A Q-tree (marked with a white band) in a 'graduated density' thinning plot at Ballycullen Forest, Co. Wicklow. Competitors to Q-trees are marked for removal at each thinning (orange marks) to provide space for crown expansion. Additional light is reaching the forest floor, which will encourage natural regeneration. Photo: Edward Wilson.

Transforming Sitka spruce plantations

The TranSSFor project is comparing conventional thinning in Sitka spruce plantations with two alternative thinning regimes.

A contemporary challenge in Irish forestry is the need to sustain timber production while increasing forest ecosystem resilience to threats from pests, diseases and climate change. Evidence from studies elsewhere has shown that forests composed of mixed-species and irregular structure stands can be highly resilient and deliver diverse ecosystem services. Most forests in Ireland, however, are composed of young, single-species plantations managed on the clearfell silvicultural system. Alternative silvicultural systems that create more diverse forest structures are largely untested (Wilson *et al.*, 2018). To address this issue, the Teagasc Forestry Development Department and University College Dublin (UCD) are delivering a five-year research study called the TranSSFor project that focuses on an approach called continuous cover forestry (CCF).

Continuous cover forestry

CCF is a collective term for several silvicultural systems that avoid clearfelling. A permanent forest cover is maintained where individual or small groups of trees are harvested at each stand intervention and natural regeneration is relied on for forest renewal. CCF is a standard forestry system in many regions of Europe, including Belgium, Germany and France. A strong evidence base supports best practice based on four guiding principles: adapt the forest to the constraints of the site; adopt a holistic approach that embraces soil, water, carbon, biodiversity and the trees; maintain a permanent forest habitat (by avoiding clearfelling); and, develop the forest structure, so that timber harvesting and natural regeneration can take place simultaneously. Nevertheless, research is required to apply these principles to Irish forests, where the major species and environmental conditions are different from elsewhere in Europe.

Pathways for transforming forest stands

The immediate research priority is to identify appropriate pathways for transforming forest stands from uniform to irregular forest structures. The TranSSFor project is addressing this by comparing conventional thinning in Sitka spruce plantations with two alternative thinning regimes less commonly applied at the present time. Two productive forests, both planted in the early 1990s, were selected for the study. One is based on a gley soil and at a relatively high altitude (300 m) in Co. Laois. The other is on a more sheltered site with a brown earth soil at a lower altitude (250 m) in Co. Wicklow. In each forest, experimental blocks were laid out to facilitate the comparison of the three thinning regimes over a medium- to long-term management period (to date 10 years).

Conventional stand management

In sustainable forestry, thinning is required to maintain control over the growth and development of the forest stand. Stand interventions take place every three to five years, depending on site productivity and exposure, from stands aged 15-20 years. In Ireland, the conventional form of stand density management is called 'low' thinning. This removes small and poor-quality trees at each stand intervention; remaining trees are more uniform in size and quality, and have adequate space for continuing growth. In the alternative thinning approaches, a balance must be achieved between timber production and the ecological requirements for natural regeneration. Rather than uniformity, suitable trees must be nurtured for seed production and small gaps must be created for seedling establishment.

Crown and graduated density thinning

The two alternative regimes being assessed in the TranSSFor project are 'crown' and 'graduated density' thinning. The key difference between these and 'low' thinning is that trees with superior quality attributes are selected after the first and second thinning interventions, in the 'crown' and 'graduated density' regimes, respectively. These are called Q-trees (main image). The trees marked for removal are generally those that are competitors to Q-trees (**Figure 1**). By removing competitors, the Q-trees are given additional space into which their crowns can expand. Providing space around the Q-trees leaves other areas where fewer trees are removed. This promotes a more irregular spacing between trees (**Figure 1**) and different tree size distributions in the forest stand (**Figure 2**).

