WILDFIRE IMPACT, RISK & MITIGATION WORKSHOP

Report and Proceedings

WEDNESDAY, 18 JANUARY 2023
ROYAL GEOGRAPHICAL SOCIETY, LONDON

HOSTED BY THE GAME & WILDLIFE CONSERVATION TRUST (GWCT). CHAIRED BY THE RT HON THE LORD DEBEN, CHAIR OF THE UK CLIMATE CHANGE COMMITTEE

Game & Wildlife CONSERVATION TRUST

Registered Charity No.1112023

Wildfire impact, risk & mitigation workshop

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Acknowledgements:
We would like to thank all the delegates for contributing to the workshop, Lord Deben for chairing and the Climate Change Committee secretariat for suggesting that a workshop attended by stakeholders and experts would be a useful addition to the evidence base.

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1. Welcome and Introduction

Welcome
From Teresa Dent CBE, Chief Executive, GWCT

GWCT IS delighted to host this workshop. We are very grateful to Lord Deben for chairing it. GWCT has been talking to Lord Deben about our concerns on vegetation management and wildfire since July 2020. We are very grateful to all of you for coming. And to members of the Climate Change Committee staff who suggested this event.

What is so refreshing, and I hope will be rewarding, about today is the fact we have people who know about every aspect of wildfire in this room.

We have the scientists who have done so much research, practical land managers, firefighters, government officials, policymakers, meteorologists, and the Climate Change Committee. We have the opportunity to combine many types of knowledge: scientific, observational, experiential, practical and behavioural.

This is a timely workshop as it will help inform the CCC Mitigation and Adaptation reports for Parliament later in 2023.

I would now like to ask Lord Deben to introduce today's proceedings.

Lord Deben

Lord Deben has been Chairman of the Climate Change Committee since 2012. Lord Deben was the UK's longest serving Secretary of State for the Environment (1993 to 1997). He has held several other high-level ministerial posts, including Secretary of State for Agriculture, Fisheries and Food (1989 to 1993). Lord Deben founded and chairs Sancroft, a corporate responsibility consultancy working with blue-chip companies around the world to help them improve their environmental, social and ethical impact, He is also chairman of Valpak Limited, and the Personal Investment Management and Financial Advice Association.

Introduction
The Right Hon the Lord Deben, Chair of the UK Climate Change Committee

I am delighted to welcome you here as Chairman of the Climate Change Committee. 12-13 years ago, we were looking at trying to reduce our net carbon emissions by 60%, then it went up to 80% and now we are aiming at net zero.

The Climate Change Committee produces the carbon budgets which the government puts to Parliament. So far, they have always been passed and once passed cannot be changed without the agreement of the Climate Change Committee itself, which, frankly, we would be unlikely to give.

The Climate Change Committee advice relies on a whole range of things including science. I am the second chair, and my predecessor made it clear that the Climate Change Committee does not have opinions; it presents the best science to enable politicians to make decisions. It is not an NGO; it is independent of government and takes no particular side. Our role simply is to help conquer the biggest threat that our nation faces.

When I first took up the role of chairman, I used to have an argument every time I went to a meeting about whether climate change existed. Thankfully, that is no longer the case and we have reached a good point now where the discussion is about the mechanics needed to reach net zero.

The Committee is always happy to revisit its view and we accept we do not get everything right. For example, we completely underestimated how quickly electric cars would be taken up and we overestimated the same for heat pumps.

I am aware that recommendations we have made about peatland have worried those managing peatlands. We are happy that the conclusions we reached were correct in terms of the evidence available then; we are conscious we need to listen now to any new science.

I would like to thank Teresa Dent for setting this up. We want to listen very carefully today. We cannot think about climate change without thinking about the issues that surround it and wildfire is a very important issue.

I extend you all a very warm welcome. I am sorry I can only stay until lunchtime today, but senior members of our team will be here for the whole day.

2. List of delegates by table number

	Name	Role
	Rt Hon. The Lord Deben	Chair, Climate Change Committee (CCC)
	Teresa Dent CBE	Chief Executive, GWCT
Table 1	Brendan Freeman	Senior Analyst, CCC (morning only)
	Steve Gibson	National Fire Chiefs Council, Wildfire Tactical Advisor
	Morgan Varner	Director of Fire Research, Tall Timbers, Florida, USA
	Joanna Rawlings	Peatland Protection and mapping, Defra
	Andrew Kibble	Senior Manager, UK Health Security Agency.
Table 2	Richard Millar	Head of Adaptation Committee, CCC (afternoon only)
	Prof Matt Davies	Assoc. Professor, Soil & Plant Community Restoration, Ohio State Univ.
	Marc Castellnou	GRAF Catalunya FRS
	Jessica Findlay	NatureScot
	Andy Smith	Head of Arm's Length Bodies Reform, Natural England
	Neil Pike	Manager, Yorkshire and N. Lincolnshire Area Team, Natural England
	Matt Jones	University of East Anglia
Table 3	Lee Lyons	Head of Peatland Protection and Biodiversity in the Overseas Territories, Defra
	Paul Hedley	UK Wildfire Strategic Lead – NFCC
	Hugh Dignon	Head of the Wildlife and Biodiversity Unit, Scottish Government
	Dr Gareth Clay	Manchester University
	Ruth Gregg	Senior Analyst, Agriculture & Land use, CCC
	Prof Nick Sotherton	Research consultant, GWCT
Table 4	Robert Stacey	Lead for wildfire team at Northumberland FRS; Secretary England & Wales Wildfire Forum; Secretary Northumberland Wildfire Group.
	Prof Andreas Heinemeyer	University of York
	Sophie Fraenkel	Peatland Protection and mapping, Defra
	Steve Pomeroy	Head of Fire Services Branch, Welsh Government
	Dr Nick Kettridge	School of Geo Earth Eco Biological Resilience, Birmingham University
Table 5	Dr Stefan Doerr	Swansea University
	Prof Claire Belcher	Exeter University
	Richard Bailey	Uplands keeper/ wildfire controller
	Roger Hargreaves	Director, COBR
	David Smedley	Head of Soil & Peatland Science, ALPS, NETL, Defra
	Henrietta Appleton	Policy Officer, GWCT
Table 6	Rob Gazzard	Advisor on Wildfire, Access, Landscapes, Peatland & Soil, Defra
	Dr Nicholas Aebischer	GWCT and Natural England Scientific Advisory Committee
	Karl Kitchen	Wildfire Prediction specialist, Met Office
	Amanda Anderson	Director, Moorland Association
	Craig Hope	Natural Resources Wales
	Dee Payne	Environmental Risk Policy Advisor, COBR

3. Summary

This summary is derived from the conclusions drawn by the workshop lead facilitator and mediator, Howard Davies.

- Wildfire is an emergent risk in the UK which presents a significant risk to life.
- With hot, dry, weather conditions increasing as a result of climate change, the risk wildfire poses has become far more severe and is now widespread across all fine fuel vegetation in England (see box 1 for an explanation of fine fuels).
- A strategic approach to managing and mitigating wildfire risk is important, both at national and local scale, as is learning from the experience of other countries.
- Evidence from other similarly fire-prone ecosystems provides a valuable insight into the efficacy of various strategies employed to mitigate the risks of wildfire, with some providing early warning of strategies to avoid.
- Taking account of other countries' insights, advice, and warnings is a vital step in decoupling wildfire risk management from the politics and tensions surrounding traditional land management practices, and prescribing action on the basis of its efficacy and ability to mitigate significant unacceptable risks.
- It is vital for all actors on the land to understand fuel load, in particular the role of 'fine fuels' and how they drive fire behaviour and significantly exacerbate risk. Evidence from other countries emphasizes the importance of retaining our land managers with their knowledge and skills.
- The social and political dimension of wildfire mitigation, in particular the limited capacity the Fire and Rescue Service in predicted imminent scenarios and the value of community preparedness, is also an important consideration.
- The willingness to continue to actively engage after the workshop was evident and a very positive collegial approach fostered.
- To crystalise the key actions to be taken, the timeline that emerged was either 'immediate' or 'short-medium' term reflecting the strong consensus in the room over the urgency of the need to mitigate the risk to the UK that wildfires now pose.

Box 1: What are fine fuels and why do they matter?

The relationship between any given fuel's surface area and its volume, and the fuel's size and shape, strongly influences the ease of ignition. The surface area of finer fuels, (0.6cm or less in diameter that dries out within an hour) such as grass, leaves, ferns, mosses, pine needles or heather, is much greater than the equivalent volume of coarser fuels such as branches and tree trunks. Fuels with a higher surface area to volume, dry more quickly and require less exposure to heat for them to be raised to their ignition point and consequently are more receptive to fire. When dried, fine fuels are referred to as flash fuels.

This means that vegetation such as moorland, heathland, crops and grasslands as well as the understory and litter layer of woodlands provide a continuous fine fuel supply, causing intense fires with a fast rate of motion, long flame length and unpredictable behaviour.

4. Priority actions

In the final exercise, delegates were given the freedom to consider all documented risks, mitigation measures, and actions and discussions, and vote on their priority top action. These were:

- Develop a wildfire strategy.
- Carry out a risk/asset/value mapping exercise.
- Local scale site examination as part of strategic management.
- Consider an approach to fuel management outwith the prescribed burning season (1st October – 15th April in Upland areas; 1st November to 31st March in other areas (Source: Heather and grass burning: rules and applying for a licence).
- Review the Wildfire Framework.
- Publish a UK wildfire risk map.

5. Parked issues

During the workshop, two issues that needed further agreement but were beyond the immediate priorities of the workshop were 'parked'. Both require further consideration.

- Definitions. The need for a consensus on wildfire language and a definition of key terms. Different stakeholders have different understandings of terminology used and this can present a hurdle to agreement. [Post meeting comment: a glossary of terminology associated with Wildfires and Forest Fires was created in 2012 as part of a European Forest Fire Networks (EUFOFINET) project. A selection of key terms is included in appendix 4. The full glossary can be found at: EUFOFINET Glossary of terminology.]
- Rewetting. Whilst there is consensus that restoration of deep peat hydrology, where possible, should happen as part of the mitigation package, the fire-fighting experience tells us intact hydrology alone will not protect peatlands from drought conditions already experienced. Consequently, the number of days that have elapsed since the last rainfall is a key measure; after 20 days the fuels such as normally saturated moss and peat will be dry and burn.

6. Proposal for next steps

The main conclusions above identify that the workshop delegates reached consensus on the need for more people (including the public) to understand the environmental, economic and social impacts of wildfire; together with the need for active management to mitigate these impacts and reduce the risk of wildfire which has increased significantly under our changed climate. In addition, the workshop concluded that current policy was ineffective in its reliance on the Fire & Rescue Services to put out/suppress wildfires and that further preventative intervention was required to manage fuel loads.

GWCT recommends that the strong conclusions from this workshop exercise are embedded in a revision of the Wildfire Framework whilst working towards a national wildfire strategy. In the meantime, local strategic plans, using available data and evidence, should inform local/regional approaches to wildfire mitigation by local partnerships.

7. Introduction to the workshop

The aim of the workshop was to

- Understand the latest thinking about wildfire risk mitigation globally with the benefit of contributors from the USA and Spain.
- Consider what is happening in the UK particularly in the light of the 2022 very hot summer.
- Reach a level of consensus on how we should be assessing future wildfire impact, risk and mitigation strategies.

This workshop will help inform the CCC Mitigation and Adaptation reports for Parliament later in 2023.

The workshop was led by two accredited facilitators with experience in the environmental field, Howard Davies and Richard Clarke. Their biographies can be found in Appendix 5.

8. Methodology

The workshop was designed to facilitate consensus-building between those attending the workshop around risk appetite, mitigation, and actions in response to future wildfire impact through a series of breakout sessions reporting back to plenary. [We note at this point that there was consensus during the workshop that it was not a future impact but an immediate one].

Session 1: Defining outcomes

This first session sought to engender a shared sense of collaboration rather than defence of pre-conceived positions, by initially focussing on understanding areas of commonality and difference, exploring

- Existing levels of consensus.
- Reflection on self and possible behavioural shifts required in the light of enhanced knowledge and understanding.
- Recognising positions held and considering whether they are helpful.
- The responsibility and accountability of the individual in reaching agreement.
- Ownership of outcomes.

Session 2: Providing the context

The second session, through a series of presentations, provided context to the subsequent sessions (covering risk, mitigation and actions to build a consensus approach to wildfire). The presentations reflected not only the perceived issues, facts and data surrounding wildfire, its management, and impact, but why mitigation measures are important. The presentations were designed to stimulate and add both value and perspective to the debates.

Session 3: Developing outcomes

The final session sought to develop genuine outcomes through considering risk appetite, mitigation approaches and priority actions. At the end a consensus was sought by allowing delegates to identify their top risk, mitigation and action. Throughout, delegates were

Box 3: The Winter Hill wildfire - June/July 2018

This wildfire blazed for 41 days covering an 18 square km area. A major incident was declared when strong winds caused 2 large fires to merge. More than 100 fire fighters were involved from several fire services.

encouraged to self-reflect and be open to what they may need to do or appreciate differently in order to address the outcomes desired.

Detailed reports on each session can be found in Appendices 1 and 2.

9. The presentations

These abstracts have been approved by the speakers. Full transcripts approved by the speakers can be found in Appendix 1.

The presentations were designed to stimulate and add value and perspective to the debates.

The first presentation was by Professor Morgan Varner, Director of Research at Tall Timbers in the USA and focussed on the century-long failed fire experiment in America. This began in 1910 when wildfire mitigation policy switched to suppression and prescribed burning was abandoned i.e. concentrating just on putting fires out when they start, and not managing the vegetation and its inherent fuel load. He gave the specific example of California where for several decades, managing fuels was avoided and prescribed fire severely restricted. The resulting last decade of record-breaking wildfires and disastrous public health outcomes has crystallized the region to come together to manage the risk through vegetation management and prescribed burning. Those management changes will not prevent wildfire overnight, but the investments will set the stage for how Californians live in a fire-prone landscape. He concluded that it is heartening to see so many in this room focused on the same sort of outcome.

Box 2: What is Pyro-convection?

Pyro-convection has two stages. The first stage is when the buoyant hot gases contained within a fire plume force the plume to rise, causing an indraft of air at the ground level that can alter fire behaviour.

The second and more dangerous stage is caused when the latent heat stored in the fire plume is released when it reaches the cooler condensation level of the atmosphere. The plume then descends, sometimes violently, in a downdraft that results in unpredictable and extreme fire behaviour.

In discussion, Morgan Varner endorsed the danger explaining that a California pyro-convection downdraft killed over 20 people on a highway 3km from the

The second presentation was by Marc Castellnou, a Forest Ecologist from the University of Lleida (Spain) and fire officer in the Catalan Fire & Rescue Service. He emphasised the importance of land management in order to reduce fireline intensity, the measurement used to quantify fire behaviour at wildfires. Fireline intensity is the amount of heat generated by vegetation and is measured in kilowatts per meter. He explained that some fires become more complex and through their own energy can create their own weather. This happens when fire intensity gets close to 10,000 kW/m such as happened at Winter Hill in 2018 (box 3). That intensity is created when there is a lot of

'energy' in the landscape. i.e., a lot of flammable vegetation or fuel load, and that comes about when there is a lack of fuel management. This type of fire is one that creates pyro-convection (see box 2).

If there is a pyro-convection event at a wildfire it cannot be controlled and so he encouraged UK authorities to act now and manage the vegetation in the landscape strategically. Climate change has altered our weather patterns resulting in longer periods of hot and dry weather which is making the fuel load available. Without the fuel load, the extreme weather cannot create fires above 10,000 kW/m. He believes that the wildfire risk in the UK can be significantly reduced if a strategic wildfire strategy is adopted, this could be achieved utilising already existing resources.

He also highlighted similarities between the UK and Portugal and the impact of Climate Change on UK fuels, creating the possibility of much higher intensity fires in the future. He explained that Portugal like the UK is wet and has mild winters which allows a huge build up of vegetation, then during hot dry summers this fuel becomes available to burn resulting in extreme fire behaviour and huge fire events. The UK will face similar problems unless the vegetation is managed especially where it is currently unmanaged and fuels are continuous and where responders will have little opportunity to contain fire spread. He explained that being wet does not protect from wildfire; indeed, it can make it worse as it means a lot of vegetation and hence fuel in the landscape. The UK has the advantage of still having an active private land management sector with generational knowledge about fire control and management alongside specialist equipment to access rural wildfires. 'Use them, don't lose them like land abandonment in Spain,' he warned.

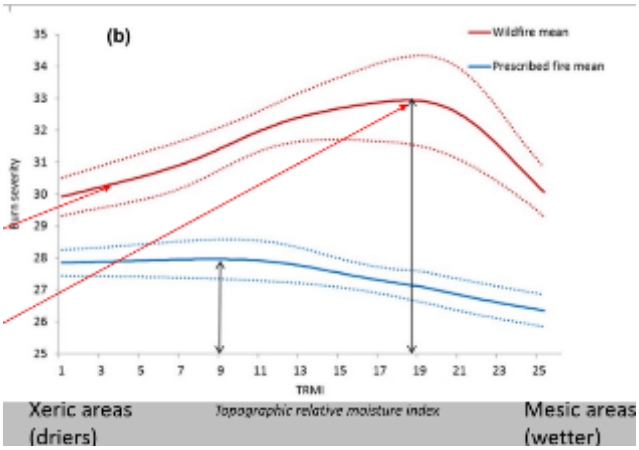
He concluded by recounting his experience of tragically losing a whole fire crew on three occasions due to unexpected fire behaviour.

Professor Claire Belcher, a Director of the University of Exeter wildFIRE Lab, then presented on fire behaviour and how this determines whether or not firefighters can suppress a wildfire and put it out.

Whilst she felt that it was clear that there is a need to manage fuel in order to manage fire risk, she posed the question of whether we are actually doing that? She referred back to our history of managing vegetation with fire, the skills built into our rural workforce, and reasoned that using burning as a habitat management tool makes perfect sense as those habitats were created using fire. But she highlighted the need to distinguish between prescribed fire to mitigate wildfire risk and that undertaken for habitat management and whether these could sensibly be co-opted for the former. However, to answer this, we need to know whether our habitat management fires do mitigate against wildfire risk and severity. Such questions involve an understanding of whether existing burn patch size and mosaic function have a role in limiting wildfire severity; whether these burns treat the locations at most risk; whether existing habitat management fires reduce actual as opposed to potential wildfire severity (as demonstrated by studies in the US) and how the coupled effects of vegetation, topography and habitat management fire severity might influence mitigating severe wildfires.

She highlighted that evidence is available to answer these questions in the uplands; but not for other key wildfire risk areas not typically subject to habitat management fires, for example areas close to the rural-urban interface. The Canford Heath fire in April 2022 and the area around Wennington in July 2022 are examples where habitat management fires do not occur close to the rural-urban interface and therefore are areas that we should consider ways in which we can mitigate fuel loads in a different fashion.

She went on to reinforce Marc's comment that the moisture regime of areas of vegetation strongly affects fire behaviour and burn severity by referring to US research that has shown that wildfire severity can actually be worse in humid environments (see graph using data from a US based study Arkle et al 2012[1]). This highlights that we need to undertake similar research for the UK's very different ecosystems.



