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Recent Findings on the Environmental Impacts of Planted Forests in New Zealand

Summary

To demonstrate the sustainability of forestry practices it is necessary to understand the environmental effects of forests and the ability to measure these effects over time. Many of these short- to long-term environmental impacts were described in Maclaren's 1996 Bulletin on "Environmental effects of planted forests in New Zealand", but there has been substantial research since that publication.

This is a summary of recent literature on the positive and negative environmental impacts of planted forests in New Zealand. Key results are as follows:

- Biodiversity - plantations provide a habitat suitable for a wide range of indigenous forest species, both aquatic and terrestrial.
- Water yield - afforestation can reduce peak catchment flood flows by up to 50%.
- Water quality and leaching - planted forests have the lowest potential for nitrate and phosphorous leaching with levels similar to indigenous forests.
- Sediment yield - afforestation of whole catchments can reduce sediment load to waterways by 50-90%.
- Soil erosion - recent research provides further support that plantations mitigate soil erosion.
- Impacts on soil nutrients – the high level of soil organic N present in established pastures decreases markedly when the pasture is planted in pine forest.

This information is relevant to forest managers needing to manage the environmental effects of their trees, and provides the baseline for further research. For the Forest and Environment FRST programme the information will contribute to planning research on indicators of sustainability.

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Introduction

The ability to demonstrate the sustainability of New Zealand forestry practices requires many complimentary activities. An important component is the understanding developed over many years of research on the effects of forestry. This knowledge can inform research aimed at measuring the extent and trends of these effects, where such measurements form a cornerstone of determining sustainability.

Maclaren (1996) provided a comprehensive overview of the environmental effects of forestry which still stands to date. Water yield and quality, soil erosion and deterioration, effects on biodiversity, and socio-economic effects are among the topics covered. The NZIF Forestry Handbook (NZIF, 2005) also includes a number of the effects of forestry in New Zealand. This summary presents some of the key findings subsequent to the original publication.

Biodiversity

Research on the biodiversity in plantation forests increasingly supports that plantations provide a habitat suitable for a wide range of indigenous forest species (Pawson & Brockerhoff 2005), though native birds within planted forests are predominantly insectivorous species or seed eaters (Spurr and Coleman 2002). The New Zealand falcon has adapted extremely well to the mix of tall trees and open spaces found in plantations with different stand ages (Seaton et al 2009). In another instance where significant historic loss of forest habitat occurred in Canterbury, exotic pine forests play an active role in the conservation of a critically endangered ground beetle (Brockerhoff et al 2005).

Even large size clearfells do not appear to constrain the recolonisation of these large open areas by relatively rich invertebrate communities. On re-establishment of forest cover, the forest specialist species gradually develop similar communities to those that existed before harvesting (Pawson et al. 2006). Brockerhoff et al. (2003) provide support that

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the vegetation of previously clearfelled areas tends to recover to pre-harvesting levels under a new rotation.

Aquatic biodiversity under planted trees has been found to be no different to that found under indigenous forestry as long as riparian strips are not felled (Quinn et al. 1997, 2004). The diversity of stream invertebrates is greater in planted pine forests compared to pasture (Quinn et al. 1997) as the diversity of the levels of shade is greater in planted pine forests compared to pasture (Davies-Colley and Quinn 1998). The diversity of litter inputs of planted pine forests into stream (Scarsbrook et al 2001) provides a greater diversity of associated aquatic habitat in planted pine forests compared to pasture (Baillie and Davies 2002).

Planted Forests and Waterways

With the supply of clean water rising in importance and the concerns about the central North Island lakes there has been additional research on factors affecting freshwater in New Zealand which greatly enhanced the knowledge base. Some important recent findings are described.

Water Yield

Davie and Fahey (2005) provide a concise review of the issues relating to water yield from forests and the impacts of afforestation, including on low flows. They found that afforestation positively benefits catchment flood peak flows, potentially reducing them by up to 50% (Fahey et al. 2004).

Water Quality

Planted forests have the lowest potential for nitrate leaching with levels similar to indigenous forests and similarly for phosphorous (Davis 2005; Hamilton 2005; Meneer et al 2004). Planted trees as riparian zones lower the nutrient outputs in catchments (Burt and Pinay 2005).

There is concern that deforestation in the Waikato will result in water quality declining given that water quality from planted forests is of greater value than that from pastoral and urban landuses (Larned et al. 2004). Concerns about water quality have also been raised regarding deforestation in Canterbury where this change will increase movement of water and of more concern will increase the movement of nutrients into groundwater (Watson et al. 2004).

Leaching

Water draining from established forest plantations contains only low levels of leached nitrogen (Table 1, after Menneer et al 2004) with the potential to decrease post harvesting with the increase of weed growth (Parfitt et al 2002). Table 2 is an example of the magnitude of leaching differences between land uses at the national level.

Land use	kg N ha-1 yr-1
forestry	3
sheep/beef/deer farming	6-66
arable/mixed cropping	35-110
dairy farming	up to 115
vegetable cropping	177

Table 1. N losses from different land uses in New Zealand (Meneer at al 2004)

Land use	nitrate-N (Gigagrams)
pasture	246
crops	17
native forests and shrubland	14
plantation forests	2

Table 2. Estimated annual runoff and leaching of nitrate-N in soils (Parfitt et al 2006)

Sediment Yield

Afforestation of whole catchments can reduce sediment load to waterways by 50-90% (Hill and Blair, 2005). Specific examples include the reforestation of soft rock terrain in the headwaters of the Waipaoa River catchment in the East Coast region of New Zealand reducing gully-derived sediment yields (Marden et al., 2005). At Pakuratahi on the erodable hill slopes there was a 65% reduction in sediment yields compared with pasture (Fahey et al 2003).

Soil Erosion and Plantations

Recent research has provided further support that plantations mitigate soil erosion. Trees strengthen soils through the binding effects of developing root systems in surface soils (Marden 2004; Phillips and Marden 2005), though the effectiveness of planted trees (either exotic or native) for erosion control is dependent on tree species, site characteristics, stocking rate and rotation age (Halliday and Knowles,

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2003; Knowles, 2006; Phillips and Marden, 2006; Phillips et al., 2008). While the risk of erosion increases during forest harvesting and re-establishment of the next rotation, this can be managed by the application of specific logging techniques and riparian buffers around waterways (Healey et al, 2000; Fahey et al., 2003; Hill and Blair, 2005; Phillips et al., 2005; Eyles and Fahey, 2006; Marden et al., 2006).

Trees also reduce the erosion of soil by wind and indeed afforestation enhances dust deposition on degraded eroding rangeland in the Central South Island (McGowan and Ledgard, 2005).

Impacts on Soil Nutrients

There is an increasing body of knowledge on the effects of different land uses, including plantations, on soils nutrient levels. For example, Sparling and Schipper (2002, 2004), Sparling et al (2004), Ross et al (1999) and Parfitt et al (2003) provide detailed soils differences and results. The mitigating effects of plantations is also increasingly better understood with the high level of soil organic N present in established pastures decreasing markedly when the pasture is planted in pine forest (Parfitt et al., 1997; Smaille and Clinton, 2009).

Conclusion

This brief overview, while not exhaustive, gives a flavour of the increased understanding of the environmental impacts of planted forests.

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