

Continuous Cover Forestry from scratch – planting mixed species and developing an irregular forest structure

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Figure 1: A rough paddock with wide-spaced poplars and regenerated native trees was converted into a woodlot by interplanting a mix of exotic species, mainly cypresses, Coast redwoods and Japanese cedar, but also some Fijian kauri and swamp cypress

Abstract

Continuous Cover Forestry (CCF) is a broad term that can include many different principles and practices. Many countries now have growing bodies of research, practical experiences and working examples to guide practitioners. However, in New Zealand, apart from sustainable harvesting from existing native forests, CCF is seldom attempted. This paper relates early experiences of establishing and managing a woodlot of mixed exotic species with an irregular forest structure. It confirms the complexities and uncertainties involved with this type of forestry and the need for an adaptive management approach. It also considers the role and form of effective research support.

Background

Tāne's Tree Trust published Ian Barton's (2008) *Continuous Cover Forestry: A Handbook for the Management of New Zealand Forests*. The following year, and using that as a guide, my wife, Katharina, and I established a small (1.2 ha) exotic woodlot with close-to-nature CCF in mind (Figure 1). Now, 15.5 years later, a 'walk-through' review of how things are shaping up finds indications for optimism, but also raises many questions. The questions highlight the very experimental nature of this type of forestry in New Zealand and stimulate thoughts about the need for both practical trials and research – and the relationship between them.

Site history and decision to plant

Located in the rugged hills around Kaeo in the Far North, our 15 ha lifestyle property is part of a broader local trend in land-use change away from pastoral farming. The area has become increasingly forested over the last half century or so. It has heavy clay soils, high rainfall and steep topography, all of which contribute to its Land Use Capability (LUC) subclass of 6e (i.e. land generally suited to pastoral use, tree crops and forestry, but with slight-to-moderate limitations, and erosion being the dominant one).

Some pastoral land is maintained, but the property is mainly covered in regenerating native forest dominated by tōtara and managed under a Sustainable Forest Management Plan under Part 3A of the Forests Act, which allows its sustainable harvesting. However, one open area (known as ‘the sedge paddock’) was always a dangerous area for livestock due to tomo holes and gaping cracks along the creeping contours.

For erosion control, some wide-spaced poplar poles (varieties kawa and toa) were planted around 2001 and in 2005. A few existing tōtara and kahikatea were also present in the rough paddock. However, by 2008, fighting the sedge and gorse was considered neither worthwhile nor sustainable and the decision was made to plant the problem out.

Design and randomness

We felt we had plenty of native forest and had already planted some small native woodlots, so for faster erosion control and diversification reasons, having some quicker growing exotic timber species appealed. Also, for environmental and aesthetic reasons, so did the idea of multi-purpose CCF.

Therefore, in May 2009, we interplanted between and around the five and eight-year-old wide-spaced poplars with a mix of naturally durable timber species, mainly cypresses (*Cupressus species*), redwoods (*Sequoia sempervirens*) and Japanese cedar (*Cryptomeria japonica*). However, a few swamp cypress (*Taxodium distichum*) and Fijian kauri (*Agathis macrophylla*) were also added, along with a particular willow to lure possums in for trapping control purposes.

The outcome reflects a combination of working with and around what was there (the existing natives and poplar plantings), an ideological and deliberate design for multi-purpose CCF (in choosing the main species mix), and some randomness with a nursery mix-up and the inclusion of some odd-ball species received as gifts.

Stocking and ‘naturalistic’ mixed-species layout

The original total stocking was roughly 1,600 stems/ha, but varied to accommodate existing site features such as trees, tracks and wet areas. Rather than grouping the species in blocks they were intermingled in a ‘naturalistic’ layout pattern, trying to both match species to microsite conditions, but also to allow options for nature to make the final choice.

In practice, this meant a high stocking rate and planting proportionally more redwoods in the lower and moister areas, cypresses clustered on the mid-slopes, and more Japanese cedar on the bonier and more exposed places. We also had to ensure species were sufficiently interspersed to mitigate the risk of us getting it wrong or natural disturbance events. This approach has since proven to be good insurance.

Developing an irregular forest structure

Developing the desired multiple tiers within a CCF forest (i.e. the reverse J-curve of size-class distribution) is not easy in a young, planted stand. While the goal is clear, the methods are not. Every site is inherently unique, with its own history, ecological context and internal variabilities too. There are no formulaic prescriptions to achieve the desired irregular forest structure. Species were selected for suitable attributes and various silvicultural principles of CCF have been applied, and after 15 years of manipulation the vision is starting to take form.