She concluded by challenging delegates to consider whether if the UK had not used habitat management fires for the last century and were confronted with increasing fire risk, how would fuel load be managed if we were starting with a blank canvas? Would it be what we do now or might we design something better?

The final speaker was Paul Hedley, the Chief Fire Officer, Northumberland Fire & Rescue Service (FRS) and the National Fire Chiefs Council wildfire lead who focussed on the data behind the extraordinary wildfire events of last year. He began by showing a Twitter feed from 19th July 2022 that went viral (see right); it was London Fire Brigade's busiest day since the Blitz and the busiest day in living memory for some other services.

He went on to say that he felt that the window of opportunity in which the UK could prepare its tactics, partnerships, and strategies before the mega wildfires shown in the earlier presentation by Marc arrived in the UK had been slammed shut by events in 2022. The time to act was now.

[1] ARKLE, R.S., PILLIOD, D.S. & WELTY, J.L. 2012. Pattern and process of prescribed fires influence effectiveness at reducing wildfire severity in dry coniferous forests. Forest Ecology and Management, 276, 174–184

To emphasise this, he displayed the table below that showed the number of recorded fires categorised as 'wildfires' by month in 2022; a total of 983 compared to 237 in 2021 and 146 in 2020. The FRS uses criteria to differentiate between 'wildfires' (that cause significant impact) and 'other vegetation fires'. Wildfires are recorded on the national reporting tool (NRT) if they are 1 hectare or more in size; have 4 or more fire service resources committed to the incident; last for 6 or more hours; have a sustained flame length at least 1.5m or present a serious risk to life, property, infrastructure or environment. On the 18th and 19th of July 2022 alone, 85 fires meeting those criteria were recorded. In 2022, for the first time, every single FRS in the UK had significant wildfires meeting the criteria, including lots of FRS that rarely had to deal with large-scale wildfires before. Most significantly, 14 English FRS declared major incidents on 19th July 2022.

2022 UK Wildfires by month recorded on the National Reporting Tool (NRT)

Month	Wildfires	Running Total	Month	Wildfires	Running Total
January	2	2	July	299	598
February	4	6	August	366	964
March	165	171	September	16	980
April	81	252	October	2	982
May	16	268	November	1	983
June	31	299	December	0	**983**

Full year total for 2021 - 237

Full year total for 2020 – 146

2022 demonstrated that there can be very considerable impacts on FRS affecting their ability to respond to other emergency events. He emphasised the need to adapt our preparations, planning, and response and, agreed with Claire, that the fuel load must be managed. There is a need to understand where the risk is, where a wildfire has the potential to do most harm, how we identify, assess and prioritise rural/urban interface risk and start to effectively manage it.

He then posed the question of what we consider to be an unacceptable loss? There will be situations/conditions in which wildfires cannot be controlled. The mentality needs to change that the FRS always needs to fight the fire; there may be times when we have to accept that the FRS cannot and there may be times when FRS make the decision to let areas burn to enable resources to be used more effectively elsewhere. This needs to be explained to the public as public awareness is really key. The FRS is talking to colleagues in the Australian Fire Authorities Council about how they educate, inform, and warn communities to prepare and manage the wildfire risk.

He concluded by emphasising that after 2022, it feels like the growing risk of wildfire is coming at a fast rate of knots.

10. Understanding risk appetite

Delegates were asked to discuss the significant risks for the UK around wildfire based on their knowledge and understanding. These could be framed as risks to ecosystem services. Examples cited could be impact on water quality, air pollution, risk to property, risk to human life etc. Risks were plotted on prepared flipchart pages (for simplicity). Delegates were asked to identify the two priority unacceptable risks and report back to plenary, recognise any grey areas and note risk tolerance. A summary of these is prioritised below based on number of delegate votes at room level.

Priority risks:

1. Loss of life. [11 votes]
2. Long term loss of ecosystem services. [10 votes]
3. Critical infrastructure damaged/ lost. [2 votes]
4. Local species extinction. [2 votes]
5. [Loss of] vitality – disease, symptoms, death. [1 vote]
6. Carbon loss. [1 vote]
7. Damage to habitats (inc. biodiversity, greenhouse gasses, carbon). [1 vote]

11. Prescribing Mitigation

Delegates considered their two priority risks in light of earlier plenary session and identified the two most important mitigation measures required to address their identified risks. The resulting cumulative list is presented below based on number of delegate votes at room level.

1. Fuel management ► fuel mapping modelling/ and risk matching mapping ► fire severity. [7 votes]
2. A 'fire-shed' management approach: [like a watershed approach in flood management]
   - fuels mapping – fine fuels and overall fuel load
   - critical path analysis
   - understand ignition sources and density. [6 votes]
3. Everyone should understand fuel load and fire behaviours, in particular what is fine fuel and what does fuel constitute. [6 votes]
4. Public awareness/education – "Firewise Communities" (*Lots of good practise locally but is there a role for national messages?*). [4 votes]
   - [Understanding] what to do if a wildfire happens - public and land managers.
   - Health messaging (targeted, compared wider heat messages).
5. [Better] land use planning. [2 votes]
6. Reducing Wildfire Occurrence - Identify risks across range of scales, national to local, what are appropriate units e.g. local resilience forums. [2 votes]
7. [Understanding] environmental degradation - scale and specific service issues. [1 vote]
8. Mitigating the impacts via: [1 vote]
   - Land Management fuel breaks.
   - Community education.
   - Mitigating health risks by evaluating possible shelter options.
   - Planning.

9. At-risk values mapping [followed by] geographically targeted response where heterogeneity in risk and fire. [1 vote]

12. Priority Actions that ensure the mitigation measures are delivered

Whilst the workshop set out to identify actions to address the future risk of wildfire, during the proceedings it became clear that the risk was immediate. The workshop top priorities were listed in section 4. Post the workshop these priority actions have been synthesised and categorised by the GWCT into two timeframes: short-term and other urgent actions.

Short-term actions:

1. Publish a UK wildfire risk map identifying risk/asset/value.
2. Local scale site examination as part of strategic management to determine ignition points, possible fuel breaks, need for fuel load management etc.
3. Where an unacceptable wildfire risk is known to exist already, act immediately to mitigate fuel load.
4. Use the most effective mechanisms for fuel load management (including fine fuels) in each wildfire risk area. Consider an approach to fuel management outwith the prescribed burning season (see page 7 for detail).
5. Review England Wildfire Framework to empower immediate action.

Other urgent actions:

6. Develop a wildfire strategy based on 'prepare, respond and recover':
    - 6.1.1. Cross departments (are all relevant department involved in wildfire discussion? Health and Planning for example).
    - 6.1.2. Involve devolved administrations, land management sector and other stakeholder groups.
    - 6.1.3. Need resources, ability and political will (could be deployed; probably have this across various organisations); who is the champion? Should it be in government or should there be a wildfire minister?

13. Conclusions

There was a remarkable lack of dissention throughout the discussions in the workshop despite the breadth of experiences, interests and perceptions of the delegates. The willingness to continue to actively engage after the workshop was evident and a very positive collegial approach fostered. Individuals were able to identify the part they need to play to prevent disaster. Whilst a good range of stakeholders attended, future actions need to include those stakeholder representatives who were unable to attend and those identified as missing from the Wildfire Framework.

Long term loss of ecosystem services and loss of life were considered the primary unacceptable risks associated with wildfire. Risk tolerance across both of these areas varied, with some delegates focusing their concern on population level impact rather than the risk to the individual. It was noteworthy that following the impact of the presentations shown, the

conversations regularly touched on the moral and ethical perspective of inaction, and the 'unforgivable' nature of the potential consequences. Many of the other risks considered unacceptable can be categorised as subsets of these primary risks, such as species extinction and habitat loss, infrastructure damage, carbon loss and impact on public health.

Fuel load management, based on a systematic approach to improving understanding, mapping and modelling risk at a UK level, accompanied by a targeted approach to increasing public awareness of the risks were the primary mitigation measures proposed. The importance of integrating fuel load management into wider land use planning policy, and the importance of building capacity to respond at the community level was also noted as priority mitigation.

Whilst the workshop set out to plot 'future' risk, following the presentations and breakout sessions it became clear that there was a strong consensus in the room for an 'immediate' need to mitigate the risk to the UK that wildfires now pose. Whilst developing a cross-departmental UK Wildfire Strategy in the longer term was considered important, in the short term it was agreed that this should be underpinned by a fine grain UK risk/asset mapping exercise and early consideration of how best to manage fuel load as part of an immediate review of the England Wildfire Framework. Where these maps already exist showing unacceptable risk, action should be taken now and not wait for further refinement.

Appendix 1: Workshop proceedings

Wildfire impact, risk & mitigation workshop

Welcome and introduction

Lord Deben as Chair of Climate Change Committee and chair of the workshop

SESSION 1

Introduction to breakout 1 - Defining Outcomes - by Howard Davies
Feedback to plenary

SESSION 2

Briefing on context by the host, Teresa Dent, CEO GWCT
Introduction to speakers by the Chair, Lord Deben
Presentations

Professor Morgan Varner, Director of Fire Research, Tall Timbers, Florida, USA
Marc Castellnou, Forest Ecologist University of Lleida (Spain) and fire officer in the Catalan Fire & Rescue Service.
Professor Claire Belcher, Director of the University of Exeter wildFIRE Lab.
Paul Hedley, Chief Fire Officer, Northumberland Fire & Rescue Service.

SESSION 3

Introduction to breakout 2 - Understanding Risk Appetite - by Howard Davies
Report to plenary
Introduction to breakout 3 - Prescribing Mitigation – by Howard Davies
Report to plenary
Introduction to breakout 4 - Proposing Action – by Howard Davies
Report to plenary
Consensus building
Summary
Next steps

Close of workshop

Teresa Dent CBE, Chief Executive, GWCT

Workshop facilitators and mediators

Howard Davies and Richard Clarke. See appendix 5 for biographical notes.

SESSION 1 – Defining Outcomes

Introduction
Howard Davies, facilitator

You have all seen the aims of today's workshop; they were set out in both the invitation and the programme. They are to:

1. Understand the latest thinking about wildfire risk mitigation globally with the benefit of contributors from the USA and Spain.
2. Consider what is happening in the UK particularly in the light of the 2022 very hot summer.
3. Reach a level of consensus on how we should be assessing future wildfire impact, risk, and mitigation strategies.

The first thing I would like you to do during this session is to consider, as individuals, what outcomes you would like from today. Please write down three and then consider what they say about you. Ask yourself, do you have to make any changes to what you think in order to build consensus?

The final aim of this workshop is to build consensus. When we get to that point, think back to this session. Remind yourself that we all come at things with inherent biases informed by our values and beliefs. I will be asking you to keep an open mind and listen to the various views and presentations. The risk is that we all tend to scan documents or discussions for anything that backs up our beliefs and values, and then use it to defend ourselves, rather than listening properly to the evidence and considering all sides.

Then we will move on to the second part of the session which is defining outcomes. I will ask each table to define their top three outcomes for today. Please write them down so that we can capture and aggregate them.

Feedback of outcomes to Plenary

This is recorded by table but is otherwise unattributed.

1. From table 1
   1.1. Acknowledge and accept the multifaceted challenge of wildfire.
   1.2. Manage complexity and fear around wildfire.
   1.3. Understand fire and rescue services' ability to respond.
   1.4. Understand public health cost and be clear what metric we are using to measure that.

2. From table 2
   2.1. Take a strategic approach to communicating and evaluating research.
   2.2. Need best practice management plans; get them all in one place and collate them.
   2.3. Need management options for wildfire risk mitigation which include evaluating the trade-offs.
   2.4. Understand the cost and opportunity of ecosystems and how we balance that against the risk of wildfire.

3. From table 3
   3.1. Need to outline the evidence gaps in the current debate and push to find funding to fill those gaps.
   3.2. Need definitions of keywords and phrases such as managed burning, controlled burning.
   3.3. At the end of today we need to agree the need for a fuel management strategy and acknowledge that a varied toolkit is needed for different areas which should include cutting, burning, re-wetting, and grazing. We need to coalesce around this fuel management point.

4. From table 4
   4.1. Prevent disaster.
   4.2. Define the problem we need to tackle; once that is done it is easier to build consensus.
   4.3. Listen and learn from each other. Build a network of wildfire 'players' to ensure an open and honest discussion.
   4.4. Expand our knowledge base.
   4.5. Create a roadmap for the direction of travel and determine solutions for different scales i.e., local, regional, national, and international. make sure we have the right management techniques for different circumstances.

5. From table 5
   5.1. Need a broader and better understanding of fire to determine policy outcomes.
   5.2. Need landscape planning and fire risk management undertaken before land management changes are made.
   5.3. Need to determine whether existing policy is fit for purpose or if it needs revision.

6. From table 6
   6.1. Important to have a common language and clear definitions.
   6.2. Need all the relevant science and information on one accessible platform.
   6.3. Need a wildfire strategic mitigation and adaptation plan from tomorrow.
   6.4. The plan needs to be empowered through legislation; someone on every piece of land needs to be responsible for implementing it.

Session 1: Points made in discussion.

Question from facilitator: do we have areas of disagreement that we need to address?

The responses suggested that there was overall level of consensus in the room with no significant areas of disagreement, although given the range of stakeholders present different perspectives were to be expected. The key areas of response were:

- Policy and oversight: the approach to wildfire mitigation needs consensus across government about how to improve our preparation for and response to wildfire. It is important that the wildfire framework attributes responsibility to those organisations and people who have the necessary skill. The Home Office should lead overall but mitigation needs to be considered at a local level and so this requires a

different oversight. Disappointment was expressed that the Home Office was not present.

- Impacts on health: need to educate partners on the wider implications of wildfire on health including the need for planning to avoid the Department of Health bearing the costs.
- Land management: existing understanding of fire in the landscape and the role of it in managing the landscape needs recognition. Understanding the long-term implications of management is extremely important and requires evidence at the appropriate timescale; errors occur when making decisions based on short-term evidence. In addition we should not be postponing immediate decisions because of fear of fire. Removing land management techniques now out of fear could lead to long-term damage.
- Timescales: wildfire operates at different levels, from the immediacy of a wildfire event to the longer-term implications of how we manage the land now. This requires balancing priorities between these two timescales which is difficult if the necessary measures are not available. In addition, the political tempo is important as politicians work on short-term timescales and like binary answers. New legislation would take 3 to 4 years minimum and that is too long a timescale to tackle the issues we are looking at now.
- Public awareness: important to involve the public and consider what the debate around risk with the public should be. If there is no debate, the public will demand unrealistic and immediate action. Whilst wildfire has a physical aspect it is important that the social aspects are not ignored and that increase public understanding is important.

Session 1: Summing up.
Howard Davies

That felt like a really good discussion. It felt important to discuss these aspects before we plunge into mitigation and risk. Thank you for being so open. I have been amazed at how little dissension there is on each table. We need to continue to ask ourselves as individual if we need to make any changes to our stance and perceptions in order to create consensus, We must act on the information we have got, as wildfire is literally raging as we speak. We've debated two different strategies; we need to know we have the context understood but we also need a programme of what to do immediately if we have wildfire.

SESSION 2 – Presentations

Introduction
Teresa Dent

It is clear from your feedback on desired outcomes given in Breakout One, that it is good to be doing this now. This is the right time and the right discussion.

The people in this room come at this subject from several different perspectives. In the previous session Sophie's table highlighted their desired outcome of 'preventing disaster'. I think we would all agree that wildfire cannot be avoided, but the risk of it does need to be reduced as much as we possibly can – in order to prevent disaster. So, we do have a point of very considerable common interest.

We are operating in a period of enormous change. Last summer was a dramatic wake-up call in terms of climate change. We were told only two weeks ago that 2022 was the hottest year on record, 2020 was the second hottest. Whether it rains all next summer or not, it was a considerable taste of what is to come. 10 years ago in 2012 there was a tiny handful of wildfires larger than 30ha; in 2022 it was 150 over 30ha and nearly 1,000 overall. This goes to the timeline point several tables made in Session One – we need to address these issues now.

The purpose of the workshop is to help us address the new realities caused by our changing climate and help find ways of avoiding the more brutal consequences of wildfire in the future, to protect our environment, property and ultimately the lives of our citizens, not least our fire fighters from the growing threat posed by the more dangerous fire types. This picks up on Roger's point about working out what we want the public debate to be – we need them to understand the risks.

We have an hour for this session. Not long. We have asked speakers to keep things short. That is because there will be lots of time later today to expand on points and ask the speakers for more information. We do want questions and discussion, but please can you jot your points down and bring them up at the end of the four talks.

Box 4: The El Nino effect

El Niño is the "warm phase" of the El Niño-Southern Oscillation with La Niña the "cool phase" that naturally follows it. La Niña has occurred since 2020; consequently, El Niño conditions are expected in 2023. This will add to current concerns over wildfire in the UK where 2023 is predicated to be even warmer and drier than 2022.

During El Niño the westerly trade winds weaken along the Equator causing warm surface water to move east to the cost of northern South America. This results in the deepening of the thermocline (the ocean depth at which warm surface water and the colder deeper waters meet).

Such events occur irregularly at 2–7-year intervals. They also vary in intensity with the stronger events disrupting global weather patterns such as drier and colder winters in northern Europe.

(Sources: National Geographic and Paloma Trascasa-Castro in the Conversation 26 Jan 2023))

Introduction to speaker 1
Lord Deben
I'm delighted to welcome four such impressive speakers. It is important that heat and fire are understood in the UK, especially as the El Niño effect see box 4] in the rest of the world, alongside increased global heating will mean that, here, in the UK, we will be more affected by wildfire risk.

Public understanding changed last summer when wildfire happened 'next door'. The wildfire on the edge of London was in a field that had previously been seen by those residents as an advantage [to live next to]; suddenly it became a threat. It was unexpected. It had never happened before. Most of us live our lives with a series of questions we have learnt to deal with. Very few of us have had to learn to deal with wildfire.

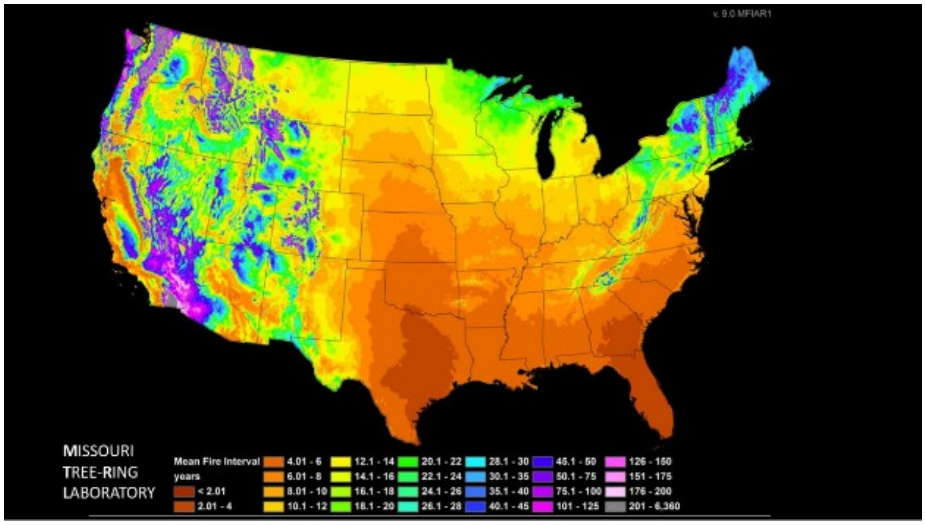
The heating of the world means that more and more people will be worried about wildfire. Our answer to them about what we intend to do about it will have to be pretty good.

