Forestry Commission

Forestry Commission

Adaptation Reporting Power:

Third round report

January 2022

Key Points

Climate change is increasingly putting our irreplaceable woodland resource at risk if we don't act. The Forestry Commission, building on evidence developed over the past 20 years has published guidance and established an outreach programme, including using the nation's forests managed by Forestry England as an exemplar. However, there is little evidence of the implementation of adaption elsewhere and unless there is a step-change in planning for the future, in the stock used for new planting and re-stocking and in approaches to management, there is a real danger that our woodlands will not provide the goods and services that future society will require and expect of them.

- Significant progress has been made under the second adaptation programme in some areas, such as outreach and guidance, filling evidence gaps, addressing uncertainty through targeted research and Forestry England has agreed a formal organisational 'Approach Statement' to resilience.
- The British Woodlands Survey continues to prove its value as a way of assessing the sector's actions and perceptions around adaptation; it is clear that, although understanding the need to adapt has increased over the past five years, there is still a significant adaptation gap placing England's woodlands at risk.
- High level actions under the 2022-2026 adaptation programme include the development of a Woodland Resilience Implementation Plan (FC), developing a Forest Resilience Strategy (Forestry England), and launching a Resilience Implementation Framework (FR).
- To date, adaptation has been incorporated into our grants and regulations as 'soft' or voluntary 'considerations'; a more robust approach may need to be developed to address the adaptation gap that has become apparent.
- Real opportunities lie ahead for embedding resilience in sustainable forest management through widespread interest in the 'tree agenda', in particular through funding for new planting provided by the Nature for Climate Fund, the review of the UK Forestry Standard, the new Environmental Land Management Schemes, the third National Adaptation Programme and as a result of the scale of the Nation's Forests as an exemplar of best practice.
- Challenges to FC implementing the programme of actions set out in this report include:
  - there is complacency in the sector because the more serious impacts of climate change are yet to be experienced by many
  - uncertainty and a lack of clear and agreed guidance around proactively implementing adaptation actions
  - a lack of appropriate planting stock
  - a lack of recognition that different approaches to adaptation are appropriate for different management objectives and woodland types
  - the need for the sector to speak with one voice on the need to adapt and to put different management objectives aside
  - balancing the nature conservation needs of protecting what we have with the need to ensure that our ancient and semi-natural woodlands can withstand the future climate.

Summary

Introduction to the review

The Forestry Commission (FC) is the non-ministerial Government department responsible for advising on and implementing forestry policy. The Commission administers grants for expanding and managing forests and regulates tree felling. It also provides advice to Ministers, undertakes and commissions research, sets standards for good forestry practice and protects Britain's forests from pests and diseases. Through its agency, Forestry England, it manages the nation's forests which amount to approximately 253,000 ha of which 212,000 hectares is woodland, equivalent to 16% of the country's woodland cover.

The Forestry Commission is not a statutory undertaker but was invited to prepare a voluntary assessment of the risks that climate change presented to its activities and functions under the terms of the Climate Change Act (2008), which was published in 2012. This report reviews progress on actions set out in the 2nd round report (ARP2) published in 2017 and presents new actions that have arisen following this review.

Working across the Defra-group

Forestry Commission continues to work closely with the Department for the Environment, Food and Rural Affairs (Defra) and its 'arms length bodies' on adaptation-related issues through:

- Supporting the development of the second and third National Adaptation Programmes (NAPs), including through the NAP Biodiversity and Ecosystems NAP Working Group, and providing input to NAP reporting and responses to Climate Change Committee (CCC) progress reports.
- Contributing to Natural England's (NE) Climate Change Adaptation Manual and Carbon Sequestration and Storage by Habitat report.
- Engaging, alongside Defra and NE, with the Forestry Climate Change Partnership, with FC now providing secretariat support.
- Supporting Defra/Environment Agency (EA) flood resilience and water quality (thermal regime of freshwater habitats) objectives through targeting Countryside Stewardship and England Woodland Creation Offer woodland creation grants using EA-derived spatial data.
- Developing and publishing, with EA, guidance on Assessing the Potential Hazards of using Leaky Woody Structures for Natural Flood Management;
- Partnering NE, EA, Kew Science and the Department for Business, Energy and Industrial Strategy (BEIS) in the Shared Outcomes Fund project 'Nature-based Solutions at Landscape Scale'.
- Implementing the actions set out in the England Trees Action Plan.

However, there are tensions balancing the needs for nature recovery in native woods with safeguarding the resilience of our wider woodland resource and the multiple goods and services it provides, including some requiring that productivity is maintained.

Understanding Climate Risk

Our understanding of the science of climate change and how it will affect forestry in England has continued to develop since ARP2. The following developments will help inform the management and creation of woodland that is adapted to climate change:

- The Ecological Site Classification decision support tool for tree species selection has been revised by: (a) extending support for decision-making to 62 tree species; (b) now including National Vegetation Classification (NVC) suitability maps for all woodland types (W1-W18); (c) amending the Soil Nutrient Regime (SNR) map to amend the treatment of calcareous brown earth soils.
- A tool for Forest Development Types (FDT) has been developed to help practitioners to use FDTs in diversifying their woodlands to enhance resilience to climate change and other threats.
- In 2020 FR launched a Climate Matching Tool which gives land managers an accessible method to visualise the projected future climate, by suggesting similar 'analogue areas' in the current climate. The tool may also be used to support the sourcing of appropriate, more southerly provenances, for tree planting and restocking.
- FR published a report on *Genetic considerations for provenance choice of native trees under climate change in England*, supported by a policy advice note, setting out the evidence supporting when the planting of more southerly provenances of native tree species is likely to confer enhanced resilience.

Review of key risks

The priority risks identified in ARP2 have been reviewed and all are considered still to be relevant to FC's three main areas of activity: (a) Impact on woodland and forest management in the nation's forests (and wider woodland resource); (b) Impact on Forest Services' ability to facilitate adaptation in private sector woodlands; (c) Impact on business and corporate activities. A commentary is provided on how the priority risks identified in ARP2 affect these three principal activities.

Identification of key risks

The following key risks were identified in the 2017 Climate Change Risk Assessment:

- Pest and disease outbreaks – Damage to trees and woodlands is likely to increase from pests and pathogens and from windstorms and droughts. Pest and pathogen damage is likely to increase because of more suitable conditions for their spread, including more environmental stresses that will make trees more susceptible, and because of new introductions. Effective monitoring, control and risk-reduction measures are essential.
- Lack of species diversity – The limited diversity of tree species planted during the expansion of UK forests in the past 60 to 80 years is an area for concern. Measures to diversify the species grown should reduce these risks and increase woodland functional resilience. However, the rate at which this can be achieved is very low and is particularly problematic in broadleaved woodlands.

- Wildfire - Risk of wildfire damage will increase in southern and eastern Britain, particularly in south-east England, because of higher temperatures, drier conditions and the mosaic of fire-prone land covers, high population density and critical infrastructure. Measures to reduce wildfire risk and damage through open habitat management and contingency planning will be of key importance.

In 2021 the Independent Assessment of UK Climate Risk Advice to Government for the UK's third Climate Change Risk Assessment (CCRA3) was published. The Climate Change Act (2008) requires that the Climate Change Committee provides advice on the CCRA to the UK Government six months before the Government's UK CCRA is laid in Parliament, with the third CCRA due in early 2022.

This assessment identified the following risks relevant to forestry, that should be the government's priority for the next five years:

- Risks to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazards.
- Risks to natural carbon stores and sequestration from multiple hazards leading to increased emissions.
- Risks to crops, livestock and commercial trees from multiple hazards.

Review of second round report *Outline Adaptation Plan*

Progress on actions outlined in the ARP2 'Outline Action Plan' is set out below:

- Organisational structure and governance: FC published a Climate Change position statement in 2019, setting out broad programmes of action. The Incident Management Team's (IMT) ability to respond to serious events, including wildfire, windstorm and pest and disease outbreaks is now well embedded into the management structure of FC.
- Recent corporate actions by Forestry England to support adaptation include: (a) the establishment of a Forest Resilience Steering Group to provide organisational oversight and strategic direction; (b) the creation of a new role in the National Operations team (Natural Capital and Resilience Programme Manager) to lead on and drive forward Forestry England's national approach; (c) a formal 'Approach Statement' for forest resilience has been agreed alongside a strategic Risk Register which outlines threats to, and consequences for, the nation's forests, and mitigating actions that need to be taken at both local and national scales; (d) a new forest resilience strategy is being developed to bring together and develop these existing documents; (e) Forestry England's 'Growing the Future: 2021-26' plan includes actions for a sustainable approach to managing the nation's forests and addressing climate change. Forestry England has also committed to reach net-zero operational greenhouse gas emissions by 2030.
- Filling gaps in evidence and addressing uncertainty: There was a strong focus on Climate Change in the seven research programmes that were developed from the 2014 Science and Innovation Strategy (SIS) for Forestry in Great Britain, with 3 devoted to different aspects of resilience. The current SIS was published in October 2020 and provides a framework for forestry-related scientific research and three of the work programmes will support adaptation.

- Outreach and Guidance: Forest Services' outreach work continues, including the publication of '*Managing England's woodlands in a climate change emergency'*, United Kingdom Forestry Standard (UKFS) training on Climate Change and support for the 2020 British Woodlands Survey. The support of the Forestry Climate Change Partnership (previously known as and the Forestry and Climate Change Working Group) continues and in 2021 Forest Services extended this to include a secretariat function.
- Embedding adaptation in forestry regulations and grants: No specific changes to forestry regulations have been instigated to address climate change adaptation, but resilience and adaptation principles were considered during the further development of the Countryside Stewardship woodland grants, including the requirement to assess both current and future species suitability when selecting planting stock. There have been some changes to the mapping layers showing sensitivities to woodland creation which impacts on the Environmental Impact Assessment (EIA) process. The England Woodland Creation Offer (EWCO) has been launched during this period and represents an improved offer for woodland creation, with climate resilience recognised through the scoring framework. Furthermore, additional payments are available for delivering specific public goods relevant to adaptation, including flood resilience and the provision of riparian shade. We have also administered the Woods into Management Forestry Innovation Funds to bring woods into management, particularly when affected by plant health issues.
- Adaptation indicator development: A number of Key Performance Indicators (KPI) have been identified as relevant to resilience and climate change adaptation, including: (a) Proportion of England's woodland area in management; (b) Number of tree pests and diseases established in England in the past 10 years; (c) Number of high priority forest pests in the UK Plant Health Risk Register; (d) Measure of woodland resilience to climate change based on the size and spatial configuration of woodland patches within the landscape. A number of other indicators have been developed since ARP2, including a measure of woodland ecological condition in England using information from the National Forest Inventory.

New actions arising from the review

The new adaptation programme 2022-2026 incorporates ongoing actions from the ARP2 programme, three new high level actions arising from this review and a suite of actions set out in the England Trees Action Plan published in May 2021, which FC (including Forestry England and Forest Research) are either leading on, or contributing to. The key work streams and actions are set out below:

Development of a Woodland Resilience Implementation Plan (WRIP): including a Review of the Keepers Of Time (KOT) policy and the definition of long established woodlands and with links to a national deer management strategy and an update of the grey squirrel action plan. Other actions that will fall under the umbrella of the WRIP programme are:

- Agreeing a definition for new native woodland to support the planting of woodlands likely to be resilient to climate change.
- Agreeing a list of naturalised and 'advancing native species' with Natural England and the wider Defra Group.
- Consider defining a new category of *Recent Native Woodland*, in which naturalised, advancing and exotic species can be introduced to enhance resilience, working within the definition of new native woodland.

Enhancing forest biosecurity and addressing interactions with climate change by contributing to:

- A new Plant Biosecurity Strategy for Great Britain.
- Introducing a condition for all tree and hedgerow planting grants that tree and plant suppliers should be able to demonstrate that they can meet the requirements set out in the published Plant Health Management Standard.
- Introducing procurement criteria for government contracts that tree and plant suppliers should be able to demonstrate that they can meet the requirements of the Plant Health Management Standard.
- Supporting and promoting the UK Plant Healthy scheme encouraging more growers to become members.
- The Nature for Climate Fund Sector Capacity Project aims to enhance the quality and diversity of UK produced trees reducing the reliance on imported stock. This includes research and development grants (Tree Production Innovation Fund), capital grant support and increasing post-planting inspection capacity.

Enhancing the presence of climate change adaptation in forestry grants and regulations by:

- Contributing to the ongoing review of the UK Forestry Standard and strengthening adaptation requirements.
- FR publishing a UK Forestry Standard (UKFS) practice guide on adapting forest and woodland management for the changing climate.
- Updating woodland management and creation plan templates to better reflect adaptation requirements.
- Working with Defra to embed the guidance given in '*managing England's woodlands in a climate emergency*' and wider adaptation guidance in Environmental Land Management scheme design.
- Working with Defra to consider climate change adaptation in revisions to Felling Licence Regulations.
- Working with FR and Defra to develop an approach for forestry grants and regulations that supports species diversification and climate adaptation using lesser used or novel species while minimising the risk of non-native species becoming invasive or introducing new pests and diseases.

Enhancing science, evidence and knowledge sharing:

- Contributing to the Centre for Forest Protection through FR collaborating with Kew and Defra.
- Leading the UK's membership of the European Forest Genetic Resources Programme (EUFORGEN) to promote the conservation and sustainable use of forest genetic resources in Europe.
- Forest Research launching a Resilience Implementation Framework, and upgrading its climate change communication offer, including adaptation guidance. FR is also making continual improvements to the ESC decision support system employing UKCP18 climate projections to replace UKCP09 projections and providing revisions to species models.
- Ensuring that climate change impacts and adaptation remain at the heart of the Science and Innovation Strategy for Forestry in Britain (SIS), supporting the development and communication of evidence-based practical guidance.
- Sector engagement on climate change will also be enhanced through a new digital woodland creation campaign, to be launched in 2022.
- Providing secretariat support and direction for the Forestry Climate Change Partnership to engage the sector and promote adaptation.
- Working with Defra on a digital forest resilience communications campaign.
- Delivering nationally accredited training on wildfire resilience to help promote good practice and create a framework for further wildfire resilience. Creating a Wildfire Risk Map to enhance resilience to wildfire.

Forestry England's Forest Resilience Strategy: This includes specific and measurable actions and targets to demonstrate leadership and best practice in the nation's forests. This will be complemented by a forest resilience indicator to monitor the status and condition of the nation's forests.

Resilient woodland creation: Woodland creation also offers opportunities for adaptation through (a) expanding the size and therefore resilience of the woodland resource; (b) linking and providing stepping-stones between our ancient and semi-natural woodland to help wildlife move adaptively; and (c) providing the opportunity to design and plant new woodlands with proactive adaptation at their heart.

The £640 million Nature for Climate Fund was announced in 2020 of which the intention is to spend at least £500 million on woodland creation. This funding has been enhanced with an additional £124 million announced in the Net Zero Strategy. FC is playing an important role in advice/promotion and the regulation of woodland creation alongside delivery through administering woodland creation grant schemes:

- England Woodland Creation Offer
- Urban Tree Challenge Fund
- Local Authority Treescapes Fund
- Woodland Creation Planning Grant
- Forestry England's Woodland Partnership

Evaluation of barriers and interdependencies

A number of barriers to adaptation have been identified, in part through the British Woodlands Resilience Survey 2015, and highlighted again in the British Woodlands Survey (BWS) 2020 and can be summarised as:

- Lack of woodland management – concerns over vertebrate pests highlights the impact that deer and squirrels have on limiting positive management.
- Lack of clarity on adaptation measures – the range of awareness and action reflects the current lack of clarity on best practice, and points further to the importance in updating the UK Forestry Standard as a priority.
- Lack of knowledge sharing practice – most respondents did not collaborate other than to share knowledge and information, with wide divergence in activity.
- Lack of diversity in new tree planting.

Although the barriers remain the same as those reported in ARP2, the confidence to deal with these barriers is increasing. The 2020 survey showed a greater awareness of environmental change than in 2015.

There is still a need for the better provision and explanation of guidance to the private sector to continue to address the barriers that have been identified, alongside a clearer articulation of FC's approach to adaptation providing granularity for different woodland types and management objectives. The divergence of the wider forestry sector in addressing adaptation has become apparent over the past five years, with resistance to proactive adaptation and assisted migration from some where nature conservation is the principal objective, even when applied solely to production forestry.

Monitoring and evaluation

Climate change adaptation has been embedded across the organisation as business as usual, rather than as a bespoke activity. Where adaptation is treated as a specific activity, evaluation mechanisms are outlined below:

- Forestry England has built on its 2011 Climate Change Action Plan in a number of ways, including developing a strategic Risk Register for threats to the nation's forests, establishment of both a Forest Resilience Steering Group and Network Group and creation of an organisational *Approach Statement*.
- Sector resilience outreach activity: The effectiveness of FC's guidance and outreach programme will continue to be assessed against a baseline set by the 2015 British Woodlands' Resilience Survey and then carried through the 2020 British Woodlands Survey (BWS). The timing of the next BWS is unknown.
- Woodland creation: The monitoring and evaluation programme for the Nature for Climate Fund (NCF) will look across the new woodlands created through all the NCF delivery mechanisms.
- Woodland condition: The National Forest Inventory's (NFI's) Woodland Condition Indicator, published in 2021, provides a baseline to report changing woodland condition against, alongside specific components of the indicator that will continue to be monitored through NFI field survey.

Benefits and opportunities

Implementation of adaptation measures has had synergies with three other programmes of work:

- Species diversification in response to recent plant health concerns has been strengthened by initiatives to increase species diversity as an adaptation measure, both in the nation's forests and in private woodlands.
- Opportunities for woodland creation and in-forest measures in existing woodlands, originally identified in the ARP1 report as an adaptation measure, continue to be as relevant today. This has put FC in a good position to facilitate long-term solutions to enhance flood resilience.
- Successful adaptation is crucial to maintaining woodland carbon stocks and sinks as the forestry sector's important contribution to meeting future carbon budgets and achieving net zero, as set out in the Net Zero Strategy.

Current Government and wider public support for tree planting, together with recent wall-to-wall coverage of climate change issues through the UK hosting the 26th UNFCCC Conference of the Parties in Glasgow, provides an unrivalled opportunity to take forward implementation of adaptation measures in the forestry sector. The key opportunities to embed the implementation of adaptation measures are:

- Tree planting programmes, including those supported by the Nature for Climate Fund.
- Domestic rural policy development, particularly the new Environmental Land Management schemes.
- Implementation of the 90 actions set out in the England Trees Action Plan.
- Debate over 'nature-based solutions' and, at a practical level, FC's contribution to the *Nature-based Solutions at Landscape Scale* project.
- The third National Adaptation Programme.
- The scale of the Nation's Forests to provide an exemplar of resilience, in combination with Forestry England's experience and Forest Research's expertise.

Key challenges

The challenges that the programme set out in this report needs to address are:

- The uncertainty associated with implementing adaptive actions in advance of the full effects of climate change being realised.
- Clear communication that different approaches to adaptation are appropriate for different management objectives.
- Drawing the forestry sector together so that it speaks with one voice on the need to adapt, putting different management objectives aside.
- Ensuring that sufficient, appropriate, planting stock is available to support the ambitious planting programmes.
- Balancing the nature conservation needs of protecting what we have with the need to ensure that our ancient and semi-natural woodlands can with-stand the future climate.

Forestry Commission: ARP third round report

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1. Introduction

1.1 Forestry Commission and the Adaptation Reporting Power

The Forestry Commission (FC) was invited to prepare a Climate Change Risk Assessment under the Adaptation Reporting Powers of the Climate Change Act (2008), in the first round of reporting. The report was published in March 2012. Although FC is not a priority reporting organisation or statutory undertaker, it was invited to report as: '*England's woodlands are important national assets which are both vulnerable to climate change and have a valuable role in helping people adapt to its effects*'. In common with other first round reporting organisations, FC was invited to prepare a second-round report (ARP2), setting out progress on actions and assessment of risk, which was published in 2017. This current review (ARP3) reports on progress on actions from the ARP2 outline adaptation programme and sets out a new programme of actions to carry forward into the next reporting period (2022-2026).

1.2 Forestry Commission's role

1.2.1 The Forestry Commission

The Forestry Commission (FC) is the non-ministerial Government department responsible for advising on, and implementing, forestry policy in England. Forestry is a devolved matter and the Commission reports to the Secretary of State for Environment, Food and Rural Affairs (Defra).

1.2.2 Forestry policy in England

Strategic forestry policy in England is the responsibility of Defra. The Government's long-term vision for the treescape it wants to see in England by 2050 and beyond is set out in the 2021 England Trees Action Plan (ETAP); this was developed in response to the England Tree Strategy consultation. A list of relevant policy documents that have been published since ARP2 is given at Annex 7.

