

POTENTIAL OF WESTLAND'S MORAINIC SOILS FOR FOREST MANAGEMENT

R. J. COKER*

SYNOPSIS

More than 160,000 ha of lowland areas of the West Coast of the South Island of New Zealand consist of soils derived from outwash gravels or ice contract deposits of Pleistocene age. Over half this area is State forest land—much of it derelict following colonial-type exploitation of the high volume indigenous forests it once carried. Fires, excess surface water, lack of seed trees, and exposure have contributed to poor regeneration of podocarps, and to a large extent these areas are wastelands with no definite management policy.

Management of the remaining well-forested terraces is being mastered by selection logging techniques which allow production without further contributing to management problems.

An evaluation of species on the better sites in Mahinapua State Forest, which was planted with exotics during the late 1920s and early 1930s, indicates that these soils have potential for exotic production forest provided that only better sites are utilized and a silvicultural regime is adopted which maximizes diameter growth.

INTRODUCTION

There is sufficient hill country suitable for conversion to exotics within a 48 km radius of Greymouth to establish an estimated 46,500 ha of exotic forest (Molloy, 1970). Assuming a mean annual increment of 26 m³/ha, the production potential from this area could be as high as 1.21 million m³ per annum, or four times the current maximum annual cutting rate for indigenous softwoods within Westland Conservancy. The potential is much greater when the radius is extended further, and it is small wonder that the poorer terrace soils have been accorded a very low priority in the conversion programme. Plantings on these soils have so far been either experimental, as in Mahinapua State Forest (established between 1923 and 1939), or as stop gaps in years when weather was unsuitable for burning in preparation for planting on hilly areas.

DEFINITION OF AREA

Most lowland West Coast soils have a glacial origin. The term "morainic" refers to those rolling terrace lands, characterized by poor soils of the Waiuta-Okarito complex, having their genesis as ice contract deposits or outwash gravels of Pleistocene age (Suggate, 1965); Suggate and Moar (1970). The limitations of these soils for management after clearfelling have led to the development of selective logging techniques

*Forester, New Zealand Forest Service, Hokitika.

aimed at perpetuating an indigenous log supply. A large proportion of the total area has already been cut over and presents a management problem, because it has failed to regenerate to merchantable species, and also failed to respond to conventional "match farming" techniques so that after burning it offers only marginal extensive grazing. More than 55% of this area is State forest land in Westland, Grey, Buller and Inangahua counties.

CURRENT MANAGEMENT

At present there is no firm management policy for these morainic soils, but the general policy for Westland is stated by Molloy (1964) in the form of four principles:

- "(1) All land suitable for agriculture will be released for farm development.
- "(2) All land not suited to agriculture but on which podocarp forest or beech forest will regenerate and develop successfully will be managed for that purpose.
- "(3) All land unsuited to agriculture, but on which exotic trees will successfully establish, will be converted to exotics.
- "(4) Experimental work—*e.g.*, species, drainage and fertilizer trials—will be continued on cutover degraded land to determine its best form of rehabilitation."

Large tracts of forest on these morainic soils have been cut over because of relatively easy access and because the original stands had high volumes of merchantable timber, up to 325 m³/ha, predominantly rimu. Because of high volume and dense stocking, very little was left standing after clearfelling except patches of pole-sized rimu and occasional mature trees considered too defective to extract. These isolated trees were subsequently largely destroyed by indiscriminate fires and exposure. Much of the land was burnt after logging and some has been repeatedly burnt, so that any advance or seedling growth of podocarps was destroyed. The better sites now carry a fire-induced association dominated by bracken, while poorer sites carry stunted manuka and twiggy coprosmas, often called "black scrub". Only in small localized areas, where fires have not penetrated, has some regeneration occurred, but overall no area of any consequence could be considered well stocked.