That is why I am delighted to welcome Professor Morgan Varner as our first speaker.

Presentation from Professor Morgan Varner, Director of Research, Tall Timbers Research Station, Florida, USA

Slide 1

Slide 2

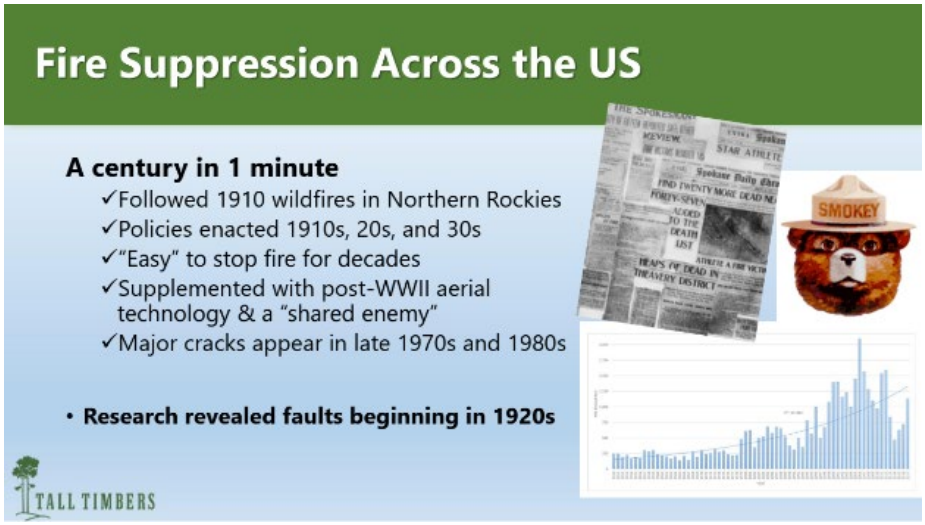


Thank you very much for inviting me here today. I want to talk to you about the century-long failed fire experiment that America has experienced, and which has led us to confront fire disasters repeatedly.

I come from Florida where we have fire-prone ecosystems spanning grasslands, forest, savannah, and woodland [slide 2 shows Florida to have a fire interval of less than 2 years].

In discussions this morning, several have mentioned the need for a road map for managing fire and fuels. Well, I can tell you we have been on a long road in America, and it has been very bumpy.

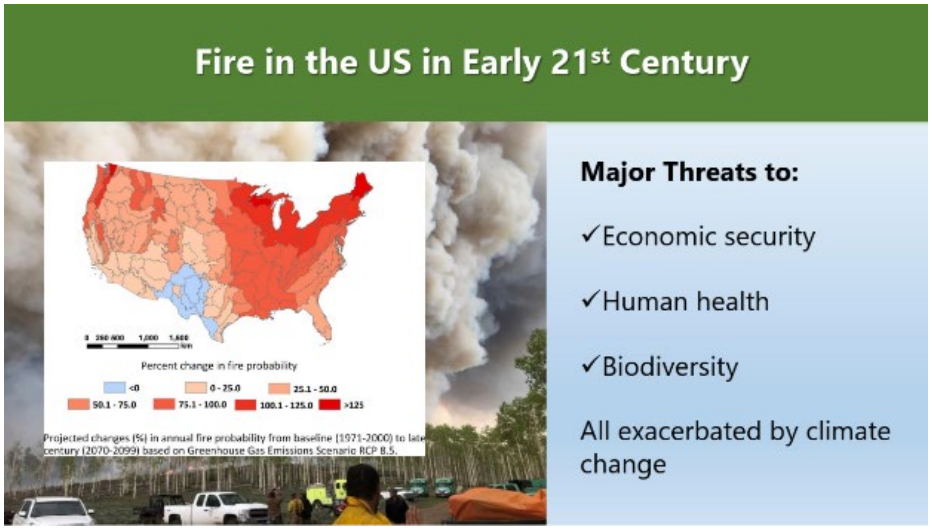
Slide 3



In 1910 our wildfire mitigation policy switched to suppression, and we abandoned prescribed burning. The mantra was full suppression – any wildfire that breaks out; we would put it out.

The cracks in that policy began appearing in the 1950s, 30 to 40 years after the policy decision was made. By the 1970s and 1980s we were experiencing large wildfires which were very difficult to suppress. The organisations we had invested in and built to suppress fire could not handle them. Today, we are experiencing single wildfires covering 400,000 to 500,000 ha. We have now had a century of wildfire policy that has focused on full suppression and has abandoned prescribed burning for vegetation and fuel load management.

Slide 4



Wildfires on this scale have resulted in serious human health issues in large urban centres. For instance, in cities far away from the fires, in Seattle, Portland, San Francisco and even inland in Chicago, smoke travels across the continent from wildfires and settles in these large urban areas; this is a big issue in terms of cost.

In the USA, only the south-east of the country did not go into full suppression mode but continued to burn for reasons of biodiversity conservation, taking a long view for the benefit to society and not in response to the immediate issues. This history of frequent prescribed fire has made wildfires rare in the region.

We can see from the modelling[2] that by the end of this century, fires will be much more frequent at the higher latitudes in the USA; states like Minnesota will be in a serious situation. They will now see the consequences of a century of fire suppression rather than fuel load management.

[2] Gao, P., A.J. Terando, J.K. Hiers, J.A. Kupfer, J.M. Varner, M.C. Stambaugh, and T.L. Lei. 2021. Robust projections of future fire probability for the conterminous United States. Science of the Total Environment 789: 147872.

Slide 5

So how do we mitigate against this wildfire hazard? California exemplifies the United States' story in terms of mitigation. For several decades, California avoided managing fuels and severely restricted prescribed fire. The resulting last decade of record-breaking wildfires and disastrous public health outcomes has crystallized the region to come together to manage the risk through prescribed burning and vegetation management. Those management changes will not prevent wildfire overnight, but these investments will set the stage for how Californians live in a fire-prone landscape.

It is heartening to see so many in this room focused on the same sort of outcome.

Slide 6

Introduction to speaker 2
Lord Deben

Professor Varner, thank you for that very powerful talk. Of course, in recent years there is a less common understanding of fire danger compared to the days when we had open fires and candles in our homes, which commonly led to fire. I remember visiting Dove Cottage where Wordsworth lived in the Lake District, and it was amazing to see how they lived then and how difficult it must have been to prevent fire breaking out in such cramped and crowded living accommodation. Of course, lots of cottages did burn down.

Nowadays we don't think about fire enough. Professor Varner has really put into context what a huge change is needed; that people will have to recognise that fire is one of the threats that they are going to have to deal with.

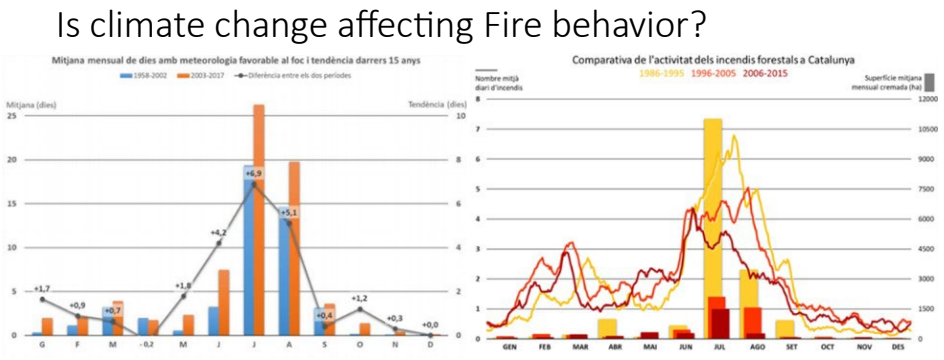
Our second speaker is Mark Castellnou from Spain, a country which has been very hard hit by climate change: rivers are drying up, temperature has always been high but is now climbing significantly higher, and issues of wildfire have become vitally important.

Presentation from Marc Castellnou, Forest Ecologist University of Lleida (Spain) and fire officer in the Catalan Fire & Rescue Service.

Slide 1

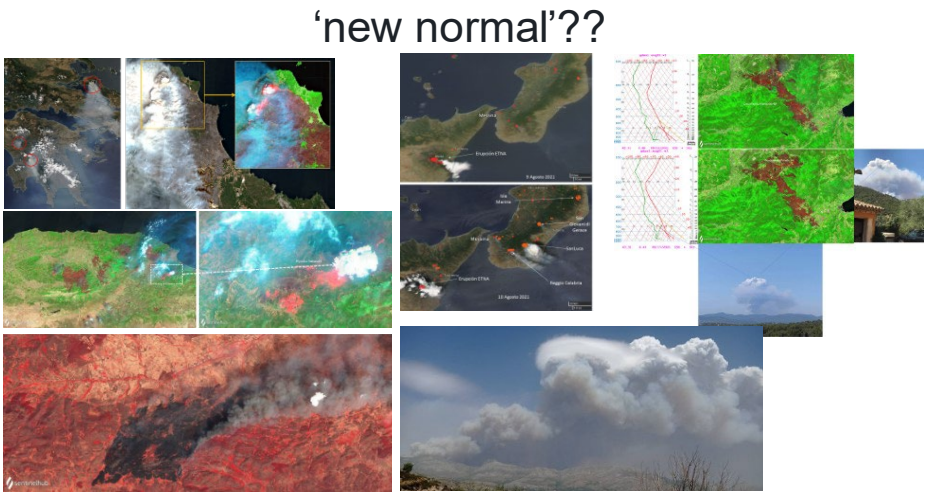
Thank you, Lord Deben. I am here today to ask you - please do not make the mistake we made 40 to 50 years ago. I am the chief of 5,000 firefighters; I do not want more firefighters I want more land management.

Slide 2



- Our efforts reduced the burnt area a 875 in 30 years
- Our landscape increased fuel continuity from 35 %to 71% in the last 30 years
- We are doing well reducing ignitions and fighting fires, but having 10 % less fires per decade, we burn now 800 ha/hour in a bad day when 30 years ago it was 345 ha/h
- Our risk has consistently increased 2 more days/year since 2003. Our season last now 1.5 months longer

Slide 3



There is a measurement we use to quantify fire behaviour at wildfires, this is called Fireline intensity, and we use Kilowatts per meter to measure the heat generated by the burning fuels.

There are two types of fire. A fire of a certain intensity remains a simple fire but other fires become more complex where they interact with atmosphere and through the energy they release, they can create their own weather.

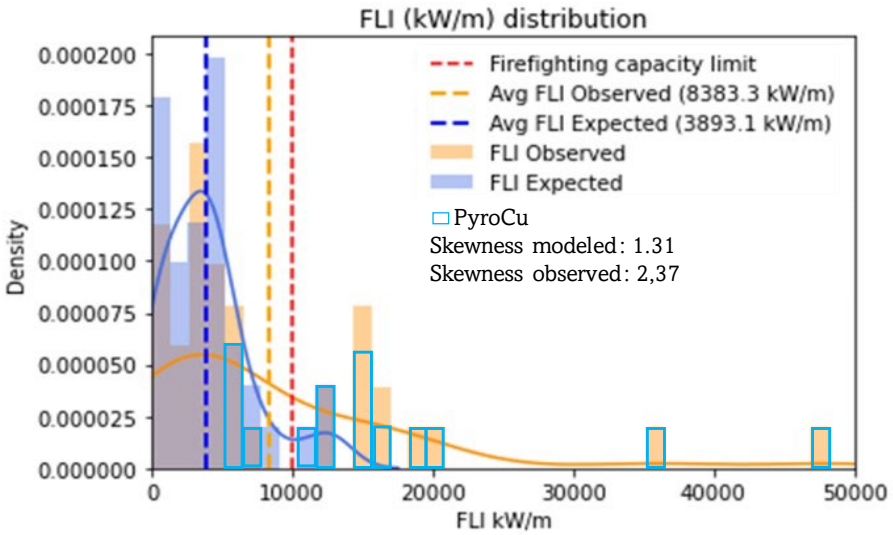
If the fire intensity gets close to 10,000 (kW/m) which we saw in the Winter Hill[3] fire in 2018 – the fire changes and starts to interact with the atmosphere to change the weather around it. That intensity is created when there is a lot of 'energy' in the landscape. i.e., a lot of flammable vegetation or fuel load, and that comes about when there is a lack of fuel

[3] Near Bolton in the northwest of England

management. This type of fire is one that creates pyro-convection [for explanation see box 2].

Slide 4

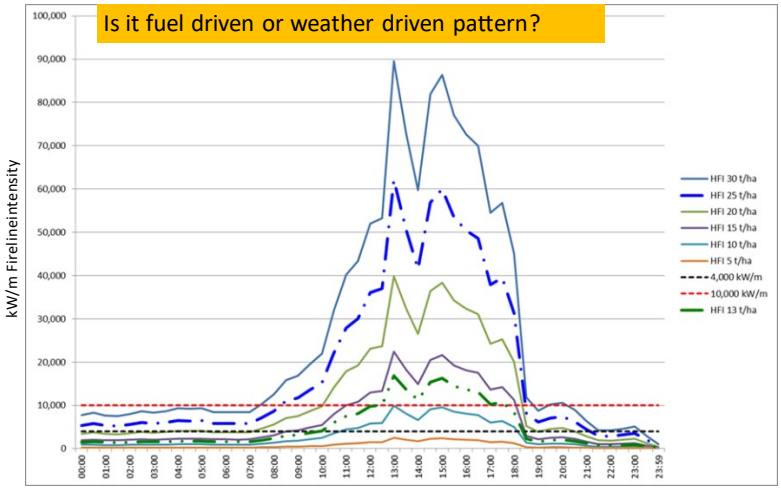
Is Fire behavior overwhelming firefighting capacity?



10,000 kW/m is the limit of firefighting capacity, any more than this and firefighters cannot survive.

Fireline intensity is the amount of heat generated by vegetation, on average this is 14,000 to 21,000 per kJ/kg, the fuel load available is measured in kg/m^2 and the fire rate of spread in metres per second (m/s).

Slide 5



In Australia, the energy in the landscape can create a fire that reaches 90,000 on the fire intensity index. This is caused by having 50 tonnes per hectare of fuel load. Less than 10 tonnes per hectare can only produce up to 10,000 fire-intensity units of energy.

The fireline intensity depends on the fuel load and how much of this is available to burn, this depends on the weather conditions. The graphic shows the energy released (kW/m) on Black Saturday in Australia 2009, a day when a wildfire killed 173 civilians. The weather conditions were extreme at noon, and the fire peaked, demonstrating extremely high intensities. We have divided the fuel load on the different parts of the landscape and we can see that 90,000 kW/m was achieved when fuel load was 30 tonnes/ha, but the critical limit of 10,000 (see above) was not reached if fuel load was 10 tonnes/ha or less. This fact provides evidence that it is not climate change or the extremely fire supportive weather it is generating that is driving extreme wildfires, it is the amount of fuel available to burn that is responsible.

A lack of landscape management allows fuel loads to build up, the weather simply makes this fuel available to burn and clearly, without the fuel load, the extreme weather cannot create fires above 10,000 kW/m. The message is clear; we need to manage landscape fuels to fight fires. Without landscape management, fires will overwhelm fire services. We have seen it everywhere in the world.

I am familiar with UK landscapes and the UK should have no wildfire problem if it manages its landscape.

Slide 6

Using longer season and using drier fuels, pyroconvection has come to dominate fire behavior

What is Pyroconvection ??

This shows that if there is a pyro convection event at a wildfire that it cannot be controlled. You do not want to put yourself in the position of having caused that. Please do not believe you have time to sort this out; you don't, you must act now and manage the vegetation on your landscapes strategically.

The issue to address is that high fuel loading has always been present in the UK but in the past humidity caused by our maritime conditions has limited the amount available to burn. But recent years are having longer dry and hot weather periods. This is making your fuel load available. As 2022 demonstrated the UK will not go through a slow process (decades long) of fuel build-up, it is going through a fast process. We have NO time!!!!

By way of an example, Portugal is the smallest, wettest country in the EU. But it is the country that burns the most. The reason is that they grow biomass at a high rate due to moist mild winters. The UK and northern Europe are going from cold winters and moist summers to a Portugal like situation of mild and moist winters to dry summers. So we can expect the UK to jump into extreme wildfires like Portugal. Portugal has seen in 2017 the biggest megafires in Europe and in the world, burning at a rate of 14,000 ha/hour and killing 141 people. Pyro convection caused those fires. California in 2018 was not expecting them and 2020 was an inferno. The same with Australia. Pyro-convection and pyro clouds, with all the extreme fire weather created, is overwhelming fire services worldwide. The UK is effectively in the same position as Portugal – a small wet country. You must not underestimate the risk of wildfire; you might be a small, wet country but that does not protect you from wildfire; the reverse is the case, as it means you have a lot of vegetation on your landscape.

We are now witnessing pyro convection events in fires of only 10 to 20 ha not thousands (surface on fire needed for pyro cloud formation back in the 90's) of hectares, and that is because of fuel load. Fuel load and humidity creates winds which sucks up the air and causes the change in the local weather resulting in extreme fire behaviour.

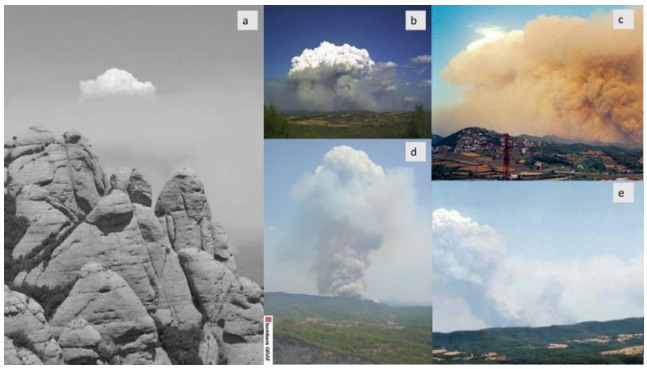
Slide 7

This video illustrates an updraft which occurs with pyro convective fires. It shows, a pyro cloud which creates an updraft that translates into indraft creating more wind on the surface. Pyro convection is accelerating wildfires through the wind increase caused by the plume and its pyro cloud on top.

