



Transformation to continuous cover forestry at Clocaenog Forest

Clocaenog Forest is in Denbighshire, near Ruthin, in northeast Wales. The forest is managed by Natural Resources Wales and covers an area of more than 4000 ha. It was planted with predominantly coniferous species in the early 20th century and most stands are now in their second rotation. The climate is cool, wet and windy and much of the forest is over 350 metres above sea level and occupies a broad, rolling upland landscape.

In 2001, the Forestry Commission established a national network of continuous cover forestry (CCF) trial sites to increase understanding of continuous cover silviculture in British forestry. CCF is a silvicultural approach that seeks to create more diverse forests, both structurally and in species composition, by avoiding clear-felling and allowing regeneration after selective felling. Clocaenog Forest was one of the trial sites and large parts of the forest have been managed using CCF principles since then. In addition, the site was selected as an intensive research area to examine different methods of transforming even-aged stands to CCF, and to study their impacts on the growth and yield of stands and on regenerating trees in the understorey. CCF could be an appropriate adaptation measure, as the development of more diverse forests should reduce the risks posed by the changing climate and increasing biotic threats.

Management objectives

Clocaenog Forest is managed for a wide range of objectives, including timber production, recreation, tourism and conservation, with management for certain endangered species such as red squirrels and black grouse being very important. Stands are managed to ensure that a diverse and appropriate range of forest structure and species are present to deliver the management objectives.

Risks and opportunities

Main climate change risks

Climate change projections indicate that temperatures in the growing season will increase, potentially resulting in more rapid growth through to the 2060s; so there is an opportunity for an increase in productivity, where other factors are not limiting. The frequency of winter storms is also projected to increase, which could increase storm damage. Increased winter rainfall may further increase the windthrow of trees, due to reduced root-soil cohesion in saturated soils. Warmer conditions may increase the incidence of pests and/or disease outbreaks.



Find detailed information in UKFS Practice Guide *Adapting forest and woodland management to the changing climate*.

Information on the UK Forestry Standard and supporting guidance is available at www.forestryresearch.gov.uk/ukfs

Vulnerabilities

As an upland forest in an exposed location, Clocaenog Forest has experienced damage by wind in the past. Clocaenog Forest is also typical of much upland forest in Great Britain, in having a very limited range of tree species, which increases the risk of damage from pests and diseases. Larch stands within the forest have been infected with *Phytophthora ramorum*, leading to felling of affected stands and adjacent larch in buffer zones. The development of advanced natural regeneration of some of the overstorey species in cleared areas has encouraged managers to adapt their practices to make the most of this opportunity.

Identifying and selecting measures

Clocaenog Forest is home to research trails and has been managed using CCF principles for two decades. Research into different methods of transforming stands to CCF has generated insights into their impacts on the growth and yield of stands and on regenerating trees in the understorey. Research at the site has helped to understand the suitability of CCF as a management option to adapt to climate change in upland areas. Successful methods of regenerating stands without clearfelling, and of introducing new species have been identified, diversifying both the age structure and species composition to reduce the risks posed by the changing climate and pests and diseases.

Implementing adaptation measures

A range of methods for managing forests using CCF transformation practices have been trialled in the Clocaenog Forest research plots. Overstorey treatments, thinning operations, harvesting methods and monitoring of impacts were planned and carried out collaboratively by local forest managers, operational teams and researchers.

Map of CCF sample plots in Clocaenog Forest



A number of permanent 1 ha sample plots ('blocks') were established in 2002 to investigate the growth of Sitka spruce stands under different types of CCF management.

Each plot is managed in a different way: Plot 1 is a control area with no overstorey or understorey interventions, allowing comparison of the effects on growth and survival with the other treatments. In Plot 2, the thinning intensity is varied spatially, to favour some patches of natural regeneration and create an irregular shelterwood. Plot 3 makes use of cone-shaped areas of well-developed regeneration in pockets of historic windblow; these are being gradually widened by successive overstorey thinnings; in addition, Plot 3 also demonstrates a strip shelterwood system, where the development of new regeneration is encouraged in successively thinned strips on the sheltered side of the stand.

Strip shelterwood system in Plot 3 showing developing natural regeneration in a recently cleared strip.



Uniform shelterwood in Plot 4 showing underplanted European silver fir (*Abies alba*).



The overstories of Plot 4 and Plot 5 are thinned evenly and regularly to maintain uniform light conditions throughout the stand; one plot demonstrates respacing of natural regeneration of Sitka spruce, while the other demonstrates underplanting with a range of shade-tolerant conifer species. The species chosen were Douglas fir, noble fir, Norway spruce, European silver fir and Sitka spruce.

Monitoring and assessment

After 15 years and several thinning cycles, substantial scientific knowledge and practical experience have been gained from the different treatment plots.

The principles developed and experience gained in the intensive research area by local staff have been applied across the majority of Clocaenog Forest. CCF management is now considered the standard approach and is expected to provide substantial improvements to resilience across the forest. Information about CCF implementation and other experimental work at Clocaenog Forest is available at www.forestresearch.gov.uk.

Lessons learnt

The secret to successful implementation stems from using a simple approach, a willingness to try new techniques and good communication. A shared understanding of the aims and objectives among all team members has been important throughout. Occasional problems or failures have been viewed as positive learning experiences, and methods have been adapted accordingly to suit the site's requirements. There is evidence that those involved have improved their knowledge of CCF, and the experiences of harvesting operators, managers and researchers have been combined to develop the simple and robust management systems being applied today.

Intended future outcomes

These adaptation measures have resulted in the forest being more structurally and species diverse, and better adapted to the changing climate, while still delivering a range of objectives, including timber production, rich biodiversity and recreation opportunities. Clocaenog Forest continues to be an exemplar of CCF management as a climate change adaptation strategy and is being used to encourage the implementation of CCF in public and privately owned forests across the UK.

This case study is one of a number supporting the UKFS Practice Guide on *Adapting forest and woodland management to the changing climate*