1.2.3 FC's strategic objectives

FC is tasked with working with a wide range of partners — other government bodies, private sector businesses, charities and civil society organisations — to deliver the functions and priorities set out in Defra's Single Departmental Plan and the England Trees Action Plan (2021-2024) which reflect the role that England's trees, woods and forests have in delivering the priorities as set out. FC works to increase the value of woodlands to society and the environment to achieve the following objectives:

- Protecting our trees, woods and forests from increasing threats such as pests, diseases and climate change
- Improving our woodland assets, making them more resilient to threats and increasing their contribution to economic growth, people's lives and nature

- Expanding our woodland resources to increase their economic, social and environmental value

Key functions include carrying out statutory regulatory functions (for example in relation to tree felling, plant health and Environmental Impact Assessment), managing the nation's forests, administering grant schemes, and providing expert advice (both nationally and locally). Urban trees and woodland are covered by the United Kingdom Forestry Standard (UKFS) and are within FC's remit.

1.2.4 Forest Services

FS's mission is to expand, protect, improve and connect England's trees, woodlands and forests; to deliver its vision of more and better protected trees and woodlands that deliver more for society, the climate, nature and a greener economy – for today and for future generations. It does so by providing a service to society based on evidence-based standards, expert advice, communications, partnerships, grants and regulation. Through this service, Forest Services aims to empower and motivate landowners and managers, businesses, civil society organisations and local communities to deliver its mission and vision. A key performance indicator framework has been developed outlining the intended impact of delivery, focusing on the strategic objectives outlined in section 1.2.3.

Under the Grants and Regulations functions of Forest Services, FC currently issues over 3,000 felling licences each year and has more than 10,000 active grant schemes. These grant schemes were mainly funded by the Rural Development Programme for England, in recent years, primarily the Countryside Stewardship Grant Scheme (CS). The England Woodland Creation Offer (EWCO) was launched in June 2021 and is one of a number of woodland creation delivery mechanisms funded by the £640 million Nature for Climate Fund. The good design of new woodlands is also supported by the Woodland Creation Planning Grant and our team of Woodland Creation Officers. FS is also responsible for supporting economic activity in the forestry sector through co-delivery of the Woods into Management Forestry Innovation Funds. FS also administers the Tree Production Innovation Fund, supporting nurseries to increase and diversify domestic tree supply. Forest Services also provides policy support, including national-level engagement and empowerment, through its Policy Advice Team, alongside.

The Plant Health Forestry team is also part of Forest Services and aims to prevent entry, provide early detection, and minimise impacts of harmful tree pests and diseases, and to ensure traceability of forestry planting material under the Forest Reproductive Material (FRM) regulations. The PHF is geographically dispersed with teams based in Edinburgh, Bristol and London, and individuals based in a variety of other locations in England and Wales, providing a service across Great Britain, including port inspections.

1.2.5 Forestry England

Forestry England manages the nation's forests on behalf of the Secretary of State. The estate covers 253,000 ha of land (2% of the total land area of England) including 212,000 ha of wooded habitat (16% of England's woodland). The nation's forests have over 68,000 ha of Sites of Special Scientific Interest (of which 98% are in favourable or

recovering condition). All the forests and woodlands are independently certified as sustainably managed (to both the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) standards). The nation's forests are also the largest outdoor recreation provider (an estimated 296 million visits in 2020-21) and timber supplier (approximately 1.4 million m^3 timber harvested per year) in England. Forestry England is the country's largest land manager, employing around 1000 people.

1.2.6 Forest Research

Forest Research (FR) is the research agency of the Forestry Commission and Great Britain's principal organisation for forestry and tree-related research. FR is internationally renowned for the provision of science, research, evidence, data and services in support of sustainable forestry. FR's vision is to be a world leader in applied forest science and a trusted and recognised provider of expertise, data, products and services for government and the tree, wood, forest and natural resources sectors.

1.3 Governance and organisational structure

1.3.1 Cross-border level Governance

Since the previous report (ARP2) there have been further fundamental changes to the governance around forestry, with the completion of devolution of forestry in Scotland (Forestry Commission Wales merged with other agencies to become National Resources Wales in 2013) in April 2019, when Forestry Commission Scotland was split into two separate bodies: Forestry and Land Scotland, which manages and promotes the national forest estate in Scotland, and Scottish Forestry, which is responsible for regulation and policymaking. Publicly owned forests in England (the nation's forests) remain the responsibility of the Forestry Commission, through its Agency, Forestry England.

1.3.2 Governance in England

The Forestry Commission is headed by the Board of Commissioners which consists of a chair and up to ten other members appointed by Her Majesty the Queen. The Commissioners, through administrative action, have delegated relevant and appropriate functions to the sub-boards of the delivery arms of the Forestry Commission namely Forestry England, Forest Services and Forest Research. Officials from Defra and the Devolved Administrations act as members of the sub-boards where appropriate. Overall responsibility, however, remains with the Board of Commissioners. In addition, the Forestry Commission Executive Board draws upon the executive leadership of all parts of the Forestry Commission to take strategic decisions on common issues.

The Board of Commissioners has also established a Forestry England and Forest Services Audit and Risk Assurance Committee (ARAC) to support it in assuring itself of the effectiveness of the internal control, governance and risk management framework.

2 Understanding climate risk

2.1 Changes in science and projected impacts

Tree species selection and future performance

During the reporting period covered by this review, the Ecological Site Classification (ESC) decision support system for tree species selection has been revised to: (a) support decision-making for 62 tree species; (b) include NVC (National Vegetation Classification) suitability maps for all woodland types (W1-W18), and; (c) amend the Soil Nutrient Regime (SNR) of calcareous brown earth soils, as this was limiting the number of suitable species options on many sites, which was not consistent with observed performance.

Forest Research plan to make updates to the ESC4 decision support system to incorporate new climate data (UKCP18). A tool for Forest Development Types (FDT) was added to the system in 2021 to help practitioners to use FDTs in diversifying their woodlands to enhance resilience to climate change and other threats. Forest Development Types are management concepts that demonstrate how species composition and stand structure are expected to develop over time. The FDTs promote the use of species mixtures and structural diversity within stands, and also encourage the use of site adapted species and natural regeneration.

Forest Research has reported that ESC is widely used across the forestry sector to support decisions over species choice, including future suitability and resilience to climate change. A number of private sector and academic groups are developing their own tools building on the ESC model which include integrating ESC into an ammonia capture woodland design tool on farms, identifying where trees are planted as shelter belts could optimally perform this function. A flood alleviation woodland design tool has also been developed based on ESC and the Woodland Carbon Code (WCC) carbon look-up tables.

A user study has recently been conducted by FR, where the social science group is compiling a report on feedback from the ESC user community. This study aims to help form an opinion on requirements for the development of the next version of the ESC system and will allow FR to develop a formal ESC user group.

Funding became available in 2021 to enable FR to generate new ESC maps for all species within the 2050 and 2080 climate scenarios based on UKCP18 climate projections. As part of this work FR has introduced *Eucalyptus glaucescens* into ESC to represent Short Rotation Forestry (SRF), and willow to represent Short Rotation Coppice (SRC). FR will also present winter cold maps for three broad categories of eucalyptus species in respect of cold tolerance. FR proposes further species to be introduced to ESC during phase 2 of the project.

FR published a report on *Genetic considerations for provenance choice of native trees under climate change in England*, supported by a policy advice note, setting out the evidence supporting when the planting of more southerly provenances of native tree species is likely to confer enhanced resilience.

In 2020 Forest Research launched a Climate Matching Tool (see Annex 5), developed by Forest Research and the Forestry Commission. The climate matching tools gives land managers an accessible method to visualise the projected future climate, by suggesting similar 'analogue areas' in the current climate. The results can be used to help with forestry or other crop species choice, and in devising resilient land management systems. It will help practitioners begin to plan adaptation responses to climate change. The tool can also be used to support the sourcing of appropriate, more southerly provenances, for new planting and restocking.

Forest research has also published a series of Climate Change Factsheets:

- Climate change and tree diseases
- Climate change and diseases of tree foliage
- Climate change and ecosystem services
- Climate change and human behaviour
- Climate change and forests
- Peatlands, forestry and climate change
- Climate change and biodiversity
- Climate change, flooding and forests

Link between climate and pest and disease outbreaks

Our understanding of the link between climate and pest and disease outbreaks continues to advance, particularly the pivotal role of climate-induced stress increasing the propensity for serious outbreaks. The knowledge of climate limitations on specific forest pests, diseases and syndromes has also continued to improve, including for acute and chronic oak decline and ash dieback. There will be different impacts of changing climate on different pest/host combinations.

Evidence from other countries

Evidence from other countries, particularly France and North America, has improved our knowledge of the likely impacts of climate change on forestry in Britain and provided examples of intervention that is deemed necessary to address the risks associated with climate change. The concept of 'Climate Smart Forestry', developed in North America and Europe is receiving wider promotion in England and featured at the 2021 Institute of Chartered Foresters (ICF) national conference. Assisted migration (both of better adapted species and genetics) and improved stand management (thinning to reduce water use and the impacts of drought) are topics where scientific understanding has improved. The UK is maintaining its membership of EUFORGEN (European Forest Genetic Resources Programme), with FC playing the role of national coordinator. The Forest Research Climate Matching Tool (see above) helps practitioners visualise the future climate by matching this to current climate analogues across Europe.

Role of forestry in flood risk management

The Working with Natural Processes (WwNP) Evidence Directory, published by the Environment Agency (EA) in 2017, catalogues the evidence supporting the role of woodland planting and other interventions in Natural Flood Management (NFM). EA's

NFM Programme built on this learning and plans to review the Evidence Directory in 2022. The Natural Flood Management (NFM) Programme sponsored by Defra and managed by the Environment Agency after the devastating effects of Storm Desmond in 2015, has planted more than 100 hectares of woodland to improve the resilience of communities to the risks of flooding. FR, FC and EA also published guidance on Assessing the Potential Hazards of using Leaky Woody Structures for Natural Flood Management, helping to support the installation of appropriate structures in appropriate locations and providing a framework for risk management.

The principle of developing opportunity maps for where woodland creation could help to reduce the risks of flooding, and improve community resilience to it, has been further developed in the targeting of grants available in the England Woodland Creation Offer (EWCO). This information was developed with the Environment Agency to ensure that the catchments of highest priority (from a flood risk point of view) were the ones that received the most priority for woodland creation. Additional payments for providing woodland in these areas is available in addition to grants that cover the capital costs of woodland creation.

2.2 Review of risks assessed in the second-round report

The key risks assessed in ARP2 are set out below. A brief commentary is provided for each. Following review, all are assessed as continuing to be highly relevant. Further detail is provided in Section 2.3 for those that are seen as representing the priority risks that need to be addressed.

2.2.1 Impact on woodland and forest management in the nation's forests and wider woodland resource

Extremes of summer drought and temperature will be beyond conditions that some species in some locations are capable of withstanding.

- Still considered a priority risk, but incorporation of UKCP09 projections and updated suitability models in ESC indicate that future species suitability may be less severely impacted than previously assessed.
- The dry spring and summer of 2018 led to major losses of trees planted the previous planting season. Forestry Commission released additional funds under the EPREC (Extraordinary Payments Received in Exceptional Circumstances) to fund the replacement of trees, where *force majeure* was claimed.
- Particularly in the context of tree health, addressing limited species diversity has emerged as a critical adaptation gap.
- FR continue to process climate data to incorporate UKCP18 into ESC.

Insufficient genetic diversity and 'conservative' provenance selection provides limited resilience and capacity to adapt to climate change.

- The lack of consensus across the sector and availability of planting stock continues to hamper progress in this area.

Silvicultural systems have developed and although Continuous Cover Forestry (CCF) is becoming more common, silvicultural systems predominantly based on single species, clear-fell, models have limited resilience to climate change and are current biosecurity concerns.

- The lack of experience in managing these systems and absence of incentives to promote stand transformation continues to limit changes to silvicultural systems.

The distribution of timber species may be inappropriate to the changing climate, resulting in risk to future productivity and consequent maintenance of UK Woodland Assurance Standard (UKWAS) certification in relation to Forestry England; in the absence of adaptation, this remains a key concern.

- Forestry England's Forest Resilience Strategy will address these concerns, while a broader range of species has been planted in the nation's forests over the past five years.

Changing climatic conditions will favour some non-native invasive species presenting risks to woodland biodiversity and increasing management costs if woodland Site of Special Scientific Interest (SSSIs) are to be maintained in good condition.

- Grey squirrels continue to threaten sustainable woodland management and limit the viability of growing broadleaved trees. The Good Nature trap has perhaps not been the panacea that it was hoped for controlling grey squirrels.
- Species diversification using species that have not been widely planted in England and for which there is a lack of evidence of their performance and environmental impact is a potential risk. FC has worked with FR to develop a framework for screening lesser-used species included in EWCO woodland creation grant applications.

Trees under (climatic) stress at greater risk to insect pests and tree disease outbreaks, coupled to changing climatic conditions more favourable to some insects and pathogens.

- Further evidence has emerged on the link between climatic stress and forest pest and disease outbreaks.

Present risk of wildfire incidents and future increases in likelihood and severity, particularly with increasing areas of open habitat management.

- Wildfire remains on the government's National Risk Assessment and Register as well as wildfire assessment, planning and advice being included on many Local Resilience Forums' Community Risk Registers and Fire and Rescue Services' Integrated Risk Management Plans.
- Wildfire has been defined as a priority risk by Forestry England for the nation's forests and in Natural England's and the Chief Fire Officers' Association Adaptation Reporting Power reports.
- Practical training around the role of forest planning and in firefighting methods themselves have been developed by FC.

Inability of the National Arboreta to maintain current collections.

- Little can be done to address the threat to current established collections besides management to maintain good health of the trees, but the arboreta are using the climate matching tool to source future accessions.

In the absence of management, larger populations of deer and squirrels benefitting from milder winters.

- Unsustainable populations of deer and grey squirrels remain a major threat to regeneration, woodland creation, woodland management and ecosystem services and will continue to do so for the foreseeable future.
- The risk was highlighted in the England Trees Action Plan, with actions involving FC set out to address the management of populations of deer and Squirrels.

Inability of nurseries to source appropriate seed (due to climate, biosecurity and trade restrictions) and supply changing requests (species and provenance) for planting material in the necessary timeframe.

- Conflicts between different management objectives has led to an absence of clear guidance; there has therefore been little demand for more southerly provenances with few nurseries stocking significant quantities of 'adapted planting stock'.
- Remains a key risk linked to species diversity and genetic adaptation.

2.2.2 Impact on Forest Services' ability to facilitate adaptation in private sector woodlands

The majority of the priority risks outlined in Section 2.2.1 also apply to England's wider woodland resource and will affect the ability of FC to carry out some of its functions, particularly the ability to enhance the resilience of woodlands. Specific risks identified in ARP2 were:

FC's advice to woodland owners may not be appropriate to the future climate, with a consequent decline in woodland condition, productivity and economic resilience of the forestry sector, possible.

- A key risk with FC's interventionist approach coming under challenge from some quarters. The risk is being addressed through being clear that different actions are required to meet different management objectives and by using expert advice from Forest Research as the foundation for guidance. The employment of Woodland Resilience Officers and Woodland Creation Officers has assisted in distributing bespoke advice to landowners, while the Forestry Climate Change Partnership provides an appropriate forum to develop a joined-up approach to communications.

FC's advice on planting mixtures may not be 'climate-proofed', leading to a lack of resilience in the woodland resource and poor return on public funding of woodland creation (through Countryside Stewardship or the Carbon Fund).

- A requirement to consider current and future performance using ESC is a requirement of the Countryside Stewardship woodland creation grant and the

English Woodland Creation Offer, but uncertainty in the future climate means that this remains a risk. The production of guidance on the use of planting mixtures is a priority for 2022.

- Poor consideration and selection of planting stock could lead to excessive losses of newly planted trees to drought and how this will be monitored and what impact that will have on national tree planting targets are unknown. Current debate over the use of plastic tree shelters (and vole guards) may result in a decline in their use or a premature switch to alternative materials that have not been fully tested, leading to poor establishment.

The need to maintain/increase food production, in part as a result of global climate change, may limit the ability of FC to facilitate a step change in the rate of new woodland planting. Land availability may be further restricted by the need to maintain water resources in areas of low (and declining) rainfall and targets for wildlife-rich habitat creation and restoration.

- Increasing woodland creation rates in line with the aspirations set out in the England Trees Action Plan 2021 - 2024 remains challenging. However, at the present time, other barriers (regulatory, economic and cultural) are more significant than competition for land with food production.

2.2.3 Impact on business and corporate activities

The main impacts of climate change on business and corporate activities are common to most organisations, and relate to working conditions, working patterns, energy use and the ability of FC's built estate to cope with the changing climate.

Climate change policies increasing energy and water costs with the consequent economic impact on the organisation.

- Long term risk that needs to be considered as part of business sustainability plans.

Risk to buildings and staff where offices are located in flood plains.

- This remains a risk, but business continuity planning has been shown to be effective.

Rising fuel costs (in response to climate change policies) reducing net financial returns from timber harvesting and transport.

- The decline in oil prices since ARP2 has resulted in the risk not being realised in the short term over most of this reporting period, but it remains a risk in the longer term.
- The policy on private vehicle emissions (maximum CO_2 emissions imposed for business use of private vehicles) has presented unforeseen challenges for management.

Assessment of new priority risks

In 2021 the Independent Assessment of UK Climate Risk evidence report for the UK's third Climate Change Risk Assessment (CCRA3) was published by the Climate Change Committee (CCC). This assessment identified the following risks relevant to forestry, that should be the government's priority for the next five years:

- Risks to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazards. Higher temperatures (warmer winters and hotter summers) leading to changes in the suitability of different habitats for different groups of species; altering the timing of natural events such as trees coming into leaf in the spring; increasing water temperatures; and increasing the risks of pests, diseases and invasive non-native species.
- Risks to natural carbon stores and sequestration from multiple hazards leading to increased emissions. The major threats to carbon stores and sequestration include hotter and drier conditions reducing the functioning and threatening the existence of peatlands and forests at higher levels of warming, erosion from wind and rain, fire damage and the potential for increased soil respiration due to higher temperatures.
- Risks to crops, livestock and commercial trees from multiple hazards. Productive agriculture and forestry sectors are essential for future domestic food security and for the UK's land to contribute fully on the path to Net Zero emissions by 2050. To maintain and enhance agricultural and forestry productivity, the health and diversity of terrestrial and freshwater ecosystems need to be protected and enhanced. Climate change poses a direct risk to crops, livestock and commercial trees through increased exposure to heat stress, drought risk, waterlogging, flooding, fire, and pests, diseases, and invasive non-native species.

The lack of diversity in tree species and genetics within species had been identified as a priority risk in ARP2. However, the risk of limited diversity had been expressed in the context of climate change and, particularly, uncertainty in the way in which climate change will progress. The risk of the lack of diversity has been heightened by the series of pest and disease outbreaks that have affected British forestry in recent years, including Asian Longhorn Beetle, *Phytophthora ramorum* on larch (and other species, to a lesser extent), *Phytophora pluvialis* on douglas-fir and western hemlock, oak processionary moth, *Cryphonectria parasitica, Ips typographus*, the syndrome known as Acute Oak Decline and ash dieback.

There are also concerns over the potential for *Xylella fastidiosa* to impact British woodlands, particularly because of its broad host range. The potential for climate change to make pest and disease outbreaks more frequent and intense was also identified as a priority risk in ARP2. The protection of England's woodland resource is also a priority for woodland policy at the present time. As such, risks from the lack of species/genetic diversity and from pest and disease outbreaks (tree health) are not new priority risks, but they have been identified as the key risks to address at the coming time. If these two risks are to be addressed, it will require intervention to enhance resilience, which highlights the third of the three key risks to the English woodland resource – the lack of management. Although the majority of conifer

woodland is in active management, 54% of the total broadleaf resource is unmanaged. Un-managed woodland provides few opportunities for regeneration of trees that are adapting to the changing environment or for species diversification.

2.2.4 Species diversification and nursery supply

Four risks were identified in ARP2 and continue to impact nursery and seed supply and may result in the use of inappropriate planting stock and, also, impact on species diversification. These risks should be considered alongside the barriers set out in Section 5. The Nature for Climate Fund Sector Capacity Project is looking at all aspects of supply and demand in seed and trees and has a wide range on interventions to address the risks. This includes capital and innovation grants to improve quality, quantity and diversity of seed and trees.

