per on a stack of timber. This was mostly used by firms exporting greater than 25% of their output. There is also generally a greater emphasis in export markets on the use of branding to encourage repeat purchasing and to identify superior product characteristics. The differences in the use of branding based on company size are mostly revealed in export rather than domestic markets. For companies exporting more than 50% of their output, product identification was considered to be important for encouraging repeat purchasing, while for companies exporting less than 25% of their output, branding was considered to be important largely to provide technical information and meet legal requirements.

In spite of the potential for using branding to differentiate lumber products, the survey shows that branding is used in only a limited way. This points to a greater potential for branding, and the accompanying marketing strategies, to have a place in developing markets for New Zealand producers.

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# Indigenous Biodiversity Conservation and Plantation Forestry: Options for the future


**David A. Norton****



## Abstract

*Our goals in plantation forests should be to integrate production and protection in the same landscape (as advocated by the Resource Management Act 1991) rather than replacing one with the other. A review of indigenous biodiversity in New Zealand's plantation forests shows that many indigenous plants and animals occur in exotic plantations, with the number of species being dependent on plantation age, proximity to indigenous remnants and a variety of site factors (slope, aspect, etc). Plantation forests contribute to the conservation of indigenous biodiversity through: (i) providing habitat for indigenous species; (ii) buffering indigenous forest remnants; and (iii) improving connectivity between remnants. Options for enhancing indigenous biodiversity conservation in plantation forests include: (i) retention of indigenous forest; (ii) establishing a greater diversity of planted species; (iii) planting a diversity of tree species along streams and roads to provide additional habitat for indigenous animals; and (iv) modifying silvicultural practices within plantations. It is suggested that through the use of spatial modelling, optimisation of the arrangement of different aged compartments, and different plantation species, will maximise both timber production and indigenous biodiversity within a forest thus allowing full integration of these two activities without the loss of production values.*


## Introduction

There has been considerable debate in New Zealand about the relationship between plantation forestry and indigenous biodiversity conservation.[1] This has been fuelled in part by the recent Greenpeace report (Rosoman 1994) but also by a growing national and international interest in biodiversity conservation. While there has been some useful contributions to this debate (O'Loughlin 1995, Spellerberg and Sawyer 1995, Perley 1996) others have largely missed the point (Sutton 1995, Purey-Cust 1996) seeing biodiversity conservation as simply a threat to plantation forestry without any positive values. In this article I argue that biodiversity conservation does not need to threaten plantation forestry and that we can achieve both production and some conservation goals in the same forest.

The historical land-use paradigm in New Zealand sees two, mutually exclusive, land-use options, preservation and production[2] as highlighted by the Reserves Act 1977. This perspective, intentionally or unintentionally, underlies the New Zealand Forest Accord (August 1991) and subsequent Principles (December 1995). While recognising that both indigenous biodiversity conservation and plantation forestry have important roles to play in New Zealand, the Accord seeks to effectively separate production from biodiversity conservation (Potton 1994, Sutton 1995, Dyck 1997), viewing plantation forests as crops that do not need to meet biodiversity conservation goals (Sutton 1995, Dyck 1997).

This polarisation of production and conservation is, however,

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[1] *Biodiversity is defined in Article 2 of the 1992 Biodiversity Convention as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". For the purposes of this article I use biodiversity to refer to the diversity of species indigenous to New Zealand.*

[2] *I use the word production throughout this article to refer to land-uses that directly utilise natural resources for commercial gain such as agriculture and forestry.*

at variance with domestic legislation, especially the Resource Management Act 1991 (RMA) which promotes the idea that biodiversity conservation and production should occur in the same landscape. Under RMA, indigenous biodiversity conservation should occur in tandem with productive activities, rather than in conflict. As such we are not looking for ways to replace production with biodiversity conservation, but instead are looking at options that allow both production and biodiversity conservation to occur in the same landscape.

