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Welsh Government

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Science and innovation strategy for forestry in Great Britain

Department for Environment Food & Rural Affairs

Scottish Forestry
Coilltearachd na h-Alba

Forestry Commission

Contents

Mae'r ddogfen yma hefyd ar gael yn Gymraeg. / This document is also available in Welsh.

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Foreword

A strategic approach to forestry research is more important now than ever. Forestry in the UK is a vital sector, with forestry and primary wood processing generating £2.5 billion GVA a year, from a total woodland area of 3.2 million hectares. In addition, it provides a vast bank of natural capital, delivering a wide range of valuable ecosystem services, helping to mitigate the effects of climate change and to address the biodiversity crisis. Forestry, trees and woodlands have the potential to help us tackle these fundamental challenges and also give strong support for a green recovery from COVID-19. They can help change our economy, society and environment for the better, and it is the ambition of the government and devolved administrations for them to do so.

Yet our forests face their own challenges to their health from pests and diseases, and in adapting to climate change. These types of challenge mean it is ever more important to have robust and innovative science to guide decisions, so that our forests are resilient and healthy with a forestry sector that is sustainable and forward-looking.

By giving strategic direction to forestry research in Great Britain, in synergy with research commissioned in Northern Ireland, this Science and Innovation Strategy provides a flexible and responsive framework for action in these times of uncertainty. It sets out high level outcomes, themes, and areas of research interest identified by the governments and forestry stakeholders. Such forestry research will be essential to ensure an internationally competitive and successful sector in the future, and secure the multiple benefits that forests and woodlands can provide.

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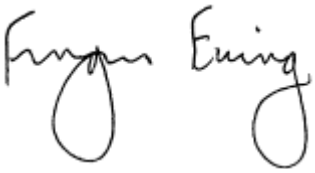

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1. Introduction

Science and innovation will enable the UK to maintain its international reputation for sustainable forest management and ambitions for woodland creation, ensuring that its trees, forests and woodlands can meet the challenges of providing a healthy future for the economy, society and the environment.

The Science and Innovation Strategy (SIS) for forestry in Great Britain (GB) supports this vision in order to make a significant and long-term contribution to government priorities across England, Scotland and Wales[1]. It builds upon the previous strategy (2014), taking into account the common objectives for all three nations, supported by the shared UK Forestry Standard, and underpinned by sound science and evidence.

The strategy sets out shared priorities which include research on the following themes:

- Sustainable forest management (see Box 1) 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

The strategy will be used as the basis for commissioning research from Forest Research and other providers, and to encourage other ways of improving the scientific underpinning of British forestry.

Box 1: Sustainable Forest Management (SFM) is the management of forests according to the principles of sustainable development and agreed by the UK at the United Nations' Conference on the Environment and Development in 1992 and subsequently through the Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 1993.

At the European level "Sustainable management" means the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regenerative capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems[2].

Governments in the UK have adopted this definition and support and promote the stewardship and use of forests and woodlands through legislation and other good practice, brought together in the UK Forestry Standard (UKFS) which ensures that international agreements and conventions are applied in the UK.

[1] Whilst not formally part of the SIS as not under the previous Forestry Commission remit, the Northern Ireland Executive have been involved in its development to ensure synergy with their research

[2] Helsinki Declaration Resolution H1, Ministerial Conference on the Protection of Forests in Europe, 1993

2. Structure of the strategy

Section 1 (Introduction) sets out the aims of the strategy and common objectives shared by the three nations involved, and introduces how the strategy will address these.

Section 2 provides an overview of the structure of the strategy.

Section 3 explains the background and highlights changes since the publication of the previous strategy, and the process used to develop the research outcomes, themes, and areas of research interest.

Section 4 covers the context and describes the main challenges and drivers faced by the forestry sector, indicating how research under the strategy can help in addressing these.

Section 5 covers the four main strategic outcomes and the research themes that will feed into these outcomes. Examples of potential areas of research interest are provided for each research theme.

Section 6 sets out how research findings will be communicated and methods for knowledge exchange and assessing the impact of this research.

Section 7 explains how research under the strategy will be commissioned and funded and sets out principles for this process.

Section 8 addresses how the strategy will be monitored and evaluated in order to ensure progress, and continual improvement.

Section 9 covers useful sources of information and key policy documents.

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3. Background

The last version of the SIS was published in 2014 by the Forestry Commission on behalf of Ministers in England, Scotland and Wales. Since then there have been fundamental changes to the devolution of powers around forestry, with the completion of devolution of forestry in Scotland, and new cross-border arrangements put in place. Ministers of all three nations have agreed to retain a shared cross-border research commissioning and monitoring function, and detailed arrangements are set out in a Memorandum of Understanding (MOU) agreed in April 2019.

The MOU acknowledges there is a need for a shared GB research strategy into forestry to:

- Agree the common needs of England, Scotland and Wales; and,
- Underpin the commissioning and monitoring of forestry research.

The MOU stipulates that governance of the strategy is provided by a Research Strategy Reference Group (RSRG) including representatives from governments of each of the three nations and Northern Ireland, and also from Forest Research as the main research provider. This group oversees development of the strategy to ensure the interests of each nation are fully represented and research is supported.

The strategy has been developed following discussion with a wide range of organisations and individuals with an interest in Britain's forests, woodlands and trees. It is based on a series of stakeholder engagement meetings conducted by each of the three nations during the winter and spring of 2019/20. These included meetings between forestry policy staff in government and forestry related agencies, as well as stakeholder events including academia, environmental organisations, researchers, professional forest managers, farmers and other land managers.

These events and subsequent engagement supported validation of the strategic outcomes, research themes and areas of research interest (see section 5). The SIS has since taken into account the impacts of the evolving COVID-19 pandemic, and supporting a green recovery is a key ribbon that runs through the themes of this strategy. The next set of research programmes will reflect this and help support a thriving industry and job creation, whilst maximising the contribution woodlands and forestry can make to improving our natural environment.

The strategy will provide a framework for forestry research for five years from April 2021, but also looks much further into the future to ensure steps are taken to provide the evidence base needed for decades ahead.

4. Challenges and Drivers

The SIS takes account of policy/legislation across all of GB, as well as shared policy drivers and challenges faced by the sector. In particular, a fundamental driver for the strategy is the implementation of sustainable forest management across the UK. The main challenges and drivers considered are outlined below, and have been instrumental in developing the research principles, outcomes, and themes outlined later on in this strategy. Progress in science and innovation also provides an overarching driver and catalyst for change, as new scientific methods, techniques and understanding creates opportunities for working practices to evolve and new answers to be provided.

