Journal of Botany 50: 473–479.

Wood JR, Dickie IA, Moeller HV, Peltzer DA, Bonner KI, Rattray G, Wilmshurst JM. 2015. Novel interactions between non-native mammals and fungi facilitate establishment of invasive pines. Journal of Ecology 103: 121–129.

Branch River - the catchment of greatest vegetation change?

Nick Ledgard

Retired FRI (Scion) researcher

Back in the 1970s and 80s I used to spend a fair bit of time in the Branch catchment in South Marlborough. This river drains into the Wairau River alongside SH63, which runs from Blenheim up to St Arnaud. Being remote and rugged, with a demanding river crossing and 4WD track through original beech forest to reach the main hut (Grieg's), it was always an attractive destination for a young man keen on the backcountry and 'hunting, shooting and fishing'. It is also home to a fascinating tale of major vegetation change over a relatively short period of time. In his 1996 book *Steepland Forests*, Peter McKelvey describes the Branch catchment work as "easily the largest purely protective reforestation project in the NZ mountainlands". Much of the following is extracted from Peter's book, aided by the results of research trials in which I was involved.

Originally the Branch catchment was densely forested up to a timber line at about 1500 m. The dominant forest species were red and mountain beech, with areas of kanuka and shrubland (mainly Ca*rpodetus*, *Pittosporum*, *Cassinia* and *Senecio* species). Above 900 m there is increasing grassland dominated by *Rytidosperma setifolium* and *Festuca matthewsii* / *Poa colensoi*, with areas of *Chionochloa australis* (carpet grass) or *C. pallens* (snow grass). The most extensive vegetation clearances took place about the turn of the century, with the last major fires between 1917 and 1920. It is likely that forest destruction through burning had been underway for several centuries before that, but the prospect of grazing sheep accelerated it in the early 1900s. The end result was thousands of hectares of largely bare, erosion-prone slopes. I have slides taken in the early 1970s of huge areas of such steep land, with the most obvious above-ground feature being the widely scattered spars of large burnt beech trees. The only wildlife seen was rapidly retreating goats, hares and the occasional chamois. So open was the country that it was hard for even a fit, keen young man to get within assured rifle range.

Animal control in the catchment began in the 1950s, and by the mid-1960s this, combined with a restriction on burning had halted the major depletion of vegetation. Below 900 m the bare and eroding slopes had begun to heal, but above that, widespread erosion and soil loss continued. A Forest Research Institute survey in the summer of 1959-60 confirmed this, and resulted in experimental planting of a range of indigenous trees and shrubs – but this failed completely. Hence, Forest Service staff turned to exotic tree species to hold the upper slopes with the thought that these might serve as a nurse cover for later native species establishment. A revegetation programme began, tentatively and experimentally, with hand planting in 1963-64. Irregularly shaped groups of trees were planted at an average spacing of one group per 4 ha, with the intention of creating seed sources for subsequent in-filling by seedlings. By 1969 some 100s of hectares had been so covered in the most accessible areas up to 1400 m. In that year blanket planting of small areas began in sheet-eroded areas at higher altitude. As can be seen, this was very successful in arresting soil loss (Fig. 1).

