**SILVICULTURE RESEARCH INTERNATIONAL**

Inspiring advances in the science and practice of forestry

# Continuous Cover Forestry

*"Continuous cover forestry (CCF) has the potential to deliver economic, environmental and social benefits like no other form of sustainable forestry. The science of CCF is rapidly developing to provide foresters and woodland owners with the information required for best practice. As a management approach CCF is very hands-on and tangible, and there is great personal fulfilment from working in harmony with nature."*

***Edward Wilson | Silviculturist | 2018***

## What is Continuous Cover Forestry?

### *Close to nature management of forests that promotes resilience and sustainability*

Continuous Cover Forestry (CCF) is an approach to the sustainable management of forests whereby forest stands are maintained in a permanently irregular structure (Garfitt 1995, Ní Dhubháin 2003, Helliwell and Wilson 2012). This structure is created and sustained through the selection and harvesting of individual or small groups of trees, from one stand intervention to the next. The term "continuous cover forestry" does not equate exactly with any one particular silvicultural system. However, it is generally considered to include irregular shelterwood, group selection and single-tree selection silvicultural systems (Wilson 2023). Existing forest stands may require the application of one or more of these silvicultural systems to achieve and maintain the desired productivity and irregular structure.

There is significant and growing interest in Continuous Cover Forestry at the present time (Helliwell and Wilson 2012, Walter 2022). This is especially true in Europe where socio-economic and ecological factors now favour the development of more diverse, multi-purpose forests, and where traditional clear-felling of even-aged plantations is less desirable (Larsen et al. 2022). As such, CCF is seen as one of the most effective ways to manage forests for an array of timber and non-timber values (i.e., ecosytem services). In addition, there is evidence that CCF is an important strategy for enhancing forest resilience in the face of climate change and other threats to forest health.

*A mature stand of Douglas fir managed on CCF principles with a developing understorey of mixed conifers, including Douglas fir, western hemlock, western red cedar and grand fir | Coombs Wood, Cumbria, UK | Photo:© 2018 E. R. Wilson.*

## Principles of CCF

The general approach to CCF can be outlined in terms of the following underlying principles, as defined by the Continuous Cover Forestry Group (CCFG):

- Adapt the forest to the site – The forest manager works with the site and respects inherent variation, rather than imposing artificial uniformity.

- Adopt a holistic approach – The whole ecosystem is regarded as the production capital of the forest, including soil, carbon, water, fungi, flora, fauna, as well as the trees themselves.
- Maintain forest habitats – Maintenance of the forest habitat is essential (which requires that clear-felling is avoided).
- Develop the forest structure – Stand improvement is concentrated upon the development of preferred individual trees rather than the creation of a uniform block of stems. A characteristic of permanently irregular stands is that yield control is based upon measurement of stem diameter and increment rather than age and area.

The principles of managing irregularly-structured woodlands and forests are linked to a developing evidence-base from the UK, Ireland, continental Europe and elsewhere (Morgan and Wilson 2013). In addition, a growing body of literature is providing guidance on best-practice approaches to implementing continuous cover forestry (e. g., Susse et al. 2011, Sanchez 2017).

*An advanced stage of stand structural development in Douglas fir managed on CCF principles | Dodd Wood, Cumbria, UK | Photo: © 2019 E. R. Wilson.*

## Benefits of Continuous Cover Forestry

Continuous cover forestry (CCF) is widely recognised as a "nature-friendly" and sustainable woodland management approach tht brings a variety of benefits to a woodland. It involves the selective removal of trees to create a diverse forest structure, and produces timber while retaining the canopy and conserving the soil. A range of benefits have now been identified that support the wider application of CCF in UK woodlands

(Forestry Commission/CCFG 2023). These embrace forest resilience, delivery of ecosystem services, continuing timber production and provision of biodiversity and nature.

### Resilience

1. CCF helps to develop a multigenerational forest with a greater variety of species, leading to a more resilient forest ecosystem – creating ideal conditions for young trees to germinate and grow.
2. Populations of young seedlings growing by natural regeneration can quickly adapt to the local environmental conditions of a changing climate.
3. Diffused light found in irregular forest structures can limit weeds – helping to aid the growth of tree seedlings.
4. Existing canopy cover provided by CCF can protect and produce better growing conditions for a wide range of shade tolerant tree species – increasing the overall species diversity of the forest.
5. Trees in a CCF system are better able to withstand high winds through the development of deep crowns and extensive root systems.