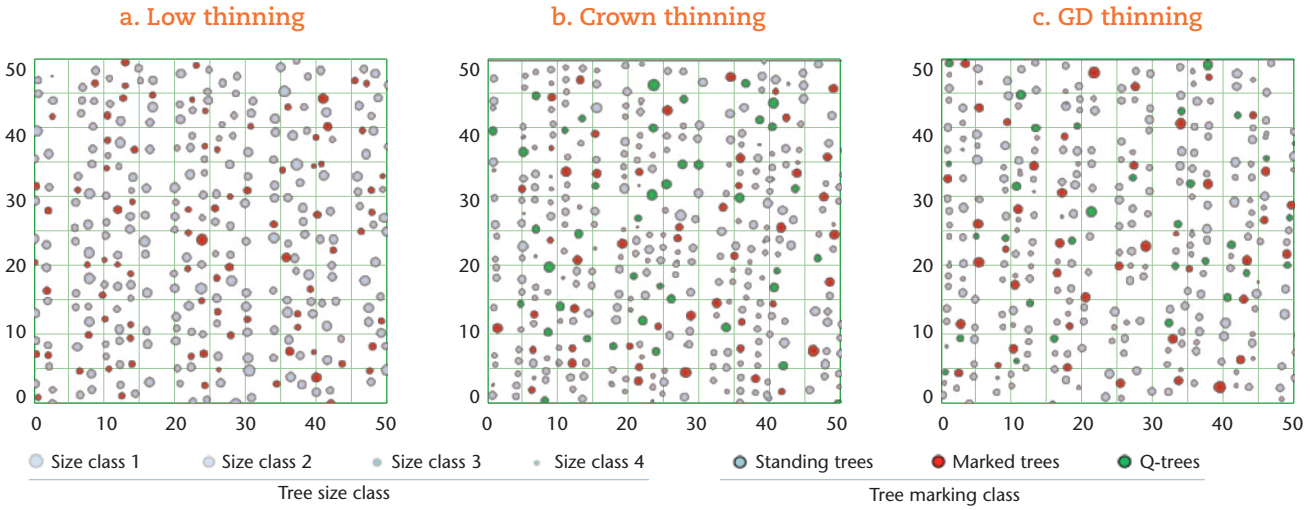

FIGURE 1: Plot maps illustrating changes in stand structure following three thinning interventions in stands managed under (a) low, (b) crown and (c) graduated density (GD) thinning regimes, in Ballycullen Forest, Co. Wicklow. Each plot is 50 × 50 m. Trees are mapped according to four size classes, based on stem diameter at 1.3 m height. Class 4 are the smallest trees; Class 1 the largest trees. Q-trees are labelled in green and trees marked for removal at the third thinning intervention are labelled in red.

Assessing tree growth and quality

The research involves traditional and novel techniques to assess tree growth and quality attributes. Drones have been used to capture aerial images and Light Detection and Ranging (LiDAR) scans of each plot. These data have made it possible to assess tree and stand productivity, competition indices, understorey light regimes and a range of environmental conditions. Initial results indicate that the mean volume of trees harvested at the second and third intervention was greater in the 'crown' and 'graduated density' thinning treatments compared with the 'low' thinning treatment. Variation in stand structure is also evident, as a result of alternative thinning regimes. Individual tree growth models are being used to project future stand development, and to predict patterns of natural regeneration within each thinning treatment.

Benefits to industry

The TranSSFor project and its predecessor are the first studies on stand transformation in Sitka spruce plantations in Ireland. Results are expected to inform the management of forest stands on sites suitable for CCF. The current project will conclude in 2022, following the fourth stand intervention. CCF is becoming more widely adopted in Ireland and the TranSSFor project will continue to generate important information in future years.

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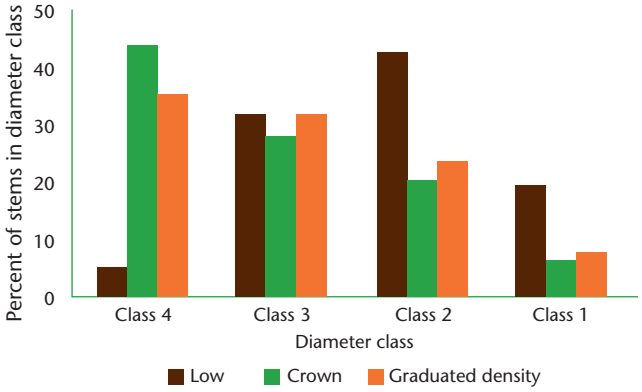

FIGURE 2: The stem class distributions in the 'low', 'crown' and 'graduated density' thinning plots after the third thinning intervention, Ballycullen Forest, Co. Wicklow. Class 4 are the smallest trees; Class 1 the largest trees.

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