Continuous Cover Forestry:

The rise of transformational silviculture

CCF has been a popular discussion topic in forestry circles for some time. Now a body of research and an increasing number of working examples are demonstrating the true potential of this flexible and resilient silvicultural approach. Here, Edward Wilson, Ian Short, Áine Ní Dhubháin and Paddy Purser comment on current developments.

INTRODUCTION

THE forestry sectors in Britain and Ireland are currently experiencing a period of growth and development. Major factors driving change include buoyant markets for home-grown timber and forest products, increased requirements to deliver a range of ecosystem services, and a need to enhance the ecological resilience of our forest resources. Especially important is the requirement to diversify the composition and structure of forests so that they can adapt to predicted changes in our climate and the very real threats from introduced insect pests and diseases.

In Britain and Ireland we rely on a small number of productive conifer and broadleaved species. For example, nearly 90% of the conifer resource in Britain is composed of five species; in Ireland, over 50% of the productive forest estate is composed of just one species, Sitka spruce. In terms of forest management, even-aged plantations and clearfelling remains the dominant silvicultural system. Clearly, adopting a wider range of genotypes, species and silvicultural systems will lead to a more diverse resource and reduce environmental risks. However, the challenge for foresters is to develop new approaches that increase ecological resilience while sustaining timber production and other forest values.

Continuous cover forestry (CCF) is one of the most important options to emerge in recent years. CCF is a flexible and adaptable management system that creates diverse and resilient forest stands. Serious discussion of CCF has been ongoing since the early 1990s thanks to the Continuous Cover Forestry Group (CCFG) and Pro Silva Ireland. With new initiatives coming forward, it appears that CCF is increasingly in demand by forward-looking woodland owners. Certainly, in Ireland the recent announcements of a €12.5 M fund and €0.8 M development grant from the European Investment Bank, combined with a new CCF management grant from the Irish Forest Service, are stimulating wider engagement. This article provides a brief overview and considers current directions in CCF, with reference to production forests dominated by Sitka spruce.

Figure 1
Continuous cover forestry at Coombs Wood, Cumbria. This Forestry Commission woodland is producing high-quality timber and has a high amenity value. The overstorey is dominated by Douglas fir. Several species are regenerating in the understorey, including western hemlock, grand fir and Douglas fir. Photo credit: Edward Wilson 2018.

DEFINING CCF

CCF is defined as the use of silvicultural systems where the forest canopy is maintained at all times in one or more level. The guiding principles are to manage and sustain the forest ecosystem, work within site limitations and use natural processes wherever possible. This involves harnessing natural forest succession, natural regeneration of trees, mixed species and increased biodiversity. Through single-tree and small group selection, production and regeneration take place simultaneously. Gradually, due to successive interventions, the forest evolves from young, simple structures to older, more complex and irregular structures (see Figure 1). Together these processes give rise to the alternative name of close-to-nature forest management.

There are several economic and environmental attributes of CCF that may contribute to its wider adoption in Britain and Ireland. Much of the discussion about CCF in Britain has been focused on the structure of the forest and the challenge of securing natural regeneration, especially where deer and ecological requirements of major species present significant challenges. However, as foresters know well from study visits to central Europe, a major rationale for CCF is high-quality timber production within a permanent forest structure. CCF enables the forester to select individual trees based on their potential for high-quality timber production. Through good thinning practice, it is possible to control the growth increment of these individuals and schedule their harvest across stand interventions to the point where they achieve their target size or optimum value.

Environmentally, several advantages of CCF forests have been identified that increase forest resilience relative to even-aged systems: they can be more windfirm (so long as the correct thinning regime is initiated early in a stand's development); they maintain a more even carbon storage; they show lower soil carbon losses during harvesting; there is reduced risk of soil fertility loss; they maintain higher humidity levels and are well-suited to both single and mixed species management.

CCF is desirable in multi-functional forests where landscape, recreation and conservation values are important. CCF can be used to great effect in sensitive catchments and riparian zones to regulate water yield, stream temperatures and reduce the risk of siltation or nitrate flushes that are often a concern downstream from clearfell sites. For example, the use of CCF in woodlands around Thirlmere Reservoir in the Lake District is instrumental in securing high-quality water for the Greater Manchester area, while also allowing timber production to proceed. As stands mature they generally acquire old-growth characteristics that enhance biodiversity. For many small woodland owners, the opportunity to support wildlife is a powerful motivator for adopting CCF.