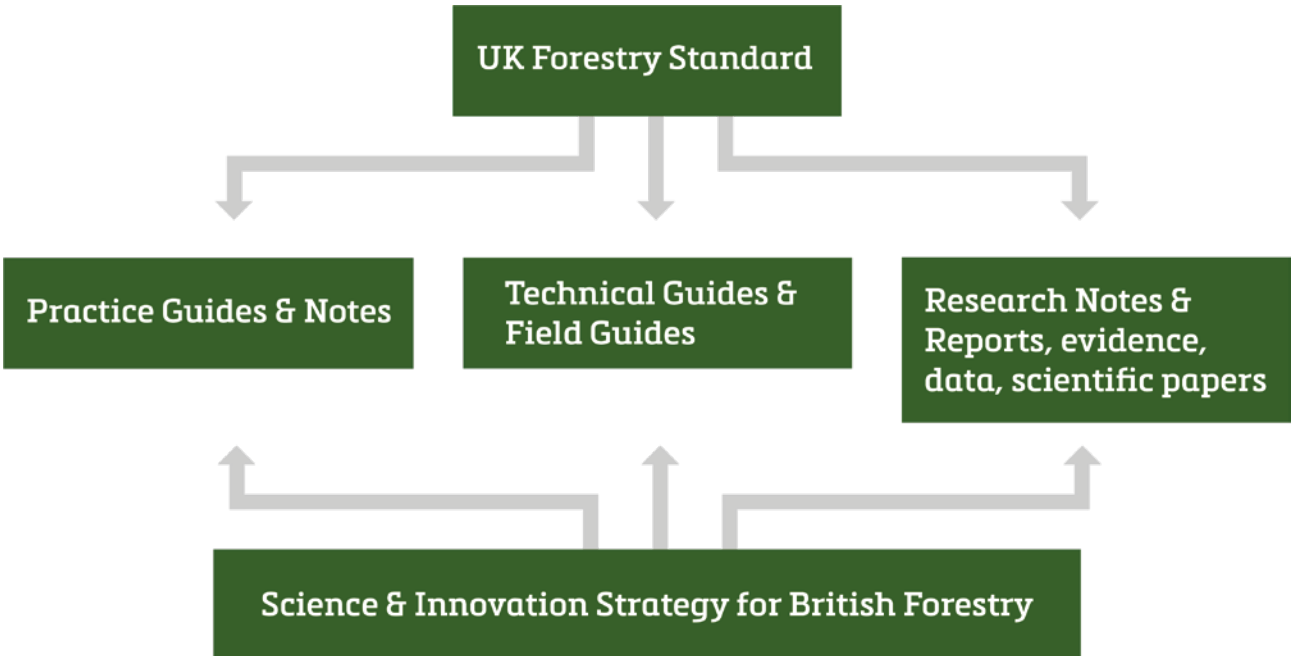
4.1 Sustainable development and implementing Sustainable Forest Management

In 2015 the UK adopted the 17 UN Sustainable Development Goals[3] which provide a blueprint to safeguard and enhance the prosperity of all its citizens. National governments are required to implement these goals through the development of high-level strategies reflecting the need for global consensus on tackling severe challenges facing society today, such as from the impacts of climate change.

Sustainable Development Goal 15 refers to the sustainable management of forests (see Box 1). The UK has signed several international agreements on forestry which enshrine the principles of sustainable forest management (SFM). The means by which the UK seeks to meet these international agreements is through the application of the UK Forestry Standard (UKFS). The UKFS has legal and good forest practice requirements on a range of aspects relevant to the use and stewardship of forests and woodlands and forms the basis of the forestry grants and regulatory system in each country.

The UKFS is relevant to all those with an interest in UK forests and woodlands, particularly owners, managers and practitioners, and all organisations with responsibilities for forests and woodlands – including government agencies, local authorities, non-governmental organisations, charities and trusts. The UKFS and its supporting guidance are closely informed by the evidence base, scientific literature, and data provided by the SIS as shown in the following diagram.

[3] www.un.org/sustainabledevelopment/



4.2 National strategies and policies

Each devolved government provides strategic direction for its national forestry resource and the SIS will provide a crucial evidence base for how to manage that resource in accordance with the UKFS and the principles of SFM. The relevant strategies for forestry in GB are set out below.

Scotland's Forestry Strategy

Scotland's Forestry Strategy 2019-2029 places forestry policy at the heart of government, helping to deliver the aims of the National Performance Framework that themselves reflect sustainable development goals. It presents a 50-year vision for Scotland's forests and woodlands, and provides a 10-year framework for action. It supports overarching policy such as the vision, objectives and principles of the Land Use Strategy, and the vision and outcomes of the Environment Strategy.

The Strategy is a keystone of ambition for forestry in Scotland, underpinned by the Forestry and Land Management (Scotland) Act 2018, and has Sustainable Forest Management at its core. It sets out Scotland's commitment to increasing woodland creation in Scotland to mitigate and adapt to climate change, and support Scotland's target to reach net zero by 2045 as set out in the Climate Change Plan. It also aims to increase the contribution of forests and woodlands to sustainable economic growth, a high quality and healthy environment and people's health, well-being and life-chances. It balances the need for long-term continuity and the need for flexibility when responding to emerging issues and opportunities. It is supported by an implementation plan to be updated every two years.

England Tree Strategy

The England Tree Strategy will set out policies to expand tree cover, support woodland management and increase public engagement with trees and woodlands, increasing tree planting in England, working towards the manifesto commitment of planting 30,000 hectares per year, across the UK,

by 2025 – working closely with devolved authorities, communities and landowners to do so. It will set out how to expand, protect and improve public and private woodlands, and will highlight the role that trees and woodlands play in supporting the economy, connecting people to nature and combatting climate change.

This strategy, together with the Tree Health Resilience strategy and developing Nature, Peat and Flood strategies, will support the delivery of the 25 year Environment Plan. The joint Defra and Forestry Commission England tree planting programme will deliver the necessary changes to accelerate woodland creation in England, including the implementation of the Nature for Climate Fund announced in the 11 March 2020 budget.

Woodlands for Wales

The Woodlands for Wales strategy sets out the forestry policy and strategic direction for forestry in Wales for the next 50 years, supported by an Action Plan updated every 5 years. The strategy was refreshed and updated in 2018 to reflect the new Natural Resources Policy arising from new legislation – the Well-being of Future Generations (Wales) Act 2015 and the Environment (Wales) Act 2016. The strategy remains focused on the foundation of woodlands and trees from which to deliver four strategic themes – responding to climate change; woodlands for people; a competitive and integrated forest sector; and environmental quality.