SOILS AND GEOMORPHOLOGY

Morainic soils (as loosely defined in this paper) include the oldest high terrace supporting true "pakihi" vegetation through to the most recent morainic detritus of the Moana formation. The extensive high terraces of the Cockeye formation occur almost exclusively north of the Arahura River. South of this extensive high terraces are absent, perhaps having been obliterated by piedmont glaciation on the narrower part of the region. Rolling terrace deposits occur south

from Arahura on the coastal plain, but to the north of this the rolling terrace soils occur inland and between the higher terraces. The resulting soils show a complete range of growth potential, from that of true "pakihi" sites to that of the more fertile hill soils, which is related to soil age and physical properties.

Generally the fertility of terrace soils decreases with increase in age of the formation they lie upon, due in part to the period of leaching, and also due to the fact that all terraces older than the Kumara 3 advance have a liberal coating of relatively impermeable wind-blown loess (Young, 1967).

The principal soil types where loess is known to be the parent material are Waiuta loam, Kumara loam and Okarito fine sandy loam, which together make up the morainic terrace soils. Young shows that the association of thick loess deposits with Okarito and Waiuta soils is clearly established, and it seems probable that development of these soils has been influenced by the texture of the loess. If this is so, internal drainage, rather than surface runoff, is required for amelioration of soil conditions. At present, however, the effects of deep ripping or cultivation on internal drainage are a subject for conjecture.

SOIL DESCRIPTIONS

Waiuta loam (N.Z. Soil Bureau, 1968)

Glacial till and outwash occurring as rolling morainic downs and undulating terraces.

- 10 cm dark brown fine sandy loam; friable.
- 20 cm pale olive grey to pale olive mottled orange massive fine sandy loam; firm.
- 23 cm brown-yellow mottled orange and dark brown heavy to fine sandy loam; firm.
- on stones and boulders in yellow-brown sandy matrix.

Kumara loam

Flat, low outwash terrace.

- 8 cm very dark brown granular peat.
- 10 cm very dark grey brown structureless loam; spongy.
- 30 cm pale brown-grey massive loam; firm.
- 8 cm granite and greywacke stones in dark brown humus matrix.
- on iron cemented gravels.

Okarito fine sandy loam

Flat to very gently undulating intermediate and high terraces.

- 1½ cm loose leaves and rimu needles.
- 5 cm dark red brown granular peaty loam; spongy.
- 20 cm dark grey-brown structureless loam; slightly sticky.
- 18 cm greenish grey massive stony gritty loam; firm.
- 18 cm very dark brown stony gritty sandy loam; non-sticky.
- on grey gravelly sand with dark red brown hard cemented pans.

POTENTIAL MANAGEMENT

High-volume podocarp stands on these terrace soil types are currently being managed by selection logging techniques. However, some areas with Waiuta soils are being clearfelled, although the limitations for management were pointed out by both Kennedy (1954) and Chavasse (1954). The alternatives appear to be either to extend selection logging on to rolling downs or to discontinue logging on these difficult soils.

Cut-over areas with these soils present a difficult problem, for reasons already described. If regeneration of podocarps is attempted, this will commit the land for 300 to 500 years, in the early stages of which fire control would be a formidable task, as the areas are extensive and unroaded. The Lands and Survey Department has recently developed a technique for the conversion of morainic soils to grassland. This involves the addition of 1,500 kg of lime, 500 kg of superphosphate (with trace elements) and oversowing with 9 kg of grass seed per hectare. Mob-stocking aids the breakdown of spongy water-retentive organic surface layers, thereby increasing effective runoff. Initial costs are relatively high. Sustainable grazing potential is considered to be about 10 stock units per hectare (A. C. R. Elcock, Senior Field Officer, Lands and Survey Department, Hokitika, pers. comm.). A third alternative form of management is, however, possible, at least on the better Waiuta soils; that is, conversion to exotic forest crops.