There is an increasing international focus, especially in Europe and North America, as well as in Australasia, on the need for green certification (e.g., through the Forest Stewardship Council) for a wide variety of consumable products including those from forests (Guy Salmon pers. comm.). While there is general agreement about the relative importance of plantation forestry and indigenous forest conservation in terms of the Forest Accord, there is a growing recognition that plantation forests can and should contribute more to biodiversity conservation than just providing an alternative timber supply to indigenous forests. This case was argued strongly by Rosoman (1994), although it was seen by many at the time as representing a major handicap for plantation forestry (Sutton 1995, Purey-Cust 1996). However, biodiversity conservation need not be a handicap and can in fact be used to better market plantation forest products both nationally and internationally.

The New Zealand Institute of Forestry has developed a position statement on biodiversity (Shaw 1997) that is more in line with the RMA than the Forest Accord. This statement recognises the importance of biodiversity "in both planted and natural landscapes" and "the importance of identifying safe and efficient operational practices to enhance and maintain biodiversity in a productive environment" and provides a positive step forward in considering indigenous biodiversity conservation in plantation forests.

In this article I initially summarise what we know about indigenous biodiversity in New Zealand's plantation forests, then discuss more generally the ways in which plantation forests can contribute to biodiversity conservation, and finish by considering some options for enhancing biodiversity conservation in production forests. My underlying thesis is that we can improve biodiversity conservation within plantation forests without necessarily reducing production by taking a landscape approach to forest management. In particular I argue that through optimising the arrangement of different aged plantation compartments, and different plantation species, we can maximise both timber production and indigenous biodiversity.

## Plantation forests and biodiversity

There has been considerable interest in the distribution and abundance of indigenous biodiversity in plantation forests. Rather then review this work in detail, I focus here on some of the main patterns observed in New Zealand plantations. Spellerberg and Sawyer (1993) provide a review of biodiversity patterns in plantation forests worldwide.

Several studies have described the distribution of indigenous plant species in conifer plantations (Rooney 1979, Clout and Gaze 1984, Gibbs 1988, Ogle 1989, Norton 1989, 1996, Molloy 1992, van Wijk 1993, McQueen 1993, Allen *et al.* 1995, Ogden *et al.* 1997). In general, exotic species dominate in younger stands, and indigenous species in older stands. The indigenous flora of plantations is comprised mainly of forest floor (e.g., ferns) and shrub species, while indigenous forest canopy species (e.g., podocarps, southern rata and tawa) are usually absent except in those plantations adjacent to indigenous forest. Allen *et al.* (1995) and Ogden *et al.* (1997) suggest that in the older plantations, the composition and abundance of the shrub and ground flora is comparable to that in indigenous forests. The diversity of indigenous species in plantations is also strongly influenced by topography, aspect, soil nutrient and moisture status, silvicultural history, land-use prior to plantation establishment, and proximity to indigenous forest remnants (McQueen 1973, van Wijk 1993, Allen *et al.*, 1995, Ogden *et al.*, 1997).

Plantation forests have also been shown to provide habitat for a number of indigenous birds (Jackson 1971, Colbourne and Kleinpaste 1983, Clout and Gaze 1984), although the indigenous avifauna is usually dominated by insectivorous or seed-eating species rather than by frugivorous or hole-nesting species (Clout and Gaze 1984). Some nationally threatened birds have been recorded using plantations (e.g., brown kiwi in Northland, Colbourne and Kleinpaste 1983; kakapo on Maud Island, Peter Gaze pers. comm.), although such instances are limited. Clout and Gaze (1984) suggest that a major influence on the utilisation of plantations by nectivorous and frugivorous birds is the presence of indigenous forest within or adjacent to the plantation and observations of birds such as kereru and tui in plantations have often been close to indigenous forest remnants. There is less information on other indigenous animals in plantations, although there is one record of a colony of long-tailed bats (Daniel 1981). A number of indigenous invertebrate species occur in plantations and the diversity of indigenous invertebrate groups can be comparable to indigenous forests especially in older plantations (Paddy Walsh pers. comm.).

