interviews were conducted with nine stakeholders, six from Wales and three from further afield. Amongst all questionnaire respondents, 97.5% believed there is risk associated with wildfires. All the stakeholders agreed that wildfires are a risk to the public, the fire service and to property. The general public were asked to comment on prescribed burning carried out by South Wales Fire and Rescue Service for wildfire risk reduction and the vast majority of these comments were positive. Stakeholders were asked to comment on prescribed burning during the legislated season and as a year-round tool. All supported the activity within the legal season and only one did not support year-round burning to reduce fuel build up and reduce risk. The results indicate that the public perceive there is a risk from wildfire and both the public and stakeholders mostly agree with the use of fire to manage vegetation, even beyond the current legal season.

Key Words:

Wildfire, prescribed burning, risk, fire break, arson, deliberate, South Wales Fire and Rescue Service

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SWFRS	South Wales Fire and Rescue service
NRW	National Resources Wales
MAWWFRS	Mid and West Wales Fire and Rescue Service
EWWF	England and Wales Wildfire Forum
NFCC	National Fire Chiefs Council
NOG	National Operational Guidance
EFFIS	European Forest Fire Information Service
LRF	Local Resilience Forum
HFR	Hazardous Fuel reduction
SSSI	Site of Special Scientific Interest
FSI	Fire Severity Index

'In a city a fire put out is a problem solved, in the countryside a fire put out is often a problem put off'

Stephen J. Pyne

1. Introduction

1.1 Motivation

I have been a firefighter for the last 28 years, I joined Mid Glamorgan Fire Service as a part-time firefighter in September 1993 aged 18. I became a full-time firefighter with Gwent Fire Brigade in December 1995 and transferred to South Wales Fire and Rescue Service in April 1996 when it was formed after the amalgamation of Mid Glamorgan, Gwent and South Glamorgan Services due to Local government restructuring. I grew up in the South Wales Valleys and the majority of my career has been spent attending incidents in this area. During this time my interest, experience and education in this complex topic has grown. My Wildfire journey as a member of South Wales Fire and Rescue Service is described in Appendix 6. There has been much research into the subject of wildfires throughout the world although very little research has been carried out into the wildfires in the South Wales valleys, most of which are due to deliberate ignitions. A large amount of work and money has been spent on trying to discourage these acts of arson with only small gains being made (Peatie and Ansell, 2010).

The common definition of a wildfire in the UK context is any uncontrolled vegetation fire which requires a decision, or action, regarding suppression (Stacey, 2012). Wildfires are driven by three main factors: vegetation (also called fuel), ignitions and weather (Fernandes and Botelho, 2003). As we cannot control the weather and have had little impact on arsonists' behaviour the only thing left which we can control is the fuel.

In order to contribute to a better understanding of wildfire in the UK in general and of the feasibility to use fuel management for reducing wildfire risk in Wales particular, this research aims to understand Welsh public perceptions and stakeholders' opinions on the risks from fires and the use of prescribed fire to manage fuel build up and reduce fire risk.

The personal motivation for this research arose as follows. Originally, to gain the data and perceptions for the research I planned to spend time discussing the issues and solutions with colleagues, but soon realised that even though firefighters are very passionate about their role and very skilled in dealing with fires, there is a limited knowledge base of the wider problem to even start discussing solutions. The issues and solutions for dealing with wildfires in Wales are much more complex than they might seem.

For many years the fire and rescue services have tried to limit accidental and deliberate fire setting in communities. In urban communities with issues such as refuse fires or accidental dwelling fires this can only be a positive as there are only positives to having fewer fires. When this rationale is then used to stop deliberate wildfires the results will be the further build-up of vegetation leading to more damaging fires in the future. If pursuing a campaign to stop deliberate wildfires there must be side by side work to reduce this fuel build up.

Currently the rules around prescribed burning of land in Wales are the same for all practitioners, with fire and rescue services having no dispensation to create fire breaks using fire outside of the legislated season to protect vulnerable communities. In order to drive a policy change it is imperative that the public and stakeholders affected are supportive or at least not against these activities. The research was carried out to help understand the perceptions around fire risk and prescribed burning.

The aim of this research is **to understand current perceptions of risk by the general public and stakeholders in South Wales on the issues of wildfires.** The term risk within this research is not in relation to the risk of a wildfire being ignited but the risk from the burning fire to firefighters the public and property.

This thesis is structured in the following way. The remainder of this chapter introduces the reader to landscape and managed fires by reviewing relevant literature. It also shows the effects of these fires, perceptions and fire management techniques from a global, UK and South Wales perspective. Chapter 2 will describe the methodology for this research and explain how data was collected and analysed. Chapter 3 will present the results of the public surveys and discuss these. Chapter 4 will present the results of the stakeholder interviews and discuss the findings and Chapter 5 is the conclusion of the research.

1.1.1 Landscape fires

Vegetation or landscape fires include all fires that burn vegetation in an open landscape, such as agricultural and prescribed burns and wildfires. *Wildfires* are uncontrolled vegetation fires that may be started naturally, accidentally or deliberately. Specific definitions vary in the literature, but the term wildfire is often associated with fires in forest, shrub- and grasslands of the USA, Australia and Mediterranean countries. Northern Europe with its temperate humid climate, however, does also experience large numbers of vegetation fires involving grass, gorse, forestry and moorland (McMorrow, 2011). These are often given various terms such as grass fires, gorse fires, mountain fires and forestry fires, however, in the context of the UK and this study, the most appropriate term is wildfire.

More formally, all vegetation fires attended by the Fire and Rescue service in the UK are recorded for statistical purposes although fires have to meet certain criteria before they can be classed as a wildfire. These criteria are set in the National Operational Guidance for Wildfires (National Fire Chiefs Council, 2017), which has been developed for Fire and Rescue Services operating throughout the UK.

To be classed as a wildfire the fire must meet one of the following criteria:

- *Involves a geographical area of at least one hectare (10,000 square metres)*
- *Has a sustained flame length of more than 1.5 metres*
- *Requires a committed resource of at least four fire and rescue service appliances / resources*
- *Requires resources to be committed for at least six hours*
- *Presents a serious threat to life, environment, property and infrastructure*

1.1.2 Managed fires

Managed fire, more commonly called *prescribed burning,* is a planned and supervised burn carried out under specific environmental conditions to remove fuel from a predetermined area of land at the time, intensity and rate of spread required to meet land management objectives (Stacey, 2012). This can be carried out for a number of reasons. These include reducing the build-up of flammable fuel loads to mitigate the severity of potential wildfires, to maintain biodiversity, habitat or improve pasture, or to undertake research on fire and its interaction with our environment (Harper et al., 2018). The availability of vegetation dry enough to burn is related to weather conditions.

1.1.3 Global wildfires

Wildfires affect large areas of the world, currently 3-4.6 million square kilometres are burnt each year which is equal to 4% of the global vegetated land surface (Doerr and Santin, 2016). There is a widely held perception that wildfire occurrence is increasing across the globe, but research suggests that this is overall not the case. Instead, the total area burnt each year is currently declining, largely due to conversion of fire-prone grassland areas in Africa to agricultural land (Andela et al., 2017). Over 80% of global wildfires occur in Africa and Australia and involve grassland, hence the reduction here has led to an overall decline despite increases elsewhere (Doerr and Santin, 2013). The global area burned has thus reduced by 24.3± 8.8% over the past 18 years (Doerr and Santin, 2016; Andela et al., 2017).

Even though the global area burned has declined, fires have become more extensive and severe in many regions. For example, the fire season in the USA is now an average of 78 days longer than in the 1970's (Westerling et al., 2006). The cost of tackling wildfires has also increased year on year in many regions and has a large effect on relevant organisation's budgets. For example, in 1995 fighting forest fires used 16 percent of the US forest service's budget, by 2015 this was more

than 50% and is predicted to exceed 67% by 2025 (United States Department of Agriculture, 2015). The six worst fire seasons in the USA since 1960 with the most extreme fire behaviour and the most cost to manage have occurred since 2000. The main reasons for this are a rise in biomass accumulation, climate change and an increase in the number of homes built near forests (Gorte R, 2013).

The most common cause of natural fires in the northern hemispheres is lightning. For example, 94% of land burnt since 2001 in Alaska has been ignited by lightning (Doerr and Santin, 2013). Humans are also an important cause of wildfires in more populated areas. They are responsible for igniting over half of the fires in the lower 48 States of the USA (Doerr and Santin, 2013). In Europe 95% of wildfires are also caused by humans (San-Miguel-Ayanz, 2011). A Spanish study found that 83% of fires were human caused, and the severity and frequency is increasing due to climate change. These uncontrollable conditions may lead to citizens being discouraged from thinking about prevention policies (Allo and Loureiro, 2020). Globally, it is estimated that 1933 people were killed in wildfire events alone that have been classed as natural disasters between 1984 and 2013 (Doerr and Santin, 2013). This figure excludes many other wildfires and is therefore likely to be a substantial underestimation.

As well as the areas around the globe known for their wildfires there are also large areas burnt in countries not associated with having a wildfire problem. The Republic of Ireland has a very similar climate to Wales and a similar fire season. This is usually between March and June and corresponds with suitable weather and vegetation conditions (Schmuck et al., 2013) Recent estimates suggest that up to 75,000 hectares of land, mostly peatland has been burnt over in Ireland between 2010 and 2015 (Stracher, 2019).

1.1.4 Wildfires in the UK

The UK has a humid temperate climate that is not generally associated with wildfire. Nonetheless, wildfires do occur annually and can cause significant problems, especially in drought years. Surprisingly, however, awareness of this risk for organisations and the public is low at both national and international levels. A fire in the NE of England in April 2003 burned 5 square

kilometres of protected landscape with smoke causing the closure of major roads and disrupted air traffic at Manchester Airport, and as well as the cost to the economy of these closures, restoration work on the moorland alone cost £2 million (McMorrow, 2011).

Fires in the UK can occur at any time of the year, but generally occur in late winter and early spring with the peak months being April and May. This is due to the amount small diameter dead and dried vegetation which has cured. Curing is the process of the vegetation dying and drying out over time. This differs from many countries which have summer fire seasons. The majority of large UK fires involve bracken, heather and grasses on moorland in remote locations which are highly managed and used for hill farming, water catchment, grouse shooting and recreation. Forest fires that occur in the UK frequently originate from fires carried from other areas of high risk such as heath and grassland (Albertson et al., 2009).

There were on average 37,371 grass and heathland fires per year between 1986 and 1993 but this increased to an average of 60,332 a year between 1994 and 2005. There is little idea of the actual extent and impact of these wildfires (Davies et al., 2008). An analysis of the UK wide Incident recording system (IRS) used by Fire and Rescue services by the Forestry Commission shows there were 210,000 wildfires in the Great Britain between 2009 and 2013 - 65,000 of these were in 2011 and burnt an area of 71,000 hectares (Gazzard et al., 2016).

Responders in the UK, compared to countries such as Australia, New Zealand, Canada and the USA, have little formal knowledge of fire behaviour or general principles of wildfire management. Wildfires continue to play a significant role in the environment and can place considerable strain on Fire and Rescue Services (Davies et al., 2008). Research around the issues of wildfires in the UK has mainly focussed on the prescribed burning of upland moors for land management and the effects of vegetation recovery on post fire regeneration of heather moorlands (Davies et al., 2008; Harper et al., 2018).

During the middle of the last century the UK was at the forefront of research into wildfire behaviour and invested heavily in fire protection. The risk of fire associated with large areas of newly established plantations led to frequent crown fires. This had significant financial and ecological implications. The UK Forestry Commission's interest in forest fire has since largely died away as plantations have matured, reducing the risk of fire, and the value of timber has also declined. Although there is interest in fire in forestry in the UK, mostly from private foresters,

there has been little strategic direction to take the issue as seriously as it merits (Davies et al., 2008).

Since 2018 there have been four wildfires in the UK that have been declared ‘major incidents’. These were Saddleworth Moor fire, Greater Manchester, June 2018; Winter Hill fire, Lancashire, July 2018; Wareham Forest Fire, Dorset, May 2020, shown in Figure 1.2; and Chobham Common fire, August 2020.

Figure 1.2.Major fire incident at Wareham forest May 2020.

Photo credit - author

The definition of a ‘major incident’ in the UK as stated by the Joint Services Interoperability Programme (JESIP) (https://www.jesip.org.uk/definitions) is: An event or situation with a range of serious consequences which requires special arrangements to be implemented by one or more emergency responder agency. Within this definition:

1. *“Emergency responder agency” describes all category one and two responders as defined in the Civil Contingencies Act (2004) and associated guidance.*

2. *A major incident is beyond the scope of business-as-usual operations, and is likely to involve serious harm, damage, disruption or risk to human life or welfare, essential services, the environment or national security.*
3. *A major incident may involve a single-agency response, although it is more likely to require a multi-agency response, which may be in the form of multi-agency support to a lead responder.*
4. *The severity of the consequences associated with a major incident are likely to constrain or complicate the ability of responders to resource and manage the incident, although a major incident is unlikely to affect all responders equally.*

The decision to declare a 'major incident' will always be a judgement made in a specific local and operational context, and there are no precise and universal thresholds or triggers. Where Local Resilience Forums (LRF's) and responders have explored these criteria in the local context and ahead of time, decision makers will be better informed and more confident in making that judgement (https://www.jesip.org.uk/uploads/media/app/Jesip-web-version/major.html).

Further reiterating their present-day significance in the UK, the country had a large number of wildfires during the hot dry weather of 2018, with 79 fires meeting the National Operational guidance criteria over the year. And yet even this number was surpassed in early 2019, with 96 fires by April 23rd (World Bank Policy Note, 2020).

Looking into the immediate future, it has been identified that fire danger across the UK will increase with climate change as a result of predicted higher temperature and lower humidity, with the average number of danger days predicted to increase as much as 3-4 times by 2080 (Arnell et al., 2021). This will clearly result in more work needed to be done by emergency planners, prescribed burners and other agencies, and calls loudly for an improved understanding of current and future risk (Arnell et al., 2021).

1.1.5 Wildfires in South Wales

In South Wales, there were over 55,000 recorded grassfires and nearly 550 forest fires between 2000 and 2008, which is eight times more per unit area than in the UK as a whole (Corcoran et al.,

2007). Between 2009 and 2020 there were a further 21,900 vegetation fires, of which 456 were forest fires (SWFRS stats dept. 2020).

The South Wales Valleys (also known as the South Wales coalfields) is an area north of the cities of Swansea, Newport and Cardiff and south of the Brecon Beacons. It is covered by both Mid and West Wales Fire and Rescue Service and South Wales Fire and Rescue Service, with the border between the two services running from Maesteg in the north to Bridgend in the south. This area has a particularly high number of wildfires but have been very little researched. What has been carried out has been in relation to arsonists and their behaviour and not about the ecological effects of the fires (Jollands et al., 2011). This reflects the fact that 95.8% of these fires are ignited deliberately, as shown in Figure 1.3 (South Wales Fire and Rescue Service statistics, 2020).

Whilst most wildfires in the UK occur on land managed for commercial activities such as shooting and sheep farming, a large proportion of the land in the South Wales Valleys is no longer managed for these purposes and has become overgrown and unmanaged with absent landlords. This build-up of vegetation has the potential to raise the fire risk. The areas with the most fires are shown in the heat map, Figure 1.4.

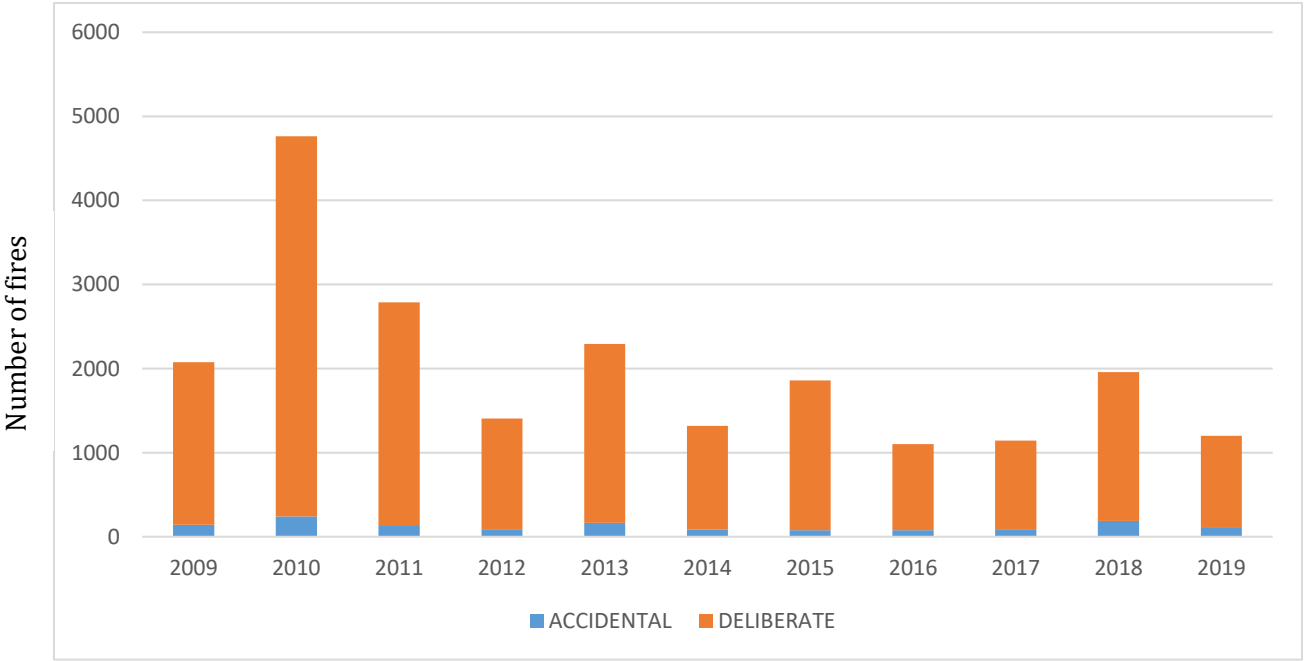

Figure 1.3. Wildfires in South Wales between 2009 and 2019 (SWFRS statistics dept. 2020.)

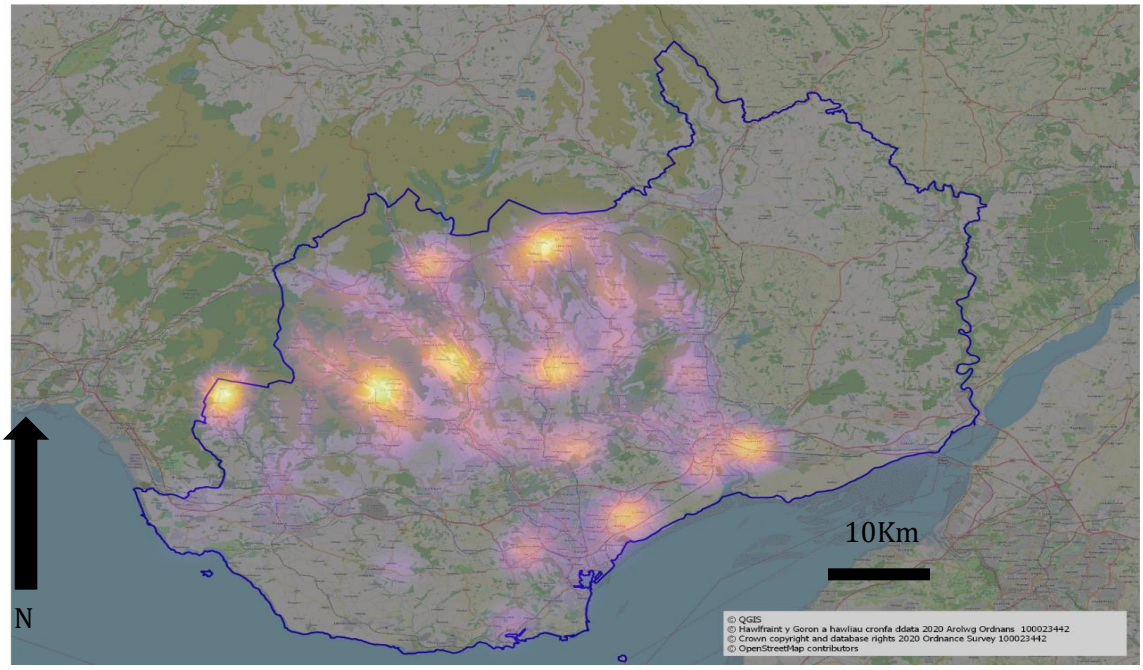

Figure 1.4. Heat map showing the areas of South Wales with the most wildfire 2009-2019. The lighter areas show the most wildfire activity. The Blue outline shows the boundary of South Wales Fire and Rescue Service (SWFRS Stats Dept.2020.)

As seen in Table 1.1, there are many property descriptions of where wildfires occur. The fires which burn the most area of land occur on open moorland where the continuity of vegetation allows the fire to grow unhindered, whilst the longest duration fires generally involve forestry areas and tree harvesting waste known as brash. These slow burning deep seated fires take a considerable amount of effort and resources to extinguish. Due to the locations of these types of fire there is generally little involvement with the public and property apart from the smoke. The highest risk to life and property generally involves smaller areas of land which are unmanaged and overgrown with bracken, here the fires can travel very quickly through the dead fine fuels.

Table 1.1 Wildfires in South Wales by vegetation type 2009-2019 (SWFRS statistics dept 2020.)

Property description	INCIDENT NUMBER
Grassland, pasture, grazing etc	7358
Scrub land	6914
Tree scrub (includes single trees not in garden)	1936
Heathland or moorland	1784
Roadside vegetation	1264
Private/domestic garden/allotment (vegetation not equipment/building)	708
Woodland/forest - conifers/softwood	456
Hedge	296
Railway trackside vegetation	295
Canal/riverbank vegetation	292
Straw/stubble burning	244
Woodland/forest - broadleaf/hardwood	146
Stacked/baled crop (incl. manure heap)	128
Standing crop	74
Nurseries, market garden	5
Grand Total	**21900**

Figure 1.5 shows the damage caused by a one hectare fire in the South Wales valleys. The fire was ignited at the bottom of a slope and travelled uphill towards property. Luckily firefighters were able to extinguish the fire and only the garden fences were damaged.

Figure 1.5 Fire damage to perimeter fences. Photo credit South Wales Fire and Rescue Service.

An emerging risk that is not widely recognised is associated with the historical coal tips which were created throughout the South Wales Valleys, a legacy from deep coal mining. As these tips have become overgrown with grass and trees they have become a wildfire risk. Large areas have also been planted with gorse (ulex) to stabilise the land but is also highly flammable. Two of these tips which have been recently burnt by wildfires have subsequently experienced land slips, potentially associated with loss of protective vegetation. A recent reclassification saw almost 300 tips classed as high risk but their locations have not yet been released by the Welsh government (BBC News, 2021).

1.2 Perceptions of wildfire

1.2.1 Global perceptions of wildfire

The move by human populations from the countryside, where fire use was familiar, to living in cities, where fire has been constrained, has been termed 'the pyric transition' (Pyne, 2001). This has led to the demonisation of fire, despite the fact that many types of vegetation and ecosystems need fire in order to survive (Scott et al., 2014). Wildfire is increasingly seen on the news and the emphasis of many of these reports is that fire is bad and should be fully eradicated (Scott et al., 2016).

From Aboriginal Australians to Native Americans, historical practices the world over have included the use of fire to manage ecosystems and to promote the growth of desirable species. However, as societies have become more sophisticated, the use of fire was seen as a regression to the peasant classes, leading to fire suppression becoming the norm (Minor and Boyce, 2017). This trend was supported by the majority of modern foresters who had been trained at forestry schools where the curriculum was heavily influenced by German forest practices. These opposed the use of any fire within forestry and was also consistent with conservationist view of the progressive era where fire was viewed as another force of nature to be tamed (Donovan and Brown, 2007). Nowhere has this shift been greater than in the USA where people have been educated to believe that fire is always bad. The 'Smokey Bear' campaign initiated in the 1950s for wildfire prevention represents the longest-standing and most successful government advertising and branding campaign in U.S. history. It is still used today in a revised form and has effectively reinforced the attitudes that fire is bad (Donovan and Brown, 2007).

In general, the public and policy makers today have a largely negative perception of fire and nearly every fire is extinguished as soon as possible. Therefore, fires do not have the opportunity to clear some of the vegetation, which results in excessive fuel accumulation, which in turn can lead to more severe and extensive fires in the future. This negative perception of fire can certainly hinder the use of prescribed burning, with the same effect on the risk of future fire. Arguably, the public need to be educated to look beyond the short term impacts of smoke and risk of escape from prescribed and managed wildfires so that they support its use and the future benefits (North et al., 2015). Certainly, however, the issues of wildfire and fuel management are very complex and public

opinion can have a significant influence on decision making about fire and fire use (Carrol et al., 2021).

Focusing on the challenge to counter this overall negative perception of fire, it should be noted that direct personal experience of wildfire is not necessary for long-term acceptability of management actions such as prescribed burning. Many who had not been directly affected by a wildfire felt prescribed burning was highly acceptable (Mylek and Schirmer, 2020). The length of time since experience of wildfire did not predict acceptability of prescribed burning, suggesting a significant wildfire in a different region or even a different country being reported in the media may be sufficient to maintain attention and support for prescribed burning over a period of time, rather than requiring personal experience or recent exposure to that wildfire (Mylek and Schirmer, 2020). Results showed that households on average were willing to support new fire prevention policies, although households who believed they were paying too many taxes did not support prevention programs (Allo and Loureiro, 2020).

Attention must also be paid to the likely wildfire consequences of landscape changes too. The planting of trees, reducing deforestation and major reforesting campaigns are being seen as the saviour of a host of problems including climate change, water shortages, flood alleviation and general wellbeing (Holl and Brancalion, 2020). Forests have traditionally been viewed as robust carbon sinks. However, extreme heat waves, drought and wildfire have increased tree morality especially in semi-arid regions which account for 41% of the Earth's land surface. In experimental work in California, grasslands have been shown to be a more resilient carbon sink in response to 21st century climate change than some forests (Dass et al., 2018). Grassland environments face a number of threats, including land use change, climate change and encroachment of woody plants which threaten traditional agricultural grazing economies and grassland dependant wildlife species. Prescribed fire has long been used in many regions around the world to maintain grasslands. It is both ecologically and economically one of the most effective tools for maintaining grasslands. However, in the U.S.A many landowners do not use this tool due to lack of knowledge, lack of resources and concerns over safety and legal liability, although research found that belonging to a prescribed burn association and owning larger properties were correlated with increase in fire use (Stroman et al., 2020). The public would need to be informed for the reasons for keeping the open grassland within the current climate of tree planting to halt climate change.

Public perception research has identified that participants, when provided with ecosystem and fire regime information for the area in the study, are more informed about their actual level of risk and make more informed decisions. Information on fire regimes can be integrated into outreach and education programmes so fire management decisions are accepted (Dupey and Smith 2018). For example, a lack of public understanding was found in Argentina, where highly flammable pine invasion was scarcely perceived as a decrease in the conservation level of the protected area (Pissolito et al., 2020). This shows how particularly widespread and familiar invasive species such as pine percolate into public perception of what is natural. Management actions from such a state of understanding need to consider the possibility of mixed public reactions and be accompanied by environmental education programs. Visitor management strategies should aim to inform people through education programs, interpretative trails and signage, as well as encouraging longer visits and activities that promote direct contact with forests at different conservation levels (Pissolito et al., 2020).

Research on perceptions and behaviours related to prescribed burning and wildfire in the United States found that out of 74 publications that met the research criteria, fire professionals had largely been overlooked in social science work on prescribed burning and wildfire (Dupey and Smith, 2018). The review revealed that only 6% of the research conducted had focused on fire professionals. It was found that interviewing fire professionals during fire season may not be as feasible as interviewing home owners. However, since these individuals are at the front of fire management understanding their perceptions and decision making strategies could provide a number of benefits to policy makers and the social science community (Dupey and Smith, 2018).

Communities in Ireland have traditionally used fire to achieve specific land management goals. Unlike England and Scotland, where most burning has been associated with grouse moor management, Irish land managers like their Welsh counterparts have used fire to improve forage for cattle and sheep. Yet, their use of fire as a management tool has become increasingly controversial (Carrol et al., 2021). These difficulties are mirrored in many other countries where environmental concerns and risk perceptions restrict social licence to conduct historic land management practices and result in significant vegetation build-up (Carrol et al., 2021). Wildfire in Ireland is seen as a transient, low human risk issue, with multiple and conflicting stakeholder involvement with no central authority to lead or coordinate responses. In effect wildfires are

nobody's problem, until they are everybody's problem. Arising from these conditions, Irish firefighting services are poorly configured and equipped to deal with wildfire issues. This is largely due to the transient and episodic nature of the issue and a resulting poor evidence base that limits policy responses and preparedness and precludes meaningful strategic responses (Stracher, 2019).

It is generally understood that firefighters fight and extinguish wildfires and prescribed burn managers use fire to remove vegetation under a prescription for various reasons. It is interesting that a study in Portugal found that a non-fire expert who lives next to a plot that had burnt stated, when interviewed, that he could not understand why the fire service had not left the plot to burn to reduce future risk (Van der Wal, 2017). There could be a particular reason why firefighters fought the fire and did not leave it to burn the plot, but this does pose interesting questions about the cross over between managing fuel and fighting wildfires.

1.2.2 Perceptions of wildfire in the UK

Awareness of the wildfire risk in the UK is low at both national and international levels (McMorrow, 2011). This lack of awareness, lack of research and the problem becoming oversimplified by the mainstream media means there is plenty of influence from non-specialists with strong opinions (Davies et al., 2016). In countries with a fire history, there is increasing realisation of the need to understand fire and to plan ahead. However, in other countries where fire is not common this is not so. In England, Surrey is one of the most forested areas and changing climate may increase the risk of catastrophic fire beyond small yet important fires. There is little appreciation of this potential risk by the local population and the potential impact that a major wildfire would have (Scott et al., 2016).

There are also deeply divided opinions around prescribed fire use and the damage that wildfires cause. An example of this is given in a BBC news article from July 2018 (Chadwick, 2018):

> "An almost unprecedented dry spell had combined with an abundance of long heather to create the perfect conditions for the fire to spread, said Rob Marrs, Professor of Applied Biology at Liverpool University. Prof. Marrs added the fire would not have spread as easily, and would have been less likely to have penetrated the peat beneath, if the dry scrub and heather had been

managed by occasional burning. He said: United Utilities and the Royal Society for the Protection of Birds (RSPB) didn't think a big fire like this would happen to them but I've been predicting this for 15 years. Leaving the land alone causes much more damage than controlled burning because there's more heather to burn so it gets hotter and spreads to the peat, which in turn spreads the fire. It wasn't a matter of if, but when, and that when is now.

