Biodiversity in New Zealand plantation forests: Policy trends, incentives, and the state of our knowledge

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Abstract

Biodiversity is an issue of increasing relevance to plantation forests in New Zealand. The New Zealand Biodiversity Strategy and other recent policy documents advocate 'sympathetic management' to conserve biodiversity on private land. As a component of sustainable forest management, biodiversity is also included in international agreements (e.g., Montreal Process) and in the certification of forest operations. However, a review of these and other policy and legal instruments revealed shortcomings in the definition of biodiversity as well as a lack of clear guidelines on how biodiversity should be considered in plantation forest management. In the few cases where explicit references have been made, 'biodiversity' is mostly used in the sense of 'threatened species.' Although our knowledge of vascular plants and birds occurring in plantations is relatively good for some regions, little knowledge is available about other taxa and the presence of threatened species. Moreover, it is not clear what exactly is meant by 'sympathetic management' and hardly any research has been undertaken in this area. More active management for preservation or enhancement of biodiversity in plantations could lead to improved public perceptions and international market access, and might enhance 'ecosystem function.' In this paper, we also discuss biodiversity indicators and provide a summary of recent research on biodiversity sustainability issues in plantations. To adequately address biodiversity in plantations, more research is needed, for example, on threatened species and other indigenous flora and fauna, sympathetic management (including cost-benefit analyses), and long-term monitoring. Interactions between policy makers, scientists and forest managers should be improved.

"In the tectonics of human affairs, biological diversity lies in the subduction zone where contentious human values confront scientific uncertainty. The profession of forestry, based as it is on modernist scientism, operates poorly when these matters collide without resolution..." Clark Binkley (1998).

Introduction

Biodiversity[3] has received much recent attention in New Zealand and it is becoming clear that this has implications for plantation forest management. Thus it is timely to re-examine policies and to review the biodiversity issues relevant to plantation forestry in New Zealand.

The decline in biodiversity has been identified as a most important global issue (United Nations 1992), with current extinction rates of animals and plants worldwide being compared to the demise of the dinosaurs (Wilson 1988). New Zealand's unique flora and fauna are suffering a similar fate, and many of the remaining species, including the national icon, the kiwi, are seriously threatened by introduced predators and the loss and fragmentation of habitat (Atkinson and Cameron 1993). The 'State of New Zealand's Environment' (MfE 1997) suggests that "biodiversity decline is our most extensive and multi-faceted environmental issue". At present, conservation efforts focus mainly on national parks and reserves, but recent Government legislation and policy such as the Resource Management Act 1991 (RMA) and the New Zealand Biodiversity Strategy (DoC/MfE 2000) place greater emphasis on biodiversity-related issues in 'production' landscapes. This certainly includes plantation forests because they can provide valuable habitat for indigenous species (Clout and Gaze 1984, Allen *et al.* 1995, Norton 1998), and this is particularly relevant in lowland areas which are under-represented in the conservation estate (Norton and Miller 2000). Biodiversity issues are also highlighted by international agreements such as the Montreal Process, and the 'green' certification of forest operations.

Historically, plantations of exotics were seen as 'fibre farms' in which biodiversity was of little relevance. It was argued that, by providing an alternative timber supply, plantations protected biodiversity within indigenous forests (New Zealand Forest Accord 1991, Sutton 1995, Dyck 1997). While it is true that plantations have made a significant contribution to the reduced harvesting of indigenous forests in New Zealand, it is not generally accepted that biodiversity in plantations is therefore irrelevant (e.g., Anon. 1994, Spellerberg and Sawyer 1996, Norton 1998). In fact, there is increasing acceptance in New Zealand forestry that biodiversity needs to be addressed in plantation management, as evidenced by a position statement from the Institute of Forestry (Shaw 1997) and a clear mandate for more biodiversity research from forestry executives[4]. However, there remains substantial disagreement over the relevance of this issue, and this is complicated by the fact that

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[3] Biodiversity encompasses much more than species richness and the conservation of threatened species. It is defined as "the variability among living organisms fromall sources [...] this includes diversity within species, between species and ecosystems" (United Nations 1992).