Slide 8

Slide 9

PyroCu/Cb fins 2010

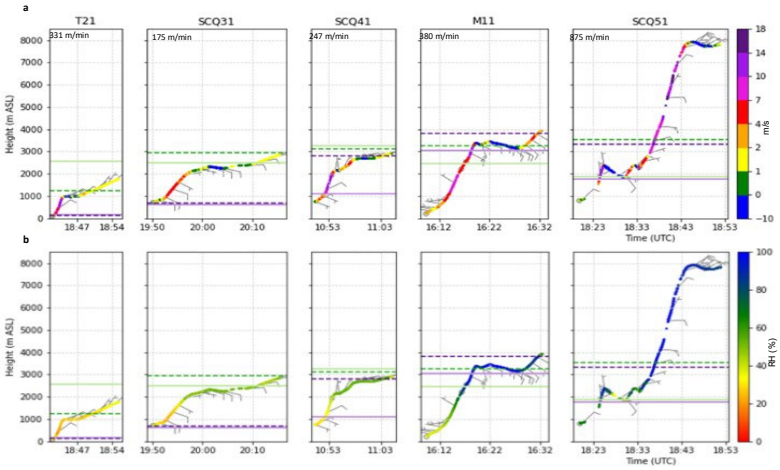


Slide 10

2021 PyroCu

Slide 11

What those changes mean for firefighters?



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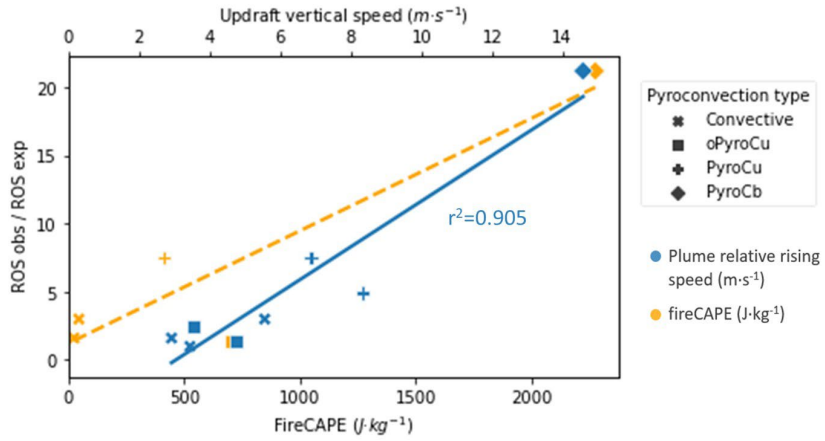


This is what is happening when firefighters go to a fire expecting a certain fire behaviour and when they actually get there the fire is 10 to 20 times worse. It is because the energy of the fire has got beyond a certain point, creating a massive updraft of air which lifts smoke and then deposits it downwind. The density of the smoke means that it is impossible to see anything; it can cause multiple road traffic accidents and cannot be fought in those circumstances. It also creates extreme spotting where burning brands are deposited and hundreds of fires are ignited in front of the main fire front, interacting together to create a firestorm. This can engulf towns and city suburbs as seen in California (98 civilians died), Portugal (141 people 2017), Greece (93 people 2018), Australia (173 people 2009).

Slide 13

Conclusions

- Classical approach (fire service and avoiding ignitions) Works on the short term
- On the long term, lessons learned show a change on fire regime due to change on landscape
- With more fuel on the landscapepyroconvectionis dominating new fire regimes worldwide
- Under Pyroconvectiondominated fire regimes, FRS has no capacity to protect society and biodiversity
- An cost-benefit approach must be taken. Preserve society and biodiversity is possible, but it has a cost. That cost has been provided for free for land managers. Not it is fading

In my career I have three times experienced the loss a whole fire crew. Those firefighters were well trained but confronted with unexpected and unknown fire behaviour. In this room, you must decide today what you need to do tomorrow in terms of limiting fire intensity in your landscape.

Do not invest in firefighters, invest in land management.

Introduction to speaker 3

Lord Deben

We now moving to the academic side of fire ecology. One of the joys of the Climate Change Committee is dealing with academics. My job is to ask the simple questions. As I get older, I am no longer embarrassed about doing that; indeed, I have found I am often asking the questions that others want to but have not. It is often a relief that somebody has asked it. And, of course, simple questions are often the most difficult to answer.

Our next speaker is Claire Belcher who is the Professor leading the wildfire team at Exeter University.

Presentation from Professor Claire Belcher, Director of the University of Exeter wildFIRE Lab.

I confess I'm still getting over the shock of the video that Marc showed us. For those of you familiar with structural fires he essentially just showed a wildfire smoke plume leading to flash over of the forest below.

Slide 1

So, we now come to fire ecology. I am interested in how fire has changed the evolution of plants and how those plants in turn have changed fire behaviour. It is fire behaviour that determines whether or not firefighters can deal with it and put it out. What is clear to me is that we need to manage fuel in order to manage fire risk. My question is are we actually doing that?

Slide 2

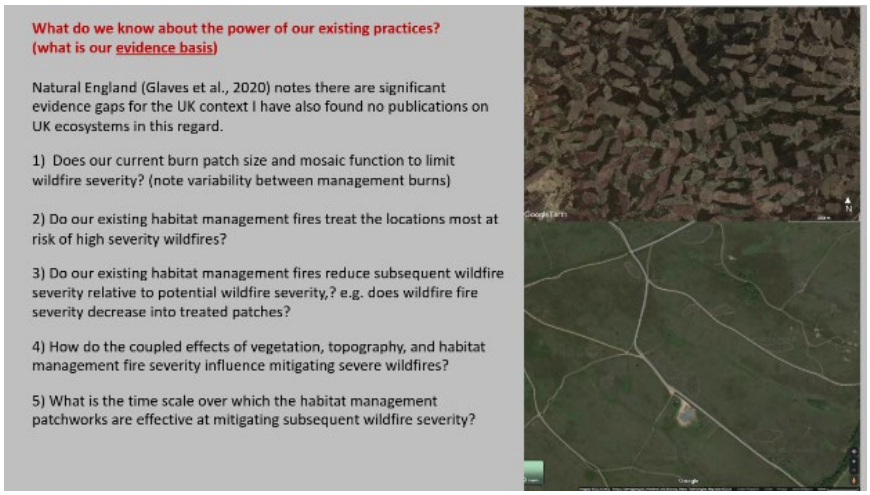
We are used to managing vegetation with fire; we have been doing it for hundreds of years. There is a lot of skill built into our rural workforce which is a really good thing. It is rational for us to use burning as a habitat management tool; it makes perfect sense because we actually created those habitats with fire.

Slide 3

Here I want to distinguish between prescribed fire (which I am using here to mean fire undertaken to mitigate against wildfire risk in this talk) and the fires undertaken for habitat management (part of normal land management). In this country the setting of fires is predominantly for the latter. We need to consider whether habitat fires can be sensibly co-opted for wildfire mitigation and consider whether (though not specifically designed for that purpose) they can in fact reduce wildfire severity. There are two points:

- Do our habitat management-based fires perform well at mitigating subsequent wildfire risk and severity?
- If we had not traditional burning practices and we had a blank canvas, how would we approach using fire as a tool to mitigate the occurrence of high severity wildfires?

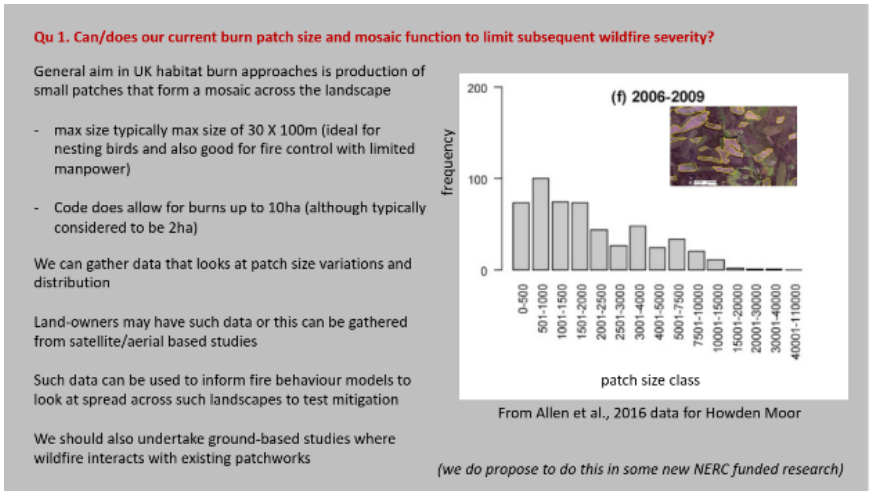
Slide 4



To develop an understanding of whether our existing habitat management fires provide wildfire mitigation we need to answer the following questions:

1) Does our current burn patch size and mosaic function to limit wildfire severity?
2) Do our existing habitat management fires treat the locations most at risk of high severity wildfires?
3) Do our existing habitat management fires reduce subsequent wildfire severity relative to potential wildfire severity?
4) How do the coupled effects of vegetation, topography and habitat management fire severity influence mitigating severe wildfires?

Slide 5



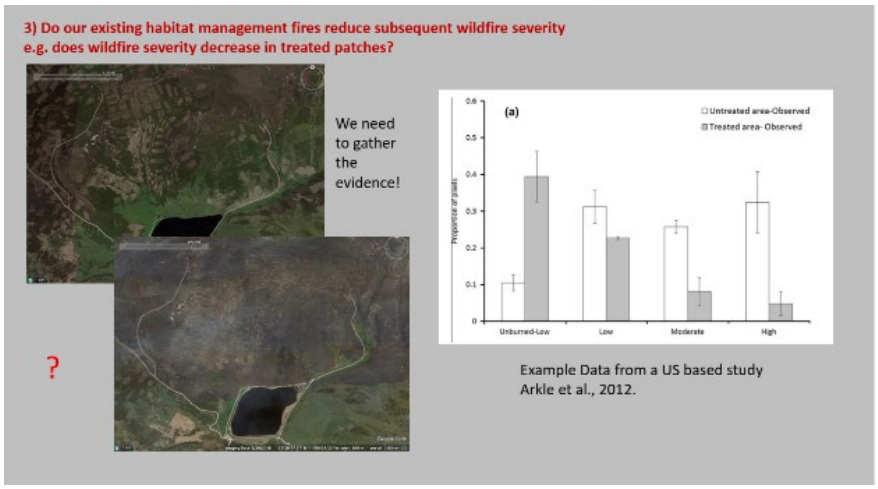
We have the ability to look at existing burn mosaics and we can make measurements of the sizes and proximity of burn patches to one another relatively simply using aerial photographs and satellite data. For example, Allen et al., 2016[4] has shown that measuring patch size across areas subject to management burns is possible. Therefore, we can use such information to inform models to make predictions of how fire will spread through our existing patchwork landscapes.

[4] Allen KA et al (2016) Prescribed moorland burning meets good practice guidelines: A monitoring case study using aerial photography in the Peak District, UK. Ecol Indic 62:76–85.

Slide 6

We need to assess to what extent existing habitat management fires treat the locations in the UK that are most at risk of high severity wildfires. In the case of moorlands and large heathland areas habitat management mosaic burns are treating regions of fire-prone landscapes that often carry the UK's largest fires. But there are also key areas that are not typically subject to habitat management fires, for example areas close to the rural-urban interface. The Canford Heath fire in April 2022 and the area around Wennington July 2022 are examples where habitat management fires do not occur close to the rural-urban interface and therefore are areas that we should consider ways in which we can mitigate fuel loads in a different fashion.

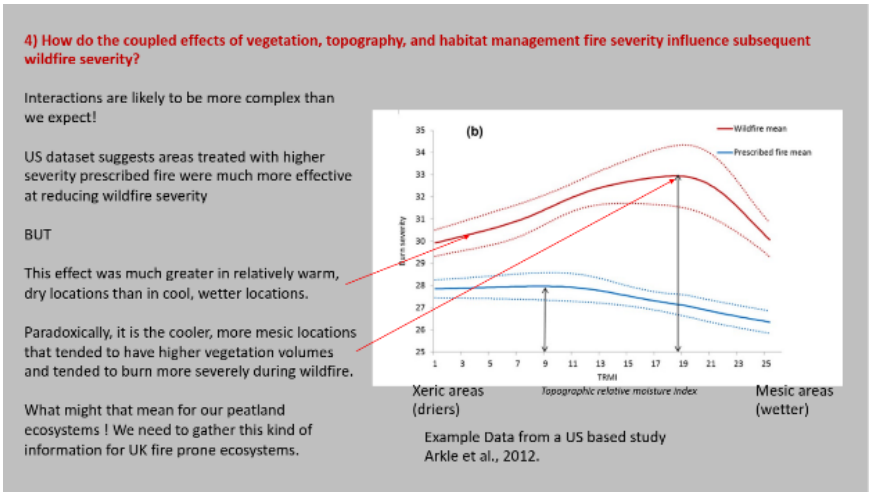
Slide 7



Because we can assess where our habitat management fires are practiced and what mosaics they form we can also test whether our habitat management fires reduce subsequent wildfire severity. We need to look at areas that have habitat management mosaics already existing which have then been recently burned by wildfires. We need to undertake research to assess whether the areas that were previously burned by habitat management fires show

a lower burn severity than untreated patches. If so, then we would be able to better understand the fire prevention capabilities of the UK's burn mosaics.

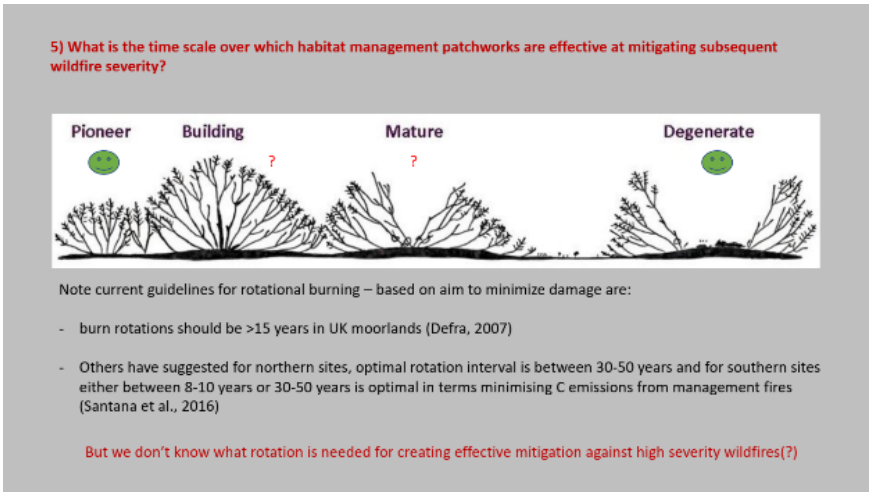
Slide 8



We need to undertake studies like those in the US where they have shown that regions subject to prescribed fire do show a reduction in wildfire intensity.

We have heard from Marc that the moisture regime of areas of vegetation strongly affects fire behaviour and burn severity. Research on US ecosystems has shown wildfire severity can actually be worse in humid environments (see graph overleaf using data from a US based study Arkle et al 2012[5]). This is particularly interesting for our more mesic peatland ecosystems. Again, highlighting that we need to undertake similar research for the UK's very different ecosystems.

Slide 9



In applying fire to the land in habitat management burns how often do we need to burn patches again before they stop mitigating wildfire severity?

[5] ARKLE, R.S., PILLIOD, D.S. & WELTY, J.L. 2012. Pattern and process of prescribed fires influence effectiveness at reducing wildfire severity in dry coniferous forests. Forest Ecology and Management, 276, 174–184

Slide 10

I have made some suggestions in the presentation about what we can and need to understand for the UK's fire-prone landscapes and how our existing habitat management burns might act to mitigate wildfire severity. But what I want to ask you all is when we are undertaking our habitat management fires 'are we really planning fuel-based fire mitigation measures? (I think we aren't) and if you think we are where is the data for that sort of planning? But we need to also ask ourselves where else might we need prescribed fires to mitigate fire severity?

Slide 11

Wildfire risk is changing in the UK. I want to ask you to consider whether if the UK had not used habitat management fires for the last century and we were confronted with increasing fire risk - how we would manage fuel load now if we were starting with a blank canvas. (Would we do what we do now, or might we design something better?).

Introduction to speaker 4
Lord Deben

We need to beware the tendency to take the view that as this is what we have always done, let's try and justify its continuation. We need to be prepared to look at new measures and, thank you Claire, for this helpful intervention.

I would now like to introduce Paul Hedley, who has first-hand experience of dealing with wildfires in the UK.

Presentation from Paul Hedley, Chief Fire Officer, Northumberland Fire & Rescue Service.

I am aware that my presentation will contain at least some repetition of the previous presentations.

Slide 1

"What the hell just happened?"

NFCC National Fire Chiefs Council

This was the Twitter feed on 19th July 2022, "what the hell just happened?" It was London Fire Brigade's busiest day since the Blitz and the busiest day in living memory for some other services.

I always thought the UK would have a window of opportunity before we saw fires like Marc showed us in which we could prepare our tactics, partnerships, and strategies to introduce the adaptations needed to mitigate the increasing wildfire threat. That window was slammed shut in 2022. My overall sense reflecting on 19th July wasn't "What the hell just happened" but that I think we were lucky to get away without serious injury, or worse, to the public or firefighters.

Slide 2

Wildfires by month recorded on NRT

Month	Wildfires	Running Total	Month	Wildfires	Running Total
January	2	2	**July**	**299**	598
February	4	6	**August**	**366**	964
March	165	171	**September**	16	980
April	81	252	**October**	2	982
May	16	268	**November**	1	983
June	31	299	**December**	0	**983**

Full year total for 2021 -**237**

Full year total for 2020 –**146**

85 wildfires recorded on NRT ove**r 18th and 19th July** affecting **28 of 46 England and Wales FRS**

NFCC National Fire Chiefs Council

This slide shows the number of wildfires recorded by month. The fire and rescue service uses a combination of one or more criteria to differentiate between wildfires that cause the most significant impact and other vegetation fires. Those fires are recorded on the national resilience toolkit (NRT) if they are ≥ 1 hectare; have ≥ 4 or more fire service resources committed to the incident; last for ≥ 6 hours; have a sustained flame length ≥ 1.5m or present a serious risk to life, property, infrastructure or environment. There were. 85 fires meeting those criteria that were recorded on the 18th and 19th of July. For the first time, every single Fire & Rescue Service in the UK had significant wildfires meeting the criteria, including lots of FRS that rarely had to deal with large-scale wildfires before.

Slide 3

Wildfires by FRS recorded on NRT

Rank	Service	Wildfires
1	M&WWFRS	120
2	Kent FRS	70
3	London FB	65
4	Norfolk FRS	63
5	Hants / IoW FRS	60
6	South Wales FRS	52
7	D&WFRS	48
8	Notts FRS	41
9	H&WFRS	39
10	North Wales FRS	32
11	Essex FRS	31
12	North Yorks FRS	25
13	D&WFRS	24
14	Lancashire FRS	21

Every UK FRS affected

15 English FRS had between 10 and 20 NRT wildfires

16 English FRS have had <10 NRT wildfires

Avon, Gloucestershire, East Sussex and Leicestershire only 1 recorded on NRT

*NRT does not include Scottish FRS or Northern Ireland FRS

NFCC National Fire Chiefs Council

14 Fire & Rescue Services declared major incidents on 19th July. 9 were due to spate conditions, concurrent events, an inability to support mutual aid, or where demand was such that there was significant pressure on the ability to respond to other emergency calls. On 19th July we had 13,500 calls to fire and rescue services in England; usually, it averages 2000 a day.