Another advocate of controlled burning, Claire Belcher, Professor at Exeter University, said leaving heather to grow on the moors provided fuel for any fire to quickly take hold. She said: We don't think of the UK as having a flammable ecosystem, but actually heather and gorse have a lot of oils in them that mean they burn very hot and radiate that heat into the peat below. Controlled burning does far less damage to habitats to fires on this scale. The peat under the burning heather is one of the valuable natural resources the fire crews are working to protect. It is made of plant matter compacted over thousands of years and protected from decay by lack of oxygen. However, once lit it can burn for months. During the prolonged drought of 1976, thousands of acres of Yorkshire moorland were destroyed by a peat fire which took a year to fully extinguish. Peat's ability to trap carbon is regarded by many as beneficial to the wider environment as it reduces the likelihood of the carbon entering the atmosphere as emissions. The RSPB said this was a primary reason why it did not carry out controlled burning, as it believed doing so would reduce the moorland's ability to store carbon. It said it was committed to preserving important natural habitats for birdlife including owls, grouse and peregrine falcons."

The above article shows the differences in opinion when it comes to managing vegetation on peatland. Peat accounts for 51% of the carbon content of soils in Britain and much of the peat erosion can be traced to either fires or exceptional downpours so it is important it is protected. (Albertson et al., 2009). There are two main concerns. One is that if the vegetation is not managed then the resulting wildfires will burn into the peat. The other is that the use of prescribed fire will result in carbon release and accidental fires if the prescribed burns get out of control. Yet it needs to be realised that through prescribed burning we can manipulate the fire regimes of the British uplands to manage the threat and impact of wildfires (Davies et al., 2008).

Most moorland in the UK is highly flammable which has favoured the use of fire as a management tool (Davies et al., 2016). The use of prescribed fire is mostly associated with heather burning for driven grouse shooting on private estates. This fact and the confusion of the general public and media between prescribed burning and wildfires has caused a bias of anti-burning sentiment in the UK. Because of this, completing much needed research is problematic and land managers are less inclined to collaborate when the prevailing public perception of fire is negative and they view scientists as having an agenda. It is important that the effects of carefully managed prescribed burns are separated from the outcomes of severe wildfires, where under drought conditions, wildfires can ignite peat layers causing smouldering peat fires and large emissions of carbon to the atmosphere (Davies et al., 2016). Wildfires may cover large areas and burn with high intensity and severity, sometimes consuming all the above-ground fuel load and significant amounts of underlying peat. Prescribed burning aims to achieve 'light' fire severity, whereby surface litter, mosses and shrubs are charred or consumed, but the soil organic layer remains largely intact. There is some evidence from models based on European forests that prescribed burning could reduce the area of wildfires, through reduced fuel load and creation of fire breaks. Research shows that on average 0.68% of moorland in the UK is burned each year with individual moors burning on average between 0.04% and 3.8% (Allen et al., 2016).

Prescribed fire use is thus a key tool and rather than discussing the banning of the tool it would be better to include technical training in fire use, certification for fire users, explicit integration of knowledge regarding relationships between fire behaviour and fire effects and an increased emphasis on monitoring and compliance. Such changes would be a first step to facilitating more precise and targeted fire use that maximizes benefits, minimizes detrimental environmental impacts and builds trust between stakeholders (Davies et al., 2016). Yet, while many countries have shifted to include science and locally-based evidence around fire use for land management, public debates in the UK and Ireland have shifted towards banning fire (Davies et al., 2016).

1.2.3 Perceptions of wildfire in South Wales

There have been only two previous studies carried out within South Wales including community and institutional stakeholders around the perceptions of wildfires. 1,000 residents of South Wales were surveyed about wildfires and related issues by Jollands et al. (2011). The results revealed that there was low public awareness of wildfires, with most people not recognising them as posing a problem to themselves or their communities. Only 33% of community respondents believed that South Wales has a problem with wildfires. Some 65% of community respondents believed that fires were deliberate but this did not translate into them perceiving wildfires as being an important issue. Young people and landowners/managers were perceived to be responsible for deliberate fire setting, but more research is called for as the evidence was largely anecdotal (Jollands et al., 2011).

Recent research focused on the perceptions of wildfires was conducted within the Brecon Beacons National Park (BBNP) (Pope, 2016). This involved a questionnaire with 178 responses: 148 from the public and 30 from the local farming community. 57% of responders had seen a wildfire and 57% of these fires were in Wales, with the 'Valleys' (the area where most fires occur in South Wales) being the most mentioned location. 59% of the public responders and 100% of the farmers agreed with the use of prescribed burning within the BBNP, although surprisingly one farmer out of 30 had not heard of it. The majority also believed that wildfires would become more frequent within the next century. When asked for negative comments regarding prescribed burning, the responders' most popular comment was 'wildlife', mentioned 50 times (Pope, 2016). The study reports that there has been dissolved organic carbon and peat sediment found in reservoirs which was due to poor catchment management, including over grazing and unsatisfactory managed burns leading to Welsh Water investing two million pounds of funding to investigate catchment management (Pope, 2016). No mention was made of the wildfires that burn within the park also being an issue.

The issue of stakeholder's not perceiving wildfires as important has begun to be addressed by the creation of an all Wales arson strategy, now in its fourth edition (Wales's Arson Strategy 4, Joint Arson Group, 2019). One of the reasons of low public perception of the risk from wildfires in this region, and across the UK in general, may be that very little property gets damaged by wildfires and areas of land burnt recover very quickly, unlike other countries where the scars from wildfires

can remain for many years. Figures 1.6 – 1.9 depict how quickly the vegetation in South Wales can return after a wildfire, in this case over a five-month period. The fuel loading from the dead bracken will not be enough after the first year for severe fires but the area will be available to burn if ignition occurs.

Figure 1.6 Wildfire in the Rhondda valley 29th May 2020. Photo credit – author.

Figure 1.7 .Photo of same area taken 20th June 2020. Photo credit – author.

Figure 1.8. Photo of same area taken 8th August 2020 showing the regrowth on the fire affected slope. Photo credit – author.

Figure 1.9.Photo showing the same area taken 20th October 2020 showing dead bracken now available to burn in the next fire season. Photo credit author.

1.3 Fire management

1.3.1 Fire management around the world

Fighting wildfires has become a global business with multimillion dollar contracts for aerial assets used on a year-round basis following the fire seasons from the northern to southern hemispheres. Climate change and excessive vegetation accumulation has made the efforts to fight every fire dangerous and expensive (North et al., 2015).

One of the reasons for vegetation accumulation is that fire managers have moved away from the prevention work of removing vegetation which was traditionally removed by using fire, to a response role. This has been the case particularly in the USA where the Smokey the Bear campaign has resulted in all fire, whether prescribed or wildfire, perceived as bad. The message that fire can be sometimes good / sometimes bad was considered too complicated for the general public to understand, so all fire was vilified (Donovan and Brown, 2007). Another reason for this vegetation build-up has been aggressive fire management policies, such as the U.S. Forest Service's '10 a.m.

Policy' introduced in 1935, which stated that all fires must be under control by 10 a.m. the following morning. If not, more resources would be called upon every day until the fire was under control (Donovan and Brown, 2007).

This policy of extinguishing all fire without questioning any ecological or prevention effects in the USA has led to a build-up of vegetation, with resulting wildfires very difficult to extinguish. Even following recent 'mega-fires', which are often defined according to their size and intensity but are more accurately described by their socioeconomic impacts (Stephens et al., 2014), the Smokey the Bear campaign has not really changed its fire prevention message. Nonetheless, a number of federal and state management agencies have changed policies to use prescribed fire and have 'let burn' policies in wilderness and remote areas, both of which help in removing excessive vegetation build-up. The U.S. Forest Service have also made one small change to Smokey's message: in 2001, Smokey's tagline was edited from "Only you can prevent forest fires" to say "Only you can prevent wildfires", reflecting the agency's change in management practices (Minor and Boyce, 2017).

The policies of extinguishing all fires is slowly changing, but this is a very slow process due to lack of coordinated policy and the actual wildfire response in the USA has changed little. Only 0.4% of fires have been allowed to burn as managed wildfires. Policies are difficult to develop because of ongoing issues of public perception of wildfire and objections to smoke (North et al., 2015).

A recent World Bank Policy Note on managing wildfires in a changing climate (World Bank, 2020) identified that governments around the world appear prepared to fund firefighting equipment and resources to try to supress fire but not risk reduction through prescribed burning. It is argued that resources need to be focused on long term and sustainable solutions by integrating fire management into land management. There is now an ongoing effort in the USA to have a National Cohesive Wildland Fire Management Strategy by Federal, tribal, state, local governments and non-government organisations to address growing wildfire challenges. The vision of this cohesive strategy is: to safely and effectively extinguish fire when needed; to use fire where allowable; to manage our natural resources; and, as a Nation, to live with wildland fire (Appendix 1).

1.3.2 Fire management in the UK

The UK has no specific agency which just fight wildfires. This role is carried out by the Fire and Rescue Service (FRS), who also deal with all other fire and rescue activities as laid down in the Fire and Rescue Services Act (2004). There are 45 services in England, three in Wales and one each in Scotland and Northern Ireland. Each is governed and funded by a Fire Authority. This service is free at the point of delivery. Fire and Rescue Services are generally equipped and trained to deal with structural fires and rescues and few have access to all terrain vehicles and specific wildfire equipment. Wildfire firefighting approaches are very similar to those in the US where every fire is extinguished as soon as possible.

Due to a comparatively wet climate the number of incidents in the UK can be highly variable and unpredictable, which leads to three problems (McMorrow, 2011):

- Resources are stretched during dry periods.
- Preparedness for wildfire is generally low, firefighters are inexperienced and it is difficult for FRS's to maintain alertness and resources.
- Wet years with little fire activity, which can appear in statistics as show success in reducing fires, lead to a vegetation accumulation heightening future risk.

There is very little prevention work carried out by FRS's, with only a few services carrying out a small number of prescribed burns to assist and educate affected groups such as landowners / managers and gamekeepers.

Land managers use prescribed burning themselves, but this is mostly for grouse moor management and pasture regeneration and not usually to manage the risk of future fires. Restrictions on burning and the current lower livestock grazing densities are allowing vegetation accumulations to become very high, increasing the risk of severe wildfires (McMorrow, 2011).

A recent study of Irish farmers who have been using fire to manage vegetation for sheep habitat for generations has found that restrictions in burning and lower sheep densities has resulted in succulent vegetation being outcompeted by woody vegetation. This has made future burning more important and also more difficult to carry out safely (Carrol et al., 2021). The study found that the reduction in the length of the burning season has reduced opportunities to burn and increased fire

risk. It was also noted that when farmers could not burn due to legislation they were more likely to set a fire and leave, which could result in a wildfire and not a managed burn. The conclusion of this study found that there are generations of skilled prescribed burners who could work closely with fire and rescue services and land management agencies to bring old and new skills together (Carrol et al., 2021).

Prescribed burning in the UK is covered by legislation with each country having its own dates when burning is permitted, this can take place in autumn and winter but typically falls into February and March when the ground is wet, but the dead vegetation may be dry enough to carry a fire (McMorrow et al., 2009). The dates for prescribed burning are shown in Table 1.2.

Table 1.2. Prescribed burning dates for lowlands and uplands UK- DEFRA

Country	Lowlands	Uplands	Legislation	Code
England	1st November – 31st March	1st October - 15th April	The heather and grass burning code regulations 2007 (England)	The heather and grass burning code (Defra 2007)
Wales	1st October – 15th March	1st October- 31st March	The heather and grass burning code regulations (Wales) 2008	The heather and grass burning code for Wales (Welsh Assembly Government 2008)
Scotland	1st October – 30th April	1st October – 30th April	Hill Farming act 1946	Muirburn code (SEERAD,2001)
Northern Ireland	1st October - 14th April	1st October – 14th April	Game Preservation Act (Northern Ireland) 1928	The heather and grass burning code (Defra 2007)

The Countryside and Rights of Way Act 2000 (CRoW Act) gives a public right of access to land mapped as open country (mountain, moor, heath and down) or registered common land in England and Wales. These areas are known as 'open access land'. The CRoW Act gives relevant authorities the right to restrict public access where they are satisfied that, "by reason of exceptional conditions of weather or any exceptional change in the condition of the land, the exclusion or restriction is

necessary for the purposes of fire prevention". CROW, Part 1, chapter 2, section 25 states the following:

> ***Avoidance of risk of fire or of danger to the public***
>
> *(1) The relevant authority may by direction exclude or restrict access by virtue of section 2(1) in relation to any land during a specified period if the authority are satisfied—*
>
> *(a) that, by reason of any exceptional conditions of weather or any exceptional change in the condition of the land, the exclusion or restriction under this section of access to the land by virtue of section 2(1) to the extent provided by the direction is necessary for the purpose of fire prevention, or*
>
> *(b) That, by reason of anything done, or proposed to be done, on the land or on adjacent land, the exclusion or restriction under this section of access to the land by virtue of section 2(1) to the extent provided by the direction is necessary for the purpose of avoiding danger to the public.*

Relevant authorities are those that manage open access rights in England, and include Natural England and the Forestry Commission; in Wales this is Natural Resources Wales (NRW).

A Fire Severity Index (FSI) was developed by the Met Office to give an objective methodology to determine when exceptional conditions occur to justify the closure of open-access land. The FSI assesses the risk of fire in any particular area, as determined by a combination of ground and weather conditions. It provides an assessment (for the current day and a 5-day forecast) based on wind speed, temperature, time of year and rainfall (FSI; Met Office, 2003).

1.3.3 Fire management in South Wales

All fires in South Wales, whether on public or privately-owned land, are fought by South Wales Fire and Rescue Service, with no other agencies engaged in firefighting. Traditionally, fires on National Resources Wales's (formerly Forestry Commission) land were fought by both fire service and forestry workers, with the forestry staff taking responsibility for ensuring no re-ignitions once fires were extinguished. The practice of forestry workers attending and assisting with extinguishing fires ceased in 2008 and the Forestry Commission sold off their firefighting assets.

The reasons for this change were that staff were not trained in firefighting, so this was an area of high risk and Fire and Rescue Service Act 2004 clearly stated that Fire Rescue Service (FRS) were the responders to fires and there was not a need to duplicate resources (Gazzard et al., 2016).

Traditionally there was little strategic planning involved in the majority of attempts to mitigate wildfires (Jollands et al., 2011). Fires were fought by firefighters wearing personal protective equipment, and using appliances and equipment designed for structural fires. The only piece of equipment specifically for fighting wildfires were fire beaters, which consist of a long wooden, metal or composite handle with a square of rubber attached which is used to beat out small flames, shown in Figure 1.10.

Attending fires puts a massive strain on the resources of the fire service, taking fire crews out of the communities they serve and make them unavailable to attend other emergencies (Jollands et al., 2011). The fire service attend thousands of vegetation fires every year, varying in size from very small to hundreds of hectares. There is the perception that fires are burning larger areas but this is difficult to prove due to the lack of accurate data. One of the reasons for allegedly larger areas being burnt is the increase in vegetation as there is a lack of grazing animals due to changes to the Common Agricultural Policy (Davies et al., 2008).

Figure 1.10. Fire beater used to extinguish small flames at wildfire incidents

Photo credit- author

Easter 2003 was a particularly intense year for firefighters in Wales, with the warm dry weather resulting in major fires. South Wales Fire and Rescue Service received 2500 calls and attended over 300 fires during the first 24 hours of the Bank Holiday. Mid and West Wales FRS received 500 calls on Good Friday and were forced to evacuate residents as flames almost reached homes. North Wales firefighters spent two days fighting a fire in the Arrenig Mountain where strong winds fanned a fire which was 10 miles long (BBC, 2003). Because of the strain these very busy fire seasons were putting on crews and the risk to the community, South Wales Fire and Rescue service initiated two projects - the 'Bernie Project' which focused on reducing deliberate ignitions given that 95.8% of fires in South Wales are ignited deliberately (Peatie and Ansell, 2009; SWFRS, 2017) and the 'Wildfire Project' (ITV, 2012) which focused on operational aspects such as training and equipment for firefighters. Because of this latter project SWFRS, have now developed new methods to deal with wildfires using better equipment and techniques (Appendix 6).

1.4 New methods of fire management in South Wales

As education and prevention work has been carried out within communities, deliberate ignitions have reduced from 4903 in 2010 to 2485 in 2019, although subsequent fires have become longer in duration and more difficult to extinguish (SWFRS statistics).

Since 2009, SWFRS firefighters have received structured training in how to deal with wildfires (Appendix 6). This has included firefighter safety, navigation and fire prediction. This training has been complemented by all-terrain vehicles (ATVs), lightweight personal protective equipment and specific wildfire equipment such as fire fogging units, which utilise very little water, and leaf blowers. Since 2011 SWFRS have also been developing a vegetation management strategy. It is based on the principle that the more effectively ignitions are reduced, the bigger the future risk to communities will become due to fuel build-up. Given that it is not possible to totally control the arsonists, or to control the weather, the focus needs to be on the management of this fuel build-up.

There are three main ways to manage vegetation to reduce the spread of wildfires within South Wales. These are prescribed burning, mowing /mulching and grazing.

1.4.1 Prescribed burning

South Wales Fire and Rescue Service began prescribed burning to assist the Brecon Beacon National Park with their burning in 2011.This was always difficult to achieve as arranging the burning has to be very ad hoc due to the unpredictable and rapidly changing weather. SWFRS started their own programme in 2015 after burning a strip fire break of 800 m length along a mountain top. This fire break subsequently stopped a wildfire entering a forested area, shown in Figure 1.11.

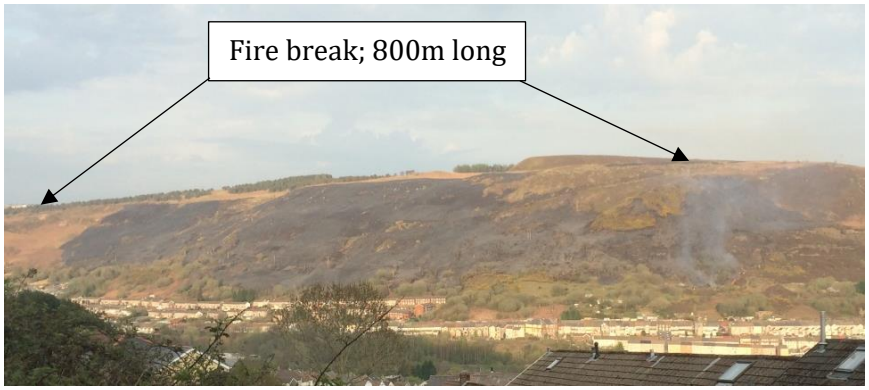

Figure 1.11. The straight line at the top of the burnt area is where the wildfire was extinguished by a previously burnt fire break. Photo credit author.

This programme has seen firefighting crews from four fire stations and officers (over 135 personnel) trained in prescribed burning techniques and provided with equipment to carry out this task. However, given that producing fire breaks by using fire is regulated by the 'grass and heather burning code Wales' there is often very little opportunity due to wet weather during this period. Another outcome of this training is that firefighters are now able to 'fight fire with fire' and stop wildfires using these techniques. 'Fighting fire with fire' or tactical burning is a method of removing vegetation from the path of a wildfire using fire.

The definition of an operational (tactical) burn from the European Wildfire Glossary cited in Stacey (2012) is;

A controlled supervised burn which is carried out by a burn team as part of a fire suppression plan. An operational burn can be classified as either offensive or defensive, depending upon its purpose:

*• **Offensive operational burn** – ignited along a control line to burn into an advancing flame front.*

*• **Defensive operational burn** – ignited along a control line to strengthen/expand the control line, but will be extinguished prior to the arrival of an advancing wildfire.*

Where land managers generally burn areas, the fire service can assist by burning strips to break up continuous vegetation, as seen in Figure 1.12.

Figure 1.12. South Wales Fire and Rescue Service - one of their first prescribed burns to create a fire break.

Photo credit - Hazel Nash Photography.

Prescribed burning in Wales is regulated by the 'heather and grass burning code 2008'. This allows for the burning of vegetation between set times:

- 1 October - 31 March in upland areas (defined as land in the severely Disadvantaged Area of the Less Favoured Area 3)
- 1 November - 15 March elsewhere.

These dates are set in place to protect ground nesting birds during the breeding season.

The process of carrying out a prescribed burn is not as complex as one might imagine. Once an area has been identified as being at risk from fire, a fire crew who are trained to carry out prescribed burning will visit the site and make a plan on how to reduce the fuel load. Once the plan has been made the crew will attend and carry out the prescribed burn. The burn crew consists of five firefighters. The officer in charge takes on the role of Burn Boss - who has overall command of the burning activities. Two firefighters take the roles of the ignition crew - it is their role to light

the fire in line with the Burn Boss' plan. A further two firefighters act as the suppression crew who extinguish the fire once the objectives are met. The exertion rate at a prescribed burn is nowhere near that of a wildfire, the burn team work slowly and steadily and walk the fire across the landscape using the slopes and wind in their favour.

The photos below show the process of a prescribed burn to protect a new forest plantation:

Figure 1.12 shows the site on arrival, vegetation spreads from the valley below on the left which is separated by a narrow track which could easily be crossed by a wildfire, then more vegetation on the right with new trees.

Figure 1.13 shows the trees which have not yet grown enough to shade out the fine fuels.

Figure 1.14 shows the process of the prescribed burn with small manageable flames being moved across the vegetation by firefighters using drip torches.

Figure 1.15 shows the fine fuels removed to make a fire break before the track to stop wildfires from the valley below

Figure 1.16 is an aerial view showing the newly created fire break and plantation.

Figure 1.13

Figure 1.14

Figure 1.15

Figure 1.16

Figure 1.17

Figures 1.13 to 1.17 showing the process and equipment for carrying out a prescribed burn. Newly planted trees are seen which are protected from fires burning up the valley sides. Photo credit – author.

1.4.2 Mowing /mulching

This method of reducing fuel involves cutting or swiping. As an alternative to burning, it is not subject to the same statutory restricted periods as burning. However, a breach of the Statutory Management Requirements 'Conservation of wild birds' and an offence under Part 1 of the Wildlife and Countryside Act (1981) would be committed if cutting or swiping intentionally resulted in: the death or injury of wild birds or their nests; or the intentional or reckless disturbance of Schedule 1 birds while nest building or at or near a nest with eggs or young. For this reason, cutting or swiping should not be carried out during the nesting season or when ground-nesting birds are known to be present. The use of cutting machinery on a Site of Special Scientific Interest (SSSI) may also be an offence if the use of vehicles has been identified as an operation likely to damage and consent for their use has not been given (Gov.wales, 2008).

Mechanical cutting is either done by using hand tools such as brush cutters, which is very labour intensive, or by wheeled or tracked machines, which sometimes struggle on the steep terrain. It is currently not known how the use of mulching equipment compares to prescribed burning in terms of its potential long-term environmental impact. South Wales Fire and Rescue Service have used a cutter each winter and spring since 2017 to create fire breaks, shown in Figure 1.18.

Figure 1.18 SWFRS cutting a fire break to protect fencing above the Rhondda valley, the difference between grazed and ungrazed land is clear to see. Photo credit- author.

1.4.3 Grazing

Following the introduction of the Common Agricultural Policy (CAP) in 1962, farmers were paid a subsidy per head of animal. This lasted until 2003 when the single payment scheme (SPS) was agreed by the European Commission and introduced in April 2005. The introduction of this scheme saw the biggest change in farming subsidies since the 1960s, with stopping of headage payments for breeding ewes and the introduction of land-based subsidies paid per hectare. There was no specific requirement to keep stock on the land and payments would be made as long as the land was in good environmental and agricultural condition (WAG, 2005). This has led to a reduction in the number of grazing livestock (particularly sheep) and a reduction in the grazing of uncultivated areas such as common land (Davies et al., 2008). Approximately 8.4% of the land area in Wales is registered as common land, covering around 175,000 ha (Law Wales-common-land) and this legislation has therefore led to an increase in the amount of vegetation which can burn. The

vegetation composition has also started to change from a variety of different grasses and heaths to predominantly bracken (*Pteridium aquilinum*) and purple moor grass (*Molinia caerulea*). Bracken is a particularly invasive plant and very difficult to control (National Biodiversity Network, 2005).

Even though grazing animals do not consume bracken they disturb it by breaking fronds when moving through it. They do graze brambles and grasses growing amongst it, which breaks up the continuous vegetation and can create fire breaks. Once livestock has been removed and bracken takes over then it is very hard to re-establish grazing, partly due to its allelopathic properties, hindering the growth of other plants (National Biodiversity Network, 2005). Dry dead bracken is also a fire risk and bracken proliferation has other negative implications, such as overhanging fronds bringing people into contact with sheep ticks (National Biodiversity Network, 2005).

South Wales Fire and Rescue Service are part of the healthy Hillsides project which hopes to reintroduce grazing at certain sites to reduce vegetation and reduce wildfire risk (Healthy Hillsides, 2017).

1.4.4 Effectiveness of prepared fire breaks

The rationale for managing fuel is clear. Once a fire is ignited the behaviour is determined by the weather, topography and fuels. Pre-emptive management actions to mitigate the negative consequences of fire are restricted to fuels (Fernandes and Botelho, 2003). There has been a lot of media debate in the USA and Australian press (Foley, 2020) regarding the effectiveness of prepared fire breaks regardless of how they are made. This has led to a perception by some that they do not work and that more money should be put into fire response not prevention (Underwood, 2009). An example of this from a Parliament of Australia report states that: "*New South Wales National Parks and Wildlife Service has spent $9 million since 1994 on upgrading and buying fire management equipment. How much was spent over that time on its fuel reduction burning program? Dr Cheney commented to the Inquiry that land management agencies must be adequately funded to do both their own fire protection and their own fuel management*" (McCormick, 2002).

Every wildfire will be different due to weather conditions and fuel moisture. A fire break which will easily stop a fire in low severity fire weather days could easily be overrun on days of high fire

weather severity. Fuel reduction burns may not halt fires under severe conditions. However, they do have some moderating effect on the fire and allow for control when conditions improve (McCormick, 2002). Fire breaks should therefore not be regarded as a static defence to be made and then forgotten. It is vitally important that fire break locations are known by firefighters and treated as a tool in the toolbox where a host of techniques can be used to make them effective at stopping fires. Firebreaks can be used as anchor points to start tactical burn operations or by allowing fires to burn into breaks will change fire behaviour and flame lengths giving firefighters time to extinguish the flames. It has been suggested that after experimental fires in eucalypt forest in mild weather by Australian researchers that a 50% reduction of fuel will halve the rate of spread of a fire and reduce fire line intensity fourfold (Fernandes and Botelho, 2003).

1.5 Historical events and future fire risk in South Wales

In the small area of the Brecon Beacons National Park which falls with the geographic area covered by South Wales Fire and Rescue service, there were 81 wildfires from January 2015 to August 2020. Ten of these fires burnt an area over one hectare (SWFRS statistics department, 2020). Two of these fires burnt in the same area, one in April 2017 and the other in April 2020. The areas the fires burnt is directly north of Merthyr Tydfil.

The Sentinel satellite images in Figures 1.18 and 1.19 show two wildfires that burnt the same area with the Brecon Beacons National Park in 2017 and 2020, and Figures 1.20 and 1.21 show the regrowing vegetation cover. The dark brown areas are burnt vegetation, the black areas reservoirs, the dark green areas forestry plantations and the light green and yellow are moorland. The first fire burnt an area of 800 hectares and the second 1250 hectares. The images show the area burnt and the speed of regrowth with vegetation cover back after both fires by the end of May.

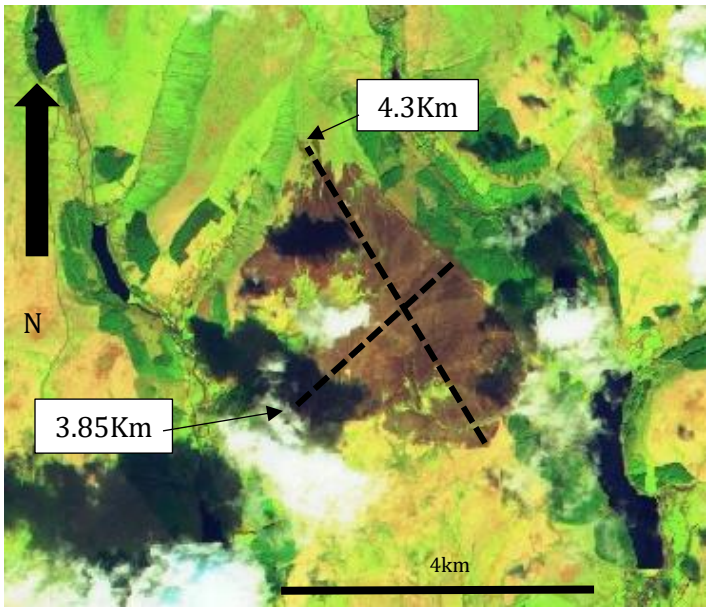

Figure 1.19. Wildfire burned from 7th to 10th April 2017.
Image taken 25th April 2017. https://apps.sentinel-hub.com/
Fire area 800 hectares.

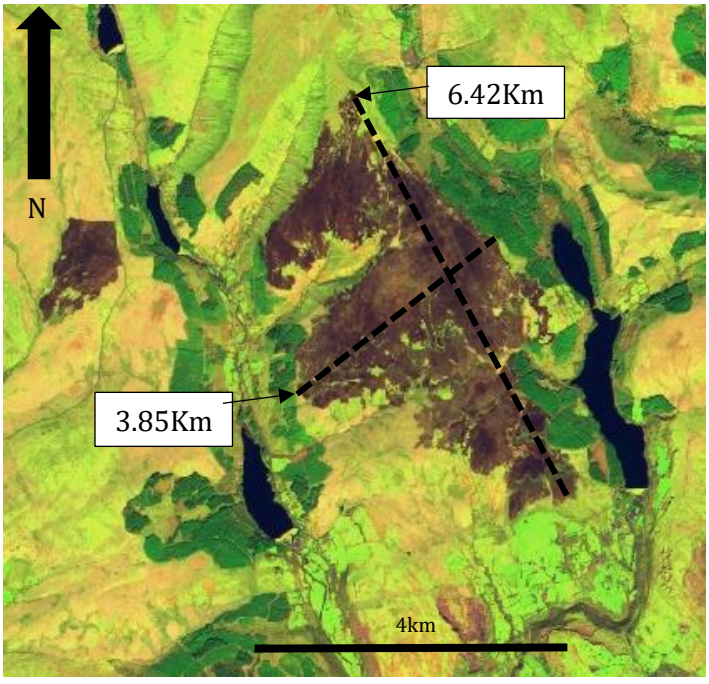

Figure 1.20 Wildfire burned from 10th to 13th April 2020.
Image taken 14th April 2020. https://apps.sentinel-hub.com/
Fire area 1250 hectares.