[4] Sustainable forest management meeting at Forest Research in Rotorua, May 1999; an unpublished report is available from the authors.

biodiversity means different things to different people (Bunnell 1997) and can be viewed at various scales from genetic to landscape levels (Gaston 1996). Furthermore, although general policies exist, there is an absence of clear guidelines as to how biodiversity considerations could be integrated into practical plantation forest management, and if or under what circumstances this should occur.

In this article we are primarily concerned with indigenous biodiversity occurring in plantation forests. We address some of the issues surrounding biodiversity in exotic plantations in New Zealand by asking:

- What are the relevant policies and incentives for biodiversity protection?
- What does biodiversity mean in the plantation context?
- How might biodiversity be measured?
- What research needs should be addressed in the future?

Relevant Obligations, Policy Instruments and Incentives for the Protection of Biodiversity in Plantations

The reasons for addressing biodiversity in New Zealand's plantation forestry are summarised in Table 1.

Legislation and policies. The RMA addresses, under section 6(c), the "protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna." However, there are no clear guidelines as to what constitutes 'significant natural areas' and how to implement the relevant RMA provisions. As a result, councils decide these issues using processes which are not standardised across New Zealand. To remedy this situation, a ministerial advisory committee was appointed to assist with the development of a national policy statement on biodiversity protection on private land (MfE 2000a). After public consultation, the committee recommended not to develop such a statement at the moment, but rather to provide non-statutory policy guidance and to implement a range of measures designed to increase biodiversity awareness and capability for sympathetic management (MfE 2000b). However, some regulatory measures are possible in the RMA consent process.

As a signatory of the United Nations Convention for Biological Diversity (United Nations 1992), New Zealand agreed to contribute to halting the global biodiversity decline, but this agreement has no direct relevance to New Zealand's plantation forests. Although the subsequently developed New Zealand Biodiversity Strategy (DoC/MfE 2000) explicitly urges that land management outside protected areas be "sympathetic to indigenous biodiversity", it is not legally binding and unless further incentives are put in place, it is questionable whether "sympathetic management" will be practised. Nevertheless, some companies already have included provisions for protected species in their environmental guidelines.

The Montreal Process. This international agreement

Table 1. Major obligations and incentives for the conservation of biodiversity in plantations forests. See text for further explanations and references.

Obligation or incentive	General issue	Implications for plantations
Resource Management Act 1991	Conservation issues are relevant also in production land uses.	Not clear. A policy document for biodiversity on private land is under development.
UN Convention for Biological Diversity	NZ signed agreement to protect its unique biodiversity.	Not clear, but possibly only relevant where threatened species occur.
NZ Biodiversity Strategy	Encourages 'sympathetic management' of private land.	Theoretically applicable but not legally binding.
Montreal Process	NZ signed agreement to report on sustainable forest management criteria and indicators (incl. biodiversity).	Not clear because so far assessments occur mostly at a national scale, although a plantation-specific assessment is now in progress.
Forest certification (e.g., FSC, VEP)	FSC: Protection of rare and threatened species and of ecosystems, maintenance of ecological functions and values.	Depending on the certification scheme, varying emphasis is placed on biodiversity; FSC places most emphasis on threatened species. Certification is increasingly important for access to international markets and certified products could fetch higher prices.
Public perception	Plantations are sometimes seen as 'monocultures' and 'biological deserts' which reflects negatively on this landuse.	Biodiversity consideration could improve public perception and facilitate consent applications and reduce pressure from environmental groups. Internationally, this could influence market access.
Ecosystem function	Plantations with more biodiversity could be more productive and suffer less from weed and pest problems.	Practical knowledge is limited; more research is needed.