What is clear from most studies of indigenous biodiversity in plantation forests is that forest harvesting represents a major disturbance to the forest and results in the loss of a substantial number of indigenous species (Clout and Gaze 1984, Allen *et al.* 1995, Ogden *et al.* 1997). Although other indigenous species establish after harvesting (Allen *et al.* 1995), these are usually short-lived species typical of disturbed sites. Thinning has a similar effect to harvesting, resulting in a reduction in shade-tolerant species and an increase in light-demanding species (McQueen 1973). The establishment of longer-lived indigenous species or species more typical of mature forest is dependent on the maturity of the plantation. Older plantations are beneficial for indigenous biodiversity because of increased spatial and vertical heterogeneity, well developed soil organic layers and associated fungal floras, a greater number of large diameter trees and increased dead wood on the forest floor (Clout and Gaze 1984, Molloy 1992).

## Biodiversity contributions from plantation forests

Plantation forests contribute to the conservation of indigenous biodiversity in three main ways: (i) providing habitat for indigenous species; (ii) buffering indigenous forest remnants; and (iii) improving connectivity between remnants.

### Providing habitat

Plantation forests provide habitat for a number of indigenous species and as such can contribute to their conservation. Many indigenous plant and animal species appear able to persist within plantations without relying on adjacent areas of indigenous forest. However, there is no information available to assess if these populations are viable in the long-term and what role re-colonisation from adjacent indigenous forest remnants plays in sustaining them. It is likely that for some indigenous species the presence of indigenous forest adjacent to plantations will be essential for their long-term survival (e.g., tui and bellbird; Clout and Gaze 1984). In some cases plantations provide habitat comparable to that found in indigenous forests. The abundance of indigenous orchids in Kaingaroa forest (Gibbs 1988) and at Hanmer (Molloy 1992) are examples of this. These plantations appear to provide the right combination of light and soil attributes, and absence of competition, that permits orchids to flourish.

Harvesting does, however, impose a severe disturbance on indigenous species within plantations (Allen *et al.* 1995, Ogden *et al.* 1997) and for some species it may be sufficient to cause their local extinction (e.g., some orchids; Gibbs 1988). Other species, for example some birds, may be less affected by harvesting as they have the ability to colonise adjacent areas of younger plantation (e.g., Colbourne and Kleinpaste 1983), although the success of dispersal after logging will be dependent on aspects of bird behaviour such as territoriality and breeding.

**Enhancing the value of indigenous forest remnants**

Remnant edges are typically characterised by altered microclimates and biological patterns resulting from external influences (Murcia 1995). Plantation forests have the potential to enhance the value of indigenous forest remnants by buffering remnant edges from these influences. The buffering effect is, however, dependent on the continued presence of plantation forest. Harvesting of plantation trees adjacent to the remnant edge will expose the edge to a variety of external influences (e.g., increased radiation and wind speeds) that were previously buffered by the plantation trees. Plantation forest adjacent to indigenous forest remnants also provides a potentially much larger area of habitat available for indigenous forest species to utilise (e.g., for feeding and breeding).

**Improving connectivity**

Several studies have suggested that the long-term viability of indigenous species within isolated forest remnants is dependent on the nature of the intervening matrix and the distance between remnants (Saunders *et al.* 1991, Bierregaard *et al.* 1992) as well as the physiological and behavioural traits of individual species (Dale *et al.* 1994). Many species occur in metapopulations, with movement between individual populations essential for sustaining the overall metapopulation through recolonisation after local extinction (Hanski and Simberloff 1997). Migration between remnants is the key process that links a metapopulation and hence the nature of the matrix can have an important effect on the viability of the metapopulation. The presence of plantation forests can enhance indigenous biodiversity by improving connectivity between indigenous forest remnants (Hampson and Peterken 1998).