All the things we associate with wildfire in other parts of the world, we are now seeing here.

Slide 4

UK FRS Wildfire Survey- 2022

Collating information from all UK FRS

39/50 returns to date

- Ff and Public Injuries
- Property Losses
- Evacuations
- Extreme Fire Behaviour

NFCC National Fire Chiefs Council

The 2022 wildfires on the FRS demonstrated that there can be very considerable impacts on fire and rescue services. We must adapt our preparations, planning, and response and, I agree with Claire, we must manage fuel load to manage risk.

Slide 5

Impacts of 2022 Wildfires on FRS

- The need to adapt – relying on Response isn't the answer
- Manage the Fuel / Manage the risk
- RUI / Evacuations
- Impact on communities / public

NFCC National Fire Chiefs Council

I am less interested in how fuel load is managed, whether it is burning, cutting, grazing, vegetation adaptation, or rewetting, I am more interested in making sure it is done. We need to understand where the risk is, where a wildfire has the potential to do harm, and start to effectively manage it.

To wrap up, a really important question to ask ourselves is what do we consider to be an unacceptable loss? We need to accept that there will be wildfires that under the right conditions we cannot control. We need to change the mentality that the FRS always needs to be fighting the fire; there may be times when it's better to accept that we cannot be effective at that time and look to position our personnel and resources where they can have an impact and opportunity to control or suppress the fire. We need to accept that those times will happen and we need to explain to the public why.

Public awareness is really key and we need to get this right. We are talking to colleagues in the Australian Fire Authorities Council about how they educate, inform, and warn communities to prepare and manage the wildfire risk.

There is so much we need to do. The wildfire risk is coming at us and after 2022 it feels like it is coming at a rate of knots.

Session 2: Introduction to questions and discussion
Lord Deben

Thank you, Paul. I remember after the fires of last year how much certain information shocked the public. They were shocked to realise that fire engines cannot travel across rough fields, that there is no water supply, no hydrants, in fields.

We will have a repetition of this if we are not very careful. To put it in context, we are talking about something that is only thought about by those who manage traditional peatland and grass land areas; now we need a strategy to take all areas in the country into account.

Questions and discussion
The Q&A session was directed at the panel of presenters.

Q1: Changes in land management practices such as the loss of grazing animals in Wales has led to massive increases in vegetation and fuel load. How can the lessons from America be translated into the UK so that we do not fall into the trap of assuming wildfire can be contained through fire suppression and not vegetation management?

A: Morgan Varner emphasised that the wildfire problem is greatest in areas where vegetation growth is most productive, not drier landscapes. Consequently, any vegetation management must be repeated. This is a worry for the UK: our landscapes are not rock and ice, they are highly productive vegetation landscapes.

Marc Castellnou reinforced this point and the need to bring back our land management knowledge. Our land managers must be used to protect our biodiversity; firefighters cannot do that. He cited the Upland mosaic in many areas, created by either grazing or grouse moor management that if lost, will result in wildfire and the loss of our biodiversity. He said that it is important that stakeholders are brave and make that vegetation management decision. The difficulty is that so often the people who make the decisions about vegetation management do not face the consequences of those decisions.

Q2: Did 19th July really catch us by surprise or were the wildfire weather predictive models good enough?

A: Paul Hedley stated that having spoken with colleagues in the red alert areas, he felt the wildfire weather notifications were accurate. West Yorkshire is exactly the area where fire was predicted and where it occurred. There were no surprises.

Claire Belcher concurred stating that the UK has got better at predicting extreme weather conditions but reminding delegates that the Saddleworth Moor fire was not predicted. That day the warning was at Orange not Red. The fire became as intense and dangerous as it did because there was no moderated vegetation in the landscape. Andreas Heinemeyer added that peatlands are highly productive landscapes and as a result it is easy to get to 20t/ha of fuel load. In addition we need to be very aware of future fire frequency.

This resulted in a discussion about the merits of rewetting to protect peatland ecosystems in particular from wildfire. Marc Castellnou reiterated that in his experience of UK ecosystems rewetting is not the sole solution. The issue is not how wet the underlying peat is but how much dry fuel is available when the fire starts. Consequently, the number of days that have elapsed since the last rainfall is a key measure. If there is more than 20 days then the fuel will be dry and burn. Climate change means that the UK cannot continue to consider that it is wet and therefore different.

Lee Lyons added that rewetting is about creating a wet habitat that results in a lower fuel load due to the wetness inhibiting vegetation growth. The UK's blanket bog is not found elsewhere and is therefore different. As a result, Government advice is focussed on creating a fuel load that does not require much management intervention although Defra does agree that burning is part of the solution.

Claire Belcher confirmed that the heat of combustion in heather is high as it has a huge fire load that is as flammable when it is moist as when it dries. She concluded that it is important to define the fine fuel loads as well, as these sustain fire even when wet [see box 1 for detail on fine fuels].

Summing up.
Lord Deben

I am conscious of this workshop is still in mid-flow. I know they will be much more talking this afternoon and I hope you will come to some conclusions. Things that strike me so far today are:

- The fact that we must deal with wildfire with the answers that we have now.
- We know those answers are not sufficient. The fact that we need to know more is absolute, but pressures are increasing because of climate change. The realities of last summer have shown us that.
- We cannot just think about it from the point of view of those who are concerned about wide-open spaces, or those that are concerned about shooting. We need to see it in context of the changes that are actually happening to weather and climate. We need answers for the whole of the question, and those answers will have to be nuanced.
- It is crucial that we define what we mean by words like rewetting. Everyone thinks they know, but the understanding may be very different. We need a clear consensus about what we mean by those words. I learnt that from working within the EU for over 16 years; one must watch translation very carefully.

Lastly, I am sorry that I must go. I hope you have a very productive afternoon. Teresa Dent will be producing a report and I hope we can come up with really effective policies in the future.

SESSION 3 – Understanding risk appetite, prescribing mitigation and proposing action.

Breakout 2 - Understanding Risk Appetite
Introduction by Howard Davies

We want this workshop to have genuine outcomes. Our discussions seem to be leading us to certain themes: data and evidence; strategy and planning; and ways of working.

Now we want to move onto risk, and this next session is designed to understand risk appetite; what is acceptable and what is unacceptable. I would like each table to write down 3 unacceptable risk, and three acceptable risks in the context of wildfire.

Understanding risk appetite report to plenary
This is recorded by table but is otherwise unattributed.

1. Table 1: preferred to think of risks as unavoidable and avoidable. Allowing avoidable risks to happen is unacceptable. These were:
   1.1. Loss of life.
   1.2. Impacts on public health, mental health etc.
   1.3. Loss of biodiversity and ecosystems.

2. Table 2: considered *unforgivable actions* rather than unacceptable risks:
   2.1. Lack of knowledge and understanding of fire behaviour.
   2.2. Lack of knowledge of effects of wildfire on human health.
   2.3. Allowing environmental degradation.

3. Table 3: unacceptable losses were:
   3.1. Loss of life, particularly firefighters.
   3.2. Short and long-term human health impacts.
   The table debated current versus future risks and how one attributed between unacceptable and acceptable based on scale.

4. Table 4: the health and well-being of society is to be protected at all costs. Unacceptable losses were:
   4.1. Loss of life.
   4.2. Loss of carbon because of its impact on climate change.
   4.3. Loss of ecosystem services/heritage
   The table felt it was important to understand how these were interconnected.

5. Table 5: unacceptable losses were assessed on the basis of both likelihood of risk as well as impact:
   5.1. Large-scale loss of life.
   5.2. Long-term loss of ecosystem services.
   5.3. Loss of habitat.
   An acceptable loss was an escaped management burn.

6. Table 6: Unacceptable risks are:
   6.1. Loss of life.
   6.2. Loss of critical infrastructure.
   6.3. Loss of habitat (which can be both an acceptable and unacceptable risk depending on rarity).
   6.4. Overwhelming either the NHS or Fire & Rescue Service.

We have struggled to be definitive about the place on the graph of these impacts; it often depends on the scenario that makes the difference between acceptable and unacceptable.

Understanding Risk Appetite discussion

1. What is the cost that moves a risk from acceptable to unacceptable?
2. How should we evaluate risk tolerance?
3. What risks are unforgiveable?
4. Noted that thinking on these issues are more advanced for flood management; can we learn from that?
5. What do we mean by fire severity; again, need to be clear on terminology.
6. Need to be mindful of wildfire exacerbating other risks, e.g. inability to respond to road traffic accidents.

Breakout 3: Prescribing Mitigation
Introduction by Howard Davies

Delegates to identify, in light of earlier plenary session, the two most important mitigation measures required to address their identified risks.

Prescribing mitigation report to plenary.
This is recorded by table but is otherwise unattributed.

1. Table 1:
   1.1. Land and fuel load management.
   1.2. Fire prevention.
   1.3. Knowledge of fire behaviour.
   1.4. Education to create awareness of complexity.

2. Table 2:
   2.1. Better mapping of at-risk assets.
   2.2. Geographically targeted mapping and response. Use similar approaches to that used for flooding i.e., instead of flood plains, we need the equivalent 'fire plains'.
   2.3. Fuel load management.
   2.4. Reduce ignition sources.

3. Table 3:
   3.1. Identify wildfire risk at national to local scales. Who does this?
   3.2. Determine appropriate units to map risks.
   3.3. Public awareness and education.

4. Table 4:
   4.1. Fuel load management.
   4.2. Fuel load mapping.
   4.3. Fire risk management.

5. Table 5:
   5.1. Public awareness and education.
   5.2. Firewise communications.
   5.3. Fuel load management (noting that there is a lack of clarity about whose responsibility this is).

6. Table 6:
   6.1. Strategic fuel load management.
   6.2. The need for all actors to understand fuel load and fire behaviour.

Mitigation measures discussion.
1. Fuel mapping has already been done, but the scale needs to be expanded.
2. Much of this is a process issue; are we sure we are tackling it in a process way?

3. There are a lot of processes in play, very complex e.g., impact of Brexit is just one process.
4. Implicit assumptions are being made about fuel and fire behaviour – we must ensure these are correct.
5. We must be outcomes based in our thinking.
6. Need more fire prevention measures such as fines to reduce ignitions.
7. In Wales tackling ignitions has reduced the number of wildfires from 51,000 to 31,000; simply tackling ignitions is not enough – it cannot override the issues of managing fuel load.
8. In Australia there has been debate about who owns fuel load and who is responsible for managing it.
9. Much of what has been discussed can be split between a single big issue of fuel load management, and then a whole boxful of complexity in terms of type of fuel, peat depth, weather, extent of drying weather, proximity to urban areas, availability of four-wheel drive firefighting vehicles etc which could be better dealt with locally.

Breakout 4: Proposing Action
Introduction by Howard Davies

Delegates to consider, on the basis of all they heard and discussed throughout the day, the two priority actions required and their role in making these happen.

Note: The point was made that civil servants are required to be agnostic when it comes to making recommendations to Government. This was accepted.

Proposing action report to plenary
To note – the following points are the reported priority actions at the room level.

- **Wildfire strategy**
  Cross departments (are all relevant department involved in wildfire discussion)
  Devolved administrations.
  Land Management sector.
  Other groups?
  Need resources, ability and political will (could be deployed probably have this across various organisations); who is the champion? Should it be in government or should there be a wildfire minister?

Short term – review England framework (groups in organisation to lobby government). Long term this is not a quick or easy task.

- Can we manage fuel outwith the prescribed burning season/correct conditions to mitigate wildfire.
- At risk/asset/value mapping.
- Local scale site examination with all actors to identify strategic management required.
- Review the wildfire framework – who ensures this?
- UK wildfire risk map.

- Strategy –
  - Prepare.
  - Respond.
  - Recover.

Consensus building
Delegates were asked to consider, discuss, and vote on their preferred top risk, mitigation, and action. The outcome of which is attached in a separate 'priority risk, mitigation and action summary' – see appendix 2.

Summary
The facilitator summarised the process to date, reminding delegates that the workshop was designed to facilitate consensus building around risk appetite, mitigation, and actions in response to future wildfire impact. He reminded delegates of the initial focus on understanding areas of commonality and difference, exploring:

- Existing levels of consensus.
- Reflection on self and possible behavioural shifts required.
- The responsibility and accountability of the individual in reaching agreement.

The first session sought to open up discussion on underpinning beliefs, values and identity before exploring empirical evidence, data, and facts.

He highlighted the value of the presentations which were designed to stimulate and add value and perspective to the debates, reminded delegates that they had explored their risk appetite, their priority risks, mitigation and actions required, and importantly their role in making these happen. He reminded delegates that they were given the freedom to consider, discuss, and vote on their preferred top risk, mitigation, and action.

The facilitator thanked delegates for not only the quality of their interaction, but the manner in which they engaged with the process.

Word cloud based on relative use of words at each table.

The purpose of this word cloud is to give an indication of the tone of the conversation rather than a detailed insight.

This is based on the text from the flip chart pages produced by each table during the defining outcomes, prescribing mitigation, proposing action, and risk appetite breakout sessions. Abbreviations that were effectively meaningless 'e.g', 'i.e' 'etc', bullet points, hyphens, full stops etc were removed.

Next steps and close of workshop
Teresa Dent

Thank you all for an excellent workshop. I can claim little credit for its success. That goes to Nick Sotherton and Henrietta Appleton who have kindly organised today. I would like to warmly thank Howard and Richard for their excellent facilitating. When I told Howard that we would need at least 6 tables of 6 today, he went a little white on the Zoom screen and said, "I am going to need some help". They have done brilliantly today.

We will all want to thank our extremely knowledgeable and impactful speakers. Morgan explained the mistakes that we need to avoid from his experience over decades in the States, and the importance of managing fuel load. Marc's presentation showed us how frightening wildfire can be and the importance of understanding not only fuel load but also the impact on drying weather and humidity. Those pyro convection events he showed us were terrifying. Clare reminded us that we should be understanding how much normal habitat management burning can help us with wildfire mitigation and identified other issues that we would do well to do some further work on. Paul reminded us how summer 2022

changed the wildfire situation in the UK for ever, and how we need to manage fuel load to prevent our Fire & Rescue service from being literally overwhelmed.

Clearly, one thing that unites us is that we are all frightened of the consequences of wildfire. The Fire Brigade is frightened because it puts firefighters at risk, it can literally overwhelm them, and it can prevent them attending other incidents where they are responsible for preserving life and property. Meteorologists and health experts are frightened because the health aspects of big wildfires are far-reaching and severe. Land managers are frightened because so much habitat and wildlife are destroyed by wildfire. Climate change experts are frightened because wildfire can cause massive releases of carbon. Policymakers are frightened because they do not want to be accused of having been asleep on this watch. Thankfully, as far as we know, no-one has died due to a wildfire in the UK; but we are all frightened that if we don't do the right thing that might happen.

For the first 20 years of my working life, I worked with land managers, farmers, and gamekeepers. I have enormous respect for their practical knowledge and understanding of how land can be managed, its complexities and its variation. The second half of my life I have worked daily with 60 amazing scientists, and I have huge respect for the way they do their science, the integrity of the work they do. I have also learnt that, without doubt, the best solutions come from those two working together; practitioners and scientists learning from each other, combining their knowledge, and thereby putting the people who must make the policy decisions in the best possible place to make good decisions.

We have had the chance to do that here today and I hope very much that we have done enough to help the Climate Change Committee prepare its next report for government.

The next step will be to write up a note of these proceedings for the Climate Change Committee. Thank you again for your excellent contributions today.

Appendix 2: Outcomes from consensus building

Wildfire impact, risk & mitigation workshop

Delegates were asked to consider, discuss, and vote on their preferred top risk, mitigation, and action.

Priorities at room level

Risk

1. Long term loss of ecosystem services
2. Loss of life
3. Critical infrastructure damaged/ lost.
4. Species extinction
5. [Loss of] vitality – disease, symptoms, death.
6. Carbon loss
7. Damage to habitats (inc. biodiversity, greenhouse gasses, carbon)

Mitigation

- Fuel management ► fuel mapping modelling/ and risk matching mapping ► fire severity.
- Fire shed management approach.
    - fuels mapping
    - critical path analysis
    - understand ignition sources and density.
- Public awareness/education (*Lots of good practise locally but is there a role for national messages*). Everyone should understand fuel load and fire behaviours, in particular what is fine fuel and what does fuel constitute.
- Short term Public Awareness/Education – "Firewise Communities"
- [Better] land use planning
- Reducing Wildfire Occurrence - Identify risks across range of scales, national to local, what are appropriate units e.g. local resilience forums.
- [Understanding] environmental degradation - scale and specific service issues.
- Land Management fuel breaks
- Community education
- Shelter evaluation
- At-risk values mapping [followed by] geographically targeted response where heterogeneity in risk and fire.
- [Understanding] what to do if a wildfire happens - public and land managers.
- Health messaging (targeted, compared wider heat messages)

Action

- **Wildfire strategy**

  Cross departments (are all relevant department involved in wildfire discussion?)
  Devolved administrations.
  Land Management sector.
  Other groups?
  Need resources, ability and political will (could be deployed probably have this across various organisations); who is the champion? Should it be in government or should there be a wildfire minister?
  Short term - review England framework (groups in organisation to lobby government).
  Long term this is not a quick or easy task.

- Can we manage fuel outwith the prescribed burning season/correct conditions to mitigate wildfire.
- At risk/asset/value mapping
- Local scale site examination with all actors to identify strategic management required. MA
- Review the wildfire framework - who ensures this?
- UK wildfire risk map.
- Strategy -
  - Prepare
  - Respond
  - Recover

Appendix 3: workshop pre-reads

Wildfire impact, risk & mitigation workshop

Climate change and the increasing threat of wildfire

"*[W]ildfires that burn for weeks and that may affect millions of people … present a challenge that, right now, we are not prepared for.*"[6]

1. Introduction

1.1. The UK will see an increasing risk of wildfire due to climate change (see section 2); however, it is important to recognise that wildfire risk is a global phenomenon[7].

1.2. In the UK the Climate Change Risk Assessments since 2012 and the National Adaptation Programmes since 2013 have identified wildfire as a climate change risk.

1.3. The United Nations Environment Programme (UNEP) recently produced a rapid response assessment of the threat of wildfire in which they highlighted three next steps for policy makers (Box 1) and made nine recommendations (Box 2)[8].

1.4. Given policy makers were encouraged to learn from each other's experiences, this workshop seeks to provide a context to the expected wildfire threat situation in the UK by considering strategies undertaken in those countries already experiencing a combination of fuel and weather conditions conducive to wildfire; namely the USA and Spain.

1.5. The Food & Agriculture Organisation's definition of a wildfire was adapted for the UK: '*Any uncontrolled vegetation fire which requires a decision, or action, regarding suppression*'[9].

1.6. UNEP defined wildfire as "*an unusual or extraordinary free-burning vegetation fire which may be started maliciously, accidently, or through natural means, that negatively influences social, economic, or environmental values*". This definition reflects the 'value' consequences of wildfire and highlights the need for prevention, not just suppression.