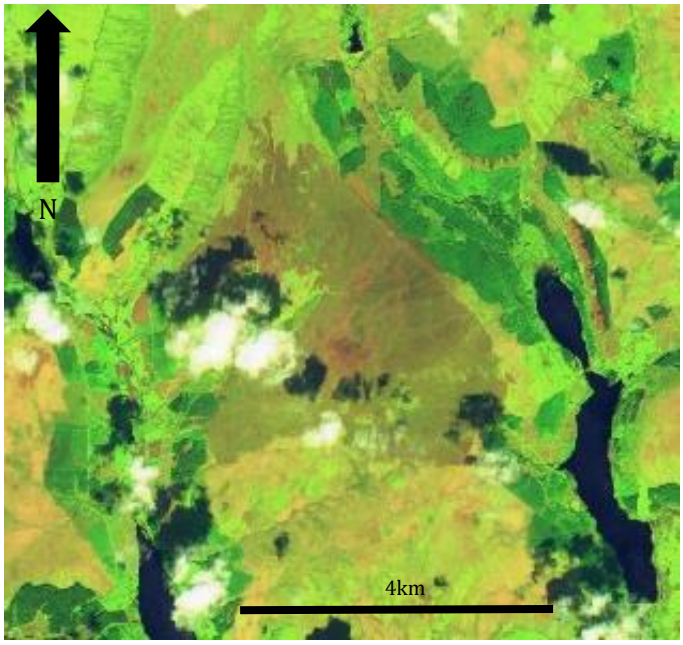

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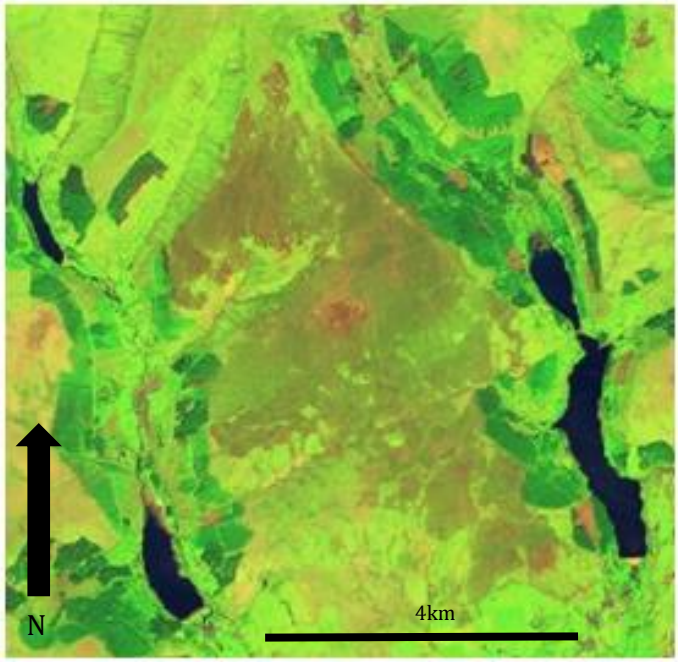
Figure 1.21 28th May 2017

Showing vegetation regrowth



https://apps.sentinel-hub.com/

Figure 1.22. 25th May 2020

Showing vegetation regrowth

The area where these fires occurred is very wet and is within the Welsh Water Brecon Beacon Mega catchment, which supplies reservoirs and rivers with drinking water for approximately 1.5 million people. The northern part of the fire burnt in an area of Special Scientific Interest (SSSI). As both fires occurred in spring, when the ground was still saturated, they only burnt the surface vegetation and did not burn into the soil. If these fires had burned in later months, when the water table is lower or at a time of drought, there would have been the risk that the vegetation would not recover so quickly due to damage to the seed bed and the onset of autumn. The burnt area would then be vulnerable to enhanced erosion from heavy rain during winter storms. These fires could also burn into the peat, resulting in a loss of stored carbon (Davies et al., 2013; Turetsky et al., 2015). This could also result in any legacy contamination which has been stored in the peat since the industrial revolution being released and subsequently entering the drinking water supply (Davies et al., 2016; Shuttleworth et al., 2014). Short fire return intervals in these degraded bogs will give less time for sphagnum moss recovery, other more flammable plants could then colonise the burnt areas increasing risk. (Turetsky et al., 2015).

There has been a rise in interest for the rewilding of these areas which were once grazed by sheep (Marrs et al., 2018). This rewilding would increase the amount of biomass available to burn, which in turn could lead to the release of stored carbon and soil contamination. Rewilding will eventually lead to tree cover which could reduce the severity of wildfires but before these trees reach maturity the areas will be susceptible to wildfires. Plans to rewild areas should therefore be supported by robust fire plans and fire breaks. A question also arises that if an area subject to rewilding does subsequently catch fire, should the area be allowed to burn, especially if the ignition is natural?

1.6 Summary, research gaps and main challenges faced by FRS in reducing wildfire risk

Wildfires are a considerable problem around the world as well as in the UK. In many areas, they have become more destructive, fire seasons are lasting longer and the cost of extinguishing fires is increasing year on year. Lightening is the cause of most natural wildfires in scarcely populated parts of the Northern hemisphere, whereas in Europe, 95% of fires are caused by humans, whether accidental or deliberate. The UK is not generally associated with extensive wildfires but they do

occur and can cause significant problems. Traditionally, fires in the UK usually occur in winter and spring when vegetation is cured and, even if they are not of the scale of others in fire-prone regions, they put considerable strain on fire and rescue services. Interest in wildfire has been rejuvenated after some large and costly fires. Since 2018 there have been four wildfires declared 'Major Incidents' in the UK. Between 2000 and 2019 there were over 75,000 vegetation fires in South Wales, the majority of which were deliberate ignitions. In many parts of the world the tradition of burning vegetation as a management tool has slowly died away and fire suppression has become the norm.

Wildfires in the UK are a frequently debated topic with deeply divided opinions. As in other countries, fire and rescue services have approached the problem the same way they would any other fire service related issue. For example, accidental property fires, where the public are constantly reminded of the importance of fire safety in the home to try to reduce ignitions. Reducing accidental property fires has a huge potential to reduce risk compared to the reduction of ignitions of wildfires that without a policy of vegetation management has the potential for fires to cause more damage. The current debate around rewetting and rewilding, with its implications for fire risk is also relevant and needs further research.

Work by Jollands et al. (2011) into the issues of wildfires in South Wales highlighted that more research is needed on the causes and perceptions of wildfires as the evidence is largely anecdotal. One of the reasons that the risk from wildfire is not a serious issue may be the fact that very little property is damaged and loss of life is very rare. Another may be that most events are of short duration and land that is burnt generally greens up quickly to cover up the event.

Firefighting in the UK is carried out by the Fire and Rescue Services funded by the taxpayer. Procedures are similar to other countries, with fires extinguished as soon as possible. As fire seasons are determined by weather the number and scale of incidents can be highly variable and rather unpredictable. Most prevention work involves encouraging people not to light fires and does not usually include vegetation management. Prescribed burning is allowed in the UK, with each country having its own legislation.

South Wales Fire and Rescue Service have been on a long journey with the development of a wildfire toolbox which includes vegetation management techniques which include prescribed burning, mowing/mulching and grazing. This work also includes the creation of firebreaks, which

are areas where fuel is removed to stop fires spreading and thereby preventing large fires. Fire Service involvement in land management has come from the need to maintain community and firefighter safety given that no other agency has been given the responsibility or resources to manage vegetation fire risk.

There are numerous research gaps in relation to wildfires in South Wales. These include: why there is such a high percentage of arson ignitions? What is the ecological impact of fires? What effects will climate change have on fires and their impacts? What effects wildfires have on air pollution in the Valley communities? Can the occurrence and extent of wildfires and their detrimental impacts be reduced by carrying out more prescribed burning? How do the public and stakeholders perceive wildfires in general in this region and the specific use of prescribed burning, including the generation of fire breaks to reduce wildfire risk?

1.7 Aim and Objectives

Based on some of the key research gaps identified above, the core aim of the research was: **to understand current perceptions of risk by the general public and stakeholders in South Wales on the issues of wildfires**. Understanding these perceptions is not only important in developing strategies for reducing risks from fire through targeted public and stakeholder information campaigns, but is also relevant in gauging potential acceptance of year-round use of prescribed burns to create barriers to limit wildfire spread.

Information was thus gathered to address the following specific objectives:

(1) Determine and analyse public and stakeholder perceptions of risk from wildfires. Specifically: are perceived perceptions of risk in line with the fire statistics?
(2) Examine the difference in risk perceptions from different locations. Specifically: comparing the more rural Tonypandy area, where people live closer to risk and are surrounded by the mountains that burn, with the more urban Cardiff, whose population is less exposed to fire, with wider information gathered via the online results from the whole of Wales.
(3) Tease out public and stakeholder perceptions of prescribed burning. Specifically: are they aware that the fire services carry out this activity to train and reduce risk, and is this activity supported by stakeholders?

2. Methodology

To address the research objectives, both quantitative and qualitative approaches were used, involving questionnaires and targeted questions in a 'mixed method' approach (McGuirk and O'Neill, 2016). Quantitative data collection involved questionnaires with closed questions with "yes or no" answers and questions with a choice of prepared answers generally narrow in focus, there was also a qualitative question which asked for a comment. These questionnaires were for the general public. Qualitative data collection had open ended questions conducted as in-depth interviews and were for the stakeholders.

2.1 Research ethics

All research considered associated ethical and research integrity aspects. It was conducted according to the 'Code of human research ethics' (Oates, 2014) which sets out the general principles to cover research involving human participants:

- Respect for the autonomy, privacy of individuals and communities.
- Scientific integrity
- Social responsibility
- Maximising benefit and minimising harm

The responders to questionnaires were informed their names were not required and the questionnaires were anonymous, the responders to the stakeholder questions were informed during initial contact that their names and organisations alongside their interview results would be used within the thesis.

I was very mindful that my position as a serving Firefighter could cause bias, whilst carrying out the face to face questionnaires so I wore civilian clothing and informed responders that I was a student at Swansea University.

2.2 Questionnaire Development

To understand public perceptions of wildfires a questionnaire was developed. It was to be kept anonymous and was submitted to, and approved by, the ethics committee at Swansea University.

The questionnaire was kept short with questions grouped with introductory statements (McGuirk and O'Neill, 2016). There were ten main questions - nine questions were closed, one asked for a comment. Having the majority of questions closed (quantitative) facilitated the coding of responses (Fink, 1995). There was also a subsection of four additional questions at the end which asked for gender, age group, first half of postcode and most recent occupation. All participants were informed they were free to withdraw at any time.

The questionnaire (Appendix 2) first introduced the researcher and the aim of the research. There were also three statements made to provide participants with context for completion of the questionnaire. The first, before question one, defined the term wildfire:

- *The term **wildfire** is the generic term for all out-of-control vegetation fires.*

The second, before question four, gave some simple statistics about the number of wildfires in South Wales:

- *There were almost 4000 wildfires in South Wales in 2010, this figure has been reducing gradually although South Wales fire and Rescue Service attended over 1000 calls to wildfires in July 2018.*

The third, before question six, gave a definition of prescribed burning and a brief reason why South Wales Fire and Rescue Service carry out this activity:

- *Prescribed burning is the intentional removal of unwanted vegetation using fire. South Wales Fire and Rescue Service have been doing this to try and stop large wildfires and protect property.*

Question one was split into three sections and was an introductory question asking if the participant had seen a wildfire and where:

1. **Have you seen a wildfire in Wales?**

1a. If YES, where was the most recent?

1b. Have you seen any evidence in Wales where such a fire may have occurred?

Question two asked about the participant's perception of risk from wildfires:

2. For Wales overall, do you consider wildfires (*tick one*):

A serious risk for many people	
A risk, but mostly for the fire service	
An occasional risk	
A very rare risk	
Not a risk at all	

Question three asked about whether the numbers of fires had increased decreased or stayed the same in the last twenty years:

3. Over the last twenty years, do you think that the number of wildfires in Wales has (*tick one*):

Decreased in number	
Stayed about the same	
Increased in number	

Question four asked about the causes of wildfires:

4. What do you think are the main causes of wildfires in Wales?

Question five was about arson fires and who lights them:

5. Where wildfires are set deliberately (arson), who do you think is lighting them (*tick all noted)*

Primary school (5 -11 year old)	

Secondary school (12- 18year old)	
Adults (18+)	

Questions six, seven and eight were based around the fire service carrying out prescribed burning, the specific dates when this can be done and asked for comments on the practice. The questions were developed to explore whether the overall public awareness of prescribed burning.

6. **Were you aware that some fire services carry out prescribed burning?**
7. **Are you aware that there are specific dates when these activities can take place?**
8. **Do you have any comments on the use of prescribed burning?**

The last part of the questionnaire asked for gender, age group, first half of postcode and most recent occupation. It then thanked the participant.

A draft version of the questionnaire was tested on 15 family and friends to ensure that the questions were easily understood and answered. Small changes were made to the wording, but the questions were found suitable and remained essentially the same.

2.3 Questionnaire locations

The questionnaire was carried out in two contrasting locations using face-to-face questions and, also, shared via social media. The reason for two locations was to identify whether there was a difference in public perception between residents of the Valleys (Tonypandy), a rural area with a high number of wildfires, and residents in South Wales's biggest city (Cardiff). To achieve the latter, respondents of questionnaires were first asked if they lived within either the valleys for Tonypandy questionnaire or the area covered by Cardiff City Council for the Cardiff questionnaire.

Face-to-face questioning was completed randomly by approaching the first person to pass. The questionnaire via social media was carried out to give an overview of Wales and not just the Valleys and Cardiff, therefore, only the answers from people who lived in Wales were considered.

Questionnaire Location One

Location one for the face-to-face questions was Tonypandy town centre (Figures 2.2 and 2.3). Tonypandy is one of the main towns in the Rhondda valley with a population of 17,789 (UK Office for National Statistics). Face-to-face questioning was carried out in the pedestrian part of Dunraven Street town centre between 1100 hrs and 1400hrs on the 4th, 7th, 8th and 9th January 2019, resulting in 100 completed questionnaires.

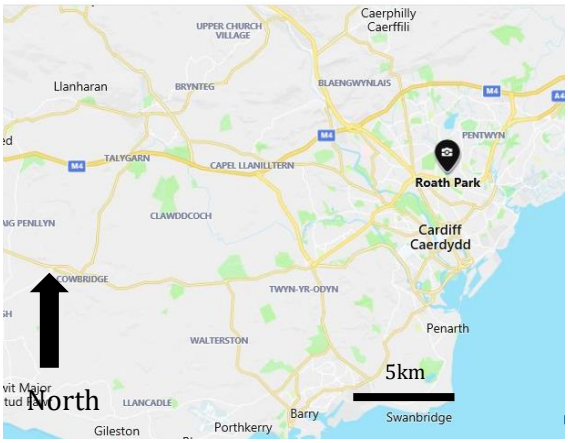
Figures 2.1 and 2.2. Location One Tonypandy town centre (Bing maps, Bing.com)

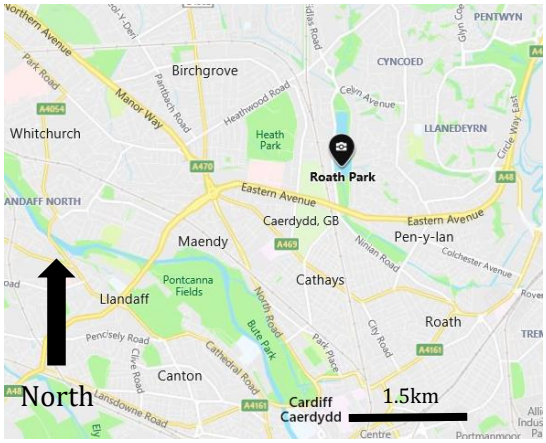
Questionnaire Location Two

Cardiff is the capital city of Wales and has a population of 365,588 (UK office for National Statistics). Face-to-face questions were carried out on the Hayes (Fig. 2.4 & 2.5), a pedestrian area in the city centre, between 1100hrs and 1300hrs on the 25th and 28th March 2019 resulting in 20 completed questionnaires. Due to the difficulty finding residents of Cardiff here, the location was changed from the city centre to the suburb of Roath (Figures 2.6 and 2.7), where there were fewer tourists and shoppers. The location was between Lake Road East and Lake Road West in a pedestrian area near Roath Park Lake, and 80 questionnaires were completed here between 1100 hrs and 1400 hrs on the 2nd and 4th April 2019.

North 3km North

Figures 2.3.and 2.4 Location Two Cardiff City Centre (Bing maps, Bing.com)





Figures 2.5 and 2.6. Location Two, Roath Park Lake (Bing maps, Bing.com)

Questionnaire Three via Social Media

The third questionnaire was carried out online using Google forms. This was shared via social media on 17th January 2019. Respondents were asked to only complete the questionnaire if they lived in Wales. Surveys completed by people not living in Wales were deleted. The form was closed on the 26th of January 2019 once there had been 200 completed surveys from Wales.

To avoid bias in the results the digital questionnaire was shared on Facebook not by myself, but by my partner, using her business and not personal page, which I am not associated with. I did not share the questionnaire myself as most of my contacts on social media are aware that I am a firefighter and this might have introduced bias.

The reach of the online questionnaire was all of Wales.

2.4 Analysis of questionnaires

The three questionnaires resulted in 400 responses: 100 in Tonypandy, 100 in Cardiff, 200 online.

Both paper face-to-face results and the online Google forms were transferred to Excel spreadsheets for analysis. All data analysis was carried out using IBM SPSS statistics software. Specifically, the questions regarding risk and comments made in relation to prescribed burning were statistically analysed using the Pearson Chi Square test on the results against age, gender and social grade to reveal any differences.

The occupation categories were grouped into social grades using the Office of National statistics categories shown in Table 2.1.

Table 2.1 Office of National Statistics social grade.

Social Grade	Description
AB	Higher & intermediate managerial, administrative, professional occupations
C1	Supervisory, clerical & junior managerial, administrative, professional occupations
C2	Skilled manual occupations
DE	Semi-skilled & unskilled manual occupations, Unemployed and lowest grade occupations

Positive comments in relation to prescribed burning were made into pictures using the web site wordart.com.

2.5 Stakeholder in-depth interviews

As well as carrying out a survey of the public, it was also important to gain the perceptions of stakeholders. Stakeholders were deemed to be individuals or organisations which are affected by the effects of wildfires to the land, it was also deemed important that this group had an understanding of the issues around wildfires. For this reason organisations involved in enforcement such as the police were not contacted. Emails were sent to individuals who I knew from previous wildfire work or organisations deemed suitable for them to identify someone. From this group I received nine positive replies. These were sent a copy of the questions by email. This email stated the purpose of the research, how the results were going to be presented and that I would be using their names and organisations in a thesis for my MSc. This resulted in a total of six completed interviews being returned. I chased up the non-responders to no avail. Originally I hoped to meet each stakeholder in person for an interview but this did not work out due to time constraints although I did speak to each respondent via telephone. Some responders stated that particular answers were their opinion and not that of their organisation, these responses are clear in the transcript. Five further individuals were contacted who, even though not based in Wales, had the experience of wildfires and the understanding of the issues in Wales to be able to comment. From these, three completed interviews were completed, making an overall total of nine.

Eight questions were developed to gain the perception of stakeholders:

1. Do you consider wildfires are a risk to the public, the fire service and property?

2. Do you believe that reducing the number of ignitions will reduce the risk or is there also a need for fuel management?

3. Statistics show that the majority of wildfires in Wales are started deliberately, in more rural areas this is usually believed to be landowners/managers. What extra help can be given to these groups to stop deliberate fire setting?

4. Statistics show that the majority of wildfires in Wales are started deliberately, in more urban areas this usually believed to be reckless fire setting. What do you think are the reasons for this behaviour?

5. There is no formal process for wildfire fire investigation. Do you agree that if the cause and origin is known then community safety activities can be aligned to these findings?

6. The guidance for the burning of heather and grass published by the Welsh Government asks if prescribed burners have attended and passed a certified course. Do you believe it should be mandatory to have passed a course before being entitled to burn land?

7. Do you have any comments on the use of prescribed burning by the fire service?

8. The season for prescribed burning starts in October and ends on the 15th March (Lowlands) and 31st March (uplands). Most burning occurs in late winter and early spring once the vegetation has cured, this is normally February to March. This legislation is for the protection of ground nesting birds whose nests can be destroyed by prescribed burns and wildfires. If these months are wet then there is very little opportunity to carry out prescribed burning. Do you think the Fire service should have an exemption to allow them to create strip fire breaks outside of the prescribed burning season?

Table 2.2 below lists the organisations and respective individuals that provided returns.

Table 2.2 Details of stakeholders interviewed.

Name	Organisations	Job Title	Location	Relevance
John Hogg	Natural Resources Wales	Head of Operations	South Wales	Lead officer for forestry and land management
Becky Davies	Natural Resources Wales	Senior Officer – South Central Wales , people and places team	South Wales	Healthy hillsides wildfire project

Nigel Elgar	Welsh Water	Catchment Partnership coordinator	South Wales	Brecon Beacon Mega catchment project
Paul Chapman	Brecon Beacons National Park	National Park Warden	South Wales	Wildfire officer and land manager
Lesley Fletcher	Royal Society for the Protection of Birds (RSPB)	RSPB site manager	Wales	RSPB land manager
Rob Yorke	Self employed	Rural chartered surveyor	South Wales	Rural commentator
Simon Thorp	England and Wales Wildfire Forum (EWWF)	Chair	UK	Lead of Forum
Ciaran Nugent	Forest Service, Department of Agriculture, Food and Marine Ireland	Regional forestry inspector	Ireland	Forester, wildfire officer
Alexander Held	European Forest Institute (EFI)	Senior expert, silviculture , fire and wildlife	Europe	Forester, wildfire expert

Once all the responses were returned, the answers to the questions were transcribed into a readable document, with the results of the key comments coded into common topics. These common topics will be discussed further in Section 4.1.3.

2.6 Limitations of questionnaires for general public and interviews for stakeholders.

Carrying out surveys face to face and online raised some issues. When answering questions face to face the respondents, if they were not sure, could ask a question. If asked I would answer the question in a way that would not influence the answer, this was not available to online respondents. The questions in the online survey were laid out the same as the face to face version, this meant

that respondents online could view the next question before they answered the question they were on. I do not believe this affected the results but is an important lesson for future surveys.

The occupation categories were grouped into social grades using the Office of National statistics categories. The survey question on occupation caused challenges when trying to put responders into groups due to the lack of information given in the online survey. Occupations such as 'NHS' but not a specific job title caused issues. To overcome this, responders had to be classified into generic groups rather than in specific roles. With hindsight the question could have been better presented to give a more specific answer.

The face to face questions were carried out on weekdays but the online version was available at all times which may have led to certain groups being over or underrepresented.

The responses from the questionnaires and the interviews cannot be compared as they were not the same. Even though this is a limitation the reason for this was that the two groups had very different knowledge and experience and the information this study wanted to extract from them was different.

Having only six responses from stakeholders in Wales caused concern. The best way to get a broader understanding of the perception of risk from wildfires and an understanding on their perception of prescribed burning would be to ask stakeholders from outside of Wales to comment. The stakeholders approached were all aware of the broader issues of wildfires, had all been to South Wales and were well aware of its complex problems. In the results and conclusion, the comments made by external stakeholders Held, Nugent and Thorp are differentiated.

3. Survey results and survey discussion

Key results of the completed questionnaires are presented below followed by a discussion of these results. Full data is given in Appendix 3, Tables S1- S21. The total number of respondents for location one and two was 100 each, and for the social media survey was 200.

3.1. Location 1 Questionnaire: Tonypandy

In Tonypandy, 54% of responses were from females and 46% from males. Tables 3.1, 3.2 and 3.3 summarise their age, postcode and social classification. Regarding age, the lowest participation was for the youngest age group (18-30 yrs. old; 15%), the remaining three having similar percentages (26-32%; Table 3.1). Most participants came from the lower Rhondda (postcodes CF39, CF40 and CF41; Table 3.2) and, regarding occupation, the majority were in the social category for semi-skilled, unskilled or unemployed (DE, 60%), whereas the lowest representation was for social category AB, corresponding to higher and intermediate managerial positions. (Table 3.3). As can be seen from table 3.3 the social grades who responded to the survey do not mirror the social grades from the 2011 ONS Census.

Table 3.1 age group frequency location 1.

Age group	Frequency (%)
18 - 30	15
31- 45	32
46 - 60	27
61+	26
Total	100

Table 3.2 Postcode frequency for location 1.

Postcode	Percentage (%)
CF32	1
CF37	4
CF38	4
CF39	19
CF40	35
CF41	14
CF42	9
CF43	5
CF44	1
CF46	1
CF47	1
CF72	6
Total	100

Table 3.3 social category frequency location 1.

Social category	Percentage from survey (%)	Percentage from 2011 ONS census (%)
AB	1	13
C1	22	28
C2	17	24
DE	60	35
Total	100	100

Have you seen a wildfire (grass fire/mountain fire/bracken fire/gorse fire) in Wales?

The vast majority of responses (92%) had seen a fire burning, only 8% had not (Table S1). From those who had seen a fire, the majority (39 out of 100) had seen it from the towns of Penrhys, Porth, Trealaw and Tonypandy (Figure 3.1), in the lower area of the Rhondda Valley and corresponding with the majority of postcodes of responders.

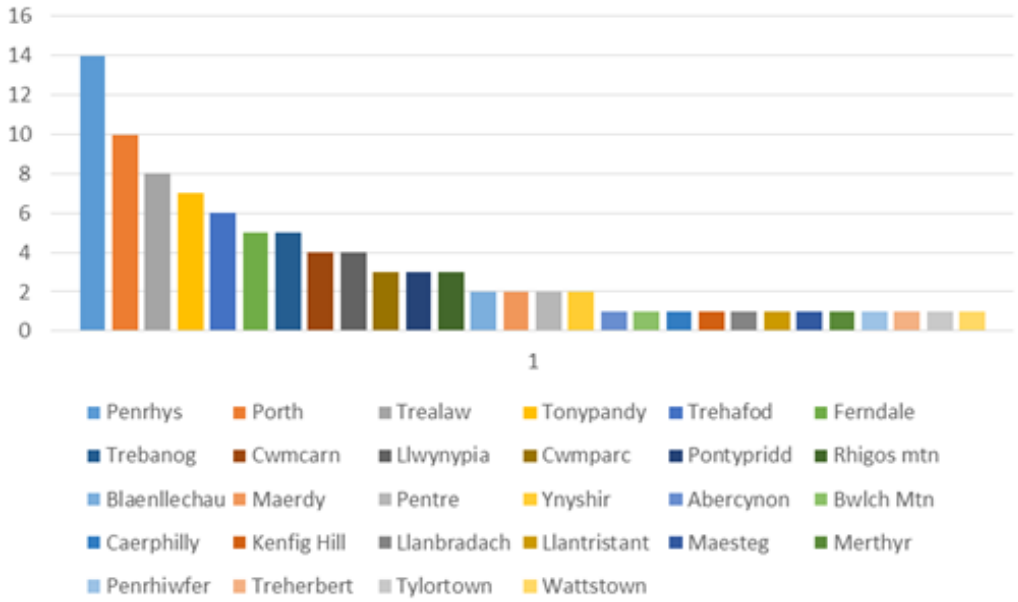


Figure 3.1 The locations above are all towns or locations in the South Wales valleys where responders had seen fires.

Regarding whether the respondent had seen any evidence of fire, the percentages were very similar, with 92% also positive answers (Table S2).

For Wales overall, do you consider wildfires (select one)

79% people believed wildfires were a risk but mostly for the fire service, 20% believed they were a risk for many people and 1% believed they were an occasional risk (Table 3.4).

Table 3.4 Perception of risk from Tonypandy Survey

	Percentage
A risk, but mostly for the fire service	79
A serious risk for many people	20
An occasional risk	1
Total	100

Over the last twenty years, do you think that the number of wildfires in Wales has (select one)

The majority (55%) of respondents believed the number of wildfires had increased, 31% that numbers had stayed the same and just 14% that numbers had decreased.

Table 3.5 Number of fires.

	Percentage
Decreased in number	14
Increased in number	55
Stayed about the same	31
Total	100

What do you think are the main causes of wildfires in Wales?

The vast majority 96% of people thought the cause was deliberate, only 4% thought accidental (Table S3). The majority (54%) in Table 3.6 thought that deliberate fires were caused by secondary school age children, the next largest group (14%) thought secondary school age children and adults. Only one person (1%) thought that fires were lit by primary school age children.

Table 3.6. Perpetrators of deliberate fires.

	Percentage
Adults (19+)	10
Primary school (5 -11 year old)	1
Primary school (5 -11 year old), Secondary school (12- 18year old)	10
Primary school (5 -11 year old), Secondary school (12- 18year old), Adults (19+)	11
Secondary school (12- 18year old)	54
Secondary school (12- 18year old), Adults (19+)	14
Total	100

Prescribed burning

From the respondents, 62% were not aware that the fire service carried out prescribed burning and 38% of people were aware (Table S4). 89% were not aware that there are specific dates when prescribed burning can occur, 11% were. Positive responses for prescribed burning are depicted in Figure 3.2. The word 'Good' in relation to the fire service carrying out prescribed burning is the most dominant along with 'more needed' and 'good idea'. Negative comments and questions are discussed in Section 3.6.

Figure 3.2. Word art picture highlighting what questionnaire' thought of prescribed burning in Tonypandy area.

3.2. Location 2 Questionnaire: Cardiff

In Cardiff, 46% of responses were from females, and 54% were from males. The summary of the age, postcode and social classification is presented in Tables 3.7, 3.8 and 3.9. Regarding the age of the participants, the lowest participation was for the youngest age group (18-30 yrs. old; 14%) followed by the oldest age group (61+; 20%; Table 3.7), the highest was for 31-45 (37%). Most participants came from the areas of Taffs Well, Radyr and Roath (Postcodes CF15 and CF23; Table 3.8) and, regarding occupation, the majority were in social categories C1 (38%) and DE (38%), the lowest in category AB (8%), higher and intermediate managerial positions (Table 3.9). As can be seen from table 3.9 the social grades who responded to the survey do not mirror the social grades from the 2011 ONS Census.

Table 3.7 age group frequency location 2.

Age group	Frequency
18 - 30	14
31- 45	37
46 - 60	29
61+	20
Total	100

. Table 3.8 Postcode frequency for location 2.

Postcode	Frequency
CF10	9
CF11	12
CF14	5
CF15	16
CF23	16
CF24	7
CF3	15
CF5	6
CF64	14
Total	100

Table 3.9 social category frequency location 2.

Social category	Percentage from survey (%)	Percentage from 2011 ONS census (%)
AB	8	25
C1	38	34
C2	16	16
DE	38	25
Total	100	100

Have you seen a wildfire (grass fire/mountain fire/bracken fire/gorse fire) in Wales?

Responses from Cardiff showed 60% of people had seen a fire burning, 40% had not (Table S8). 84% had seen where a fire had occurred, 16% had not (Table S9).

The most common location for a fire to have been seen was Caerphilly Mountain (9%), followed by Rover Way (6%) and Garth Mountain (5%), shown in Figure 3.3.

