**FRAMING AND DISCUSSION PAPER - NATIONAL FORESTRY STAKEHOLDER MEETING 10 November 2022**

**Building Resilient Future Forests**

**Purpose:** This paper gives a background to building resilience in our forests and woodlands as part of wider work on climate and landscape resilience, to inform discussions on how policy and practice could evolve to support the vision set out in Scotland’s Forestry Strategy along with wider Scottish Government objectives, and create more resilient forest and woodland ecosystems by 2070.

**1. Context**

The declaration of a Global climate emergency by Scottish Ministers in 2019, and the government’s commitment to net zero by 2045 has brought climate change to the centre of government policy. These commitments together with increasing examples of increased temperature, droughts and pests as well as wildfire and storms, have heightened the need for action to improve the resilience of Scotland’s woods and forests, along with the need to contribute to lowering the amount of carbon dioxide in the atmosphere.

The magnitudes of risk are already large and rapidly increasing. At the global scale, in the UN 2022 'Global Assessment Report on Disaster Risk Reduction' they warn of a scenario of ‘global collapse’ unless outcomes on mitigation and adaptation can be achieved. The UN urges nations to develop and implement mitigation strategies that minimise the speed and eventual level of climate change (by reducing or preventing emissions), and establish resilience strategies that allow us to cope with the climate change that does take place.

Scotland has a mature statutory policy framework for building resilience to the impacts of climate change, which sits alongside commitments on mitigation (net zero by 2045).

* The Climate Change (Scotland) Act 2009 requires the preparation of strategic programmes for adaptation in response to each 5-yearly round of UK-wide Climate Change Risk Assessment (CCRA) – the evidence for which is prepared by the independent UK Climate Change Committee (CCC).
* The Act also requires annual reporting and for the CCC to set out independent assessments of the progress made.
* The second Scottish Climate Change Adaptation Programme (SCCAP2) covers the period 2019 to 2024.

The most recent CCC report (March 2022) on Scottish approaches to adaptation (‘’Is Scotland climate ready?’’) welcomes the outcomes-based vision in SCCAP2, however calls for more action in priority risk areas. Eight priority risk areas were set out in the CCC’s UK independent assessment of climate risk published in June 2021 (CCRA3). Four of these high priority areas relate directly to woodlands and forests:

* Risks to natural carbon stores and sequestration from multiple hazards leading to increased emissions
* Risks to crops, livestock and commercial trees from multiple hazards
* Risks to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazards
* Risks to soil health from increased flooding and drought

The Scotland’s Forestry Strategy (SFS) identifies climate change as a key strategic driver and sets out a vision where by 2070 ‘*Scotland’s forests and woodlands will be a more resilient* *adaptable resource, with greater natural capital value, that supports a strong economy, a thriving environment, and healthy and flourishing communities’*. One of the 6 priority areas for action identified in the Strategy is to: *increase the adaptability and resilience of forests and woodlands* and the second Forestry Strategy Implementation Plan (2022-2025), reaffirmed that the resilience of Scotland’s forests remains a key strategic driver.

**2. What is resilience: definitions**

It is helpful to understand the different elements of a simplified resilience framework:

* Adaptation – Long term change. Driving change by increasing the extent, connectivity, diversity and health of our trees in order to reduce the impact of future threats.
* Resistance – Risk reducing measures. Reducing the threat or absorbing the impact of a risk with no substantial change or loss to the treescape.
* Response and recovery – Detection and response. When threats do occur, facilitating an effective response to enable the treescape to recover.

There is a balance needed when choosing resilience measures. For example, if more adaptive or resistance measures are used then there may be less need for response and recovery, or vice versa. This could also vary nationally, for example with no standard requirement for each woodland or forest to employ the same measures.

