NatureScot
Scotland's Nature Agency

**NatureScot**

**SCIENTIFIC ADVISORY COMMITTEE**

**DISCUSSION PAPER**

# Creating more woodland in Scotland – challenges, opportunities and choices

## Purpose

1. The paper explores issues around the design and delivery of new woodland in Scotland for both carbon and biodiversity objectives. The paper informs our advice and policy as part of the development of the new Scottish Biodiversity Strategy. We wish to develop this work with Scottish Forestry.

## Action

1. **The Committee is asked to:**
2. **Consider and comment on the analysis set out in this paper;**
3. **Advise on general approaches for planning within uncertain long-term environmental conditions, especially risk-reduction options; and**
4. **Endorse further collaborative policy development work on this issue.**

## Preparation

1. The paper was written by Duncan Stone. It is sponsored by Des Thompson.

## Background

1. Scotland has little woodland by European standards, having lost most of its natural woodlands many centuries ago. Many of its remaining ‘natural’ or native (i.e. non-commercial) woodlands are in poor condition to support biodiversity, and newer plantings often have limited biodiversity by design and management. Improving the ability of woodlands to support nature is a key ambition in the developing post-2020 Scottish Biodiversity Strategy. The national response to the climate emergency has also focussed on increasing woodland cover and diversity as a key land use change to capture and store atmospheric carbon. This has led to ambitious targets for new woodland – 12000ha/year now, rising to 18000ha/year by 2025.
2. There are a range of views on the design and delivery of this new woodland, based on the interpretation of several studies and the ranking of the various objectives that new woodland might deliver. This paper attempts to clarify our choices and seeks the views of the Committee on an appropriate evidence-based position for NatureScot to develop. Recently, Forest Research published an Adaptation Climate Change Factsheet ‘[How can we adapt our forests and woodlands for the changing climate?’](https://www.forestresearch.gov.uk/research/climate-change-adaptation-factsheet/) That presents ten measures to reduce climate risks and improve resilience.

## Carbon balance associated with new woodland

1. A number of recent studies agree on the basic model of carbon flux in new woodland (see references). Ground preparation, drainage, tree root growth and litter accumulation modify the carbon content of the soil so that after planting:

* carbon-rich soils tend to lose carbon for 10-20 years
* carbon–poor mineral soils gain carbon rapidly and over a longer timescale

1. The growth of trees captures atmospheric carbon and stores it in the woody stem and roots of the tree, as well as above-ground litter accumulation. This carbon sink can be secured for the long term in long-lived trees, or as wood products used for durable purposes. It can also be reversed and the carbon lost if the tree dies, or is used for non-durable wood products.
2. In recent years, the most extensive form of woodland creation has been cultivation and new planting on carbon-rich soils (up to 50cm deep peat) in the uplands. This has operated on the assumption that the carbon lost from the soils is recovered in the growth of the trees in subsequent decades. In 2020, Scottish Forestry produced new cultivation guidelines to limit carbon loss from soils before planting in recognition of concerns over the carbon balance on these soils, although planting on carbon-rich soils is still accepted.

## Biodiversity balance associated with new woodland

1. Biodiversity is not a simple single metric like carbon flux, and there are legitimate choices to be made between woodlands of different types and alternative nature-rich habitats. For example, we remain concerned that the last small fragments of lowland species-rich grassland are vulnerable to unintentional loss from woodland creation. Nevertheless, we are confident that if non-wooded habitats of the highest value are avoided, new woodland can make a substantial net contribution to biodiversity recovery, with the most critical variables being:
2. **Location**
   1. Proximity to existing natural woodland to allow poorly dispersing woodland species to colonise
   2. Proximity to burns and rivers (especially for freshwater biodiversity and to reduce climate heating impact)
   3. Large contiguous area of woodlands with good local connectivity
   4. Avoiding high biodiversity non-woodland habitats
3. **Management**
   1. Sustained low grazing impacts to allow natural regeneration and ground flora/shrub layer development
   2. Invasive species restricted/removed
4. **Tree species** 
   1. The best net biodiversity balance is likely to be based on native species and species that can fill the natural niches and functions of woodland habitats in Scotland
   2. A sufficient diversity of tree species is required, and single-species dominance generally gives poorer outcomes
   3. Woodland biodiversity is closely linked to larger and older trees – hence long-term viability of tree species is vital
5. We believe these biodiversity-linked variables can be compatible with timber production, assuming good design and management.