Monopoly in trading: The UK has a small number of seed trading businesses. The FC recommendation to adopt the 'portfolio approach' including seed sourced from France has challenged their business models as access to seed is largely controlled by one company in France, which already trades in the United Kingdom. This has resulted in little incentive for the seed trading businesses to advocate current FC advice on the use of more southerly provenances of native species; the UK leaving the European Union has further increased the cost and complexity of importing seed.

Genetic diversity and availability of adapted planting stock: Prior to the need to adapt to climate change being articulated, accepted practice was to plant local origin material as this will have adapted to local soil and climate. Although it is acknowledged that more southerly origins will confer improved productive performance as the climate changes, there is continued debate as to whether this is an appropriate action within native woodlands and many conservation bodies continue to advocate and plant local origin material. Scientific evidence on the role of forest genetics in climate change adaptation also tends to focus on semi-natural woodlands and long-term evolutionary processes, rather than woodlands being established for a range of purposes where the performance of those individuals being planted is critical for meeting management objectives.

While the market is still demanding local origin material of native tree species, many of the nurseries are not prepared to take the commercial risk of growing 'adapted planting stock' and sufficient quantities are not available for adaptation measures to be widely implemented. In many cases mixed messages pertaining to best practice for different woodland types by various organisations also confuses guidance. There is a clear need for all involved in the forestry and woodland sector to accept that different adaptation measures are appropriate and needed to enhance the resilience of the tree-woodland-forestry continuum, as a whole.

Seed sourced from inappropriate origins: The industry imports seed of native species from Eastern Europe. This has largely been driven by the desire of the nursery sector to produce planting stock from seed in a single year; failure of mast years in the UK and preferred regions of western Europe, for oak in particular, has resulted in seed being importing from Eastern Europe where the mast is more reliable. This challenge

has been addressed by FC raising the issue with the sector and by providing help with research into the storage of vulnerable seed. However, seed of unknown or, potentially, inappropriate provenance is still regularly available online.

Importation of seedlings and trees: Before ARP2 was published, it was apparent that the practice of growing UK provenances in continental European nurseries was widespread while, for a number of decades, the landscape industry has imported large mature plants from mainland Europe. Both practices run a high risk of importing pests and diseases to the UK. The desire to plant more southerly origins of native tree species has resulted in the importation of planting stock directly from regions that have a similar climate to that projected for the UK in the future. There are also risks associated with importing lesser-known species with the potential to introduce new pests and pathogens and, also, their unknown susceptibility to the UK's palette of fungi and insects.

The UK nursery sector believes that it could satisfy the home market with material all grown within the United Kingdom. However, nurseries argue that uncertainty and discontinuities in the availability of incentives for planting means that they would be carrying too high a financial risk to do this. Nursery practice is now more widely understood by the sector and the public and schemes such as Plant Healthy promote best practice. The Nature for Climate Fund also provides support for the nursery sector through the Tree Production Innovation Fund.

Genetic adaptation: The rate at which climate change is progressing requires tree species to move up to 30 times faster than they recolonised the UK after the last ice age. Assisted genetic migration (i.e. planting more southerly origins) represents an approach for maintaining the suitability of individual species and is being widely adopted for some exotic conifer species such as Douglas-fir. Many of the major forest nurseries are now stocking improved genetic material from more southerly origins for the main native forest species, but evidence from the 2020 British Woodlands Survey indicates that use of 'adapted planting stock' is not widespread: *"70% of respondents had not reviewed local climate change projections. Most respondents favoured an increase in native species from the current level as they did in 2015, but this increase had risen by 3% to 65% native species in 2020. Preferences in native vs. non-native tree species varied by a respondent's aims for managing their woodland. Most woodland owners were considering diversifying the range of species in their woodlands, with most preferring UK-sourced + UK-grown material. There was not strong support for using improved material (i.e. Forest Reproductive Materials); There was clear support for natural regeneration to enable site-based adaptation."* (BWS, 2020).

Capacity of nurseries: Given the increased planting targets for England there is a risk that nurseries cannot supply the volume and species choices of trees required. A potential move away from the use of plastic tree shelters may exacerbate this with some organisations suggesting that tree planting should take place more often without protection from deer, rabbits and hares and with a higher stocking density to cover for expected losses. The Nature for Climate Fund Sector Capacity Project is taking significant action to mitigate this including developing insights into supply and demand

data to help nurseries with long-term planning. The Tree Production Innovation Fund supports research and development including innovation in mechanization. Capital grants support modernization and increasing nursery capacity. Nursery notification is part of the EWCO with larger planting schemes, which is helpful for planning in the short term (2 years) but does little to help nurseries plan supply requirements in the longer term. FC published guidance on the use of tree shelters in 2020, providing advice on the requirement for recycling and steps to minimise their use.

2.2.5 Tree health

Deterioration of tree health in existing woodlands remains the most significant risk currently faced by our woodlands.

Biosecurity: The number of pests and diseases having a negative impact on England's Woodlands has increased dramatically over the past 25 years. This is likely to be a result of a combination of climate change and global trade in plant commodities. The arrival of ash dieback in the UK, even though some was blown in from the continent, was a wake-up call for foresters to consider the sourcing of their planting stock and to reduce the risk of importing pest and diseases. The importation of live plant material continues to be the highest risk pathway for pests and diseases to arrive in the UK.

Evidence from the British Woodlands Survey 2015 highlighted this risk: there are low levels of awareness and action in relation to biosecurity among woodland owners, which was only marginally better among forestry professionals, suggesting that there is a need to review whether current guidance on biosecurity and risk assessment can be made more effective. The 2020 British Woodlands Survey did not specifically cover biosecurity, but it did highlight that there was a lack of contingency planning by respondents.

Lack of species diversity: *Dothistroma* needle blight on pine species and *Phytophtphora ramorum* on larch has injected urgency into tree species diversification in conifer woodlands and the nursery sector continues to respond by making an increasing range of conifer tree species available in UK nurseries. However, in the uplands, Sitka spruce still dominates planting stock posing a significant future risk.

Ips typographus (also known as the European spruce bark beetle), is the most serious pest affecting spruce species in its Eurasian range, occurring across both the native range for Norway spruce and, in Western Europe outside, the host's natural range.

During 2018 and in 2021, a number of outbreaks of *Ips typographus* were found in Kent and East Sussex which are subject to further surveillance and official action. *Ips typographus* is primarily a 'secondary pest', which attacks dead or weakened trees. However, under the right environmental conditions its numbers can rise enough to cause outbreaks on healthy trees. This may be compounded in GB and Ireland where *P. abies* and *P. sitchensis* does not naturally occur, by the suitable climatic range for the pest increasing in the UK, potentially putting upland spruce plantations at risk. The current outbreak is hoped not to be a risk to the main areas of upland Sitka spruce but highlights the ongoing threat of serious outbreaks in continental Europe as a result of climate change, which we may experience here as our climate alters.

The Forestry Commission's contingency plan sets out the steps which are being taken in response to the current outbreak of Ips typographs Kent and East Sussex. The Plant Health (*Ips typographus*) (England) Order 2019 came into force on 16 January 2019 which enables the Forestry Commission to demarcate areas around confirmed outbreak sites and imposes movement restrictions on conifer material capable of spreading the pest. The size of the regulated area has been revised to reflect the current distribution of *Ips typographus* in the UK as survey work has identified further infested areas in 2021. The demarcated area covers parts of Berkshire, Buckinghamshire, Hertfordshire, Surrey, City and County of the City of London, Greater London, East Sussex, West Sussex, Kent and Essex within the boundaries shown in the demarcated area.

An interest in species diversity of native trees has started to build but there is a general lack of understanding of the role of genetics and tree breeding and a shortfall of such planting stock. Consequently, in May 2017 the Future Trees Trust (FTT), Forest Research and the Confederation of Forest Industries (Confor) launched a National Tree Improvement Strategy. The strategy plans to improve the breeding of trees over the next 25 years, providing genetically diverse, resilient, future-proofed trees. The Strategy for UK Forest Genetic Resources was published in 2018 by Kew/FR/CEH/WT/FTT and endorsed by FC and Defra.

The findings of the British Woodlands Survey 2020 highlighted an interest in increasing species diversity but mostly focused on increasing native tree species diversity, rather than 'exotics'.

2.2.6 Woodland management

The changing climate will put our woodlands, particularly those in the drier and more southerly and easterly parts of England more frequently into stressed conditions. This will almost certainly have a negative impact on these woodlands. Only 19% of conifer woodlands are unmanaged. However, 54% of our broadleaf woodlands are currently unmanaged. For woodlands to be healthy and resilient they need to be dynamic with a range of age classes represented to promote evolutionary adaptation and to enable assisted migration. Regeneration only occurs when there is a silvicultural or natural intervention creating enough space and light to encourage the establishment (or planting) of a new generation of trees. Deer also continue to limit the establishment of regeneration.

As in the British Woodlands Survey 2015, the British Woodlands Survey 2020 continues to highlight that: "*Most respondent woodland owners (69%) did not have a UKFS compliant management plan in place. Lack of engagement with the UKFS and potentially failure in compliance is a serious impediment to progress towards climate change action policies*."

The skills shortage within the sector as well as a decrease in higher education establishments teaching forestry courses is a risk that if not addressed could have profound effects in the future. Programmes such as the Development Woodland Officer project are a step in the right direction. It is also crucial that those receiving a forestry education should have climate change risks embedded into silviculture and forest planning modules.

3 Addressing uncertainty

3.1 Uncertainty in climate impacts relevant to the forestry sector

As a result of the long timeframe associated with the forest management cycle, uncertainty is a key barrier to the uptake of adaptation measures in the forestry sector. It is important that while we recognise uncertainty, this does not stop the sector from acting. Such action is required to protect our trees and woodlands and enhance the capability of the sector, allowing us to build back greener and ensure that woodlands fulfil their potential to contribute to net zero and societal demands.

It is challenging for the sector to address this uncertainty because of mixed messages from key players with regards to woodland creation, management and adaptation. The refreshed accord from the Forestry Climate Change Partnership should assist in ensuring these key players work together and agree there are different approaches suitable to different woodland types and different management objectives. Research projects, such as the NewLeaf project, will assist in achieving clarity from academia on adaptation. The NewLeaf project will assess how quickly trees can adapt to change in the wild and whether human intervention is needed to protect their future. However, action is also needed now to address the challenge of climate change, using the best evidence we currently have to hand. Further research might alter the interpretation of the evidence but maintaining inactivity until all uncertainties are clarified may compromise England's woodland resource.

Climate projections: The precise way in which climate change progresses, particularly its timing, remains the largest uncertainty in the forestry sector. Adaptation actions, specifically the selection of planting stock, will also need to accommodate both current and future climates; this may involve the planting of more frost-sensitive species and/or genotypes involving significant risk if occasional cold winters remain a feature of England's climate. One of the biggest issues is the extremes of climate that are becoming more commonplace. These uncertainties associated with the future climate are currently (and probably permanently) intractable; however, they do provide context for the 'resilience approach' adopted by Forest Services and Forestry England, focusing on diversity, better matching of species to local (and variable) site conditions, and a need to accommodate both current and future climates. A 'no regrets' approach to decision making is required using the best evidence available at that time.

Wind risk: The impact of windstorms is highly dependent on direction and distribution of wind speeds within the mean. Current climate projections do not include projections of changes in the wind climate, enhancing uncertainty in a key area of forest planning and management that is already subject to a high degree of uncertainty. Although the decision support system, ForestGALES gives some indication of propensity to wind damage, it does not extend to future climate projections.

Biological response: Although there is a reasonable knowledge of how common tree species respond to weather conditions (and the performance across climatic clines), there is no certainty as to how they will respond to the changing climate (including the potentially beneficial effects of rising atmospheric carbon dioxide levels). Climate matching provides an indication of how trees perform under similar climatic conditions to those that England will experience as climate change progresses, although it is unlikely that exact climate analogues exist, particularly given the UK's location on the Atlantic seaboard.

Interactions between climate change and forestry pests and diseases:

CCRA2 identified disease and insect pest outbreaks as the most significant risk to the forestry sector in the UK. Although the Defra Group Plant Health Risk Register (PHRR) provides a list of more than 1200 potential plant disease/insects that the UK is at risk from, including 399 'forest pests' (as at end March 2021) there is limited information as to how/when they are likely to be introduced and how they will interact with the changing climate. The PHRR identifies where there are high levels of uncertainty associated with a pest's risk score and highlights the key uncertainties and its potential impacts. The PHRR also provides information on uncertainties relating to pest – climate interactions and details how potential impact of climate uncertainties may affect the level of risk.

Pest and disease outbreaks will remain an issue of high uncertainty but, as explained elsewhere, stronger evidence is emerging of the interaction between trees under climatic stress and pest/disease outbreaks. Information such as that presented by the Climate Matching Tool can be used to explore the potential changing distribution of pests and diseases as they adjust their range in response to climate change and to anticipate the potential challenges caused by a changing climate such as increased susceptibility to pest and disease outbreaks.

Wildfire behaviour: Larger, high impact and numerous wildfire incidents are likely to occur due to meteorological factors. Fire risk maps are in the process of being developed and FC is a partner in the Fire Danger Rating System (UK FDRS) project that will improve preparedness in advance of wildfire incidents on forest land. This will have a significant impact on how we plan for the future and adapt to a climate with increased wildfire impact, likelihood and severity.

3.2 Evidence gaps

A number of critical research questions were drawn up by FC as input to the development of the Science and Innovation Strategy (SIS) for Forestry in Great Britain, published in 2014 and ARP2 covered these questions. In preparation for the 2020 SIS, covering the period 2021-26, the list of critical research questions was revisited and those relating to climate change adaptation and resilience are listed in Annex 1. Success criteria for each question topic are also set out in Annex 3. All were incorporated into FR's seven research programmes for 2021-26, which mirror the research themes of the 2020 revision of the SIS, (see Annex 2).

3.2.1 What would success look like?

To inform the requirements of forestry research of Forestry England and Forest Services (FS) for the 2021-26 SIS for Forestry in Great Britain a paper was produced that built on work in a policy and advice team session and a joint Forestry England and FS session (see Annex 3). The new SIS needed to reflect the main priorities of:

- Increasing woodland cover.
- Improving forests' resilience to climate change related impacts.

3.3 Approach to addressing uncertainty

The approach adopted both within Forestry England and in FS guidance to the private sector is to ensure all actions regarding woodland planting and management are consistent with current climate, and then:

- Consider whether those actions would remain sustainable under conditions represented by a high climate change scenario in the middle of the century.
- In particular, asking the question: is planting stock at the southern extent of its range?
- Species diversification is being promoted, to provide resilience to both climate change and biosecurity threats.
- Alternatives to clear-fell systems of management are being promoted as these are likely to be more resilient under a range of future climate scenarios.
- Management plans are being promoted to encourage woodland managers to think of the future.
- Woodland owners/managers are being encouraged to bring unmanaged woodlands into management to encourage evolutionary adaptation and provide the opportunity for more interventional approaches to adaptation to be implemented.
- Woodland owners/managers are being encouraged to reduce other pressures on woodland ecosystems (invasive species, populations of squirrel and deer).
- Woodland owners and managers are being encouraged to 'plan for the unexpected' (i.e. contingency planning) to minimise the impact and aid the recovery from extreme weather events (windstorm, flood, drought, wildfire).

The above points are key to ensuring woodland management and creation is UKFS compliant and meets the future demands of society.

3.3.1 Engagement with the private sector

The series of extreme weather events since 2010 (winter cold, drought, flood/extreme rainfall and windstorm) has resulted in a slightly different approach to communicating climate risks to the private sector; rather than a focus on changes to the mean climate, as depicted in climate change projections, sector engagement has communicated the need for woodlands to be able to cope with extreme weather events which, themselves, will become more extreme as the climate changes. In the context of impacts on the woodland resource, water availability is likely to be the limiting factor;

extreme rainfall events are likely to have the greatest impact on forest infrastructure. In terms of encouraging the private sector to adapt species choice, FS has continued to advise that ESC suitability projections for the UKCP09 2050s high emissions projection remains appropriate since, although it represents one of the more extreme projections for the middle of the century, it is consistent with more central projections for the end of the century; additionally, trees will need to survive the more extreme events, particularly drought.

FC launched a digital climate change campaign in 2021 to communicate the likely impacts of a changing climate as identified in Managing England's woodlands in a climate emergency by sharing a suite of digital content to encourage landowners to actively manage their land for more resilient, sustainable forests. FC also produced a series of publications in collaboration with the Royal Forestry Society, outlining the need for forest resilience and practical options to implement resilience as well as a collection of case studies demonstrating how woodland owners are responding to the pressures of climate change and pests and diseases on a range of different site types. These have been produced alongside outreach seminars developed in partnership with the Institute of Chartered Foresters and Forestry Climate Change Working Partnership to communicate the need for adaptation and to encourage the integration of resilience into woodland creation and management thinking across the sector.

Contingency planning and incident management has been refined since FC's second round ARP report was published, representing a new approach to dealing with uncertainty associated with the stochastic nature of weather events that are linked to the changing climate. This approach has been embedded across the business and is set out in further detail in Section 4.2.1.

4 Review of second round report *Outline Adaptation Plan*

4.1 Summary of Actions

Table 1. Progress in implementing the actions set out in the ARP2 Outline Adaptation Plan are set out in the table below, with further detail provided in Section 4.2.

Action and risk addressed by the action	Progress
Action 1: A revised Climate Change Action Plan for the Public Forest Estate will be published in 2016. **Issue addressed:** Risks to the trees and woodlands in the nation's forests together with opportunities to reduce emissions in the functioning of the business.	Partially complete
Action 2: FCE will publish a policy position statement in 2017 on the use of Forest Reproductive Material (both species and genetics) and its use to adapt to the changing climate. **Issue addressed:** Misunderstanding and consequent criticism of FC's guidance on adaptation of the growing stock has led to confusion over appropriate actions on individual sites, in turn leading to limited implementation of actions to address climate risk.	Complete
Action 3: FS will work with the Forestry Climate Change Partnership to facilitate the understanding and implementation of appropriate actions. **Issue addressed:** The lack of implementation of adaptation actions which has increased the vulnerability of English woodlands to climate change.	Complete
Action 4: FS's Contingency Planner will draft a recovery plan for extensive wildfires as part of wildfire contingency planning. **Issue addressed:** At the time, a wildfire risk assessment was required to deploy of Rural Development Programme funding for recovery following an extensive wildfire event.	Complete
Action 5: Forest Services will create a Wildfire Risk Map. **Issue addressed:** A risk map of potentially vulnerable sites and landscapes is required for regulation (EIA), forest management planning and future climate change modelling.	Not started
Action 6: FS will develop a contingency plan for drought, to cover impact, evaluation and recovery phases. **Issue addressed:** Severe drought event likely to have the most significant impact on English woodlands and, at present there is no plan in place to prepare or respond to such an event.	Not started
Action 7: FS will work with Forest Research and Forestry England to develop 'climate change adaptation areas' to demonstrate several different types of adaptive practice in Alice Holt Forest. Initial work will select and include adaptation areas into the new Alice Holt Forest Design Plan. **Issue addressed:** Lack of practical examples of climate change adaptation best practice for operationalising the requirements of the UKFS Forests and Climate Change Guidelines.	Complete
Action 8: FS will work with Forestry England to embed Wildfire Management Plans into Forest Design Plans (FDP) for woodlands and forests at most risk from severe wildfire in southern England. **Issue addressed:** Increasing wildfire risk and potential for consequent loss of woodland.	Complete

Action 9: FS support Natural England to develop wildfire resilience in Countryside Stewardship mandatory options. **Issue addressed:** Increasing wildfire risk and potential for consequent loss of woodland and other habitat.	Complete
Action 10: FS will work with Forest Research to develop an annual growth indicator based on 'sentinel sites'. **Issue addressed:** The lack of structured monitoring of tree/forest growth rates prevents analysis of the impact of weather events to guide adaptation.	Not started
Action 11: FS will ensure that climate change impacts and adaptation remain at the heart of the Science and Innovation Strategy for Forestry in Britain. **Issue addressed:** Ongoing research needed to fill evidence gaps and provide clarity on adaptation measures.	In progress
Action 12: FS will develop Tree health Incident Management Plans in line with the requirements of the National Plant Health Contingency Plan (being reviewed / developed by Defra). **Issue addressed:** Pest and disease outbreak management.	Complete
Action 13: FS to develop a Tree Health strategic and operational assessment of response options to improve decision-making for Operations Commanders during incidents. **Risk addressed:** Pest and disease outbreak management.	Complete
Action 14: FS to work with DEFRA to finalise the DEFRA Generic Contingency Plan for Plant and Bee Health. **Risk addressed:** Pest and disease outbreak management.	In Progress
Action 15: FS will work with FR to test susceptibility/resistance to pest and disease outbreaks. Develop a rapid experimental approach to test the susceptibility of a range of tree species to novel pests and diseases. **Risk addressed:** Pest and disease outbreak management.	In progress

4.2 Details of implemented actions

Details of key actions highlighted in Table 1 are provided below, together with further detail on the progress of the action during the ARP2 reporting period; key areas of activity are then focused on in sections 4,2.2 to 4.2.6.