on sustainable forest management (Anon. 1995), to which New Zealand is a signatory[5], has been ratified by countries which together contain over 90% of the world's temperate and boreal forest. The Montreal Process defines a sustainable forest management framework that can be used for the development of policies at the national level, and the conservation of biodiversity is one of seven criteria (Anon. 1995). At the national level New Zealand fares well on the 'ecosystem diversity' indicators because of the comparatively large proportion of native forest in national parks and reserves (MoF 1997). On the 'species and genetic diversity' indicators, the assessment is not as favourable in either indigenous or plantation forests because nation-wide many species are threatened or remain only in small, fragmented populations, and because there is a lack of information (MoF 1997). Montreal-Process-motivated policies for regional or management unit scales (i.e., stands or forests) have not yet been developed for New Zealand. Because criteria used internationally are based on managed natural forests or semi-natural plantations of indigenous tree species, the interpretation of 'biodiversity' criteria for New Zealand's plantations is challenging. Based on international policies and perceptions (see below), it is possible New Zealand's plantations will ultimately have to meet sustainable management criteria, including biodiversity, in their own right.

Environmental certification. There is an increasing trend towards environmental certification of forestry practices and products (Fletcher and Hansen 1999). This is important to ensure international market access, and certified products might also yield premium prices. Biodiversity is assessed as part of several principles of the Forest Stewardship Council (FSC), the internationally most widely adopted certification scheme. FSC certification has been obtained, for example, for about 23% of the forestry land area in the USA, and for 79% in Sweden (Marais 1999, updated from Forest Stewardship Council 2001). With the recent certification of the estate of Fletcher Challenge Forests, about 300,000 ha of New Zealand plantation forest (nearly 20% of the total stocked area) has been FSC certified (Forest Stewardship Council 2001), and further applications are in progress. A New Zealand certification scheme, VEP[6], is currently being developed especially for plantations. Because mutual recognition with FSC is being sought (James Griffith, pers. comm.), VEP might need to use criteria similar to those used by FSC for the assessment of biodiversity (and other criteria).

Public perception. Issues of public perception are important in forestry. Although many people do not or cannot distinguish between exotic and indigenous species, pine plantations are often regarded as unnatural (Fairweather and Swaffield 1999). In a recent survey of Gisborne/East Coast area residents, perceptions such as pine plantations 'souring the soil' (Fairweather *et al.* 2001) or even 'killing the soil' (Lisa Langer, unpublished data) were expressed. In other random surveys of the public up to 39% disapproved of clearfelling of plantations (Shaun Kilvert-Killerby, pers. comm.). More concerns were voiced by Rosoman (1994). However, many of these concerns rest on wrong perceptions, and in terms of biodiversity, plantation forests compare favourably with agricultural land uses. This provides an opportunity to improve the image of plantations, particularly if greater use was made of the potential to promote and maintain indigenous biodiversity in plantations, which would certainly be well received by the public. In North America, Westvaco is aware of this and has received numerous awards[7] for integrating forestry and biodiversity protection.

Ecosystem function. It has long been thought that many 'ecosystem processes' are dependent on the maintenance of biological diversity (e.g., Naeem *et al.* 1994), although the general concept is currently much debated (Wardle 1999). In a plantation forest context, decomposition and nutrient cycling are processes that could be negatively affected by 'biodiversity deficiencies'. However, although our knowledge of this complex subject is scant, at present it appears that New Zealand plantations do not show obvious signs of such ecological dysfunction.

'Ecosystem health' can also be affected when exotic organisms threaten the integrity of indigenous biota. Exotic insect pests, browsing mammals and weeds can have significant detrimental effects on ecosystem function and can also reduce the productivity of pines (Richardson *et al.* 1996, Jacometti *et al.* 1997). Since such organisms also challenge our indigenous biodiversity (MfE 1997), there is a notable mutual interest in this issue in plantation forestry and conservation. Because most weed problems are caused by exotics, encouraging indigenous vegetation could reduce the need for weed control and enhance biodiversity values of plantations at the same time. There is also a possibility that more biodiversity might provide greater resilience against pest and disease outbreaks. For example, appropriate habitat management can promote natural enemies of pests resulting in their natural control (Landis *et al.* 2000).

