

How is changing climate suitability affecting the productivity and sustainability of Scotland's forestry?	Version
	26/03/16
<p>Climate change is expected to bring both risks and opportunities to Scotland's productive forestry.</p> <p>The projected warmer climate will increase tree growth generally across the country (though there will be significant regional variability) with a resulting increase in productivity in areas not limited by water and available nutrients. This increase will also potentially aid the target of Forestry Commission Scotland (FCS) to increase the country's woodland by an additional 100,000ha between 2012 and 2022. This would significantly contribute to Scotland's emission reduction targets by locking up carbon in the growing trees. New woodland areas also bring wider environmental benefits and if spatially targeted within habitat networks will reduce habitat fragmentation.</p> <p>Whilst a wider selection of species will be able to grow, particularly favouring high quality broadleaved trees in the South, the climatic changes will also alter the suitability of sites for species of trees already growing commercially in Scotland which could impact both positively and negatively on the productivity and sustainability of the forestry sector.</p> <p>Changes in the seasonable distribution of rainfall are projected to increase the risk of drought in summer with a resulting decrease in suitability for species more sensitive to water limitations (e.g. Sitka spruce). Increased winter rainfall and a greater frequency of intense rainfall events will decrease the stability of slopes in some areas.</p> <p>Milder winters and warmer wetter springs are likely to favour the abundance and distribution of over-wintering pests and diseases, and damage or stress resulting from drought, temperature extremes or storm damage will increase susceptibility to these pathogens.</p> <p>An increase in periods of drought will heighten the threat to Scotland's forests from wildfires. Though typically in Scotland the main damage from such events is to the understorey, even if tree mortality does not occur, fire damaged surviving trees are more susceptible to subsequent attack by pathogens or other stressors.</p> <p>Wind throw can cause significant damage through uprooting and snapping of stems. Though there is still a high degree of uncertainty surrounding the projected impact of climate change on high winds and storm events in Scotland, it is known that forest stands in wetter soils are at greater risk from high winds. Furthermore, the projected increase in growth rate may mean forest stands reaching a height which puts them at risk at a younger age.</p>	

### Adaptation options

In order to minimise the risks and maximise the opportunities, forest managers need to factor in climate change as part of their routine management and planning. The relatively long time

periods between the establishment of young trees and harvesting means that forest practitioners must be aware of the projected changes in climate, how this will impact on specific sites, and the consequent changes in growth, population dynamics of pests and diseases and wider forest ecology.

**Predictive forest management.** A number of management tools are available to aid decision making and promoted by FC Scotland and Forest Research in their adaptation guidance. The Ecological Site Classification (ESC) decision support tool provides guidance on appropriate tree selection and incorporates future climate change projections to allow users to incorporate future suitability into planting decisions. ForestGALES utilises data on the probability of damaging winds occurring along with information on planned species, cultivation and drainage to help minimise windthrow risk when planning planting.

**Diversification** is a key adaptation strategy identified in FCS' Climate Change Programme for building resilience to climate change related threats and an uncertain future climate. Scotland's productive forests consist of relatively few species in significant proportions, with a single species (Sitka spruce) occupying around 43% of all forest area. Increasing diversity of species, provenance and choice of genetic material will spread the risk and reduce potential impacts as well as increasing wider biodiversity and supporting forest ecosystems to adapt. Diversifying management approaches and varying the timing of operations will also increase stand resilience in a changing climate.

**Adaptive and flexible site management** will be increasingly needed to spread risk, increase overall resilience and reduce the impact from potentially damaging events e.g.

- Low-impact silvicultural systems (LISS), supported by Woodland Improvement Grants, may become more appropriate as they can increase the resilience of the overall forest system.
- The timing of the use of heavy machinery may need to be altered to account for an increase in times when the ground is waterlogged and to prevent consequent soil damage and maintain compliance with the UK Forestry Standard.
- As in the farming sector, forest nurseries may need to factor in the use of more irrigation in drier periods in Eastern Scotland.
- Identifying ways in which the general resilience of the forest can be improved through management in order to help withstand additional pressure from climate change e.g. reducing stress from deer grazing.

**Contingency planning** needs to be in place at site, regional and national level. Forest managers will need to ensure plans are in place to provide adequate responses in the event of catastrophic fire, wind damage or outbreaks of pests and diseases. An example of larger scale planning is The Scottish Windblow Contingency Plan which provides strategic regional and national planning for dealing with catastrophic windblow events.

**Partnership working and knowledge exchange** help to build the overall resilience of the sector. The Climate Ready Forest Network (a partnership between FC Scotland, Forest Research, ClimateXChange and private forest owners) aims to support the forest sector in Scotland adapt to climate change by:

- Enabling the exploration of barriers to climate change adaptation and create partnerships to enable solutions.
- Providing a showcase for real-life examples of best practice and innovation through demonstration sites, case studies, workshops and resources.
- Providing a forum for knowledge exchange, the sharing of ideas, and to provide a source of inspiration and support.

Forestry can also play a vital role in reducing wider risks from climate change and adaptation of the forestry sector needs to be considered in conjunction with wider land use planning and adaptation considerations. Strategic planning of woodland expansion can encompass multiple benefits including the role of woodlands in natural flood management, riparian planting to prevent riverbank erosion and reduce thermal stress on freshwater systems, increasing slope stability to prevent landslides disrupting infrastructure and the role of urban woodland in regulating temperature and providing sustainable drainage systems. The creation, expansion and importantly the sustainable management of woodland is supported by the Forestry Grant Scheme.