**3. Why do we need to build the resilience of our woodlands and forests: impacts**

Sustainable Forest Management (SFM) aims to create benefits and outcomes that are socially just, ecologically sound and economically viable – the three pillars of sustainability. Scotland’s woodland and forests as a nature-based solution provide a huge range of benefits and ecosystem services, which would be at risk if they were not resilient to a future climate. For example:

* Mitigating climate change - forest’s as natural carbon stores support our challenging target to reach net zero by 2045. Trees remove carbon dioxide from the atmosphere and store the carbon in solid form as wood. Productive forests transfer the carbon into wood products potentially for long periods. Wood products can also be used as an alternative to other materials that release greenhouse gases in their production, such as concrete and plastics, and woody biomass can be used directly as a source of energy to replace fossil fuels.
* Our woodlands and forests, and expansion of them, improve ecosystem and ecological resilience, and provide and enhance habitats, species, ecological processes, and nature connectivity as part of wider dynamic landscapes. Increasing the biodiversity and health of all our woodland, but especially semi natural and ancient woodland, such as managing herbivores and INNS will increase their ability to regenerate and build resilience to the changing climate and support nature restoration. Woodlands as part of integrated land use can provide shelter and shade in a warmer climate, for farm animals, and riparian shelter for stream habitats.
* Forest and woodlands enhance Scotland’s urban environment by providing greenspace in our towns and cities, with key benefits for people’s mental and physical health enabling resilient communities, and supporting a number of key SG outcomes such as the Natural Health, Mental Health, and Physical Activity Plans, and the learning in greenspace approach.
* Healthy and resilient expanded forest and woodlands will help to ensure a resilient rural economy and communities, by ensuring a sustainable timber supply for a multitude of uses like housing and furniture etc. They provide rural jobs, supporting the SG economic strategy. Resilient forests provide flood mitigation by slowing the water flow in areas prone to flooding. They can also help to protect transport and energy networks from flooding and landslides in turn enabling a more resilient Scotland and supporting the economy.

**4. What do we need to build resilience to: threats**

The latest Intergovernmental Panel on Climate Change report warns that without immediate and deep emission reductions across all sectors, keeping global warming below the 1.5°C threshold will be impossible.In Scotland, this is leading to a climate with hotter drier summers and warmer wetter winters. These locking-in changes are leading to a range of impacts and increased risks, which will intensify over coming years.

The threats to forests and woodlands are:

* Temperature - increased generally, and an increase in the length and severity of high temperatures.
* Pest and diseases - increased pest and diseases due to warmer temperatures and risk from insects could also be increase with drought stresses, as well as increased wetness (west coast) could increase risk from some pathogens.
* Frost - reduced number but changed timing, such as occasional hard frost which could be very damaging after bud-burst.
* Wildfire – increased due to reduced rainfall and higher temperatures
* Flooding and waterlogging of woodland in coastal areas or low floodplains, and more increased rainfall events, despite a reduction in total rainfall.
* Windthrow - increased storm frequency and intensity
* Drought – increased due to reduction in total rainfall and change in distribution of rainfall

**5. How to build resilience: measures**

Work has been progressing on this in Scotland in relation to woodlands and forests through work commissioned by SF on strategies for building resilience, and the subsequent FR Practice Guide on Adaptation. The Practice Guide identifies the measures that can be employed to build resilience. See **Annex 1** for more information on these measures, opportunities and constraints, and estimates of risk reduction, ease of implementation and scale at which they could be employed.

The measures identified include: increasing the diversity of species, provenance, and structure at a number of scales; more use of management methods such as thinning, shorter rotations and natural regeneration; tree breeding for resistance; monitoring and surveillance; better planning for risk in forest design plans; and contingency planning for response and recovery to events.

**6. Discussion on building resilience: issues**

As has always been the case with SFM, there is a balance when creating and managing woodland, between the economic, social and environmental benefits that forests and woodland provide. The balance can be influenced at a national level through policy and incentives, but is also dependent on the land available for planting, the landowner’s objectives for the site, and individual site conditions.

This balance now needs to be achieved in the context of a climate emergency, nature crisis and increasing uncertainty. Mitigation and resilience strategies are major drivers, influencing how we implement SFM in the future and what our future forests will look like, but cannot be considered in isolation. We need a woodland to make a strong contribution to mitigation to minimise the speed and eventual level of climate change, in balance with resilience measures that allow woodlands to cope with the climate change that does take place.