4.2.1 Progress on actions in this period

Action 1: A revised Climate Change Action Plan for the Public Forest Estate to be published in 2016. The plan will both build on progress made in the previous CCAP and reflect the current vision of resilient forests of the future, as outlined previously. The updated CCAP will consider the developments made in the 2011-16 CCAP and will seek to build on the progress made.

Progress: Forestry England's forest resilience approach has expanded and evolved considerably since ARP2. We have built on the Climate Change Action Plan in a number of ways, including developing a strategic Risk Register for threats to the nation's forests, establishment of both a Forest Resilience Steering Group and Network Group and creation of an organisational Approach Statement.

Action 2: FC will publish a policy position statement in 2017 on the use of Forest Reproductive Material (both species and genetics) and its use to adapt to the changing climate.

Progress: In 2019, Forest Research published the research report 'Genetic considerations for provenance choice of native trees under climate change in England' which was followed by the publication of a joint Policy Advice Note from the Forestry Commission, Natural England and the Woodland Trust on the topic of 'Genetic considerations for provenance choice of native trees under climate change in England'. Currently, the FC is considering revising the seed zone system to reflect climate change, employing a tool produced by Forest Research to explore potential seed zones based around selected climate variables. Forest Research is undertaking a research project focusing on adapting existing forestry species by looking at provenance choice and trialling emerging and new tree species that could adapt to the changing climate.

Action 3: FS will work with the Forestry Climate Change Partnership (previously known as the Forestry and Climate Change Working Group) to facilitate the understanding and implementation of appropriate actions.

Progress: The Action Plan for Climate Change Adaptation of forests, woods and trees in England was published in 2018 highlighting priority actions for FC; a progress report was published in 2019. FS committed to providing a secretariat function to the Forestry Climate Change Partnership (FCCP) in 2021. A draft of the revised Accord, originally published in 2015, is at Annex 8.

Action 4: FS's Contingency Planner will draft a recovery plan for extensive wildfires as part of wildfire contingency planning. The plan will set out actions to ensure that the loss of woodland area is minimized and include the development of a wildfire risk assessment which would be required for the deployment of Rural Development Programme funding. The plan will be based on Forestry Commission's Practice Guidance and link to Forest Services Major Wildfire Incident Contingency Plan. Wildfire risk will be monitored and disseminated using wildfire alerts and warnings from the Natural Hazards Partnership.

Progress: Forest Management Plans will be reviewed using Forestry Commission's Practice Guidance as well as other relevant sources of information. In case of an extraordinary incident or multiple Major Incidents which have a catastrophic impact, recovery will be defined by the England Wildfire Task Force. A recovery plan will be produced for individual fire events as and when.

Action 5: Forest Services will create a Wildfire Risk Map. Partnership work between University of Manchester, Forest Research and Forest Services has successfully demonstrated an approach used by Canada and New Zealand.

Progress: Forestry Commission is a partner of and on the project steering group for the NERC-funded project "Toward a UK Fire Danger Rating System" (UK FDRS).

Action 6: Forest Services, working with Forest Research and the National Forest Inventory team, will develop a contingency plan for monitoring the impact of a future

severe drought event and implementing necessary responses, to ensure that the sector can learn from such an event and enhance resilience.

Progress: No progress made at present, although FS and FR are in discussion on how to take this action forward in next reporting period (ARP3).

Action 7: FS will work with Forest Research and Forestry England to develop 'climate change adaptation areas' to demonstrate several different types of adaptive practice in Alice Holt Forest. Initial work will select and include adaptation areas into the new Alice Holt Forest Design Plan.

Progress: The Alice Holt Forest climate change adaptation trail opened in 2019.

Action 8: FS will work with Forestry England to embed Wildfire Management Plans into Forest Design Plans (FDP) for woodlands and forests at most risk from severe wildfire in southern England.

Progress: Wildfire Management Plan drafted for Haldon Forest and Dartmoor FDP in partnership with FS Wildfire Subject Matter Adviser. Work is started on the New Forest's Open Habitats FDP Wildfire Management Plan, with training delivered on 12th and 13th February 2020 in the New Forest with Forestry England staff. Additional Lantra accredited Wildfire Management Plan module training delivered to Forestry England staff in the New Forest in December 2021.

Action 9: FS support Natural England to develop wildfire resilience in Countryside Stewardship mandatory options. FS meeting with DEFRA and Natural England to define the requirements for wildfire resilience within Countryside Stewardship (CS) options UP3 and 4 (Upland Management) using FC wildfire Practice Guide and case studies from Forestry England Forest Design Plans. Work will start on using lessons learnt on CS Options LU1, 2 and 3 (Lowland Heath).

Progress: Wildfire considerations now covered in the Countryside Stewardship options UP3, UP4, LU1, LU2 and LU3.

Action 10: FS will work with Forest Research to develop an annual growth indicator based on 'sentinel sites'. At present, although there are networks of mensuration permanent sample plots and forest intensive monitoring sites together with the five-year field sampling programme associated with the National Forest Inventory, growth data is not collected at an annual time-step. The development of an annual growth indicator for 'sentinel sites' would enable the impacts of inter-annual weather variability to be analysed and the impact of climate change on the forest/tree growth to be evaluated. The arboreta at Westonbirt and Bedgebury are part of the International Plant Sentinel network.

Progress: No progress made due to Covid pandemic although FS and FR are in discussion on how to take this action forward in next reporting period (ARP3).

Action 11: FS will ensure that climate change impacts and adaptation remain at the heart of the Science and Innovation Strategy for Forestry in Britain (SIS). The SIS sets

the direction for forestry research in Britain to 2020. Research commissioning and governance processes, together with the future status of Forest Research are currently under review through the cross-border Forestry Governance project. FS and Forestry England will ensure that adaptation remains at the heart of forestry research to address the risks identified in ARP2 and CCRA3.

Progress: New SIS programme place running from 2021-2026, with climate change and adaptation at its core.

Action 12: FS will develop Tree health Incident Management Plans in line with the requirements of the National Plant Health Contingency Plan (being reviewed / developed by Defra). FS Tree Health team working in collaboration with Defra and APHA, will develop a specification for implementing responses, to ensure that the sector can learn from pest and disease outbreak events and enhance future resilience.

Progress: Within the outbreak management process (defined within the Generic Contingency Plan for Plant Health in England) Incident Action Plans (IAP) are prepared by the Incident Management Team as part of the response to a pest or disease outbreak. The IAP is informed by pest-specific contingency plans and this, in turn, informs the surveillance and control measures required. Actions and decisions are recorded using the situation report for each incident management area. These situation reports are collated into a common operating picture for the Lead Government Department meetings.

Action 13: FS to develop a Tree Health strategic and operational assessment of response options to improve decision-making for Operations Commanders during incidents. FS Contingency planner is working with the Tree Health team to define assessment of options based on framework contracts and experience of previous incidents.

Progress: The Plant Health Risk Group has commissioned pest and disease-specific contingency plans for those pests and diseases which pose the greatest risk, and which should be subject to stakeholder consultation. These individual contingency plans for priority pests inform the IAP and are prepared by the Incident Management Team and have a review programme in place.

Action 14: FS to work with DEFRA to finalise the DEFRA Generic Contingency Plan for Plant and Bee Health. FS Contingency Planner and Tree Health working with DEFRA to ensure inter-operability and clear reporting processing between various agencies and organisations.

Progress: The Generic Contingency Plan for Plant Health in England is currently being revised (due to be completed in early 2022) and will feed into the revised National Plant Health Biosecurity Strategy due to be published in 2022. DEFRA is developing a centralised IT system for the plant health services. FC form part of this DEFRA programme which takes account of FC's operational needs.

Action 15: FS will work with FR to test susceptibility/resistance to pest and disease outbreaks. Develop a rapid experimental approach to test the susceptibility of a range of tree species to novel pests and diseases.

Progress: FS and FR have agreed a process whereby FR liaise with other agencies / countries to discuss potential host lists and then carry out inoculation testing to determine susceptibility of different host species. The results of these tests are then fed into the survey methodology within the IAP. FS also commission FR to carry out specific work for horizon scanning as required in addition to that carried out in response to a pest or disease outbreak.

4.2.2 Changes in Governance

Since the previous report (ARP2) there have been further fundamental changes to the governance around forestry, with the completion of devolution of forestry in Scotland (Forestry Commission Wales merged with other agencies to become National Resources Wales in 2013) in April 2019. Publicly owned forests in England (the nation's forests) remain the responsibility of the Forestry Commission, through its Agency, Forestry England (previously Forest Enterprise). There have been no fundamental impacts on the way in which climate change is addressed following devolution, although there have been some organisational changes that have improved capacity to respond to major incidents, as set out below.

Contingency planning and incident management

Forest Services has a tried and tested approach to incident management that is practiced at exercises; Exercise ELM 2018 (Xylella outbreak), Exercise NOBEL FIR 2019 (major wildfire). The exercise for 2020 was delayed until 2021 and the 2021 exercise was cancelled due to Coronavirus. Forestry Commission's Incident Management Team was active from March 2020 to September 2021 responding to Coronavirus. Therefore, major exercises were not required. Running through these exercises involved the setting out of clear roles across the organisation, the allocation of duty officer responsibilities for a member of the FS Executive Team at all times and close working with the contingency planning teams in Defra and the Environment Agency, ensure that the Forestry Commission is ready to deal with real events when they happen.

The incident management process becomes operational when amber or red alerts are received from the Natural Hazards Partnership and the National Severe Weather Warning System (triggering the establishment of incident-specific requirements), or when a new pest or disease outbreak or infestation arises. Since ARP2 the Incident Management Team (IMT) has been activated 29 times, as detailed in Table 2.

Table 2: Chronology of activation of the Incident Management Team, to 30 September 2021.

Number	Incident Ref No	Incident Type	Dates (From – to)		IMT type	IMT status
1	001-2017	2. Tree health Incident	21st December 2016		Defra led	Stood up
2	002-2017	1. Catastrophic Windblow	12th September 2017	13th September 2017	National IMT	Stood up
3	001-2018	1. Catastrophic Windblow	1st March 2018	6th March 2018	National IMT	Yes
4	002-2018	3. Major Wildfire	22nd May 2018	22nd May 2018	National IMT	Yes
5	003-2018	3. Major Wildfire	27th May 2018	28th May 2018	National IMT	Yes
6	004-2018	3. Major Wildfire	22nd June 2018	29th July 2018	National IMT	Yes
7	005-2018	1. Catastrophic Windblow	20th September 2018	20th September 2018	National IMT	Stand by
8	006-2018	2. Tree health Incident	04-Dec-18	Ongoing	National IMT	Stood up
9	001-2019	3. Major Wildfire	15th April 2019	16th April 2019	National IMT	Stand by
10	002-2019	2. Tree health Incident	5th July 2019	Ongoing	National IMT	Stood up
11	003-2019	3. Major Wildfire	11th July 2019	19th July 2019	National IMT	Stand by
12	004-2019	3. Major Wildfire	23rd July 2019	29th July 2018	National IMT	Stand by
13	005-2019	4.Tree Health Incident	23rd October 2019		National IMT	Yes
14	001-2020	5. Flu Pandemic	10th March 2020	16th September 2021	National IMT	Yes
15	002-2020	3. Major Wildfire	28th March 2020	28th March 2020	National IMT	Stand by
16	003-2020	3. Major Wildfire	17th April 2020	17th April 2020	National IMT	Stand by
17	004-2020	3. Major Wildfire	20th April 2020	27th April 2020	National IMT	Stand by
18	005-2020	4. Tree Health			National IMT	Stood up
19	006-2020	3. Major Wildfire	9th May 2020	11th May 2020	National IMT	Stand by
20	007-2020	3. Major Wildfire	14th May 2020	4th June 2020	National IMT	Stood up
21	009-2020	3. Major Wildfire	24th June 2020	29th June 2020	National IMT	Stand by
22	010-2020	3. Major Wildfire	31st July 2020	14th August 2020	National IMT	Stand by
23	011-2020	3. Major Wildfire	18th September 2020	22nd September 2020	National IMT	Stand by
24	001-2021	3. Major Wildfire	5th April 2021	8th April 2021	National IMT	Stand by
25	002-2021	3. Major Wildfire	19th April 2021	28th April 2021	National IMT	Stand by
26	003-2021	3. Major Wildfire	16th April 2021	17th April 2021	National IMT	Stand by
27	004-2021	3. Major Wildfire	18th July 2021	22nd July 2021	National IMT	Stand by
28	005-2021	3. Major Wildfire	6th Sept 2021	8th Sept 2021	National IMT	Stand by
29	006-2021	4. Tree Health	22nd Sept 2021		National IMT	Stood up

Enhanced plant health forestry team capability

As a result of concerns over the increased frequency and severity of forestry pest and disease outbreaks, particularly ash dieback and *Phytophthora ramorum*, an enhanced Plant Health (forestry) budget has been allocated to FC by Defra, supporting dedicated

tree health officers and other FC staff as designated. FS's Plant Health Forestry team works closely with Defra, the Animal and Plant Health Agency, Natural England, Environment Agency, major eNGOs and the wider forestry sector. The team has contributed to, and works towards, the objectives of the Plant Biosecurity Strategy for Great Britain and the Tree Resilience Strategy which was published in 2018. A National Plant Health Risk Register has been developed as a major reference tool to identify forestry pests and diseases of greatest risk. Pest Specific Contingency Plans (PSCPs) and Pest Risk Analyses (PRAs) are produced for those of greatest concern. PSCPs & PRAs will be developed or updated as required. The Generic Contingency Plan for Plant Health in England is currently being revised (due to be completed in early 2022) and will feed into the revised National Plant Health Biosecurity Strategy due to be published in 2022.

4.2.3 Engaging the sector

Forest Services, together with Forest Research and Forestry England plays a leading role in the Forestry and Climate Change Partnership, established in 2013 and in 2021, committed to provide a secretariat function.

FC published 'Managing England's Woodlands in a Climate Emergency' in 2020. This publication recognises the urgent nature of the impact that climate change is having on England's woodlands and highlights actions that can be taken to make a range of woodlands more adaptive to change, while staying within the framework of the UKFS. FC also published 'Responding to the climate emergency with new trees and woodlands' as a guide to help local authorities and landowning businesses achieve net zero through woodland creation.

In 2020 FC also published internal guidance (Action Note) on the flexibility inherent in the *Ancient and Native Woodland Practice Guide* and provided training for relevant FS, Forestry England and NE colleagues. This gives woodland Officers the confidence to approve adaptation activities proposed by woodland managers, where appropriate.

As awareness grows within the English forest industry other organisations, including the Confederation of Forest Industries (Confor), the Institute of Chartered Foresters (ICF) and the Royal Forestry Society (RFS), have included information related to climate change in their training and information resources. A collection of ten case studies entitled, 'Managing for Resilience' has been published by RFS in partnership with the FC. Working in partnership with the RFS, FC also collated a collection of resources, including; guidance and advice notes, reference materials and online tools and databases, all under the heading of 'Resources for managing woodland for resilience'. Most of the resources highlighted are equally relevant to promoting adaptation in woodland.

To give practitioners confidence in the performance of some of the lesser used tree species, FC co-sponsored the Sylva Foundation to develop an internet site 'SilviFuture' to host a database giving details of individual stands of minor species and a 'blog facility' to share knowledge and encourage debate. This sits well with the Forest Research Tree Species Database that gives detailed information on more than 60 tree

species commonly used or are likely to play an expanding role in forestry due to climate change.

To facilitate the sharing of knowledge and create an iterative learning platform, FC continues to operate a members-only Linked-In site exploring issues around adaptation to climate change and resilience in silviculture. The ICF and the RFS have also initiated their own blogs to encourage members to have similar discussions.

All FC Area teams have run tree health seminars (although the response to Covid 19 has limited this over the past two years), and a significant effort has been made to train FC staff on practical ways they can mitigate the risk of spreading tree diseases around the country through their site visits.

Sector activity

The work around the Forestry Climate Change Partnership brings together a partnership of major forestry and woodland stakeholders to discuss adaptation in its widest sense and how the industry could plan for action going forward.

The 'Action Plan for Climate Change Adaptation of Forest, Woods and Trees in England', published in 2018 contains actions to address significant gaps in forestry policy, research and practice are necessary to deal with the unprecedented pace and scale of environmental change; a progress report was published in 2019. Launching the Plan on behalf of the Partnership, Sir Harry Studholme, the then Chair of the Forestry Commission stated:

> *"Our forests, woodlands and trees are already facing unprecedented challenges from environmental change and the changes will continue. The impacts of this will alter the ecology, the appearance and the management needs of these woods and forests. We have to adapt because if we do not the costs will be paid by all of us for generations to come. That is why I welcome the launch of this plan to drive forward a truly collaborative response by the forestry sector."*

Soon after its formation in 2014, the Forestry Climate Change Partnership noted that there was no benchmark to assess the views and activity of the sector on environmental change, and to measure progress against. As a result, the partnership launched the 2015 British Woodlands Resilience Survey. The results of the survey present a sector-wide barometer on the understanding and action around climate change issues in forestry. The 2015 survey was repeated in the British Woodlands Survey 2020 with the main points highlighted below.

- Most respondent woodland owners (69%) did not have a UKFS compliant management plan in place. Lack of engagement with the UKFS and potentially failure in compliance is a serious impediment to progress towards climate change action policies.
- 70% of respondents had not reviewed local climate change projections.
- Among four important management activities for adaptation, two were being adopted by the majority (reviewing tree species suitability and implementing continuous cover management), two other actions (reviewing climate change

projections and gaining understanding of soils) were not, which could undermine good decision making.

- Most respondents favoured an increase in native species from the current level as they did in 2015, but this increase had risen by 3% to 65% native species in 2020. Preferences in native vs. non-native tree species varied by a respondent's aims for managing their woodland.
- Most woodland owners were considering diversifying the range of species in their woodlands, with most preferring UK-sourced and UK-grown material. There was not strong support for using improved material (i.e., Forest Reproductive Materials) among most respondents.
- The woodland area represented by the survey was 71,251 hectares; equivalent to 3% of privately-owned woodland area in Britain.
- Among 234 Woodland owners who had restocked an existing woodland or created a new woodland within the last five years, 69% (161) had specified the provenance of their planting material, while 11% (26) were unsure, and 20% (47) said they had not.

Four management activities were identified as actions to support forest resilience. This highlighted that a minority of woodland owners and agents had neither reviewed climate change projections for their specific location nor completed a survey of soils, although most were practicing continuous cover management in some form and had reviewed tree species suitability. When asked about future intention, a majority indicated that they intended to review tree species suitability. It was reassuring to note that thinking and action was most advanced where timber production was an important objective, and where it is likely to require the most urgent attention. However, the analysis also raises concerns that woodlands managed for other objectives may not be resilient and therefore that the delivery of their goods and services may be compromised.

Tree Health engagement

FC's aims have been (1) to promote collaborative action by the tree, woodland and forestry community to maintain a healthy and resilient plant sector; by providing up-to date guidance in dealing with specific pests and diseases and on planting resilient landscapes; and (2) increasing awareness and understanding of the importance of tree health within the 'engaged public', by working with NGOs and membership organisations across the sector and through proactively sharing information with the industry.

In terms of specific biosecurity engagement, the FC Plant Health Forestry (PHF) team in England employ two Biosecurity Officers. Their focus is on the actions listed in the 'Raising Awareness and Involvement' and 'Biosecurity Consortium' sections of the UK Plant Biosecurity Strategy (currently under review). Both posts work closely with other members of the PHF team, FC Policy Advice team, Forestry England, Forest Research, and other DEFRA colleagues, to develop and update biosecurity related policy and guidance for key stakeholder organisations. The Biosecurity Officers maintain strong links with practitioners in the arboricultural and forestry sectors through close

engagement and the provision of technical advice and communications on plant health and biosecurity. The Forestry Commission have supported the industry lead Plant Healthy Certification Scheme and the Plant Health Alliance since its inception. The certification scheme aims to make it easy to identify businesses or organisations that trade and grow plants to high plant health and biosecurity standards.

Wildfire engagement

FC provided wildfire prevention training to Fire and Rescue Services and Land Managers using the UK Forestry Standard's Practice Guide Building Wildfire Resilience into Forest Management Planning to inform content, with 107 persons attending (2018 to 2020) and Forestry Commission Lantra accredited training modules have been launched (since September 2021) which have been attended by 13 people.

