# *Pinus radiata* site index rankings for New Zealand

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## ABSTRACT

*A national assessment of the relative suitability of land for Pinus radiata is presented using site index as the measure of site quality. The physical base for the assessment was the land use capability units of the New Zealand Land Resource Inventory.*

*The data indicate that 12% of the North Island and 44% of the South Island are unsuited to Pinus radiata while 24% and 6% respectively have a site index greater than 29 metres.*

## INTRODUCTION

Most foresters are well aware that great care needs to be taken when using site index to predict timber yield at the local level, but at the regional and national level it is a suitable measure of productivity. In this paper the results of a regional and national assessment of the relative suitability of land for *Pinus radiata* are presented. Site index is used as the measure of site quality.

The physical base for assessing site index was the land use capability unit (LUC unit) of the New Zealand Land Resource Inventory (NZLRI) (NWASCA 1975-79). The site index value for each LUC unit was collected as a combined exercise involving foresters of the New Zealand Forest Service and the NZLRI mapping team between 1979 and 1981.

Site index was chosen as the measure of site quality, because it is the commonly accepted measure throughout New Zealand and is a term commonly understood by other land orientated professional groups such as soil conservators. *Pinus radiata* was chosen due to its predominance in exotic forestry in New Zealand. Its use, however, did mean that specialised habitats such as wetland or high altitude areas could be downgraded or assessed as unsuitable, even though the sites could be suited to other tree species. Modern standards of silviculture practice (including current cultivation and fertilizing practices) were assumed to be in use, with these being applied regionally.

'Suitability' was the site index value, with high site index values having a high suitability. Areas considered physically unsuited to exotic forest (e.g., LUC Class VIII land) were ranked as 'unsuitable' together with areas with very low site indices. Economics was not considered.

## BACKGROUND

Kirkland (1981) provided a national overview of land available for exotic forest planting. As a base for the study, he used the New Zealand Land Resource Inventory (NWASCA 1975-79). He excluded areas such as protection land (LUC class VIII), wetlands in LUC classes VI and VII, slopes over 35°, and various vegetation types. This left an area of about 15.5 million ha. Map units comprising this area were then grouped into categories according to suitability for afforestation based on size, LUC class and land cover. Hunter and Gibson (1984) developed a model to relate *P. radiata* site index to physical variables such as soil depth, strength, nutrient concentration and climate factors such as average temperature and annual rainfall. When tested on 299 permanent plots throughout New Zealand this model generally behaved reliably, indicating that it should prove useful in providing an initial assessment of site index and hence 'suitability' of land for *Pinus radiata* in those areas whose site index is not known from trials.

The present study aims to provide a national and regional assessment of site index for *Pinus radiata*. Such assessments, however, are not intended as a substitute for detailed on site planning.

## DATA COLLECTION PROCEDURE

The NZLRI contains eleven regional LUC classifications (Fig 1) — the ten covering the North Island have been correlated (Page, 1985). The separate LUC classifications contain 925 (correlated to 662) land use capability units. These represent groupings of inventory units which, at the scale of mapping, were considered to be physically similar, to have the same potential productivity and management requirements and to require the same soil conservation measures (SC & RCC 1969). Brief descriptions of the LUC units are provided for each region in Extended Legends (e.g., Fletcher 1981) and in regional LUC Bulletins (e.g., Noble 1985). The LUC units can therefore be used as a base for extrapolation of interpretive data, regionally or nationally.

Site index values were assessed for each landuse capability (LUC) unit in the NZLRI. Within each Island, standard assessment procedures for assessing site index were followed (with only minor exceptions). In the North Island, foresters in each NZFS Conservancy provided the site index data. At sites typical of each LUC unit, each forester assessed the site index. Where these data were available from permanent growth monitoring plots within the LUC unit they were used. Where they were not, a best professional estimate was provided. The procedure was repeated for a number of sites in the same LUC unit. In the few places where access to LUC units was not possible, colour slides were used to illustrate the land. After collation by a member of the NZLRI team, the data were reviewed to check consistency with similar LUC units. The data were then returned to the NZFS Conservancies for confirmation. At this stage the forester could modify the data either from further reference to any permanent plot information, or after reviewing the total set of regional figures. The data were then incorporated into the NZLRI data base.

In the Bay of Plenty-Volcanic Plateau region a modelling approach was used (Mountfort, 1979) to assess site index. This related site index to altitude on tephric soils with modifications as required for atypical sites.

Once site index values had been collected for each of the ten regional (LUC) classifications (Fig. 1), values were reviewed in terms of the North Island LUC Regional Correlation (Page, 1985) to check for anomalies. These were referred back to the NZFS Conservancies for verification and modification as appropriate.

In the South Island, LUC units were first grouped within each NZFS Conservancy according to characteristics influencing tree growth; particularly climate (rainfall and temperature), altitude, topography and soils. Representative map units from within each LUC unit grouping (where possible already supporting or close to exotic forests) were selected and

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conservancy foresters gave an assessment of site index. Within state forests and many private forests, site index values were assessed from plot data and these were used as reference points. Field inspections were not normally carried out.