## The central issue of uncertainty over the future

1. For both carbon and biodiversity objectives we have an understanding of the general positive and negative activities, but it is much harder to convert these ideas into specific woodland creation guidance. That is because the key decisions are taken long before the desired results appear, and thus we need to consider at the start the circumstances that will apply far into the future. In a stable environment, planning is simple – but in a rapidly changing and uncertain environment, it is very complex. Key drivers for woodland objectives will change in nature, frequency and extent – things like temperature, precipitation, drought, wildfire, novel biotic impacts (pests, pathogens, larger fauna (e.g. feral pigs), plant competitive balances) and societal requirements. Even if we could predict how these drivers will change, we are uncertain of their individual or interacting impact on our woodlands, and their delivery of carbon or biodiversity objectives. This is well stated in a recent Forestry Commission England publication: ‘*England’s woodlands have been managed during previous centuries under the assumption that the environment they are growing in will be relatively stable. This key assumption is no longer valid’.*[[1]](#footnote-1)
2. The key recent studies of woodland creation and carbon relevant to Scotland are all still making that ‘key assumption’ – that the woodlands and trees will perform in the way that they have done over the last 40 years or so in which the data was gathered. None adequately addresses the fundamental issue that the future for which they provide predictions is unlikely to be like the reference periods they use. Furthermore, there does not appear to be any critical analysis of the assumption that carbon sequestered decades in the future can offset carbon lost from soil disturbance in the years immediately after planting. Conservation science too has barely started to address the potential for major change in the woodland biodiversity we are protecting or restoring. For example, NatureScot’s only formal change in SSSI management is to become more tolerant of sycamore as a partial replacement for ash.

## Additionally - Societal issues

1. Projects with a 40, 80, 100+ year timespan need a view to societal acceptability not just at the beginning, but all the way through. The sustainable delivery of carbon and biodiversity outputs depends on people accepting this form of land use, and in Scotland we have examples old and new of woodlands cleared because they no longer met people’s needs. At present we detect rising dissatisfaction in southern Scotland at the extent of new plantation forestry – and in our design of native woodlands we run a risk that the woods will produce no income to offset future costs of deer management.

## Principles and recommendations – moving towards risk reduction

1. Substantial work has been done to develop the concept of resilience for woodland in the face of climate and environmental change, but it does not seem to have driven real change in woodland establishment or management in either ‘production’ or ‘natural’ woodlands. In particular, ideas about resilience do not seem to have introduced real diversity into how we create or manage woodland. In practice, for both production and nature objectives, we are still assuming that we can predict the future well enough to design the right kind of woodland for that future. This assumption no longer seems valid under our expectations of rapid and chaotic environmental change in coming decades.
2. If, as Forestry Commission England and many others have noted, the future environment is not stable, how can we take the right decisions now when we do not, indeed cannot, know the future growing environment for trees, the future tree mortality drivers or the future societal requirement. Arguably, we can only go forward with a different question – not what is ‘the right tree’ or the right establishment technique, but instead proceed seeking to reduce the risk of unacceptable outcomes. In other words, instead of a strategy that uses the optimal approach under today’s conditions, we choose a broad enough range of different options that will avoid catastrophic failure of our aims in years to come. Hence, this paper suggests that the overall principle for woodland creation should change from ***Optimising*** to ***Risk reduction.***
3. Focussing on risk reduction is likely to require substantial changes in forest creation and management - and a continual re-evaluation as the pace of environmental change accelerates around us. Further work is necessary, but some recommendations can be made:

* Rapidly increase the diversity of production tree species to reduce the risk to carbon capture and the timber industry - this has started to be discussed, but little has been done, even in the national forest estate, which has about 98% of the area of Sitka spruce that it did in 2010.
* Direct new planting away from the most carbon-rich soils towards mineral soils.
* In the uplands, focus woodland on the drier elements of the soil mosaic – crags, steep slopes, bracken areas, burnsides etc.
* Strongly encourage natural regeneration around existing natural woodlands.
* Move to and then maintain low levels of grazing (particularly deer) in all woodlands, especially natural woodlands.
* Improve the economic/employment potential of natural woodlands
* Stop using the geo-political Scotland-England border as a fundamental ecological range boundary, and allow species more adapted to warmer temperatures to begin to grown more widely in Scotland – especially to fill the vacated niches occupied by elm and ash.
* Invest further in biosecurity, including border control and internal monitoring to give time for outbreak management.

1. NatureScot is already applying some of these principles in various combinations – for example in promoting landscape-scale deer management to allow large-scale natural regeneration from natural woods, or in supporting broadleaf production woodlands as a key element of agroforestry investment.

## Discussion

1. The **Committee is asked to discuss the issues raised**. The [Forest Research factsheet](https://www.forestresearch.gov.uk/documents/8256/21_0025_Leaflet_CC_factsheet_Adaptation_wip07_Acc.pdf) (noting further listed information sources) is important. Given the implications of future uncertainty in the context of reducing the risk of failure to our long-term carbon and biodiversity woodland objectives, **are there additional evidence sources that would make the case more compelling for investing in new approaches focused on risk reduction?** The Committee will note the Committee paper on ‘Carbon biodiversity synergies’, which has a bearing on this area. Staff propose to discuss the issues raised with Scottish Forestry colleagues, and **Committee advice on particular areas for discussion would be helpful**.