Forestry Commission's Wildfire Practice Guidance is also the reference guide for Countryside Stewardship options for lowland and upland heathland management.

4.2.4 Embedding adaptation in forestry regulations and grants

Forestry regulations

In the context of woodland creation acting as an adaptation measure through enlarging the size and therefore the resilience of the woodland resource, an amendment to the EIA regulations was introduced in 2017 to help address the perceived burden of regulations surrounding woodland creation. A Low Risk map for woodland creation, was introduced, together with new process of notification (as opposed to seeking an EIA opinion) for proposals of up to 50 ha in size in low risk areas.

The UK Forestry Standard (UKFS) is currently undergoing review, providing opportunities to strengthen requirements for enhanced resilience and implementing adaptation measures through UKFS requirements underpinning forestry grants, forestry regulations, forest certification and the management of the nation's forests.

Countryside Stewardship Woodland Creation and Maintenance Grant

Adaptation was embedded in Countryside Stewardship forestry grants developed as part of the EU co-financed Rural Development for England, 2014-2020. Specific adaptation measures for the Woodland Creation Grant are set out below:

- UKFS requirements for species choice (using ESC to predict productivity) apply;
- Targeting to contribute to flood alleviation;
- Additional 'points' for riparian woodland where Environment Agency (EA) shade mapping ('Keeping rivers cool') indicate lack of riparian tree cover;
- Targeting to increase the size (and resilience) of existing woodland priority habitat;
- Additional points for larger (and, therefore, more resilient) woodland.

Forestry also Commission provided additional support under the EPREC (Extraordinary Payments Received in Exceptional Circumstances) to fund the replacement of trees, lost due to severe drought conditions in spring and summer 2018.

Countryside Stewardship woodland management grants

The delivery of adaptation within the Countryside Stewardship Higher Tier grant aimed at ensuring that the management of woodland within the scheme meets the requirements of the UKFS. The following grants contribute towards ensuring a focus on adaptation:

Woodland Improvement Grant

Consists of a payment per hectare, with additional one-off payments for capital items that deliver biodiversity benefits. The scoring system focusses funding on ancient and other designated woodland, for woodlands where water benefits are required as well as in woodlands classed as unmanaged. Specific adaptation measures for the Woodland Improvement Grant are set out below:

- Contributions for deer and grey squirrel control.
- Contributions for enacting silvicultural transformation such as CCF.
- Contribution towards the control of invasive species.
- Capital items such as forest roading can be used to support bringing unmanaged woodland into management.

Woodland Planning Grant

A one-off payment to enable the production of a ten-year UKFS compliant Woodland Management Plan (WMP) along with associated felling permissions. The production of a UKFS compliant WMP is a crucial part of ensuring that woodland is adaptive, and that future management is fit for purpose. The requirements of the plan ensure that the author considers risk and plans for eventualities, the plan also includes the requirement to monitor woodland condition and to review progress. The production of the plan also requires stakeholder consultation, ensuring it meets societies needs for the future.

Woodland Tree Health Grant

The tree health grant was initially targeted at encouraging the replacement of trees removed under a statutory plant health notice were there was no legal requirement to replace trees removed under the order. It has now been used in conjunction with Chestnut Blight (*Cryphonectria parasitica*) outbreaks, but more commonly in relation to ash dieback. Restocking of diseased trees with a diverse mixture of trees is facilitated by the payment of a one-off grant. Payments are based on a per hectare cap and the cap is dependent on the type of woodland to be restocked and the tree species that are being used to restock. As always, the felling and restocking must comply with the UKFS. The grant funds trees and protection infrastructure.

England Woodland Creation Offer (EWCO)

The EWCO is a flagship new grant scheme for farmers and landowners to encourage investment in woodland creation. These woodlands will help to mitigate climate change, deliver nature recovery and provide wider environmental and social benefits. The EWCO scheme offers additional contributions where the planting provides additional ecosystem services such as public access, Keeping Rivers Cool and improving water quality.

Tree Production Innovation Fund

The grant was opened in June 2021 with the aim of supporting projects with outputs that will better equip nurseries to supply the trees required for new woodlands and urban planting projects. Applicants are invited to apply for between £20K and £200K in grant funding to support innovative projects that address one or more of the following challenges identified as barriers to tree nursery production: (1) how can we make better use of available seed and vegetative planting material to maximise the quantity, quality and diversity of trees produced? (2) how can we develop growing systems to enhance their efficiency and resilience to change, whilst delivering improved quality and diversity of product (including activities to promote biosecurity)? (3) how can innovative environmentally sustainable weed control solutions be used to reduce reliance on herbicides?

Other government grants, incentives or funding mechanisms managed by FC within this reporting period, that assist with adaptation and resilience to climate change through trees or woodlands, are set out below:

Woodland Creation Planning Grant (WCPG)	The WCPG provides funding to prepare a Woodland Creation Design Plan which is compliant with the UK Forestry Standard.
HS2 Woodland Fund (HS2WF)	The HS2WF provides funding for woodland creation and restoration of plantations on ancient woodland sites (PAWS). The land will need to be within a 25-mile zone of phase one of the HS2 route from London to the West Midlands.
Urban Tree Challenge Fund (UTCF)	UTCF provides capital funding to plant and establish large 'standard' trees in urban and peri-urban areas. The fund will provide three years of establishment payments following planting of the trees.
Woodland Carbon Guarantee (WCaG)	The WCaG is an incentive scheme to help accelerate woodland planting rates across England to mitigate for the effects of climate change. These new woodlands will permanently remove carbon dioxide (CO_2) from the atmosphere.
Woodland Carbon Fund (WCF) Closed April 2021	The WCF offers capital funding for the creation of new productive woodland for carbon sequestration. This includes the planting of trees and costs of protection items including tree guards, fencing and gates. Applicants can also get funding for the installation of forest roads and recreational infrastructure.
Woods into Management Forestry Innovation Funds	The Funds aim to restore vulnerable woodland habitats and help woodlands adapt to a changing climate and recover from the impacts of pests and diseases, through three separate funds: routes to market for ash timber Innovation Fund; temporary infrastructure Innovation Fund, and; regional woodland restoration Innovation Funds.
Local Authority Treescapes Fund	This fund is aimed at establishing more trees in non-woodland settings such as in riverbanks, hedgerows, parklands, urban areas, beside roads and footpaths, in copses and shelterbelts, including neglected, disused and vacant community spaces.

4.2.5 Implementing adaptation in the nation's forests

Forestry England's Resilience Approach

Forestry England's forest resilience approach has developed considerably since ARP2, recognising that we need ambitious, proactive and sustained management action. A Forest Resilience Steering Group has been established to provide organisational oversight and strategic direction. The group meets quarterly to drive forward national action planning and coordination. A new role in the National Operations team (Natural Capital and Resilience Programme Manager) has been created to lead on and drive forward Forestry England's national approach.

A formal organisational Approach Statement to forest resilience has been agreed, defining forest resilience as "the resilience of our natural capital (i.e. the forest ecosystem) against threats and risks that compromise its ecological integrity and ability to deliver societal benefits". In addition, a strategic Risk Register outlines threats to and consequences for the nation's forests, together with mitigating actions that need to be taken at both local and national scales. A new forest resilience strategy is being developed to bring together these existing documents, adding greater detail, specific medium- and long-term targets, and expectations for different staff groups.

More broadly, Forestry England's '*Growing the Future: 2021-26*' plan includes actions for a sustainable approach to managing the nation's forests and addressing climate change. The organisation has committed to reach net-zero operational greenhouse gas emissions by 2030. Forestry England's vision for climate is "The nation's forests are resilient to climate change, increasing their value for communities by producing high-quality, sustainable timber and absorbing carbon emissions". The plan sets out three targets in this area:

- At least 2,000 hectares of new, high quality, predominantly broadleaf woodlands planted. The partnerships that deliver these will strengthen connections to their wider settings, enabling our forests to play their crucial role in landscape-scale climate resilience.
- Greater structural and tree species diversity in the nation's forests to support adaptation to climate change and securing a sustainable timber supply for future generations.
- Continued investment in research to help our forests be diverse and resilient and lead the way in mitigating and adapting to the impacts of climate change on forest landscapes.

These targets will be delivered through a combination of bespoke and existing programmes. The Forestry England Woodland Partnership is creating significant areas of new woodland through a leasehold model. Forest resilience principles are embedded into the design and establishment of these woodlands, including site-specific assessments of current and future environmental conditions, diverse species selection and a portfolio approach to planting (including natural regeneration, local provenances and assisted migration). A detailed example of how we are integrating resilience principles into woodland creation is provided in the Pleasant Forest case study (see Annex 4). Forestry England's design for Pleasant Forest was recently awarded a 'highly

commended' in the woodland creation category at the All England Woodland Resilience Awards, which recognised exemplars of adaptive woodland management. Forestry England has also been awarded 'Plant Healthy' certification which recognises the highest plant health and biosecurity standards.

Increasing species diversity

Increasing structural and tree species diversity is a central target of Forestry England's forest resilience approach. A range of decision-support tools are now widely used across the organisation, such as the Ecological Site Classification tool, which assesses species suitability for different site characteristics and includes future climate projections. Forest Development Types (FDTs) are a promising way of planning and managing more complex silvicultural systems, and a new FDT Working Group has been established to explore how Forestry England will incorporate FDTs into their planning and operations.

Forestry England's Plant and Seed Supply unit is fundamental to forest resilience, both in delivering a diverse range of tree species and genetics and ensuring security of supply. A state-of-the-art one hectare glasshouse has been built, increasing the capacity of plant production and leading the way in modern techniques.

Individual districts are increasing forest resilience through a diverse range of programmes and projects. For example, the Thetford Forest Resilience Programme (East District) is an ambitious initiative creating a 50-year Concept Plan for a resilient future forest, directly involving 35 staff in 16 workstreams, with a dedicated Programme Manager. Central District are transitioning 6,000 ha of Corsican pine to alternative species through a wide-scale strip felling programme. Other districts are addressing resilience through regular updates to forest plans. All districts have increased tree species diversity since ARP2.

Increasing species diversity is fundamental to adapting the nation's forests to a changing climate and also to mitigate the impacts of an increasing number of forest pests and diseases and the changing site conditions such as drought in the East of England. The diversity of species planted across the nation's forests is included as an adaptation indicator with data since 2010 presented in Annex 10.

Knowledge and Capacity Building

Forestry England's commitment to invest in research includes a bespoke Forest Resilience Service Level Agreement with Forest Research for 2021-26. This covers both new and existing research areas, such as emerging species, growth and yield models, environmental DNA and biodiversity indicators. Forestry England are also developing a tailored forest resilience indicator to monitor the status and trends of the resilience of the nation's forests over time.

Knowledge and capacity building is a crucial focus area for Forestry England's forest resilience approach, equipping staff with the necessary skills and information to apply resilience principles widely. A Forest Resilience Network Group has been created to share experiences and ideas between districts and functions, assess new tools and policy, and identify and prioritise areas where districts need strategic support. There is

great staff engagement with training and knowledge sharing, such as through site visits, workshops and webinars. The recent internal forest resilience conference to mark COP26 is an excellent example, involving over 220 staff in an online day of expert talks covering policy, research and practice, and over 80 staff in a series of follow-up site visits.

An internal, national forest resilience communications strategy has been developed to build and maintain momentum in operationalising forest resilience, disseminate strategy and science, and celebrate achievements across the organisation. External communications focus on explaining and promoting Forestry England's forest resilience approach, such as a recent climate campaign on the Forestry England website and social media.

We recognise that forest resilience is a borderless issue. Partnership working enables Forestry England to collaborate on cross-cutting themes and lead the wider industry response. Forestry England are a member of the Forestry Climate Change Partnership and a signatory of the 2021 Climate Change Accord.

4.2.6 Working across the Defra-group

Forestry Commission has worked closely with Defra and its 'arms length bodies', and continues to do so, on adaptation-related issues through:

- Supporting the development of the second and third National Adaptation Programmes, including through the NAP Biodiversity and Ecosystems NAP Working Group, and providing input to NAP reporting and responses to CCC progress reports.
- Contributing to NE's Climate Change Adaptation Manual and Carbon Sequestration and Storage by Habitat report.
- Engaging, alongside Defra and Natural England, with the Forestry Climate Change Partnership, established as a NAP action in 2014, with FC now providing secretariat support.
- Supporting Defra/EA flood resilience and water quality (thermal regime of freshwater habitats) through targeting Countryside Stewardship and England Woodland Creation Offer woodland creation grants using EA derived spatial data.
- Developing and publishing, with EA, guidance on Assessing the Potential Hazards of using Leaky Woody Structures for Natural Flood Management.
- Partnering NE, EA, Kew and BEIS in the Shared Outcomes Fund project 'Nature-based Solutions at Landscape Scale'.

However, there are challenges balancing the needs for nature recovery in native woods with safeguarding the resilience of our wider woodland resource and the multiple goods and services it provides, including some requiring that productivity is maintained.

4.2.7 Adaptation indicator development

The indicators detailed below provide either a baseline to monitor progress against or a time series giving an indication of woodland resilience or public/sector attitudes to resilience. A brief summary of their role in reporting on adaptation is provided with further detail, including recent trends given in Annex 10.

New planting of woodland and trees in England (Forest Services Key Performance Indicator)

Woodland creation helps to expand the overall size and therefore resilience of the woodland resource. It is most effective as an adaptation measure when expanding existing woodlands or linking woodlands in the landscape (including by forming 'stepping stones') helping wildlife to migrate as the climate changes.

Percentage of woodland that is sustainably managed (Forest Services Key Performance Indicator)

Woodland management opens up the canopy to promote natural regeneration and evolutionary adaptation while it also provides the opportunity to implement adaptation measures such as species diversification and transformation to continuous cover systems of management.

Number of additional tree pests and diseases becoming established in England within a rolling 10-year period (Forest Services Key Performance Indicator)

A key indicator of the rising threat to England's woodlands from new pests and diseases and the success of biosecurity measures in addressing that threat.

Number of high priority forest pests in the UK Plant Health Risk Register.

An important indicator highlighting pests and diseases that warrant greater attention in biosecurity surveillance.

Measure of woodland resilience to climate change based on the size and spatial configuration of woodland patches within the landscape (Forest Services Key Performance Indicator)

A spatial indicator that provides an evaluation of the role of woodland creation (and removal) in reducing fragmentation and improving the connectivity of woodlands to enhance their resilience in line with the Lawton principles of 'bigger, better, more joined up'.

Woodland ecological condition in England using information from the National Forest Inventory (Forest Services Key Performance Indicator)

Aggregate indicator incorporating a range of metrics that relate to ecological condition, including, for example, species diversity, canopy structure, regeneration, biotic damage, deadwood and veteran trees.

Wildfire indicator on the nation's forests and other public and private woodlands

This indicator reports the impact (area burnt, number of incidents and duration) of wildfire within forests and woodlands providing a framework for evaluating the impact of climate change and risk management on wildfire risk.

Diversity of tree species planted within the nation's forests

A key indicator of progress made in species diversification in the nation's forests, including both broadleaf and conifer species.

5 Outline Adaptation Plan 2022-2026

FC's ARP3 outline adaptation plan is summarized in Table 3 with further details given in the following sections. The plan is based on actions from the ARP2 outline adaptation plan that have not started, are partially completed or are ongoing, together with actions set out in the England Trees Action Plan and 2018 Tree Health Resilience Strategy (see Annex 6) that FC is a contributor to, and new actions responding to the findings of this review. Actions for Forest Services, Forestry England and Forest Research are included.

Table 3. Summary of actions from the ARP3 outline adaptation plan for the ARP reporting period 2021- 2026, together the issue the action addresses and the source of the action.

Further or new action **Issue(s) addressed by the action**	**Timescales for actions**
Action 1: Launch the Centre for Forest Protection **Issue addressed:** pests and disease outbreaks and climate change *England Trees Action Plan (ETAP) Action 3.1*	Winter 2021/ Spring 22
Action 2: Develop a Woodland Resilience Implementation Plan (WRIP) to improve the ecological condition of our woodlands and increase their resilience to climate change, pests and diseases. **Issue addressed:** pests and disease outbreaks and climate change *England Trees Action Plan (ETAP) Action 3.3*	Autumn/Winter 2022/23
Action 3: Improve tree health grants and restocking support in response to pest or disease incidences. **Risk addressed:** loss of tree cover and lack of resilience. *England Trees Action Plan (ETAP) Action 3.6*	Pilot launched summer 2021; Full rollout autumn/ winter 2024
Action 4: Publish a new GB Plant Biosecurity Strategy. **Issue addressed:** Lack of common approach to plant health. *England Trees Action Plan (ETAP) Action 3.23*	2022
Action 5: Provide dedicated financial support, guidance and pilot new approaches to deliver riparian planting through the new England Woodland Creation Offer. **Issue addressed:** Flooding. *England Trees Action Plan (ETAP) Action 1.17 & Action 1.18*	Ongoing
Action 6: FR will publish a UKFS Riparian Woodland Practice Guide. **Issue addressed:** Lack of guidance on riparian woodland creation and management to maintain the thermal regime of freshwater habitats. *2014 SIS action*	Spring/Summer 2022
Action 7: Support the Forestry Climate Change Partnership. **Issue addressed:** Lack of clear guidance and adaptation implementation. *England Trees Action Plan (ETAP) Action 3.10*	Ongoing
Action 8: Continue actions as agreed under the Climate Change Position Statement 2019 and Future Forests programme. **Issue addressed:** Corporate response to climate emergency. *Continuation of new action from ARP2 programme*	Ongoing
Action 9: Forestry Commission will publish a new UKFS practice guide on adapting forest and woodland management for the changing climate. **Issue addressed:** Lack of clear guidance on appropriate adaptation. *England Trees Action Plan (ETAP) Action 3.10*	Winter 2021/22

Action 10: FS will ensure that climate change impacts and adaptation remains at the heart of the Science and Innovation Strategy for Forestry in Britain (SIS). **Issue addressed:** Addressing evidence gaps and supporting development of adaptation best practice. *Ongoing action from ARP2 programme*	2026
Action 11: Delivering nationally accredited training on wildfire resilience. **Issue addressed:** Wildfire. *New action from ARP2 Programme*	2022-23
Action 12: Forest Services will work in partnership to create a Wildfire Risk Map. **Issue addressed:** Wildfire. *Ongoing action from ARP2 programme and 2017 NAP*	2024
Action 13: Develop a national deer management strategy. **Issue addressed:** Increase in distribution and numbers of deer. *England Trees Action Plan (ETAP) Action 3.4*	Spring 2022
Action 14: Update the Grey Squirrel Action Plan (GSAP). **Issue addressed:** Continued threat from grey squirrels. *England Trees Action Plan (ETAP) Action 3.5*	Spring 2022
Action 15: Develop new guidance for England that will help determine when afforested peat should be restored to bog and the costs associated with that. **Issue addressed:** Peatland protection and resilience. *England Trees Action Plan (ETAP) Actions 1.23, 1.24 & 1.25*	Action 1.23 and 1.24: Spring 2022. Action 1.25: by Summer 2024
Action 16: FC to support Defra in providing funding to support UK public and private sector nurseries and seed suppliers. **Issue addressed:** Lack of planting stock. *England Trees Action Plan (ETAP) Action 1.29 [Package of support for nurseries including capital grants and TPIF launched June 2021]*	Spring 2022
Action 17: Maintain our membership of the European Forest Genetic Resources Programme. **Issue addressed:** Lack of genetic diversity in trees and woodlands. *England Trees Action Plan (ETAP) Action 3.11*	Ongoing
Action 18: Support and promote UK plant healthy scheme encouraging more growers to become members. **Issue addressed:** Biosecurity. *England Trees Action Plan (ETAP) Action 3.20*	Ongoing
Action 19: Continue to support research to ensure our forests and treescapes are resilient to current and future threats, including investigating climate adaptation and pests and diseases. **Issue addressed:** Evidence gaps. *England Trees Action Plan (ETAP) Action 5.6*	2021-2026
Action 20: Forestry England to develop a Forest Resilience Strategy. **Issue addressed:** Enhancing Resilience. *New ARP3 action from Future Forests programme*	December 2022
Action 21: Forestry England: Creation of a forest resilience indicator **Issue addressed:** Lack of Resilience indicator. *New ARP3 action from Future Forests programme*	December 2022
Action 22: Update the woodland management and creation plan templates.	December 2022

Issue addressed: Need to embed adaptation planning as business-as-usual activity. *Ongoing action from ARP2 adaptation programme*	
Action 23: Advise Defra on how future (ELM) grant support could be effective in implementing the guidance given in '*managing England's woodlands in a climate emergency*' and the supporting evidence alongside other woodland creation/management objectives. **Issue addressed:** Need to embed adaptation as business-as-usual activity. *New ARP3 action from Future Forests programme*	Ongoing
Action 24: Evaluate the effectiveness of the UKFS Climate Change Guidelines at the next review point (2022). **Issue addressed:** Adaptation requirement strengthened in UKFS, underpinning forestry grants, regulations and best practice. *Ongoing action from ARP2 adaptation programme*	2023
Action 25: Promote and embed adaptation measures in woodland (and other habitats) created through the Shared Outcomes Fund project 'Nature-based solutions at Landscape scale'. **Issue addressed:** Opportunity to integrate adaptation measures across landscapes and habitats. *New ARP3 action*	2022-2024
Action 26: Introduce a condition for all tree and hedgerow planting grants that tree and plant suppliers should be able to demonstrate that they can meet the requirements set out in the published Plant Health Management Standard. **Issue addressed:** Biosecurity. *England Trees Action Plan (ETAP) Action 3.21*	To be confirmed
Action 27: Introduce procurement criteria for government contracts that tree and plant suppliers should be able to demonstrate that they can meet the requirements set of the Plant Health Management Standard. **Issue addressed:** Biosecurity. *England Trees Action Plan (ETAP) Action 3.22*	To be confirmed

5.1 Further detail on selected actions

Action 2 – Woodland Resilience Implementation Plan

Develop a Woodland Resilience Implementation Plan (WRIP). Our trees, woodlands and forests are at risk from a range of pressures including pests and diseases and climate change. The WRIP will be developed to improve the ecological condition of our woodlands and increase their resilience to climate change, pests and diseases.