Some of the issues when considering how to implement the resilience measures in Scotland are discussed below:

**Balance of SFM benefits:** Following on from above, if we consider implementation of diversification measures as an example, greater diversification could lead to a shift in the balance of benefits. Resilience to some threats could potentially be reduced, along with increased benefits for biodiversity and amenity, but implications for other benefits for timber and climate mitigation (i.e. carbon) should also be considered. Costs could be increased, and there are current constraints around supply of seed for productive species. We would need to be mindful not to introduce alternative species that are also known to be already susceptible to a pest or disease.

Furthermore, deer populations have grown to such an extent that it is difficult to establish many native and alternative productive species without protective fencing, and ensure survival of natural regeneration.

**Scale:** The measures can be implemented at different scales. For example, if we consider species diversification – this could be implemented a national, regional, or more local level (landscape, ecosystem or stand). According to the CXC planted forest diversity index the 1.4 million hectares of forests and woodlands in Scotland are ranked as having moderate diversity, with a slight upward trend over the last 18 years. FR advise that at local level plantings of intimate species mixtures are likely to be more resilient to pests and pathogens, however in forests that are managed by clearfell, diversifying species across different stands in a landscape creates a matrix structure, which could be more resilient both ecologically and for timber supply.

For some measures there may be considerable advantages to working at a landscape scale, such as proactive management of some pest and diseases, drought or creating matrix structures of species or age diversity. Some measures will benefit working with neighbours through Regional Land Use Pilot’s (RLUP’S) for example, and integrating with other land use systems such as farming.

**Timescales:** In contrast to other sectors, five, twenty and even fifty years are short-term planning horizons for some elements of woodland management. By the 2080’s, an oak tree planted now will only be half-way through a commercial rotation, while as a component of semi-natural woodland, it would still be at a juvenile stage.

For productive Sitka spruce the standard rotation length is more like 40 years. Both can have long lifespans if retained, and both contribute to forest ecosystems. These long timescales also mean that only about 2% (see table 1 below) of the overall forest resource in Scotland is created or restocked each year, which limits the speed of change. There has been some consideration of shortening rotation lengths (<30 years) to reduce risks from pests and disease or drought, but this could affect other SFM and mitigation benefits, such as the amount of carbon in the growing trees.

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| --- | --- | --- |
| New woodland creation | 18,000 by 2024/25 | 1.2% of overall woodland resource each year |
| Restocking | 10,200 hectares a year (average amount of publically funded over the last 5 years) | 0.7% of overall woodland resource each year |
| Management planning | Approximately 854,000 hectares of woodland are under active management through a Forest Plan. | Some opportunity to influence the long-term objectives of 85, 000 hectares - about 6% the of the overall woodland resource each year. |

**Table 1. Change to forest and woodland resource**

**Planning and management:** Forest planningis a key part of building resilienceand can address each of the elements as well as considering the balance of SFM benefits, and the balance between mitigation and adaptation. It can also consider interdependencies between the forests and the infrastructure to support them. For example, planning at local level can ensure urgent access considerations, which may be needed more frequently in future, to remove diseased or windblown trees.

Planning at national level through to local level needs to link up in some form. Any decisions for building resilience taken at national level will be largely implemented at local level, and need to be practical and achievable. Planning can help ensure active and adaptive forest management to help manage uncertainty. Thinning for example, is a management measure that can be employed to accelerate some SFM benefits, whilst allowing opportunities to build resilience within rotation. Also, ensuring our woodlands are in good condition and connected will generically improve their resilience.

**Location and objectives:** In some cases, the choice of measures will depend on the location, characteristics and objectives of the site.

For example, choosing the appropriate tree provenance for current and future climate at that site, is a key management decision. As Forest Research state ‘*provenance choice for a changing climate is complex, uncertain and the approach is likely to be different for sites where the main objective is timber production, compared with those with primarily conservation objectives’*. Depending on the site and objectives for example, there could be benefits choosing ‘selected’ seed that is climate matched for a future climate, or seed that locally sourced and has high levels of adaptive diversity.

