Alice Holt Climate Change Adaptation Trail Worksheet

Grid ref: SU 80264 43415

Start: Alice Holt Arboretum car park

This worksheet accompanies the *Alice Holt Climate Change Adaptation Trail Guide*. It describes each stop on the trail and includes information about the challenges and opportunities our forests and woodlands are facing as a result of climate change and actions being taken to help them adapt.

The measures being demonstrated are selected for the tree stands in Alice Holt Forest and have taken into account probable future conditions. The climate here is likely to be considerably warmer, with hotter, drier summers and more frequent and perhaps more severe periods of drought. An overview of how climate change is affecting forestry in the UK and future impacts are described in the LWEC Report Card*.

Adaptation actions will be increasingly necessary to prepare forests for the anticipated additional stresses from a changing climate. Well-structured and diverse forests will be more resilient to a changing climate. Adaptive forestry is about thinking ahead, planning and trying things out to see what works and what doesn't. As you go along the trail you might want to think about how the measures you are seeing would work in your forest or woodland. Questions are posed for you to consider along the trail, if you wish.

This trail is designed for forest managers, owners, students and decision-makers to come and see the areas and engage in a discussion about the adaptation actions being undertaken and insights gained from historical trials.

Further information about the trail, stops and the adaptation-decision-making process is available on the Forest Research website: www.forestresearch.gov.uk

* LWEC Report Card is available at http://bit.ly/2aa4tu1

Grid ref: SU 80562 43551

Stop 1 Can we increase resilience using species pairing mixtures?

Mature Corsican pine, underplanted with two broadleaved species in spring 2018 to meet woodland restoration objectives, increase species diversity and demonstrate drought tolerance.

Stop facts: 2.4 hectares

Adaptation measures: Increased tree species diversity and wider age range. Early stages of a transition from clear-fell to an alternative forestry system and increased use of native broadleaved tree species of local provenance.

What can you see?
A stand of maturing Corsican pine (*Pinus nigra* ssp. *laricio*) growing on a sandy soil. The area has been fenced and underplanted with hornbeam (*Carpinus betulus*) and beech (*Fagus sylvatica*) of UK 405 provenance.
The balance of the two tree species has been adjusted in area A to include more hornbeam which is expected to perform better than beech in future because it has a higher drought tolerance.

Before adaptation – species:
Canopy 100% Corsican pine planted in 1940.
Understorey: 15% Corsican pine planted in 2008.

After adaptation – species:
Canopy 100% Corsican pine planted in 1940.

Area A: 70% hornbeam (UK405)/
30% beech (UK405) P1+1 spring 2018.

Area B: 70% beech/30% hornbeam.

Prescription: This stand was assessed for management aims, history, vegetation and soil type. The adaptation prescription involved a light thin using hand tools and then a harvester to increase light levels and clear the understorey, mulching to clear regeneration and scrub and prepare for planting. The area was fenced and split into two sub-compartments.

Monitoring: Beat-up rate (i.e. number of trees which need to be replaced due to mortality) and tree growth are being monitored to better understand the effectiveness of the approach to adaptation. We will monitor the response of the mature Corsican pine to high-wind events now the canopy is more open.

Question 1
What are the main threats from climate change to this mature stand of Corsican pine up to the end of the rotation in 2040?

Grid ref: SU 80568 43499

Stop 2 Can we reduce drought impact by thinning?

Stop facts: A young Corsican pine (*Pinus nigra* ssp. *laricio*) stand which has been thinned at two different intensities. Interventions such as thinning offer an opportunity to change aspects of a stand and consider emerging risks. The aim here is to extend the expected yield in the face of climate change and needle blight.

Plot 1: 2.2 hectares
Plot 2: 1.9 hectares

Adaptation measures: Reduced competition for water between trees, particularly in the heavier thinned area. In addition, more airflow through this stand should help increase resilience to Dothistroma needle blight, which is reducing growth and yield.