Finalized site index values were stored as part of the NZLRI database on the Vogel Computer Centre IBM 3081 computer and are available on request.

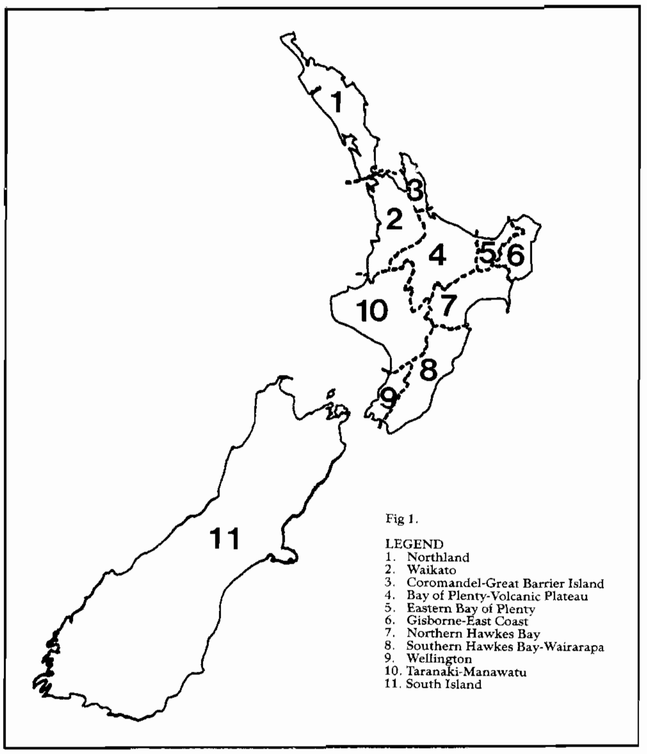


**FIGURE 1: Land use capability classification regions.**

## VARIABILITY OF THE DATA

Variability in the accuracy of the site index data could be attributed to three main causes:

1. The paucity of quantitative site index data available. In many areas the amount of plot data was small and the assessments although based on professional experience were only 'best estimates'.
2. The physical variation within the NZLRI LUC units mapped at 1:63,360 scale. To minimize this, only the site index of 'type' (i.e., typical map units within each LUC unit) was assessed. The exception to this was the Bay of Plenty-Volcanic Plateau LUC region, where the altitudinal range of each LUC unit was assessed. This resulted in a wider spread of site index values than in other regions.
3. Observer variation between foresters. This variation was minimized by ensuring that different foresters assessed a proportion of the same LUC unit and by referring all compiled regional data back to Conservancy headquarters for review.

In recognition of these limiting factors the site index was recorded as a range rather than as a single figure. In most LUC units the range was limited to 3-4 metres but in LUC units with significantly varying relief the extreme was 10m.

## DISCUSSION

Figs 2a and 2b indicate the range of site index median values recorded. The values ranged from a high of 38 in the Bay of Plenty to less than 15m, mostly in the eastern South Island high country. In the Southern Hawkes Bay-Wairarapa and Taranaki-Manawatu regions (regions 8 and 10 in Fig. 1), areas with site index less than 20 were recorded as unsuitable. This area was not significant, however, because such areas amounted to only 21,000 ha. The area of each group of site index values is given in Table 1 for both the North and South Islands.

TABLE 1: Site index (*Pinus radiata*) *rankings for the North and South Islands*

| *SITE INDEX* | *NORTH ISLAND* | | *SOUTH ISLAND* | |
|---|---|---|---|---|
| *m* | *ha* | % | *ha* | % |
| >29 | 2,786,100 | 24.3 | 237,700 | 1.6 |
| 25-29 | 6,063,900 | 53.0 | 902,100 | 6.0 |
| 20-24 | 1,045,700 | 9.1 | 3,847,700 | 25.4 |
| 15-20 | | | 2,226,700 | 14.7 |
| | 141,200 | 1.2 | | |
| <15 | | | 1,313,700 | 8.7 |
| Unsuitable | 1,155,200 | 10.0 | 6,097,200 | 40.3 |
| Towns, rivers etc | 255,400 | 2.2 | 505,100 | 3.3 |
| | 11,447,50 0 | | 15,130,200 | |

To simplify computer analysis, the site index value for each of the 925 LUC units was taken as the median of the assessed range of values for that unit. These were then combined into five groupings for the North Island and six for the South Island (Table 1 and Figs 3 and 4). The addition of the sixth South Island grouping was in recognition of the lower site index values recorded in that Island. (Note: the 6th grouping was omitted from Figure 4 to ease presentation.) These groupings were also used in the King Country Land Use Study (1978) but with the 'low' site index further subdivided.