The individual landowner who puts forward a parcel of land for woodland creation will have objectives in mind for the site, may that be productive timber or rewilding, which will also affect the measures chosen, and the balance of SFM benefits.

For mitigation, location and land type can have a large impact on the mitigation benefits a woodland can provide, with trees grown on better quality land having higher sequestration rates. Objectives that also include wood products going into long term storage, will increase any mitigation benefits.

**Limited change and uncertainty**: Even though there has been an increasing awareness of climate change and the risks there has perhaps been limited change in approach so far, which could be due to issues such as:

* + The uncertainly of assessing the likelihood and impact of risks over long time periods. For example, with high uncertainty around pest and disease risk, it is difficult to know how much adaptation to build into the forest. SCCAP states that ‘*due to the inherent uncertainty in some aspects of climate change, adaptation policies need to be flexible and adjusted as and when new information becomes available’*.
  + Barriers in the supply chain such as availability of alternative species, changing processing equipment to accept a new and broader range of species, and increased associated costs.
  + Availability of the capacity and skills in the sector to manage our forests in a different way, such as using different silvicultural systems.
  + Lack of personal experience of risks - e.g. some effects Storm Arwen has reminded foresters of the threat of wind after a run of quiet years.

**Investment:** The investment in forestry often acts as a driver for the type of woodland planted. Investors in productive forestry diversify their risk at different scales, and using a portfolio of investment. Those that have a pure forestry investment diversify by including forests across all age ranges and locations. Funds often plan over a limited time horizon, so may sell a limited life fund after 15 years rather than plan across a whole rotation. Private investment in woodland creation for carbon, is also a key driver in the types of woodland planted. ESG (environmental and social governance) is also playing a growing role. Many buyers under the Woodland Carbon Code have been attracted by wider environmental and community benefits.

There is a question around whether the risks are fully accounted for by individual enterprises. There is also the question of where the residual risk is held for the impacts of large scale failure due to the risk outlined above, how private companies can be encouraged to take account of nature based risks, or how the state intervenes or by default becomes liable, and potential financial implications of that to the wider economy.

**Monitoring and surveillance:** Currently extensive monitoring is done for pest and diseases across Scotland, and further development is underway to start monitoring for areas under stress, which could be at higher risk to pest and disease outbreaks. Proactive horizon scanning is undertaken to prevent pests and diseases reaching our trees, and our borders are managed to aid resistance to future pests and diseases. Once areas of pest or disease have been identified, powers exist to manage that risk via a number of approaches such as pest risk areas, demarcated areas and SPHN’s to enable removal of the trees. These enable us to respond and ultimately enable recovery where needed.

**7. Building resilience: implementation and key levers for change**

There are a number of ways Scottish Forestry are developing an approach to resilience such as ensuring forest resilience is included in strategic and policy documents, ensuring it is a research priority, and ensuring an extensive monitoring programme as follows:

* **SCCAP2** refers to forestry in Chapter’s 3 and 5 both in reference to the ecosystems regulation function of forests, and the importance of forests from a public engagement perspective.
* **The SFS and Implementation plan** all make clear statements that resilience is a key priority, and needs to be considered across all elements of the SFS. For example, we need resilient forests to ensure that we have resilient ecosystems, resilient communities, and a resilient supply chain.
* **Research:** Adaptation and Resilience were given high priority in both the previous and current Science and Innovation Strategies. Research is ongoing on new species choice, drought impacts, wildfire guidance and flooding mitigation. A ‘hub’ of information on building resilience is also currently under development. Other work on broader ecosystem resilience is underway as part of the SEFARI work programme.
* **Monitoring and surveillance:** SFhas an extensive monitoring and surveillance programme – surveying 1 million hectares of trees per year. New approaches are being considered to pre-empt and slow the spread of disease, and use new surveillance information such as satellite data to enable more frequent and effective monitoring.
* **National conversation and stakeholder engagement:** The recent ICF conference focussed on climate change and resilience. The Minister stated the importance of this issue, and there was broad agreement amongst delegates of the need for greater action on resilience.