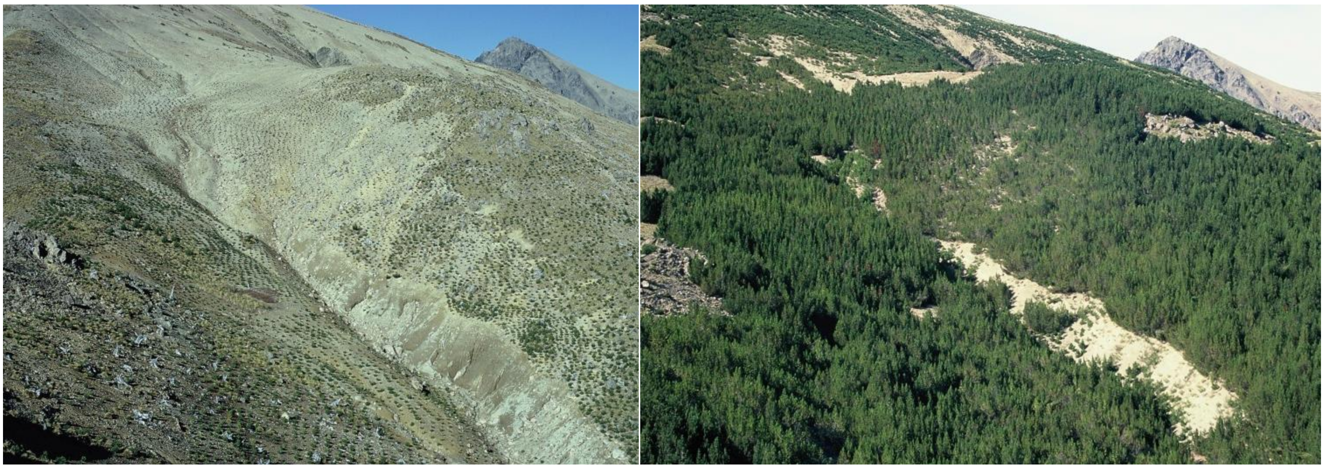

Figure 1. An eroding Branch headwater planted in the 1970s (left), re-photographed in 2007 (right).

By 1973, almost half a million trees had been planted. The main species were contorta/lodgepole pine (*Pinus contorta*), followed by Corsican, mountain and radiata pine (*P. nigra*, *P. mugo* and *P. radiata*) and Douglas-fir (*Pseudotsuga menziesii*). In addition, poplars and willows were established experimentally up to 1100 m, but this was so laborious that it was soon restricted to road stabilisation and amenity plantings.

Hand sowing of tree seed began in 1966, when 270 ha were covered using the same pattern as in group planting. However, this was soon superseded by cheaper aerial seeding, which showed similar results to the hand sowing. Initially, both fixed wing and helicopters were used, flying along the contour in flight lines 75-90 m apart. Images taken by myself in 1981 and 2007 clearly show the results (Fig. 2, p.18).

By 1969, the strip sowing looked so effective that it was replaced by aerial blanket sowing. Between 1965 and 1973, almost half a tonne of seed was sown, almost half of which was contorta pine. The main species were the same as those planted (listed above), with the addition of Scots and ponderosa pine (*P. sylvestris* and *P. ponderosa*), and European larch (*Larix decidua*).

Figure 2. Lines from sown conifer seed on eroding Branch slopes in 1981 (left), and re-photographed after further sowing and in-filling in 2007 (right).

The larger scale reforestation work was encouraged by the prospect of a Branch River Hydroelectric Power Scheme, which would take clean water out of the Branch River (plus its major tributary, the Leatham) to fill Lake Argyle (29 ha), from which the water would be directed down through a power station into the Wairau River. This Scheme was eventually commissioned in 1983. The eroding slopes in the upper catchment was sending huge amounts of shingle down the river, and directly threatening the viability of the power scheme. I remember an old lady who lived by the lower river, pointing out a spot a little further up where, when she was a child, her father had felled a tall beech tree so that they could cross the river with dry feet. My response was that one would need the equivalent of ten trees to make a dry foot crossing now.

At the time, the cost of aerial seeding ranged from $3.79/ha through to $7/ha, with seed being 75% of that cost and helicopter hire 20%. Initial mortality of germinated seedlings was excessive, especially at higher altitude, with over 50% dying in the first season – lifted out of the ground by frost, or as a result of desiccation and animal damage. Best results were in broken, rocky faces and on sites where tussock cover was incomplete. Poorest results were where tussock, shrub or forest cover was dense. After a few years the seedling mortality fell abruptly and growth rates approached those of planted trees. Contorta pine was the fastest, especially at higher altitudes, followed by Scots pine. At lower altitudes, radiata and ponderosa pine did well. Douglas-fir was slow at first, but once the mycorrhizal problem was overcome (in the 1980s) it has arguably become the most successful species (more later). Mycorrhizal fungi live in a symbiotic association with plant roots and can greatly increase water and nutrient absorption, and hence overall growth. Douglas-fir seedlings struggle without the correct mycorrhizae working for them.

In all this sowing work, it proved impossible to establish tree seedlings directly onto bare, exposed subsoils. It was soon realised that it was essential to stabilise such sites first, to provide protection from frost-lift, desiccation, wind, and water erosion. Research elsewhere had shown that aerial oversowing with grasses and legumes plus fertiliser could provide the required protection in the early years. Trial and error in the Branch showed that this technique could succeed, and that if pine seed was incorporated in the mix, the woody species could be sufficiently well established to survive by the time declining soil fertility had led to the disappearance of the herbaceous species. After 1975, this vegetation establishment technique was widely used.

Right from the word 'go', an absolutely vital component for revegetation success was control of wild animals. Reducing numbers of the large animals – deer, goats, chamois, and pigs – was not too difficult, but the smaller animals – hares and possums – proved more troublesome. Initially, control of the latter was by shooting combined with hand poisoning using cyanide and compound 1080. However, more extensive coverage was needed, so aerial poisoning began in 1970, and it was accepted that continuous pressure on animal herbivory had to be maintained into the future.