### Ecosystem services

1. Machinery needed to carry out CCF management can be limited to felling tracks to preserve soils – avoiding soil compaction and erosion.
2. CCF retains a canopy of large, mature trees, which help to trap airborne pollutants and protect forest soils – supporting the long-term storage of carbon.
3. CCF creates a more irregular looking woodland by mimicking natural processes – complementing the local landscape and offering a welcome setting for recreational activities for improved health and well-being.
4. CCF maintains natural woodland water cycles by buffering stormwater – improving flood alleviation and water quality.

### Timber production

1. Removing individual or groups of trees, known as thinning, will provide regular income and a sustainable timber crop.
2. By carrying out felling little and often, CCF can balance the competition between individual trees for space, light and nutrients.
3. Growing different tree species will help minimise the impact of fluctuations in timber prices, allowing you to harvest different species at the right time – helping to sustain your timber income.
4. A species-rich forest is more resilient to threats from climate change, high winds and pests and diseases which can protect your timber supply.
5. Natural regeneration can reduce the costs associated with replanting.

### Biodiversity and nature

1. Thinning will allow more light to enter the forest floor, boosting biodiversity by encouraging natural regeneration and other plants, while the forest canopy protects plants and animals from the extremes

of climate change.
2. Selective felling of larger trees creates a mosaic of interconnected habitats, supporting a wider range of wildlife including insects, mammals, birds and plants.
3. CCF mimics more natural forest processes, well suited to many ancient woodland trees and plants.
4. CCF encourages mature trees, as well as an understorey of mosses, flowering plants, shrubs, young trees and deadwood to provide places for plants, animals and fungi, all benefitting the forest's ecology.

*Dunranhill Forest, County Wicklow, Ireland is currently being managed on continuous cover forestry (CCF) principles. It is one of the most advanced examples of a Sitka spruce plantation under transformation to CCF and demonstrates the value of a permanent forest in the landscape. See Wilson et al. (2021) for further information. Photo credit: © 2021 E. R. Wilson/Silviculture Research International.*

## Silvicultural Transformation

The vast majority of productive woodlands in Ireland, Britain and western Europe are derived from plantations. These are usually composed of one or very few tree species. To achieve an irregular structure, these stands must be transformed through a series of planned interventions (Vitková and Ní Dhubháin 2013). These interventions must consider current and future stand stability, the development of irregularity, promotion of natural regeneration and sustained timber production.

In many cases, the most effective strategy for early-stage stand transformation (i.e., in younger stands) is a crown thinning regime. This involves the selection of high value individual trees that are provided with space and freedom from competition so that they can increase in size more rapidly than trees in the matrix of the stand. Ideally, the crown thinning regime will commence from the second stand intervention, onwards. This concentrates stand increment on the best quality trees, which in time form a conveyor belt of value-added stems available for harvest when they achieve their target size. It also drives the irregular structure of the stand by creating variable conditions and gaps for natural regeneration. As the number of stems in the original stand is reduced, seedlings will occupy the canopy gaps and create a permanent, irregular structure. This process of transformation will likely facilitate the influx of a larger number of tree species and provide a more diverse range of habitat features for woodland wildlife, compared with conventional even-aged (planted) forest stands.

For more mature stands, where natural regeneration is already starting to be expressed, the more normal pathway for transformation is to adopt a silvicultural system such as irregular shelterwood, group selection or single-tree selection. Whichever approach is applied, it is important to focus on promoting the best quality stems, while opening the stand canopy in a way that encourages the irregular structure to develop.

*A patch of Norway spruce natural regeneration in a stand under transformation to CCF | Ardennes, Belgium | January 2020 | Photo: © 2020 E. R. Wilson.*

Transformation is currently an important research theme in forest science. The TranSSFor project (Teagasc/University College Dublin, 2017-2022) is focused on stand transformation to CCF in planted woodlands of Sitka spruce (*Picea sitchensis*). This is significant because Sitka spruce accounts for approximately 1,000,000 ha of forest area in Ireland and Britain, which represents >50% and >20% of the productive forest area, respectively. The vast majority of Sitka spruce forests are managed on a crop rotation model, with clear-felling normally between stand ages 30-50 years, depending on site productivity and management objectives. The TranSSFor project aims to strengthen the emerging evidence-base for the wider adoption of CCF in Sitka spruce production forests.

**TranSSFor Project** | Transformation of Sitka spruce stands to continuous cover forestry | 2017-2022

The TranSSFor project is the most detailed research study addressing the early-stage transformation of Sitka spruce production forests.