The canopy is dominated by the poplars, which had a clear head start (Figure 2). The biggest poplar trees are about 18 m high. Their diameter at breast height (DBH) exceed 50 cm, and they are pruned up to between 6 m and 9 m high (Figure 3). Their large spreading crowns range above the emerging middle tiers of conifers (which are up to about 13 m high) comprising cypresses, redwoods and Japanese cedar – with DBH mostly in the 20–35 cm range and pruned up to 6.5 m. Suppressed and slower specimens are still present in the lower tiers and native regeneration is abundant in the understorey.



Figure 2: The intended mixed-species, mixed size-class forest is starting to take shape. Twenty-three-year-old poplars range above various 15.5-year-old conifers, with plenty of native regeneration in the understorey



Figure 3: Rather than maximising the stocking and performance of trees for the first harvest, silviculture is attempting to create a multi-tiered forest structure for continual recruitment through the size-classes

The result is already a mixed species forest with many size-classes. This is partly a function of staggered establishment (i.e. poplars first), partly microsites and differential performance between and within species, partly silvicultural interventions, and partly also due to climatic events. Not all trees are pruned, and thinning to date has been light and variable. Further thinning of the unpruned redwoods and managing the coppice regrowth from the stumps is envisaged. However, the need to maintain sufficient light levels or canopy gaps is also anticipated.

Resilience through species diversity

The often-suggested advantage of mixed species/age forest structure over a single age-class plantation has also been demonstrated. Cyclones Hale and Gabrielle hit in January and February of 2023 just after a thinning intervention. I had tried to mitigate the risk of windthrow amongst the cypresses by planting what I thought to be a more windfirm variety (*Cupressus torulosa*) on the higher and more exposed parts of the site. I also carried out fastidious and frequent sail-pruning and thinning.

Nevertheless, patches of the forest still sustained significant losses from windthrow. Neither that



Figure 4: Regular thinning of the forest has been an excellent source of firewood – unfortunately including many pruned stems following cyclone events



Figure 5: The predominant species are Mexican cypress (*C. lusitanica*), redwoods and Japanese cedar. These were planted 15.5 years ago into rough pasture between and around some existing natives and five and eight-year-old poplars

species choice alone nor the silvicultural intervention was sufficient mitigation. The *C. torulosa* turned out to be *C. arizonica* instead. These cypresses have grown slowly and suffered the greatest losses, followed by the redwoods. But none of the poplars or Japanese cedar were windthrown.

Although there are certainly now ‘holes’ in the forest where I have cleared the leaning and thrown trees, and I may yet plant in the gaps, there are probably just enough ‘followers’ that haven’t been thinned to be recruited. These have been pruned-up since. Also, the redwood stumps will all sprout again. So, the situation is not completely lost. Indeed, these events are naturally creating a clumpy but irregular forest structure. Mixing the species has added resilience in this case. I also salvaged a lot of firewood from the thinnings and forest tidy-up (Figure 4).

Advantages of including coppicing species

Apart from adding resilience in windthrow and fire events, the thinning of species that coppice, such as redwoods (also Acacia and Eucalyptus spp.), presents further opportunities to create an irregular or uneven size-class forest. However, sprouts from the stumps clearly require sufficient light to survive and competing sprouts will need some thinning.

Redwood stumps along the edges of tracks sprout vigorously. I deliberately cut them a bit higher from the ground and maintain them as living ‘posts’ for use as anchors for snatch-blocks for winch-assisted felling and for future log extraction. Coppicing from harvested stumps is expected to have erosion and regeneration benefits too.

Multiple values

Aesthetic and recreational qualities are developing within this forest too, and I am conscious to create and maintain these for my own and my family’s pleasure. On a lifestyle block this makes sense. This influences my silvicultural decisions (e.g. young redwoods in the semi-shade have such a pretty fan of lower branches that I leave some unpruned or at least leave the pruning to the last sensible moment – Figure 5). This management is not always maximising potential timber production. However, silviculture has also become recreation for me, and creating a beautiful forest in such a short timeframe has become another very satisfying aspect.

Natural regeneration

Replacing harvested trees by natural regeneration is the holy grail of CCF forestry. However, so far, very little natural regeneration of the cypress or cedar



Figure 6: (Left) Abundant taraire seedlings beneath a redwood tree; (Right) a puriri seedling beside a thinned cypress stump

is being observed. While the redwoods and poplars may coppice (resprout from their stumps) following the harvest, replacement of the other exotic species may need active planting. In contrast, natives are colonising the understorey in high numbers. Good seed sources adjoin the stand.

The large-seeded native broadleaves spread by the wood pigeons are particularly abundant (e.g. karaka, taraire, puriri and nikau – Figure 6). Some kahikatea (but very few tōtara) seedlings are present, presumably due to the shade and groundcover conditions. Smaller native shrub trees are common, including pigeonwood, kawakawa, karamu, hangehange, mahoe, and various tree and ground ferns. There are also some exotic weed species such as Chinese privet and loquats. However, kikuyu grass still dominates the gaps and poorly stocked areas, which significantly inhibits any regeneration in these places. While shade can be expected to eventually address that problem, the future development of the understorey is far from clear.