The dependence of New Zealand forest birds on indigenous forest varies from those that are obligate forest dwellers relying on intact forest throughout their annual cycle (e.g., kaka, kakariki, mohua and robin) to those that are facultative forest dwellers that commonly occur in a range of habitats including farmland (e.g., greywarbler, fantail and bellbird; O'Donnell 1991). Primary forest dwellers (e.g., tomtit, kereru and tui) are intermediate, spending most of their annual cycle in indigenous forests but occasionally leaving to feed on seasonal foods elsewhere. The majority of the bird species listed by Clout and Gaze (1984) as common in plantation forests are facultative forest dwellers (Table 1) while the majority of those listed as absent from plantations are obligate forest dwellers. The species listed as sometimes present in plantations comprise mainly primary forest dwellers (Table 1). For this latter group in particular, plantation forest has the potential to improve connectivity between remnant indigenous forest areas by providing conditions suitable for bird movement. The occasional presence of some obligate forest dwellers in plantations (e.g., robin and kakariki, Black 1963) suggests that plantations may improve connectivity for these species too.

## Options for enhancing biodiversity conservation in plantation forestry

Several studies have commented on different management options for enhancing indigenous biodiversity within plantation forests both in New Zealand (Clout 1984, Clout and Gaze 1984, Rosoman 1994, Spellerberg and Sawyer 1995, Ogden *et al.* 1997) and elsewhere (e.g., Hunter 1990, Peterken *et al.* 1992, Spellerberg and Sawyer 1993, Forman and Collinge 1996). These can be broadly grouped into four types of management action: (i) retention of indigenous forest and related communities; (ii) establishing a greater diversity of planted species; (iii) planting a diversity of tree species along streams and roads to provide additional habitat for indigenous animals; and (iv) modifying silvicultural practices within plantations.

**Table 1. Dependence of bird species commonly present, occasionally present and absent from plantations on indigenous forest. Adapted from Clout and Gaze (1984) and O'Donnell (1991).**

| Bird species | Dependence on indigenous forest |
|---|---|
| **Commonly present in plantations** | |
| fantail | facultative |
| greywarbler | facultative |
| long-tailed cuckoo | primarily |
| shining cuckoo | facultative |
| silvereye† | facultative |
| tomtit | primarily |
| whitehead | – |
| **Sometimes present in plantations** | |
| bellbird† | facultative |
| brown creeper | primarily |
| brown kiwi | – |
| kereru† | primarily |
| NZ falcon | primarily |
| NZ kingfisher* | facultative |
| NZ robin | obligate |
| morepork* | primarily |
| rifleman* | primarily |
| tui† | primarily |
| weka | facultative |
| **Absent in plantations** | |
| great spotted kiwi | obligate |
| kaka*† | obligate |
| kakariki (yellow-crowned)*† | obligate |
| kakariki (red-crowned)*† | – |
| kea† | facultative |
| kokako† | – |
| mohua* | obligate |

**† partially frugivorous or nectivarous.**
*** obligate tree-hole nester.**

**Retention of existing indigenous forest**

The retention of indigenous forest and other indigenous ecosystems within plantation forests provides key habitat for many indigenous species (Colbourne and Kleinpaste 1983, Clout 1984, Clout and Gaze 1984). Recent legislation changes (e.g., the Forests Amendment Act 1993) and the signing of the Forest Accord, have resulted in a virtual stop in the replacement of indigenous forest by plantations with most new plantations established on formerly farmed land. Through the RMA consents process any area of significant indigenous vegetation or habitat for indigenous wildlife are set aside from production.

**Establishing a greater diversity of planted species**

A second management response to integrating biodiversity conservation better into plantation forestry is to establish a greater diversity of planted species. Clout (1984) suggested that a mixture of stands of different age and species would increase the range of habitat types available for indigenous birds. Rosoman (1994) suggested that such plantings should represent a minimum of 40% of all new plantings (20% indigenous and 20% mixed exotic). However, it is not the amount of new species planted that is important, but the way these plantings are spatially arranged (see also Clout 1984). For example, special purpose exotic (e.g., eucalyptus) or indigenous plantations (e.g., totara or beech) are likely to be more beneficial when located adjacent to indigenous forest remnants than when located distant from them. While the cost of establishing alternative species is higher than growing radiata pine, mainly because of longer rotation lengths, the cost of growing some indigenous species (e.g., mountain beech) appears comparable to that of other plantation species (e.g., Douglas-fir; Bilek and Norton 1996).