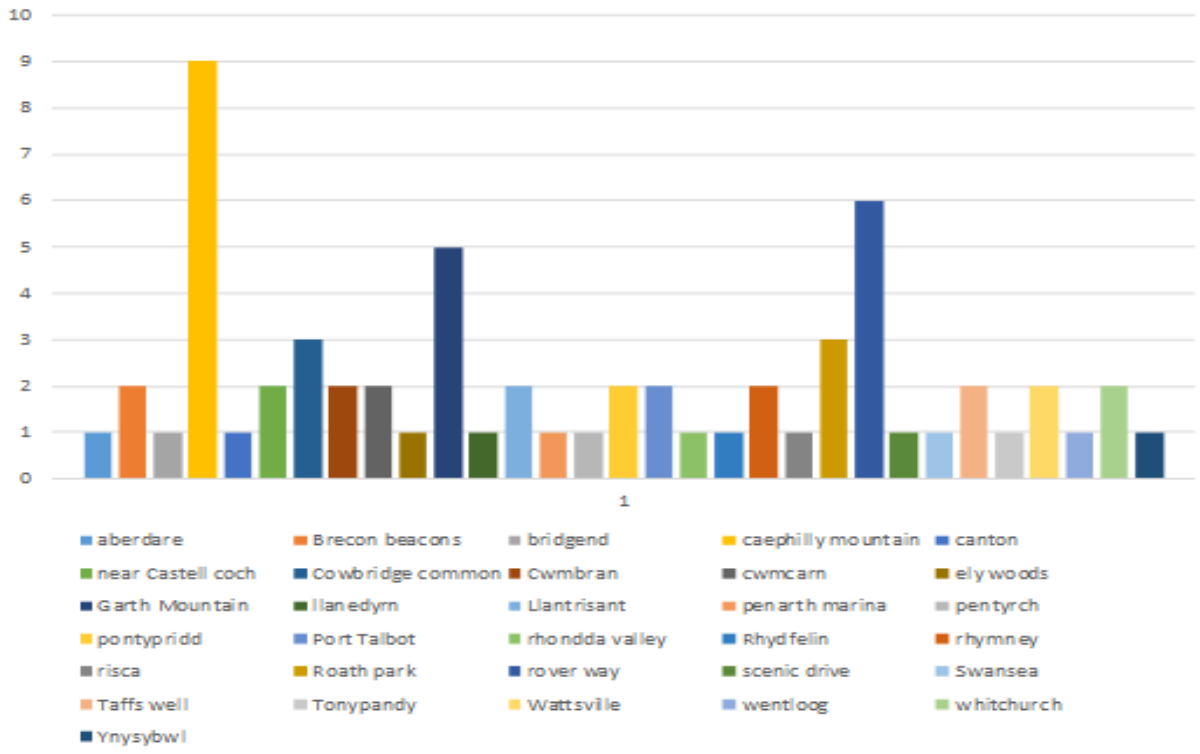


Figure 3.3 These are the towns or areas within South Wales mentioned by the respondents.

For Wales overall, do you consider wildfires (select one)

The majority of respondents (55%; table 3.10) believed wildfires were an occasional risk, 41% a risk mostly for the fire service, 3% no risk at all and 1% a very rare risk.

Table 3.10 Perception of risk from Cardiff reponses

	Percentage
A risk, but mostly for the fire service	41
A very rare risk	1
An occasional risk	55
Not a risk at all	3
Total	100

Over the last twenty years, do you think that the number of wildfires in Wales has (select one):

The majority of the people asked (57%, Table 3.11) believed there had been and increase, 32% thought the number had stayed the same and 11% thought there had been a decrease in the number of wildfires.

Table 3.11 Number of fires.

	Percentage
Decreased in number	11
Increased in number	57
Stayed about the same	32
Total	100

What do you think are the main causes of wildfires in Wales?

The vast majority of the interviewees (86%) believed the fires were deliberate, whereas only 14% believed they were started accidentally (Table S10). The majority of the people asked (49%; Table

3.12) thought that deliberate fires were caused by secondary school age children, the next largest group (22%) thought them lit by adults. Only one person (1%) thought that fires were lit by primary and secondary school age children.

Table 3.12 Perpetrators of deliberate fires.

		Percentage
	Adults (19+)	23
	Primary school (5 -11 year old)	11
	Primary school (5 -11 year old), Secondary school (12- 18year old)	1
	Primary school (5 -11 year old), Secondary school (12- 18year old), Adults (19+)	5
	Secondary school (12- 18year old)	49
	Secondary school (12- 18year old), Adults (19+)	11
	Total	100

Prescribed burning

Most of the people interviewed (70%) were not aware that the fire service carried out prescribed burning, 30% were aware (Table S11). Most (84%) were not aware that there are dates when prescribed burning can take place and just 16% knew about this (Table S12). Positive responses are depicted graphically in Fig. 3.4. The word Good in relation to the fire service carrying out prescribed burning is again the most dominant along with 'good idea and 'more needed'. Negative comments and questions are discussed in section 3.6

Figure 3.4 Word art picture highlighting what people thought of prescribed burning, Cardiff area. Wordart.com

3.3. Social media questionnaires

As explained in the methodological section, results were all from postcodes within Wales. 42.5% of responses were from females, 57.5% (115) from males. The summary of the age, postcode and social classification is presented in Tables 3.13, 3.14 and 3.15. Regarding the age of the participants, the lowest participation was for the oldest age group (61+ yrs. old; 12%) followed by the youngest age group (18 - 30; 16%; Table 3.13). The highest represented age group was 31-45 (36%). Most participants came from the areas of Pontypridd, Tonteg and Porth (Postcodes CF37, CF38 and CF39; Table 3.15) and, regarding occupation, the majority were included in social category C1 (56%), whereas the lowest representation was for social category AB (4.5%), corresponding to higher and intermediate managerial positions (Table 3.14). Only 1 person (0.5%) did not give their age and 15 (7.5%) did not give a social category.

Table 3.13 Age group frequency online.

Age group	Frequency	%
No reply	1	0.5
18 - 30	32	16
31- 45	72	36
46 - 60	71	35.5
61+	24	12
Total	200	100

Table 3.14 Social category frequency online.

Social category	Frequency	%
No reply	15	7.5
AB	9	4.5
C1	112	56
C2	16	8
DE	48	24
Total	200	100

Table 3.15 Postcode frequency of respondents from the online survey.

Postcode	Frequency	Percentage
CF10	2	1
CF14	3	1.5
CF24	1	.5
CF31	3	1.5
CF32	3	1.5
CF34	3	1.5
CF35	3	1.5
CF36	1	.5
CF37	15	7.5
CF38	10	5
CF39	34	17
CF40	6	3
CF41	3	1.5
CF42	4	2
CF43	11	5.5
CF44	1	.5
CF45	5	2.5
CF47	2	1
CF48	4	2
CF5	3	1.5
CF62	1	.5
CF63	1	.5
CF71	2	1
CF72	4	2
CF83	5	2.5
LD1	3	1.5
LD3	2	1
LD5	1	.5
LL30	1	.5
LI34	1	.5

Postcode	Frequency	Percentage
LL38	1	.5
LL57	1	.5
NP10	1	.5
NP11	1	.5
NP12	2	1
NP13	1	.5
NP16	2	1
NP19	1	.5
NP22	2	1
NP23	1	.5
NP25	1	.5
NP4	1	.5
NP44	2	1
NP7	4	2
NP8	2	1
SA1	1	.5
SA10	1	.5
SA11	2	1
SA15	1	.5
SA18	3	1.5
SA19	2	1
SA2	2	1
SA3	6	3
SA38	1	.5
SA4	1	.5
SA6	1	.5
SA7	1	.5
SY21	1	.5
SY23	3	1.5
SY5	1	.5
Total	200	100

Have you seen a wildfire (grass fire/mountain fire/bracken fire/gorse fire) in Wales?

The majority (91%) had seen a fire burning, 9% had not (Table S15). From those who had seen a fire the majority, 29 out of 200 (14.5%) had seen fires in Aberdare and Porth (Figure 3.5).

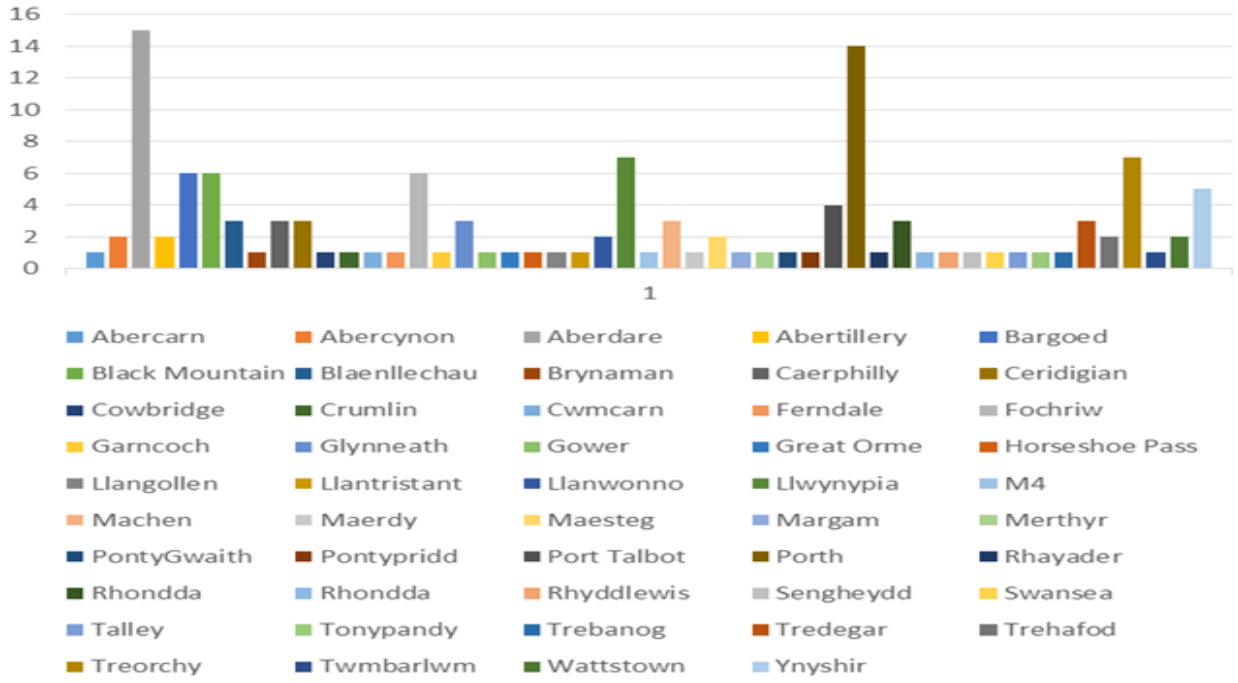


Figure 3.5 Areas of Wales where wildfires had been seen.

For Wales overall, do you consider wildfires (select one)

Table 3.16 Perceptions of risk for online responses.

	Frequency	Percent (%)
A risk, but mostly for the fire service	18	9
A serious risk for many people	176	88
A very rare risk	6	3
Total	200	100

When asked about their risk perceptions, 176 (88%) people believed wildfires were a risk for many people, 18 (9%) believed them a risk but mostly for the fire service, and only 6 (3%) believed they were a very rare risk (Table 3.16).

Over the last twenty years, do you think that the number of wildfires in Wales has (select one):

Table 3.17 Number of wildfires.

	Frequency	Percent (%)
Decreased in number	15	7.5
Increased in number	129	64.5
Stayed about the same	56	28
Total	200	100

The majority, 129 (64.5%) believed the number of wildfires had increased, 56 (28%) that numbers had stayed the same and 15 (7.5%) that the numbers had decreased.

What do you think are the main causes of wildfires in Wales?

94.5% believed the fires were deliberate, 5.5% believed they were started accidentally (Table S17). The majority, 87 (43.5%; Table 3.18), thought that deliberate fires were caused by secondary school age children, the next largest group (53; 26.5%) lit by secondary school age children and adults. Only one person (0.5%) thought that fires were lit by primary school age children.

Table 3.18 Perpetrators of deliberate fires.

	Frequency	Percent (%)
Adults (19+)	42	21
Primary school (5-11 year old)	1	0.5
Primary school (5-11 year old), Secondary school (12-18year old)	4	2
Primary school (5 -11 year old), Secondary school (12-18 year old), Adults (19+)	13	6.5
Secondary school (12- 18year old)	87	43.5
Secondary school (12- 18year old), Adults (19+)	53	26.5
Total	200	100

Prescribed burning

76% were aware that the fire service carry out prescribed burning. 24% were not (Table S18). 57.5% were not aware that there are dates when prescribed burning can take place, 42.5% were aware (Table S19). Positive responses are depicted graphically in Fig. 3.6. The word Good in relation to the fire service carrying out prescribed burning is the most dominant along with 'good idea' and great tool'. Negative comments and questions are discussed in Section 3.6 .

Figure 3.6 Word art picture highlighting what people thought of prescribed burning. Wordart.com.

3.4 Results from all three questionnaires and merged results.

When comparing the responses from the two locations (rural vs. urban) and the online survey, interesting similarities and differences are observed. Here, the merged results from all questionnaires are also shown to give an overall summary.

Have you seen a wildfire (grass fire/mountain fire/bracken fire/gorse fire) in Wales?

Table 3.19 Question 1 results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
Yes	92	60	91	83.5
No	8	40	9	16.5

More people from Tonypandy (92%) had seen a wildfire burning compared to Cardiff (60%) as would be expected, 91% of people online had seen a fire burning (Table 3.19).

Have you seen any evidence in Wales where such a fire may have occurred?

Table 3.20 Question 1b results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
Yes	92	84	91	89.5
No	8	16	9	10.5

More people questioned in the Tonypandy area (92%) compared with Cardiff (84%) (Table 3.20) had seen where a fire had burnt.91% of people online had seen where a fire had burnt.

For Wales overall, do you consider wildfires (select one):

Table 3.21 Question 2 results from three questionnaires and merged results

	Tonypandy %	Cardiff %	Online %	Merged %
A serious risk for many people	20	0	88	49
A risk, but mostly for the fire service	79	41	9	34.5
An occasional risk	1	55	0	14
A very rare risk	0	1	3	1.75
Not a risk at all	0	3	0	0.75

In Tonypandy 20% of people felt that wildfires posed a serious risk for many people compared to 0% in Cardiff (Table 3.21) and 88% of online responses. The majority of Tonypandy responses perceived wildfires a risk but mostly for the fire service (79%) compared to 41% in Cardiff and 9% online. 55% from Cardiff believed that fires were an occasional risk compared with 1% from Tonypandy. Only 7 (2.5%) people perceive fire to be a very rare risk or no risk at all.

Over the last twenty years, do you think that the number of wildfires in Wales has (select one)

Table 3.22 Question 3 results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
Increased in number	55	57	64.5	60.25
Decreased in number	14	11	7.5	10.0
Stayed about the same	31	32	28.0	29.75

The responses from Cardiff and Tonypandy are very similar with only slight variation with online responses. 55% of people from Tonypandy believe there has been an increase in fires compared with 57% from Cardiff.

What do you think are the main causes of wildfires in Wales?

Table 3.23 Question 4 results from three questionnaires and merged results

	Tonypandy %	Cardiff %	Online %	Merged %
Deliberate	96	86	94.5	92.75
Accidental	4	14	5.5	7.25

The vast majority of responses from Tonypandy (96%) believe fires are started deliberately compared with Cardiff (86%), the online results are similar to Tonypandy.

Where wildfires are set deliberately (arson), who do you think is lighting them (you may select more than one)

Table 3.24 Question 5 results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
Primary school (5 -11 year old)	1	11	0.5	3.3
Secondary school (12-18year old)	54	49	43.5	47.5
Adults (19+)	10	23	21	18.8
Primary school (5 -11 year old), Secondary school (12-18year old)	10	1	2	3.8
Primary school (5 -11 year old), Secondary school (12-18year old), Adults (19+)	11	5	6.5	7.2
Secondary school (12-18year old), Adults (19+)	14	11	26.5	19.5

The majority of all groups believe that arson caused wildfires are ignited by secondary school age children: Tonypandy 54%, Cardiff 49% and Online 43.5%. Only 1% in Tonypandy and 0.5% Online believed fires were lit by secondary school age children compared with 11% from Cardiff. Although 10% of people from Tonypandy believed fires to be lit by Primary school and Secondary school aged children compared to 1% from Cardiff and 2% Online.

Prescribed burning

Table 3.25 Question 6 results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
No	62	70	24	45.0
Yes	38	30	76	55.0

The majority of responses from Tonypandy (62%) and Cardiff (70%) (Table 3.25) were unaware that the Fire Service carry out prescribed burning, compared to the vast majority of Online responses (76%) who were.

Are you aware that there a specific dates when prescribed burning can take place?

Table 3.26 Question 7 results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
No	89	84	57.5	72.0
Yes	11	16	42.5	28.0

The majority of responses from all areas (Table 3.26) were not aware that there a specific dates when prescribed burning can take place, Tonypandy 89%, Cardiff 84% and Online 57.5% but 42.5% of the latter did.

Please select your gender

Table 3.27 Gender question results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
Female	54	46	57.5	53.75
Male	46	54	42.5	46.25

There were more female responses (Table 3.27) from Tonypandy (54%) and Online (57.5%) compared with Cardiff (46%), although overall no one group is over or under represented.

Please select your age group

Table 3.28 Age question results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
No response	0	0	0.5	0.25
18 - 30	15	14	16	15.25
31 – 45	32	37	36	35.25
46 - 60	27	29	35.5	31.75
61 +	26	20	12	17.5

There was a slight bias of responses to all questionnaires from age group 31-45 (Table 3.28): Tonypandy 32%, Cardiff 37% and Online 36%. In the face-to-face questionnaires the age group least represented is 18-30: Tonypandy 15% and Cardiff 14%, but the least group Online is 61+: 12%, compared with Tonypandy 26% and Cardiff 20%.

Social category

Table 3.29 Social category results from three questionnaires and merged results.

	Tonypandy %	Cardiff %	Online %	Merged %
No response	0.0	0	7.5	3.8
AB	1	8	4.5	4.5
C1	22	38	56	43.0
C2	17	16	8	12.2
DE	60	38	24	36.5

The vast majority of responses from Tonypandy were social category DE (60%) (Table 3.29) with the main category from Cardiff being category C1 (38%) and DE (38%) The minority group for all responses was AB (Tonypandy 1%, Cardiff 8%, Online 4.5%). In the Online questionnaire, 15 people did not give their occupation.

3.5 Comments on the use of prescribed burning from the questionnaires

3.5.1 Commenting overall

Of the 400 people who completed the questionnaire, 166 (41.5%) made a comment and 234 (58.5%) did not (Table 3.30). From Tonypandy 50% made a comment, 35% from Cardiff and 40.5% online. This suggests a good degree of engagement with the topic, so it is now worth investigating who commented most.

Table 3.30 Comments from the questionnaires

	Frequency	Percent
Comment	166	41.5
No comment	234	58.5
Total	400	100

The data were then analysed using the Chi square test to see if there is a pattern to responders making comment or if they are random in response in relation to gender, age, area and social category (Table 3.31). All the individual tables are included in Appendix 5 S3.34 – S3.41. A common (typical) threshold was set at $p<0.05$ (95%) to determine whether a test outcome was statistically significant or not. None of the tables violated the Chi square test's Expected values assumption.

Table 3.31 Comments / no comment vs gender, age, location and social category

	Comment		No Comment	
	Count	Percentage	Count	Percentage
Male	93	50.3	93	49.7
Female	73	34	142	66
18 - 30	17	27.9	44	72.1
31 - 45	52	36.9	89	63.1
46 - 60	60	47.2	67	52.8
61+	37	52.9	33	47.1
Tonypandy (1)	50	50	50	50
Cardiff (2)	35	35	65	65
Online (3)	81	40.5	119	59.5
AB	10	13.3	8	86.7
C1	71	41.3	101	58.7
C2	26	53.1	23	46.9
DE	57	39	89	61

Gender vs making a comment or not

With a significance of 99.9%, above the 95% threshold, gender was important as to whether people made a comment on the questionnaire or not. Specifically, male participants were more likely to comment (50.3%, as compared to 34% of women).

Age group vs making a comment or not

With a significance of 98.3%, above the 95% threshold, age was important as to whether people made a comment on the questionnaire or not. There are more comments made by people as they get older up until 61+, after which commenting drops again.

Area vs making a comment or not

With a significance of 90.9%, below the 95% threshold, area was relatively unimportant as to whether people made a comment on the questionnaire or not.

Social category vs making a comment or not

With a significance of 94.9%, rounded to 95%, social category was important as to whether people made a comment on the questionnaire or not. Respondents from the higher social categories were generally more likely to comment.

From this analysis I conclude that people who were male, middle-aged/younger older and of higher social class were more likely to make a comment about the use of prescribed burning. The link to age and social class may suggest a link between feelings and better understanding of the process but it is impossible to be conclusive.

3.5.2 Commenting positively, neutrally or negatively

A further line of analysis was to consider whether the comments were generally favourable (positive) to the use of prescribed burning or more neutral or even negative. Again, I start with the overall picture (Table 3.32). Comments were overwhelmingly positive (78.9%), with neutral views next (16.3%) and very few respondents making negative comments about the practice (4.8%).

Table 3.32 Comments from the questionnaires: positive, neutral, negative

	Frequency	Percent
Positive	131	78.9
Neutral	27	16.3
Negative	8	4.8
Total	166	100

It was then hoped to analyse the three qualitative categories further to see if the type of response was explained well by gender, age, area or social category. However, due to the concentration of responses in the positive category, this analysis could not be meaningfully undertaken using Chi square as the Expected Values assumption was consistently broken and simplification of the tables to deal with this not seen as worthwhile.

All tables are included in Appendix 5 S3.42 – S3.49 but a summary table (Table 3.33) at least suggests greater positivity of comments from men, Tonypandy residents and people from social classes C1/C2.

Table 3.33 Positive, negative or neutral comments vs gender, age, location and social category

	Positive		Neutral		Negative	
	Count	Percentage	Count	Percentage	Count	Percentage
Male	78	83.0	12	12.8	4	4.3
Female	53	73.6	15	20.8	4	5.6
18 - 30	13	81.3	2	12.5	1	6.3
31 - 45	39	75.0	11	21.2	2	3.8
46- 60	50	82.0	8	13.1	3	4.9
61+	29	78.4	6	16.2	2	5.4
Tonypandy (1)	44	86.3	7	13.7	0	0
Cardiff (2)	26	74.3	5	14.3	4	11.4
Online (3)	61	76.3	15	18.8	4	5.0
AB	7	70.0	3	10.0	0	0
C1	61	84.7	8	11.1	3	4.2
C2	21	80.8	3	11.5	2	7.7
DE	41	73.2	12	21.4	3	5.4

3.6 Positive comments

From the 400 responses made to the questionnaires, a total of 166 people made comments regarding the fire service carrying out prescribed burning. 131 of these comments were positive. As stated earlier the most common words were 'Good' and 'GOOD IDEA', 'GREAT TOOL' and 'MORE NEEDED'. This suggests that, in spite of relatively little detailed knowledge of prescribed burning, it was generally seen as a legitimate practice. These comments are listed in Appendix 4.

3.7. Non positive comments

From the 400 responses made to the questionnaires, a total of 166 people made comments regarding the fire service carrying out prescribed burning. Thirty-five comments were not supportive or were questions. The latter were not all specifically negative but require further explanation / investigation, and these results are displayed below and further discussed in Section 4.1.2.

The thirty-five comments can be grouped into four categories:

- Public information (15 of 35 comments)

These comments were about the public wanting more information about when prescribed burning activities are taking place. For example,

More information needed for public

Needs to be communicated to the public

Online information about what is being done, why and when

- Wildlife and environment (7 of 35 comments)

These comments were about the public having concern for the environment and wildlife from prescribed burning activities. For example,

I hope the wildlife are protected

Risk to wildlife

I'm concerned about protecting local flora and fauna, and the impact of prescribed burning on their habitat.

- Negative comment and further information required (8 of 35 comments)

These are negative comments about the use of prescribed burning, such as;

Don't think there any need for this to be done

Not sure if there is a need for this

Think it's a waste of time and resources

- Landowners/managers and training (5 of 35 comments)

These comments were about who should carry out these activities and how they are trained. For example,

Seems like it could be a waste of potential bedding / fodder for farm animals.

Happy for Fire service to do it, not happy for farmers to do it

I believe some landowners do this and allow them deliberately to get out of control.

3.8. Discussion of survey results

The core aim of the research was: **to understand current perceptions of risk by the general public and stakeholders in South Wales on the issues of wildfires**. Understanding these perceptions are important in developing strategies for reducing risk from fire through targeted public and stakeholder information campaigns. Below is the discussion from the survey results.

The first few questions in the questionnaire were regarding respondents having seen a fire and its location and having seen evidence of a fire. The majority of all of those questioned, irrespective of location, had seen a wildfire burning within Wales, although there were important differences between locations. It was expected that most people from the Valleys locations would have seen fires or evidence of them as there have been over 21,000 between 2009 and 2019. (SWFRS Statistics Department). Indeed, five times more people questioned in Tonypandy had seen one compared to people questioned in Cardiff. This all tallies with Pope's (2016) research in the Brecon Beacons National Park (South Wales), which showed that 57% of people questioned had seen a wildfire and that the 'Valleys' was also the most common word associated with wildfires.

The majority of people questioned had seen evidence of where a fire had occurred. Again, the greater proportion in the Valleys compared to Cardiff was expected. The eight people questioned in Tonypandy (8%) and the eighteen people (9%) online who had not seen a fire burning were the same people who had not seen evidence of where a fire may have burned.

Almost all - 97.5% - of a total sample of 400 people questioned across Wales believed there is a risk to the public associated with wildfires. A report on wildfire in Wales with 1,000 questionnaires published in 2011 (Jollands et al., 2011) found only 33% of respondents believed South Wales has a problem with wildfires, and only 18% believed that wildfires were a problem in their local area. Jollands' research via telephone also found that stakeholders did not perceive wildfires as an important issue. Some of this strong difference to what I found may be explained by age and other complicating factors, such as Jollands et al.'s informal discussions with young people under 18 years of age, some of whom even admitted to setting fires. Specific age group categories were not identified by Jollands et al. and I did not question anyone under 18 years old. Nonetheless, the much greater proportion of respondents in the current work who perceived fire as a risk in South Wales is striking.

Jollands et al. (2011) also found that respondents who had seen a fire or evidence of one or had seen a publicity campaign aimed at raising awareness were more likely to consider South Wales to have a problem. If the perceived risk from wildfires is raised if people have seen one, evidence of one, or a publicity campaign raising awareness, then this could explain the very substantial increase in the perceived risk between the studies. There has been a large increase in high visibility campaigns using both television and internet social media platforms, plus education programs have been initiated in schools and colleges. There have also been a number of large wildfires seasons around the world gaining many hours of media attention, including some UK focused. Since the Jollands et al. study South wales fire and Rescue Service have become involved in a number of projects involving a large number of partners, the most high profile of these is the Welsh Government funded Healthy Hillsides Project. This project aims to engage with communities across South Wales and test different land management techniques to understand the effect they can have on reducing risk from wildfire.

It is also important to recognise that issues like risk from wildfire are typically cyclical (Mylek and Schirmer, 2020). Attention to a problem and perceived risk of the problem will rise and fall with media interest. In a study carried out in the USA, it has further been found that when respondents are provided with ecosystem and fire regime information for the area, they are more informed of the actual level of risk and make more informed decisions (Dupey and Smith, 2018). As most of the information about wildfires in South Wales is from the mainstream media or social media, and the majority of these outlets class all wildfires as 'bad', this must qualify the otherwise positive discovery of nearly all respondents seemingly being aware of wildfires in South Wales today, since they may have little true understanding what the real risk is from these fires.

Jollands et al. (2011) found that all groups questioned, including foresters and firefighters, considered wildfires to be deliberately caused. Yet, this did not translate into them perceiving wildfires as necessarily a problem. Out of the 400 people who completed my questionnaire, 24 (6%) from the online questionnaire stated their occupation as firefighter. All believed that wildfires were started deliberately and considered wildfires a serious risk to many people. This further seeming increase in risk perception could be because wildfires are becoming larger and become more difficult to extinguish and because firefighters now receive wildfire training which

emphasises risks. It all suggests a need for more research into perceptions of risk from fire managers globally (Dupey and Smith, 2018).

A question regarding the numbers of fires over the last twenty years, was asked as I was originally informed that the fire service had data on this with which I could compare survey results. It was, however, found during the current study that this data was not reliable. The UK Government introduced the Incident Recording System (IRS) in April 2009 (Fire Service Incident Recording System 2009). This online form is completed after every incident attended, whatever the incident type. This was a totally different way of recording incidents to the previous method: Fire Damage Report form 1 (FDR1) was only completed for fires where property was damaged. Because of this change of reporting, there was only appropriate data available from 2009-19 (Fig. 3.7). It showed the number of fires recorded exceeds 1000 in every year, from very small to very large.

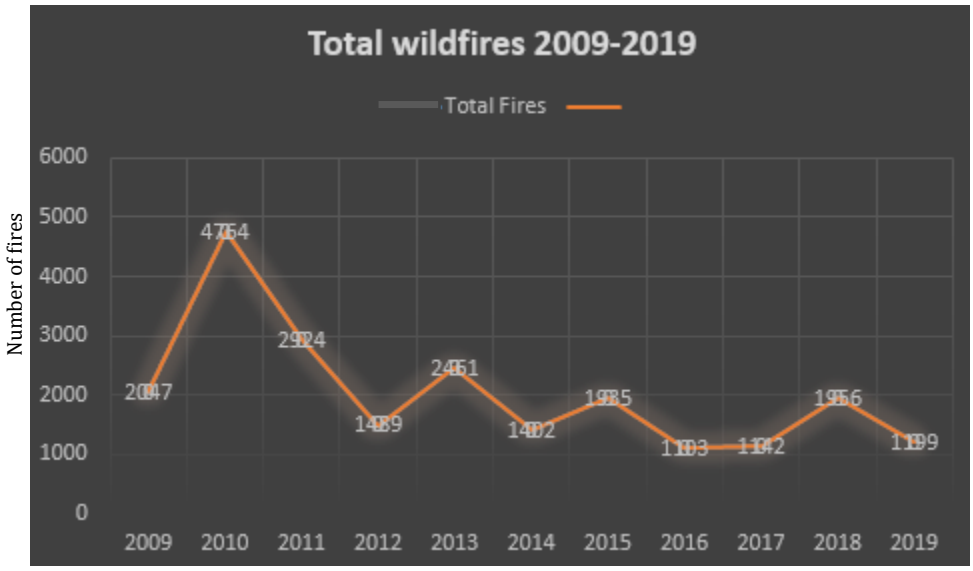


Figure 3.7 Total wildfire count, 2009-2019 (Data: SWFRS Stats Dept. 2020)

Figure 4.1, using the IRS data, shows that the number of fires has varied strongly over the last 11 years. This contrasts with the perception of the majority of responses that the number of wildfires had increased. As already stated, perceptions of the number of fires may be influenced by the amount of media attention these fires are getting, both in Wales and internationally. Fires are also becoming larger. For example, a July 2018 fire burnt for three weeks across 250 hectares of forestry, scrubland and grassland (SWFRS stats. Dept. 2019). It made national news on a number

of occasions (e.g. https://www.bbc.co.uk/news/uk-wales-south-east-wales-44880298; https://www.southwalesargus.co.uk/news/16379588.wildfires-continue-burn-twmbarlwm-mountain-cwmcarn-forest-drive-following-reports-deliberate-fire-setting/)

Identifying the number of ignitions is reasonably easy as most but not all are reported to the fire service. What is more difficult is to measure the area that is burnt. There has been little research on this in the UK. Smith (2020) has analysed data from the European Forest Fire Information System (EFFIS) for UK fires, 2011-20. There is only data available for Wales from 2017, shown in Figure 3.8, but it is available from 2011 for the other UK countries. From 2017 to 2020 the number of recorded large fires in Wales, rose from 10 to 39 and the area burnt from 564 hectares to 7840 hectares (Smith, 2020). It must be noted, however, that the EFFIS system only identifies wildfires over 30 hectares in size and can also miss fires due to cloud cover or the fire being of short duration, only burning between satellites over passing. For example, the total area burnt identified in 2017 by EFFIS is 546 ha, whereas South Wales Fire and Rescue Service attended a wildfire in the Brecon Beacons National Park between the 7th and 10th April which alone measured over 800 ha.