Will the abundant native seedlings ever be recruited up through the layers of this forest or will increasing shade from the maturing exotic trees suppress them? Will some of the exotic species replace themselves through staggered performance, coppicing and/or seeding, or is the forest destined to become a native forest in the long term?

Arguably this effort at CCF is creating a novel ecosystem and its silviculture, by necessity, involves much guesswork and reacting to observations.

Deciduous trees and leaf litter

Observation is invaluable in any experiment and in this case apparent effects from the deciduous poplar

trees are thought-provoking. Although the crowns of emerging conifers are often competing with the broader and taller poplar canopies, many are still doing remarkably well in growth performance. Maybe the deciduous habit of the poplars permits sufficient light to sustain this sub-canopy competition.

The towering hardwood crowns certainly ameliorate the damaging effects of wind, and the roots seem to have arrested the worst of the erosion, as originally intended. Also, birds perching in their canopies have delivered many seeds, and the rich broadleaf litter and light conditions seem to have encouraged germination and the growth of seedlings.

At least at this stage the older, taller, deciduous trees appear to contribute positively to the irregular forest structure. However, above the 6–9 m of pruned butt log, these trees have large spreading crowns with little or no sawlogs. It is hard to imagine harvesting them without wreaking significant damage on the residual forest.

Summary of progress review

Our effort to create a multi-purpose and multi-valued CCF woodlot is very much a practical experiment and personal learning curve. This follows the traditional approach of the New Zealand Farm Forestry Association in valuing practical trials and local experiences based on ‘doing it’. However, in this case, and in the absence of research guidance, silviculture has largely been based on guesswork.

There are many external unknowns, including future market demand for low volumes of mixed-species logs. However, the above walk-through review

has outlined a mix of promising and problematic observations to do with the management of the stand's structure. This is to be expected. Overseas literature shows the long-term stand dynamics of CCF forests are usually associated with high complexity and high uncertainty. Due to factors such as climate, lack of knowledge and experience, as well as weed issues, I expect complexity and uncertainty to be very pronounced characteristics of CCF forestry in New Zealand too. There is no one singular prescription of 'how to', and multiple values and interests will be affected by the decisions and choices made – often with complex knock-on effects.

I have not tried to measure or model this forest. Its small-scale and extreme variance in measurable attributes defy easy stratification and inventory. Nevertheless, the question arises of how measurement and monitoring could effectively inform my management decisions?

Adaptive management

The dynamism of irregular CCF forestry requires integrative, flexible and 'adaptive management'. When there is no time to wait for science to lead or guide, adaptive management is an approach that accepts the uncertainty of the situation, but enables us to proceed even without having all the information that we would like (Larsen & Nielsen, 2007). So, the emphasis is on active monitoring (i.e. what is happening?) and iterative feedback loops concerning the effects of interventions (de Boo & Wiersum, 2002). Building this functional and complementary relationship between practical trials and research is needed. But what might that look like?

A network of research plots

Perhaps an inspirational approach is the extensive network of permanent forest-based CCF research plots started by the Association Futaie Irreguliere (AFI) in France (Susse et al., 2011). The network is now complemented by plots in many other European countries. It is about recording and understanding, rather than prescribing, management systems. Many quantitative and qualitative aspects of the forest are assessed (e.g. growth, health, regeneration, costs, economics and responses to silviculture etc). The permanent sample plots are reassessed at five-yearly intervals and the findings from the network are published in summary documents.

The AFI has become a valuable way for managers to exchange information. Moreover, it seems to be an effective way for research to support adaptive management – practice at the coalface. Could a similar network be established in this country?

A report, commissioned and funded by the Ministry for Primary Industries titled *Continuous Cover Forestry Business Models for Aotearoa New Zealand*

(Anon., 2023), highlighted three main scenarios for the application of CCF in New Zealand:

- Planting and establishing new CCF forests (both native and exotic), especially on post-harvest plantation sites
- Transitioning existing plantation forests to CCF regimes
- Selection forestry in regenerating native forest.

However, the need to develop silvicultural science and people capabilities were among the recommended priority areas to focus support for its development in this country. To that end, it proposed the creation of regional and national networks of research trial and demonstration sites in each of the three forest situations outlined above. My experiences serve to highlight the need for that type of research support.

Conclusion

While multi-value CCF forestry is an appealing goal, it is very complex and its practice in New Zealand is still very much in the experimental phase. Inevitably, early attempts will rely on the intuitive skill and guesswork of enthusiastic foresters. However, a challenge for research on CCF practice in New Zealand is how to most effectively inform and support adaptive management.

The promising observations, apparent problems and many questions arising in this little forest, after only 15 years, illuminate the pleasures but also the unknowns of silviculture by guesswork and anecdote alone.

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