There are a number of key levers for change that will be part the considerations on how to further develop the approach, and take forward further action on resilience as follows:

* **UK Forestry Standard (UKFS):** Future forests that do not meet the needs of future generations are not sustainable, therefore the UKFS, which outlines the governments approach to SFM, recognises the need through a number of guidelines, to conserve and enhance carbon and plan for forest resilience. The UKFS is current under review with enhancing resilience part of the considerations.
* **Forestry Grant Scheme:** Some measures to build resilience are implemented through the FGS via scheme requirements. There is the ability within the scheme, and working with other government schemes, to implement resilience measures at different scales where needed.
* **Forest Planning as part of FGS/UKFS:** There are number of tools already in place to help land managers plan for resilience such as:
* ESC – the tree species suitability tool, and the complementary Climate Matching Tool enable selection of the right choice of species and provenance for a future climate. This shows regions with a similar current climate (across the UK and continental Europe) to the climate projection for any UK location, and gives an indication of the climate that trees are likely to experience in the future.
* ForestGales enables planners to consider wind risk
* The new concept of ’Forest Development Types’ gives guidance for managers wanting to make greater use of mixed species stands and a wider variety of stand structures.
* The FR 5 step Resilience Implementation Framework.

**8. Conclusion**

One of the challenges CCC have set themselves is to help make adaptation more meaningful, and articulate the steps that need to be taken to achieve a resilient UK or Scotland.

Similarly our challenge, is to articulate what a resilient treescape in Scotland looks like as part of resilient landscapes, and continue to enable this, where required, ensuring the right levers and delivery mechanisms are in place, to enable the measures to be delivered in a way, and quantity, that will achieve more resilient woodlands and forests by 2070.

Helen Sellars, Scottish Forestry

**9. Questions for discussion:**

* **What are the characteristics of climate resilient woodland or forests in a resilient landscape?**
* **What can we do to strengthen these characteristics in our woodlands and forests ecosystems to enable adaptation, but also resistance, response and recovery?**

**10. Some ideas on the characteristics:**

* + Connected
  + Diverse
  + Healthy
  + Managed
  + Accessible
  + Resistant

**ANNEX 1**

**Table 1** A list of measures to build resilience in Scotland’s forests and woodlands with examples of opportunities and constraints, scale at which they can be applied and estimated risk reduction and ease of implementation (including time and cost).