**Diversifying amenity plantings**

Many forestry companies make considerable use of amenity plantings, for example along roads and around recreational amenities. Careful selection of species for these plantings could considerable improve habitat for many indigenous species, especially birds, for little additional cost. Species selection should focus on species that provide food resources such as nectar and fruit (Clout 1984, Clout and Gaze 1984) and need not be indigenous species. It has also been suggested that the use of indigenous species in riparian zones will improve indigenous biodiversity values (Gillian *et al.* 1992, Rosoman 1994) but again appropriate exotic species are likely to provide similar benefits, at least for indigenous forest birds.

**Modifying silvicultural practices**

The major impact of plantation forestry on indigenous biodiversity occurs during harvesting. While the diversity of plant species can be high in recently clearfelled areas, this is usually of species typical of disturbed sites rather than mature forest species and comprises a large proportion of exotic species (Allen *et al.* 1995). It is clearly not appropriate or desirable to stop clearfelling, but the way in which harvesting is undertaken can be modified to benefit indigenous biodiversity without adversely affecting the economic viability of plantation forestry.

Most studies of indigenous biodiversity in plantations have observed that this is greatest in the oldest stands. There is however a trend of decreasing rotation length in New Zealand plantation forests from a mean of 40-50 years in 1970s and 1980s to 25-30 years in 1990s for radiata pine at Kaingaroa (Euan Mason pers. comm.). An increase in rotation length has been widely advocated as a means to enhance indigenous biodiversity in plantations (Harris 1984, Clout 1984, Clout and Gaze 1984, Peterken *et al.* 1992, Rosoman 1994, Ogden *et al.* 1997). However, this is usually considered uneconomical in New Zealand because financial profitability begins to fall above a certain stand age (Ted Bilek pers. comm.) or because of increasing environmental risks with increasing stand age (e.g., windthrow; Bilek and Norton 1996). However, Peterkin *et al.* (1992) suggested for British plantations that a trade off for increasing rotation lengths in some areas might be to reduce rotation lengths in other areas thus maintaining financial returns from the forest, although the economic implications of this were not investigated.

The use of single tree or group selection harvesting will result in the continued presence of mature forest at a site and this has been suggested as beneficial for indigenous biodiversity (e.g., for orchids; Molloy 1992). However, except for very high value timber species such as oak or walnut, single tree or small-group harvesting is usually uneconomical and even for more widely grown higher value species such as Douglas-fir and macrocarpa single-tree extraction is only marginally economical (Bill Studholme pers. comm.). However, as timber prices continue to increase, especially for higher value species, single tree or small-group extraction may provide a viable alternative economically with obvious indigenous biodiversity conservation spin-offs.

