

Forestry & Energy

REVIEW

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Transformation of Sitka spruce stands to Continuous Cover Forestry (CCF): Synergies and Trade-off

In the 1920's only 1% was forest, however (partially thanks to an increased awareness of forest benefits, functions, and products) now over 11% of the land area is forested.

About half of this forest is Sitka spruce (*Picea sitchensis*) plantations. Sitka spruce is commonly planted in Ireland because it has fast growth and is suitable for the available markets. At the end of the forest rotation, a plantation forest is often harvested during a single operation (clearfelled) and then replanted. Over the last two decades there has been increasing interest in alternative forest management practices that do not require all of the trees to be felled at the same time. To research alternatives to clearfelling, the DAFM-funded ContinuFOR project trials different thinning options to transform an even-aged Sitka spruce plantation to continuous cover forestry (CCF). CCF often involves periodically harvesting a single tree or small groups of trees so the forest maintains some tree cover at all times. CCF can result in a more diverse forest structure with trees of different ages, sizes, and species, providing

additional benefits and functions.

In 2010, the DAFM-funded “Low Impact Silvicultural Systems (LISS)” project selected two sites of Sitka spruce ready for their first thinning – Fossy Hill in Co. Laois and Ballycullen in Co. Wicklow. These sites were divided into three blocks, and each block had three 50×50m plots placed within it. Three thinning treatments were then randomly assigned to the plots, so all treatments were represented in each block. The thinning treatments were: Low thinning, Crown thinning, and Graduated Density thinning (see description below). Trial sites were then monitored and maintained by the LISS project and later during the Teagasc-funded TransSFor project (2017-2021). The work continues with the DAFM-funded four-year ContinuFOR project led by UCD with Teagasc and Maynooth University as partners and FERS Ltd. contracted for modelling tree growth. The work in



Grace Jones (Postdoctoral researcher, Teagasc) and Mark Whelan Spain (Bachelors Forestry student, UCD) measuring Time-of-Flight with the TreeSonic timer (Fakopp, Hungary) at Fossy Hill

these projects has allowed numerous students and land managers to learn about continuous cover forestry operations, and for researchers to undertake specific smaller studies. Presently ContinuFOR has 6 main tasks that will investigate additional aspects of the transformation process while also continuing to monitor stand development over time.

THINNING TREATMENTS

A common thinning regime in Ireland used in Sitka spruce stands (Low thinning) involves removing the smallest and poorest form stems, alongside any wolf trees. Wolf trees grow much faster than their neighbours and have a tendency to have poor form with bad branches. Low thinning removes the smallest and worst stems so that the retained crop trees have more room to grow. It should result in a stand of trees that are a similar size and have a reasonable stem quality, and is suitable for clearfelling.

In Graduated Density and Crown thinning, high quality trees (Q-trees) are selected to have a neighbouring competing tree removed. In these treatments, the Q-trees are favoured so they will have extra room to grow. This should mean higher volume growth for the superior trees. Unlike the Crown thinning, the Graduated Density treatment aims to create a broader range of tree sizes by removing more trees from the rows immediately next to the racks, and reducing the selection intensity further from the racks. At the second thinning, a new rack is made between the previous ones so that the thinning intensity gradient is reversed. This is easier to see in a diagram where the rack has 100% of stems removed during thinning 1 (a) and thinning 2 (b):

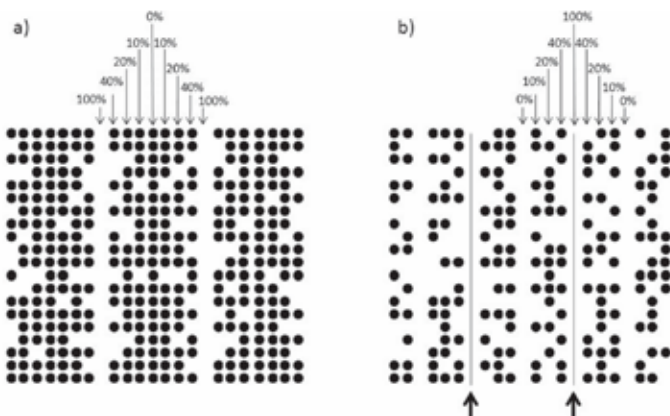


Illustration of Graduated Density Thinning indicating proportion of trees removed per row. From Vitková and Dhubháin (2013). a) 1st thinning intervention; b) 2nd thinning intervention.

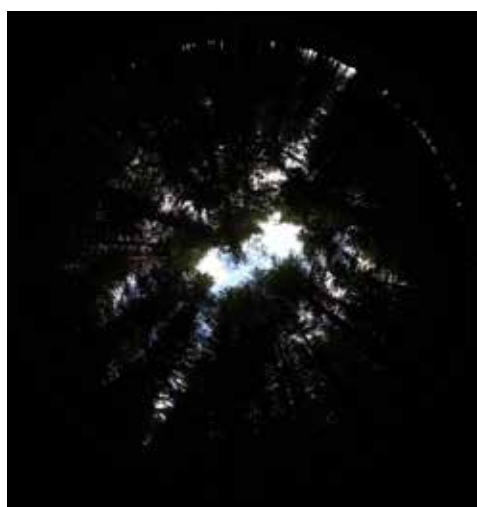
SOME OF THE WORK WE HAVE BEEN DOING IN CONTINUFOR

Trees in these trials have been individually monitored since 2010 during the LISS project. The trees are painted with identification numbers and 1.3 m height marks to ensure that the same tree can be measured at the same point over time. We have exact coordinates for each tree too, to help monitor changes in stand structural diversity and canopy openness. This allows us to report on individual tree size and how each tree has grown over the course of the trials. Basal area is the cross-sectional area of trees at 1.3 m height, and is important when considering tree growing space or for calculating volume. Some forest management plans aim to keep the basal area per hectare below a certain level to encourage natural regeneration, which is particularly important for CCF. We are incredibly lucky to have long-term trials that have been established, and continuously maintained and measured during earlier projects. We also appreciate the ongoing support and active involvement of the site owners.