There are two strands to the TranSSFor project: 1. comparison of thinning regimes that promote early-stage transformation of Sitka spruce plantations; 2. training in early-stage transformation of Sitka spruce plantations. In both elements of the project the focus is to compare crown and graduated density thinning regimes with the standard (low) thinning regime most commonly applied in plantation forests. The major difference in the thinning regimes is that crown and graduated density thinning promotes greater structural diversity and facilitates natural regeneration; low thinning promotes greater uniformity in the crop trees. A feature of the crown and graduated density thinning regimes is the selection of future crop trees (Q-trees), that have good stem form, light branching and healthy crowns. These trees are given more space to grow than matrix trees as part of the thinning pattern (see below). The study was initiated in 2010 and has completed three thinning interventions. The fourth thinning interventions are planned for 2023.

Results from this research study will be published in peer-review journals, with the first papers due to appear in 2024.

*Q-tree (marked with white band) in a graduated density thinning plot | TranSSFor Project | Ballycullen Forest, County Wicklow, Ireland | Photo: © 2019 E. R. Wilson.*

## Case Studies in Stand Transformation to CCF

A number of plantation forests are now being transformed to CCF through both early and late transformation pathways. Among the most important reviews are those by Hart (1995), Wilson (2013) and Vitkova et al. (2013). Some of the earliest examples of stand transformation were the operational trials initiated in the early 1950s by Prof. Mark Anderson at Glentress Forest (and three other sites in Scotland) (Wilson and Morgan 2013, Wilson et al. 1999). A recent working example of early-stage transformation in Sitka spruce, at Dunranhill Forest, Ireland, is presented by Wilson et al. (2021). Other published examples can be found here for Kyloe Wood, Northumberland, England (Wilson 2023b) and central Jutland, Denmark (Wilson 2023a). Evidence from a wider range of forests and stand conditions is necessary to build the confidence and skills required for wider adoption of CCF as a mainstream approach to forest management in productive conifer woodlands, and also in mixed-species and broadleaved forests (Mason et al. 2022).

## Knowledge gaps and obstacles to wider adoption of CCF

It is widely recognised that there are significant knowledge gaps and barriers to progress with CCF (e. g., Vitková et al. 2014, Puettmann et al. 2015). Table 1 below presents a summary of the main knowledge gaps affecting the uptake of CCF and the major obstacles to its wider use across Europe. The knowledge gaps and obstacles are ranked in order of priority based on a survey of European practitioners and researchers (Mason et al. 2022) . The results are grouped by the categories of constraint identified by Puettmann et al. (2015).

**Table 1.** Knowledge gaps and obstacles to wider adoption of continuous cover forestry in Europe (adapted from Mason et al. (2022)).

| **Knowledge gaps [in order of significance]** | | **Obstacles [in order of significance]** | |
|---|---|---|---|
| **Type** | **Category of constraint** | **Type** | **Category of constraint** |
| Applying CCF in an era of climate change (e.g. selecting climate adapted species; managing carbon stores) | Ecological | Limited knowledge about CCF amongst owners and poor know-ledge transfer | Informational/ educational |
| Resistance and resilience of CCF stands compared with even-aged ones | Ecological | Lack of CCF skills in profession and amongst forest workers | Cultural/historical (+ informational/ educational) |
| Using mechanized harvesting systems in CCF | Logistical/ administrative | Browsing pressure from deer and other animals | Ecological (+ logistical/ administrative) |
| Limited professional awareness of CCF including lack of examples | Informational/ educational | Economic considerations such as low timber prices for larger logs produced in CCF | Economic |
| Poor data on the economic aspects of CCF including timber quality and yields | Economic | Grant and tax schemes that are unsympathetic to CCF | Logistical/ administrative |
| | | Introducing CCF into even-aged forests | Ecological (+ informational/ educational) |

## Resources and References

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## Further information

- Continuous Cover Forestry Group (UK) – www.ccfg.org.uk
  - CCFG National Conference (2014) – Information, Resources, Presentations
- Forest Research (UK) – www.forestresearch.gov.uk
- Pro Silva – www.prosilva.org
- Pro Silva Ireland – www.prosilvaireland.com
- TranSSFor Project (Teagasc) – www.teagasc.ie
- Continuous Cover Forestry in Central Jutland – Study Tour Report – www.silviculture.org.uk/continuous-cover-forestry-ccf-in-central-jutland-denmark

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