The strategy sets out a planting target of 2000 hectares a year from 2020-2030 and beyond, underpinning the Welsh Government strategies for a Low Carbon Wales and Prosperity for All: A Climate Conscious Wales. The strategy supports the objectives of Wales' Nature Recovery Action Plan, Clean Air Plan, and the First Minister's vision for a National Forest in Wales. These policies recognise the contribution forests and woodland can make to the sustainable management of natural resources in Wales and the well-being of its people.

4.3 Climate change

Mitigation

The impacts of the climate change emergency are being felt on a global scale, with increasing frequency of extreme weather events. In terms of carbon reduction commitments, the report 'Land use: Policies for a Net Zero Report UK (2020)' published by the UK Climate Change Committee, highlighted a need to increase UK forestry cover from 13% to at least 17% by 2050 by planting around 30,000 hectares of broadleaf and conifer woodland each year. This is reflected in ambitious tree planting targets across the UK. The creation of new forests and woodlands is recognised as an important tool for reducing greenhouse gas (GHG) emissions and helping to meet climate change targets.

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.

Adaptation and resilience

Forests and woodlands can also help us adapt to climate change by, for example, providing natural flood management and shelter for livestock, protection of water and soil and air quality and climate regulation in urban areas. There is growing interest in natural solutions to mitigate the impacts of climate change, as well as in placing a financial value on these benefits. A clear evidence base is essential to maximise the potential that woodlands and forests can bring.

However, our forests and woodlands also need to adapt to a changing climate and become more resilient to the growing threats and challenges they face. As a result of climate change, projections show that tree growth rates are likely to increase because of longer, warmer growing seasons, particularly in cooler and wetter areas. At the same time, the threat to forests and woodlands from extreme weather events and wildfires is expected to rise, and drought is becoming a problem in certain areas.

Given the changing climate and greater globalisation of trade and travel, it is anticipated that the threat to trees from pests and diseases (see 4.6) will grow.

Knowledge of species tolerance to climate extremes and pests and diseases is therefore critical, as is evidence on alternative species and their interaction with the environment. Innovative design and management will be needed to ensure our forests continue to provide economic, social and environmental benefits.

Integrated Land use

To achieve the greatest benefits from forestry and to support the strategic direction of country policies it is important to manage forests and woodlands with due consideration of how they interact with surrounding land uses, and the opportunities they can provide. Integrating trees, woodland and shrubs with agriculture and other land uses can increase soil carbon stocks and contribute to the wider environmental sustainability objectives of improved water quality and soil fertility.

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4.4 Biodiversity crisis

There is growing recognition of a "biodiversity crisis" as demands on land from forestry, agriculture and development increase. Some woodland species continue to decline despite increases in woodland cover. The UK State of Nature Report (2019)[4] highlights the main pressures on woodland biodiversity to be a lack of management, overgrazing by deer, increased recreational disturbance and nitrogen pollution. The National Forest Inventory (NFI) Woodland Ecological Condition (WEC) report for GB (2020)[5] indicates that herbivore damage is at unfavourable levels for a proportion of all woodland types across GB. The findings were that around 50% of woodland area has signs of herbivore browsing damage below 1.8 m in Britain; 47% in England, 26% in Wales and 59% in Scotland, indicating the magnitude of this problem in certain areas.

Pests and diseases can also affect the tree species composition of woodlands; this can impact on biodiversity that is dependent or associated with a particular tree species, such as Ash and Oak.

New woodland creation can provide connectivity, reduce habitat fragmentation and provide buffering from adjacent land uses. It needs to be designed and located so as to maintain wider ecosystem services and enhance these where possible. The NFI WEC report indicated that non-native woodlands have a contribution to make to biodiversity and these contributions should be developed through design and sustainable management.

Improving our understanding of forest, woodland and associated ecosystems and how they function, together with the impact of their management on biodiversity is critical. Understanding the impact or contribution of forests and woodland to wider ecosystems is also important in the quest for "the right tree in the right place for the right reason". We need to enhance the biodiversity of all woodlands through appropriate management, and ensure new woodland is well designed to maintain or enhance environmental quality and mitigate risks to habitat and ecosystem services.

4.5 Natural capital and environmental quality

All UK governments are committed to protecting, enhancing and valuing the environment and increasing the stocks of natural capital, which are essential to provide a wide range of ecosystem services. Natural capital accounting is a system which can be used for monitoring progress towards environmental goals.

Forestry is an important element of the UK's natural capital, and plays a valuable role in supporting environmental benefits. Examples of these include carbon sequestration to mitigate climate change, managing water in times of flood or water scarcity, protecting and improving water quality, and helping to reduce soil erosion. There is an increased interest in research to place a value on such benefits so they can be fully recognised and realised.

Urban forests and woodlands also play an important role and provide a range of benefits to their populations. Urban forests can create spaces which encourage active travel, learning, play, exercise and other forms of recreation, and help promote physical and mental health and well-being, improving social inclusion and reducing health inequalities.

[4] State of Nature, 2019 – nbn.org.uk/wp-content/uploads/2019/09/State-of-Nature-2019-UK-full-report.pdf

[5] NFI Woodland Ecological Condition, 2020 – reports – www.forestresearch.gov.uk/tools-and-resources/national-forest-inventory/what-our-woodlands-and-tree-cover-outside-woodlands-are-like-today-8211-nfi-inventory-reports-and-woodland-map-reports/nfi-woodland-ecological-condition/

Forests and trees can help mitigate the impacts of increasing urban development, for example, by improving air quality and reducing noise, rainfall run-off intensity and flooding. They can also assist in economic regeneration of degraded urban landscapes, including vacant, derelict and contaminated sites, and develop considerable biodiversity value and cultural significance.

4.6 A sustainable innovative forest sector supporting the rural economy

A move to a low carbon economy is likely to place an increasing demand on timber and forest products. With a large proportion of our timber currently imported and likely increases in global demand, there is a need to increase our domestic production and the supply of fibre to support sustainable economic growth in the sector. There is likely to be an increasing demand in the future for sustainable construction and infrastructure materials as well as biomass. As climate change predictions mean changing growing conditions, there is a need to investigate alternative and improved species, their timber attributes, tolerances and genetic variance.

There are exciting opportunities for innovation such as producing new wood fibre and value added products, for example cellulosic plastics from biorefineries. Research and innovation will be needed to stimulate higher efficiency and productivity throughout the supply chain, from forest nurseries to wood fibre processing. For example, developing remote sensing technology to monitor forests and provide more data to support decision making.

As highlighted by the recent Climate Change Committee report[6] and to reach our ambitious climate change objectives, there is also a need to expand the amount of sustainably managed hardwood forests, and consider the role for Short Rotation Forestry and Short Rotation Coppice to help meet the net zero target.