Box 1: UNEP Wildfire Rapid Response Assessment crucial next steps for Policymakers:

1. Audit your full wildfire costs and invest in planning, prevention and recovery not just response.
2. Learn from others, best practice is out there.
3. A stronger multilateral response is needed.

Box 2: UNEP Wildfire Rapid Response Assessment recommendations:

1. Recognise and respond to the impact of climate change on the prevalence and behaviour of wildfires
2. Understand wildfire behaviour and improve fuel management and wildfire monitoring
3. Promote an integrated fire management approach
4. Support and integrate indigenous, traditional, and contemporary fire management practices into policy
5. Strengthen international and regional cooperation on wildfires
6. Rebalance investments spent on reactive suppression to proactive wildfire mitigation and management
7. Empower communities and local authorities
8. Improve firefighter safety
9. Promote the collection of data and information on the gender dimension of wildfires.

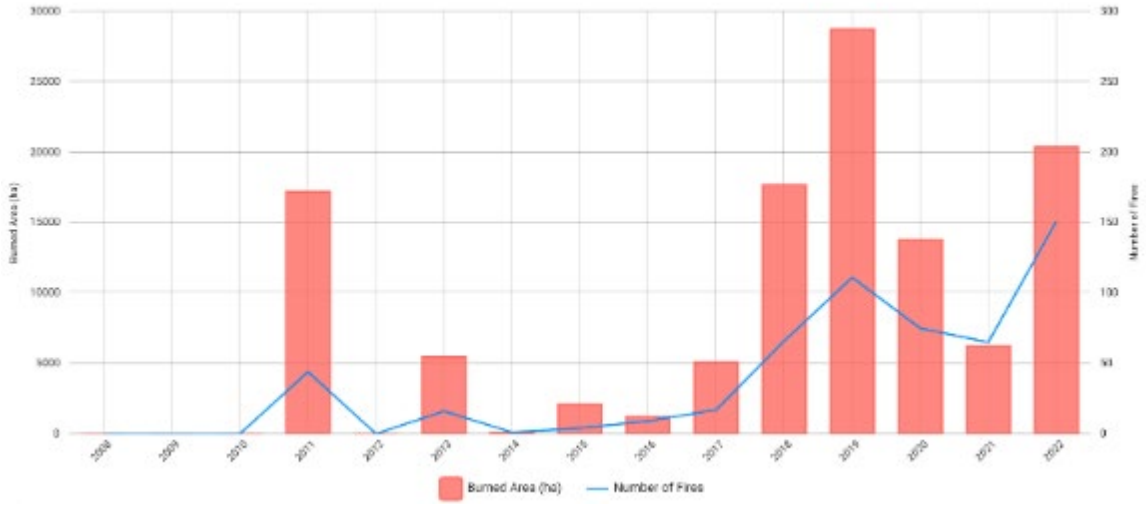
2. Projected future trends in UK fire weather.

[6] United Nations Environment Programme (2022). Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires. A UNEP Rapid Response Assessment. Nairobi.
[7] ibid
[8] ibid
[9] https://www.gov.scot/publications/fire-rescue-service-wildfire-operational-guidance/pages/4/

2.1. Past trends analysed using satellite-derived data for the last 18 years identified a peak in Spring (due to availability of dead/dry fine fuel surface vegetation) and a secondary peak in Summer (due to hotter, drier weather)[10].
2.2. Future projections based on two degrees of global warming relative to 1850-1900 show a large increase (200%) in hazardous fire weather in Summer, with a smaller 150% increase for the Spring.
2.3. The model also projects a possible extension of the wildfire season into early Autumn, subject to fuel load.
2.4. Put simply, climate change is driving increasingly frequent (2-3x pa) periods of fire supportive weather of longer duration; conditions projected to double to 6x pa by 2100[11].
2.5. Trends towards a warmer and wetter climate in the UK will result in higher fuel loads due to increasing production of vegetation and changes in land management practices[12].
2.6. Importantly, wildfire risk is not dependent on an increase in the amount of existing vegetation; drier warmer weather results in more of the existing vegetation becoming available to burn (Steve Gibson – pers comm).

3. Wildfire trends in the UK

3.1. In 2013 wildfire was included for the first time in the National Risk Register. Since then, there has been a significant increase in the number of fires of greater than 30ha (EFFIS data).



3.2. See appendix 1 for 2022 statistics from the National Reporting Tool data.
3.3. Recent analysis for the Adaptation Committee[13] reported that mountain, heath and bog lost the greatest area (based on area burnt average across 2009/10 and 2016/17).
3.4. The evidence report for the second Climate Change Risk Assessment[14] noted that conversion to continuous cover management systems, for example in forestry, may increase fire risk and, that in the south and east of the UK wildfire risk is likely to increase given proximity of contiguous areas of heathland and conifer plantations to significant population densities and critical infrastructure.

[10] Perry, M.C. et al (2022) Past and future trends in fire weather for the UK. Nat. Hazards Earth Syst. Sci., 22, 559–575, 2022 https://doi.org/10.5194/nhess-22-559-2022
[11] Zhang, R. et al., 2020. Increased European heat waves in recent decades in response to shrinking Arctic sea ice and Eurasian snow cover. Climate and Atmospheric Science, Volume 3
[12] POSTNOTE Number 603 June 2019 Climate Change and UK Wildfire
[13] Ffoulkes, C., et al. (2021) Research to review and update indicators of climate-related risks and actions in England. ADAS report to the Committee on Climate Change.
[14] Brown, I., et al (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 3, Natural Environment and Natural Assets.* Report prepared for the Adaptation Sub-Committee of the Committee on Climate Change, London

4. How climate change impacts on UK wildfire risk (see figure 1, page 4)

4.1. The characteristics of a wildfire including its duration and severity are influenced by vegetation type, structure, continuity and moisture content.

4.2. Consequently, the occurrence and severity of wildfires can be affected by climate change either directly through increases in fire weather (drought, higher temperatures, decreased atmospheric humidity) or indirectly through changes in vegetation which affects available fuel loads[15]; and in the case of peatlands both increased vegetation and drying making them more prone to wildfire[16].

4.3. In addition, projected hotter, drier summers in the UK (see 2.2 above) will affect human recreational behaviour and increase likelihood of human-induced ignitions[17].

4.4. Some UK habitats are fire-adapted e.g. peatlands and heathlands but climate change can alter the frequency of fire away from the 'natural' fire regime[18]. More frequent fires can affect nutrient cycling, decomposition rates, carbon storage and sequestration, plant regeneration, biodiversity and ecosystem composition and succession[19].

4.5. Given the contribution that peatlands make to ecosystem services and Net Zero ambitions it is of concern that higher severity wildfire driven by more frequent summer droughts could change the vegetative composition of our moorlands[20].

> *"A wildfire is the result of a complex interaction of biological, meteorological, physical and social factors that influence its likelihood, behaviour, duration, extent and outcome. Changes in many of these factors are increasing the risk of wildfire globally..."* (UNEP 2022)

5. Current UK policy on wildfire

5.1. The Wildfire Framework for England[21] allows for both the mitigation of wildfire impacts (through Defra overseeing interrelationship of land management and fuel load) and suppression.

5.2. The Home Office, which has the lead responsibility for wildfire, emphasises suppression[22] given it has ministerial responsibility for fire and rescue policy (since January 2016). However, the response of the FRS in England is hindered by fire behaviour and lack of opportunities for effective suppression as well as resources and a coordinated national training standard[23].

5.3. Defra has a key role to play in promoting wildfire mitigation and adaptation not only in support of assisting the FRS in responding to wildfire incidents but also given their role in the delivery of the 25YEP, clear air strategy, Peat Action Plan and Tree Action Plan, and the impact of wildfire on carbon storage and emissions as part of the CCRA and National Adaptation Programme.

5.4. Department for Levelling Up, Housing and Communities promotes wildfire risk within Local Resilience Forums. Wildfire risk should be considered in local planning decisions; for example, Surrey Heath District Council requires this under current Environmental Impact Assessment regulations[24].

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[15] ibid
[16] Turetsky, M. et al. (2015) Global vulnerability of peatlands to fire and carbon loss. Nature Geosci 8, 11–14. https://doi.org/10.1038/ngeo2325
[17] Peak District National Park Wildfire Risk Assessment 2022
[18] The characteristic pattern of fire established over time and space based on parameters such as frequency, energy output and seasonality.
[19] United Nations Environment Programme (2022). Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires..
[20] Berry, P. and Brown, I. (2021) National environment and assets. In: The Third UK Climate Change Risk Assessment Technical Report
[21] Wildfire Framework for England – December 2021 (fireengland.uk)
[22] POSTNOTE Number 603 June 2019 Climate Change and UK Wildfire
[23] Peak District National Park Wildfire Risk Assessment 2022
[24] POSTNOTE Number 603 June 2019 Climate Change and UK Wildfire

5.5. In Scotland the Government published guidance for FRS personnel based on suppression and fire management[25]. This states that the FRS is looking to shift focus from response to prevention through engagement with stakeholders and practitioners.

5.6. In Wales, where most wildfires are the result of arson incidents, multiple agencies led by the FRS has produced a Wales Arson Reduction Strategy[26] which recognises the need to also engage with landowners and managers to consider methods to reduce fire loading and preserve habitats.

5.7. Wildfires impact on a broad range of economic, social and environmental services (including human health and loss of life). Currently the National Risk Assessment does not value the natural capital at risk from wildfire (see "Assessing the financial, social and environmental effects of wildfire" p.7). Consequently, prevention and mitigation are likely to be cost-effective approaches to wildfire reduction[27] if costs of damage to ecosystem services are accounted for.

5.8. Suppression only policies can increase the risk of wildfire particularly under extreme weather conditions[28].

6. The impact of land management policy on wildfire risk

6.1. Changes in agricultural policy can increase wildfire risk by affecting the fuel load and its management. For example, through changes in livestock numbers affecting vegetation type and structure[29].

6.2. The focus on public money for public goods is driving changes in land use away from farming towards carbon incentivised land uses such as tree planting or reduced management (regeneration) whilst conservation policy is migrating towards reduced intervention (re-wilding).

6.3. Future ecosystem management policy must consider balancing conservation and wildfire impacts as a 30% increase in fuel loads is predicted in some vulnerable semi-natural habitats[30]. See Box 3.

6.4. The move to a post-Brexit agricultural support system is projected to reduce the number of 'active' farmers by 20% in 2030 (from 2020 levels)[31], particularly in marginal areas such as the uplands[32].

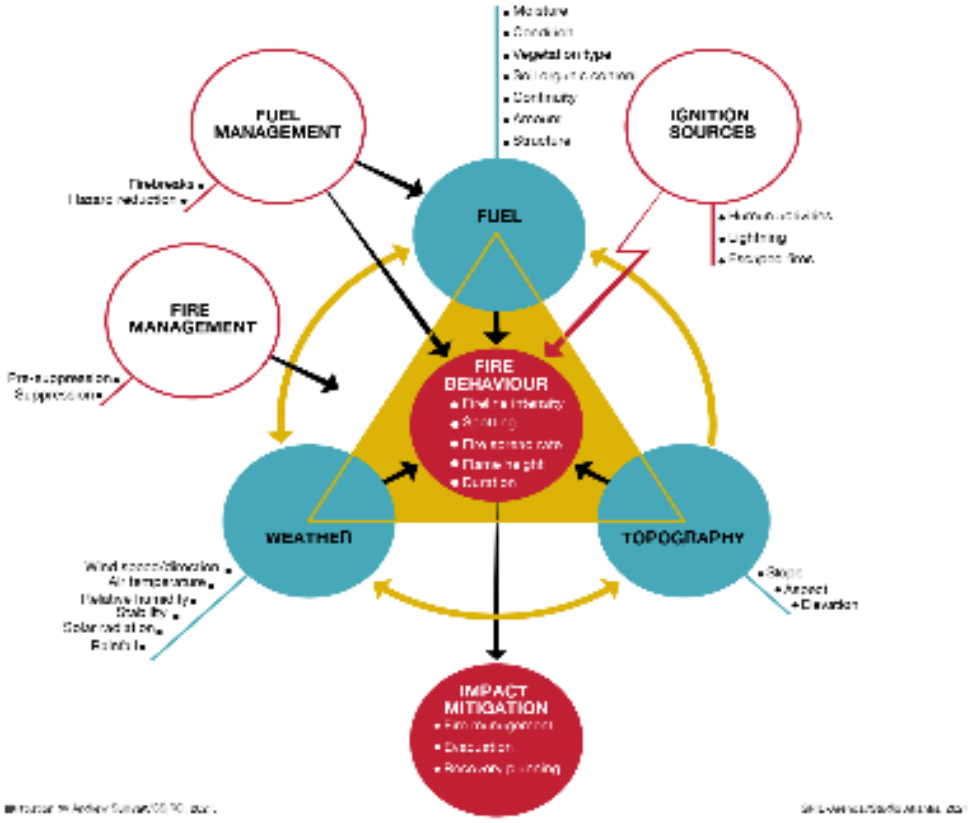
Box 3: Predicted increase in wildfire risk in National Parks by 2080[9]

Country	National Park	% Difference in Fire Index (areal mean) (1980s-2080s)
England	Lake District	30%
	North York Moors	30%
	Northumberland	30%
	The Broads	30%
	Yorkshire Dales	30%
	Exmoor	40%
	Peak District	40%
	Dartmoor	40 – 50%
	New Forest	50%
	South Downs	30%
Scotland	Loch Lomond and the Trossachs	30%
	Cairngorms	30 – 40%
Wales	Pembrokeshire Coast	30 – 40%
	Brecon Beacons	30 – 40%
	Snowdonia	40 – 50%

Notes: Values based on the McArthur Forest Fire Danger Index.

[25] https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2013/10/fire-rescue-service-wildfire-operational-guidance/documents/wildfire-operational-guidance/wildfire-operational-guidance/govscot%3Adocument/00436138.pdf
[26] https://www.northwalesfire.gov.wales/media/338799/jr0731-wars4-doc-2019_web.pdf
[27] Multihazard Mitigation Council 2018 in UNEP 2022
[28] POSTNOTE Number 603 June 2019 Climate Change and UK Wildfire
[29] Milligan, G. et al (2016) Winners and losers in a long-term study of vegetation change at Moor House NNR: Effects of sheep-grazing and its removal on British upland vegetation, Ecol. Indicators, 68 (89-101) https://doi.org/10.1016/j.ecolind.2015.10.053.
[30] Belcher et al., (2021) UK wildfires and their climate challenges.
[31] https://www.fwi.co.uk/news/farm-policy/farmer-numbers-expected-to-plummet-as-bps-is-taken-away
[32] https://www.farminguk.com/news/upland-farmers-face-income-crisis-in-transition-to-new-schemes_59730.html

Figure 1: Factors and conditions influencing wildfire occurrence (from UNEP 2022)[33]



[33] United Nations Environment Programme (2022). Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires.

Assessing the financial, social and environmental effects of wildfire

"*… the true cost of wildfires – financial, social, and environmental – extends for days, weeks, and even years after the flames subside*" [34]

1. Introduction

1.1. Whilst wildfire threat is quantified in area burnt (see Climate change and wildfire p.2), this metric is a poor indicator of overall impact, especially at the rural-urban interface[35].

1.2. The United Nations Environment Programme in its recent assessment of the threat of wildfires[1] highlighted three crucial next steps for policy makers, one of which was to "*Audit your full wildfire costs and invest in planning, prevention, and recovery, not just response*". Their rationale was that there needs to be a rebalancing of efforts towards prevention/mitigation because these costs are a fraction of those associated with suppression and economic and environmental impacts.

1.3. Given that the cost (both direct and indirect) of wildfires to our economy and natural capital are currently unquantified[36], the costs of a single wildfire, Stalybridge/Saddleworth in 2018, based on known and estimated impacts over the short and long term[37], are reviewed. The Peak District is particularly at risk of wildfire due to visitor pressure as well as climate change. Wildfire here carries significant social and economic risks due to its proximity to large urban populations and critical infrastructure (e.g. reservoirs).

Saddleworth Moor Fire in numbers	
How far it spread	3.7 miles
Homes evacuated	50
Residents evacuated	150
A365 closed	4 miles
Spread of PM2.5 effects	80km
People exposed to PM2.5 effects	4.5 million

1.4. The value of ecosystem services provided by our semi-natural habitats that wildfire events threaten are also highlighted; as are the impacts of wildfire on human health and wellbeing, the built environment, the economy and the Fire & Rescue Services (FRS).

1.5. The costs highlighted below are potentially an "avoided loss" if wildfire policy was to focus on mitigation as much as, if not more than, suppression. See Wildfire Mitigation.

2. Stalybridge/Saddleworth Moor wildfire 2018 – an example of both the short and long term 'costs' of a wildfire

2.1. The wildfire ignited on 24 June 2018 during an exceptionally dry period and burned for over three weeks. European Union data show that in 2018 the UK recorded the second largest area affected by wildfire[38].

2.2. It is an example of where fire intensity and rate of spread, due to few suppression opportunities and an unmanaged vegetation fuel load, overwhelmed the efforts of Greater Manchester FRS (see also 4.1).

2.3. ***Costs of suppression***: £1.2 million[39]. This is based on the costs to the FRS including the deployment of about 100 soldiers. However, it should be noted that unaccounted for costs would also have been incurred by the landowners and gamekeepers who supported the FRS and other local wildfire group volunteers. For example, at the same time Arnfield Moor also suffered a wildfire and this was attended by Derbyshire FRS supported by twelve gamekeepers as well as United Utilities employees, Peak District National Park/National Trust/RSPB wardens, farmers and other volunteers[40].

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[34] United Nations Environment Programme (2022). Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires. A UNEP Rapid Response Assessment. Nairobi.
[35] Shuman, J. K. et al (2022) Reimagine fire science for the anthropocene. PNAS Nexus. 2022(1): 1-14.
[36] The National Risk Assessment does not value the natural capital at risk from wildfire
[37] The long-term post-fire effects vary according to vegetation/soil type but broadly reflect the impact that high severity fires have on the regeneration of vegetation and the exposure of bare soils to weathering.
[38] EU DG for European civil protection and humanitarian aid operations
[39] PDNP Wildfire Risk Assessment 2022
[40] https://www.moorlandassociation.org/2018/06/keepers-continue-to-combat-saddleworth-moor-wildfire/

2.4. ***Costs/impacts of the wildfire at the time***:

2.4.1. United Utilities (landowner): £700,000 including helicopters for firefighting, supporting the emergency services, draining reservoirs to avoid contamination and immediate repairs to the catchment land[41]. Saddleworth Moor wildfire affected upland terrain that supplies the greater Manchester area with drinking water[42].

2.4.2. Carbon emissions: 26,281t CO_2 worth £1.68 million[43].

2.4.3. Smoke impacts on human health: £21.1m (the economic impact of mortality due to $PM_{2.5}$). Concentrations of $PM_{2.5}$ were significantly elevated in Greater Manchester and up to 80 km away resulting in 4.5 million people being exposed to concentrations of $PM_{2.5}$ above the World Health Organisation's 24-hour guideline[44].