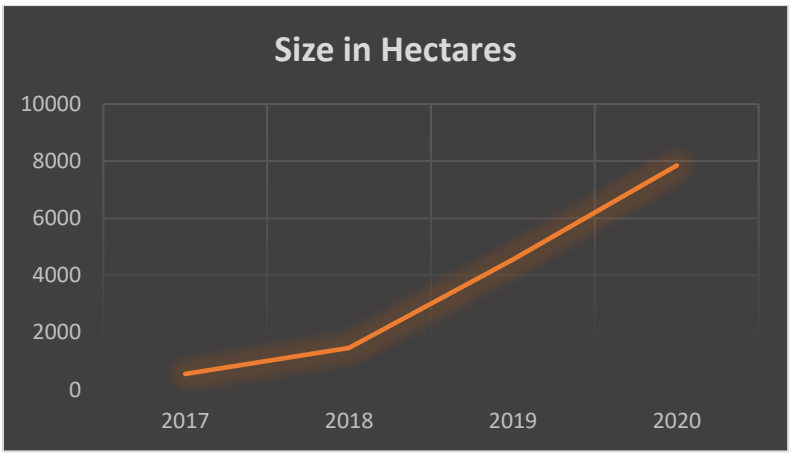


Figure 3.8 Area burned in Wales as identified by EFFIS (Data: Smith, 2020).

Two questions were about asked about how people thought fires were ignited: if deliberate or accidental and, if deliberate, by which age group. As with Jollands et al. (2011), there is still limited data available to compare these perceptions with who actually lights deliberate fires. However,

SWFRS statistics show in Table 3.9 that out of the 21,901 fires recorded only 1037 were determined to have been caused accidentally; 95% were deliberate.

Figure 3.9. Accidental and deliberate wildfires, 2009 to 2019 (Data: SWFRS Stats Dept. 2020)

The fact that most fires are started deliberately appears to be supported by the fact that there are very few fires in mostly rural and sparsely populated Monmouthshire and Vale of Glamorgan compared to areas surrounding the more densely populated valleys and cities, shown in Figure 3.10.

Returning to the findings of this study, almost all people interviewed recognised that most wildfires in South Wales are deliberately started. The biggest group of people questioned (47.5%) believed that fires are ignited deliberately by secondary school aged children (12–18 years). Currently there is no reliable data available to corroborate this, any evidence only anecdotal. It must also be noted that whenever a fire engine responds to an incident it attracts a crowd, and there will be a high number of children due to the excitement factor. This could be one of the reasons that the public associate children with fire setting. Although not suggested by respondents in my research, Carrol et al. (2021) found that in Ireland farmers get accused by the public of lighting fires. Sometimes they wish to burn land for management reasons and if they cannot do this legally they may light a

fire and leave it but how common place this is in Wales really is unclear. Wales and Ireland have similar vegetation, farming practices and weather patterns and the above information has also been mentioned in relation to Wales in Jollands et al. 2011 research but again is anecdotal.

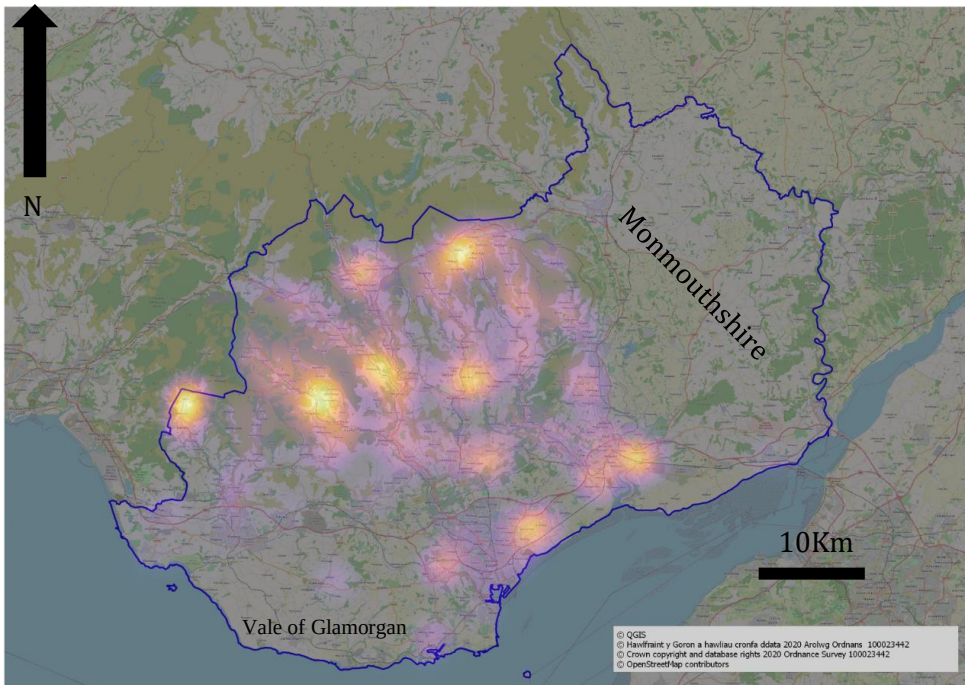


Figure 3.10. Heat map showing the areas of South Wales with the most wildfires 2009-2019 (Data: SWFRS Stats. Dept. 2020)

Turning now to prescribed burning, the majority of people from the face-to-face questionnaires (66%) were unaware that the fire service carries out such burning to reduce risk. In contrast, most responders to the online questionnaire (more than 75%) were aware. The reason for this difference may be that the fire service use social media to publicise their risk reduction work and the people who responded to the online questionnaire located it on social media. This further suggests that the face-to-face and online groups differ in their overall knowledge and resulting perceptions of wildfire in South Wales. If this is the case then there is an opportunity for development of an education strategy to bridge the gap, as discussed by Dupey and Smith (2018).

Unsurprisingly, most people questioned were also unaware that there are specific dates when prescribed burning is permitted, although the online group was more aware, reinforcing its more 'informed' impression. The general lack of knowledge around prescribed burning and the times

this is allowed echoes previous research in Ireland by Carrol et al. (2021) and in the UK by Davies et al. (2008) where they found that this knowledge is lacking.

3.9. Discussion of Comments of interest and Non-supportive/negative comments

From the 166 responses made in the questionnaires regarding the fire service carrying out prescribed burning there were 8 which stood out as interesting to discuss and 35 which were not supportive or at least raised questions. All are listed in Appendix 4. The non-supportive and questions have been coded into four categories as described in the Result sections:

Comments of interest

Six of the comments were around how prescribed burning has been carried out in the past to remove dead grass and encourage new growth after the winter. These comments were all made by responders over the age of 61. The use of prescribed burning by land managers appears to have reduced significantly over time. Anecdotal evidence gained from speaking to farmers and commoners does not suggest one specific reason but many. Changes to legislation with the risk of losing the single farm subsidy for noncompliance, less workforce and less animals to put out onto common land are topical as well as not using common land due to anti-social behaviour resulting in the reason for burning not being required.

A comment from a forester stating they were guilty of complacency before a fire and climate change is increasing the risk, it was interesting to note that they stated they can improve their forest design plan to protect it from fire but it is the 'valleys attitude' which is a significant problem. This mirrors comments from the stakeholders regarding arsonists having no empathy with the landscape.

Public information

These comments support of the use of prescribed burning but also a desire for more information on when and why it is being carried out. This once again reinforces a need for a more extensive communication campaign to explain the process (Dupey and Smith, 2018).

Engaging this information point further, it must be noted that because of the unpredictable weather conditions, with high levels of precipitation in South Wales during the prescribed burn season, it

is very difficult to plan in advance the exact dates when burning will occur. Hence, the sites and dates of burns are constantly changing. Whenever burns do take place, their locations are shared on the fire service Facebook and Twitter social media pages. The fire service control room are in radio and mobile phone contact with the officer in charge of the burn and the burning activities are allocated an incident number and radio channel as in real incident. This means if smoke is seen by a member of the public and they call the fire service the control room operators can contact the crew on the ground to see if this is their prescribed burning and not an incident. If any doubt, a fire engine will be mobilised.

Prescribed burning itself is always carried out by crews wearing bright red or gold personal protective equipment so they are easily identified as firefighters. A fire engine is generally parked nearby to alleviate any concerns. It may be possible to have a dedicated website page for this information but the amount of prescribed burning carried out does not really warrant it. For example, in the five years I have been carrying out prescribed burning in South Wales, I am aware of only one occasion when a member of the public called the fire service and an engine was mobilised to a false alarm.

Environment and wildlife

These comments tap into the destructive power of fire. Whilst this clearly cannot be denied, greater distinction needs to be made between true wildfires and the use of prescribed fires, which may also have relative benefit to wildlife. Harper et al (2018) discusses the blurred lines between the effects of prescribed fires for land management and the use of prescribed fires to mitigate the extent, likelihood and impact of illegal arson. The effects of prescribed burning in the uplands for game/land management has been researched but there appears to be no UK research into the effects of prescribed burning to mitigate risk or protect habitats. The creation of fire breaks across landscapes have to potential to stop landscape size fires and protect biodiversity.

From 2000 to 2019 there were over 79,600 wildfires in South Wales, 55,000 between 2000 and 2008 (Jollands et al., 2011) and 21,900 between 2009 and 2019 (SWFRS stats dept. 2020). The

fire service and partners have worked hard to reduce the numbers of ignitions and raise awareness of the risk, although when ignitions are reduced this somewhat paradoxically leads to a build of vegetation which means subsequent wildfires have the potential to be more damaging.

In contrast, prescribed burning activities are planned in advance and sites only chosen after taking into consideration the previous number of wildfire ignitions in the area and the risk from wildfire to life and property. Burning only takes place under specific weather conditions when the ground is still damp, to lessen risk. The fire service only burn strips of land to break up fuel continuity, so if wildfires do occur the total area burnt will be less and there will be less loss of habitat. From all of this, there is always the chance that prescribed burning can damage wildlife habitats but this is lessened by just burning strips, only carrying out burns in areas already burnt or with a high chance of being burnt, and by only burning under favourable weather conditions.

As outlined before, the three main methods to remove unwanted vegetation are burning, cutting and grazing but that latter two also have their own environmental impacts. As well as burning, the fire service do cut fire breaks but this is a much slower process, costs more due to the machines needed and the machines cannot always cut every area due to ground conditions, access difficulties and land steepness.

The ecological complexity of trying to manage wildfires is further illustrated in the following example. In March 2015, a crew from SWFRS carried out a prescribed burn for the Wales and West Wildlife Trust so they could reintroduce grazing in an overgrown field. The crew burnt an area of approximately one hectare from the middle of a six hectare field. The weather conditions were dry, but the ground was still damp. After the burn Trust volunteers walked across the site to see if there were any signs of damage or dead wildlife but they found none. Approximately one month later, however, two wildfires occurred on a common managed by the Trust, burning an area of approximately 7 hectares. After these fires, volunteers again walked the site to look for signs of damage or dead wildlife. This time they found (Figure 3.11-3.13) forty six dead slow worms, two dead adders, one dead toad and two dead shrews. There were also fifty three damaged bird nests and thirty two damaged mammal nests.

Figures 3.11, 3.12, 3.13. Dead mammal (top), snake (bottom left) and slow worm (bottom right) found at site of a wildfire by wildlife trust volunteers Photo credit Wales and West Wildlife trust.

Negative comments and comments requiring further general information.

On the one hand, only four respondents of all 400 questionnaires were strongly critical of the practice of prescribed burning, at least as they understood it.

Examples of the comments were:

Don't think there any need for this to be done

Think it's a waste of time and resources

On the other hand, the practice could still be presented more openly to counter potential critics as shown here. Fire crews are constantly training to prepare for incidents, it is very difficult to train

for a wildfire without seeing and extinguishing an actual fire. For many years, the only preparation work the fire service carried out before wildfires starting in the spring was to ensure there were 5 fire beaters on each fire engine. By being more proactive, the Fire Service can now protect vulnerable areas before fires are lit. Furthermore, carrying out prescribed burning gives crews an opportunity to observe fire behaviour and get an understanding how fires behave in different fuel types. There is no significant cost to these activities as the crews are already at work. During a prescribed burn a crew will consist of 5 firefighters who will be out working for a few hours per shift, depending on weather conditions. This can be compared to fighting wildfires, which require many more resources including fire engines, water carriers, 4x4's and helicopters for days and nights on end. A result of these large wildfires could inevitably be major damage to the environment.

SWFRS ran a trial in 2004 to see if there would be fewer instances of arson if the fire engines being mobilised did not use their blue lights and sirens whilst on route to the incident. It was suggested that this would remove an excitement factor for arsonists but all it did in practice was slow response times, which meant that fires had more time to develop and needed more fire engines to extinguish.

Attention must surely go, therefore, less to such well-meaning initiatives and more to the preventative potential of prescribed burning. Once the dead vegetation on the valley sides is dry in early spring, the fires start. With a recorded number of nearly 80,000 wildfires in 20 years, it is hard to see how the smoke and flames seen from the small number of prescribed fires will encourage arsonists. And finally, as prescribed burning activities are much less of a risk than wildfires, this gives fire crews the opportunity at the time to engage with members of the public and discuss what they are doing and why.

Landowners / managers and training

These points largely centre on the practices of the owners of the land. If more animals were grazing on the hillsides there would be less vegetation available to burn but an alternative fate for this vegetation is not for bedding as it is usually not cost effective and often not even possible to harvest it. As noted above, Carrol et al. (2021) have observed the link that has been made between farmers

and wildfires. Certainly, farmers have traditionally burnt dead vegetation in the spring to clear land and green it up quicker for grazing animals. There is very little training available for this activity and farmers are generally the older generation and work singlehandedly. However, burning land is not as popular as it once was and to burn land now under-grazed has the potential to cause fires both larger than in the past and unmanageable (Carrol et al., 2021). Finally, with damage caused by fires to sheep fences in the uplands, it is unlikely that a farmer would deliberately let a fire get out of control and have the burden and the cost of replacing these fences.

Clearly, however, the comments on partnerships and training together are very pertinent. A key to getting on top of the problem of wildfires in the South Wales Valleys is through partnerships and the coordinated lessons and training these can facilitate (Figures 4.5 and 4.6). SWFRS work closely with a wide range of partners: Police, Natural Resources Wales, volunteer groups. The fire service work, for example, with commoners and grazier groups, including the Welsh National Union of Farmers, to educate and help manage land in a safe and controlled manner with both fire and cutting machinery. Here, it should be noted that an aim of prescribed burning is to not only reduce the risk to communities and firefighters, but also to assist and educate land managers. Whilst there is often real difficulty in booking specific dates for burning activities due to rain (this is the reason straw is used when training, which can be spread out at the last moment and burnt even if raining), getting partnership groups together at short notice is a logistical problem that can be overcome.

Figure 3.14 Prescribed fire Training event for NRW foresters and ecologists. September 2018.

Photo credit - author

Figure 3.15 Straw spread out at Usk Agricultural College for a burning demonstration for students, families and farmers. June 2018.

Photo credit- author

A final comment to note was that prescribed burning activities '*Should be carried out by professional people and not the fire service'*. It is unclear whether this implied that the fire service was not 'professional' or whether it should not be burdened with an additional role.

This again shows that more media attention is required in regard to the reasons for prescribed burning and the actual process. To reiterate the actuality: firefighters are trained professionals highly regarded by the public, every firefighter undertaking any activity as part of a burn team has attended a training course covering theory and practical burning; and all are equipped with suitable PPE and always have fire suppression equipment on hand. Whilst carrying out these activities not only is there a gain for the public with the reduction of vegetation but the firefighters are also gaining valuable experience The alternative: at present there is very little training available for land managers who wish to carry out prescribed burning activities and large areas of land damaged by wildfires are unmanaged. In summary, there is no other group than the firefighters who can deal with wildfires in South Wales in 2021.

4. Stakeholder interview results and discussion

Below are the stakeholders' responses to the eight questions, the responses have all been grouped to allow easier reading and understanding. The identity of the stakeholders, their organisations and role are given in Table 2.1

4.1 Stakeholders' interview responses

1. Do you consider wildfires are a risk to the public, the fire service and property?

Everyone asked answered yes to this question. Overall, all stakeholders agree that wildfires pose a risk to the public, the fire service and property. Most of them were also concerned about the environment:

Davies believes that "wildfire is a risk to public health and these impacts are likely to be long term and not yet fully understood." "The unpredictability and size of wildfires make them extremely risky to the public, fire service and property." "Wildfires are also a risk to our environment and the knock on effects to the public and public services can be great."

Hogg believes that as well as a risk to the public, fire service and property "the impact also extends to the impact on the environment." is also a long lasting risk to the environment.

Elgar believes there is a "direct risk to the public, fire service and property and there is also an indirect risk."

Yorke believes there is a "risk to the fire service and property, and that the risk to the public is less as they should see a fire and move away from it to a place of safety." He also believes the "risk to the fire service can be lessened if they do not fight every fire if the effects the fire is having are minimal."

Nugent believes that wildfires are "a threat to fragile habitats, responders and rural communities." "This risk can be reduced by having sustainable landscapes."

Held is concerned for all three and stated that "in an urbanised fragile society even a small wildfire can have catastrophic consequences and cause major disruption."

2. Do you believe that reducing the number of ignitions will reduce the risk or is there also a need for fuel management?

Overall, all stakeholders agreed that reducing ignitions had potential to reduce risk but fuel management will also be required:

Chapman believes that "reducing ignitions alone will not reduce the risk from wildfires, more emphasis is required on fuel management."

Davies believes that the "reduction of ignitions is a good but one ignition can still cause a massive risk, therefore fuel management should become a priority to reduce the risks from wildfire."

Hogg also believes "there is a need to both reduce the number of ignitions as well as considering fuel management."

Elgar believes that "fuel management is crucial as it can bring multiple benefits. However, it must be appropriate and not to the detriment of biodiversity/protection of habitats."

Fletcher believes that "reducing the amount of ignitions will reduce risk." When discussing prescribed burning Fletcher states "there is a role for this type of management, especially if it is considered and then coupled with good environmental management. By this I mean that there should be no burning on deep peat habitats (more than 50cms) as the risk of damage to this type of peatland is too high and has large environmental consequences" "Where burning on the habitat is an appropriate method of management, then if burning can consider important biodiversity e.g. SSSI features, BAP species etc and burn in a way which avoids damage or benefits. For example if there are areas of heath with rare plants susceptible to burning, these would be excluded, and if there were nesting birds of prey, again these would need to be considered and consulted on, even outside of the breeding season to not impact on the right structure of habitat for them."

Yorke was concerned that the effects of the "UK leaving the European Union could lead to a reduction in grazing on the uplands which will lead to a build of vegetation. This could also lead to more tree planting so it is important that the right tree species are selected so not to add to the risk." "Burning of vegetation at specific locations may be required to reduce risk."

Nugent believes that "the timing of ignitions is more important than the number of ignitions. Ignitions in high risk weather are much more of a risk than in low risk periods. Sensible fuel management will reduce the severity and extent of wildfires."

Held believes that "fuel management comes first. Reducing ignitions is helpful, and part of the tool box, but the fuel is the key role player here. While we can never eliminate all possible ignition sources, we CAN manipulate the availability, structure, composition and amount of available fuel BEFORE an unwanted fire occurs."

Thorp believes that "reducing ignitions and fuel management will both reduce the risk of damage from wildfire. Both actions may be appropriate in some areas, but in other areas one or other of these two actions may have the greatest impact on the risk of damage."

3. Statistics show that the majority of wildfires in Wales are started deliberately, in more rural areas this is usually believed to be landowners / managers. What extra help can be given to these groups to stop deliberate fire setting?

Overall, all stakeholders agree that help in the form of training for land managers will help stop deliberate fire setting:

Chapman believes that "training sessions for graziers and landowners/managers are essential so they understand the full impact and consequences of unwanted fires." "There should be better access to gain licenses for burning outside of the season which can be hampered by bad weather, without easy access to licenses there is a risk of deliberate fire setting rather than correctly controlled managed fires. A significant financial penalty system should be introduced to subsidies and grant schemes for landowners who burn illegally based on satellite observation of vegetation and soil degradation. Multi-agency task groups should be set up to give guidance and professional assistance to groups on the ground. This will range from how to fill in applications to practical assistance for safe and legal burning."

Davies believes that "if people understood the impacts of fires and how these impacts affect local communities they would act more sensibly." "More community based solutions are very important to give ownership of the problems back to communities."

Hogg believes “support is needed for landowners so they understand the impact and consequences from deliberate fire setting.”

Elgar believes that “there are a number of possible sources of ignitions for wildfires, some intentional and some accidental.” Elgar believes the following may help reduce the number of uncontrolled fires on agricultural land.

“Education – engagement and education exchanges with the agricultural community. A consequence of burning can be the undesirable domination of molinia grass, a fire adapted plant, the very thing which fires are then set to remove.

Planning - facilitate the development of fire plans and their implementation with individual farms and grazing groups.

Communication – it is very important that everyone affected understands that land managers are part of the solution and not just part of the problem.”

Fletcher believes that “engagement and awareness raising with landowners around the consequences and benefits of burning.” This will “enable them to make the right decisions on if and when to burn and to seek the proper consent with the correct safety mechanisms in place. Training and support for upland managers where burning is identified as appropriate is required to enable and empower them to act appropriately and safely.”

Yorke believes that “classes/course are required to enable land managers to burn safely.”

Nugent believes that “assistance should be provided to support landowner/managers who wish to use fire responsibly. This should include professional standards, planning and implementation. Follow up monitoring of prescribed burnt areas is essential to understand the relationship between fire and the effect on the landscape. The information gained needs to be shared as best practice.”

Held believes it is “very important we do not assume anything in relation to fire setting and ignitions need to be investigated. We can then empower landowners to apply fire safely at the correct times with reduced risk. Working against the interests of land managers will never be sustainable.”

Thorp believes that "Training and raising awareness of the risks associated with bad practice when carrying out prescribed burning. The aim should not be to prevent prescribed burning (deliberate fire setting?) but to stamp out bad practice."

4. Statistics show that the majority of wildfires in Wales are started deliberately, in more urban areas this usually believed to be reckless fire setting. What do you think are the reasons for this behaviour?

Overall, all stakeholders agree that there is a disconnect between fire setting and the consequences of these actions:

Chapman believes "that reckless fire setting is due to a total lack of empathy with the results of uncontrolled fires."

Davies believes this may be because of "a disconnect between land users and landowners." This may also be because of a "lack of understanding of land management practices." "More joined up working with communities, land users and landowners could reduce the fuel load and lead to less uncontrolled fires being started."

Hogg believes "there are probably many reasons for fire setting and as with any anti-social behaviour it can be very complicated to understand the reasons why. It is possible people who light these fires do not understand the consequences of their actions and have little empathy for the people and nature which are affected."

Both Elgar and fletcher did not believe they or their organisations did not have sufficient knowledge to comment on this question.

Yorke believes that it could be because of "boredom or just for fun. It may also be just too easy."

Nugent believes "there is a disconnection by offenders from the outcomes of fire setting and the perceived low risk of offenders being caught and punished by authorities."

Held believes "youths need a vision and a purpose in life. With few role models and youth development/leadership programmes, high unemployment and low education levels and a

disconnect with nature there will always be problems. This is not only a fire problem but a societal problem with way more wicked problems than fire setting. Fire is just the tip of the iceberg."

Thorp believes that fire setting is due to "the 'fun' element of causing mayhem and then sitting back and watching the fire develop and firefighting activities."

5. There is no formal process for wildfire fire investigation. Do you agree that if the cause and origin is known then community safety activities can be aligned to these findings?

Overall, all stakeholders agreed that it is essential to investigate fire ignitions to plan effective community safety strategies:

Chapman believes "that this is essential as it can identify the cause of the fires. Plans can then be developed to target activities to stop the ignitions or reduce the impact."

Davies believes that "understanding the issues and identifying the causes is of great importance." "Working on assumptions of who starts fires and why can lead to poor use of resources to tackle the problem. Information and evidence is very important."

Hogg believes that "engagement with communities and the investigation of ignitions is essential in finding long term sustainable solutions."

Elgar believes that "it is very important to understand the reasons behind the causes so that appropriate solutions can be implemented."

Fletcher believes that investigation "can potentially be of benefit although it does depend on the findings how this can feed into a community safety strategy."

Yorke believes that "identifying the causes of fires can provide data as to where community safety resources are required and lead you to be able to identify the correct groups to target."

Nugent believes that "investigation of ignitions is essential so that data acquired can lead to an adaptive management approach."

Held explained that “fire investigation is common in other countries and how this leads to structured data lead campaigns to reduce ignitions and to plan fire mitigation strategies.”

Thorp also believes that “investigation of ignitions is required to gain more information about the fires, the source of the ignition, the area affected and an assessment of the impact. Etc.”

6. The guidance for the burning of heather and grass published by the Welsh Government asks if prescribed burners have attended and passed a certified course. Do you believe it should be mandatory to have passed a course before being entitled to burn land?

Overall, all stakeholders agreed that training would be beneficial, there was difference of opinion what format this training should follow:

Chapman believes “this is essential but it must not be a paper exercise, it needs desirable outcomes and would need a renewable license system with bi annual course attendance.” He also stated that the “course would cover essential criteria and could be linked to a prescribed burning workbook which is completed by practitioners as a record of achievement.”

Both Davies and Hogg believe that training is required but were not sure what format this would take. Davies states “this should be mandatory”

Elgar believes “a system of imparting best practice to land managers would be beneficial however, we do not have an opinion on if this should be mandatory.”

Fletcher believes that “passing a course is one way to assess competency. There may be other ways to assess competency, e.g. some sort of assessment for people that have done it for a long period of time safely. However, some kind of assessment of competency would be useful. This could be one such mechanisms.”

Yorke believes “passing a course would be useful to enable people to burn safely” but does not have an opinion on the format of such training.

Nugent believes “it is preferable that people supervising burns have received some form of training.” He also believes that “it is not essential that this training be formally accredited for all users.”

Held believes that “people who wish to burn land as a management tool should be evaluated against a set standard such as the eurofire standard EF6. https://gfmc.online/wp-content/uploads/EuroFire-Training-Materials-EF6-Ignition-ENG.pdf . This gives basic understanding of equipment, ignition sources and safety.”

Thorp believes that “some experience is essential but there are insufficient training courses available for prescribed training to insist on attendance at a formal course. Attendance at a course must also be combined with practical experience before anyone can claim to be qualified to carry out prescribed burning. This is a complex issue and more discussion is needed on this topic. In Scotland initial discussion has taken place and there is little opposition to the proposal that training and experience should be documented so that those carrying out prescribed burning can prove competency.”

7. Do you have any comments on the use of prescribed burning by the fire service?

Overall, all stakeholders agreed that prescribed burning by the fire service is a positive action, there was also discussion how this can benefit land managers by assisting with training and transfer of skills:

Chapman believes that “prescribed burning has long been one of the tools best suited to controlling vegetation and stopping large upland wildfires. If fire and rescue services have the resources to work with landowners and groups the public engagement at this level can only be a good thing.” As “fire and rescue personnel are respected within communities this could be an excellent way to raise other user’s competency.”

Davies “would like to see fire and rescue services work closely with land managers so both sides can understand the benefits and problems associated with prescribed fire.” “Working closely with conservation managers can open up options for land management such as burning where other options have been exhausted. Understanding the effects prescribed fire use compared to the damage caused by a wildfire will enhance understand by all involved. By working together there

will be an increase in the importance of conservation and an understanding for constraints at appropriate times."

Elgar believes that the use of fire by the fire and rescue service "is a valuable tool in a toolbox of options. There is no one quick fix to controlling fuel loading, it may also involve a combination of modifying grazing practices and cutting."

Fletcher believes that the use of fire by the fire and rescue service "can be a very useful way to protect the environment, people and property although the caveat is how it is done and where, ensuring there is consideration to local environmental needs."

Yorke believes this is an "excellent opportunity to work with land managers so learning can be shared and links with the rural communities enhanced. This would also be an excellent opportunity to give local education and information." This would also be a "good opportunity to implement certified courses, training or competency assessment."

Nugent believes this is a "very good idea and it is an ideal time to work and make links with local land managers." "As the fire and rescue service and government agencies are held in high esteem it is essential that fires are managed correctly with no escapes so the highest standards of decision making need apply."

Held believes that "fire and rescue services who have developed the skills and knowledge to burn are in a fantastic position. Ideally firefighters should be proficient in using prescribed fire before they fight wildfires as their understanding of fire behaviour will be greatly enhanced. This would also be enhanced by working with land managers to transfer skills. Once firefighters have the knowledge to use prescribed fire they have a transferable skill that they can then use to use fire to fight fire in the operational arena. Some European countries have teams who role is to manage the fuel build up, the fire service could build and maintain these teams to develop future firefighters."

Thorp believes that the use of prescribed fire "gives fire and rescue services valuable training in managing fires on open land as well as reducing the risk of damage to areas protected by the fire breaks they have made. However, there is a danger that the FRS will be expected to carry out all prescribed burning in Wales. A cadre of people with experience of prescribed burning needs to be developed and maintained if enough prescribed burning is to take place in Wales."

8. The season for prescribed burning starts in October and ends on the 15th March (Lowlands) and 31st March (uplands). Most burning occurs in late winter and early spring once the vegetation has cured, this is normally February to March. This legislation is for the protection of ground nesting birds whose nests can be destroyed by prescribed burns and wildfires. If these months are wet then there is very little opportunity to carry out prescribed burning. Do you think the fire service should have an exemption to allow them to create strip fire breaks outside of the prescribed burning season?

Overall, all stakeholders apart from Fletcher agreed that there could be positives in allowing the fire service to burn out of season to remove vegetation. Most agreed this would need to be done on a site by site approach:

Chapman believes that "fire and rescue services should have better access to licenses to carry out burning outside the legal burn season." "Fire and rescue service can identify through statistics high risk areas and manage these before fire occur. Given the speed of change to our climate and the inability of vegetation types to keep pace, fire breaks will need to be created or maintained in most landscapes whether they are natural, planted or burnt. No group should have blanket exemption but the system to allow burning needs to be more dynamic and as a result better at achieving its aims."