We want to help woodland managers improve the ecological condition, resilience, carbon sequestration potential, biodiversity and connectivity of woodlands, encouraging a more diverse age structure and species mix via low impact silvicultural systems such as continuous cover forestry. The Woodland Resilience Implementation Plan (WRIP) will set out the management actions (including updating existing guidance or writing new guidance) required for a wide range of different woodland types to contribute to ecological and climate change resilience.

The development of the WRIP will coincide with the review of the Keepers of Time (KOT) document and the definition of long-established woodlands, both of which are England Trees Action Plan (ETAP) actions and fundamental to the development of the WRIP. There are also dependencies with ETAP actions 3.4 and 3.5 (production of a national deer management strategy and the update of the grey squirrel action plan) within the WRIP project implementation document.

Other actions that will fall under the umbrella of the WRIP programme are:

- Consider including a definition for new native woodland in the next iteration of *Managing England's woodlands in a climate emergency (MEWCE)*;
- Agree a list of 'advancing native species', including Scots pine, with Natural England and the wider Defra Group and publish in MEWCE;
- Consider defining a new category of 'Recent Native Woodland', in which there is greater flexibility to enhance resilience.

Actions 5 and 6 – support for riparian planting

Ensure that EWCO provides additional adaptation benefits, such as riparian planting by means of targeted incentives. Provide dedicated financial support and guidance for riparian planting through EWCO, using over 100 existing catchment partnerships to target delivery. Pilot new approaches to deliver coordinated woodland creation within targeted catchments, harness private investment and maximise benefits. EWCO targeting maps for riparian shade prioritisation ('Keeping Rivers Cool') will be revised in Spring/ Summer 2022, using a new lidar-derived dataset with 100% land coverage. FR will also publish a UKFS Riparian Woodland Practice Guide.

Action 7 – support the Forestry Climate Change Partnership

Support the Forestry Climate Change Partnership in bringing the sector together to speak with a single voice on the need for adaptation across the management objectives and preferred actions of all members of the partnership; support the updating of the Climate Change Accord and Action Plan and FC to provide secretariat support to further the effectiveness of the partnership.

Action 8 – continue the Future Forest programme

Continue actions as agreed under FC's 2019 Climate Change Position Statement (the Future Forests programme).The Forestry Commission has a key role to play, and we will continue to work closely with our Forestry Climate Change Partnership Action Plan partners and all parts of the tree, woods and forestry sector to protect our woodlands for future generations.

We will:

- lead by example, making the woodlands we look after more resilient
- provide advice and support to landowners and managers so they can make changes now
- keep learning through research, monitoring and the exchange of knowledge

Actions 11 and 12 – enhancing wildfire resilience and response

Delivering nationally accredited training on wildfire resilience to help promote good practice and create a framework for further wildfire resilience. Ensuring woodlands are more resilient to natural hazards. Forest Services will also create a Wildfire Risk Map. While Forestry Commission has a database of wildfire incidents attended by Fire and Rescue Services. For regulation (EIA), forest management planning and future climate change modelling, we require a risk map of possible high threat sites and landscapes. Partnership work between University of Manchester, Forest Research and Forest Services has successfully demonstrated an approach used by Canada and New Zealand.

Action 15 – peatland protection

Develop new guidance for England that will help determine when afforested peat should be restored to bog, and to minimise impacts on peaty soils from tree planting. Develop metrics that allow decision-makers to assess the realistic costs of forest to bog restoration. Improve land use decision-making through the new peatland map data, once it is complete in 2024. These actions will support peatland protection and the objectives of the England Peat Action Plan (EPAP) by, typically, removing poorly performing plantations that compromise the hydrology of peatland habitats.

Action 16 – provide support for tree nurseries

FC to support Defra in providing funding to support UK public and private sector nurseries and seed suppliers, to enhance quantity, quality, diversity and biosecurity of domestic tree production. This will include capital grants and support to augment investment and stimulate innovation. FC opened the Tree Production Innovation fund in June 2021 with the aim of supporting projects with outputs that will better equip nurseries to supply the trees required for new woodlands and urban planting projects. Applicants are invited to apply for between £20K and £200K in grant funding to support innovative projects that address one or more of a number of challenges identified as barriers to tree nursery production. Providing better data on demand and supply will allow nurseries to plan for future needs. Capital grants will enhance the quantity, quality and diversity of nursery supply and will help build resilience against disease and extreme weather events. Forestry England will also publish a plan to exploit the full genetic potential, in terms of seed supply, for the nations forests.

Action 17 – support for EUFORGEN

Maintain our membership of the European Forest Genetic Resources Programme to promote the conservation and sustainable use of forest genetic resources in Europe. The UK Forest Genetic Resources Strategy was published in 2019. The strategy aims to create a framework for collaboration to better understand, protect and use the genetic diversity in the UK's trees. FS will take the lead as UK national coordinator for EUFOGEN.

Action 18 – support and promote the Plant Healthy scheme

Support and promote UK plant healthy scheme (Animal and Plant Health Agency APHA lead) encouraging more growers to become members. Biosecurity risks are increasing

due to increased international trade of plant materials, and as climate change is altering the geographical range of many pests and diseases. Forestry England arboreta plan to gain plant healthy certification for their propagation units in 2022.

Actions 20 and 21 – Forestry England resilience strategy and indicator

Forestry England will develop a Forest Resilience Strategy, including specific and measurable actions and targets. Mitigates against the risk of action being too slow, reactive or ineffective by providing specific targets against which progress can be monitored. It will also outline expectations for different staff groups, clarifying individual and team responsibilities and providing accountability. Forestry England will also develop of a forest resilience indicator to addresses the lack of adequate information to monitor the resilience status and condition of the nation's forests.

Action 25 – Nature-based Solutions at Landscape Scale

Forest Services will work with Natural England, Environment Agency, Kew Science, Defra and BEIS to embed adaptation principles in any woodland (and other habitats) created through the HMT Shared Outcomes Fund project, Nature-based Solutions at Landscape Scale. The project is a £12.5 million project coordinated by Natural England to test joined-up landscape scale delivery of nature-based solutions for climate and nature recovery objectives. FC's main role is in testing and developing new blended funding models for landscape scale action in three pilot areas, together with ensuring that new carbon finance models adopt the robust monitoring, reporting and verification principles of the Woodland Carbon Code.

5.2 Filling gaps in evidence and addressing uncertainty: Climate Change in FC's Science and Innovation Strategy for Forestry in Britain

The Science and Innovation Strategy for Forestry in Great Britain (SIS) (see Annex 1) was published in 2020. It provides a framework for forestry-related scientific research. It aims to support the management of our forests, woodlands and trees in England, Scotland and Wales.

This framework recognises the key role the sector has in:

- addressing the challenges of reversing the decline in biodiversity, climate change, and
- supporting the green recovery from COVID-19, and science and innovation's contribution in this.

The strategy sets out high level outcomes, themes and areas of research interest. These have been identified by the Welsh, UK and Scottish Governments and forestry stakeholders. This includes research on the following themes:

- sustainable forest management in light of environmental change
- markets for forest products and services
- societal benefits from trees, woods and forests

- resource assessment and sector monitoring
- achieving multiple ecosystem benefits
- woodland creation and expansion
- tree health and biosecurity

Delivery of the research commenced in April 2021 and will run for 5 years. Key areas relevant to adaptation and resilience are summarized below:

ESC works on 20/30 year mean climate data, but Forest Research have identified that risks to forests are likely from extremes that deviate substantially from the mean conditions. To provide some advice on this aspect, FR propose to use a process-based model which works at a finer temporal granularity than ESC to provide statistical analysis of extreme droughts that will have impacts on growth rates and suitability. FR also plan to test the outputs of such models over mean periods to help align the knowledge-based ESC tool with physiologically driven outcomes of yield into the future.

To complement ESC based estimates of species tolerance to long term trends in temperature and precipitation, a series of climatically driven drought risk maps will be provided. This will allow the identification of sites with drought related risks irrespective of species using the Standardised Precipitation Evapotranspiration Index (SPEI). This is a widely used index for appraising drought severity and will allow regional pictures of event frequency and severity to be identified, which users can than relate to tree species, objectives and local soil properties.

In addition, FR is working on a Resilience Indicator for Forestry England. This indicator is being developed with a drought risk component that will link to the Sub Compartment Database (SCDB) to assess the vulnerability of stand/site interactions. By adding a likelihood of SPEI for future decades the indicator will be able to assess drought risk. Currently, FR is unable do all of this for the private sector. However, they are mapping the probability of species in the private sector using a machine learning techniques. A method to map the location of oak across Britain has been developed which has a high level of accuracy. This approach could now be extended to cover other major tree species, to help provide NFI regional advice on the risk of abiotic and biotic impacts, forest resilience, and the provision of ecosystem services from woodlands.

5.3 Sector partnership

Conclusions from BWS 2020 survey

BWS 2020 provides an important dataset for informing forestry policy; while understanding of and interest remains high, there continues to be little evidence of widespread implementation of actions to enhance resilience. The analysis highlights that this adaptation deficit is largest where timber production is not a major management objective and reveals motivations behind implementing resilience actions that can be harnessed in future policy development.

2020 British Woodlands Survey concerns	Actions planned to counter these concerns
Not enough woodland creation – respondents are clear that barriers exist even if land was available, chiefly funding and bureaucracy.	• EWCO now offers higher rates of payments with additional payments for ecosystem services • EIA simplification • Recruitment of Woodland Creation Officers and other specialised staff
Lack of woodland management – concerns about vertebrate pests highlights the damage that deer and squirrels have on actions which can assist adaptation, including natural regeneration. The minority of respondents (31%) having a UKFS-compliant management plan in place is unsatisfactory.	• Woods Into Management project • Deer Action Plan to be created • Update to grey squirrel action plan • Work to be carried out to improve service level standard of WMP • Revision of UKFS • Woodland Resilience Implementation Plan to be created
Lack of diversity in new tree planting – the respondents show a general trend towards desiring more native species. This will please some while frustrating others, given polemic views on native and non-native tree species and merits for adaptation.	• New guidance on lesser used species • Forest Research to continue publishing data on non-native species and on old species trials • Review of UKFS • ESC to include new species
Nurseries are providing a limited range of stock – there was a low response for BWS 2020 among tree nurseries. However, among practitioners, UK-grown planting material is favoured which mostly likely reflects increasing concerns about biosecurity, which is encouraging. Low interest in Improved stock might indicate limitations for enhancing genetic diversity or, at least, for supporting productivity.	• Nursery Innovation Fund in operation
Lack of contingency planning – BWS2020 results very clearly indicate a close relationship between current activities and future intentions. More advocacy and support for practitioners will reap long-term benefits.	• Focus on contingency and other planning highlighted in UKFS online training • UKFS Review
Continuous cover management – the majority of respondents were applying this forest management technique and intend to in future, which is very encouraging.	• UKFS Review
Forest planning and design – low awareness of climate change projections, tree species suitability and influence of soils, all point to poor preparedness in planning and implementing resilience woodlands in future.	• Recruitment of replacement Woodland Resilience Officers to promote best practice more widely
Clarity on adaptation measures – the range of awareness and action reflects the current lack of clarity on best practice, and points further to the importance in updating the UKFS as a priority.	• Review of UKFS
Lack of knowledge sharing practice – most respondents did not collaborate other than to share knowledge and information with wide divergence on current levels of activity. There was however interest expressed in future collaboration, particularly to manage pests and diseases. Support for cooperation and collaboration could have potential for driving landscape-scale change.	• Forest Research to launch a knowledge hub • Forestry Climate Change Partnership to launch a website

The digital resilience campaign run jointly with Defra will continue and support a new digital woodland creation campaign, due to launch early in 2022. The key aim of the campaign will be to reinforce the urgency of adaptation, but that different measures are appropriate for different woodland types and management objectives and over different timescales – addressing the mixed messages that have acted as a barrier to the implementation of adaptation actions over the past 5 years.

Further clarity on appropriate actions will be provided by the UKFS Practice Guide on Adapting Forests to climate change, the ten case studies that will accompany the Practice Guide, the series of climate change notes and more effective communication via an updated FR website.

The material provided by Forest Research will augment the guidance published by Forest Services, the demonstration of best practice in the nation's forests and material provided in partnership with the Royal Forestry Society, the Institute of Chartered Foresters, the Forestry Climate Change Partnership and other organisations and Natural England's Climate Change Adaptation Manual.

5.4 Appraisal of mechanisms to monitor and evaluate

Climate change adaptation has been embedded across the organisation as business as usual, rather than as a bespoke, activity. Where climate change adaptation is treated as a specific activity, evaluation mechanisms are outlined below:

- Sector resilience outreach activity: The efficacy of the sector outreach Programme will be evaluated against the baseline British Woodlands Survey in 2020, when it is repeated (date to be confirmed).
- Adaptation in woodland creation grants: The effectiveness of climate change measures in the Nature for Climate Fund (including the England Woodland Creation Offer) will be evaluated through the Programme's monitoring and evaluation programme.
- Key performance indicators will continue to monitor progress in woodland expansion, the spatial configuration (and resilience) of the woodland resource, biosecurity threats (and responses to them) and wildfire risk.
- The National Forest inventory provides a longer-term monitoring framework for evaluating the efficacy of adaptation measures, particularly future updates of the woodland ecological condition indicator.
- An evaluation of the 2022-2026 ARP3 programme will be provided in FC's fourth round report that would (provisionally) be expected to be completed in 2026.

6 Opportunities, benefits & challenges

6.1 Benefits

Given the long timeframe associated with forest planning and management, it is not possible to identify opportunities or benefits deriving from each of the actions in the adaptation programme set out in the ARP2 report. Interdependencies were covered in detail in FC's ARP1 report; the analysis holds and is not repeated in this review. However, there are three areas where the implementation of adaptation measures has had synergies with other programmes of work:

1) Species diversification in response to recent plant health concerns has been strengthened by initiatives to increase species diversity as an adaptation measure, both on and off the nation's forests.

2) Opportunities for woodland creation and in-forest measures in existing woodlands were identified in the ARP1 report as an adaptation measure to flood management and have been further highlighted in the Natural Flood Management Programme, during this reporting period. This has put FC in the position of having a good knowledge base on which to promote the ability of trees and woodlands to contribute towards natural flood management.

3) Successful adaptation is crucial to provide mitigation against climate change on the journey to Net Zero. Whilst creating new woodland will help deliver additional carbon reductions, the existing woodland resource must also be sustainably managed to preserve and increase the carbon sink and support the development of a low-carbon economy through the continued production of wood products for other sectors such as construction or for fuel.

6.1 Opportunities

Current Government and wider public support for tree planting, together with recent wall-to-wall coverage of climate change issues through the UK hosting the 26th UNFCCC Conference of the Parties in Glasgow provides an unrivalled opportunity to take forward implementation of adaptation measures in the forestry sector. The key opportunities can be summarised as:

- The Nature for Climate Fund: At least £500 million has been allocated to tree planting, woodland creation and woodland management to 2025, together with a proportion of the additional funding for the Nature for Climate Fund announced in the autumn budget. The principal objective is to meet future carbon budgets and achieve net zero, alongside supporting nature recovery. To make a significant contribution to carbon abatement, the woodlands we plant need to be adapted to both the current climate and the climate of the future; this provides a mandate to embed the principles of adaptation across the ambitious tree planting programme so that as well as enhancing the resilience of the woodland resource through increasing its size and connectivity, those new woodlands and treescapes are adapted to the future climate.

- Environmental Land Management schemes: Following the decision for the UK to leave the European Union, opportunities arise from flexibility in domestic rural development schemes, specifically Environmental Land Management (E.L.M). While the England Woodland Creation Offer is expected to transition into E.L.M., new opportunities for adapted treescapes will arise for small scale planting through the Sustainable Farming Incentive, together with landscape approaches in Landscape Recovery; it is therefore critical that FC works closely with Defra to embed forestry and woodland adaptation in all three components of E.L.M.
- England Trees Action Plan: The England Trees Action Plan (ETAP) set out 90 actions to support the vision of a more treed landscape providing for the needs of future generations, including through carbon storage and supplying society's timber requirements, particularly for construction. ETAP provided a holistic vision for England's tree and woodland resource, with resilience at its heart.
- Nature-based solutions: The place of nature-based solutions in addressing climate and biodiversity crises is prominent in domestic and international debate. Well-designed multi-purpose woodlands must be high on the agenda and the Shared Outcomes Fund project, Nature-based solutions at Landscape Scale, provides a practical opportunity for FC to embed adapted woodland design into resilient landscapes.
- National Adaptation Programme: The third National Adaptation Programme will be published early in 2022 and provides the opportunity to set a course for embedding resilience in the three key risk areas identified by the CCC in the CCRA3 evidence report – terrestrial biodiversity, natural carbon stores and commercial forestry – addressing the CCC's observations that more action is required to address the ongoing effects of climate change.
- The Nation's Forests: The scale of the Nation's Forests (253,000 ha) represents an opportunity in its own right, through providing a practical exemplar of a sustainable approach to forest resilience, for both existing and new woodlands, grounded in the expertise in Forestry England as the largest manager of forests and woodlands in England and the research and expertise of Forest Research.

6.2 Key challenges

The challenges that the programme set out in this report need to address are:

- The uncertainty associated with implementing adaptive actions in advance of the full effects of climate change being realised.
- Clear communication that different approaches to adaptation are appropriate for different management objectives.
- Drawing the forestry sector together so that it speaks with one voice on the need to adapt, putting different management objectives aside.
- Ensuring that sufficient, appropriate, planting stock is available to support the ambitious planting programmes.
- Balancing the nature conservation needs of protecting what we have with the need to ensure that our ancient and semi-natural woodlands can with-stand the future climate.

Annex 1: Critical research questions for England

How to design and manage woods for the future

- What is the projected impact of climate change on existing woodlands, including expected increased occurrence of extreme weather events?
- What are the species, or mix of species, likely to thrive in the future? What species could provide alternatives to mitigate for loss of existing species?
- What are the main risks posed by potential invasive species and how should they be managed?
- How should species mixes be managed?
- What are the implications, financial and others, of changing forestry practices – e.g. of growing new species, or increasing continuous forestry cover, or relying more on natural regeneration?
- What mechanisms will best incentivize landowners and managers to create and manage resilient woodlands?
- What will climate change mean at a local/site level, including in terms of biodiversity?
- How can new technologies help monitor impact on trees?
- How do we build resilience at a landscape scale?
- What are the extent and impacts, positive and negative, of deer and squirrel populations?
- What are the 'maximum tolerable' densities for different types of woodland and objectives (deer, squirrel, wild boar)?
- What is the impact of recent pine marten releases on grey squirrel population as well as wider impact?
- What is the impact of recent releases of beavers?
- What evidence is there in favour of, or against, the (re)introduction of large predators e.g. to reduce the impact of deer on forestry establishment?
- What is an appropriate use of chemicals and plastics in forestry? How we reduce their use?