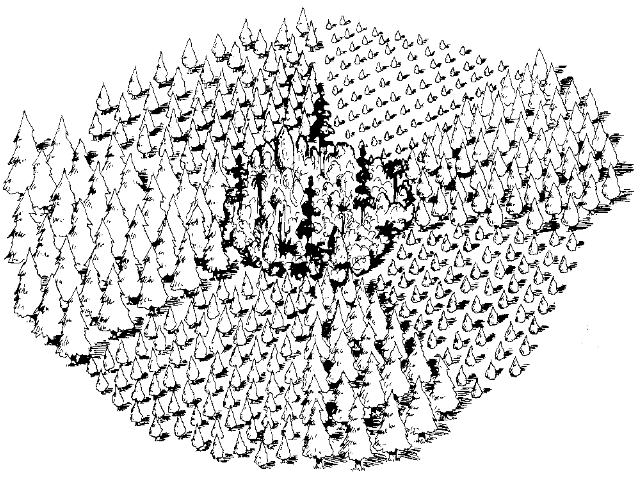

**Figure 1. An indigenous forest remnant surrounded by plantation forest managed on a rotational basis.**

A third management response, and the one with the greatest potential for achieving biodiversity conservation goals within production forests, involves taking a landscape approach to the spatial arrangement of different aged plantation stands with respect to other landscape components, especially remnant indigenous vegetation. The use of rotational harvesting has been advocated for managing old growth Pacific northwest forests of North America by Harris (1984). In this system a core old growth remnant is surrounded by a series of managed stands that have a sufficiently long gap between harvesting to ensure that at any one time the old growth remnant is surrounded by a large proportion of mature forest, thus increasing the total area of habitat available and buffering the remnant. A similar system has been suggested for managing upland conifer plantations in Britain (Peterken *et al.* 1992) which involves assigning 15-20% of the plantation to long rotations surrounding permanently uncut cores.

A similar approach could be used for managing plantation forests around indigenous forests remnants or between remnants in New Zealand. By ensuring that there is always a large area of mature forest present adjacent to the remnant (Fig. 1), additional plantation habitat would be available for indigenous species in the remnants to utilise. By having a continuous sequence of mature aged plantation stands between remnants (Fig. 2), there would also always be the opportunity for indigenous species to move between remnants. Rotational harvesting could also be used away from remnants to ensure that there are always mature plantation stands adjacent to younger plantation stands to provide the opportunity for species to colonise new sites or to disperse to during harvesting.

The key to enhancing indigenous biodiversity in New Zealand plantation forests is to take a landscape perspective of the forest, viewing the forest as a spatial array of different elements that can be arranged in different ways (Forman 1995) depending on management goals. The key elements within a plantation are individual stands or compartments of different age and species composition, remnants of indigenous vegetation including riparian strips, and amenity plantings. Some of these are fixed in the landscape (e.g., indigenous remnants and riparian strips) but others can be arranged in different ways. In North America, spatially modelling tools have been used to optimise timber harvesting while meeting biodiversity conservation goals (Bettinger *et al.* 1997, Snyder and ReVelle 1997) and similar modelling could be used in New Zealand plantations to optimise the arrangement of different aged compartments, and different plantation species, to maximise both timber production and biodiversity conservation. The key feature of this approach is that it considers biodiversity conservation at the landscape scale rather than at the stand scale and thus removes the direct conflict between protection and production at any given site.

Multiple-objective decision making has been widely used to maximise economic returns to timber management while simultaneously minimising impacts on other activities (e.g., soil conservation and recreation; e.g., Dykstra 1984, Whyte and Daellenbach 1987, Whyte 1996). However, multiple-objective decision making does not offer the same opportunities that spatial modelling does for optimising the arrangement of landscape elements within plantation forests in order to achieve both production and protection goals.

## Conclusions

While foresters make extensive use of modelling techniques to optimise timber production (Garcia 1995), this needs to be expanded to optimise both timber and biodiversity values at the forest level (c.f. Bettinger *et al.* 1997, Snyder and ReVelle 1997). There is no quantitative information of this nature available for New Zealand plantation forests and this is clearly a key research need if we are to better manage indigenous biodiversity in these forests. Specific areas where more research is needed include: (i) optimisation of landscape design for both production and biodiversity conservation; (ii) quantification of the likely effects at a forest level of increasing rotation lengths or using different species on forest economics; (iii) better understanding of the long-term trends in indigenous biodiversity over several rotations of forest trees; (iv) identification of the key elements for sustaining indigenous species in plantation forests (e.g., experimental studies looking at dead wood, nesting boxes etc) and how these affect forest production; (v) understanding how indigenous species utilise plantation forests in conjunction with remnant indigenous forests; and (vi) quantifying the benefits of plantation forests in comparison to pasture as a neighbour to indigenous forest remnants.