Figure 1: Summary of immediate Saddleworth Wildfire costs

Cost/Loss	Value £m
Suppression	1.2
Landowner	0.7
Carbon emitted	1.68
Health	21.1
2012-17 restoration	2.0
Other costs	Unknown
Total	26.68

2.4.4. Impacts on local communities: 50 homes evacuated affecting 150 people.

2.4.5. Previous restoration costs (2012-2017): £2 million (gully blocking and revegetating bare peat)[45]. Funded by agri-environment schemes.

2.4.6. Other costs: including loss of grazing and livestock, loss of fencing, loss of wildlife (impacts on biodiversity and pollination services) and road closures. Value unknown.

> "*We could see flames 50ft high like a raging ball of fire all on the hill side. It was really scary, we were really worried the smoke would hurt Isla so we had to get out.*" (local Saddleworth resident)

2.5. Total 'immediate' costs: c. £26.5 million.

2.6. ***Legacy costs/impacts of the wildfire***:

2.6.1. Carbon:

2.6.1.1. an estimated 15,400 tonnes of Carbon sequestration capacity was lost worth £3.6 million[10].

2.6.1.2. As an illustration to inform debate, if it is assumed that the wildfire left the site as the equivalent of eroding bare peat (drained), which is estimated to release 13.28t CO_2e/ha/yr[46], this suggests that in excess of 20,000t CO_2e/yr will continue to be released; although this is unlikely to be a straight-line response as carbon will be absorbed as the area re-vegetates. The effects could last up to 10 years[8,47].

2.6.1.3. Exposed peat can be lost by wind-blow, surface water flow and frost heave, resulting in losses of 0.8-1.0cm per year[48]. No additional cost is estimated for this as it is assumed to be included in the carbon losses. However the loss of peat is also a 'cost' to other ecosystem services such as water quality and release of other GHG gases such as methane[49].

2.6.2. Habitat restoration: c£2.5 million (c£1500 per hectare/1800 hectares burnt[50]). Wildfire can leave Sphagnum-dominated peatlands hydrophobic[51] affecting rewetting attempts.

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[41] Belcher et al., (2021) UK wildfires and their climate challenges. Expert Led Report Prepared for the third Climate Change Risk Assessment

[42] ibid

[43] Reducing the risk of wildfire | Moors for the Future

[44] Graham, A.M. et al (2021) Impact of the June 2018 Saddleworth Moor wildfires on air quality in northen England. Environmental Research Communications, 2, 031001

[45] Private Lands Portfolio: Saddleworth Moor | Moors for the Future

[46] Gregg, R et al (2021) Carbon storage and sequestration by habitat: a review of the evidence (second edition) Natural England Research Report NERR094. Natural England, York. Table 4.3.

[47] https://inews.co.uk/news/saddleworth-moor-fire-blaze-wildlife-greater-manchester-170704

[48] Fire damage on Blanket Mire Penny Anderson 1997

[49] Gray, A., et al. (2021) Peatland Wildfire Severity and Post-fire Gaseous Carbon Fluxes. Ecosystems 24, 713–725 https://doi.org/10.1007/s10021-020-00545-0

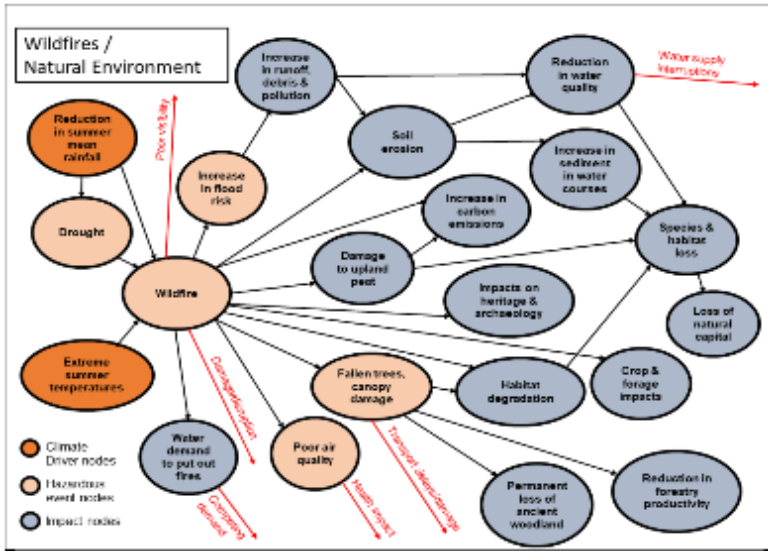
[50] Belcher et al., (2021) UK wildfires and their climate challenges.

[51] Kettridge, N et al (2014) Burned and unburned peat water repellency: Implications for peatland evaporation following wildfire, Journal of Hydrology, Vol 513, 335-341,https://doi.org/10.1016/j.jhydrol.2014.03.019.

2.6.3. Possible impacts on recreation/tourism: £205,000 (Environment Agency estimate)[52].

3. Value of Ecosystem services vulnerable to wildfire

Figure 2: Risk interactions associated with wildfire



3.1. It is important that the potential impacts of wildfires on our natural capital are quantified. This is not currently the case; "*there is concern that the NSRA [National Security Risk Assessment] does not fully consider impacts on the natural environment, including loss of ecosystem services*"[53].

3.2. Wildfires are considered a pressure indicator (damage inflicted on the landscape by humans) by the Office for National Statistics in their natural capital accounts.

3.3. Figure 2 demonstrates the risks involved.

3.4. This 'avoided loss' is an important justification for wildfire policy to address mitigation and prevention.

3.5. **Provisioning services:**

3.5.1. Timber production: £227 million[54]

3.5.2. Agricultural biomass: £2.4 billion[21] (£32m recorded loss in 2020[55])

3.5.3. Water supplies: £3.4bn[56] (2018, UK data) (£888 million (2016) for peatlands only[57]). Wildfire can negatively impact water quality through releasing contaminants, affecting colouration and affecting storage infrastructure (sedimentation).

3.5.4. Others: Potential impacts on onshore wind[58] and solar energy production[59].

3.6. **Regulating Services**

3.6.1. Climate regulation (carbon sequestration): £1.5 billion[60].

3.6.2. Air quality: £634 million (2018, UK data)[61].

3.6.3. Natural hazard regulation – flood mitigation: £218.5 million (woodland)[62].

3.6.4. Pollination services & biological control[28]: value unknown.

3.7. **Cultural services**

3.7.1. Recreation/tourism – £1,893 million (value of visits to semi-natural habitat in 2018 (2019 prices)[63].

3.7.2. Heritage/socially valued & cultural landscapes: value unknown.

3.7.3. Field sports: worth £2 billion a year to UK economy[64].

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[52] Reducing the risk of wildfire | Moors for the Future

[53] Betts, R.A. and Brown, K. (2021) Introduction. In: The Third UK Climate Change Risk Assessment Technical Report [Betts, R.A., Haward, A.B. and Pearson, K.V. (eds.)]. Prepared for the Climate ChangeCommittee, London

[54] Belcher et al., (2021) UK wildfires and their climate challenges.

[55] The Third UK Climate Change Risk Assessment Technical Report.

[56] ONS UK Natural Capital Accounts: Semi-natural habitats (2021).

[57] ONS UK Natural Capital Accounts: Peatlands (2019).

[58] ONS UK Natural Capital Accounts: Semi-natural habitats (2021).

[59] California wildfire smoke dimmed solar energy in 2020 (phys.org)

[60] Belcher et al., (2021) UK wildfires and their climate challenges.

[61] ONS UK Natural Capital Accounts: Semi-natural habitats (2021).

[62] https://www.forestresearch.gov.uk/research/forestry-and-natural-flood-management/valuing-flood-regulation-services-for-natural-capital-accounts/

[63] ONS UK Natural Capital Accounts: Semi-natural habitats (2021).

[64] PACEC 2014 – The economic, environmental and social contribution of shooting sports to the UK. http://www.shootingfacts.co.uk/pdf/The-Value-of-Shooting-2014.pdf

3.7.4. Biodiversity – conservation: unknown but a recent study estimated that the biodiversity value of the Derwent area in the Peak District was £2.5 billion[65]. In addition, extensive damage could invalidate designations such as SSSIs[66].

4. **Capacity of the FRS to cope with increased incidence and severity of wildfires**

4.1. Current wildfire policy (see p.5) emphasises suppression but the ability of the FRS to suppress wildfire incidents is hindered by fire behaviour and lack of opportunities for effective suppression. See 2.2 re Saddleworth Moor fire.

4.2. An added pressure is that wildfire incidents occur in response to particular weather patterns and are therefore often concentrated into a short period of time. Again the Saddleworth Moor wildfire exemplifies this problem as there were six wildfire events[67] within a relatively small area as well as Winter Hill wildfire attended by Lancashire FRS. These and countless other smaller wildfires were affecting the FRS resilience to adequately respond to other incident types (Steve Gibson – pers comm).

4.3. These effects are also felt at the rural-urban interface (RUI). For example, on 19th July 2022 it was reported that London Fire Brigade had its busiest day since World War II.

> "*a completely and fundamentally different operating environment where fires burn with such ferocity, and spread with such speed in suburban areas that you CAN'T STOP THEM.*" Dave Walton, Dep Chief Fire Officer in West Yorkshire.

4.4. Significantly this concentration of firefighting resource means that there is no capacity to handle other types of fire.

4.5. There is no coordinated approach to FRS wildfire training and resources. As a consequence, many firefighters are ill-prepared/under-resourced to fight a wildfire, increasing risk to firefighters' health and safety as well as resulting in larger and more damaging fires.

4.6. Whilst no firefighters have yet to lose their life in the UK, this is not the case in Europe. UK policy needs to learn from these experiences when evolving wildfire policy.

4.7. The World Health Organisation classifies firefighting as a category1carcinogen risk.

> Saddleworth Moor resident: "*You could hardly breathe and your eyes were burning*"

5. **Other costs to society**

5.1.1. **Economic activities:** impact on critical infrastructure such as power lines, roads, telecoms mast (e.g. Winter Hill 2018) and airports. Impact on schools and businesses.

5.1.2. **Housing**: costs of evacuating homes and loss of property.

5.1.3. **Health:**

5.1.3.1. Loss of life – for example there was an estimated 4 deaths due to increased $PM_{2.5}$ levels from Saddleworth Moor wildfire in 2018[68].

5.1.3.2. Air pollution/smoke inhalation – effects can extend over significant distances e.g. Saddleworth affected air quality up to 80km away[69].

5.1.4. **Environmental threats:** examples include increased threat of landslides due to impacts on slope stability[70]. This is a particular risk on the coal waste slopes in the South Wales valleys. Similarly, as wildfires remove the protecting surface vegetation over extensive areas the risk of flood events is increased[71]. In addition, relying on suppression alone might lead to the increased use of fire-retardant chemicals which are highly persistent in the environment and affect water quality[72].

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[65] PDNP Wildfire Risk Assessment 2022
[66] Llantysilio Mountain Fire Report September 2019.
[67] https://www.derbys-fire.gov.uk/news/news-items/arnfield-moor-fire-update
[68] Graham, A.M. et al (2021) Impact of the June 2018 Saddleworth Moor wildfires on air quality in northern England. Env Res Comms 2, 031001
[69] ibid
[70] United Nations Environment Programme (2022). Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires. A UNEP Rapid Response Assessment. Nairobi
[71] Pereira, P et al (2021) Short-term effect of wildfires and prescribed fires on ecosystem services. Environmental Science & Health 22:100266 https://doi.org/10.1016/j.coesh.2021.100266
[72] Ibid.

Wildfire Mitigation

"*Managing the available fuel before a wildfire breaks out through planned (prescribed or hazard reduction) burning or other hazard mitigation actions (e.g., physical removal or chemical treatment) can reduce the intensity and thus likely impact of a wildfire.*" (UNEP 2022)

1. Introduction

1.1. Fires cannot exist without fuel. Strategies to address the fuel component of the fire behaviour triangle (see figure 1, p4) need to consider how those fuels are spatially distributed across the landscape.

1.2. The type, load and moisture of fuels need to be considered in the adaptation and management of the UK's semi-natural landscapes to wildfire risk.

> "*Locally, the impact of land-use change alters the dominant vegetation and fire dynamics.*" (UNEP 2022)

> "*If we can get the prevention right, it will help with the response*" (Mark Smyth NI FRS, pers comm)

1.3. Whilst reducing ignitions is desirable, and through education and engagement possible, it is not feasible to seek to prevent all wildfires; action and investment in mitigation measures are vital.

1.4. In the context of wildfire, mitigation is the creation of 'defensible' spaces[73] so that fire behaviour does not exceed the limits of suppression.

1.5. In addition, the quantification of negative impacts such as human health and ecosystem services is vital to demonstrate the importance of effective mitigation[74]. See p7.

1.6. Approaches to fire mitigation are also driven by risk aversion and public perception[75].

2. Fuel management approaches in the UK

2.1. Fuel management for mitigation purposes needs to be at the landscape-scale and in advance of the wildfire event. However, some approaches to fuel management are undertaken during a wildfire event; such as tactical burns[76].

2.2. Each technique will have its benefits and weaknesses reflecting economic and ecological constraints and so no one approach should be used in isolation.

2.3. When analysing cost:benefit ratio of action and technique, the costs of inaction (high fuel intense wildfires) need to be fully accounted for.

> "*FRS incident commanders and fire chiefs will not put their firefighters in danger to bring high fuel load intense fires under control*" (Belcher et al 2021)

2.4. Post-fire recovery should also be considered as the ability for an ecosystem to return to pre-fire status is affected by the severity of the burn and fire regime (frequency etc).

2.5. The following review of approaches to fuel management is taken from the expert led Report on wildfire for the Third UK Climate Change Risk Assessment (CCRA3)[77] (except where otherwise referenced) which includes more detail.

2.6. **Mechanical means**

2.6.1. **Objective**: to break up fuel continuity.

2.6.2. **Techniques:**

2.6.2.1. **Forestry harvesting/vegetation (grass & heather) cutting:** Most effective if the resulting biomass is removed from the site. If no material is removed the fuel structure is merely altered which will not reduce fire severity or spread.

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[73] COP27 Health Pavilion. Wildland Fires event. 10 November 2022. Dr Kari Nadeau (Stanford University).
[74] United Nations Environment Programme (2022). Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires. A UNEP Rapid Response Assessment. Nairobi.
[75] Ibid.
[76] Used by the Fire & Rescue Services to remove fuel ahead of the fire front.
[77] Belcher et al., (2021) UK wildfires and their climate challenges. Expert Led Report Prepared for the third Climate Change Risk Assessment

2.6.2.2. **Other**: ploughing in crops, land clearance (including use of pesticides), scraping, subsoiling and turf cutting. At Winter Hill trenches were dug into the peat to protect property[78].

2.6.3. **Benefits**: not subject to burning season regulations although some operations may be subject to other regulations. Given risk of smoke, may be more appropriate at rural-urban interface. Used to create firebreaks in prescribed burning. Resulting biomass can be used as an energy crop or the brash used in peatland restoration.

2.6.4. **Weaknesses**: not all areas are accessible to equipment (steep slopes/wet areas). Can damage archaeology, impact on hummock-hollow microtopography found on peatlands[79] and expose bare soil (impacting soil carbon).

> "*What is clear is that considering fire as a blanket term and using or banning it in broad terms needs more nuance if we are to understand the implications*". (Belcher et al 2021)

2.7. **Tactical/controlled/prescribed burning**[80]

2.7.1. **Objective:** break up fuel continuity and remove fuel load (also has other ecological objectives where habitats are fire-adapted such as peatlands and heathlands).

2.7.2. **Techniques:**

2.7.2.1. **Prescribed burning:** use of fire behaviour to generate a chosen impact, in this case removing fuel loads to lower wildfire risk. UNEP referred to it as hazard reduction burning.

2.7.2.2. **Controlled burning:** the use of fire for biodiversity and game management. This can also lower wildfire risk (as recognised by Heather & Grass etc. Burning (England) Regulations 2021).

2.7.2.3. **Tactical burning:** "*the use of fire by FRS or land management agencies during wildfires to remove fuel ahead of the fire, to prevent fire spread in certain directions and/or to rapidly create fire breaks during major incidents.*"[81] Successfully deployed to contain the Winter Hill wildfire in 2018.

2.7.3. **Benefits:** well-designed prescribed fires can address game management, biodiversity[82] and fuel management outcomes[83]. In the uplands supports heather conservation which is fire-adapted (heather germination cued by fire). Competitive cost-to-benefit ratio at scale[84].

2.7.4. **Weaknesses**: adaptation of prescriptive burning to mitigate wildfire may be required owing to climate change. Due to climate change, the current burning season (1st October -15th April in England) may not allow enough time (given variability in weather conditions in this period) for sufficient fuel clearance to address wildfire concerns[85]. Concerns about its impacts on a range of ecosystem services.

2.8. **Rewetting**[86]

2.8.1. **Objective:** to increase the resilience of degraded peatlands to climate change and wildfire by raising the water table and reducing soil moisture deficit[87]. (Note: the wildfire mitigation potential of rewetting has never been tested within a UK context[88]).

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[78] https://www.bbc.co.uk/news/av/uk-england-lancashire-44674579

[79] Heinemeyer, A. et al (2019) Assessing soil compaction and micro-topography impacts of alternative heather cutting as compared to burning as part of grouse moor management on blanket bog. Peerj 7:e7298

[80] Defined as a supervised burn conducted to meet specific land management objectives. For further explanation of different burning terminology see Belcher et al (2021) p40.

[81] Belcher et al., (2021) UK wildfires and their climate challenges. P40.

[82] Used by agencies such as Forestry England, National Trust and RSPB in conservation of species and habitats (e.g. Purbeck Mason Wasp on Dorset Heathland)

[83] Used by FRS and landowners such as Forestry England to remove highly flammable fuel such as gorse thickets or Molinia

[84] United Nations Environment Programme (2022). Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires. A UNEP Rapid Response Assessment. Nairobi.

[85] Belcher et al., (2021) UK wildfires and their climate challenges.

[86] This was not discussed in depth in Belcher et al (2021). Information sources referenced.

[87] Brown, I., et al. (2016) UK Climate Change Risk Assessment Evidence Report: Chapter 3, Natural Environment and Natural Assets. Report prepared for the Adaptation Sub-Committee of the Committee on Climate Change, London.

[88] Ashby, M & Heinemeyer, A (2021) A critical review of the IUCN UK Peatland Programme's "Burning and Peatlands" position statement. Wetlands 41:56. https://doi.org/10.1007/s13157-021-01400-1

2.8.2. **Technique:**

2.8.2.1. Grip/drain blocking and *Sphagnum* moss planting.

2.8.2.2. Co-action of cessation of drainage and vegetation management through unsustainable livestock management and burning regimes[89].

2.8.3. **Benefits**: "*A healthy peatland with high, stable, water tables and Sphagnum growth, naturally suppresses excess heather and other dry understory ground vegetation*"[90].