Davies believes "an exemption could be possible in some circumstances and a blanket ban on the use of prescribed fire is not always useful and a more considered approach could be more effective." Davies explained that "Working with an ecologist can make prescribed burning appropriate in some locations and instances based upon the habitat and circumstances. Having action plans for locations in place to mitigate for the ecological factors can be achieved, though not a given. Prepping the land in advance can prevent birds nesting and therefore prescribed burning would be appropriate and not cause harm. Each site should be looked at as an individual case. By the Fire Service working closely with an ecologist or employing one as part of a trial could work around this issue."

Hogg believes "burning should be allowed outside of the permitted season but as assessment is always needed on a site specific basis."

Elgar has “no view as to how legislation might be changed, however we acknowledge that each individual situation may have its own circumstances where a degree of flexibility would help reduce the severity and impacts of wildfire.”

Fletcher believes that there should be no legal exemption. “The nests and eggs of birds are protected by law and it is impossible to know what ground nesting species are present and to be certain that no nests were destroyed or chicks killed, in fact it would be highly lightly that some were.”

Yorke believes that the “burning by fire and rescue service outside the permitted season may be possible in high risk areas where other methods are not viable.” It should “not generally be used in high nature value areas although this is a very tough situation and a case by case assessment will be required.”

Nugent believes that prescribed burning outside of the permitted season “may be required although it should be possible with flexibility and planning to burn within the dates provided, although dedicated resources may be needed to achieve this.” “Once the season is closed wildfires of low intensity can be managed as ‘wildfire within prescription’. These fires if ignited can augment formal burning and be allowed to burn whilst being managed by fire and rescue personnel.”

Held believes that “the fire and rescue service should be permitted to burn all year round.” He states that “ground nesting birds are at risk from a long list of predators, environmental conditions and last but not least by loss of habitat. By not managing land and not creating fire breaks to break up the landscape wildfires can lead to complete loss of habitats and species. So in view of the bigger picture the potential loss of a small number of nests to managed fire will in overall benefit the larger population and habitat.”

Thorp believes that fire and rescue services should have an exemption, “the existing season is too restrictive. Anyone attempting to carry out management of vegetation using prescribed burning is severely restricted and this leads to not enough burning taking place. Cutting is often not an alternative due to the nature of the ground. The result is that vegetation depth, and hence fuel load, increases, which in turn increases the risk of damage from wildfire. The effect of this is to put at risk the habitat the restrictions on burning dates were designed to protect. A more flexible approach is required which would place more responsibility on the land managers to employ best

practice techniques to maximise the benefits and minimise the risks associated with prescribed burning."

4.2 Stakeholder interview discussion

As already explained, three of the stakeholders were not from Wales, but were very experienced in dealing with and understanding the complex issues of wildfires. The responses from Held, Nugent and Thorp are clear to see in the text. As in the Results, stakeholders' opinions will be considered here question-by-question.

Key outcomes

Question	Agreed	Disagreed
1. Do you consider wildfires are a risk to the public, the fire service and property?	All stakeholders show broad agreement on the topic of risk from all stakeholders	
2. Do you believe that reducing the number of ignitions will reduce the risk or is there also a need for fuel management?	All stakeholders agreed	
3. Statistics show that the majority of wildfires in Wales are started deliberately, in more rural areas this is usually believed to be landowners/managers. What extra help can be given to these groups to stop deliberate fire setting?	All of the stakeholders believed that if landowners/managers had more assistance to learn how to burn safely, and to understand the consequences of bad practice there would be a reduction in deliberate fire setting	
4. Statistics show that the majority of wildfires in Wales are started deliberately, in more urban areas this usually believed to be reckless fire setting. What do you think are the reasons for this behavior?	All stakeholders agreed that deliberate fire setting is due to a lack of empathy by those igniting them with their surroundings.	
5. There is no formal process for wildfire fire investigation. Do you agree that if the cause and origin is known then community safety activities can be aligned to these findings?	All stakeholders agreed on the importance of investigating the cause and origin of wildfires agreeing that the results can then be used to provide data to where community safety resources are required once	

	the correct groups are identified	
6. *The guidance for the burning of heather and grass published by the Welsh Government asks if prescribed burners have attended and passed a certified course. Do you believe it should be mandatory to have passed a course before being entitled to burn land?*	All stakeholders supported the need for attendance at a training course before carrying out prescribed burning	
7. Do you have any comments on the use of prescribed burning by the fire service?	Everyone agreed that this was a good thing.	
8. The season for prescribed burning starts in October and ends on the 15th March (Lowlands) and 31st March (uplands). Most burning occurs in late winter and early spring once the vegetation has cured, this is normally February to March. This legislation is for the protection of ground nesting birds whose nests can be destroyed by prescribed burns and wildfires. If these months are wet then there is very little opportunity to carry out prescribed burning. Do you think the Fire service should have an exemption to allow them to create strip fire breaks outside of the prescribed burning season?	Most stakeholders agreed that the fire service should be able to carry out prescribed burning year round a site assessment to identify environmental considerations would be required.	Fletcher disagrees with the use of fire year round and believes there should be no legal exemption and the nests and eggs are protected by law.

There appears to be strong consensus between the different stakeholders. Fletcher disagrees with year round fire use which is understandable due to the perceived risk to ground nesting birds.

Do you consider wildfires are a risk to the public, the fire service and property?

Results show broad agreement on the topic of risk from all stakeholders. Yorke was of the opinion that the risk is less to the public than to the fire service. He also stated that the fire service could reduce the risk to themselves by not fighting every fire depending on the fire's impact. This highlights the idea that 'fire' is portrayed simply as bad and should be extinguished (Scott et al.,

2016) and the interviews by Van Der Wal (2017) who found that non fire specialists could not understand why the fire service do not leave some fires to burn.

Long lasting risk to the environment (Hogg)

Five stakeholders also raised the importance of damage to the environment from wildfires being a concern and the long-lasting impacts are unknown. Firefighters need to understand this and be able to manage this risk. As many of the stakeholders have a role in environmental work this response is to be expected. Held commented on the major disruption that can be caused by even small wildfires. This has already happened in the UK with the closure of major roads, railways and even flights diverted (McMorrow, 2011).

Yorke stated that the public can move away from fires to a place of safety. This may be the case in the rural uplands but is not so easy when the fires are impacting on communities as they do in the densely populated Valleys. This highlights the difference in areas where fires are fought from very rural to very urban. Yorke also raised important points about knowing the effects the fires are having on the landscape. If firefighters do not have this knowledge, then they work hard to extinguish every fire. Lack of knowledge means that fires burning in early spring which can be termed 'mildfires' as they do not cause lasting damage and are generally easier to extinguish, are extinguished to leave the vegetation for possible 'wildfires' summer which are generally a lot harder to extinguish and can result in long term damage. This was discussed by Stephens et al. (2014) in the US context, where the policy of extinguishing all fires without questioning any ecological or prevention effects has led to a build-up of vegetation and resulting wildfires that are very difficult to extinguish. With more knowledge, firefighters would be at less risk and there would be less risk to the public if they manage the fires rather than fight them all, as discussed by North et al. (2015).

Finally, long term health issues associated with smoke from wildfires are not yet fully understood. Public Health Wales have been carrying out research into self-referrals to general practitioners'

surgeries following high numbers of wildfires in valley communities where the smoke lingers. This research is currently ongoing.

Do you believe that reducing the number of ignitions will reduce the risk or is there also a need for fuel management?

Reducing ignitions alone will not reduce the risk from wildfires (Chapman)

All stakeholders agreed that reducing ignitions without managing the fuel would not reduce risk, Fletcher stated that there may be a need for fuel management but alongside good environmental management. Davies believed that a reduction in ignitions would be good as one ignition can lead to a large fire and fuel management should become a priority. Most commented that fuel management was important and more emphasis is required. Held believed that fuel management must come first as fuel is the 'key player'. The rationale for managing fuel is clear. Once a fire is ignited the behaviour is determined by the weather, topography and fuels. Pre-emptive management actions to mitigate the negative consequences of fire are restricted to fuels (Fernandes and Botelho, 2003).

Fletcher was concerned that there should be no burning on deep peat, areas with rare plants or areas with ground nesting birds of prey. Yorke had concerns that there will be a fuel build up as a result of fewer grazing animals as a consequence of the UK leaving the European Union. This fuel build up was found in research into field burning in Ireland as a consequence of less grazing and burning (Carrol et al., 2021). Nugent stated that it's the timings of ignitions and not the number of ignitions which cause problems. This would seem important as all wildfires which have become major incidents in the UK happened in late spring or summer.

Reducing ignitions without managing the fuel which will build up will cause future problems (Carrol et al., 2021). It is understandable that Fletcher did not support burning in certain area but she does not comment on what can be done to lower risk from wildfires. The Fire Service have actively patrolled for many years to try to stop wildfires and this has had little effect. It may even have caused more issues as patrolling was just as vigorous on days of lesser risk as on days of very high risk. It is a very complicated issue and requires robust thought and reasoning to allow some fires to be ignited which could lead to a lessening of risk in the future. This was supported by Nugent. Held's support of a toolbox of ideas to manage wildfires is also very important and fits in well with current policies within South Wales Fire and Rescue Service.

Burning on deep peat was highlighted by Fletcher as very bad for the environment due to loss of carbon. This idea is mirrored by environmentalists across the UK but with little comment and no way to deal with risk. Much peat erosion in the UK can be traced to fires or exceptional downpours (Albertson et al., 2009), although there is no research to state if the former are wildfires or prescribed burns. The issue of managing vegetation over peat was discussed by Davies et al. (2016) and Carrol et al. (2021), who found issues around fires and fuel management complex and needing an evidence based approach. Burning strips instead of large areas could be a way to reduce risk whilst also protecting the peat. If burning is carried out when the soil is still wet and does not remove all of the vegetation, which could lead to erosion, this could be a vital tool to protect these areas by breaking up the fuel continuity and will not be as damaging as some believe. It needs to be recognised more widely that through prescribed burning we can manipulate the fire regimes of the British uplands to manage the threat and impact of wildfires (Davies et al., 2008). Leaving areas without management is a game of chance. Yorke's comment regarding the loss of grazing animals is a very real threat to the South Wales uplands. The effects of less grazing have already been seen and subsequent fuel build up can cause problems such as the already mentioned large fires in the Brecon Beacons National Park. Environmental schemes and agricultural policy need to also consider the consequences to the environment from their actions.

Statistics show that the majority of wildfires in Wales are started deliberately, in more rural areas this is usually believed to be landowners/managers. What extra help can be given to these groups to stop deliberate fire setting?

The aim should not be to prevent prescribed fire but to stamp out bad practice (Thorp)

All stakeholders believed that if landowners / managers had more assistance to learn how to burn safely, and to understand the consequences of bad practice there would be a reduction in deliberate fire setting. Chapman believed that better access to licences to burn out of season may also help but there should be significant financial penalties for landowners who burn illegally. This has been carried out in Ireland and has had positive results (Carrol et al., 2021). Elgar and Held agreed that there are a number of potential ignition sources and nothing should be assumed. Held also believed that landowners need to be empowered to burn safely. Davies, Hogg and Nugent agreed that if landowners better understood the relationship between fire, the landscape and local communities they would act more sensibly. Davies believed this could be achieved by community based solutions and Nugent and Chapman felt it needed professional assistance.

There is currently very little training available for landowners who wish to use fire and if there was more then maybe people would act more responsibly. Landowners who burn their land do so for their own reasons, which may not be in line with ecological reason or public opinion. In a study in Argentina, Pissolito et al. (2020) found that management actions should consider public perceptions and include education programs and signage. The burning code states that further information regarding burning can be gained from the local fire and rescue service but these organisations do not always have the knowledge or capacity to offer assistance. This issue has been tackled within South Wales Fire and Rescue with the appointment of a landowner engagement officer who works with landowners and commoners to gain trust and promote best practice. It is not always easy to gain trust, as was found by Davies et al. (2016) and completing research is difficult as land managers are less likely to collaborate when public perception is

negative. The burning code also sets out rules which must be adhered to when carrying out burning activities. For reasons such as wet weather and the burning season time frames or lack of support staff, these rules cannot always be complied with, and it is easier for a landowner to ignite a fire and leave than stay and risk financial penalty for not adhering to the rules (Carrol et al., 2021). Chapman's statement regarding licenses and the ability to get them for burning out of season is also worth noting. A better system may be for ecologists trained to understand not just the impacts of fire but also the impacts of fire exclusion to assess rather than relying on fixed dates, this is especially important with the changing seasons linked to climate change.

Anecdotal evidence suggests that landowners are responsible for lighting most wildfires in some rural areas but, as suggested by Elgar and Held, such fires need investigation not assumption. As found by Jollands et al. (2011) supposed causes claimed for wildfires in Wales are mostly anecdotal and need further research.

The Healthy Hillsides project aims to highlight and promote good land management practice, the difficult part when it comes to prescribed burning is that organising demonstrations is totally weather dependant during the burn season.

Statistics show that the majority of wildfires in Wales are started deliberately, in more urban areas this usually believed to be reckless fire setting. What do you think are the reasons for this behaviour?

A disconnect by offenders and a low risk of being caught and punished (Nugent)

All stakeholders agreed that deliberate fire setting is due to a lack of empathy by those igniting them with their surroundings. How we encourage greater empathy needs to be discussed by all relevant stakeholders. Hogg stated that as with any anti-social behaviour it can be very complicated to understand the reasons why, but he believed it may be that they do not understand the

consequences or have little empathy for people and nature. This was supported by Held, who believed this was not only a fire problem but a societal problem, and fire is just the tip of the iceberg. Yorke and Thorp thought that fire setting was for fun, from boredom or to cause mayhem. Nugent raised the point that as well as being a disconnect by offenders, the risk of being caught is low.

The reasons for deliberate fire setting are many and are not fully understood. Even though stakeholders believed that we need to reduce deliberate ignitions, how to do this was not commented on and seems very complex. As stated trying to stop deliberate fire setting is difficult and it may be easier to carry out fuel management activities and to move to managed wildfires during the fire season to reduce risk. Yet, issues around managed wildfires are also complex, with only 0.4% of fires in the USA being allowed burn due to issues of smoke and public perception (North et al., 2015).

There is no formal process for wildfire fire investigation. Do you agree that if the cause and origin is known then community safety activities can be aligned to these findings?

Identifying the causes is of great importance (Davies)

All stakeholders agreed on the importance of investigating the cause and origin of wildfires, also agreeing that the results can then be used to provide data where community safety resources are required, once the correct groups are identified. Held stated this is common in other countries and Thorp commented that investigation can also assess the impact of these fires.

Wildfires are not routinely investigated in the UK and there are no training courses currently available. This is the complete opposite to structural fires, which are investigated jointly by the fire service and police. Work has been carried out by a Dutch team of police and firefighters and a pioneering wildfire investigation course has been developed based on the US FI210 course.

The guidance for the burning of heather and grass published by the Welsh Government asks if prescribed burners have attended and passed a certified course. Do you believe it should be mandatory to have passed a course before being entitled to burn land?

Insufficient courses available to insist on attendance at a formal course (Thorp)

All stakeholders supported the need for attendance at a training course before carrying out prescribed burning but there were differences of opinion in what format the training should take and whether it needs to be accredited or not. Fletcher believed that passing a course is a way to prove competency but that it may be better to assess individual competency rather than just have them attend a structured course. This was supported by Thorp, who believed that practical experience is also required, raising the key point that there is insufficient formal training available. A search of the internet for prescribed burn training within the UK only returned one company offering it, based in Scotland. It was not clear whether this training is accredited by an awarding body or not. It was also found to be the case in Ireland of no formal training but knowledge handed down over generations. Carrol et al. (2021) felt from this that the clearest path forward would be to develop working partnerships between farmers, land managers and firefighters. Training for prescribed burning in the US is common, with a host of government and non-government organisations offering it. This may be because of the resurgence in the use of prescribed fire following many damaging wildfire seasons. Efforts to build relationships take many forms and events such as prescribed burn training exchanges (TREX) have thrived (Carrol et al., 2021). It would appear very beneficial that formal courses for prescribed burning engage with all sectors not just land managers so that best practice and skill sharing can be achieved. One of the easiest methods to achieve this in the UK would be to start with the Fire operations groups (FOGs). These are regional groups made up of Government and Non-government agencies including land

management and fire services. (https://www.peakdistrict.gov.uk/looking-after/projects-and-partnerships/fireoperationsgroup/fog). Working together to understand the issues for each sector and developing training courses would be also be an excellent way to reduce risk and promote mutual trust.

Figure 4.7 presents an extract from the burning management plans guidance for land manager's document published by the Welsh Government. The question asks about training and for a certificate number but neither of which are currently available in Wales.

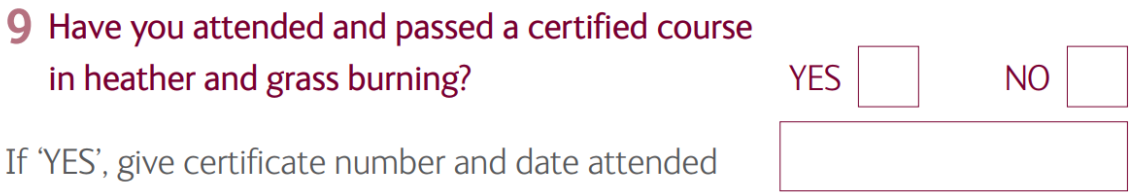


Figure 4.1 Burning management plans guidance, Welsh Government.

Do you have any comments on the use of prescribed burning by the fire service?

An excellent opportunity to work with land managers (Yorke)

All agreed prescribed burning was a good thing. Chapman, Held and Yorke also believed now would be a good time to implement training, raise competencies and transfer skills. Elgar believed this is a valuable tool and solutions also included modifying grazing practices and cutting. Held stated that a fire service who have developed the skills and knowledge to burn are in fantastic position to then fight wildfires. He also believed that the fire service, like in other European countries, could build and maintain a team of people whose role is fuel management, and who could then develop into firefighters. This was supported by Thorp, who stated that a cadre of people with the necessary skills and experience is needed for enough prescribed burning to take place.

Fletcher agreed the use of prescribed burning can be a very useful way to protect the environment although the caveat is how it is done and where, ensuring consideration to local environmental needs.

Whenever prescribed burning activities are taking place, the landowners are invited to take part, although this is not always easy due to weather and short notice. There is also the issue that some of the land is abandoned and so has no manager or management plan. Elgar's comments regarding cutting and grazing are worth noting as the more grazing animals are reduced, the more vegetation will grow. To Held's and Thorp's call for a group of land managers whose role is fuel reduction, this has been proposed as an idea as an apprentice scheme to the Fire and Rescue Service but it has yet to gain ground. Protection of environment is mentioned by Fletcher and is always a priority, although the areas of South Wales where prescribed burns take place are areas which will otherwise be burnt by wildfires. By burning areas of our choice means we can choose where the smoke goes, where the fire will burn to, how large the burnt area is and how much fuel we wish to remove.

The season for prescribed burning starts in October and ends on the 15th March (Lowlands) and 31st March (uplands). Most burning occurs in late winter and early spring once the vegetation has cured, normally February to March. This legislation is for the protection of ground nesting birds whose nests can be destroyed by prescribed burns and wildfires. If these months are wet then there is very little opportunity to carry out prescribed burning. Do you think the Fire service should have an exemption to allow them to create strip fire breaks outside of the prescribed burning season?

Should be completed all year round (Held)

No legal exemption (Fletcher)

As expected, this topic did not have the broad agreement the others did. Most stakeholders agreed that the fire service should be able to carry out prescribed burning year-round, although a site

assessment to identify environmental considerations would be required. Chapman believed this could be achieved by having better access to licences and that the system to allow burning out of season needs to be more dynamic. Davies thought the blanket ban on burning at certain times of the year is not useful. She believed that the fire service could benefit from always working with an ecologist or even employing their own. Elgar agreed that more flexibility is required and could help reduce the severity of fires and their impact on wildlife. Nugent supported the need to burn out of the season but stated that it should be possible to burn within the permitted season with suitably dedicated resources. Wildfires burning can be dealt with as wildfire 'within prescription' or managed wildfires.

Held believed that burning should be permitted all year round. His rationale was that ground nesting birds are at risk from many predators and environmental conditions as well as loss of habitat. Not managing the land and not creating fire breaks to break up the landscape wildfires can lead to a complete loss of habitat. As part of the bigger picture, the potential loss of a small number of birds to managed fire is acceptable for the overall benefit to the larger population and habitat. This was supported by Thorp, who stated that activities are hampered by the weather causing fuel loading to increase, which then leads to more damaging fires. The effects of restrictive seasons put at risk the habitats that burning restrictions were put in place to protect.

Fletcher, however, disagreed with these opinions and believed there should be no legal exemption, as nests and eggs protected by law. When carrying out prescribed burning it is impossible to know what ground nesting species are present and be certain that no nests were destroyed. Hogg, Elgar and Yorke believed that burning outside of the permitted season is acceptable but should be on a site by site basis.

Licences can be applied for to burn outside of the season but this is not a simple process. As stated by Davies, working with ecologists would be beneficial but, as explained earlier, it is important that they have the necessary skills required to analyse the effects of fire and fire exclusion.

Nugent supported burning year-round although believed more could be done within the current prescribed burn season with dedicated resources. This idea was supported by Thorp, although dedicated resources are not currently available. The idea of wildfires within prescription or managed wildfires is important and can go a long way towards reducing risk although greater

understanding of fire behaviour is required for this to be a success and more public communication and interaction.

Held supports year-round burning. It will always be a concern that nests may be damaged by burning narrow strips, but this needs to be put into context with wildfires on a landscape scale. Fletcher's opinion is also important but, as stated by Held, the risks from not burning may put the whole habitat at risk. Having a National Cohesive Wildland Fire Management Strategy (Appendix 1), similar to the US, where the vision is to safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire, could go a long way towards managing this complex issue.

The only themes the stakeholders did not agree on was whether reducing ignitions would reduce risk or would fuel reduction work be needed, and use of prescribed fire on a year round basis. This is understandable as different stakeholders have different perceptions. It also shows how important research is when debating this topic (Davies et al., 2016). Recurring themes that stakeholders mentioned were the environment, training for land managers, managed wildfires and a dedicated fuel management team. All have been discussed widely in this present research.

5. Conclusion

The aim of the research was to understand current perceptions from the general public and stakeholders on the issues surrounding wildfires in South Wales. Their understanding is not only important in developing strategies for reducing risks from fire through targeted public and stakeholder information campaigns, it is also relevant for gauging the potential acceptance of year-round use of prescribed burns to create barriers that limit the spread of wildfires.

Information was gathered through questionnaires from public and stakeholders to address the following specific objectives:

(1) Determine and analyse public and stakeholder perceptions of risk from wildfires. Specifically: are perceived perceptions of risk in line with the fire statistics?

(2) Examine the difference in risk perceptions from different locations. Specifically: comparing the more rural Tonypandy area, where people live closer to risk and are surrounded by the mountains that burn, with the more urban Cardiff, whose population is less exposed to fire, with wider information gathered via the online results from the whole of Wales.

(3) Tease out public and stakeholder perceptions of prescribed burning. Specifically: are they aware that the fire services carry out this activity to train and reduce risk, and is this activity supported by stakeholders?

From assessing these objectives, four core conclusions came through, to be followed here by an overall conclusion for the study.

Conclusion one

The vast majority of the public (97%) and all stakeholders perceive that wildfire is a risk in Wales to some degree; however, there are substantial differences between the types of respondent such as age and location. Trying to quantify the reality of the risk from wildfires in Wales is very difficult. Large fires occur every year although there are very few members of the public injured and little property damage (apart from forestry plantations) by wildfires. Fires have become larger

and more difficult to extinguish. The number of annual ignitions has reduced, although this could be a component of this complex problem.

Conclusion two

Most people in the online survey consider wildfire a serious risk, whereas most people interviewed in the rural area believe it is only a risk to the fire service. This may be linked to the fact that even though the area does have a large volume of wildfires, very few members of the public are injured and very little property damaged. The very short duration of most fires and the speed of post fire recovery may also play a part in this perception. **The Cardiff (urban) respondents do not believe that fire is a serious risk but more an occasional one and mostly to the fire service**. This shows that perceptions are highly geographically variable. The higher perception of risk in the online survey may be due to the fact that people who use social media platforms may have more access to information and in some ways be more informed / knowledgeable about wildfires in general, also people will complete questionnaires for topics that interest them and this can cause bias.

Conclusion three

The Valleys and Cardiff public had limited awareness that the Fire Service carry out prescribed burning compared to online respondents. However, **most comments made regarding the activity were positive** and this activity was also supported by all stakeholders, who understood the importance.

Overall conclusion

This research overall has found that **public perception of risk associated with wildfires in Wales has risen in the last 10 years compared to Jollands et al research in 2011. Even though the amount of ignitions has dropped from 4903 in 2010 to 2485 in 2019. Fires have become larger and more difficult to extinguish, with stakeholders beginning to understand and stress the importance of fuel management. This understanding now needs to be conveyed to the concerned general public and decision makers so that clear policies can be developed to work to prevent future destructive wildfires devastating Welsh communities.**

More specifically, the burning of fire breaks has the potential to protect life, property and habitats from destructive wildfires. At present, the times when this activity can take place are restricted by legislation. Prescribed burning is allowed in generally the wettest season, which makes burning difficult in practice. Yet, it is strongly suggested that prescribed burns, rather than destroying habits, can produce fire breaks with the potential to protect the ecosystem. By understanding more fully – as the present study has begun to do - the perceptions of both the public and key wildfire stakeholders, policy makers can open up dialogue and raise awareness to explore further the emotive option of some year-round burning by trained operators.

6. Further research suggested beyond the present study

Alongside prescribed burning, there are other solutions to investigate how we can manage the risk from wildfires more effectively. These were outside the scope of the current study and need more research. The impacts, effectiveness for fire prevention and the public perception would all need to be taken into account as part of any future research.

These include:

- Managed wildfire – when the fire service attend an incident they do not need to extinguish it as soon as possible but can if conditions allow, let the fire burn to fire breaks, either natural or constructed, to fulfil a management objective. Even though the definition of a wildfire is any uncontrolled vegetation fire which requires a decision, or action, regarding suppression not all fires are the same, weather and seasons play a vital role. Responders need to have an understanding of the environmental impacts of fires as winter and spring season fires are very different to summer fires.
- Legislation – there is no legislation regarding management of abandoned land, which means it becomes overgrown and a fire risk. If there was legislation requiring landowners to manage vegetation to stop fires spreading from their land this would be a substantial move forward.
- Tree planting - Trees act as fire breaks as, once established, they shade out bracken and the ground beneath is usually damp. Planned belts of native fast-growing broadleaf trees would also break up fuel continuity.
- Reduction of forestry waste – waste from commercial tree harvesting is a major cause of large fires in South Wales. Further research is needed to find a viable cost-effective use for this material so that it is not such a major contributor to large fires.

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Appendix 1- USA Cohesive wildland fire management strategy

National Cohesive Wildland Fire Management Strategy

What is the Cohesive Strategy?

The National Cohesive Wildland Fire Management Strategy is an ongoing effort by Federal, Tribal, state and local governments and non-government organizations to address growing wildfire challenges in the United States. For more information, visit http://www.forestsandrangelands.gov/.

Addressing wildland fire is not simply a fire management, fire operations, or Wildland Urban Interface (WUI) problem – it is a larger more complex land management and societal issue. The vision of the Cohesive Strategy is to: *Safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire.*

Overarching Theme:

The Cohesive Strategy is about more than fire suppression.

Sub-themes and Supporting Points:

- *The Cohesive Strategy reflects the values and concerns of the public and all governments.*
  - The problems created by wildland fire affect all lands and all levels of government.
  - An effective strategy must be a "ground-up" effort, with wildland fire management personnel, the public and all levels of government actively involved.
  - There is no "one-size-fits-all "approach. A national strategy provides a common basis for determining the best course of action.
  - The Cohesive Strategy is designed to better align national level decision-making with regional and local interests.

- *The Cohesive Strategy relies on people working together.*
  - Wildland firefighting agencies need to cooperate and be respectful of each others' process to work collaboratively for the good of all.
  - A national strategy must recognize the differences and tensions that exist among partners and stakeholders and why those differences exist.
  - An effective strategy guides all organizations to recognize and accept each others' management differences and promote a cohesive response across all jurisdictions.

- *Wildfire is a dynamic process.*
  - Today's longer fire seasons produce larger wildfires that are more difficult to put out. The Cohesive Strategy represents the creative thinking and cooperation needed to meet the challenges of a new kind of fire season.
  - Fire-adapted landscapes can become out of balance and vulnerable to fire, insects, and climate change. The Cohesive Strategy addresses these challenges by restoring fire-resilient landscapes.
  - The Cohesive Strategy is based on the best available science.

Produced by National Park Service Division of Fire & Aviation – Branch of Communication and Education

The Cohesive Strategy communication framework may be found at http://go.usa.gov/m9h

Appendix 2 Public questionnaire

Perceptions of Wildfires in Wales

My name is Craig Hope and I am a Swansea University Masters student researching wildfires in Wales

The information you give in this questionnaire will remain anonymous and you may withdraw at any time.

*The term **wildfire** is the generic term for all out-of-control vegetation fires*

1. Have you seen a wildfire in Wales?

Yes	No

1a. If YES, where was the most recent?

1b. Have you seen any evidence in Wales where such a fire may have occurred?

Yes	No

2. For Wales overall, do you consider wildfires (*tick one*):

A serious risk for many people	
A risk, but mostly for the fire service	
An occasional risk	
A very rare risk	
Not a risk at all	

3. Over the last twenty years, do you think that the number of wildfires in Wales has (*tick one*):

Decreased in number	
Stayed about the same	
Increased in number	

There were almost 4000 wildfires in South Wales in 2010, this figure has been reducing gradually although South Wales fire and rescue service attended over 1000 calls to wildfires in July 2018

4. What do you think are the main causes of wildfires in Wales?

5. Where wildfires are set deliberately (arson), who do you think is lighting them (*tick **all** noted)*

Primary school (5 -11 year old)	
Secondary school (12- 18year old)	
Adults (18+)	

Prescribed burning is the intentional removal of unwanted vegetation using fire. South wales fire and rescue service have been doing this to try and stop large wildfires and protect property.

6. Were you aware that some fire services carry out prescribed burning?

Yes	No

7. Are you aware that there a specific dates when these activities can take place?

Yes	No

8. Do you have any comments on the use of prescribed burning?

Finally, just a few facts about yourself… Please could you tell me:

9. Gender

Male	Female	Transgender	Prefer not to say

10. Age

18 - 30	31 - 45	46 - 60	61 +

11. First half of postcode | | | | |

12. Most recent occupation

Thank you very much for your time!