Understanding threats from pests and diseases

- What are the top 5 high risk pathways?
- Climate adapted species and southerly provenances: what are the specific seed pathway risks and solutions?
- What do we know about existing/native tree species susceptibility to emerging pests and diseases threats, and susceptibility of emerging species to existing pests and diseases?
- What are the optimal management approaches to reduce the impact of pests and diseases? (e.g. optimal Integrated Pest Management solutions.)

How can we be more effective in helping the public to understand and accept the benefits of active forest management?

- Why do people hold the opinions they do about woodlands and active woodland management?
- What information should be provided to which segments of the population, using what tools and channels, to turn around public perception of forestry?
- How do we explain landscape changes?

How can future forests support better health and well-being?

- What do people really think of their local trees/woodlands?
- What does the health sector understand of the benefits of woodlands and how to 'prescribe'?
- What is the best way to get people to connect with woodlands? What methods will best work to get them to value and use trees and woodlands? What impact do people's values have on how they use woodlands?
- How can we value, and improve trees and woodlands contribution to the health agenda?
- What is the urban canopy cover trend?
- How will climate change impact urban trees specifically?

How can we be more effective in convincing more landowners and managers to create more woodland?

- What are the arguments and information that we need to make to different segments of the landowners and land managers population to convince them to create woodlands?
- What are a range of economic models for farm forestry?

What will the impacts of climate change be on soils, and what will this mean for forestry?

- What is best practice (equipment and techniques) to minimize soil disturbance and carbon release?
- What impact will climate change have on soils?
- What is the overall soil impact of forest operations, including preparation stage and brash removal?
- What are the carbon and other GHG impacts of creating woodland on peat?
- What are the costs and benefits of restocking vs. restoring to peat?
- How do carbon fluxes work in woodland soils, and on sites restored from woodland sites?
- What are the benefits and risks of ancient woodland soil translocation?
- What is a tolerable level of disturbance for mycorrhizae? How quickly does it establish in different scenarios? Does inoculation help?

What will climate change mean for yield and greenhouse capture projections?

- How will climate change projections impact on production?
- How can remote sensing and other developing technologies help improve our models?

What are the future/potential markets for existing and new or emerging species?

- What are the timber properties characteristics of emerging species?
- What are the anticipated future forest product markets?
- What scope is there to improve the productivity of the forestry sector, and how?
- How do changing markets impact the economics of different silvicultural systems (e.g. increasing demand for short roundwood vs. sawlogs)?
- What would be the impacts [on yield and timber quality] of switching to shorter rotations to allow a more flexible response to evolving market demand?
- When is it appropriate (technically, site needs, finances) to harvest more or all of the trees?
- What is the economic viability of different types /scales of woodland?
- What is the GVA of forestry, wood processing and bioenergy businesses in different parts of England?

What is the impact of our choices and decisions on natural capital and ecosystems services delivery?

- How can we characterise and quantify the ecosystem services flow from woodlands for biodiversity, health and well-being, air quality, natural flood management (deemed to be those for which less evidence is available)?
- How can we value biodiversity, health and well-being, air quality, natural flood management ecosystem benefits?
- How will flows and value of ecosystem services evolve in the future?
- How can we value urban trees ecosystem services?
- How could we evaluate the ecosystem services value delivered by single urban trees?
- How could woodland creation be targeted and designed to deliver water quality?
- How could woodland creation be targeted and designed to deliver water natural flood management?

Evolving the National Forest Inventory

- Which woodlands are actually in active management?
- Where is woodland removal happening in relation to felling licences granted?
- Where is planting and restocking occurring and of what quality?
- What is the species diversity of new woodland creation and restocking?
- What is the rate of loss of ancient woodland?

Annex 2: Adaptation in the Science and Innovation Strategy (SIS)

Programme 1 - Sustainable Forest Management in the light of environmental change

WA1: Environmental Change impacts & susceptibility assessments
Bringing together work on forest susceptibility to environmental change impacts, the drivers of responses observed, and risk associated with environmental change and climate extremes.

WA2: Climate Smart Forestry
Generating evidence on Greenhouse Gas balances (GHG), soil carbon function and the environmental change mitigation benefits of different silvicultural systems, forest and peatland management. It will also provide socio-economic evidence supporting the understanding of mitigation/adaptation delivery and barriers to uptake in the forestry sector.

WA3: SFM (Sustainable Forest Management) and building resilience to Environmental Change
Delivering an improved understanding of forest management which accounts for resilience to environmental change, and which adheres to sustainable development principles (maintaining production, biodiversity, regenerative capacity, and ability to fulfil ecological, social and economic functions without damage to other ecosystems).

Programme 2 – Markets for forest products and services

WA1: Availability of future markets
Improving the productivity and quality of the softwood and hardwood timber resource to widen future markets. Activities will include tree improvement through selection and breeding, together with the development of timber properties models which will be used to assess the quality of future timber supplies and inform management decisions.

WA2: Barriers to use of domestic timber
Overcoming barriers to the use of domestic timber, while improving efficiency in the supply chain and building resilience. Activities will include improved methods for assessing quality, use of remote-sensing, and breeding for resistance to disease.

WA3: Market potential of emerging species
Characterising the properties of timber that will be produced from British forests as managers seek to increase diversity and improve resilience in response to climate change.

WA4: Short Rotation Forestry
Investigating Short Rotation Forestry to improve the productivity of biomass. This activity will reduce the need for imports and contribute to CO2 capture.

WA5: Payments for ecosystem services
The aim of this WA is to investigate the development of payments for ecosystem

service markets.

Programme 7 – Tree health and biosecurity

WA1: Diagnostic, advisory and phytosanitary provision

Operating and evolving FR's Tree Health Diagnostic and Advisory Service (THDAS), providing an early warning system, detecting new biotic threats and prompting reactive research. Reporting will be promoted via the web-based tool TreeAlert, and citizen science surveillance through Observatree. It integrates with phytosanitary work to evaluate risks from new and existing regulated pests and pathogens through horizon scanning and surveillance, thereby informing the responses of Plant Health teams, policymakers and practitioners.

WA2: Understanding pest and pathogen threats

Focusing on understanding new and changing pest and pathogen threats including invasive beetles (such as of *Ips typographus*) and pathogens with changing profiles or altered behaviour (including *Dothistroma* and *Phytophthora*) to determine the vulnerability of UK forest types to their establishment and to identify proactive management actions. There will also be a focus on host species, as part of an integrated approach to understand the susceptibility of new and emerging tree species to pests and diseases.

WA3: Improved detection, monitoring and surveillance

Develop existing and new methods for monitoring and surveillance of key pests and pathogens, based on a greater understanding of their ecology, dispersal capability, host preferences, epidemiology and genetics. Approaches include use of improved trapping methodologies, development of DNA based diagnostic tools and metabarcoding, and exploration of the use of remote sensing.

WA4: Pest and disease management for resilient treescapes

Informing forest management to increase resilience to pests and diseases. Work includes refining established management methods such as spatial modelling, chemical treatments and non-chemical or bio-control treatments. Novel methods will also be developed for control, improved prediction of pest spread, and use of viruses to control fungal pathogens. The WP also includes ongoing support and advice for control of mammal pests, particularly grey squirrels.

WA5: Interdisciplinary approaches to enhance biosecurity

Adopting an interdisciplinary approach on topics relevant to woodland expansion. It will harness natural resistance in tree populations, particularly oak, larch and juniper and explore the social dimensions of tree health including evaluation of biosecurity messaging on public behaviours and improving our understanding of the biosecurity practices of hard-to-reach stakeholder along plant pathways.

Further details of all research programmes developed following publication of the new Science and Innovation Strategy for forestry in Great Britain are available on the Forest Research website.

Annex 3: Science and Innovation Strategy – success criteria

To inform the forestry research requirements of Forestry England and Forest Services (FS) for the 2021-26 SIS for Forestry in Great Britain a paper was produced that built on work undertaken in a policy and advice team session and a joint Forestry England and FS session. The new SIS needed to reflect the main priorities of:

- Increasing woodland cover.
- Improving forests resilience to climate change related impacts.

For each of the ten evidence needs, a paragraph was produced highlighting what success would look like. Those paragraphs are reproduced below.

How to design and manage woods for the future: The design and management and woodlands minimise the negative impact of climate change and associated changes on those woodlands and the ecosystem services they deliver (*or* build on potential opportunities). The impact of deer, squirrel and biotic threats on woodlands is well understood and minimised. Forest managers are confident in what they need to do.

Understanding threats from pests and diseases: Woodlands are more resilient to pests and diseases through improved understanding and active management of higher risk pathways – including conditions and restrictions for some imports. Woodland management practices minimise the impact of pests and diseases, from seed collection and nurseries through to harvesting.

How can we be more effective in helping the public to understand and accept the benefits of active forest management? The public understand the benefits delivered by woodlands and the need for active woodland management to ensure these can be delivered in the future.

How can future forests support better health and well-being? Public policy, in particular for health and well-being, fully recognises the positive role of woodland and is supporting connecting communities with woodlands. Members of the public are aware of and interested in how woodlands can benefit their health and well-being, and they use woodlands for that purpose. The planning system integrates woodland into development. The implementation of Environmental Net Gain has resulted in more value placed on and less detrimental impact on woodlands close to people.

How can we be more effective in convincing more land owners and managers to create more woodland? Landowners and managers see how woodland creation can contribute to meeting their objectives. They are confident that land use change is the right choice for them, and how to design, create and manage woodlands that will meet their needs.

What will the impacts of climate change be on soils, and what will this mean for forestry? Forest managers understand, and act to protect, the inherent value of soils for sustainable forest management.

What will climate change mean for yield and greenhouse capture projections? Forest managers and policymakers have access to, and are using, fit-for-purpose modelling tools. Greenhouse gases inventory and models reflect the reality of what is happening in woodlands.

What are the future/potential markets for existing and new or emerging species? Woodland owners and manages start planting species that are both likely to thrive towards the end of the century and managing them to maximise the versatility of timber products for future, as yet unknown, demand and markets.

What is the impact of our choices and decisions on natural capital and ecosystems services delivery? Forest and land managers and landowners make well informed decisions about natural capital asset management, based on sound data and evidence. The value of ecosystem services delivered by woodlands increases.

Evolving the National Forest Inventory: The National Forest Inventory provides information and reporting to NFI customers that allows them to understand what the woodland resource is, and the impact of forestry policies and activities. Information is provided in time to allow management, or regulatory, response. It relies on a robust methodology. The goals of the NFI are agreed and sustainably funded.

Annex 4: Forestry England case study – Pleasant Forest woodland creation

Pleasant Forest is a 118 ha multi-purpose woodland being created on a former arable farm. The design includes a diversity of woodland types to reflect different aims in different blocks. Resilience is key to the long-term delivery of the site's objectives, including carbon sequestration, sustainable timber production, high natural capital value, biodiversity net gain, and recreation.

The site's location in southeast England makes it extremely vulnerable to environmental change and disease pressures. The extreme UKCP18 high emissions scenario projects 3-5°C increases in summer temperatures and 10-20% winter rainfall increases by 2070. The management plan accounts for this through careful species choice, habitat diversity (including large areas of continuous cover forestry) and habitat restoration to alleviate future effects of temperature extremes, drought, and winter flooding.

Resilience will be delivered through high species and structural diversity. Detailed site assessment – including climate modelling, the Ecological Site Classification tool, soil surveys and consultation with Forest Research – led to the selection of 22 conifer, 19 broadleaf and 14 shrub species. On groundwater-affected soils, species include aspen, common alder and black poplar, whilst species on sandy soils include scarlet oak, Scots pine and maritime pine, selected for drought tolerance. Intimate species mixtures will be widely used. High forest conifer and coppiced broadleaf mixtures, bordered by shrubs, will provide structural diversity whilst open areas adjacent to ancient woodland will encourage natural regeneration.

A portfolio approach to planting will include local provenance seed alongside southerly provenances selected through climate matching analysis. Forestry England's nursery will grow French provenance black walnut, small-leaved lime and hornbeam. The risk of failure associated with previously untested French provenance seed is mitigated by the variety of provenances used and planting in intimate mixtures to allow natural succession of the best-suited species.

Research trials on site will inform proactive management decisions for Pleasant Forest and more widely. These include a Forest Research operational trial of 19 different productive species (such as Wellingtonia and coast redwood) and a progeny trial of sycamore in partnership with the Future Trees Trust. A further 4ha broadleaf source-identified seed stand will provide future genetic material for Pleasant Forest and other appropriate woodlands.

To guide nature recovery on site Forestry England follow Lawton's principles of 'Better, Bigger, More, Joined up' by enhancing existing mature trees and hedgerows, creating habitat and promoting ecological connectivity. Habitats established for Forestry England's 'flagship' species (great crested newt and dormouse), such as a stepping-stone network of 10 new ponds, will benefit a wide range of species. A mosaic of diverse shrub and nectar-rich grassland corridors will provide a habitat network for

declining species of migrant birds, invertebrates and reptiles. Wildflower areas will be established using green hay from local greensand sites.

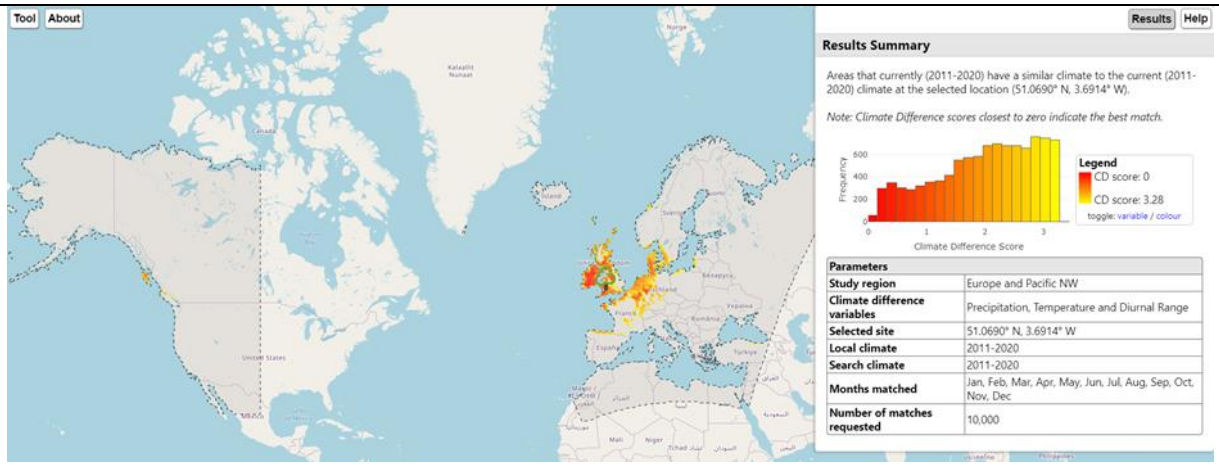
Digital visualization of Pleasant Forest prior to woodland creation taking place.

Digital visualization of Pleasant Forest following woodland creation.

State-of-the-art biodiversity monitoring will employ eDNA techniques, draw on expertise of partner organisations, and involve local schools, recognising that knowledge-sharing and cross-generational collaboration are key to creating a socially resilient woodland.

Pleasant Forest has been designed with environmental and social resilience at its heart, to create a thriving new woodland that is fit for the future. Forestry England are proud that their design for Pleasant Forest was recently awarded a 'highly commended' in the woodland creation category at the All England Woodland Resilience Awards, which recognised exemplars of adaptive woodland management.

Annex 5: Forestry Commission case study – The Climate Matching Tool



https://climatematch.org.uk

There is an increasing need to better understand, and have access to, information on future climate projections and what such changes mean for forests and woodlands in the UK (BWS, 2020). Challenges remain in translating available information on future climate projections into accessible methods to demonstrate what local ecology may look like 50 years from now.

In 2020, Forest Research launched the Climate Matching Tool (CMT) to support forest managers to plan and plant forests that are resilient to both the current and future climate (Forest Research, 2020). The Climate Matching Tool addresses the challenges of utilising data on climate projections by providing a visualisation of locations with a comparable present-day climate to the future climate of any location in Europe (Forest Research, 2020). The CMT helps landowners and practitioners to visualise what the ecology of a site may look like in the future.

Developed in collaboration with UK and international partners, the CMT applies the UKCP18 climate data from Europe to identify sites that are similar to one another based on 3 key variables.

- monthly mean precipitation
- average temperature
- diurnal temperature range

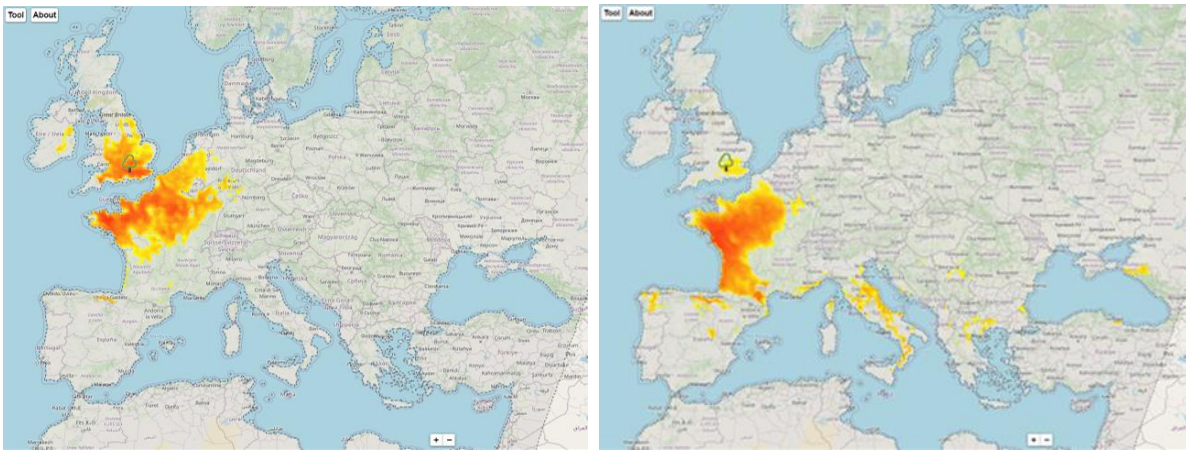
The climatic matches can be interrogated on the basis of each individual variable to explore suitability where a species' range is limited by certain factors (such as moisture availability or frost episodes). Alternatively, the three variables can be evaluated at the same time to give an idea of the general, future climate over 10 or 30 year periods. This information can be used to determine the changes to species and provenance selection, woodland structure and functioning required to support adaptation to a changing climate.

Use of the tool to investigate future climate analogues in England indicates that the effects of climate change are not likely to be felt equally across the country. These changes are projected to be more severe in the south and east of England, where the current range of broadleaf species and provenances used may become unsuitable for forestry by the end of the century (Forestry Commission, 2020). Equally, some areas of the England may see suitability for certain forestry species increase. Areas where water is not a limiting factor may experience faster levels of tree growth as a result of increased CO^2 levels and longer growing seasons (Forestry Commission, 2020).

In the northwest of England, climate modelling indicates that conditions for some naturalised species such as beech will remain favourable or improve (Natural England, 2009). As the distribution of tree species alters in response to climate change, the opportunity should be taken to diversify the species mixtures within woodlands (Forestry Commission, 2020).

Climate projections for sites in the south and east of England indicate that these areas are likely to experience a future climate (2071-2080) which is representative of the conditions observed today in the north and west of France (see images below). Looking beyond geographic boundaries can help to anticipate future species and genetic suitability, and the potential challenges caused by a changing climate such as increased susceptibility to pest and disease outbreaks, and changes in the distribution of a pest's host range.

Climate match for Southeast England 2021-2030 (left) and 2071-2080 (right)



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Annex 6: Actions from the Tree Health Resilience Strategy (2018)

Action 1: International Leadership & Awareness Raising – *Take a leading role in international efforts to strengthen biosecurity and build resilience. Facilitate information sharing and work collaboratively to ensure those involved in tree health are aware of risks and know what to do to reduce them.*

Future focus (government led):

- Publication of a new Plant Health Biosecurity strategy in 2020.
- Continued awareness raising campaigns – e.g. Don't risk it, Keep it clean.
- Promotion of International Year of Plant Health 2020.
- Work with key stakeholders using networks to ensure knowledge transfer between those engaged in caring for the nation's trees.

Future focus (sector led)

- Establishment of a senior UK committee of representatives from across the trades and professions that will drive forward better biosecurity practices.
- Collaboration with government on awareness raising.

Action 2: Horizon Scanning & Risk Assessment – *Maintain our world leading risk-based approach to ensure that activity and decisions are informed by a systematic assessment of risk and targeted to deliver the best protection to unforeseen risks.*

Future focus (government led):

- Continue to maintain and develop the UK Plant Health Risk Register and Risk Group.
- Develop a new tree health section on the Plant Health Portal to provide accurate and up to date information on threats to trees.
- Develop further partnerships with industry, the public and stakeholders to broaden the network of those feeding into horizon scanning activities.
- International collaboration to improve communication on risk.