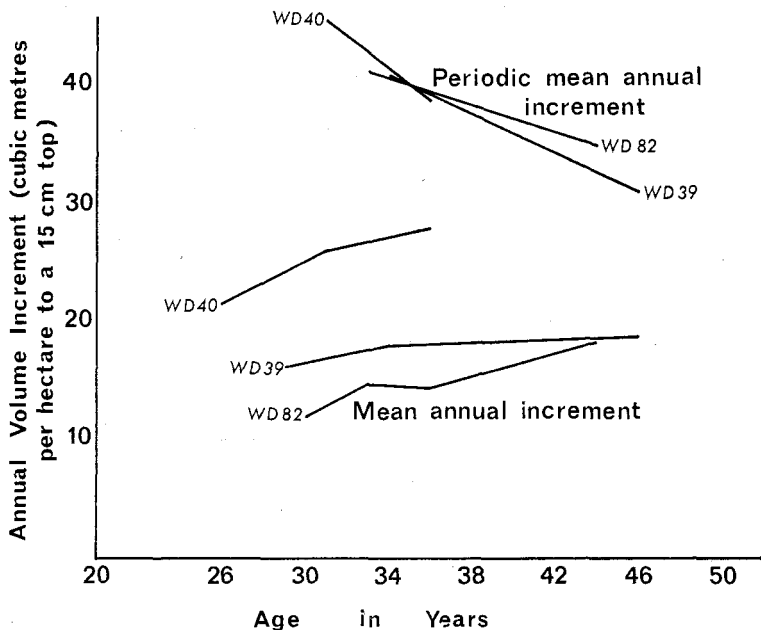


FIG. 1: Age and volume increment for three radiata pine sample plots in Mahinapua Forest. (The prefix WD refers to Westland Conservancy.)

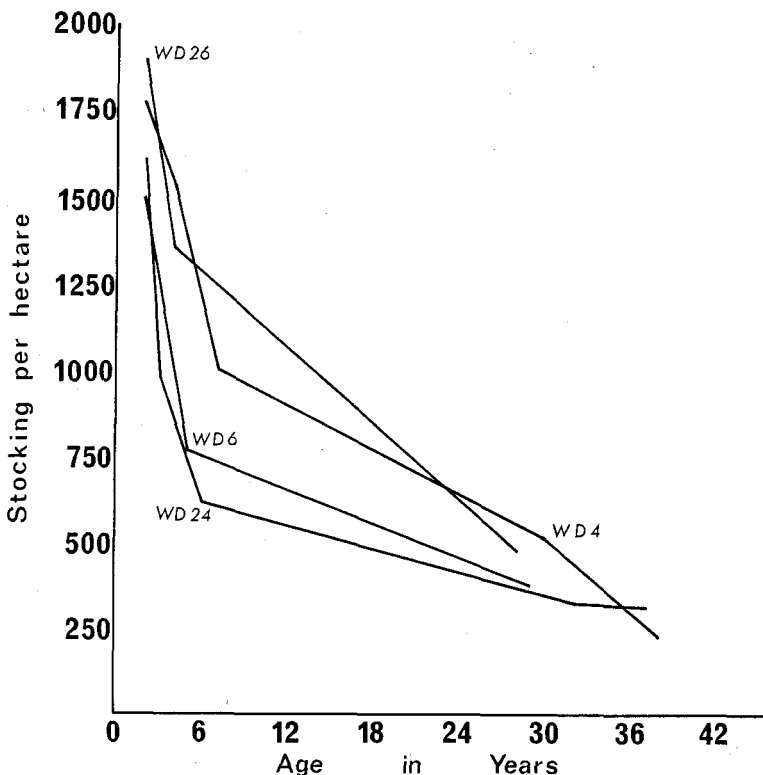


FIG. 2: Age and stocking per hectare for four sample plots in radiata pine established in the early planting phase in Mahinapua Forest.