What can you see?
Two sub-compartments of Corsican pine are growing on a sandy soil. Both areas were thinned using a harvester in February 2018. One area was thinned to a standard prescription, the other was thinned very heavily. Hotter, drier summers increase competition for water so there should be less competition for water and less drought stress evident in trees where heavier thinning has been undertaken.

Before adaptation – species canopy:
Plot 1: 95% Corsican pine, 15% birch understorey planted in 1992.

Plot 2: 95% Corsican pine,15% birch understorey.

Prescription: Plot 1 was thinned as is typically done ("standard thin") to remove the maximum amount possible without causing a loss of cumulative volume production, which is usually estimated as 70% of the current Yield Class (maximum mean annual increment) for a stand.

Plot 2 was thinned much more heavily to remove 130% of the volume production expected over the length of the thinning cycle.

Monitoring: Tree-stem radial and height growth and soil moisture content are being monitored to better understand the effectiveness of the approach to adaptation, particularly during dry periods.

Question 2
What are the multiple benefits of thinning this stand and what are the penalties? When would you consider an intervention of this kind?

Grid ref: SU 80492 42696

Stop 3 Can we encourage natural selection using direct seeding?

Stop facts: A stand of mixed broadleaved species established by direct seeding on former grazing land. This stop highlights the importance of trials and demonstrations.

Adaptation measures: Woodland creation is important for climate-change mitigation, helping sequester carbon in the trees and soil, providing timber products or biomass for energy to substitute for fossil fuels, and providing climate change adaptation benefits such as flood protection. Direct seeding optimises the chances of natural selection and is a low-cost method of woodland creation. With fencing to protect seed and stems from predation and browsing, establishment has been successful, with good stem form evident.

What can you see?

The direct seeding experiment is the furthest left of the three fenced trial plots visible from the drive. Established in 2009, the area consists of 10 different tree species and several shrubs. The woodland established in three years. The experiment demonstrated that correct ground preparation and weeding are critical when direct seeding is used. Information on direct seeding is available in the Practice Guide *Creating New Broadleaved Woodland by Direct Seeding* (Willoughby *et al.*, 2004) and Research Information Note 288 *Cultivation of lowland sites for new woodland establishment* (Willoughby and Moffat, 1996).

Prescription: The aim of this research trial was to show a cheap and efficient establishment method for woodland, which could be sown on agricultural land from seed using the type of machinery available on a farm.

Question 3
With a partner (if possible), discuss the pros and cons of direct seeding.

You may wish to consider:
a) rate of establishment;
b) natural selection pressures;
c) access to machinery;
d) how seed predation might differ if direct seeding was undertaken within a woodland.

References
Willoughby, I. et al. (2004). *Creating New Broadleaved Woodland by Direct Seeding.* Forestry Commission Practice Guide. Forestry Commission, Edinburgh. i–iv + 1–32 pp.

Willoughby, I. and Moffat, A. (1996) Cultivation of lowland sites for new woodland establishment. Forestry Commission Research Information Note 288. www.forestresearch.gov.uk/documents/1460/rin288.pdf

Grid ref: near SU 80357 42463

Stop 4 What are our options to address changing fire risk?

Stop facts: A research trial of different seed origins of coast redwood (*Sequoia sempervirens*) which shows the importance of provenance trials.

Adaptation measures: This species is suitable for underplanting and may be considered as part of a strategy for species diversification, where the site conditions and the use of non-native species are considered appropriate. It can be used in combination with stand age diversification. Coast redwoods can be cloned, will self-seed and can be coppiced. The species is one of the most highly valued timber species in its native California, where it is now endangered. Trees show wildfire resistance, which is advantageous in light of the increasing fire risk associated with the changing climate. The main considerations for use in the UK are sourcing seed, risk of frost damage when young and uncertainty as to how the species would tolerate flooded soil conditions.

What can you see?
This trial involved different seed origins of coast redwood and concluded that northern Californian coast redwood provenances performed better than southern ones.

Question 4
In what circumstances might coast redwood prove a useful species?