The challenge for plantation forestry is to move beyond the old paradigms that see indigenous biodiversity conservation and production as mutually exclusive activities and to develop new paradigms and strategies that ensure that both activities are met in the same landscape. This approach is totally compatible with the intent of the RMA and is far more likely to meet the growing international pressure for green certification than the current paradigms will. The recently published New Zealand Institute of Forestry position statement on biodiversity (Shaw 1997) is a step in this direction. Goals in plantation forest management should be to integrate productive and protective uses in the same landscape, rather than replacing one with the other.

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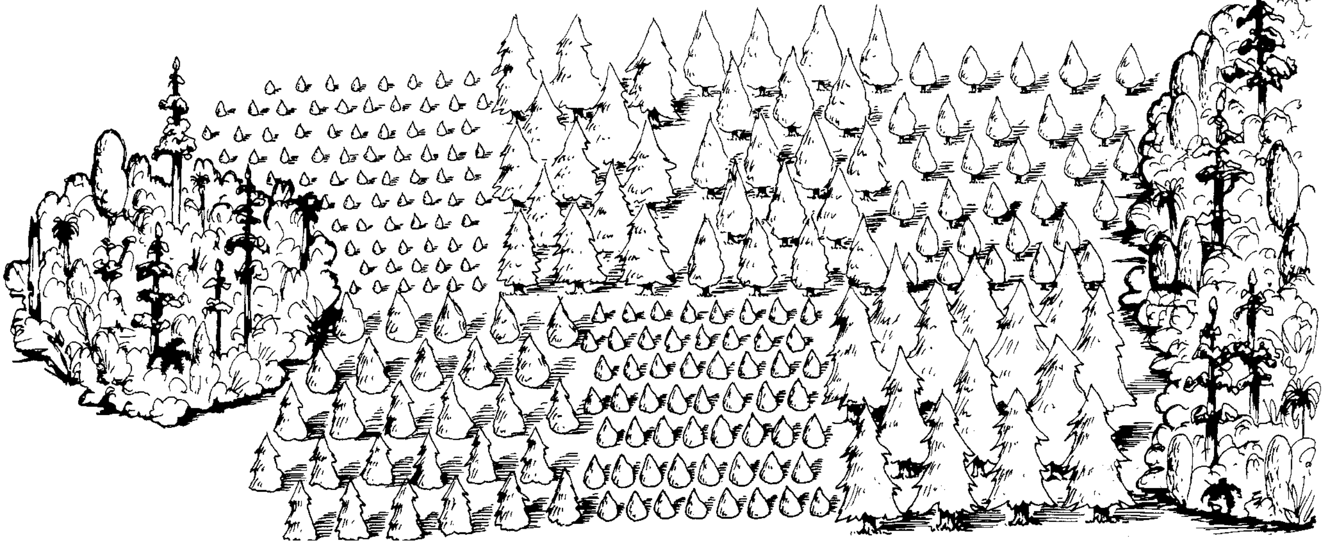
**Figure 2. Plantation forest connecting two indigenous forest areas managed on a rotational basis such that there is always mature forest present between the two indigenous forest areas.**



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## INSTITUTE NEWS

# President's Comment

For the last two decades the Institute has 'recognised' the professional ability of a number of its members, and most recently the constitution has provided for the registration of members who have achieved, and are pledged to maintain, a level of attainment within the forestry profession.

A corollary of such recognition is the setting of consistent standards, and periodic confirmation that these are being acheived in practice and over time.

A great deal of this responsibility falls on the shoulders of the Registration Board, and in particular the Chairperson, a role filled very ably by Bruce Manley for the last six years. Bruce and the remainder of the Board have worked hard, building on the body of practice and precedence of former Board's to ensure present registration procedures are both appropriate to our profession and rigorous enough to provide some assurance of the performance of registered members.

For registered members (of whom most are registered consultants) recognition by the Institute conveys to the wider community some proof of capability in practice, an attribute often of some value to those registered.