Mitigating worries with wildings

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Wilding pines will take over the high country." This was a comment by a speaker at a High Country Landscape Management Forum held in Queenstown in September 2005. It attracted many nods from the audience. Subsequent discussion led to the insinuation for many at the Forum that all conifers spread and that they are 'bad news', not just for the high country but for many other landscapes as well. Unfortunately, although the comment, and the insinuation that many connected to it, was wrong, such thinking is not uncommon in this country. This should be of considerable concern to foresters.

This article addresses why there is such concern about wildings, a common misconception about forestry and wildings, the importance of knowing the real facts and promoting them, how to mitigate wilding spread, and how we as foresters must accept such mitigation as a normal part of 'everyday' forest management.

Species and area affected by wildings

Ten introduced coniferous species are encountered most often as wildings in New Zealand. These are Bishops or muricata pine (*Pinus muricata*), Corsican pine (*P. nigra*), dwarf mountain pine (*P. mugo*), contorta or lodgepole pine (*P. contorta*), maritime pine (*P. pinaster*), ponderosa pine (*P. ponderosa*), radiata pine (*P. radiata*), Scots pine (*P. sylvestris*), Douglas-fir (*Pseudotsuga menziesii*) and European larch (*Larix decidua*).

The main locations where wilding spread affects significant areas at densities >100 trees/hectare, along with the dominant species involved, are shown in Fig. 1 (adapted from Ledgard 2001).

The exact area affected by wildings is difficult to estimate, due to different interpretations of the word 'affected'. In 2000, I estimated an area of 150,000 ha to have at least 1 wilding/ha (Ledgard 2001), the main component being that affected by contorta pine in the Central Plateau area of the North Island. In 1975, some 30,000 ha had an 'infrequent' to 'dense' covering of contorta pine on the Plateau (Hunter & Douglas 1975). Although the majority of these wildings have been removed, the present area affected is estimated at over 90,000 ha (J. Mangos, Land Manager, NZ Army, Waiouru), mainly due to the widely scattered presence of lone outlier trees. In the South Island, I wrote of 40-50,000 ha being affected by at least 1 wilding/ha (Ledgard 2001), whereas DOC states in their South Island Wilding Strategy (2001) that 'the uncontrolled spread of introduced conifers presently threatens over 210,000 ha of land administered by DOC in the South Island'. In DOC's strategy document the 'Area under threat' is defined as 'the area … that is likely to be threatened by wilding conifers in 10-15 years if no control is undertaken'. If this definition is extended to land outside the DOC estate, then the area potentially 'affected' in the South Island is unlikely to be under 300,000 ha.

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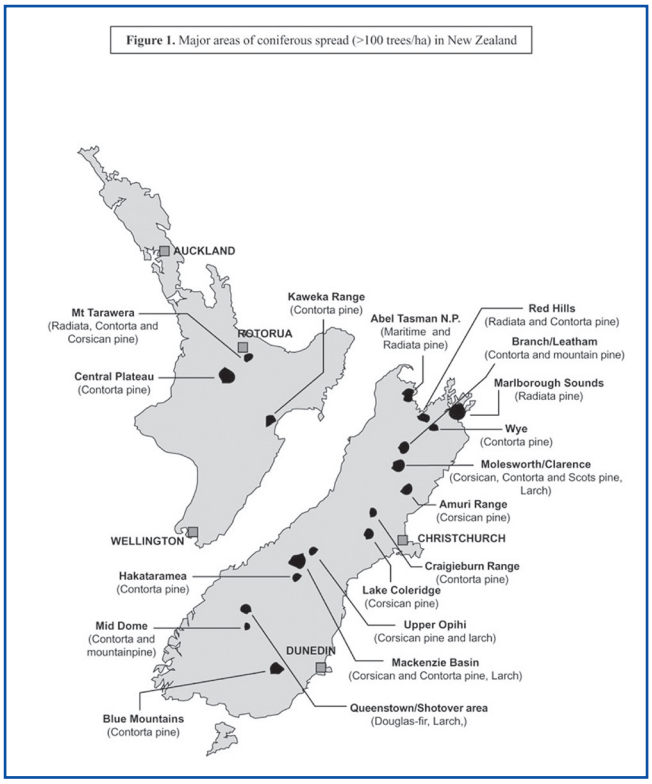
Fig. 1: Major areas of conifer spread (> 100 trees/ha) in New Zealand (adapted from Ledgard, 2001).