Defining Biodiversity in Plantations

Issues of scale. Because biodiversity is a broad concept that can be interpreted in different ways, policies need to provide clear definitions. However, present policies aimed at protecting biodiversity are mostly generic and focus at the national level without explicit guidelines for smaller scales. In practice, approaches to protecting biodiversity and the resulting outcomes depend on whether one considers a stand, a whole forest, or entire landscapes (Franklin 1993) (Fig. 1). At the stand level we are concerned with organisms that share their habitat with the planted trees and are thus directly affected by silvicultural operations and forest management. A different set of potential management issues is raised at the forest scale which may include

[5] A report on Montreal Process criteria and indicators in New Zealand is required by 2003.

[6] VEP (Verifying Environmental Performance) is currently being developed by NZFIC and FOA as a certification scheme specific for NZ plantation forests (Gray 1999).

[7] www.westvaco.com/environment/awards/awards.htm

Fig. 1. A Coromandel landscape with a recently planted Radiata pine stand that surrounds a riparian zone with indigenous vegetation. Older stands are in the background. Biodiversity issues increasngly apply to the planted area itself, not just to riparian zones and indigenous remnants within plantations.

several stands of different ages and different plantation species, as well as areas of high biodiversity value such as indigenous remnants and riparian areas. At the landscape level, where plantations are part of a mosaic of different land uses, the issues are broader again, and require a more comprehensive perspective that includes the inter-relationships between forestry and various other land uses. In this context the prevention of spread of wilding pines is an important environmental issue (DoC/MfE 2000).

What do policies mean by biodiversity? Any management decision aimed at protecting biodiversity requires a meaningful definition that clarifies what is meant by 'biodiversity' (Franklin 1993). It makes a big difference whether one is concerned with (1) only certain rare or threatened species, (2) all indigenous species, or (3) entire ecosystems. In New Zealand there is currently no clear definition used by policies relating to private land. Which definition applies in future appears to largely depend on the interpretation of "significant indigenous vegetation and habitat" (DoC/MfE 2000, p. 37). This has important implications for the future relevance of biodiversity to plantation forestry because, to our knowledge, threatened species rarely occur in plantations whereas other indigenous species are often abundant. Obviously, New Zealand's biodiversity would gain more from a broad definition that values all indigenous biodiversity.

There can be no doubt, however, that any definition will give special attention to the protection of indigenous remnants within plantations, particularly in regions where 'significant habitats' are not adequately protected (DoC/MfE 2000). In this context it is important to note that it is questionable whether such remnants, especially small ones, will be viable without appropriate management of surrounding stands to 'buffer' them or to increase the 'connectivity' between them (Norton 1998).

Riparian areas within plantations are also important, and relatively clear guidelines already exist concerning their establishment and protection (Boothroyd and Langer 1999). Although the major driver for this appears to be the protection of water quality and stream habitat for fish and other aquatic organisms, there are also immediate benefits for the terrestrial flora and fauna in these areas. Nevertheless, without other measures the protection of narrow strips in the vicinity of streams is unlikely to fulfil demands for the protection of biodiversity in plantations.

The State of our Knowledge and Research Needs

Indicators: How to measure and assess biodiversity? Given the complexity and wealth of different perspectives on forest biodiversity (Bunnell 1998, Simberloff 1999), it is obvious that 'measuring' biodiversity in plantations as well as defining operational biodiversity criteria and indicators for their sustainable management requires some contemplation (Simberloff 1998). It is essential to clearly define what such indicators are meant to indicate (Lindenmayer 1999), but often no definitions are provided or they are very vague. These could be:

- to assess the state of forest biodiversity at a national level (as for the Montreal Process),
- to determine whether biodiversity is sustained at a local management unit scale (perhaps compared to natural reference areas),
- to monitor whether biodiversity declines over time, or
- to detect changes in organisms that are representative of some abiotic parameter.