[6] www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/

4.7 Pests, diseases and biosecurity

The number of tree pests and diseases present in the UK and having an impact on our trees and forests such as ash dieback (*Hymenoscyphus fraxineus*) and *Phytophthora ramorum* is increasing. Some arrive in the UK through global trade and travel and some can be wind borne. Others are indigenous but have increased damage potential due to warmer or wetter climates providing favourable conditions. At the same time, adverse climatic events and other environmental stresses such as pollution are making our trees, woodlands and forests more susceptible to the impacts of pests and diseases. Their interactions with woodland ecosystems are often complex, requiring continual research and development to understand their dynamics and impacts.

As part of our response to the escalating threats to tree health we must strengthen our biosecurity and increase the resilience of our treescape[7]. This requires more efficient and effective horizon scanning and surveillance, using scientific advances like genomic surveillance, remote sensing, and molecular detection of novel pests. An interdisciplinary approach needs to be applied to the mitigation and management of tree pests and diseases. This should include not only investment in more targeted and innovative control technologies, but also research into preparedness, species tolerance, host adaptation, and an understanding of the public perception of pest and disease management.

4.8 A green recovery from COVID-19

Due to the national and global impacts of the COVID-19 coronavirus outbreak, nations are preparing recovery plans to help stimulate economies once the pandemic has been brought under control. The governments of the UK wish to deliver 'green economic recovery' and the forestry sector has a clear role to play with the potential to support both economic and environmental recovery.

Such recovery provides heightened stimulus for forestry to provide innovative solutions and approaches and to allow for the expansion of the forestry industry. The new opportunities and arrangements may include revised working practices and greater reliance on technology such as remote sensing, all of which may require underpinning with research and evidence. Therefore proposals under this SIS must be sufficiently flexible to accommodate these emerging requirements.

4.9 Circular economy

A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. It has sustainability at its heart, and all governments in GB support a move in this direction.

An important component of the circular economy is focused around innovation and research. It is widely recognised trees, woodlands and forests as well as forest products have an important role in these aspirations. Research and innovation will be needed to ensure that forest products such as timber are capable of reuse or recycling before ultimate disposal to ensure a sustainable forest sector. Further development in enhancing and assessing timber quality is important to provide construction grade timber more efficiently with less waste, encouraging greater use in place of concrete and steel.

It will also be important to consider ways to reduce pollution and increase sustainability, for example by minimising chemical and plastic use, and decarbonisation in forestry.

[7] Treescapes are terrestrial landscapes in which trees play a significant role.

4.10 Health, well-being and communities

Woodlands and forests and trees have long been recognised as important landscape and cultural assets. They are appreciated for their active recreation opportunities and amenity, and provide opportunities for local economic benefit such as tourism and education. They are recognised for their beneficial effects on well-being through providing a space for people to exercise, relax, play and learn.

Numerous studies have identified a positive relationship between greenspace including trees and population health. The evidence is particularly strong in terms of the restorative potential of forests and woodlands for people's mental well-being and quality of life. This is not only from access to and use of these areas, but also through their aesthetic contribution to the places where people live and the landscapes they enjoy. An outcome of the COVID-19 pandemic, with its restriction on travel, has been an increased realisation by many of the importance of accessible green space close to where they live.

These benefits are becoming more important to mitigate physical and mental stresses as well as the impacts of climate change, and an appreciation of their value will increase with knowledge and evidence of benefits and best practice. Greater involvement of communities in decisions about forests and woodlands, as well as in direct management and ownership, will increase communities' influence over their local environment leading to greater empowerment.

Well placed woodlands around urban or industrial areas can intercept pollution and improve air quality, with associated health benefits. Others can provide educational and training opportunities as well as a focus for community involvement. Urban trees can provide amenity value, habitats, noise reduction, climate regulation and shade, whilst contributing to drainage and active travel routes.

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5. Research Themes and Outcomes

5.1 Strategic Outcomes

There are four strategic outcomes central to the SIS:

- Improved evidence base
- Increased knowledge and understanding
- Policy and practice informed by science
- Skilled research community/ national capability

These are broadly similar to the outcomes from the previous 2014 strategy, much of which is still relevant today.

i) Improved evidence base

There is a need for a strong evidence base built on sound innovative science to help deliver healthy and resilient forest ecosystems to provide multiple benefits for society. Forest research needs to be flexible in a changing world, responding to what is coming on the horizon, and providing the evidence to help find new innovative and economic solutions to these challenges and opportunities. The new research under this strategy will be enabling and drive development of new approaches and technologies. The evidence base will need to be broad enough to enhance our understanding of sustainable forest management, but also demonstrate how forests and woodlands are connected to and essential to wider agendas. The research will maintain broad linkages to wider research and be integrated and multidisciplinary. In turn this will support development of forestry and wider land use policy, including sustainable and inclusive economic growth and contributions to the circular economy.

ii) Increased knowledge and understanding

The improved evidence base will provide decision makers with the knowledge and understanding of how to deliver public benefits through forest and woodland management and expansion as a resilient and highly valued component of sustainable integrated land-use. New analytical methods can help unlock the data and evidence and deepen the insights which can be gained. The delivery of the strategy will take account of feedback from the sector regarding the importance of knowledge exchange, and ongoing stakeholder engagement. There are new methods to explore to make existing evidence more accessible, which can complement established mechanisms, such as production of scientific papers and website content. The increased knowledge will help inform future public and private investment in forestry, by demonstrating the economic benefits and public goods it provides, and its contribution to wider agendas to ensure maintained stakeholder and public support.

iii) Policy and practice informed by science

Well-informed and knowledgeable decision makers and practitioners will utilise evidence from this strategy in developing improved regulation, policies and practices. This will be supported by continued access to a responsive skill base of forest researchers providing high-quality advice so that decisions take account of the latest understanding of the key processes and interactions of these complex environments. The evidence will support more innovative and sustainable forestry practices, which will be key in a time of green recovery, and will enable policymakers and practitioners to respond to what is on the horizon. This will include development of new technologies, along with for example, new ways of collecting and

analysing large amounts of data, helping to further inform developments in policy and practice.

iv) Skilled research community/ national capability

The strategy will support training, development and broadening of scientific and other expertise, skills and capability across the forestry sector. This will build capacity amongst the research community to tackle tree related problems. These skills will be of particular importance in the context of current environmental challenges, such as the impact of climate change and declines in biodiversity, and will enable further innovation and science uptake through knowledge exchange and engagement with the forestry sector.