More recently, the area affected by wildings (at least one wilding/ha) in Canterbury (total area 2.3 million ha) was estimated at 62,000 ha (Old 2003). On Molesworth Station (in the DOC estate since 2005), which is characterised by extensive open slopes and valleys with little woody vegetation of any stature, I calculated that approximately a third of the total area of 180,000 ha has (or until recently had) an 'association with wildings'; i.e. a presence of at least 1 wilding / 100 ha (Ledgard, 2006 DOC contract report). Perhaps the second largest area in the South Island is in the Marlborough Sounds, where I estimate around 40,000 ha to be similarly affected.

The major seed sources for the larger areas of 'historic' conifer spread (as shown in Fig. 1) can be evenly apportioned into three categories:

- Government erosion control operations mostly undertaken in headwater catchments between the 1950s and 1970s (Kaweka Range in Hawkes Bay, Wye and Branch/Leatham catchments in Marlborough, Craigieburn Range and Hakataramea valley in Canterbury, and Mid Dome in Southland).
- Commercial plantations (Mt Tarawera and Central Plateau in the North Island, Red Hills/Mt Arthur in Nelson, Amuri / Hanmer Ranges in Canterbury, and Blue Mountains in Otago)
- Farm and private plantings (Abel Tasman National Park in Nelson, Marlborough Sounds and Molesworth in Marlborough, Lake Coleridge and Mackenzie Basin in Canterbury, and in the Queenstown area).

Why worry about wildings?

Concern about wilding spread is present in many countries, particularly in the Southern Hemisphere (Richardson & Higgins 1998). In New Zealand, wildings are seen to threaten:

- Landscape values – particularly to disrupt existing open and often treeless landscapes.
- Conservation values – spread can dominate or degrade the habitats of indigenous flora and fauna.
- Existing pastoral uses – grazing species can be shaded out by taller-growing trees.
- Future land use options – wilding dominated land is more expensive than open grassland to convert to other uses such as improved pasture or managed forest.
- Existing hydrology –dense wilding stands covering a significant percentage of a catchment (greater than 20% - in Davie & Fahey 2005) will reduce water yields.

In 2001, the Department of Conservation (DOC) produced a South Island Wilding Strategy (DOC 2001) in which it is stated that wilding conifers are 'the most significant weed threat in many areas'. Over the last decade, the Canterbury (Environment Canterbury), Otago and Southland (Environment Southland) Regional Councils have all featured wildings in their Regional Pest Management Strategies (e.g. Environment Canterbury 2002).

Concern is greatest in the drier zones of the country, where there are large areas of lightly vegetated land and the opportunities for invasion by vigorous pioneering conifers are frequent. It is least in the wetter regions, where the reversion of other woody species (often native) is more vigorous, leaving shorter 'windows of opportunity' for introduced conifer invasion. DOC has compared the cost-effectiveness of a diverse range of conservation projects in the dryland environment around Twizel in the South Island's Mackenzie Basin, with the much wetter Maniapoto area, south-west of Hamilton in the North Island (Stevens 2004). The conclusion was that wildings have comparatively little opportunity to spread in the Maniapoto and are 'a relatively short-term successional weed within seriously disturbed shrub and forest communities' (Stevens 2004). In the Twizel area however, 'wilding conifers have … substantial opportunities to spread and to change the natural composition, structure and function of native communities'.

Misconception - tendency to extrapolate historic spread cases to present-day forestry

As can be seen from the above, there is certainly cause to be concerned about the risk of wilding invasion, but it is incorrect to extrapolate a key feature associated with existing areas of spread to present-day forestry generally. That feature concerns the species involved. Fig. 1 shows seventeen areas of significant conifer spread. The most common species mentioned is contorta pine. It is the most vigorous spreading conifer in New Zealand (Ledgard & Langer 1999), and is involved in twelve of the seventeen areas. Its propagation and planting is now forbidden in the Regional Pest Management Strategies of a number of regions (e.g. Environment Canterbury 2002) – hence, no-one is currently planting this species. Similarly, very few people are planting most of the other species featuring in Fig. 1 - namely Scots, maritime and Corsican pine and European larch. The only species commonly planted today are radiata pine and Douglas-fir. Radiata pine can certainly be found as wildings, mainly due to its common occurrence throughout the country, but in terms of natural spreading vigour it is ranked low when compared to the other conifer species named above (Ledgard & Langer 1999; Ledgard 2004). However, the same cannot be said of Douglas-fir – the risk of it spreading is much higher.