Appendix 3

Tables from questionnaires

S1 *Have you seen a wildfire (grass fire/mountain fire/bracken fire/gorse fire) in Wales?(tonypandy)*

		Frequency	Percent
Valid	No	8	8.0
	Yes	92	92.0
	Total	100	100.0

S2 *Have you seen any evidence in Wales where such a fire may have occurred?(Tonypandy)*

		Frequency	Percent
Valid	No	8	8.0
	Yes	92	92.0
	Total	100	100.0

S3 *What do you think are the main causes of wildfires in Wales? (Tonypandy)*

		Frequency	Percent
Valid	Accidental	4	4.0
	Deliberate (arson)	96	96.0
	Total	100	100.0

S4 *Were you aware that some fire services carry out prescribed burning?(Tonypandy)*

		Frequency	Percent
Valid	No	62	62.0
	Yes	38	38.0
	Total	100	100.0

S5 *Are you aware that there a specific dates when these activities can take place?(Tonypandy)*

		Frequency	Percent
Valid	No	89	89.0
	Yes	11	11.0
	Total	100	100.0

S6 *Gender (Tonypandy)*

		Frequency	Percent
Valid	Female	54	54.0
	Male	46	46.0
	Total	100	100.0

S7 *Most recent occupation (Tonypandy)*

		Frequency	Percent
Valid	admin	1	1.0
	adult education	1	1.0
	bank clerk	1	1.0
	bar maid	1	1.0
	bar staff	1	1.0
	builder	2	2.0
	bus driver	2	2.0
	business analyst	1	1.0
	call centre	1	1.0
	car shop	1	1.0
	care assistant	1	1.0
	care sales	1	1.0
	carer	3	3.0
	carpenter	1	1.0
	cleaner	3	3.0
	consultant	1	1.0
	cook	1	1.0
	decorator	1	1.0
	delivery driver	2	2.0
	dinner lady	1	1.0
	educational researcher	1	1.0
	estate agent	1	1.0
	factory worker	9	9.0
	gardener	1	1.0
	groundsman	1	1.0
	hairdresser	2	2.0
	housewife	1	1.0
	mechanic	3	3.0
	milkman	1	1.0
	nurse	3	3.0
	outreach worker	1	1.0
	painter	1	1.0
	pastor	1	1.0
	personal trainer	1	1.0
	photographer	1	1.0

	plasterer	2	2.0
	post office	2	2.0
	project manager	1	1.0
	quality assurance	1	1.0
	receptionist	2	2.0
	retail	2	2.0
	retired	3	3.0
	retired civil servant	1	1.0
	retired shop keeper	1	1.0
	roofer	1	1.0
	sales	1	1.0
	school admin	1	1.0
	school caretaker	1	1.0
	secretary	1	1.0
	shop fitter	1	1.0
	shop worker	4	4.0
	solicitor	1	1.0
	student	5	5.0
	student teacher post grad	1	1.0
	support worker	1	1.0
	taxi driver	4	4.0
	teacher	2	2.0
	Teacher	1	1.0
	teacher retired	1	1.0
	teaching assistant	1	1.0
	typist	1	1.0
	tyre fitter	1	1.0
	window cleaner	1	1.0
	Total	100	100.0

S8 *Have you seen a wildfire (grass fire/mountain fire/bracken fire/gorse fire) in Wales?(Cardiff)*

		Frequency	Percent
Valid	No	40	40.0
	Yes	60	60.0
	Total	100	100.0

S9 *Have you seen any evidence in Wales where such a fire may have occurred? (Cardiff)*

		Frequency	Percent
Valid	No	16	16.0
	Yes	84	84.0
	Total	100	100.0

S10 *What do you think are the main causes of wildfires in Wales? (Cardiff)*

		Frequency	Percent
Valid	Accidental	14	14.0
	Deliberate (arson)	86	86.0
	Total	100	100.0

S11 *Were you aware that some fire services carry out prescribed burning?(Cardiff)*

		Frequency	Percent
Valid	No	70	70.0
	Yes	30	30.0
	Total	100	100.0

S12 *Are you aware that there a specific dates when these activities can take place?(Cardiff)*

		Frequency	Percent
Valid	No	84	84.0
	Yes	16	16.0
	Total	100	100.0

S13 *Gender (Cardiff)*

		Frequency	Percent
Valid	Female	46	46.0
	Male	54	54.0
	Total	100	100.0

S14 *Most recent occupation (Cardiff)*

		Frequency	Percent
	Accountant	2	2.0
	Administration	2	1.0
	apprentice welder	1	1.0
	Author	1	1.0
	Barrister	1	1.0
	builder	1	1.0
	bus driver	1	1.0
	Business Owner	1	1.0
	careers advisor	1	1.0
	carer	3	3.0
	carpenter	1	1.0
	Chauffeur	1	1.0
	Chef	2	2.0
	child care	1	1.0
	child minder	1	1.0
	childcare	1	1.0
	childminder	1	1.0
	cleaner	1	1.0
	Company Director	3	3.0
	Customer Service Manager	1	1.0
	Cyber Security Engineer	1	1.0
	Director	3	3.0
	Doctor	1	1.0
	driving instructor	2	2.0
	Education Consultant	1	1.0
	electrician	1	1.0
	farm sales	1	1.0
	Financial Services manager	1	1.0
	Fundraiser	1	1.0
	hair dresser	1	1.0
	Home renovation	1	1.0
	Hotel supervisor	1	1.0

	housewife	1	1.0
	kitchen fitter	1	1.0
	Labourer	1	1.0
	Learning Programmes Consultant	1	1.0
	Lecturer	1	1.0
	lorry driver	2	2.0
	Management	1	1.0
	Mechanic	2	2.0
	Nhs	1	1.0
	nhs admin	1	1.0
	NHS project manager	1	1.0
	nurse	4	4.0
	Nurse	1	1.0
	Painter and decorator	1	1.0
	physio therapist	1	1.0
	plasterer	1	1.0
	Plumber	2	2.0
	Police officer	1	1.0
	Property development	1	1.0
	Retail	1	1.0
	Retailer	1	1.0
	Retired	1	1.0
	retired teacher	1	1.0
	Royal Mail	1	1.0
	sales	1	1.0
	Sales	1	1.0
	Sales manager	1	1.0
	Secretarial	1	1.0
	Self employed	1	1.0
	Self-employed Newsagent.	1	1.0
	shop assistant	1	1.0
	shop owner	1	1.0
	Shop owner	1	1.0
	solicitor	1	1.0
	Solicitor	1	1.0
	student	7	7.0
	taxi driver	2	2.0

	teacher	1	1.0
	Teacher	2	2.0
	teaching assistant	2	2.0
	Technology Consultant	1	1.0
	vet assistant	1	1.0
	Window fitter	1	1.0
	Total	100	100.0

S15 *Have you seen a wildfire (grass fire/mountain fire/bracken fire/gorse fire) in Wales?(Online)*

		Frequency	Percent
Valid	No	18	9.0
	Yes	182	91.0
	Total	200	100.0

S16 *Have you seen any evidence in Wales where such a fire may have occurred?(Online)*

		Frequency	Percent
Valid	No	18	9.0
	Yes	182	91.0
	Total	200	100.0

S17 *What do you think are the main causes of wildfires in Wales? (Online)*

		Frequency	Percent
Valid	Accidental	11	5.5
	Deliberate (arson)	189	94.5
	Total	200	100.0

S18 *Were you aware that some fire services carry out prescribed burning?(Online)*

		Frequency	Percent
Valid	No	48	24.0
	Yes	152	76.0
	Total	200	100.0

S19 *Are you aware that there a specific dates when these activities can take place?(Online)*

		Frequency	Percent
Valid	No	115	57.5
	Yes	85	42.5
	Total	200	100.0

S20 *Gender (Online)*

		Frequency	Percent
Valid	Female	115	57.5
	Male	85	42.5
	Total	200	100.0

S21 *Most recent occupation (Online)*

	Frequency	Percent
No reply	15	7.5
Account Manager	1	.5
Accountancy Assistant	1	.5
Accounts clerk	1	.5
Admin	1	.5
Admin Assistant	2	1.0
administration	1	.5
Administration	2	1.0
Administrator	1	.5
Agri-ecologist	1	.5
Allied health professional	1	.5
Animal Behaviourist	1	.5
Area manager	1	.5
Bank manager	1	.5
Bricklayer	1	.5
Builder	1	.5
Business intelligence manager	1	.5
Business owner	2	1.0
Careers Adviser	1	.5
Carer	1	.5
carpenter	2	1.0
Charity assistant manager	1	.5
Childcare practitioner	1	.5
Civil servant	4	2.0
Civil Servant	3	1.5
Cleaner	1	.5
Clinical Coder	1	.5
Clinical coder nhs	1	.5
College Trainer	1	.5
Community Safety Apprentice	1	.5
Consultant Construction	1	.5
Cook	1	.5
Dental support worker	1	.5

Design Manager	1	.5
Dinner Lady	1	.5
Director	1	.5
ecologist	3	1.5
Ecologist	3	1.5
Ecology	1	.5
Education Manager	1	.5
Electrician	2	1.0
Engineer	2	1.0
Equality Officer Further Education	1	.5
Event Manager	1	.5
Factory technician	1	.5
Factory worker	1	.5
Farmer	3	1.5
Farmer contractor	1	.5
Farmer.	1	.5
Farming	1	.5
Fire Cadet Instructor with SWFRS	1	.5
Fire fighter	24	1.0
Forester	1	.5
Foster carer	2	1.0
Foster carer	2	1.0
Freelance/Business Owner	1	.5
Funeral director	2	1.0
Graphic Designer	1	.5
Head of Events	1	.5
Head of Fire Control	1	.5
Head Teacher	1	.5
Head teacher	1	.5
Health care assistant	1	.5
Health care worker	1	.5
Holistic Therapist	1	.5
Home tutor	1	.5
Hospital administrator	1	.5
House wife	1	.5
HR Officer, SWFRS	1	.5
Insurance Claims Examiner	1	.5
IT Executive	1	.5

	Judge	1	.5
	Keep wales tidy litter picker	1	.5
	Local Authority senior manager	1	.5
	Manager	2	1.0
	Marketing Manager	1	.5
	Mother	1	.5
	Moto Services Manager	1	.5
	Motorcycle Instructor	1	.5
	Music Producer	1	.5
	Nhs	1	.5
	Nurse	3	1.5
	NURSE	1	.5
	Nursery nurse	1	.5
	Office worker	1	.5
	Outdoor Instructor	1	.5
	Paediatric nurse practitioner	1	.5
	Paramedic	1	.5
	Parish priest	1	.5
	Part Time Waitress / Full Time University Student	1	.5
	Pastoral Coach in FE college	1	.5
	Personal banker	1	.5
	photographer	1	.5
	Policy Officer	1	.5
	Production manager	1	.5
	Production Supervisor	1	.5
	Property manager	1	.5
	Psychologist	1	.5
	Public service worker	1	.5
	Receptionist	1	.5
	retired	1	.5
	Retired	4	2.0
	Retired Firefighter	1	.5
	Retired Lecturer	1	.5
	Retired teacher	1	.5
	Sales Administrator	1	.5
	School secretary	1	.5
	School staff	1	.5

	Science technician	1	.5
	Security officer	1	.5
	Shop staff	1	.5
	Soldier	1	.5
	Student	2	1.0
	Taxi driver	1	.5
	Teacher	10	5.0
	Teaching assistant	2	1.0
	Technical Officer	1	.5
	Train Driver.	1	.5
	Transport and Courier	1	.5
	Unemployed	1	.5
	Volunteer administrator	1	.5
	waitress	1	.5
	Warden	1	.5
	Welsh water technician	1	.5
	Wildlife Trust officer	1	.5
	Total	200	100.0

Appendix 4

All comments made in relation to prescribed burning

A fantastic asset for a Brigade to use
A good idea
A sensible planned way to remove risk
A worthwhile task which could save a lot of resources
Anything the fire service can do to keep people safe is a good thing
As long as the fire brigade is aware and available to contain it if it gets out of control
Been done for years and should be done
Can be a good idea
Can be a sensible option as it creates barriers to future destructive fires
Can be beneficial but would be better if public informed beforehand to avoid emergency calls and comments on social media
Commoners also carry this out
could be effective if done safely
Could we Not cut it?
could work if done by trained people
Do more to prevent risk to property
don't think there any need for this to be done
Excellent tool to have available to help firefighters in dealing with the problem
Excellent tool to help firefighters
fantastic idea , thank you
Farmers tend to burn open moorland too , it provides better grazing for livestock . It's been common practice for decades.
Forestry during dry weather a major concerns
good
good
good
Good idea
Good idea
Good idea
Good idea
good idea
Good idea
Good idea
good idea
Good idea
good idea
good idea

good idea
good idea
good idea
good idea
good idea , more needed
good idea if done properly
good idea if No risk
good idea to be prepared for fire near property
good idea to reduce vegetation loading
good if controlled
good if for safety
good if it helps
good if it stops fires
good if it works
good if it works
good if it works
good if it works
good thing
Good way to manage vegetation
Good way to stop big fires
great idea
Great idea
Great idea
Great idea but reliant on farmers complying
Great idea to prevent fires from escalating into a large uncontrolled fire!! Create fire breaks.
great if it helps
Great tool. Only aware of this procedure and many other contributory factors involved since attending the wildfire course. Really en
Happy for Fire service to do it, Not happy for farmers to do it
Helps bring wildfires under control in a safe and measured method.
I agree
I agree with it
I believe some landowners do this and allow them deliberately to get out of control.
I have No issue when done safely by trained individuals. Though I live in a community where farmers set fire to the areas without t
acts.
I hope the wildlife are protected
I suppose there are good reasons for doing this and if it's controlled by the Fire Service, homes and people woulD remain safe howe
I think done correctly it is a good idea.
I think it is a positive approach in an attempt to reduce the spread of wildfires
i think its a good thing
I think they are beneficial and should continue along with other prevention methods such as information in communities and schoo
I'm concerned about protecting local flora and fauna, and the impact of prescribed burning on their habitat.
I've always seen it used on hills as a regeneration tool
If fire service and landowners do it then it's good

If it helps then it has to be a good idea
If it helps to contain dangerous wild fires
If it protects us all, this is an amazing idea.
If they successfully stop wild fires then I believe they are a good idea
I'm a forester. Guilty of ignorance and complacency before fire in my wood last summer. Climate a factor of increasing significance.
Important part of habitat management.
In 2000 we nearly lost our house to deliberate fires. Wished prescribed burning had taken place then.
In the right place and at the right time it is very valuable
is there a need?
is there less cost doing this than fighting the fires?
Is this the most environmentally friendly way to deal with the unwanted vegetation?
it is a necessary management plan
It is a useful tool if carried out properly
It is good as long as controlled
It makes sense
It needs good and clear early warning for the community to be confident in it.
It seems to be working well
It should be more widely publicised so public gain an understanding of its benefits.
It sounds like a sensible and safe option to trying to prevent intentional or Ben accidental wildfires.
It works
It would be useful to know where and when it will be taking place to prevent unnecessary worry.
It's hugely beneficial.
it's a good thing
I've watched online videos about prescribed burning and I think it's a brilliant idea and there should be more of it.
Keep up the good work
Knowing when/where it is being done would be useful to know. Could be on council websites
Local residents should know
Makes sense for the management of some kinds of land
makes sense if it reduces risk
Many people assume ALL burning is prescribed and are very defensive that arson DOES, on Times, happen
May encourage arsonists
more advertising
more information needed for public
more needed
More needed
more needed to stop large fires
Must be done in conjunction with other agencies including the farmers
must be done right by trained people
needs to be communicated to the public
needs to be done
needs to be done by professionals in a controlled way, good idea
No if official
No issue if safe

Not aware but good if it helps
Not aware but it should be used more
Not sure if there is a need for this
NRW should do more.
online information about what is being done, why and when
Positive move
public need informing more
Public should be informed beforehand
Public warnings should be in place
really interesting
Risk to wildlife
Sad that it needs to be done to stop arson
seems a good idea
seems a good idea
seems a good tactic
seems a good thing
seems a good thing to do
seems important to thing to do
Seems like it could be a waste of potential bedding/ fodder for farm animals.
seems reasonable proactive behaviour
Seems sensible approach
seen it on tv and it looked really effective
should be advertised more
Should be carried out by professional people and Not the fire service
Should be done more
Should be used more to manage land when and where suitable
Should happen more often and landowners should possibly be mandated by law to do so
Sounds good as a safety measure
Sounds sensible
Taking away the fuel in a controlled manner can only be a good thing
The Fire Service is a professional organisation and would be trained to operate prescribed burning whenever or wherever necessary
The loss of wildlife, Flora and Fungi does Not seem justified, however, I've Not been privy to reports or papers which may provide ev
There are definitely, in this area, places which almost annually seem to be set alight. Clearing the area where they start would make
Think it's a waste of time and resources
Think it's an excellent form of control & prevention. More fire crews should be trained to use.
This is a very useful method when carried out correctly at the appropriate times by suitably qualified and experienced people
this was done in the past to get sheep onto the hills earlier
Use in the areas that have the highest calls
Used to see it up on the hills was told it was to encourage new growth
Useful if managed carefully to minimise risk of damage to wildlife and property.
useful to protect buildings and trees
Warnings to locals is crucial
was done years ago

We should do more burning in more areas
works in other countries
Yes I think this kind of action is a massive plus .working towards protecting people of the community

Appendix 5.

Output tables from the Pearson chi square analysis

By Gender (probability of making a comment or not)

Table 3.34 Gender vs making a comment or not

			Comment	No comment	Total
Please select your gender	Female	Count	73	142	215
		Expected Count	89.2	125.8	215.0
		% within Please select your gender	34.0%	66.0%	100.0%
		%	44.0%	60.7%	53.8%
	Male	Count	93	92	185
		Expected Count	76.8	108.2	185.0
		% within Please select your gender	50.3%	49.7%	100.0%
		%	56.0%	39.3%	46.3%
	Total	Count	166	234	400
		Expected Count	166.0	234.0	400.0
		% within Please select your gender	41.5%	58.5%	100.0%
		%	100.0%	100.0%	100.0%

Table 3.35 Gender vs making a comment or not. Pearson Chi-square test

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.905[a]	1	.001
Continuity Correction[b]	10.243	1	.001
Likelihood Ratio	10.930	1	.001
N of Valid Cases	400		

By Age Group (probability of making a comment or not)

Table 3.36 Age vs making a comment or not.

			comment	No comment	Total
Please select your age group		Count	0	1	1
		Expected Count	.4	.6	1.0
		% within Please select your age group	0.0%	100.0%	100.0%
	No age given	%	0.0%	0.4%	0.3%
	18 - 30	Count	17	44	61
		Expected Count	25.3	35.7	61.0
		% within Please select your age group	27.9%	72.1%	100.0%
		%	10.2%	18.8%	15.3%
	31 - 45	Count	52	89	141
		Expected Count	58.5	82.5	141.0
		% within Please select your age group	36.9%	63.1%	100.0%
		%	31.3%	38.0%	35.3%
	46 - 60	Count	60	67	127
		Expected Count	52.7	74.3	127.0
		% within Please select your age group	47.2%	52.8%	100.0%
		%	36.1%	28.6%	31.8%
	61 +	Count	37	33	70
		Expected Count	29.1	40.9	70.0
		% within Please select your age group	52.9%	47.1%	100.0%
		%	22.3%	14.1%	17.5%
	Total	Count	166	234	400
		Expected Count	166.0	234.0	400.0
		% within Please select your age group	41.5%	58.5%	100.0%
		%	100.0%	100.0%	100.0%

Table 3.37 Age vs making a comment or not. Pearson Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.063[a]	4	.017
Likelihood Ratio	12.584	4	.013
N of Valid Cases	400		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is .42.

By Area (probability of making a comment or not)

Table 3.38 Area vs making a comment or not.

			comment	No comment	Total
area code		Count	50	50	100
Tonypandy		Expected Count	41.5	58.5	100.0
		% within area code	50.0%	50.0%	100.0%
		%	30.1%	21.4%	25.0%
	Cardiff	Count	35	65	100
		Expected Count	41.5	58.5	100.0
		% within area code	35.0%	65.0%	100.0%
		%	21.1%	27.8%	25.0%
	Online	Count	81	119	200
		Expected Count	83.0	117.0	200.0
		% within area code	40.5%	59.5%	100.0%
		%	48.8%	50.9%	50.0%
Total		Count	166	234	400
		Expected Count	166.0	234.0	400.0
		% within area code	41.5%	58.5%	100.0%
		%	100.0%	100.0%	100.0%

Chi-Square Tests

Table 3.39 Area vs making a comment or not. Pearson Chi-square test

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.799[a]	2	.091
Likelihood Ratio	4.788	2	.091
Linear-by-Linear Association	1.647	1	.199
N of Valid Cases	400		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 41.50.

By Social Category (probability of making a comment or not)

Table 3.40 Social category vs making a comment or not.

			Comment 1.00	No comment 2.00	Total
social code		Count	2	13	15
No response		Expected Count	6.2	8.8	15.0
		% within social code	13.3%	86.7%	100.0%
		%	1.2%	5.6%	3.8%
	AB	Count	10	8	18
		Expected Count	7.5	10.5	18.0
		% within social code	55.6%	44.4%	100.0%
		%	6.0%	3.4%	4.5%
	C1	Count	71	101	172
		Expected Count	71.4	100.6	172.0
		% within social code	41.3%	58.7%	100.0%
		%	42.8%	43.2%	43.0%

	C2	Count	26	23	49
		Expected Count	20.3	28.7	49.0
		% within social code	53.1%	46.9%	100.0 %
		%	15.7%	9.8%	12.3%
	DE	Count	57	89	146
		Expected Count	60.6	85.4	146.0
		% within social code	39.0%	61.0%	100.0 %
		%	34.3%	38.0%	36.5%
Total		Count	166	234	400
		Expected Count	166.0	234.0	400.0
		% within social code	41.5%	58.5%	100.0 %
		%	100.0%	100.0%	100.0 %

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Chi-Square Tests

Table 3.41 Social category vs making a comment or not. Pearson Chi-square test

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.431[a]	4	.051
Likelihood Ratio	10.135	4	.038
N of Valid Cases	400		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.23.

Gender vs making a positive, negative or neutral comment

Table 3.42 Gender vs making a positive, negative or neutral comment

			p= positive n = negative x =neutral/question			
			N	P	X	Total
Please select your gender	Female	Count	4	53	15	72
		Expected Count	3.5	56.8	11.7	72.0
		% within Please select your gender	5.6%	73.6%	20.8%	100.0%
		% within p= positive n = negative x =neutral/question	50.0%	40.5%	55.6%	43.4%
	Male	Count	4	78	12	94
		Expected Count	4.5	74.2	15.3	94.0
		% within Please select your gender	4.3%	83.0%	12.8%	100.0%
		% within p= positive n = negative x =neutral/question	50.0%	59.5%	44.4%	56.6%
Total		Count	8	131	27	166
		Expected Count	8.0	131.0	27.0	166.0
		% within Please select your gender	4.8%	78.9%	16.3%	100.0%
		% within p= positive n = negative x =neutral/question	100.0%	100.0%	100.0%	100.0%

Table 3.43 Gender vs making a positive, negative or neutral comment. Pearson Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.228[a]	2	.328
Likelihood Ratio	2.210	2	.331
N of Valid Cases	166		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 3.47.

Age vs making a positive, negative or neutral comment

Table 3.44 Age vs making a positive, negative or neutral comment.

			p= positive n = negative x =neutral/question			
			N	P	X	Total
Please select your age group	18 - 30	Count	1	13	2	16
		Expected Count	.8	12.6	2.6	16.0
		% within Please select your age group	6.3%	81.3%	12.5%	100.0%
		% within p= positive n = negative x =neutral/question	12.5%	9.9%	7.4%	9.6%
	31 - 45	Count	2	39	11	52
		Expected Count	2.5	41.0	8.5	52.0
		% within Please select your age group	3.8%	75.0%	21.2%	100.0%

		% within p= positive n = negative x =neutral/question	25.0%	29.8%	40.7%	31.3%
	46 - 60	Count	3	50	8	61
		Expected Count	2.9	48.1	9.9	61.0
		% within Please select your age group	4.9%	82.0%	13.1%	100.0%
		% within p= positive n = negative x =neutral/question	37.5%	38.2%	29.6%	36.7%
	61 +	Count	2	29	6	37
		Expected Count	1.8	29.2	6.0	37.0
		% within Please select your age group	5.4%	78.4%	16.2%	100.0%
		% within p= positive n = negative x =neutral/question	25.0%	22.1%	22.2%	22.3%
Total		Count	8	131	27	166
		Expected Count	8.0	131.0	27.0	166.0
		% within Please select your age group	4.8%	78.9%	16.3%	100.0%
		% within p= positive n = negative x =neutral/question	100.0%	100.0%	100.0%	100.0%

Table 3.45 Age vs making a positive, negative or neutral comment. Pearson Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.659[a]	6	.948
Likelihood Ratio	1.633	6	.950

N of Valid Cases	166

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .77.

Area vs making a positive, negative or neutral comment

Table 3.46 Area vs making a positive, negative or neutral comment. Pearson Chi-square test

			p= positive n = negative x =neutral/question			
			n	p	x	Total
area code	1	Count	0	44	7	51
		Expected Count	2.5	40.2	8.3	51.0
		% within area code	0.0%	86.3%	13.7%	100.0%
		% within p= positive n = negative x =neutral/question	0.0%	33.6%	25.9%	30.7%
	2	Count	4	26	5	35
		Expected Count	1.7	27.6	5.7	35.0
		% within area code	11.4%	74.3%	14.3%	100.0%
		% within p= positive n = negative x =neutral/question	50.0%	19.8%	18.5%	21.1%
	3	Count	4	61	15	80
		Expected Count	3.9	63.1	13.0	80.0
		% within area code	5.0%	76.3%	18.8%	100.0%
		% within p= positive n = negative x =neutral/question	50.0%	46.6%	55.6%	48.2%
Total		Count	8	131	27	166
		Expected Count	8.0	131.0	27.0	166.0
		% within area code	4.8%	78.9%	16.3%	100.0%
		% within p= positive n = negative x =neutral/question	100.0%	100.0%	100.0%	100.0%

Table 3.47 Area vs making a positive, negative or neutral comment. Pearson Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.743[a]	4	.150
Likelihood Ratio	8.303	4	.081
N of Valid Cases	166		

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 1.69.

Social category vs making a positive, negative or neutral comment

Table 3.48 Social category vs making a positive, negative or neutral comment. Pearson Chi-square test

		p= positive n = negative x =neutral/question			
		N	P	X	Total
AB	Count	0	7	3	10
	Expected Count	.5	7.9	1.6	10.0
	% within social code	0.0%	70.0%	30.0%	100.0%
	% within p= positive n = negative x =neutral/question	0.0%	5.3%	11.1%	6.0%
C1	Count	3	61	8	72
	Expected Count	3.5	56.8	11.7	72.0
	% within social code	4.2%	84.7%	11.1%	100.0%
	% within p= positive n = negative x =neutral/question	37.5%	46.6%	29.6%	43.4%
C2	Count	2	21	3	26

		Expected Count	1.3	20.5	4.2	26.0
		% within social code	7.7%	80.8%	11.5%	100.0%
		% within p= positive n = negative x =neutral/question	25.0%	16.0%	11.1%	15.7%
	DE	Count	3	41	12	56
		Expected Count	2.7	44.2	9.1	56.0
		% within social code	5.4%	73.2%	21.4%	100.0%
		% within p= positive n = negative x =neutral/question	37.5%	31.3%	44.4%	33.7%
Total		Count	8	131	27	166
		Expected Count	8.0	131.0	27.0	166.0
		% within social code	4.8%	78.9%	16.3%	100.0%
		% within p= positive n = negative x =neutral/question	100.0%	100.0%	100.0%	100.0%

Table 3.49 Social category vs making a positive, negative or neutral comment. Pearson Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.993[a]	8	.537
Likelihood Ratio	6.908	8	.547
N of Valid Cases	166		

a. 9 cells (60.0%) have expected count less than 5. The minimum expected count is .10.

Appendix 6.

South Wales Fire and Rescue Service wildfire Project

The Journey from Firefighters to Fire Managers.

In 2007 South Wales Fire and Rescue Service (SWFRS) started a wildfire project. This project had two strands and the aim of the first was to reduce ignitions by engaging with communities, this work was carried out by the Community Safety Department (CS). The second was to look into operational equipment and tactics to enable firefighters to deal with the fires in a safer way. I was seconded to the second group which was a partnership between the Operational Risk Management Department (ORM) and the Operations Department (OPS).

The reason for my involvement was because I was an experienced watch manager who had fought wildfires for many years, I had realised that there must be a better way to fight these fires and had expressed this view. Traditionally firefighters would fight fires with no understanding of fire prediction and changes in weather whilst wearing Personal Protective Equipment (PPE) designed to keep firefighters safe in structural fires. The main method of extinguishing a fire would be a fire beater which is used to beat out and smother the flames. Originally these beaters were made of thin trunk of a tree with some conveyor belt rubber bolted to the end, then the handles became aluminium, the handles are now fibre glass. The fire service were well equipped with 4x4 fire engines and light 4x4 vehicles but these were not suitable to be driven off road on the steep valley sides and the open moorland which was usually still very wet even when the vegetation was very dry.

Firefighter dressed in structural fire PPE with a fire beater and a structural fire engine, Photo credit – author

In 2007 I was made aware that Northumberland Fire and Rescue Service (NFRS) were running wildfire courses for other fire and rescue services so I invited them to South Wales to give a taster course so we could evaluate the training and see if it would benefit us. When NFRS visited they were shocked by the scale of arson and the amount of unmanaged land in the South wales valleys after their experiences of well managed forestry and shooting estates in the North East of England. The course was found to be very beneficial and arrangements were made for more training.

These courses were 2 days duration and topics covered were

- Map reading and navigation
- Wildfire prediction system
- Fuel classes
- weather
- Firefighter safety
- LACES safety protocol

Attending these courses was a huge eye opener for both firefighters and managers within SWFRS and it was the first time that we understood we could predict fire behaviour and make plans to extinguish it whereas in the past we had chased fires having little understanding of why they behaved and moved in a certain way. NFRS being the leaders in introducing wildfire training and

tactics have definitely made firefighters in South Wales and across the United Kingdom safer and NFRS are owed a debt of gratitude for this.

During this time I led another project to purchase off road vehicles which were capable of gaining access to our steep terrain carrying firefighters and firefighting media. After a thorough assessment of vehicles and equipment available we purchased and took delivery of four Argocat 8x8 vehicles along with off road trailers and fire fogging units in March 2009. These vehicles were unique in not only their ability to traverse very wet unforgiving terrain but also their ability to deliver water for firefighting whilst being driven which a standard structural fire engine cannot.

Four fire stations were chosen due to their locations and volume of wildfire calls, a training course was developed and firefighters were trained to drive the vehicles and operate the equipment.

Argocat 8x8 complete with off road trailer and fire fogging system capable of transporting 4 firefighters

Photo credit – author

Realising the importance of training firefighters and the cost involved to have them trained by an external provider SWFRS formed a wildfire instructor group consisting of 14 personnel, this group attended a one week specialist wildfire course hosted by NFRS and were then tasked to develop suitable training courses.

Three levels of training were then identified by this team

- Level 1- online training package to be completed every year by all operational personnel.
- Level 2- two day course to be completed by all supervisory managers.
- Level 3- selected tactical officers who would become subject matter advisors to assist incident commanders at more complex incidents.