EXOTIC PLANTING IN MAHINAPUA FOREST

It was logical to assume that soils which had yielded high volumes of indigenous timber should be suitable for successful growth of exotic trees, but Mahinapua Forest plantings have largely been considered a failure; they have even been described as "an exotic nurse crop for indigenous regeneration". After relating the better stands to soil types, it appears that Waiuta soils are, however, suitable for the growth of *Pinus radiata* and *P. muricata* at least. On the better sites, heights from 18 to 24 m were achieved in 20 years (site indices of 60 to 78 ft; Lewis, 1954). Examples of volume production on these sites, for sample plots with good stocking, are shown in Fig. 1.

Reasonable growth occurs on Okarito soils only where lateral drainage is good—for example, on banks of streams—but generally these soils offer a very shallow rooting medium, and windthrow is not uncommon. Over extensive areas of Okarito soils, growth of radiata pine is very poor.

Soon after planting commenced in Mahinapua Forest in 1923, it was found that western red cedar (*Thuja plicata*)

survived well even on poor sites. This is still generally true; survival is good but growth on all except the best sites is meagre. Fertilizer applications have failed to increase growth significantly.

Some stands of radiata pine have recently been logged; about 3,000 m³ have been taken from 8 ha during the past two years in compartment 12, which is a mosaic of Waiuta and Okarito soils. Yield is therefore below 350 m³/ha at 43 years—an m.a.i. of approximately 8.3 m³/ha/yr.

POTENTIAL OF RADIATA PINE ON MORAINIC SOILS

From sample plot records it appears that plantings were originally made at 2.4 × 2.4 m spacing. Mortality in the first few years due to competition from bracken and deaths from *Armillariella* appear to have been severe. Changes of stocking with age are shown in Fig. 2.

The only data for a fully stocked stand are from an area of one hectare planted in 1966. From this has been projected the probable development of an unthinned stand of radiata pine with a site index of 70 ft (Beekhuis, 1966). This stand has also been used as basic data to project the probable development when two early thinnings, at 8 and 12 years, respectively, are undertaken. Supporting information for

TABLE 1: SOURCES OF INFORMATION FOR ESTIMATING THE PROBABLE DEVELOPMENT OF FULLY STOCKED STANDS OF RADIATA PINE ON MORAINIC DOWNS

Sources	Details		
Sample plots	WD 40 — site index 78 ft		
	WD 82 — site index 70 ft		
	WD 4 — site index 63 ft		
	WD 39 — site index 60 ft		
The 1966 radiata pine assessment, Mahinapua Forest	<i>All plots with site index greater than 60 ft</i>		
	<i>Mean s.p.ha</i>	<i>Mean dbh (cm)</i>	<i>Age (yr)</i>
	247	47	40
	255	48	38
	273	47	37
	322	52	42
Stands thinned to low stockings	<i>Mean s.p.ha</i>	<i>Mean dbh (cm)</i>	<i>Age (yr)</i>
Nemona Forest			
Compartment 31	370	29	19
Compartment 32	544	19	14
Basic data from Compartment 8, Mahinapua Forest	<i>Mean s.p.ha</i>	<i>Mean dbh (cm)</i>	<i>Age (yr)</i>
	2890	6	7