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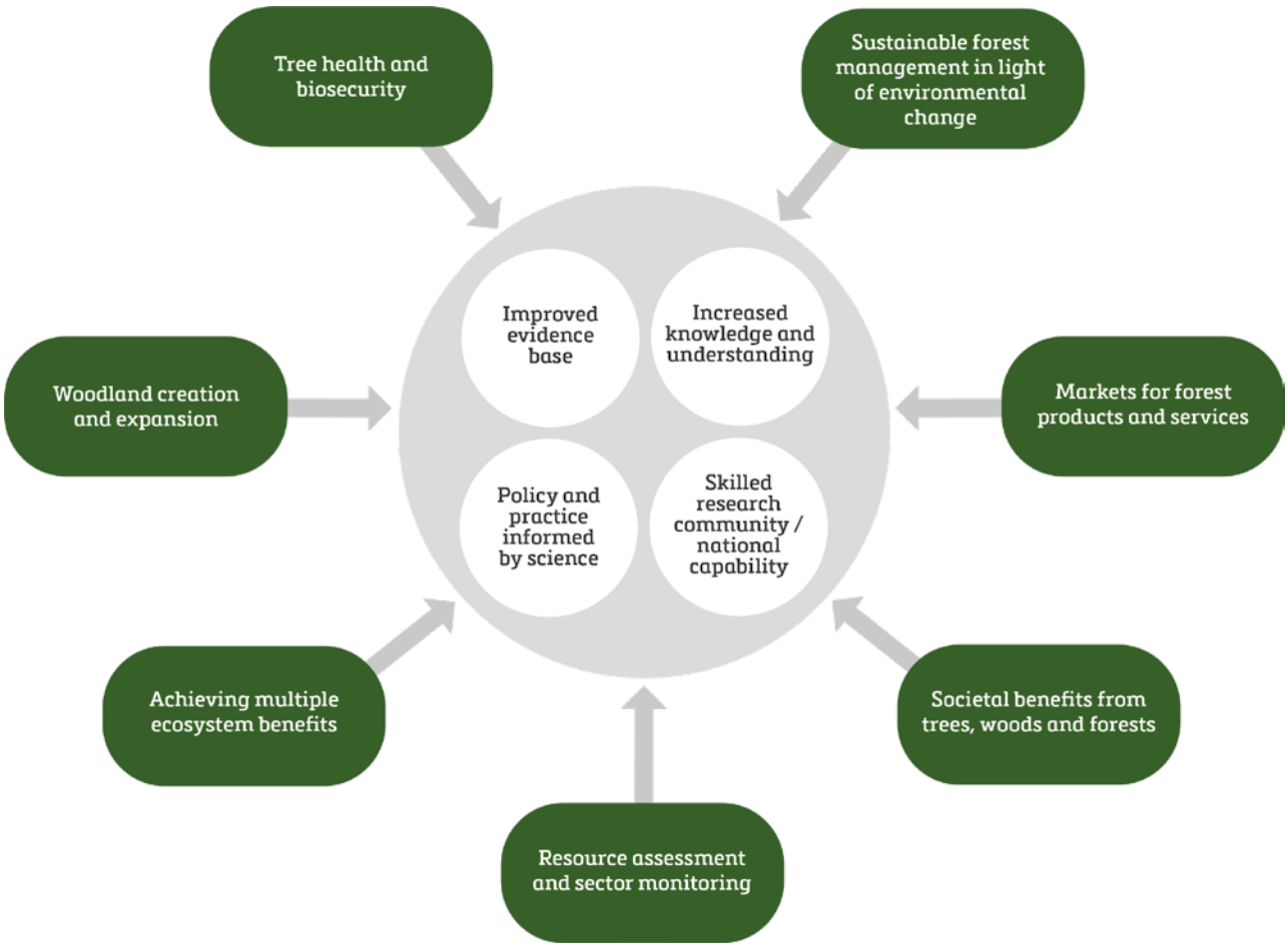
5.2 Research Themes

There are seven research themes agreed by all three nations as a framework for the strategy and which support key government forestry policy priorities. All research promoted under the strategy will align with at least one of the research themes and therefore will directly support the delivery of the four strategic outcomes (Fig.1).

Figure 1. Relationship between SIS research themes (shown in green) and strategic outcomes (shown in white).



Linkages between drivers, strategic outcomes and research themes

The four strategic outcomes describe the broad response required to address the multiple drivers and challenges identified in this strategy. Some of the drivers are pervasive and impact upon almost every research theme necessary to meet the strategic outcomes. For example, the growing recognition of a 'biodiversity crisis', and the impacts of climate change are wide-reaching. Drivers such as national strategies and policies, COVID-19 pandemic, natural capital and environmental quality, the circular economy, and scientific progress will also influence many themes.

Other drivers are contained more discretely in matching research themes, for example pests, diseases and biosecurity drivers link closely to the tree health research theme, and the health, wellbeing and communities drivers link to the societal benefits from trees, woods and forests research theme. Progress towards a sustainable innovative forest sector supporting the rural economy will be provided in particular by the research theme covering markets for forest products and services.

Finally, the research theme on resource assessment and sector monitoring will provide data and techniques that will inform and underpin all areas of the strategy.

The research themes will support the strategic outcomes as follows:

- Research carried out under the themes will provide an improved evidence base – Strategic Outcome i).
- This will lead to increased knowledge and understanding across the sector – Strategic Outcome ii).
- Increased knowledge will result in policy-makers, practitioners, and other stakeholders being better able to develop effective new policy and practice informed by science – Strategic Outcome iii).
- This will also ensure a skilled research community with an increased national capability – Strategic Outcome iv).

It is recognised there is inevitably some cross-over between themes, and research on one area will often contribute to progressing two or more themes. The aims of the strategy will be met through collaboration between researchers, research providers, and with other government departments, stakeholders, and different land-use sectors. The resulting research programmes will often require cross sectoral and interdisciplinary action, drawing upon both established and emerging scientific fields including ecology, economics, genetics, genomics, hydrology, pathology, remote sensing, spatial and data sciences, and social sciences.

Within each of the research themes a number of broad areas of research interest (ARIs) emerged from the many research questions identified during stakeholder engagement events and policy workshops held in 2019/20. Those listed below illustrate shared areas of research interest across GB that will form part of the research funded under this SIS. The strategy is designed to be dynamic in order to be able to respond to changes in drivers or challenges, and therefore ARIs may evolve or change significantly during the period covered by the strategy. The themes are not ranked in any particular order.

i) Sustainable forest management in light of environmental change

This theme covers the development and application of sustainable forest management principles and practices in light of current and future challenges such as climate change, biodiversity loss, pests and diseases and supporting economic growth. Recent research has led to the development of several techniques and tools to help forest managers adapt forests to our changing environment. This includes the development of an Ecological Site Classification, a climate adaptation toolkit, better understanding of genetic adaptation and gene/environment interactions and new characterisation of greenhouse gas fluxes at key sites. Further studies are required to better understand the complex interactions and refine the advice for woodlands under different management objectives (including native and ancient woodlands).