Once these issues have been clarified, an appropriate indicator needs to be selected. Theoretically, the best indicator of general biodiversity would be to compare the abundance and 'well-being' of *all* species in a plantation and in nearby natural habitats. This is, of course, neither possible nor desirable because assessing *all* species would be an enormous job at enormous cost (Lawton *et al.* 1998). Instead, certain species or higher taxa are usually selected as indicators based on our knowledge of these species and of their relationships with ecological processes or values. For example, kiwi have been proposed as 'Environmental Performance Indicator' for terrestrial biodiversity (MfE 1999). On its own, this particular indicator is not very useful for plantations because kiwi occur in only a small fraction of plantation forests (Kleinpaste 1990), and they would have no use in regions such as the Canterbury Plains where kiwi are about as abundant as white rhinos. Another problem with such an approach is that the occurrence or abundance of one species or higher taxon rarely correlates with that of another (Thiollay 1992, Lawton *et al.* 1998).

The common approach of simply using species richness as an indicator is flawed because there is not necessarily any relationship with conservation value or sustainability (Bunnell and Chan-McLeod 1998) and, because species richness increases with the size of the area surveyed, it is not very informative without appropriate reference. Furthermore, different land uses cause varying responses in different groups of organisms (Lawton *et al.* 1998). This is highlighted by results of

several studies of biodiversity in New Zealand plantation forests. Assessing nematodes, Yeates (1999) established that plantation forest habitats are 'worse' for biodiversity than pasture. On the contrary, when indigenous birds, vascular plants, or insects are assessed (Clout and Gaze 1984, Allen *et al.* 1995, Hutcheson and Jones 1999), plantation forests score well, especially compared with pasture. For example, Harris and Burns (2000) found not a single indigenous plant in Waikato pasture. Obviously, more than one group of organisms needs to be examined to permit objective conclusions.

Biodiversity indicators for policy makers have been compiled by Reid *et al.* (1993). These range from the number of threatened species to the area under protection, and could have increasing relevance to plantations. For managers of British forests and plantations, Ferris and Humphrey (1999) recommend the use of a combination of 'compositional' indicators such as the extent of broadleaved plants, and 'structural' indicators such as the quality and quantity of deadwood. We are in the process of examining various potential indicators for such purposes. Research to date demonstrates that indicators need to take account of the differences in flora and fauna across New Zealand's environmental regions. It would be difficult to conceive an indicator that was equally valid for the lush forests in the moist and fertile parts of the North Island and for the dry, slow-growing forests in the Canterbury Plains.

Which species occur in plantations, and how are they affected by forest management? Studies of plants and animals in plantations found a remarkable number of indigenous species living there (for details we refer to recent reviews by Allen *et al.* 1995, Maclaren 1996, Norton 1998). Previous studies provide much insight into which species can occur in plantations, but little direct evidence exists as to how their occurrence is affected by forest management, although this appears essential for assessing sustainability. Most studies have focussed on the central North Island plateau, and our knowledge of other regions is limited. Insects should not be overlooked when assessing sustainability. They represent approximately 65-85% of all species globally (Hammond 1992) and are widely used in biodiversity studies (e.g., Niemela *et al.* 1993, Lawton *et al.* 1998). In an ongoing study, we are examining how the diversity of understorey plants and insects varies geographically and how this is influenced by forest management. In surveys of only four plantation forests we have recorded a total of 270 vascular plant species, of which over 200 are indigenous (nearly 10% of the New Zealand flora), and about 370 mostly indigenous beetle species.

Another key issue is how forest management and harvesting can be conducted to minimise impacts on bird life without significantly affecting profitability. Some forest owners now collaborate with the Department of Conservation to determine how the protection of kiwi can best be integrated with forestry operations (Ray Pierce, pers. comm.).