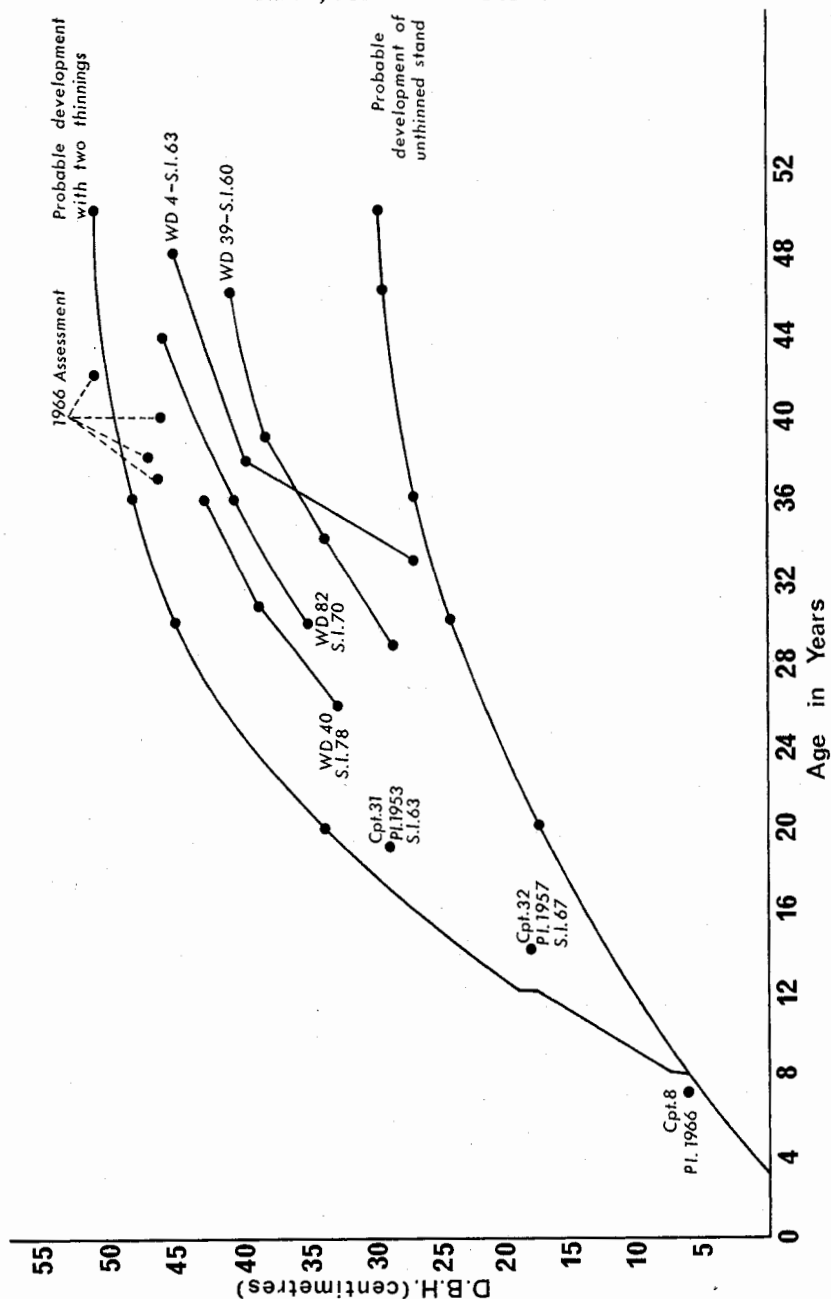


FIG. 3: An indication of the probable development of dbh with age in fully stocked stands of radiata pine (thinned and not thinned) related to evidence available, on morainic downs with Waiuta soils. (Pl. indicates year planted; S.I. indicates site index, in feet, of plots quoted in Table 1.)

diameter growth in both thinned and unthinned stands is drawn from the several sources noted in Table 1, and is shown in Fig. 3.

It would appear from this that reasonable growth can be obtained, provided soils are chosen with care, suitable stocking is maintained in early years, and early thinning is undertaken to promote diameter growth.

CONCLUSIONS

On this basis there are several possibilities for the management of cut-over areas on morainic rolling country. The land could be converted to pasture by intensive methods and used for farming; or alternatively it could be used for exotic forestry. There seems little point in attempting to regenerate merchantable indigenous species, while abandonment cannot, in the long run, be justified. An untried possibility would be a combination of forestry and farming by intensive methods. Growing radiata pine on these sites has some advantages. Branching is light, and 95% of the land can easily be worked with tractors or skidders. The main disadvantages are relatively slow growth rates compared with the hill country soils, and the patchy nature of the soil distribution, which can be complex even in small areas. Whether this can be rectified by suitable methods of site preparation, such as intensive deep ripping, is at present unknown. Nor can it be ruled out that future pressures could lead to some justifiable, but at present unforeseen, use of this land.

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