2.8.4. **Weaknesses**: Currently the time taken for the restoration of full functionality (not just carbon sequestration) and therefore resilience is poorly understood[91]. In addition, not all peatland can be rewetted as it is dependent on suitable topography[92] (for example it is estimated that only 30% of the Peak District NP is restorable[93]). There are also concerns about implications of climate change on summer water table levels[94] and bog vegetation[95]. Methane and nitrous oxide emissions can increase[96]. Potential for success of rewetting may be affected under future climate scenarios such as warmer summers[97]. Risk to other ecosystem services[98].

2.9. **Other approaches**

2.9.1. **Grazing –** has a role to play in reducing fuel loads and changing vegetation structure and moisture[99] (generally grass and heather). However this needs to be managed (species, density, feeding patterns[100]) and undertaken in combination with other techniques**.** In some areas it is argued that the removal of herbivores has been instrumental in increasing wildfire risk e.g. South Wales valleys (SWFRS – pers comm[101]).

2.9.2. **Ignition mitigation –** in the UK the majority of wildfires are caused by human action; natural causes such as dry lightning have not been often experienced to date but this may change. Consequently, informing the public of the risks of wildfire and possible ignition sources such as disposable BBQs through community education and awareness-raising programme are seen as important. For example the national parks undertake such programmes in advance of the wildfire season and also can restrict access to high risk areas - https://www.peakdistrict.gov.uk/learning-about/news/current-news/fire-risk-closure-to-access-land-extreme-red-heat-warning

3. Global approaches

3.1. Globally wildfire management is considered to consist of 5 phases – the 5Rs.

3.2. The 5 phases are:

- Review and analysis
- Risk reduction
- Readiness
- Response
- Recovery.

3.3. The approaches undertaken during each phase are neatly summarised in Figure 1 overleaf.

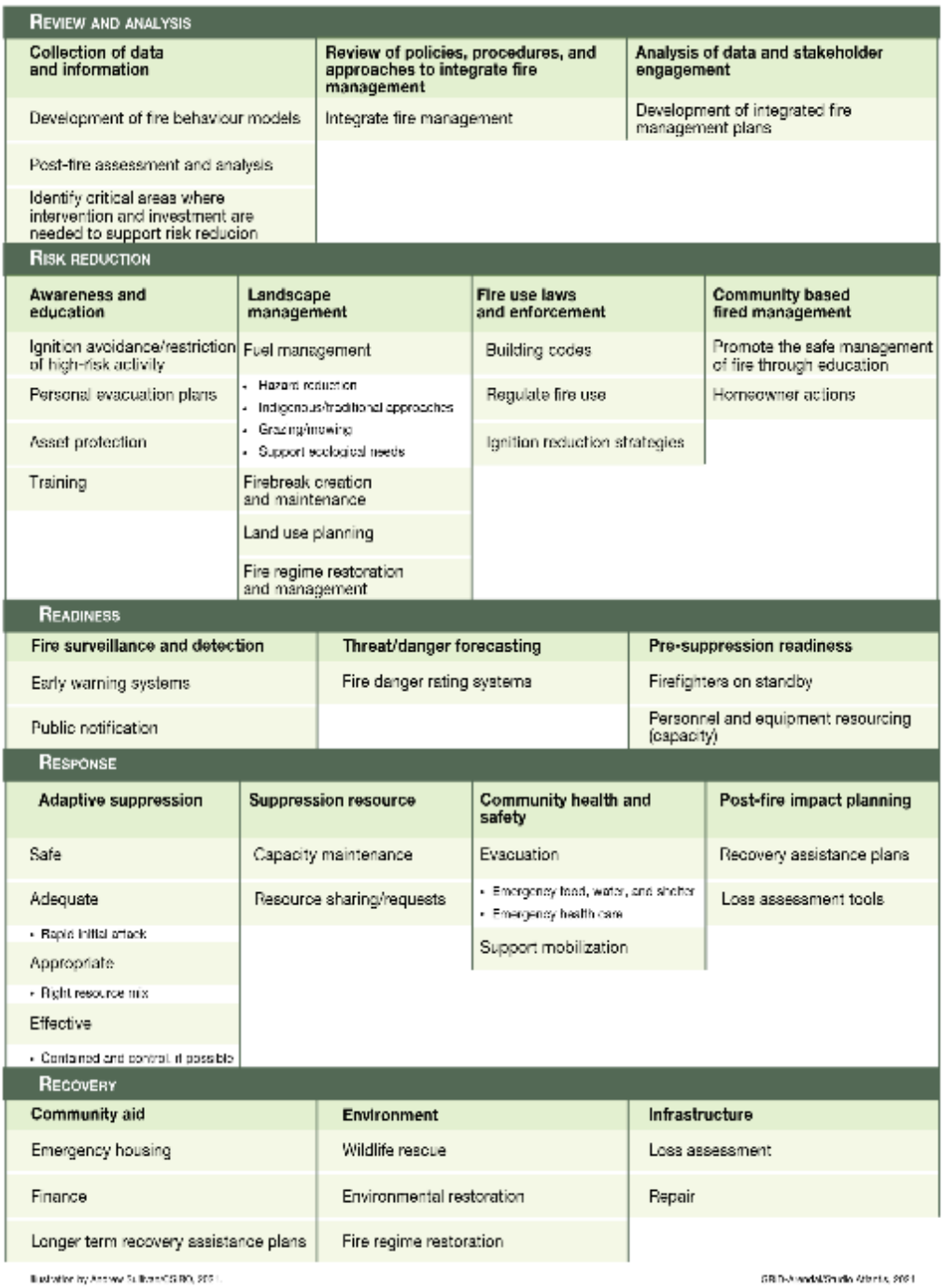
3.4. Prescribed burning for hazard reduction is regarded as a highly effective and relatively inexpensive approach to wildfire mitigation yet its use has been limited by barriers such as

[89] IUCN UK Peatland Programme Burning and Peatland Position Paper March 2020.
[90] ibid
[91] Loisel, J & Gallego-Sala, A (2022) Ecological resilience of restored peatlands to climate change. Communications Earth & Environment (2022) 3:208 https://doi.org/10.1038/s43247-022-00547-x
[92] Peak District National Park Wildfire Risk Assessment 2022..
[93] Natural England – pers. Comm
[94] Labadz JC, Hart RG, Butcher DP (2007) Peatland hydrology research project: Bolton fell Moss and Walton Moss: Progress report to Natural England. Nottingham Trent University, Nottingham
[95] Davies GM, Legg CJ (2011) Fuel moisture thresholds in the flammability of Calluna vulgaris. Fire Technology 47:421–436
[96] POSTnote 668 Reducing peatland emissions.
[97] Ashby, M & Heinemeyer, A (2021) A critical review of the IUCN UK PP Burning & Peatlands position statement. Wetlands (2021) 41: 56 https://doi.org/10.1007/s13157-021-01400-1
[98] ibid
[99] Rouet-Leduc, J et al (2021) Effects of large herbivores on fire regimes and wildfire mitigation JAppEcol. 58(12) https://doi.org/10.1111/1365-2664.13972
[100] Ibid.
[101] Presentation by Craig Hope at Wildfire Conference 2022.

cross-agency collaboration, lack of capacity, lack of agency direction, political conflict, public attitudes and narrow burn windows[102].

3.5. In many countries prescribed burning is regarded as a cultural practice by indigenous peoples that increases ecosystem resilience, and this is being recognised in wildfire mitigation[103].

Figure 1: Integrated fire management – the 5Rs (from UNEP 2022)



[102] Yung, L et al (2022) New types of investments needed to address barriers to scaling up wildfire risk mitigation. Fire Ecology (2022) 18:30 https://doi.org/10.1186/s42408-022-00155

[103] Bureau of Indian Affairs releases Native Fire - An Educational Video about the Safe Use and Application of Prescribed Fire | Indian Affairs (bia.gov)

Wildfires by month recorded on National Reporting Tool (NRT)

Month	Wildfires	Running Total	Month	Wildfires	Running Total
January	2	2	**July**	**299**	598
February	4	6	**August**	**366**	964
March	165	171	**September**	16	980
April	81	252	**October**	2	982
May	16	268	**November**	1	983
June	31	299	**December**	0	**983**

Full year total for 2021 - 237

Full year total for 2020 – 146

84 wildfires recorded on NRT over 18th and 19th July affecting 28 of 46 England and Wales FRS

Wildfires by FRS (NRT data)

Rank	Service	Wildfires
1	M&WWFRS	120
2	Kent FRS	70
3	London FB	65
4	Norfolk FRS	63
5	Hants / IoW FRS	60
6	South Wales FRS	52
7	D&WFRS	48
8	Notts FRS	41
9	H&WFRS	39
10	North Wales FRS	32
11	Essex FRS	31
12	North Yorks FRS	25
13	D&WFRS	24
14	Lancashire FRS	21

- Every UK FRS affected
- 15 English FRS had between 10 and 20 NRT wildfires
- 16 English FRS have had <10 NRT wildfires
- Avon, Gloucestershire, East Sussex and Leicestershire only 1 recorded on NRT

*NRT does not include Scottish FRS or Northern Ireland FRS

Note: FRS classify a vegetation fire as a wildfire if it meets one or more of the following criteria:
• Involves a geographical area of > 1 hectare
• Has a sustained flame length of > 1.5 metres
• Requires a committed resource of ≥ 4 FRS appliances
• Requires resources to be committed for ≥ 6 hours
• Presents a serious threat to life, environment, property and infrastructure

Appendix 4: glossary of terms (from EUFOFINET project)

Wildfire impact, risk & mitigation workshop

Burn severity - A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff [litter] consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts.

Condition of vegetation - Stage of growth or degree of flammability of vegetation that forms part of a fuel complex. This will be dependent upon time of year, amount of curing and weather conditions.

Convection - The transfer of heat by the movement of a gas or liquid. In meteorology, convection is the predominantly vertical movement of warmed air.

Convection column - A rising column of pre-heated smoke, ash, particles and other debris produced by a fire.

Convection-driven fire - A fire that is spread predominantly by the intensity of the convection column.

Cool fire - A low intensity fire or part of a fire.

Extreme fire behaviour - Fire behaviour that becomes erratic or difficult to predict due to its rate of spread and/or flame length. This type of fire behaviour often influences its environment.

Fine fuel moisture - The moisture content of fast-drying fuels. Measurement of moisture content will indicate the relative ease of ignition and flammability of a fine fuel. [Fine fuels are explained in detail in box 1].

Firebreak - An area on the landscape where there is a discontinuity in fuel which will reduce the likelihood of combustion or reduce the likely rate of fire spread.

Fire behaviour - The reaction of a fire to the influences of fuel, weather, and topography.

Fire danger - A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and impact. Fire danger is often expressed as an index.

Fire dynamics - The detailed study of how chemistry, fire science, and the engineering disciplines of fluid mechanics and heat transfer interact to influence fire behaviour.

Fire ecology - The study of the relationships and interactions between fire, living organisms and the environment.

Fire hazard - Any situation, process, material or condition that can cause a wildfire or that can provide a ready fuel supply to augment the spread or intensity of a wildfire, all of which pose a threat to life, property or the environment.

Fire intensity - The rate at which a fire releases energy in the form of heat at a given location and at a specific point in time, expressed as kilowatts per metre (kW/m) or kilojoules per meter per second (kJ/m/s).

Fire prevention - A collective term for all proactive activities that are implemented with the aim of reducing the occurrence, severity and spread of wildfires.

Fire regime - The pattern of fire occurrence, fire frequency, fire seasons, fire size, fire intensity, and fire type that is characteristic of a particular geographical area and/or vegetation type.

Fire severity - Fire severity can be defined in two ways:

- The degree to which a site has been altered or disrupted by fire.
- The capacity of a fire to cause damage.

  Fire intensity and the amount of time a fire burned within a particular area, among other possible factors, will influence fire severity.

Fire storm - Violent convection caused by a large continuous area of intense fire.

Fire suppression plan - A pre-determined strategic scheme or programme of activities which is formulated in order to safely and effectively accomplish fire suppression objectives. A fire suppression plan will outline the selection of tactics, selection of resources, resource assignments and how performance and safety will be monitored and maintained at a particular incident. Fire suppression plans need to be dynamic to take into account any changes in conditions or circumstances.

Fuel - Any material that can support combustion within a wildfire environment. Fuel is usually measured in tonnes per hectare.

Fuel-driven fire - A fire or part of a fire that is spread predominantly by the arrangement, condition, and/or other characteristics of the fuel within which it is burning. This situation occurs in the absence of a significant effect from the forces of alignment, such as wind, slope and aspect. Fuel-driven fires can produce erratic fire behaviour.

Fuel load - The amount of fuel present within a particular area. Fuel load is measured in weight per area measured (usually in kilograms per square metre). Fuel loading is expressed in relative terms as either “heavy fuel loading” or “light fuel loading”.

Fuel management - The process of managing fuel or fuel arrangement. The aim of fuel management is usually to create a discontinuity in fuels to achieve fragmentation.

Managed burn - A planned and supervised burn carried out for the purpose of removing fuel either as part of a land management exercise (a prescribed burn) or a Fire Suppression Plan (an operational burn).

Mitigation - A collective term used for those activities implemented prior to, during, or after a wildfire which are designed to reduce the actual or potential consequences of the wildfire. Mitigation measures can include efforts to educate governments, businesses and the general public on appropriate actions to take to reduce loss of life and property during wildfire incidents. The development of mitigation measures is often informed by lessons learned from prior incidents.

Prescribed burn - A planned and supervised burn carried out under specified environmental conditions to remove fuel from a predetermined area of land and at the time, intensity and rate of spread required to meet land management objectives.

Prevention - The act or process of reducing the occurrence and/or impact of wildfires.

Rate of spread - A measurement of the speed at which a fire moves across a landscape. Rate of spread is usually expressed in metres per hour.

Smouldering fire - A fire burning without flame and with minimal rate of spread.

Spotting - fire behaviour where sparks and hot burning embers are transported by the wind or convection column to land beyond the fire perimeter resulting in spot fires.

Appendix 5 – biographical notes

Wildfire impact, risk & mitigation workshop

Howard Davies
Howard is an accredited mediator, executive coach, and facilitator, with a passion for building collaboration and driving positive change. He has significant experience across the public and voluntary sectors with more than thirty years work in the environmental sector in senior leadership roles, both executive and non-executive. He now works in an advisory capacity for many organisations, coaches senior leaders in the environment and health sectors, and is closely involved in the work of the IUCN promoting global environmental accreditation. Howard has a degree in Natural Sciences with Biology, is a member of the IUCN's World Commission on Protected Areas, a Fellow of the Royal Geographical Society, and a Fellow of the Royal Society of Arts.

Richard Clarke
Richard is an environmental professional, executive coach and change management consultant with over thirty years' experience. He has worked with organisations, teams and individuals to enable environmental conservation and enhancement through strategic management, policy development and organisational management. He has represented National Parks and AONBs furthering their interests and supporting English and Welsh governments. He adopts the highest standards and has a wealth of knowledge. In recent years he has developed his expertise around encouraging behavioural change, developing personal awareness of others and coaching to enable better performance. He is a qualified ILM 7 Coach, and Lumina Spark practitioner guiding individuals and teams through coaching programmes and self-assessed psychometric profiling. In 2020 he was short-listed by the Association of Business Psychologists for their Workforce Experience Awards.

Lord Deben
Lord Deben has been Chairman of the Climate Change Committee since 2012. Lord Deben was the UK's longest-serving Secretary of State for the Environment (1993 to 1997). He has held several other high-level ministerial posts, including Secretary of State for Agriculture, Fisheries and Food (1989 to 1993). Lord Deben founded and chairs Sancroft, a corporate responsibility consultancy working with blue-chip companies around the world to help them improve their environmental, social and ethical impact, He is also chairman of Valpak Limited, and the Personal Investment Management and Financial Advice Association.

Teresa Dent CBE
Teresa joined Land and Estate Agents Strutt & Parker as a farming consultant. She was a partner with the firm for 13 years. She joined what was then The Game Conservancy and is now the Game & Wildlife Conservation Trust (GWCT) as Chief Executive at the end of 2001. More recently Teresa is working with farmers to bring Farmer Clusters together at catchment scale to achieve ambitious environmental outcomes and established a Natural Capital Advisory subsidiary for GWCT. Teresa is a Fellow of the Royal Agricultural Society of England, was a board member

of Natural England (the Government Agency for nature conservation in England) for 6 years until 2020, the first Chair of the Marlborough Downs Nature Improvement Area, is a director of the Environmental Farmers Group, a founder member of the Curlew Recovery Partnership, an honorary member of the National Gamekeepers Association and the Grasshoppers Farmer Group, and was awarded a CBE for services to wildlife conservation in the 2015 Queen's Birthday Honours List.

Morgan Varner
Morgan Varner is the Director of Fire Research at Tall Timbers. He coordinates Tall Timbers' local to international collaborations aimed at improving our understanding of fire behaviour and predictions of fire effects on plants and animals. Varner has a PhD in Interdisciplinary Ecology from the University of Florida School of Natural Resources & Environment, an M.S. in Forestry from Auburn University School of Forestry & Wildlife Sciences, and a B.S. in Forest Resources from the University of Idaho College of Forestry, Wildlife, & Range Sciences. From 2014-2016, Varner was the Chair of the Coalition of Prescribed Fire Councils, Inc. Varner came to Tall Timbers from the USDA Forest Service Pacific Northwest Research Station Seattle, Washington where he was Team Leader and Research Biological Scientist at the Pacific Wildland Fire Sciences Lab.

Marc Castellnou
Marc is a forest ecologist from University of Lleida (Spain, 1997) as well as a fire officer since 1999 in the Catalan Fire and Rescue Service. He serves in the Catalan Fire Service as a Strategic Wildfire Analyst and Incident Commander as well as being Chief of the GRAF (Specialist Wildfire Unit Catalonian FRS) type one crews. He is also a Wildfire Expert for the European Civil Protection and Humanitarian Aid Operations (DG ECHO). Marc is a leading wildfire expert who has gained extensive experience in wildland fire fighting across the globe. He has been a Senior expert for the European Forest institute from 2014, was awarded with Fire Safety award 2015 for the IAWF in Boise, USA, awarded the Montero Burgos prize for forest issues communication through media, Madrid 2017, and has been an associated professor at University of Lleida, Master Fuego since 2015.

Professor Claire Belcher
Claire is a fire ecologist specialising in understanding the flammability of vegetation and the impact of fire on ecosystems and planetary health. She is Director of the University of Exeter wildFIRE Lab. She is currently part of two large multi-million pound funded research teams working towards building a UK Fire Danger Rating System and one looking at the effects of management fires on ecosystems and biodiversity (IDEAL UK Fire).

Paul Hedley
Paul held the interim chairmanship of the England and Wales Wildfire Forum from February 2009 until December 2010. In August 2011, Paul established the NFCC (then CFOA) Wildfire Group in order to raise the awareness across the FRS sector of the risks and dangers of Wildfire incidents within the UK and improve FRS wildfire pre-planning, prevention and response. He co-authored the Scottish Government's Wildfire Operational Guidance (published in October 2013) which was the first wildfire guidance specifically developed for UK FRS, and he was a member of

the Project Board which oversaw the development of the National Operational Guidance (NOG) - Wildfire Guidance published in April 2016.