Future focus (sector led):

- Sharing intelligence on high-risk trades and purchasing practices.

Action 5: Safe Sourcing & Better Biosecurity Practices – *Work collectively to improve sourcing of material and ensure high standards of biosecurity are adopted throughout all practices.*

Future focus (government led):

- New consultation with industry on quarantine for high-risk species and commodities.
- Raise awareness and support the development of assurance and certification schemes, including exploring the potential for harmonisation of schemes.
- Explore if public procurement strategies can be strengthened to specify safe sourcing.
- Explore opportunities to support UK tree production.

- Support understanding and management of Forest Genetic Resources including the new UK strategy for Forest Genetic Resources and a continued commitment to wild source seed collection to support tree conservation and identification of future species (e.g. for timber).
- Explore opportunities for hardwood timber supplies, to help increase the proportion of broadleaf woodlands that are sustainably managed.

Future focus (sector led)

- Raising awareness of assurance and certification schemes which provide end to end assurance along the pipeline.
- More widespread application of voluntary quarantines for high-risk trees and commodities.
- Sharing intelligence about high-risk trades.
- Changes to practices to specify safe sourcing e.g. Royal Horticultural Society ban on imported trees being used directly in shows, gardens or for retail.
- Emphasise biosecurity in routine management operations e.g. cleaning machinery and equipment prior to movement between sites; sourcing quality planting stock; managing sub-contractors to achieve same standards.

Action 6: Preparedness & Contingency Plans – *Work to improve preparedness and contingency planning to help ensure effective outbreak response*.

- Future focus (government led):
- Readiness reviews of priority pests e.g. Xylella and Emerald Ash Borer.
- Consultation on top threats for preparedness and readiness reviews.
- Continued development and review of pest specific contingency.

Future focus (sector led)

- Preparation of site-specific (and perhaps sector-specific e.g. nurseries) contingency plans for high risk and vulnerable sites e.g. shows, collections and arboretums.

Action 7: Targeted Surveillance - *Maintain strong surveillance capability and work with interested parties to increase knowledge about spread/ distribution.*

Future focus (government led):

- Launch of Observatree phase two.
- Development of new approaches to detect and identify pests and diseases, including investment in early detection/in field diagnostics.
- Investment in remote sensing technologies where proven cost effective.
- Analysis of National Forest Inventory (NFI) to provide data on elements of woodlands and investigate new monitoring programmes (including trees outside woods).

Future focus (sector led):

- Increased surveillance and reporting through routes such as TreeAlert.
- Greater emphasis on surveillance in training.

Action 8: Species & Pest Specific Management Plans – *Manage priority pests and diseases already present in England in line with the resilience circle.*

Future focus (government led):

- Evolving policies and management programmes in line with the new resilience circle.
- Launch of Action Oak, a new public-private partnership model of investment in oak health.
- Funding the Tree Council to work with the sector to develop Ash Dieback Local Action Plans.
- Work in collaboration to provide guidance and advice and ensure knowledge transfer.

Future focus (sector led):

- Work in partnership to manage priority pests and diseases, developing and implementing local action plans for priority pests and diseases.

Action 9: Grant Schemes – *Leaving the European Union and the Common Agricultural Policy will give us the opportunity for fundamental reform.*

Future focus (government led):

- New agricultural policy to be underpinned by payment of public money for the provision of public goods.
- HS2 (High Speed 2) Woodland Fund to support restoration of existing ancient woodland sites and the creation of new woodlands along the HS2 route (Phase 1 route only).

Action 10: More trees, woods and forests for the future – *Deliver the 25-year Environment Plan commitments to increase tree planting by creating new forests, and incentivising extra planting on private and the least productive agricultural land, where appropriate.*

Future focus (government led):

- Development of the Urban Tree manual to support the planting of the right trees in the right place.
- Supporting the New Northern Forest.
- Encouraging large-scale woodland and forest creation.
- Promoting, sourcing and planting of provenances suitable to local conditions and future climate change scenarios

Future focus (sector led):

- Delivery of the New Northern Forest comprising 50 million trees over 25 years.

Action 11: Woodland and Tree Management – *support active management.*

Future focus (government led):

- Update the Ancient Woodland Inventory.
- Encouraging natural regeneration, species and provenance choice and management practices which improve resilience.
- Better integration of trees and woods within agriculture, including agro-forestry.
- Encourage diversification (including species and structural) and promote processes that underpin genetic adaptation and resilience.

- Promote public access, engagement and learning opportunities to ensure the public 'value' woodlands to complement more formal public benefit valuations.
- Support the Squirrel Accord.
- Duty to consult prior to felling street trees.

Future focus (sector led):

- Bringing more woodland into active management and encourage actions to enhance long term resilience.
- Support the new UK Strategy for Forest Genetic Resources and deliver its action plan through existing and new collaborative activities.
- Support the Squirrel Accord.

The Forestry Commission working in partnership with others such as the Forestry Climate Change Partnership has a role to play in encouraging the sector to take up the future focus actions (highlighted above).

Annex 7: Policy published since ARP2

Policy and important documents related to, or impacting on, adaptation in England's forests since ARP2	
2017	UK Forestry Standard (UKFS) fourth revision published https://www.gov.uk/government/publications/the-uk-forestry-standard Clean Growth Strategy published https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf
2018	25-Year Environment Plan Published https://www.gov.uk/government/publications/25-year-environment-plan Second National Adaptation Programme published https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727252/national-adaptation-programme-2018.pdf UK Climate Projections 2018 published https://www.metoffice.gov.uk/research/approach/collaboration/ukcp
2019	UK Climate Change Act amended to achieve net zero by 2050
2020	British Woodlands Survey 2020 report published https://www.sylva.org.uk/bws
2021	England Trees Action Plan published https://www.gov.uk/government/publications/england-trees-action-plan-2021-to-2024 England Peat Action Plan published https://www.gov.uk/government/publications/england-peat-action-plan Climate Change Committee's (CCC) independent Assessment of Climate Risk published. https://www.theccc.org.uk/publication/independent-assessment-of-uk-climate-risk/ Government response to CCC report published https://www.gov.uk/government/publications/government-response-to-the-climate-change-committee-report-on-progress-in-adapting-to-climate-change Net Zero Strategy – Build Back Greener launched https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf IPCC Sixth Assessment Report: the Physical Science Basis published https://www.ipcc.ch/report/ar6/wg1/

Annex 8: The Forestry and Climate Change Partnership Accord 2021

The Forestry Climate Change Partnership worked in 2021 to refresh their Accord (although at this time it is still not been formally accepted), it states:
'Our shared vision is for Britain's trees, woods, and forests to be resilient and therefore able to meet their full potential in providing the full range of ecosystem services upon which human society and nature depends. This 2021 Accord reaffirms and updates the principles of an accord first agreed in 2015.

We, the undersigned signatories to the 2021 Climate Change and Forestry Accord, agree to take urgent action, recognise the need to work together, and commit to promote the importance of the adaptation of our trees, woods, and forests to climate change.

I. Climate change and related environmental threats, including flooding, fire, pests, and pathogens, present significant threats to our trees, woods, and forests. We recognise that by encouraging greater resilience, we may encourage better adaptation to these threats. We also recognise that there may be opportunities which can be exploited to enhance sustainable forest management in accordance with the UK Forestry Standard.

II. We will agree an action plan and work together to deliver it with a focus on:

a. communicating with those who have a direct stake in the management of trees, woods, and forests;

b. delivering training and education to practitioners to promote adaptation and resilience of trees, woods, and forest;

c. influencing research that supports adaptation of trees, woods, and forests to climate change, and disseminating these findings to practitioners;

d. providing a coherent voice to influence the development of forestry policy and guidance on climate adaptation.

III. We believe that urgent action is necessary to improve the resilience of our trees, woods, and forests to climate change. Given the long-life cycle and immobility of trees, and the long-term practice of silviculture, changes to many widely-practiced approaches to forest management need to be made without delay.

IV. While the signatories to this accord will undertake their own actions to support resilience, we recognise the need to work together towards the common goal of improving adaptation to climate change. Many of these organisations will seek to collaborate through their involvement in, and support of, the Forestry and Climate Change Partnership.'

Annex 9: Acronym glossary

Acronym	Meaning
AFOLU	Agriculture, Forestry, and Other Land Use
APHA	Animal and Plant Health Agency
ARP	Adaptation Reporting Power
ASNW	Ancient Semi-Natural Woodland
BWS	British Woodlands Survey
CCAP	Climate Change action Plan
CCC	Climate Change Committee
CCF	Continuous Cover Forestry
CCRA	Climate Change Risk Assessment
CMT	Climate Matching Tool
CONFOR	Confederation of Forest Industries
COP26	26th Conference of the Parties (November 2021, Glasgow)
CS	Countryside Stewardship
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EIA	Environmental Impact Assessment
EPAP	England Peat Action Plan
EPREC	Extraordinary Payments Received in Exceptional Circumstances
ESC	Ecological Site Classification
ETAP	The England Trees Action Plan
EU	European Union
EUFORGEN	European Forest Genetic Resources Programme
EWCO	England Woodland Creation Offer
EWGS	English Woodland Grant Scheme
FC	Forestry Commission
FCCP	Forestry Climate Change Partnership
FDP	Forest Design Plan
FDRS	Fire Danger Rating System
FDT	Forest Development Types
FIZ	Forestry Investment Zone
FR	Forest Research
FSC	Forest Stewardship Council
FTT	Future Trees Trust
GB	Great Britain
GHG	Greenhouse Gas
GRCF	Green Recovery Challenge Fund
GSAP	Grey Squirrel Action Plan
GVA	Gross Value Added
HR	Human Resources
HS2	High Speed 2

HS2WF	HS2 Woodland Fund
IAP	Incident Action Plan
ICF	Institute of Chartered Foresters
IFOS	Inventory and Forestry Support
IMT	Incident Management Team
KOT	Keepers Of Time
LU	Lowland Heath
NCFP	Nature for Climate Fund Programme
NFI	National Forest Inventory
NFM	Natural Flood Management
NGO	Non-governmental organisation
NVC	National Vegetation Classification
PEFC	Programme for the Endorsement of Forest Certification
PHF	Plant Health Forestry
PHRR	Plant Health Risk Register
PRA	Pest Risk Analysis
PSCPs	Pest Specific Contingency Plans
R&D	Research and Development
RFS	Royal Forestry Society
SCDB	Sub Compartment Database
SFM	Sustainable Forest Management
SIS	Science Innovation Strategy
SNR	Soil Nutrient Regime
SPEI	Standardised Precipitation Evapotranspiration Index
SRC	Short Rotation Coppice
SRF	Short Rotation Forestry
SSSI	Site of Special Scientific Interest
THDAS	Tree Health Diagnostic and Advisory Service
TPIF	Tree Production Innovation Fund
UK	United Kingdom
UKFS	The United Kingdom Forestry Standard
UKWAS	UK Woodland Assurance Standard
UTCF	Urban Tree Challenge Fund
WA	Work Area
WCaG	Woodland Carbon Guarantee
WCC	Woodland Carbon Code
WCF	Woodland Carbon Fund
WCO	Woodland Creation Officer
WCPG	Woodland Creation Planning Grant
WMP	Woodland Management Plan
WRIP	Woodland Resilience Implementation Plan
WwNP	Working with Natural Processes

Annex 10: Indicators relevant to adaptation and resilience

The indicators detailed below provide either a baseline to monitor progress against or a time series giving an indication of woodland resilience or public/sector attitudes to resilience.

New planting of woodland and trees in England (Forest Services Key Performance Indicator)

There was a total of 2,178 hectares of recorded new planting of woodland in England in 2020-21, including that with and without central government support.

Percentage of woodland that is sustainably managed (Forest Services Key Performance Indicator)

As of 31 March 2021, 59% of all woodland in England was sustainably managed, totalling 770,000 hectares of woodland in management. This is a gradual increase since the April 2011 baseline of 52%, and 58% in September 2016. The equivalent figure for woodland other than in the nation's forests was 51%, totalling 556,000 hectares of woodland in management.

Number of additional tree pests and diseases becoming established in England within a rolling 10-year period (Forest Services Key Performance Indicator)

The number of additional tree pests and diseases becoming established in England within a rolling ten-year period fell from a peak of seven in the ten-year period 2000-09 to a low of three in 2007-16. Four tree pests and diseases became 'established' in England in the most recent ten-year period 2011-20.

Number of high priority forest pests in the UK Plant Health Risk Register.

In 2016, a new headline plant health indicator was added to FC's Corporate Performance Indicators. The indicator reports trends in forest pests from the UK Plant Health Risk Register that records and rates risks to UK crops, trees, gardens and ecosystems from plant pests and pathogens.

As of March 2021, there are now 399 pests identified as forest pests on the UK Plant Health Risk Register, 14 (4%) of which have been assessed and are considered high priority. Of these 14 pests and diseases, 8 are currently present in England, with three being classed as widespread. These are *Hymenoscyphus fraxineus* which causes ash dieback, *Phytophthora alni* which affects all alder species in Great Britain, and *Pseudomonas syringae pv. aesculi*, that causes horse chestnut bleeding canker.

Measure of woodland resilience to climate change based on the size and spatial configuration of woodland patches within the landscape (Forest Services Key Performance Indicator)

Maintaining and improving connectivity is important in promoting nature recovery in fragmented habitats, especially under a changing climate. When habitats are more connected, species can expand populations or migrate at different rates in response to

threats and pressures. Greater connectivity makes it easier for woodland ecological communities to gradually adapt to changes in climate. Connectivity of woodland is measured according to the size and distribution of patches of forests and woodlands, relative to a value of 100 assigned to 2011. This indicator shows an increase in connectivity for forests and woodlands in England between 2011 and 2018, which is the last date for which data are available.

Woodland ecological condition in England using information from the National Forest Inventory (Forest Services Key Performance Indicator)

There are 914 thousand hectares (ha.) of native woodland in England (around 68% of all woodland) and 419 thousand hectares of non-native woodland (30%). 99.5% of native woodland, and 95.6% of non-native woodland, is in favourable or intermediate condition, based on the National Forest Inventory 2010-15 survey cycle data.

Wildfire indicator on the nation's forests and other public and private woodlands

This indicator reports the impact (area burnt, number of incidents and duration) of wildfire within forests and woodlands. It uses Department of Communities and Local Government supplied Incident Reporting System data provided by England's Fire and Rescue Services and the National Forest Inventory (NFI). The FC is in the process of producing statistics that will revise and update our existing enumeration of wildfires in England and it is anticipated that these total numbers will become available in the earlier part of 2022.

Area of woodland created in areas targeted for flood risk management

This indicator reports the area of woodland created in areas that have been mapped as potentially benefitting from increased tree cover to contribute to flood risk management. The indicator therefore reports the contribution of woodland creation to societal resilience, rather than the resilience of the woodland or the forestry sector. The data-set is restricted to woodland creation funded through the Countryside Stewardship grant scheme (Rural Development Programme) or its predecessor, the English Woodland Grant Scheme (from 2012, when spatial targeting for flood risk management was introduced). Since ARP2 was published, this is no longer an indicator used to measure adaptation within FC's Key Performance Indicators, although the Nature for Climate Programme Management Office (Defra) is likely to publish data on the location of new woodland created through the programme together with the public goods that woodland would be expected to provide.

Diversity of tree species planted within the nation's forests

This indicator was first published in the Adaptation sub-Committee's 2013 progress report (Managing land in a changing climate). A time series has been constructed which shows changes in both conifer and broadleaf planting between 2010-2020. This indicator shows diverse planting on the nation's forests over the past ten years, the percentage of each species planted between 2010-2020 is shown in the tables below:

Percentage of Broadleaf Species Planted on the Nation's Forests 2010-2020:

Species	2010 -11	2011 -12	2012 -13	2013 -14	2014 -15	2015 -16	2016 -17	2017 -18	2018 -19	2019 -20
Oak	26.1	21.7	40.1	35.6	42.3	37.4	33.4	24.8	29.6	18.8
Birch	22.8	25.9	18.6	22.3	20.1	23.7	20.0	31.5	19.8	34.2
Beech	2.5	1.5	1.7	2.9	2.5	2.7	3.5	1.6	1.8	0.8
Common Alder	5.9	10.4	8.1	5.7	5.2	6.3	5.9	10.0	9.6	7.8
Sycamore	1.7	4.3	6.5	3.0	1.5	1.6	1.0	2.1	1.2	1.1
Ash*	8.7	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweet Chestnut	9.4	5.0	1.1	1.6	2.3	1.8	2.5	1.3	0.6	0.9
Hornbeam	0.0	0.0	0.9	4.9	5.8	7.6	5.2	2.0	2.3	2.1
Wild cherry	2.2	2.4	3.3	3.1	1.9	2.3	2.4	1.5	1.3	2.8
Rowan	7.6	9.6	7.1	6.1	5.8	5.4	7.7	7.8	11.3	8.6
Hawthorn	0.4	0.1	0.0	0.6	1.1	0.6	1.2	1.2	1.1	1.5
Aspen	1.7	3.1	3.1	2.0	4.3	2.7	5.2	4.8	7.3	5.4
Willow	2.2	6.1	4.2	3.3	3.7	3.8	4.3	5.0	6.6	10.1
Poplar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Hazel	0.9	0.7	0.5	1.1	0.8	0.4	1.9	1.4	1.5	1.4
Lime	0.4	0.7	1.6	1.0	0.3	0.5	1.3	0.2	2.2	0.4
Field Maple	0.5	0.0	0.1	0.2	0.2	0.5	0.1	0.1	0.2	0.0
Blackthorn	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1
Holly	0.0	0.1	0.1	0.0	1.8	0.9	0.4	0.2	0.4	0.7
Wych elm	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.1
Wild service	0.0	0.0	0.0	0.0	0.0	0.7	0.9	0.5	0.6	0.4
Walnut	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0	0.1	0.1
Other *	6.8	3.8	0.0	0.0	0.0	0.0	0.5	2.6	0.0	0.0
alder	0.0	0.0	2.4	1.6	0.3	0.0	1.0	0.8	1.4	2.1
Red Alder	0.0	0.0	0.0	0.9	0.0	0.1	0.1	0.4	0.5	0.5
Euc gunnii	0.0	0.0	0.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Norway maple	0.0	0.0	0.0	2.8	0.0	0.3	0.4	0.0	0.2	0.1
Hickory	0.0	0.0	0.0	0.2	0.0	0.1	0.2	0.0	0.0	0.0
Tulip tree	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.0

Percentage of Conifer Species Planted on the Nation's Forests 2012-20:

Species	2012 -13	2013 -14	2014 -15	2015 -16	2016 -17	2017 -18	2018 -19	2019 -20
Norway spruce	15	12	11	10	12	8	7	8
Sitka spruce	46	41	45	42	42	43	36	48
Corsican pine	0	0	0	0	0	0	0	0
Scots pine	16	19	18	18	15	17	17	9
Lodgepole pine	0	1	2	1	1	2	1	1
Radiata pine	0	0	0	0	0	0	0	0
European larch	0	0	0	0	0	0	0	1
Hybrid larch	4	2	1	1	0	0	0	0
Japanese larch	0	0	0	0	0	0	0	0
Douglas fir	13	13	9	12	12	13	15	12
Grand fir	0	1	1	1	2	1	1	2
Noble fir	0	0	0	0	0	0	1	1
Western red cedar	1	3	3	2	4	4	7	2
Western hemlock	0	1	1	2	1	2	2	3
Oriental spruce	0	0	0	0	0	1	1	1
Omorika spruce	0	3	3	2	2	3	2	2
Maritime pine	0	1	0	1	0	1	1	1
Weymouth pine	0	1	0	0	0	0	0	0
Macedonian pine	1	0	0	0	1	2	1	2
Coast redwood	0	1	1	1	1	0	0	1
Wellingtonia	0	0	1	1	0	0	0	0
Japanese cedar	1	1	1	0	1	1	2	4
Atlantic cedar	0	0	0	1	0	0	0	0
Leyland cypress	0	1	1	1	1	0	0	0
Dawn redwood	0	0	0	0	0	0	0	0
Lawson cypress	0	0	0	0	0	0	1	0
Yew	0	0	0	0	0	0	0	0
European silver fir	0	1	1	1	1	0	2	2
Pacific silver fir	0	0	0	0	0	0	0	0
Swamp cypress	0	0	0	1	0	0	0	0
Monkey puzzle	0	0	0	0	0	0	0	0
Nordman fir	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0