Research

Basic knowledge about wilding ecology is essential for understanding and managing spread successfully. The first formal research trial was carried out by Dr Udo Benecke in the mid 1960s, looking at the role of grazing and pasture management in controlling contorta pine seedling establishment (Benecke 1967). The next major phase of research was initiated in the mid 1980s by the author and Lisa Langer (formerly Lisa Crozier). Trials were established to determine the ecology and demography of wilding spread in order to gain a better understanding of the wilding life cycle and the stages of that cycle where control strategies could be implemented most cost-effectively. Life history research has focused on seed production and dissemination, seed bank longevity in the soil, seedling microsite preferences, factors influencing seedling emergence and early survival (plant competition, animal browse, mycorrhizal presence). Recently, this information has been incorporated into predictive models. A more detailed summary of this research is given in 'Wilding conifers – New Zealand history and research background' (Ledgard 2004).

Mitigating spread risk

Research results and experience in the field has highlighted four key areas for mitigating the risk of wilding spread. These are species choice, plantation siting and design, surrounding land management and the use of predictive models.

Species choice

The propensity to spread and spreading vigour varies with species.

The age of significant seed production by the major introduced conifers generally ranges between age 8 and 13 (Ledgard 1988; Ledgard & Langer 1999), although a small proportion of trees will always produce seed a few years earlier than the rest. Contorta and dwarf mountain pine are the earliest coning species, and both of these species will produce seed to well above native tree line (1300-1500 m). The cone production of others, such as Corsican pine and Douglas-fir, drops off with increase in altitude, with little seed produced above 900 m and 1200 m respectively. At 900 m on Molesworth station, Corsican pine cones are hard to find and wildings will not be seen, whereas contorta and Scots pine are

spreading vigorously. Not far way, between 350-700 m asl, Corsican pine has spread extensively from Hanmer Forest. In general, seed production increases where trees are under some stress, often associated with reduced rainfall.

Conifer seed is disseminated by wind, and the distance of seed dispersal varies with species. The lighter the seed, the greater the distance it is likely to travel (Ledgard 2004) – two of the lightest species being contorta pine and Douglas-fir. The dissemination of Douglas-fir seed is also enhanced by the way it displays its cones - hanging down from the tips of branches, as opposed to being held closer to branch (or main) stems, as is the case with the other spreading conifers.

Seedling microsite preferences also vary. The major difference is between Douglas-fir and the pines. The pines can tolerate the more open, exposed sites, whereas Douglas-fir is more shade tolerant, and more able to establish within low-stature bushes and scrub (Cattaneo 2002). However, contrary to what many believe, it will not establish readily under closed canopy forest (Chavasse 1979; Ledgard 2002).

Once established, the attraction of conifers to browsing animals differ. Radiata, ponderosa and contorta pine are the most favoured by animals, whilst Corsican pine is the least (Crozier & Ledgard 1990). Young seedlings are particularly susceptible to browsing by rabbits (Davis *et al*. 1996), so the dramatic drop in rabbit numbers after the arrival of the rabbit calicivirus disease in 1998 led to a rapid increase in wildings.

Douglas-fir deserves special mention when it comes to species choice, especially as it is the most commonly planted species after radiata pine. Up until about 20 years ago, it did not feature as a major spreading species – it was hardly mentioned by Chavasse (1979) in his review of exotic tree species spreading into native forest. However, it is certainly a vigorous spreading species today (Ledgard 2002), probably due to an increase in numbers of readily available mycorrhizal propagules in the environment and a corresponding increase in the number of young seedlings becoming mycorrhizal at an early age (Dickson 2001) – without mycorrhizae they do not usually live more than 2-3 years. Douglas-fir is also more shade tolerant than the pines, which means it may invade open shrublands and canopy gaps in forests more readily.

Plantation location and design

The main determinants of spread relative to plantation siting are slope, aspect and exposure relative to the prevailing winds. Seed is likely to spread furthest from ridgetops and slopes exposed to strong winds. These are known as seed 'take-off' sites. Probably one of the best known is the top of Mid Dome in Southland (1480 m asl), from where contorta pine seed has been blown many kilometres. No spread-prone conifers should be planted on seed take-off sites, particularly if they are upwind of lightly vegetated and/or lightly grazed land.