The level 1 course was developed and embedded into the SWFRS Operational Skills Platform, a level 2 course was developed along with an outside navigation exercise and personnel were instructed by the 14 wildfire instructors, a plan and timetable was produced to start training personnel. At this time the group felt that they did not have the experience to develop a level 3 course so it was decided that these courses would be hosted by NFRS.

At this time we also developed categories for wildfire response, A Category One wildfire is a wildfire with no more than two fire service assets for no more than two hours, Category Two fires are Wildfires which requires more than two Fire Service assets or burn for more than two hours. Wildfire officers are mobilised to all Category Wildfires within South wales.

In 2010 I and another firefighter attended a training exchange to South Africa for UK firefighters hosted by Working on Fire. The aim of this exchange was to introduce firefighters to prescribed fire which is a method to manage vegetation with fire. This two week exchange was a very important part of my journey to understanding wildfire and how we can manage it in south Wales.

The Author with UK and Working on Fire Firefighters, Pilanesberg National Park, South Africa

Photo credit- Northumberland Fire and Rescue Service

The geographical area of south Wales covered by South Wales and Mid and West wales Fire and rescue Services was also the area covered by the Coed Y Cymoedd Forestry Commission District, this district was unique in the UK as they had a Firefighting helicopter on standby through the summer months to assist with extinguishing fires on forestry commission land. In 2010 the command and control of the helicopter was handed over to SWFRS as the Forestry commission had scaled back their firefighting resources. Because of this agreement we started to train with the helicopter crews and I chair the all wales helicopter group which has before and after season meetings to plan and debrief the season with crews and Forestry commission.

Contract helicopter equipped with a 1000l Bambi bucket fighting a wildfire in the Rhondda Valley, South Wales

Photo credit- Author.

In 2011 equipped with the knowledge I had gained from the exchange to South Africa I made contacts in the Brecon Beacons National Park (BBNP) and we started to support their prescribed burning activities with the Argocats and Fire fogging units. This made their work not only safer but also quicker as they could manage more ground with our support.

During this time I was also researching for vehicles suitable for towing the Argocats to incidents and then being used as a firefighting resource once in attendance, the vehicle that was finally chosen was the Land Rover 130 Crew cab. This vehicle was equipped with a 450 litre water tank, a fire fogging system and 90 metres of high pressure hose. The system I developed was that the crew mobilise to the incident with their standard structural fire engine which carried 1800 litres of

water, they also take the Land rover which carries 450 Litres of water towing the Argocat on a trailer which carries 200 litres of water. All vehicles arrive at the incident carrying their allotted water, when the Argocats water is used it can be replenished twice by the Land Rover which can get closer to the scene of operations being a 4x4 vehicle, the Land Rover can then be replenished four times by the structural fire engine. This system means crews can be more self-sufficient and do not need to call on further resources to deal with incidents. The Land Rovers could also be used for firefighting so a dual attack could be made by the land Rover and Argocat.

One of Four Land Rover 130 Crew cabs used to tow Argocat off road vehicles and firefight off road

Photo credit- Author

In 2012 I attended a one week wildfire cause and origin determination course hosted by the Dutch fire service and Police with instructors from the USA and Australia. This course mirrors the US FI210 course but has been adapted to fit with EU laws. I later presented to the NFCC wildfire group on my experience of the course and the value this could bring to the UK fire and rescue services in developing wildfire prevention strategies. At the time there were changes being made in the UK in relation to fire investigation legislation so this was not progressed.

Certificate of expertise, wildfire cause and origin determination

Realising that fuel management and the use of tactical fire was important in combating wildfires I made presentations to the senior management team of the work we had done on the BBNP and how we could use fire to fight fire. In 2013 9 members of SWFRS and a Ranger from BBNP attended a training course arranged by the Pau Costa Foundation and hosted by the GRAF Team of the Catalonian Fire service. During this course we were also taught about fire behaviour and ignition patterns using straw spread over the ground to simulate wild vegetation. I found this an amazing teaching tool as with our wet climate and burning legislation vegetation is not always available to burn. When SWFRS hosted the UK wildfire conference in November 2013 I gave a live demonstration of this to the delegates which was a great success.

SWFRS firefighter carrying out prescribed burning under the supervision of a GRAF firefighter Photo credit- author

The following year of 2014 was very wet and wildfire was not high on anyone's agenda, we carried on assisting the BBNP with prescribed burning but opportunities were few because of the rainfall. The fire services across Wales made the news as there had been a dramatic reduction in the number of wildfires attended. It was at this time I started to realise how it was important not to link the number of ignitions in a year to how safe communities were. In the past we had lots of ignitions and lots of small fires, what we were now finding was ignitions were reducing but fires were burning larger areas of land and becoming more difficult to extinguish.

In 2015 I was approached to carry out a prescribed burn for the Wales and West wildlife trust at a site they wanted to graze but had too much vegetation, I visited the site to make a plan and subsequently attended with a fire crew to carry out the prescribed burn, using the experience I had gained over the last few years this was an easy task and the wildlife trust were very impressed with the work we carried out. During the prescribed burn I was interviewed by a film crew for a news article, my message was based around what I had been learning from other countries and what I had seen for myself within South Wales, less grazing animals and changes in land use combined with a reduction in wildfire ignitions and possible changes in weather were in the long term going to cause bigger and more damaging fires, "we cannot control the weather, we cannot control the arsonists but we can control the fuel" being my main message.

The first prescribed burn carried out by SWFRS

Photo credit – Hazel Nash Photography.

A week later myself and my crew carried out another prescribed burn to create a fire break at a site in the Rhondda valley, this was a site which see regular arson related wildfires which can spread to a small block of forestry . The purpose of the prescribed fire was to see if we could stop a future wildfire by being proactive instead of reactive. We burnt a fire break approximately six metres wide and 800 metres long below a footpath, this was a cool burn and did not burn down to the mineral soil so would not cause any erosion issues in the future.

SWFRS firefighters conducting the first fire service prescribed burn in the Rhondda Valley, March 2015

Photo credit – Hazel Nash Photography.

After the burn and some rainfall the site was visited to see how much vegetation had been removed by the fire and if there was any erosion from the rain.

Effects of prescribed burn on vegetation and soil. Photo credit – author

As stated, the reason for picking the site for the trial was due to the amount of arson related wildfires, approximately a month after the prescribed burn had taken place a number of fires were ignited along a footpath at the bottom of the mountain and a wildfire spread towards the fire break. I was notified as I was off duty and attended to witness the effectiveness of the fire breaks. When the fire which was in full alignment reached the fire break the lack of fuel reduced the flames dramatically and the fire self-extinguished.

Prescribed burnt fire break burnt across the mountain, the straight edge at the top is where the wildfire was stopped.

Photo credit – author

2015 turned out to be a busy wildfire season and I was asked to present on fuel reduction to Fire Service management, politicians, the media and the police. I was asked to brief the Government

minister on what we could do to be proactive to stop the large damaging wildfires and this was fed into a Wildfire summit held by the Welsh Assembly Government.

During the spring of 2015 National Resources Wales which was a government department made from the amalgamation of the Forestry commission, the environment agency and the countryside council for Wales were also looking into wildfires and ways to manage vegetation by reintroducing grazing, one of the sites they had planned to use was burnt and luckily due to an administration issue there had been a delay so the new fences had not been erected so were saved from the wildfire. I got to meet this team and briefed them on what we had done and what we could do in the future. Following this initial meeting we formed the healthy hillsides project which was a partnership between SWFRS, NRW, the wildlife trust and Rhondda Cynon Taff local authority as this was the local authority with the most wildfires. This project was government funded with the aim to make the Rhondda valley a safer place to live.

SWFRS role in the project was to identify areas at risk from wildfire and then plan to reduce the vegetation by using prescribed fire. To enable this work to be carried out I presented to the SWFRS senior management team my plan to train the 28 whole time firefighters at Tonypandy fire station in wildfire and prescribed burning and was given approval.

Each fire fighter attended the two day wildfire safety course which we had developed which due to changes in roles and retirements the initial 14 instructors was now down to 3 with me as the lead. I also developed a one day introduction to burning course which would give the firefighters the tools so they could use fire safely to manage vegetation. What I had found working alongside international colleagues was their courses did not cater for the total beginner with simple but essential information such as what fuel was in a drip torch and at what ratio these were mixed. The course also covered the grass and heather burning code, firemet, fire severity index, ignition patterns and equipment followed by a practical session where straw is used to simulate wild vegetation as I had seen in Catalonia and demonstrated at the wildfire conference. As part of the risk assessment for this process a prescribed burning form was developed and firefighters taught how to complete it.

Gwasanaeth Tân ac Achub De Cymru
South Wales Fire and Rescue Service

South Wales Fire and Rescue Service

BURN PLAN

DATE		START TIME		FINISH TIME	
BURN BOSS		CALL SIGN		TEL. NO.	

LOCATION ADDRESS			
GRID REF / GEO CODE		NEAREST MAIN ROAD	

KESTREL READINGS
RULE OF 30

TIME	TEMPERATURE MAX 30°C	HUMIDITY	WIND SPEED MAX 30kph/18mph	WIND DIRECTION

LOOKOUT NAME & LOCATION					
FIREFIGHTING RESOURCES					
OBJECTIVE OF BURN					
FUEL TYPES					
CONTROL INFORMED	YES	NO	SITE RECCE	YES	NO

FIRE SEVERITY INDEX	LOW	MODERATE	HIGH	EXCEPTIONAL

BREAKOUT PLAN - IF FIRE ESCAPES PLOT WHAT IS YOUR PLAN?

SITE SPECIFIC HAZARDS (E.G. ELECTRICITY CABLES, QUARRIES ETC.)

L LOOKOUTS	A AWARENESS/ ANCHOR POINTS	C COMMUNICATIONS	E ESCAPE ROUTES	S SAFETY ZONES

TEST BURN COMPLETED	

DRAW PLAN ON REVERSE INCLUDING BREAKOUT PLAN

Prescribed burning planning form designed by the author to use as part of the burn plan and risk assessment

At the same time I introduced to the service drip torches which were used to light prescribed and tactical burns and the use of petrol engine leaf blowers to extinguish wildfires alongside standard fire beaters after seeing them being used internationally with great success. I developed a training course and the crews were trained in their use.

Drip torch containing 75% diesel and 25% petrol used for igniting prescribed and tactical fires, Stihl Br600 leaf blower used alongside a fire beater to extinguish fire, new equipment for SWFRS Photo credit- author

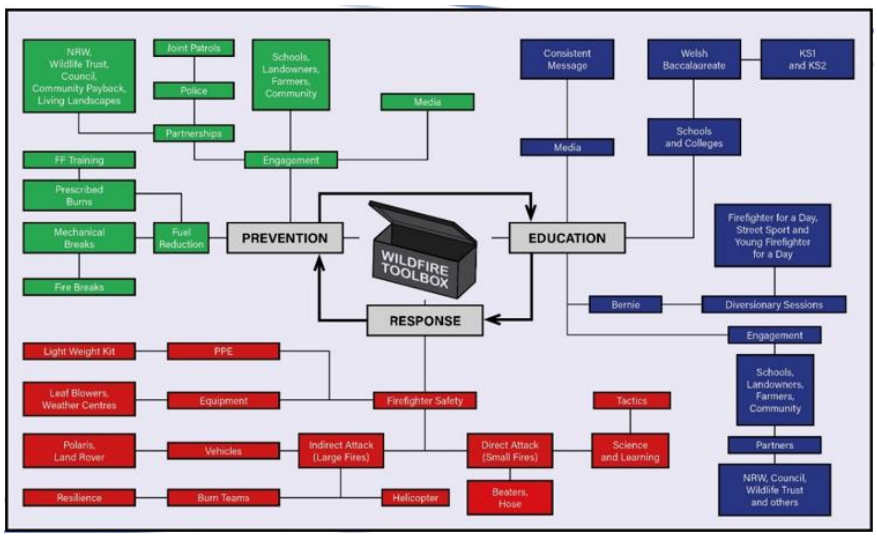
In early 2016 the initial training was complete the crews commenced carrying out prescribed burns gain experience, this involved the removal of strips of fuel to create fire breaks under my supervision on private, local authority and forestry commission owned land during the prescribed burn season and all crews gained valuable experience. Once this experience had been gained the crews were declared operational and could be called onto wildfires under my command and use fire to extinguish them.

Fire crew using fire to create a wider fire break to stop uphill wildfires jumping a forest road. Photo credit- author

The first use of tactical fire to fight a wildfire in South Wales was on the 23rd march 2016 when I and a crew from Tonypandy attended a well-developed fire near the village of Cwm, Ebbw Vale. Crews had been struggling to contain the fire and stop it spreading to houses and stables. I carried out a recce and we briefed the incident commander with our plan and carried out a burn to stop the head of the fire with a great success.

As we were now losing our level 3 wildfire officers through retirement but could not fund continuous course externally I was asked to develop a Level 3 course for SWFRS so we could train our officers in house. I attended a course in Northumberland along with some SWFRS officers and then worked towards a BTEC qualification in wildfire management. Once I had gained this I developed a course specifically for SWFRS, as well as training officers how to plan for and manage large wildfires this five day course also taught them how to carry out prescribed and tactical burning and how to work with firefighting helicopters. I taught the first course in march 2016 to ten students from SWFRS, I currently run one or two of these course each year depending on demand and I now train Mid and west wales Fire and rescue service and North Wales Fire and rescue service staff alongside South Wales.

In June of 2016 I presented the findings of the prescribed burning work to create and widen fire breaks and the use of fire to fight fire to the SWFRS senior management team and asked for permission to expand the burn capability across a further three stations so we would have four stations who were trained. At the same time I presented the Wildfire Toolbox which a colleague and I had developed to give crews a suite of tools to educate, prevent and respond to fires, I believe it is very important not to rely on one tactic such as burning but to embrace as many tactics as possible. Permission was given and using wildfire call statistics the three stations were chosen.



South Wales Fire and Rescue Service Wildfire Toolbox, version 1, June 2016

During this time I had been working to find a suitable replacement vehicle for the Argocats as they were now seven years old and showing signs of wear. A suitable replacement was found after testing a number of vehicles. The new vehicle was a Polaris avenger 6x6 and this was equipped for firefighting and carrying equipment such as leaf blowers, drip torches, beaters and fire rakes by the fleet and engineering Department of South Wales Fire and rescue service. To train the operators I developed a course which covers both the theory and practical requirements. I also developed an instructor course and now each of the four whole time watches at the four wildfire fire stations have an instructor who can train new members of staff.

Polaris avenger 6x6 equipped fir firefighting, note innovative stowage of fire beaters also acting as mud flaps

Photo credit – Robin Funffinger

These four wildfire stations were all trained ready for the spring of 2017 in Wildfire safety, prescribed and tactical burning and how to operate the Polaris and ancillary equipment.

In November 2016 I was awarded a letter of Congratulations from the Chief Fire Officer of South Wales Fire and Rescue Service, the award citation reads ‘ in recognition of his dedication to continuous improvement, championing the issues of tackling wildfires and developing tactics that increase firefighter safety in their environments’

Author being awarded a letter of congratulations from SWFRS CFO and chair of Fire authority

Photo credit- SWFRS

In January 2017 I attended the 14th Wildland Fire Safety Summit of the International association of Wildland Firefighters which was co-organised by the Catalan Fire and Rescue Service and Pau Costa Foundation, and the first edition of the International Congress on Prescribed Fires was co-organised by the Catalan Fire and Rescue Service, the University of Barcelona and Pau Costa Foundation. These events were attended by over 500 experts from 23 countries

I was invited to speak and display a poster at the Congress on Prescribed Fire where I took the audience on my journey to introduce prescribed and tactical fire skills and equipment into South wales Fire and Rescue service to make firefighters and communities safer. This presentation was very well accepted with lots of interest from other countries who were trying to develop similar strategies.

A part of the original wildfire project was to look into a suitable personal protective uniform for firefighters to wear at wildfires, I had been researching this for many years and in 2016 after presenting to a number of departments the go ahead was given to find suitable kit. We identified a manufacturer who we designed the kit with and trialled it. When the trial was successful every firefighter in South Wales was issued with lightweight kit which can be worn at wildfires

Lightweight fire kit, designed by SWFRS

Photo credit - author

The fire season of 2017 saw firefighters embracing the new skills by managing land and using tactical fire to fight fire on a number of occasions, memorable incidents were an 80 hectare wildfire

involving grass and forestry which was extinguished by myself and one crew using fire and an 800 hectare fire in the Brecon Beacon National Park which was extinguished by two Polaris crews and the helicopter along with myself and one tactical officer.

80 hectare wildfire extinguished by one tactical burn crew

Photo credit –author

In March 2017 I was invited to Northern Ireland to present and give practical demonstrations at a wildfire fire investigation seminar alongside Alex Held who I had met in South Africa, this event was organised by the Northern Ireland environment agency (NIEA) and supported by the fire service and Police. In June I was asked to attend Northern Ireland by the NIEA as part of a European request for assistance in determining the cause and origin of a number of large wildfires that had occurred in April and May alongside a Dutch fire fighter and Police officer. We spent 4 days visiting sites along with the fire service and Police and identified the origin and cause of a number of fires.

In May of 2017 I attended the first UK Wildfire tactical advisors course held in Northumberland, this role is to assist other fire and rescue services deal with large scale wildfires when they do not have the experience themselves.

In June 2017 I was invited to attend the first flamework event in Mafra, Portugal alongside a group of international colleagues. The event is hosted by Carlos Trinidade who is the local manager of the civil protection agency, the purpose of these events is to promote prescribed burning excellence by learning from each other, I gave a presentation and demonstrations of the work I had been doing within SWFRS.

In November 2017 I spoke at the UK wildfire conference in Bournemouth about the wildfire project, the introduction of prescribed and tactical fire and the wildfire toolbox. I also introduced the use of a remote control cutter for creating fire breaks and opening up footpaths, this vehicle was hired for our use for a month through our partnership with the healthy hillsides group and was paid for by the NRW proceeds of crime fund.

McConnell robo cutter used to create fire breaks across South wales

Photo credit – author

In February 2018 I organised an international training exchange with firefighters from across the UK and Ireland along with colleagues from Spain, Portugal and Germany attending a 3 day work shop with the BBNP. The purpose of this event was to show case the work we had done to our UK colleagues and also to receive critical feedback from our international colleagues who had been using fire for a lot longer to manage fuel and stop wildfires.

In March 2018 I arranged a one day wildfire conference at SWFRS headquarters for key stakeholders from across South Wales with speakers from across the UK and Ireland to present on the wildfire risk and ongoing work to make communities safer.

International Wildfire exchange hosted by SWFRS in the Brecon beacons National Park Feb 2018

Photo credit – author

The spring of 2018 was very wet which resulted in there being a significant reduction the number of wildfires attended compared to dryer years. At the end of May I was asked to take part in a television news interview to talk about the reduction and link it to the community work that had been done in Wales, by this time I had come to the conclusion that we were not going to ever eliminate deliberate ignitions and the more we reduced ignitions the more the fuel would build up so we needed to increase our fuel management work. At the same time long range forecasts coming from colleagues in Europe were showing a long hot summer ahead, I declined the interview as I didn't believe it would have been a true reflection of the unfolding reality.

On Sunday the 24th June 2018 a fire was ignited on Saddleworth Moor, Manchester, firefighters tried to contain the fire but struggled and the wildfire was declared a major incident on Wednesday 27th June, tactical advisors from services across the UK attended and requested a tactical burn team. I was mobilised along with a team from South Wales on the Wednesday evening but due to a communication error we were recalled and mobilised again on Thursday the 28th. As we were arriving on scene some of the tactical advisors were mobilising to a fire at winter Hill in Lancashire. After assessing the incident there were no real opportunities to use tactical fire so I briefed the incident command team on how they could use the military who had been requested to create a fire break in the peat to stop the smouldering fire. I was asked to take the soldiers to the sector and direct them what was required, I briefed the 30 soldiers and they commenced digging a trench in front of the fire which we then filled with water using pumps from a nearby stream.

Soldiers from the British army heading towards a smouldering peat fire to dig fire breaks Photo credit - author

Trench dug across moorland to stop smouldering peat fire Photo credit - author

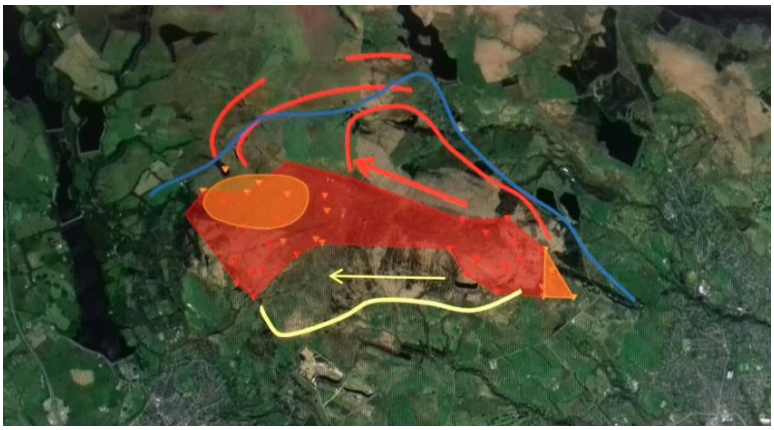
Soldier filling trench with water from nearby stream to stop fire spread. Photo credit - author

SWFRS crews were released from the Saddleworth Moor fire on the afternoon of Saturday 30th June. Whilst on route back to South Wales I was contacted and asked if we could attend the Winter Hill fire which had also been declared a major incident. After getting permissions from my service three of us attended. On arrival we were briefed that the fire was out of control, crews had been evacuated and the fire was threatening National critical infrastructure which was a telecommunication mast which supplied television and emergency service radio to the North West of England. I assessed the scene and made a plan and then the three of us carried out a tactical burn to remove the fuel around the mast, the outbuildings and the concrete anchor points. We completed this by 1am when we then assessed the rest of the fire ground and I asked for further assistance from SWFRS to keep burning throughout the next day.

SWFRS firefighter removing vegetation using fire to protect National Critical Infrastructure, Winter Hill, Lancashire 2018 Photo credit – author

At 5 am on Sunday July 1st the second team arrived from SWFRS and I briefed them and the incident commander and we commenced burning out the vegetation on the right flank of the fire. Firefighters had tried to extinguish this flank for a number of days but the fire kept relighting, there was house at the bottom of the hill which was at risk and if the fire had jumped the narrow track it had the potential to double in size. Whilst carrying out this burn I was contacted by Marc Castellnou the lead officer of the Catalonian Fire service GRAF team who was watching the fire using satellites and had the same plan as myself that the right flank needed to be extinguished. We briefed the family who lived in the house on our plan as they had be preparing to evacuate and

instead of leaving they sat in their garden and watched us extinguish the fire using fire whilst having a barbeque. This story was later featured in a Guardian news article.



Satellite image with fire analysis overlaid and sent to burn boss by Marc Castellnou, Graf lead officer, July 2018

Photo credit - Marc Castellnou

Another reason why we extinguished this fire and did not let it burn was because the fire was slowly backing down the hill so was putting a lot of heat into the ground which was igniting the peat. As the tactical burn was lit from the path as an anchor point and burnt very fast uphill before extinguishing when it met the wildfire and the fuel was consumed. Because the fire ran up the hill fast it did not heat the ground and cause the peat to catch fire.

Winter Hill tactical burn, the yellow line is the point where the tactical burn met the wildfire and self-extinguished, the peat under the area deliberately burnt is not burning whereas the peat under the wildfire is. Photo credit- author

The rest of July and into August where spent fighting wildfires across South Wales due to the prolonged drought, most of the fires were deep seated and required considerable effort to

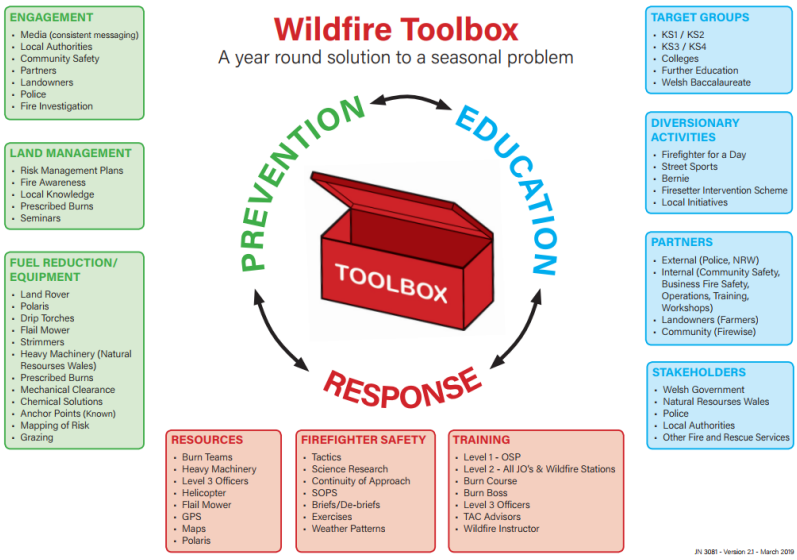
extinguish and to stop re lighting. Lots of these fires occurred on NRW land and involved forestry waste known as Brash which becomes very hard to extinguish. Due to this I did some research and purchased 1600m of 25mm forestry hose which would be shared between the Polaris trailers to enable us to get copious amounts of water to deep seated fires.

Following the success of the tactical Burn team which was deployed to the two major incidents in England the team were awarded an Operational acknowledgement award from the SWFRS Chief Fire Officer and I was asked to train a team for Lancashire Fire and rescue service which I did in November 2018.

In 2019 it was decided by NRW that the firefighting helicopter would now be coordinated by their central control centre and be an all Wales asset which we would still command, because of this we attended the other two services in Wales to train them on how to use the firefighting helicopter and to show them the new methods we had developed to fight fires.

I spoke at conferences in France and England and SWFRS hosted the 2019 UK wildfire conference in November with the conference topic being Fuel management and using my Tag line of 'manage the fuel, reduce the risk'. The conference was a great success with speakers and attendees coming from across the globe.

In March 2019 we also updated the wildfire Toolbox.



Updated SWFRS Wildfire toolbox- 2019

2020 started again as a very wet year with large scale flooding and damage caused by a number of storms the most memorable being Storm Dennis. There was very little opportunity to carry out any prescribed burning due to the wet weather, in March the weather finally dried up and we put in place refresher training for our wildfire stations and wildfire tactical officers. Unfortunately the COVID-19 pandemic stopped this as there was a voluntary embargo on prescribed fire so not to put the fire service under undue pressure. The dry weather remained for most of March and into April and May with SWFRS attending a large number of fires, the largest of which was in the BBNP which burnt 1251 hectares of moorland and spread to forestry plantations before being extinguished. I was asked to complete a cause and origin investigation into this fire which I did. I located the origin and shared my findings with SWFRS and other stakeholders. In 2021 SWFRS hope to trial fire investigation at wildfires as to have a robust prevention strategy we need to understand their cause and not just assume. To assist with this trial qualified fire investigators will be trained by myself so they can then be deployed to incidents.

We had maintained the hire of a remote control cutter for a few months every year since the trial in 2017, we had moved onto an ICUT3 cutter with a forestry mulching head and I put procedures in place so we could use this at wildfires as well as carrying out preventative work. This was used at incidents on a number of occasions and we are now hopeful that the healthy hillsides project will fund the purchase of one.

Firefighter operating a remote control cutter to create a fire break and stop a wildfire, Wattsville, South wales, April 2018 Photo credit - author

In the afternoon of Monday 18th May a wildfire occurred in Wareham Forest, Dorset. This fire spread very quickly in the dry vegetation fanned by a strong wind and 25 pumps were requested

and a major incident declared which was supported by UK wildfire tactical advisors. I and a colleague were deployed to the incident to support the local tactical advisor on Thursday the 21st May. The incident had been contained and crews were managing hotspots before a significant weather change which would bring a predicted 30mph wind and temperatures in the mid 20's degree Celsius. We toured the area for familiarisation and I spoke to the incident command team regarding tactics including helicopters and tactical burning. Because of the predicted risk the local forest district secured permission to use a helicopter and I put them in contact with our provider. On Friday 22nd May the winds arrived as predicted and by midday the fire has reignited and was spreading through forestry plantations. I spoke with the incident command team and arranged for the helicopter to attend to assist with firefighting. On arrival I briefed the pilot and became the commander of the air sector. As the fire was now out of control and jumping across wide forestry roads I spoke to the command team and suggested a burn team should be requested, they agreed and my team was despatched from Wales. Whilst waiting for them to arrive I made a complete tour of the sectors and made a plan for the tactical burn. When the crew arrived I briefed them and the command team and we went to tour the sectors, the team agreed with my plan and when the appliances in attendance were scaled down we commenced burning. We commenced at 2300 hrs and were finished by 0300 hrs when we had burnt a line of approximately 1.5 Km. The purpose of the burn was to remove the fuel from inside the road network so the fire could not spread any further. We carried out a further burn at the Wareham forest fire on the Saturday evening and the crew left on the Sunday after containing a large section of the fire using fire.

South Wales firefighters carrying out night time tactical burn, Wareham Forest, May 2018

Photo credit - author

After the fires of 2020 I did some research into the use of leaf blowers and the wildfire team presented to the senior management team on their use and how they make firefighting easier, due to this ten new leaf blowers were purchased and I have developed a training package to support their use.

Firefighter evaluating the Stihl BR800 leaf blower

Photo credit author

In June 2020 due to retirements and changes of position with in the National Fire Chiefs Council wildfire group I was given the lead of two new areas of work which are tactical fire use and aerial firefighting for the UK. At the start of 2021 I became a partner at the advanced fire analyst project (AFAN) which is a European funded project building a network and framework for remote wildfire analysis managed by the Pau Costa Foundation. The Season of 2021 was not very memorable for

UK fires with only a brief period of fires in late April, one of these fire affected an area of clear felled forestry above the village of Machen in Caerphilly, the fire was difficult to extinguish on steep , lose ground. I flew over the incident in the helicopter and then carried out a remote assessment, predicting where the fire would burn and made a plan how to extinguish it.

Due to the complexity of this and other incidents we have developed a Category 3 level of wildfire where we will use our UK tactical advisors and community fire safety advisors to not only make a plan to extinguish the fire but to also ensure the public are aware of our plans.

In the evening of Friday 6th August I received a phone call to ask if I could pull together a team to attend the wildfires which were burning out of control in Greece, I accepted and pulled together a group of 4 from our wildfire training team and we deployed to Greece as part of a 21 person team, we were on the ground working by Monday 9th August.

Welsh Wildfire instructors deployed to Greece to assist with 2021 wildfires, myself on left.

Credit - Author

During this deployment I carried out the role of wildfire advisor and analyst while my team became the wildfire leads for the other UK teams who were not experienced in wildfire as us. This was a fantastic opportunity to give something back to the wildfire community and we learnt

valuable lessons which we can pass on to our colleagues. Both during and after the deployment there was a high level of media interest and I gave numerous interviews about the fires , how there is a link between fire and land management and how we have tried to change this within South wales fire and rescue service. There is now a plan to try to formalise this overseas wildfire response similar to the assistance that wildfire tactical advisors give within the UK.

UK Fire and rescue Service response to Greece August 2021 along with Greek civil protection and UK embassy staff. Myself in middle holding Welsh flag.

Credit - Author