Laura Harris (Maynooth University) has been taking photos to record canopy openness and will relate these to her understory species surveys. Photopoints and vegetation survey points were located throughout each plot on a sampling grid. Derek and Grace (Teagasc) measured diameter for every tree at both sites, and so canopy openness can also be compared to plot basal area. In addition, they measured a subsample of trees for height and length of green canopy. Height will help to estimate standing volume, but the length of the green canopy might relate to wood quality.

Maarten Nieuwenhuis and Fan Zhang (UCD) along with Kevin Black (FERS Ltd.) are assessing a range of existing single tree models to forecast growth for Irish CCF stands. They are also collating and assessing available data sources, evaluating and calibrating growth models, and evaluating and prioritising potential model extensions. This should help predict the volume of wood in CCF stands at different sites, under different management regimes, and over time, to reduce the uncertainty around continuous cover forestry regimes. Some wood quality metrics are being measured for the trial sites by Grace (Teagasc), and hopefully we can compare time-of-flight (ToF) and wood density to site conditions, growth rate, and thinning treatment. These wood quality metrics are from a TreeSonic Timer (tool measures ToF in standing trees) and wooden cores taken from sample trees. ToF and wooden cores are non-destructive testing and evaluation methods since the tree stays standing. It is expected that trees with higher ToF will have a lower wood stiffness. Stiffness is important because it affects suitability for different structural uses; a board produced from a tree stem with low stiffness will likely sag or bend if any weight is added.

The current two ContinuFOR sites are due to be thinned for their fourth time in the coming months. Prior to each thinning operation selected trees from each treatment are marked for removal with orange



Photos taken with a fish-eye lens by Laura Harris (PhD student, Maynooth University) showing the contrast between foliage and sky with different photo exposure settings.

Natural regeneration of Sitka spruce within a Ballycullen plot.



Grace Jones, Derek Gibson, and Ian Short (Teagasc), Paddy Purser (Purser Tarleton Russell Ltd.) and Padraig O'Tuama (CCF Management) getting ready to mark trees for thinning.

dashes, while trees of a superior quality (Q-trees with better form and branches) in the Crown and GDT treatments are also marked with white bands. The aim of the thinning in the Crown and GDT treatments is to favour these Q-trees, to provide them with more growing space, and to create an irregular canopy structure. This is in contrast to the Low thinning treatment, where the objective is to increase stand quality and uniformity. A special mark is also used if there is some biodiversity consideration (such as a nest) where the tree should be retained. The markings make it easier for the forest harvester operator to quickly select the right trees for felling, and also shows them which trees to protect. To keep the treatments consistent, the same percentage of trees, based on total plot basal area, were marked for removal (20% and 25% for Fossy Hill and Ballycullen respectively). The machines need to have a path to move along (a rack) which is usually made during first and second thinning operations, by removing every 7-9th row of trees.

FUTURE WORK

Now, the ContinuFOR project team is looking to set up a third trial site. A potentially suitable site will have six or more hectares (15 acres) of uniform Sitka spruce that are nearly ready for their first thinning. The Teagasc thinning ready reckoner can be used to inform whether a forest is ready for thinning. Ideally the forest will have a medium productivity and soil and be within 100 km of Dublin, but others further away can be considered.. Think this could be you? Get in touch with Ian or Grace (see below for contact details).

During the LISS project, a survey of Forestry professionals and Forest owners was conducted by Lucie Vítková and Áine Ní Dhubháin (UCD). Áine Ní Dhubháin will perform similar surveys this year to: a) determine the extent to which CCF/transformation to CCF is being practised in Ireland, and b) assess the perceived benefits, constraints, and drivers to CCF adoption. It will be interesting to see if the responses have changed over time, or if the same challenges and drivers are still affecting CCF in Ireland.

Forests are more than just timber, so John Devaney and Laura Harris (Maynooth University) will also investigate the non-timber services of CCF forests, including biodiversity, carbon sequestration, and climate resilience. Once the growth models are calibrated, carbon pools are estimated, and thinning data is collected, Áine Ní Dhubháin will compare the financial performance of the three thinning treatments. A financial comparison of the costs and benefits (focussing on timber production and carbon dynamics) will be conducted using existing data from experimental plots and stands being transformed to CCF.

As you can see, our project team has already been very busy but with much more to do, and this is only a small overview of the ContinuFOR project. Work is ongoing, so if you want to follow along or find out

more feel free to check out our website (www.teagasc.ie/continufor/) and follow us on social media (#ContinuFOR on Instagram and Twitter)

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Teagasc Thinning Ready Reckoner is available here: <https://www.teagasc.ie/crops/forestry/advice/timber-harvesting/thinning-ready-reckoner/>

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Stakeholder meeting at Fossy Hill- many members and experts help guide our team