Good plantation design involves trying to avoid having long edges at right angles to the prevailing wind, especially adjacent to spread-prone land. However, this is often difficult. What is more possible, is the planting of a less spread-prone species around stand margins. Edge trees are usually closest to spread-prone land and have green cone-bearing crowns down to low levels. Hence, most wildings around plantation edges are likely to have grown from seed disseminated by edge trees. Two rows of less spread-prone radiata or ponderosa pine around the margins of a Douglas-fir plantation will lower the risk of wilding spread from the more spread-prone fir. In this instance, radiata is the better edge tree as it is faster growing. Edge row planting is most effective on flat land – in hilly country, wind eddies are more frequent and can pick up seed from inside the stand.

Surrounding land management

Spread is most likely to occur on undeveloped, lightly vegetated and/or lightly grazed land. It is least likely to occur within closed canopy shrublands or forest, within improved pasture, and on land which is mob-stocked by sheep at least annually (Benecke 1967; Crozier & Ledgard 1990). Gibson (1988) found that sheep were far more effective at controlling wildings than cattle. Even grazing by sheep at very low levels (>0.5 sheep/ha) will significantly reduce wilding establishment (Benecke 1967). Benecke also demonstrated that pasture improvement by use of fertilisers on their own (without grazing) increased vegetation competition to the extent that contorta pine wildings were unable to establish successfully. Davis (1989) explored the option of establishing plantations by direct drilling and found that competition from resident vegetation inhibited establishment unless a herbicide was applied. Recent research has endorsed the strong effect of competition, by showing that the establishment of nine conifer species from seed on unimproved grasslands was reduced by an average of 40% by one application of nitrogen fertiliser (Ledgard, unpublished data).

Decision support systems and predictive models

The major aim of the wilding research has been to gain information which can be used to assist the decision-making of land managers and administrators. To this end, a simple decision support system (DSS) has been produced for calculating spread risk from new plantations (Ledgard 1994; Ledgard & Langer 1999). This can be readily used by foresters and farmers, is available in paper and electronic form (http://www.forestry.ac.nz/euan/sppchc/sppchc.htm), and is advocated by administration agencies dealing with spread-prone land. A similar DSS is being developed for assessing the risk of wilding spread into new areas.

Wilding models will not only assist in determining the life history stages most susceptible to interception, but they can also be used to assess the efficacy of control strategies, such as the removal of trees of different ages and on varying sites. This is important when there are limited resources which must be spent as cost-effectively as possible. The first major progress on a predictive model was made in 2002 (Buckley *et al*. 2005). More recently, the author has collaborated with Heather North of Landcare Research to develop a simulation model (the Ben-Tal Laing model) plus a GIS model for prediction of areas at risk of wilding invasion. In validation runs, the simulation model worked

well for spread in the Craigieburn area, but its use elsewhere will depend largely on the availability of good input data. The GIS model is less data demanding and can be usefully driven with expert knowledge.

Acceptance of wilding spread by foresters

Up until relatively recently, it could be said that most foresters and land mangers have failed to acknowledge that the spread of wilding conifers is a natural part of growing trees in New Zealand, and should be accommodated accordingly. Without containment, seedlings will regenerate outside managed areas just as readily as sheep will escape from land which is not properly managed or fenced. Managers of farm animals take this for granted and think nothing of spending time to fix fences (prevent escape) and to recover animals that have strayed off their properties (remove escapees). It is a normal part of their accepted 'everyday' management. It has to be the same with those growing trees. Before any planting commences, plans should consider wilding spread risk and put in place funds and strategies to minimise the risk of unwanted spread. Once trees mature and start producing cones, checks for wildings and their removal before coning, must become a regular activity.

Conclusion

Many introduced conifers grow well in New Zealand. A number regenerate naturally, some more vigorously than others. This is the price we pay for living in a country which has an environment which promotes some of the world's best growth of plantation conifers. Introduced trees have tremendous prospects for enhancing New Zealand's long-term environmental, social and economic well-being, but in order to realise these gains properly, we have to be well aware of the problems. The risk of unwanted wilding spread is one of these and we have to deal with it accordingly.

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