ARIs

- Climate change impacts and susceptibility assessments on forests, soils and ecosystems and how forests can help to mitigate and adapt, including GHG modelling and forecasting
- Impacts of forest operations on soils, soil carbon and the wider environment
- Forest management of different types and different scales for carbon sequestration, flood management, climate adaptation, and building resilience (including agro-forestry)
- Minimisation of use of chemicals and plastics, and decarbonisation in forestry
- Potential future species and further investigation into existing genetic variability and inherent adaptive potential

Reproduced courtesy of Forest Research.

ii) Markets for forest products and services

This theme covers identifying and assessing current and potential markets for forest products and services and how woods and forests can supply these. Recent research has substantially improved our understanding of the timber properties of main species and informed choices over breeding programmes. Long-term breeding collections have been maintained and improved material for planting has been made available. Further studies are needed to understand new markets for products from trees and identify the types of species which may be used to diversify forests.

ARIs

- Availability of future markets for softwood and hardwood forest products, supported by improved quality and productivity
- Barriers to use of domestic timber, improved efficiency of the supply chain, and building resilience
- Market potential, adaptability, and pest and disease susceptibility of emerging species including risk analysis
- Viability of different species and approaches for Short Rotation Coppicing/Short Rotation Forestry
- Payments for ecosystem services – with focus on developing the market

Reproduced courtesy of Forest Research.

iii) Societal benefits from trees, woods and forests

This theme covers understanding how to maintain and improve the delivery of the wider well-being benefits which trees, woodlands and forests can offer in both urban and rural settings. Recent research has begun to identify the benefits which people can gain from the presence of trees and activities associated with them. Monitoring and evaluation methods have been developed as have new ways of describing the character of urban forests. Further studies are needed into ways to improve access across society to the physical and mental health benefits, and how this can be reflected in resource management decisions.

ARIs

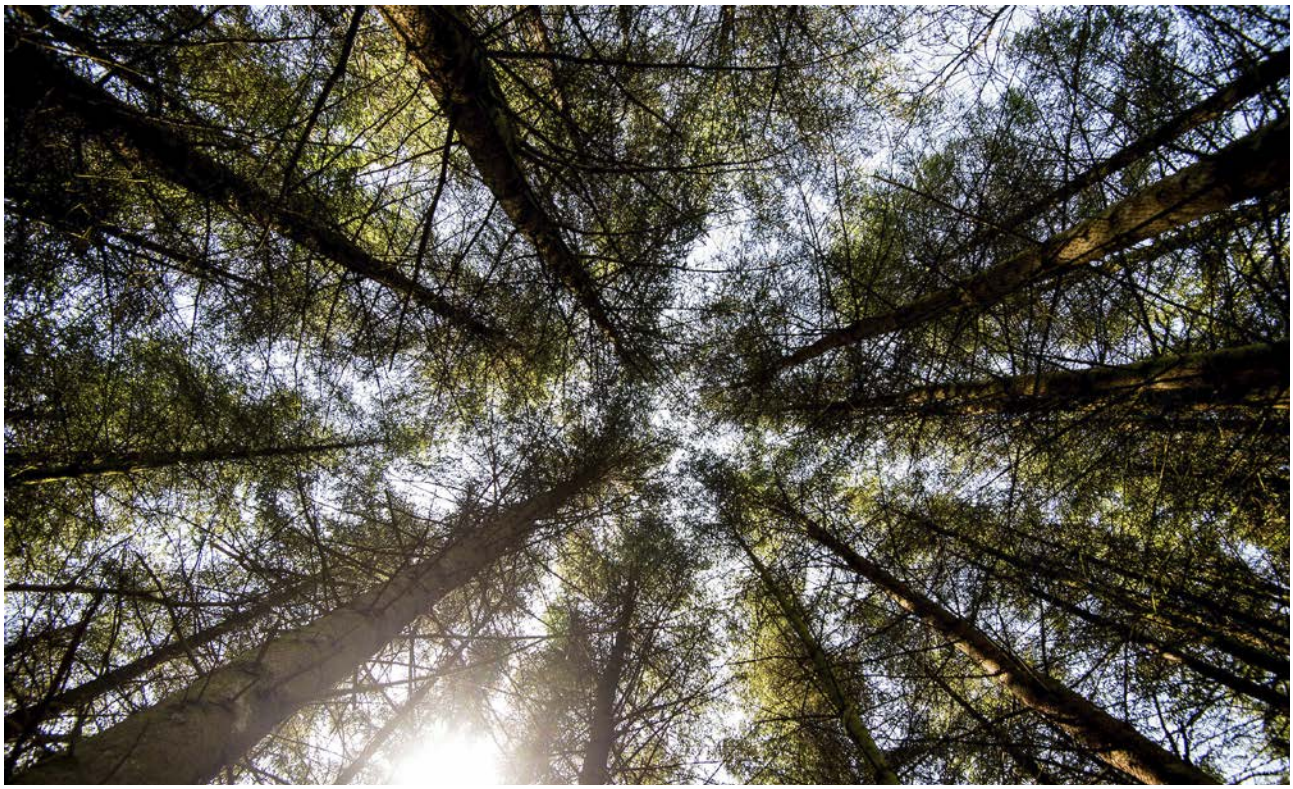
- Awareness, connection and engagement of all people with trees for health, well-being and learning
- Improving the methods and levels of community engagement in forest design and management and cross-sectoral collaboration
- Valuing tree/forest-based solutions for improved health and well-being including the contribution of exercise and greenspace to healthy living and public health benefits of urban trees
- Identifying learning and employment opportunities and how to promote them

iv) Resource assessment and sector monitoring

This theme covers improving and developing new monitoring, forecasting and evaluation techniques to support the assessment of the GB forest resource and delivery of associated goods and services. Recent research and inventory provided a reliable description of Britain's forests and many key aspects including future production. National statistics have been produced and evidence published from the NFI. Further development is required of underpinning data capture techniques and a range of models to provide updated estimates and timely identification of changes and trends.