TRANSFORMATION OF PLANTATIONS TO CCF

PERHAPS the most important challenge for foresters is managing the transformation from even-aged stands to continuous cover forests. To increase the area of woodland managed as CCF, it is necessary to identify even-aged stands that can be developed into irregular structures. The process is achieved as a planned and progressive series of stand interventions that emulate the successional stages in natural woodland. The principles of CCF transformation are well defined and the practice of CCF is now the standard approach to forest management in many parts of Europe. Generally, initiating the transition at an early stage in stand development, ideally from the first and second thinning, is desirable over a late-stage transformation. Sticking with a thinning schedule and avoiding delays are also critical for stand stability, crop tree development and natural regeneration.

Transformation requires a long-term commitment and can be viewed as a development phase stage in securing continuous cover forests (see Table 1). There are four well-defined stages, summarised as follows.

Stage 1: Preparation – concentrating stand increment on high-quality trees

Stands should be identified early in their development based on their suitability for thinning and productivity. Poor-quality trees (inferior phenotypes) should be removed and better-quality trees (superior phenotypes) should be retained. Individual tree stability can be increased through the thinning process (i.e., modifying height:diameter ratios), and the selection process then continues with frequent light thinnings. Identifying good-quality stems across a range of diameter classes will, by default, lead to greater irregularity in the canopy strata. Best results are achieved with 'crown' thinning as opposed to 'low' thinning, the norm in most even-aged plantations.
This approach allows the forest manager to concentrate stand increment on high-quality stems. One advantage is that a proportion of larger competitors to high-quality trees will be removed at each thinning and help generate a positive cash flow.

Stage 2: Regeneration

As the stand matures and trees start to produce seed, consideration can then include the regeneration process. Thinning should aim to reduce basal area and enable appropriate levels of light to reach the forest floor.
Threshold basal areas for regeneration, and separately for sustained growth, are now well understood for most of our productive species; this information can act as a guide for thinning prescriptions. Avoiding uniform removal of the overstorey trees, and maintaining a degree of 'clumping', will allow natural regeneration to become established in small cohorts at irregular spacings throughout the stand and will meet the requirements of diverse species with variable regeneration requirements (Table 2).

Stage 3: Structural development

In this stage, tree selection focuses on removing high-quality (crop) trees at their desired target size, and maintaining good-quality smaller trees (i.e. future crop trees) from across a broad range of diameter classes. Ideally, a maximum of 20% of basal area and a volume no greater than the stand increment will be removed at an intervention. On highly productive and stable sites it might be necessary to select a volume greater than stand increment in order to control basal area and encourage structural development.

Stage 4: Structural maintenance

Finally, the stand will be transformed to an irregular structure where the objective is to maintain a sustained yield of high-value trees while promoting the development of the understorey strata. Ideally, the harvest volume will equal the stand increment, and a balance will be maintained between maturity of final crop trees and structural development. Trees should be marked for removal at their optimum economic value, often called the target size, or if they are damaged and not contributing to the development of the stand structure. Wind damage, if it occurs, becomes part of the management system and generally understorey trees are released to fill the gaps created by blowdown of larger individuals. A thinning cycle of 3–5 years may prove optimum to keep the system going.

Table 1 Summary of development phases in the transformation process to CCF.

DEVELOPMENT PHASE	ACTIVITIES
Forest in transformation	Selection for quality involves early first thinning and a more selective approach from second thinning onwards where trees of good quality are retained, regardless of their size. Gradual improvement of forest stock through the selection and retention of high-quality trees from which natural regeneration will be derived. Grow quality forest stock to optimum tree dimensions and volume.
Successfully transformed to continuous cover forest	Harvest a regular volume of quality timber, resulting in the rejuvenation of the forest. Learn from the forest and refine management over time.

Source: Teagasc, 2016. 'Continuous Cover Forest Management.' Farm Forestry Series No 19. Teagasc Forestry Development Department, Athenry. 12 pp.

Table 2 Classification of the main British and Irish tree species based on their light requirements at the seedling stage of development.

LIGHT DEMANDING	INTERMEDIATE	SHADE TOLERANT
Conifers:		
European larch Japanese larch Hybrid larch Scots pine Corsican pine Lodgepole pine	Douglas fir Sitka spruce Noble fir	Western hemlock Norway spruce Grand fir Western red cedar Yew
Broadleaves:		
Birch (silver and downy)	Ash Cherry Lime Oak (pedunculate and sessile) Rowan Sweet chestnut Whitebeam	Beech Hornbeam Field maple Sycamore

Source: B, Mason, G. Kerr and J. Simpson, 1999. 'What is continuous cover forestry?' FCIN29 Forestry Commission, Edinburgh, 8 pp.