## References

Key references:

1. Recent work demonstrating and summarising the impacts of tree planting on soil carbon and net greenhouse gas changes:

* K.B. Matthews, Doug Wardell-Johnson, Dave Miller, Nuala Fitton, Ed Jones, Stephen Bathgate, Tim Randle, Robin Matthews, Pete Smith, Mike Perks, [Not seeing the carbon for the trees? Why area-based targets for establishing new woodlands can limit or underplay their climate change mitigation benefits](https://doi.org/10.1016/j.landusepol.2020.104690), Land Use Policy, Volume 97, 2020, 104690, ISSN 0264-8377.
* Friggens, N. L., Hester, A. J., Mitchell, R. J., Parker, T. C., Subke, J. A. and Wookey, P. A. 2020. [Tree planting in organic soils does not result in net carbon sequestration on decadal timescales.](https://onlinelibrary.wiley.com/doi/10.1111/gcb.15229) Global Change Biology, 26, 5178-5188.
* Williamson, J.L., Tye, A., Lapworth, D.J. *et al.* [Landscape controls on riverine export of dissolved organic carbon from Great Britain.](https://doi.org/10.1007/s10533-021-00762-2)*Biogeochemistry* (2021).
* R Gregg, J. L. Elias, I Alonso, I.E. Crosher and P Muto and M.D. Morecroft (2021) [Carbon storage and sequestration by habitat: a review of the evidence (second edition) Natural England Research Report](http://publications.naturalengland.org.uk/publication/5419124441481216) NERR094. Natural England.
* Forster, E.J., Healey, J.R., Dymond, C. *et al.* [Commercial afforestation can deliver effective climate change mitigation under multiple decarbonisation pathways](https://doi.org/10.1038/s41467-021-24084-x). *Nat Commun* **12,**3831 (2021).

1. Work illustrating wider uncertainties in impacts of afforestation on soil carbon loss, e.g.

* Lilly, A.; Chapman, S.J.; Perez-Fernandez, E.; Potts, J., 2016. [Changes to C stocks in Scottish soils due to afforestation](https://www.forestresearch.gov.uk/research/soil-sustainability/woodland-creation-and-soil-carbon-and-nutrient-dynamics/changes-to-c-stocks-in-scottish-soils-due-to-afforestation/). Contract Report to Forestry Commission.

1. Recent work summarising the potential climate change impacts on soil and woodland, and the knowledge gaps on this topic:

* Neilson, R.; Lilly, A.; Aitkenhead, M.; Artz, R.; Baggaley, N.; Giles, M.E.; Holland, J.; Loades, K.; Ovando Pol, P.; Rivington, M.; Roberts, M.; Yeluripati, J. 2020. [Measuring the vulnerability of Scottish soils to a changing climate](https://www.climatexchange.org.uk/research/projects/measuring-the-vulnerability-of-scottish-soils-to-a-changing-climate/) ClimateXChange
* [Agriculture and Forestry Climate change report card technical paper 9](https://nerc.ukri.org/research/partnerships/ride/lwec/report-cards/agriculture-source09/). Forest Ecosystem Services & Climate Change. Duncan Ray, Louise Sing and Bruce Nicoll Forest Research, Northern Research Station, Roslin, MidlothianUK

1. Work demonstrating the impact of forestry cultivation on soil carbon *(*both from papers presented to Scottish Forestry Customers Representatives Group 17 March 2021):

* Cultivation for upland woodland creation sites – Applicant’s Guidance
* Calculated scenarios of carbon (C) change in peat soils due to different levels of ground disturbance associated with different cultivation techniques Elena Vanguelova*, Forest Research, Alice Holt*

1. Work illustrating the long-term security of carbon captured by trees and used as timber and wood products:

* [Harvested Wood Products and Carbon Substitution: approaches to incorporating them in market standards](https://www.forestresearch.gov.uk/documents/7492/FR_HarvestedWoodProducts_CarbonSubstitution_Oct2017_02HIxW3.pdf) Forest Research Gregory Valatin October 2017
* T.J. Sloan et al. [Peatland afforestation in the UK and consequences for C storage Mires and Peat](http://mires-and-peat.net/media/map23/map_23_01.pdf), Volume 23 (2018/19), Article 01, 1–17

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1. [Managing England’s woodlands in a climate emergency v2 2020](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/872285/Climate_Change_Full_Guide.pdf) [↑](#footnote-ref-1)