*Developed using the information in the FR Adaptation manual*

| Measure | Opportunities | Constraints | Scale | Resilience Framework  element | Estimated Risk reduction rating (darker = greater) | Ease of implementation (darker = greater) |
| --- | --- | --- | --- | --- | --- | --- |
| Increasing species diversity | Reduce wind, wildfire, pest and pathogen, drought and frost risk if different species have different vulnerabilities to these risks.  Enhance biodiversity and improve amenity value, and improve connectivity between currently under-represented tree species.  Ensure that the species and provenance choice is adapted to grow in the future climate  Greater use of productive hardwood species possible.  Can be achieved by under planting. | For productive stands, alternative species could have lower suitability or timber yield potential, so potential impact on timber and carbon sequestration.  Limited seed supply for less commonly used species;  Emerging conifer species often take longer to reach a sufficient height to be used as planting stock and this can increase costs.  1-2% of the total area of woodland in Scotland is restocked or planted each year.  Important not to introduce alternative species that are more susceptible to pests and diseases ie Norway Spruce and Ips topographus  Alternative species currently slightly less attractive to the timber processing sector. | Local  Landscape  National | Adaptation |  |  |
| Increasing Provenance diversity | Key management decision as above | Availability of the seed of the provenance and alternative species  Provenance choice for a changing climate is complex, and uncertain.  The approach is likely to be different for sites where the main objective is timber production, compared with those with primarily conservation objectives. | Local,  Regional,  National | Adaptation |  |  |
| Creating mixed species stands | As above | As above  Removal of single diseased species not possible in a tightly grown stand. The outcome currently is clearfell of entire stand to remove one of the mixture species.  Quality of ground will limit the types of mixtures, especially on poor quality land. Potential limitations around harvesting and separation of different species for different markets/mills | Local | Adaptation |  |  |
| Structural  Diversification (age) | As above | As above | Local  Landscape | Adaptation |  |  |
| Natural regeneration | Naturally regenerated trees may be better adapted to the site soil and recent climate conditions than their parents, and may be better adapted than planted nursery stock.  Using natural regeneration may encourage adaptation through natural selection.  Use of natural regeneration may lower the risk of wind damage and drought, but increase the risk from fire. | Increased costs due to increased management requirements including ground preparation and measures to protect seed and seedlings, more weeding and subsequent thinning/respacing.  There may also be increased harvesting costs due to the complexity of stands and the larger assortment of timber sizes.  There are also practical constraints to achieving successful natural regeneration that need to be managed, including variability of seed production, seed viability, seed predation by rodents and birds, within-stand light availability, weed competition and browsing of seedlings by deer.  Due to the slow time taken for establishment natural regeneration has slightly lower carbon sequestration than planted native woodland and significantly less than fast growing productive woodlands | Local  Landscape  National | Adaptation |  |  |
| Thinning | Changes can be applied within a rotation to accelerate adaptation ahead of end-of-rotation measures, such as changing the species composition of a woodland using under-planting or enrichment planting, or by stimulating natural regeneration. | Wind risk, which increases immediately following stand thinning.  Wildfire risk can be reduced by thinning, particularly at early stages of stand growth, if the resulting brash is managed appropriately. | Local  National | Adaptation |  |  |
| Design planning (incl infrastructure) | Expanding and creating new forests and woodlands provides an opportunity to design for the future climate and integrate adaptation measures to the plans.  Creating new woodland can have multiple social, economic and environmental benefits.  The type and purpose of the woodland, its design, management plan and silvicultural details can be clearly identified, and planned to take account of the impacts of gradual changes, alongside changing the frequency of extreme events.  The management plans can make reference to the main risks from climate change identified, and set out which adaptation measures are being applied.  Different infrastructure may be required to prepare for increasing storm frequency, which can damage or disrupt utility, road and communications networks. | Increased time and complexity of plans. | Local  National | Adaption, Resistance, response and recover |  |  |
| Tree breeding | Breeding programmes can be put in place to develop new strains of species to be resistant to a particular risk, such as drought or a disease. | Breeding programmes can be costly and take a number of years. | National | Resistance |  |  |
| Active adaptive forest and woodland management | Current business as usual management likely to be insufficient. More need for more regular adaptive management when impacts occur. | Increased costs | Local  National | Resistance, response and recover |  |  |
| Shorter rotations | The same volume yield and carbon sequestration may be possible with shorter rotation lengths, due to increased growth rates.  Could provide more frequent opportunities to replace tree species or provenances with those better suited to the changing climate | May be necessary to avoid increasing wind risk from faster growing  Could be felling before maximum mean annual increment (MMAI)  If applied extensively without increased growth rates, they would reduce landscape structural diversity and may adversely affect biodiversity. |  | Resistance. Respond and recover |  |  |
| Contingency plans/risk assessments | Having appropriate contingency plans in place for, pest and disease outbreaks, extreme weather events and fire, is a UKFS Requirement for General Forestry Practice  Considerable benefit to agreeing in advance about when and how to respond, and having set thresholds for decision-making. | Greater costs associated with high impact events | Local  Regional  National | Resistance, Respond and recover |  |  |
| Monitoring and surveillance | Regular monitoring can ensure that impacts on the forest resource are picket up early to enable early response and reduction of impact. | Monitoring programmes can be costly  Opportunities to develop new monitoring approaches, such as using satellite data to regularly monitor woodlands. | National | Resistance, Respond and recover |  |  |