Effective monitoring of climate change impact and evaluation of adaptation action is very reliant on the availability of reliable and comprehensive data. Improving the collection, collation and availability of data will be necessary to improve the knowledge base available for research, policy implementation and management practice. Currently the majority of data is available for the National Forest Estate only- greater engagement by the private sector in the provision of publicly available data that can be coordinated with existing data collection methods will be needed in order to build up a fuller picture of adaptation across all of Scotland's forests.

### What do the indicators tell us?

CXC's indicators focus on potential risks (and opportunities) to Scotland's commercial forestry due to climatic changes, realised impacts, and highlight actions to address these risks or to increase overall resilience:

The RISK or opportunity of the changing climatic suitability of sites and the threat from extreme events:

- *Proportion of major timber species on Scotland's National Forest Estate planted in areas likely to be climatically suitable in 2050 (Sitka spruce and Scots pine)* uses the Forestry Commission's Ecological Site Classification tool to examine existing stock and identify how this may be impacted by projected climate change. This shows that the proportion of current forest area projected to increase in suitability exceeds that projected to decline. By 2050 approximately 81% of current Sitka spruce and 77% of Scots pine will be on suitable (or very suitable sites).
- *Proportion of coniferous woodland on the National Forest Estate with a high/medium-high risk of wind throw* uses Forest Research's ForestGALES tool to assess wind risk to the existing forest stock. The indicator will be used to show how the risk changes in response to changing woodland cover, species composition and management practices. The latest

figure shows that less than 9% was at medium-high risk which is relatively low considering Scotland's overall high wind risk.

The realised IMPACT on forestry of the changing climate:

- *Number and area of reported wildfires in forests and key habitats* provides a proxy measure, based on the incidents responded to by Scottish Fire and Rescue, to help monitor the impact of wildfire on Scotland's forests which are anticipated to increase in response to warmer drier springs and summers. Between 2012 and 2013, 479 separate incidents impacted on approximately 270ha of woodland, however there is a high degree of variability between years and it is not yet possible to identify any significant trends.

Monitoring management ACTIONS and strategies which focus on specific adaptive measures or which aim to increase the general resilience of Scotland's forests:

- *Diversity of tree species ordered for planting in Scotland* utilises data from a survey of the conifer stock ordered from nurseries by both the public and private sectors, capturing information about species choices and diversification. Increasing diversity is a critical strategy to increase overall forest resilience to a wide number of potential risks. Whilst there has been a small increase in the number of novel species, the amount and species composition of ordered conifer has remained quite constant.
- *Planted forest tree species diversity index* considers the composition of standing forest in Scotland and measures the diversity using the Shannon Index (an ecological indicator of diversity which accounts for both the number of species and their proportionate distribution). There is some evidence to suggest that there has been a slight increase in the diversity of planted forest species over the last 20 years in Scotland as a whole, though broadleaf woodland continues to be generally more diverse than coniferous. However there is variation across Scotland, influenced by a number of factors including proportion of commercial forestry, species suitability (soil type and climate), as well as local, site-by-site, commercial and biodiversity management strategies.
- *Area of woodland with active, approved deer management plans* provides a measure of the extent of management to reduce deer impacts which pose a significant threat to the resilience of woodlands. Deer browsing, bark stripping and trampling can prevent woodland regeneration, damage standing stock and increase vulnerability to pests and diseases. Currently approximately 55% of Scotland's woodland are under active deer management.
- *Number of uses and users of the Ecological Site Classification (ESC) decision support tool* monitors how this useful management tool is being successfully promoted and subsequently utilised for forestry planning which takes climate change into account. The number of uses (in Great Britain as a whole) steadily increased from 131 uses in 2009 to 1012 in 2012, along with a steady increase in the number of new users.
- *Number of uses and users of the ForestGALES decision support tool* monitors how this tool, which aims to assist forest managers in their decisions about planting forests to minimise windthrow, is being utilised. Between 2009 and 2012 the number of uses (in Great Britain as a whole) steadily increased along with a steady number of new users being added each year particularly from the private sector.

It is hoped that future availability of suitable data will enable the development of a number of additional indicators:

- Timber productivity
- Area/ proportion of forest at high risk of wildfire
- Area of forest affected by windthrow

### Other relevant indicators

CXC's indicators focus on a number of key forestry pests and diseases which have a known link to climate change and with known high impacts, as well as the distribution of invasive non-native species. It will be increasingly important to understand and monitor their prevalence and understand how legislation and action on the ground is managing these risks and reducing the economic impact. See the overarching narrative and associated indicators:

- *Pests, diseases and invasive species (forestry)*

Forestry Commission Scotland's Climate Change Programme highlights the importance of the forestry sector understanding the impacts of climate change on biodiversity and the need to encourage natural regeneration, increase native woodland creation and develop forest habitat networks, and prevent the loss and fragmentation of existing priority habitats:

- *Proportion of total woodland under High Nature Value (HNV) forestry*
- *Area of land under landscape scale conservation*
- *Amount of natural regeneration in native woodlands*

Change in land capability due to climate change will result in more land in Scotland being suitable for agricultural improvement and therefore may alter the availability of land for woodland expansion:

- *Area of Prime Agricultural Land (Land Capability)*
- *Comparison of land capability against actual land use*