Does biodiversity decline with each rotation? There are concerns about whether biodiversity will decline over successive rotations, because of a depletion of the seed bank and other possible causes, but comparisons of stands in different rotations (Allen *et al.* 1995, Brockerhoff *et al.* 1999) suggest that the risk is minor. The diversity of vegetation in plantations that replaced indigenous forest or shrubland is likely to decline to some degree until an equilibrium is reached, whereas diversity will increase significantly in plantations established on former pasture (Schipper 1996). These observations are important in relation to perceptions that biodiversity is lost after harvesting. Our research suggests that there is only a temporary decline (Fig. 2) and that even recently harvested stands provide habitat for indigenous species, albeit different ones. Furthermore, because most plantations consist of many stands where harvesting occurs at different times, there should always be stands with desirable levels of plant biodiversity. However, much of our evidence on spatial aspects and the development of biodiversity over successive rotations is based on relatively few observations and mostly 'indirect' comparisons of different stands in different rotations. More research and long-term monitoring are needed to verify these observations and to establish whether current biodiversity levels are likely to be maintained in future.

Plantations and biodiversity at the landscape level. Understanding the relationships between plantations and other land uses requires more research, particularly at the interface between protected areas and plantations (Fig. 1). Suggestions on how plantations could contribute to the protection of biodiversity at the forest/landscape scale include concepts such as provision or maintenance of

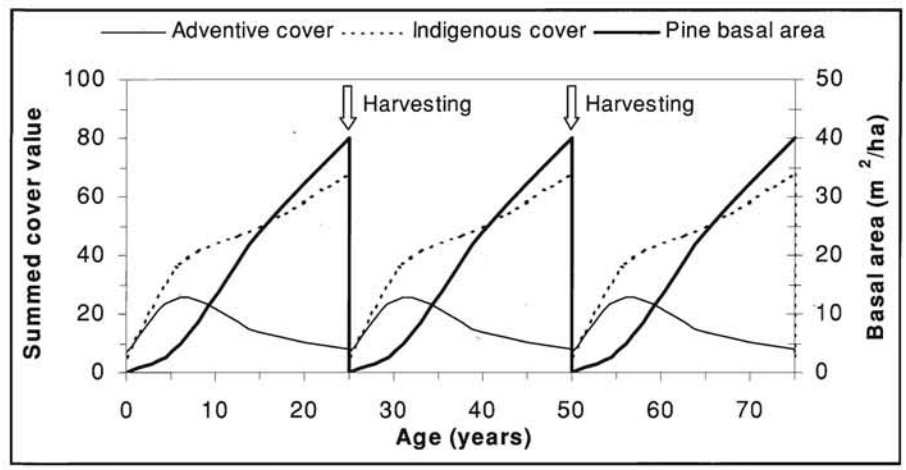

Fig. 2. Schematic development of the understorey vegetation at a hypothetical 'balance' state (shown as summed cover values for adventive and for indigenous understorey plants) in relation to basal area of a New Zealand *Pinus radiata* plantation over three rotations.

2000), although many of these concepts are still philosophical (e.g., Simberloff *et al.* 1992) and have not yet been critically examined in the New Zealand plantation context.

Science, policy and realisation. Greater linkages between scientists, policy makers and forest managers are needed, as outlined by Maini (1998), to achieve useful outcomes. Surprisingly, recent policy documents such as the Biodiversity Strategy (DoC/MfE 2000) and 'Biowhat?' report (MfE 2000a) read as if how to manage biodiversity in production landscapes is well-known and say little about any specific research needs relating to 'sympathetic management' of production landscapes. Future policies should state more clearly what is meant by biodiversity, and what actions are needed when. Finally, the co-operation of forestry companies and private landowners will depend on the way these policies will be implemented and whether Government will be able to provide some support for measures that incur costs. At the same time, a willingness to include biodiversity considerations in forest management guidelines could be rewarded in other ways such as better access to international markets, fetching premium prices, an improved public image, and greater harmony with an environmental movement that might now be diverted from criticising indigenous forestry.

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