ARIs

- Develop the data acquisition capacity of the NFI and ensure effective utilisation of data for monitoring SFM of all woodlands
- Development of improved yield modelling, including for native species
- Use, interpretation and connectivity of new technologies for detecting change – integrating remote sensing, mobile devices, and citizen science with established techniques
- Ensure data availability for monitoring trends in urban canopy cover



v) Achieving multiple ecosystem benefits

This theme covers increasing understanding of how trees, woods and forests can provide multiple benefits and how choices influence interactions and trade-offs at a range of spatial scales. Recent research has underpinned the growing appreciation of the many benefits associated with the presence of trees including carbon sequestration, mitigation of diffuse pollution and habitat provision. New methods have been developed to enable landscape scale assessments of ecosystem services. Further study is required to enable detailed characterisation of each ecosystem service, enabling sound choices to be made and rewarded.

ARIs

- Valuing and promoting the benefits from forest ecosystem services and how they will change over time and place (including urban woodlands)
- Designing and managing forests within an integrated set of land uses to achieve multiple ecosystem benefits including flood risk mitigation
- Design of finance mechanisms (including forestry grant schemes) to achieve multiple benefits
- Methods to identify and manage woods of high conservation value
- Management to increase biodiversity, improve water quality and enhance other ecosystem services in all woodlands.

vi) Woodland creation and expansion

Increasing woodland cover is a priority for all three nations. The location as part of an integrated land management system, the character of the woodland, and means by which this may be achieved need to be better understood. Recent research has improved understanding of some of the barriers to expansion and identified helpful techniques to overcome them. New species trials have been established and lessons summarised from long-term silvicultural experiments. Further study is required to untangle the complex interactions and provide reliable options which provide multiple benefits, such as for biodiversity.

ARIs

- Improving public and landowner engagement with woodland creation and expansion to provide public goods and services
- Barriers to land use change (including economic implications and priority habitats)
- Identification of optimal areas for woodland creation and expansion to deliver ecosystem services and increase biodiversity (including urban areas and habitat networks)
- Impacts of establishment techniques, species choice and silvicultural system on carbon sequestration and soil carbon (alongside other ecosystem services), including consideration of objectives and end use

vii) Tree health and biosecurity

This theme covers developing sector preparedness for an enhanced response to potential and established tree pests and diseases, and increasing the range of techniques available to manage problems and develop environmental resilience from the local to national level. Recent research has profiled some of the key pests and diseases and informed outbreak management. A comprehensive Tree Health Diagnostic and Advisory Service has been developed, incorporating public reporting and engagement with citizen scientists, and new molecular techniques have been developed to identify pests and diseases. Further work is required to respond to new and emerging threats, and to refine prevention and control methods (for example developing novel technology to improve early identification of tree health issues).

ARIs

- Horizon scanning for future threats to priority tree species (including new and emerging pests and diseases, the identification of the high-risk pathways and modelling of host and habitat vulnerabilities)
- Improved mitigation of threats and their impacts (including through innovation in detection, surveillance and control technologies, and enhanced application of approaches such as integrated pest management and nature-based solutions)
- Management options to promote treescapes that are resilient to threats such as pests and diseases, while conserving genetic diversity and the complexity of ecological systems
- Interdisciplinary approaches which enable better biosecurity standards and behaviours
- Assessment of the impacts of mammalian pests, for example deer and squirrels, and of novel management methods.

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6. Knowledge Exchange and Impact

Knowledge exchange between researchers and with end users will be key to delivering the outcomes of this strategy. In order for the improved evidence base created to result in real impact, good communication of research findings is essential in order to achieve the other strategic objectives e.g. increasing knowledge and understanding, informing policy and practice, and creating a skilled research community and national capability.

The findings of research achieve greatest impact when they are targeted and made relevant to user groups, either directly or via communicators. Scientific peer-reviewed papers remain a key step underpinning many forms of communication, assuring the findings are sound and meet accepted scientific criteria. A robust knowledge base will underpin developments in policy and the delivery of good practice and will be best achieved by ongoing engagement of stakeholders throughout the duration of the strategy.

The past focus on outputs of research, for example numbers of papers and reports, will be complemented in this SIS by increased focus on engagement with end users and analysis of the impacts achieved by the research (see section 8). In turn this will help better understand the range of impacts, the multiple pathways by which they are achieved, and some of the barriers which prevent users from making use of the latest evidence.

Research impact can take many forms, and has recently been categorised[8] as:

Instrumental: changes to plans, decisions, behaviours, practices, actions, policies

Conceptual: changes to knowledge, awareness, attitudes, emotions

Capacity-building: changes to skills and expertise

Connectivity: changes to the number and quality of relationships and trust

Attitudes: towards knowledge being exchanged, and research impact itself

Each of these forms of impact is sought from implementation of this strategy, although different emphases will apply to certain topics and themes.

[8] Edwards, D.M. and Meagher, L.R. (2019). A framework to evaluate the impacts of research on policy and practice: a forestry pilot study. Forest Policy and Economics

Knowledge exchange is integral to achieving impact from research, and there are many ways in which it can be carried out. These include processes of co-creation of the research programme themselves, and the use of different and new channels to communicate results. New methods are developing in line with technological developments and in response to pressures such as the COVID-19 pandemic, and different methods may be appropriate at different stages in the research lifecycle.

Engagement will increase the pathways available for disseminating findings to the wide range of users and provide feedback for development of the research, and ultimately revision of the strategy. Key actors in the proposed Knowledge Exchange are researchers, policy makers, forestry practitioners and communicators but there is scope for selective involvement of new audiences and end users who can help deliver the outcomes in this strategy.

Working with policy makers – the strategy will encourage research which will improve and build on the science/policy interface so that appropriate advice and relevant evidence base are easily accessible and brought to bear in decision making, policy development and implementation.

Working with forestry practitioners – the strategy will encourage research which develops knowledge and understanding and helps deliver sustainable forest management, including in support of the UK Forestry Standard.

Working with researchers – the strategy will encourage researchers to develop new skills, collaborate, make available their findings, and to engage actively with stakeholders to achieve impact

Working with other communities of interest and wider society – the strategy will encourage contributions where appropriate which draw on a wide range of other expertise, and seek to share the insights, technologies, and methods to expand the range of environmental, economic and social benefits achieved via the strategy.

Collaborating with communicators and knowledge brokers – the strategy will encourage the skills and insights brought to bear by professional communicators, who can help identify target audiences, advise on cost-effective options and help disseminate finding in innovative and effective ways.