Grid ref: SU 80545 42291

Stop 5 What can species trials tell us about future risks? Leyland cypress clone bank

Stop facts: A research trial of different clones of Leyland cypress (× *Cuprocyparis leylandii* – syn. × *Cupressocyparis leylandii*) affected by wind-throw.

Adaptation measures: The trial survived the 1987 storm but was subject to wind-throw during storms in 2012/13. Although the trial is now abandoned, it demonstrates the importance of long-term trial plots to highlight potential issues in novel species, such as susceptibility to wind-throw, disease and management requirements, *before* they are grown commercially. Although poorly adapted to hot summers in its native USA, this species will tolerate some warmer temperatures and will self-prune, although it is light-demanding.

What can you see?
Shallow roots are evident on the wind-thrown remnants of this trial, which raised concerns about the stability of this species to high-wind events during the later phases of a rotation. Leyland cypress is proven to grow rapidly and can tolerate pollution, salt spray and grow on a range of soil types. Planting to date has primarily been for screening purposes. It is known to suffer from disease (*Phytophthora*), but this species may still be considered as a future choice depending on the planting objectives.

Question 5
Although wind risk is higher further north, in uplands and along coastal areas extreme weather events can still impact trees in other areas. How can climate change increase susceptibility of trees and woodland to wind-throw?

You may wish to consider topics such as combinations of primary and secondary impacts of climate change, and how increasing drought and flood episodes and more extreme weather might change the susceptibility of trees to wind-throw and what we know about different tree species and their root structures.

Grid ref: SU 79729 43026

Stop 6 (optional). What alternative species might suit future conditions?

Stop facts: A clone bank of western red cedar (*Thuja plicata*) was planted in 1964 with trees raised from cuttings taken from superior specimens identified in forests across the UK.

Adaptation measures: Nurseries and foresters have taken a fresh interest in this species in light of the current outbreaks of pests and diseases on other commercial species. Western red cedar is a conifer that has potential for wider use in forestry due to its timber qualities and is of commercial interest for diversification reasons and low maintenance. Today the stand serves as a reference source of genetic material for future breeding and selection programmes.

What can you see?
This clone bank has been established on a north-facing slope at Alice Holt. The dense foliage has blocked light from reaching the forest floor and as a result there is little potential for ground flora and associated wildlife in this stand. However, alternative planting strategies could be considered to improve ground flora growth and wildlife habitat potential.

Question 6
What planting strategies could be employed to improve the wildlife potential of areas, if foresters decide to plant this species more often?

Grid reference: SU 80057 43180

Stop 7 Understanding species diversification

Stop facts: 7 hectares.

Adaptation measures: This mature collection of trees dating from the 1950s is an important reference, showing how different species have grown in the British climate to date. This area also has tree species which are threatened in their native countries and are planted here to support 'living' conservation projects.

What can you see?
This arboretum is home to an important collection of conifers, including several species endangered in their native country. The arboretum is being restored by volunteers from the Alice Holt Community Forum in partnership with other organisations. In addition to the conifers, look out for Italian alders and various species of *Nothofagus* (southern hemisphere beeches) alongside fine examples of oak, sweet chestnut and ancient yew trees in the area surrounding the arboretum.

More information about the arboretum, its history, tree trail, wildlife and latest news is available online: aliceholtforum.org.uk/ahcf/arboretum/

Question 7
There are different ways to adapt to the changing climate. Species diversification is one of the better known measures and is often considered to be a good 'insurance policy' for future climate change. What are the advantages and disadvantages of species diversification in a woodland you're involved with or use?

You may wish to consider the following topics and discuss these in a group (where possible):
a) local markets;
b) economies of scale from felling smaller areas/mixed stands;
c) alternative measures to species diversification;
d) whether contractors would be interested in the thinnings;
e) how might you involve others to raise awareness of the impacts of climate change on trees and woodland?

Have you walked the Climate Change Adaptation Trail at Alice Holt?

Tell us what you think at @Forest_Research using #AdaptAH
Email: adaptah@forestry.gsi.gov.uk

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