By the mid-1970s, overall results were considered promising enough to be undertaken annually, and this continued through to 1986. Some workers were almost full-time in the Branch, controlling animals over summer, and establishing a new vegetation cover over winter. Over 1 million trees were planted and more than a tonne of seed sown. In the 30 years since that time, the cover of vegetation has thickened and spread enormously. Even on the steepest slopes, where the initial sowings failed in the actively eroding gullies, there is now increasing closure. This is because trees established and grew well alongside gullies, so that when undermined by the expanding sides, they fell alive into the gully with part of their root system still intact. This stopped further soil loss beneath the fallen tree, and created small check dams which arrested debris from proceeding further downslope. As more and more trees fell in the same way, seedlings were enabled to establish on the now stable gully surfaces, and a continuous tree cover is currently developing across the slope (Fig. 2). The riverbed has also stabilised, with vegetation (mostly wilding conifers) now dominant (Fig. 3, p. 20).

To my knowledge, no-one has attempted to quantify the within-catchment environmental gains that all the revegetation efforts have achieved in the Branch. However, my own observations are that the rate of erosion has declined significantly (no doubt about that) and that there are now soils (with A horizons) developing under the conifers, where just bare subsoils existed before. Consequently, the water flow in the river is now more steady, consistent and cleaner – approaching the state it would have been in before the forest destruction began in earnest. Within-river aquatic insect life would also be returning to normal. Trout can now be seen in the river – and I can assure readers that there were none present in the 1970s and 80s. Bird life, both native and introduced, can now be seen in amongst the new woody cover, where none was present before. And where there are margins of indigenous plant species, new native seedlings can be found under the exotic cover. To my mind, that is the current major challenge – to promote increasing numbers of native plants to establish under the protective exotic woody cover, where their greater shade tolerance gives them an advantage over the more pioneering, light dependent exotic species. For that was the ultimate objective of the revegetation efforts – to facilitate a return to an indigenous plant cover.

Figure 3. Tramping by the Branch River in 2007. The formerly barren and mobile riverbed is now almost totally covered with wilding confers.

One should never end an article such as this with negatives, but unfortunately, it is the negative consequences of the Branch revegetation efforts that now capture the most outside attention. So successful has been the growth of introduced trees within the catchment, that the No 1 concern of present-day managers is the unwanted spread of wilding trees beyond the catchment boundaries. Huge areas are being invaded downwind to the east in the Waihopai catchment and the headwaters of the Saxton River on Molesworth Station. There is little doubt that if these invasions are not stopped, conifers will soon become the dominant cover outside closed canopy native shrub and forest lands. Even within the Branch, the successional move towards more shade tolerant native species will be compromised by an almost-as-shade-tolerant introduced species – Douglas-fir. Since its mycorrhizal problems were overcome in the 1980s, this species has become rampant, now appearing in sites where it was once considered to be a non-starter.

As Peter McKelvey concluded in his book "Anyone viewing the Branch valley today, with knowledge of what it was once like, will be impressed by the more stable, productive environment". He went on to add "But the 'foreign' plant cover will be emphatically noticeable too". If he was still alive today, he would underline, bold and italicise that last statement. And what are my thoughts almost 50 years since I first strode those steep bare Branch catchment slopes? I knew the benefits of establishing a new vegetation cover on eroding country as I was trained in that discipline – but I did not envisage the magnitude of it. We were also not sufficiently knowledgeable about differing species performance ('the right species in the right place'). Hence I regret that contorta pine and Douglas-fir were included in the mix of species used (Fig. 4).

Figure 4. Looking south from ridge tops in the Branch catchment in the 1970s (left) and again in the early 2000s (right). Below 1600 m all this catchment was beech forest prior to sweeping fires in the early 1900s. A small remnant can be seen in the far distant left of the 1970s image. All the other subsequent vegetation in the right image is introduced conifers – mostly established from aerially sown seed. The result is a stabilising cover with soil forming benefits, plus biodiversity gains and improved sites for more shade-tolerant native plant successions. But the pioneer conifers are now moving on to where they are not needed.

References

McKelvey P. 1995. Steepland forests. A historical perspective of protection forestry in New Zealand. Christchurch: Canterbury University Press.

Hayward JD, Wishart CJ. 1975. A decade of revegetation work in the Leatham State Forest – Nelson conservancy. NZ Forest Service Internal Report.