There are several ways in which the knowledge exchange and impacts of commissioned research will be supported and improved during the implementation of this strategy:

- Increasing the number of user groups to promote wider involvement of end users.
- Creation of Knowledge Exchange and Impact Plans at commencement of each commissioned project (whether delivered by FR or other providers) and resourcing the core knowledge exchange and communication activities.
- Maintaining a balance between peer-reviewed and accessible targeted content in written outputs, minimising the grey literature produced, and encouraging Open Access publishing.
- Maintaining easily accessible on-line catalogues, libraries and archives of publications.
- Encouraging partnership working where feasible, especially where this leverages additional resources to research activities consistent with the priorities of this strategy.
- Supporting training of forest scientists through professional development and participation in peer networks.
- Supporting training of new forest scientists through apprenticeships and provision of higher degrees and fellowships.
- Encouraging accessible experts to contribute professional opinion and robust knowledge on a range of forest, woodland and tree issues of contemporary interest.
- Identifying and engaging the help of knowledge brokers and advocates (e.g. in research organisations, professional bodies and trade bodies) who can add value and provide additional links and communications channels between scientists and end users.
- Adding to the published evidence underpinning the UK Forestry Standard and its supporting suite of guidance.
- Monitoring and evaluating knowledge exchange and impact so that improvements continue to be made.

7. How Research is Commissioned

Responsibility for the coordination and administration of the commissioning and procurement of shared research via this strategy lies with the Welsh Government. This includes the research delivered by Forest Research as main provider, as well as ongoing and future contracts and other commitments funded through the external research budget. However, the ambition of the strategy will only be met through the involvement of other funders including research councils and the private sector, and collaboration will be sought to encourage this.

The Welsh Government will manage an affordable and adequately resourced mechanism for programme management to hold research providers accountable, and will secure contractual commitment from research providers as follows:

- timetable, outputs and delivery,
- detail of resources to be committed,
- collaborations and arrangements that will support delivery and
- arrangements for effective dissemination of research.

The focus of the research and evidence commissioned will reflect cross-border policy priorities. The full suite of themes and areas of research interest will be better addressed if researchers also access other funding mechanisms, and adopt a collaborative approach where possible.

The strategy will focus primarily on applied research of shared (pan-GB) interest such as underpinning knowledge and evidence gathering, as defined by the OECD Frascati principles[9]. It will also include some development related activity such as operational guidance, data, methods and advice, and by increasing evidence and understanding will seek to support new practices and stimulate further innovation. However, to avoid erosion of research activity and capability, it will encourage others to support development activity and innovation at a GB level. Individual countries and other interested parties will need to resource research and development needs that are specific to their needs.

Basic research undertaken primarily to acquire new knowledge but not directed towards any particular use is not the focus of this strategy. However, the strategy will encourage collaboration so that the applied research draws on the best curiosity-driven basic research and will ensure engagement with research councils and other funders to facilitate and stimulate such interchange.

[9] www.oecd.org/sti/inno/Frascati-Manual.htm

8. Monitoring and evaluation

Monitoring and evaluation will assess progress of the strategy, and identify opportunities for continual improvement. Methods used will be proportionate to the size of each research activity, and will encompass both the Forest Research core programmes, and the externally commissioned contracts.

Monitoring will focus on assessing delivery of the four strategic outcomes of the strategy and deploy a combination of both quantitative and qualitative methods, drawing on learning from research in the previous SIS as follows:

Outcome 1 – Improved evidence base

Qualitative:

- Existence of, and improvements to, data holdings, time series, long-term monitoring, well-maintained experiments
- Peer scrutiny through the Expert Committee for Forest Science
- Quality management systems
  - Monitor continual improvement over the SIS period

Outcome 2 – Increased knowledge and understanding

Quantitative:

- Number of outputs and knowledge exchange activities, by type (peer-reviewed journal papers, popular articles, reports, major events e.g. conferences, models/tools)
  - Reported at end of SIS
- User feedback.

Qualitative:

- Conceptual impacts: qualitative changes (attributable to the SIS) to knowledge, skills, awareness, understanding, attitudes, values, etc. – by stakeholder group (e.g. researchers, policy, practitioners, processing, community, other)
  - Case studies, interviews and questionnaires, conducted throughout the SIS period, reported at the end as descriptions plus quotes from stakeholders. Reporting structured to highlight the range of conceptual impacts on different stakeholder groups.

Outcome 3 – Policy and practice informed by science

Quantitative:

- Instrumental impacts: tangible changes to the economy, environment and society (attributable to the SIS, both positive and negative).
  - Case studies using quantitative methods to demonstrate the ultimate impacts attributable to the SIS, e.g. numbers of woody debris dams to manage flood risk through natural processes, or forest area protected using biocontrol agents; economic analyses where appropriate, e.g. tree breeding programmes and eradication of certain pests and diseases

Qualitative:

- Instrumental impacts: changes (attributable to the SIS) to decisions and actions, e.g. policies, plans, and practices.
  - Case studies, interviews and questionnaires, covering the range of funded research, and conducted throughout the SIS period, reported at the end of the SIS as descriptive text plus quotes from stakeholders. Reporting structured to highlight the range of impacts on different stakeholder groups

Outcome 4 – Skilled research community/national capability

Quantitative:

- Number of researchers – by discipline, qualification, age etc.
- Number of doctoral students/completed PhDs during the SIS period – by discipline
- Core and external research funding
- Leverage of additional funding – by source (countries, EU, UKRI, etc.)
  - Reported at start and end of SIS period to show changes; database maintained by FR and other research providers.

In addition to the above, processes and governance across the strategy will be considered as part of monitoring of the MOU.

Quality assurance through external peer review and involvement of stakeholders will be implemented in a proportionate way under the strategy, for both research commissioned from FR and for external research from other providers. This will ensure the science to be delivered is of the highest quality, relevant and appropriate whilst providing value for money.

This will be achieved by co-production of research programmes with government, researchers, and stakeholders; also peer review by the Expert Committee for Forest Science at critical stages, and production of peer-reviewed papers. There will be an expectation that research providers comply with Joint Code of Practice or other recognised scheme of quality management.

A yearly programme of work will be documented and agreed with the countries providing funding, with co-ordination for this process provided by the Welsh Government.

9. Useful sources of information

United Kingdom

UK Forestry Standard

Land use: Policies for a Net Zero Report UK (2020)

England

A Green Future: Our 25 Year Plan to Improve the Environment

England Tree Strategy

Environment Bill 2020

Scotland

Scotland's Forestry Strategy

National Performance Framework

Forest and Land Management (Scotland) Act, 2018

Wales

Woodlands for Wales strategy and action plan (2018)

Prosperity for All: A Climate Conscious Wales and A Low Carbon Wales (2019)

Nature Recovery Action Plan for Wales

Welsh Government Tree Health Strategy

Northern Ireland

Northern Ireland Forestry – A Strategy for Sustainability and Growth 2006

Forestry Act (Northern Ireland) 2010

Ministerial Statement – Afforestation Programme (Northern Ireland Assembly, Official Report, 2 March 2020, Vol.126, No.4)