CCF IN PRACTICE

IN contrast with other areas in Europe, a relatively small area of Britain and Ireland is currently managed on CCF principles. Research by Scott Wilson (Britain) and Lucie Vítková (Ireland) has identified a large and growing number of adopters of CCF, although the total area remains relatively small (e.g. 10,600 ha in Ireland currently under CCF management). Experience with CCF is most advanced in broadleaved and Douglas fir stands, commonly found on sheltered sites with favourable conditions for natural regeneration (and with good browse control).

Especially noteworthy is work by David Pengelly, Andy Poore and the late Rodney Helliwell who have created an evidence base for lowland Britain. A survey of forestry professionals in Ireland found that while there was significant interest in CCF, a lack of experience, training and reliable measures of stand performance remains a barrier to further progress. To promote greater understanding of CCF, the Irregular Silviculture Network (ISN), a group of forest owners, managers and researchers working in Britain and Ireland, has established long-term research stands that provide information on structural development, individual tree performance, costs and revenues, and wider ecosystem services. This network is being enumerated on a five-year cycle and yielding valuable information to support 'best practice'.

A critical element of CCF is the selection and marking of trees to remove and retain at each stand intervention. It is a fascinating aspect that requires a forester to draw on the science and art of silviculture. A detailed understanding of tree development and quality criteria is required. Linked to this is a need for regular, simple inventories of stand structure, with records of diameter distribution, stem quality classes, growth increment and basal area being the most important parameters for decision-making and prescription design.

CCF AND SITKA SPRUCE

OF high interest at the present time is the potential application of CCF to Sitka spruce-dominated production forests. The majority of this resource is managed in plantations less than 40 years in age. Transformation of a small proportion of Sitka spruce plantations to CCF would significantly increase overall forest structural diversity and support a policy of increased ecological resilience.

Guidance for transformation of Sitka spruce stands to CCF is gradually evolving, with important work being led by Forest Research, several universities and experienced practitioners. Particularly well known is the large-scale operational trial at Clocaenog Forest, which is managed by Natural Resources Wales. Here, a variety of selection and shelterwood systems are being tested on sites at relatively high elevations. In the private sector, forestry consultants Phil Morgan and Huw Denman have been working on techniques in several woodlands in upland locations throughout Wales (see Figure 2).

Considerations for transformation in Sitka spruce plantations are now becoming more apparent. An early start to the transformation process is especially important to promote stand stability on upland sites and where soils are relatively shallow. Maintaining good drainage across the site is necessary to avoid an adverse rise in the water table. Extra care may be necessary in opening the canopy after thinning operations; too much side light will stimulate epicormic shoot development that can reduce sawlog quality. Research continues to fill knowledge gaps and support CCF in Sitka spruce woodlands.

Figure 2
Sitka spruce in transformation to CCF at Bryn Arau Duon Forest, Wales. This upland forest was planted in 1962 and has a Yield Class of 16. It has been thinned three times on a four year cycle. The focus at each intervention is to concentrate the increment on high-quality trees and to facilitate natural regeneration. A well-developed infrastructure supports access to the stands. Photo credit: Phil Morgan 2017.

Figure 3
The TranSSFor thinning experiment, Co Laois, Ireland. The stand was established in 1992 and thinned in 2011 and 2014. This image shows the crown thinning treatment with potential crop/frame trees marked with a white band. The third thinning will be completed by a Coillte harvesting team in August 2018. Photo credit: Edward Wilson 2018.

CURRENT RESEARCH

KEY players in the scientific community remain Forest Research, who are delivering projects through the Forestry Commission's Regeneration and Sustainable Silviculture Programme. In Ireland, the COFORD-funded Low Impact Silvicultural Systems project (LISS), led by University College Dublin (UCD), was completed in 2014. This is continuing through the TranSSFor Project, which is funded by Teagasc and jointly managed with UCD. As part of this work, a thinning experiment was initiated in 2011 in two Sitka spruce stands on contrasting soil and site types (see Figure 3). The experiment was designed with low, crown and graduated density thinning treatments. Coillte and a private woodland owner are active supporters of this research.

The research and policy community recognises that transformation of planted woodlands to CCF is both a technical and professional challenge. In addition to silviculture research, there is increasing emphasis on professional development and the cultural shift required to adopt new forestry approaches. Training courses offered by SelectFor, the Forestry Commission (UK) and Teagasc (Ireland) are proving essential to inspire confidence among forest owners and professionals.

SUMMARY

CCF is an increasingly attractive option for sustainable forestry in Britain and Ireland. New initiatives and incentives, especially in Ireland, are giving forest owners, investors and practitioners the support to embrace CCF. Identifying potential crop trees at an early stage in stand development, followed by regular crown thinning, are the keys to successful transformation of plantations to resilient, continuous cover forests.

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