TABLE 2: Land Unsuitable for *Pinus radiata*

| | North Island | | South Island | |
|---|---|---|---|---|
| LUC Classes I to VII | ha | | ha | |
| Floodplains and swamps with impeded drainage | 105,400 | | 89,510 | |
| Stony and flood prone floodplains | — | | 75,890 | |
| Saline areas | 13,700 | | 5,460 | |
| High altitude land | 20,200 | | 806,180 | |
| Mountain land | 22,600 | | 241,660 | |
| | | 161,900 | | 1,218,700 |
| LUC Class VIII (Protection Land) | 993,300 | | 4,878,500 | |
| | | 1,155,200 | | 6,097,200 |

The most significant inter-island difference in the site index values is the disparity in areas suitable for growing *Pinus radiata*, with 88% of the North Island being suitable as compared with only 57% of the South Island. In table 2 the unsuitable areas are grouped into five categories. The area of class VIII land is also shown: on such land physical hazards are considered to be such that use should be restricted to catchment protection rather than on site economic gain. On the LUC Class I to VII land in both Islands the main causes for land not being suitable are: high altitude (land higher than 1000 m.a.s.l. was considered unsuitable for *Pinus radiata*) and soil wetness. Wetlands were considered unsuitable when the water table was at or near the surface for a significant portion of the year. Some areas of very steep hill country were not suitable due to slope angle, low fertility, shallow soil depth or erosion hazard. Where such areas formed only a small part of a map unit they were not identified separately.

Site index values are generally much higher for the North Island than for the South Island (Fig. 2). The North Island pattern is relatively simple, with site indices greater than 25 on 77% of the land area. Site index values over 29 occur mainly on the pre-Taupo Formation tephras, on the free-draining alluvial surfaces and on low-altitude hill country. High rankings also occur on the eastern hill country north of Napier. Site index values are significantly lower in the South Island, where only 8% of the land area has a site index greater than 25m. These areas are restricted to higher rainfall, lowland districts. The 1.6% of South Island land area with the highest ranking (>29) is restricted to the West Coast and Nelson, and the land area with next highest rankings to the West Coast and Marlborough (and small areas of the North Canterbury sand country).

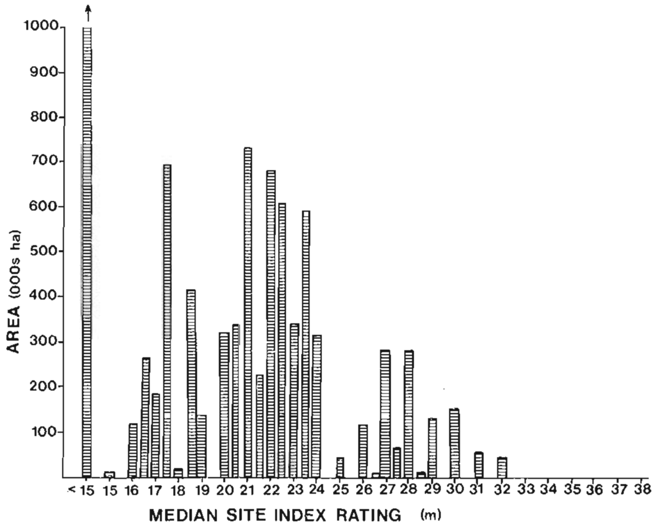


**Fig 2A. North Island areas of each site index grouping.**

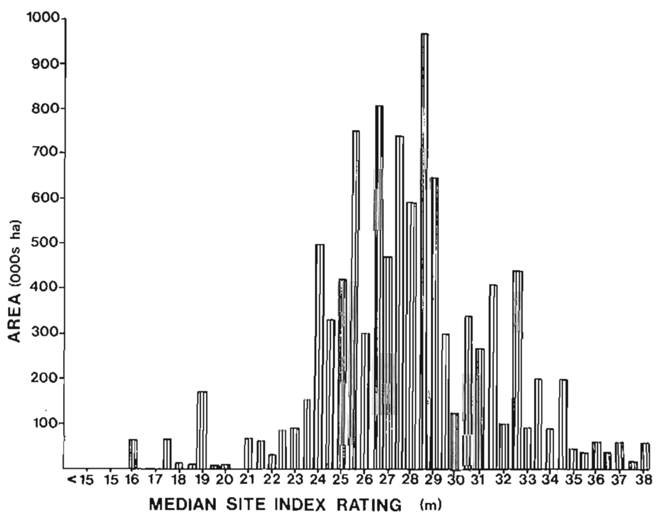


**Fig 2B. South Island areas of each site index grouping.**

In the extended legends for all regional LUC classifications (e.g., Fletcher 1981), forest suitability was subdivided into three groupings; production, erosion control and protection. Of these, only erosion control forestry is further discussed in this paper. In the NZLRI, erosion control forestry was taken to be exotic forestry that had erosion control as its principal function. In this case specific management procedures are required to minimize erosion (and water management) during establishment and harvesting. In the North Island 26% of land suitable for *Pinus radiata* was assessed as requiring erosion control forestry but only 11% of land in the South Island was similary assessed (Table 3). These differences reflect the greater extent of land in the North Island which is susceptible to mass movement erosion and the consequent need for forestry as an erosion control measure.

This paper has provided a broad analysis of the distribution of site index of *Pinus radiata* in New Zealand. A more

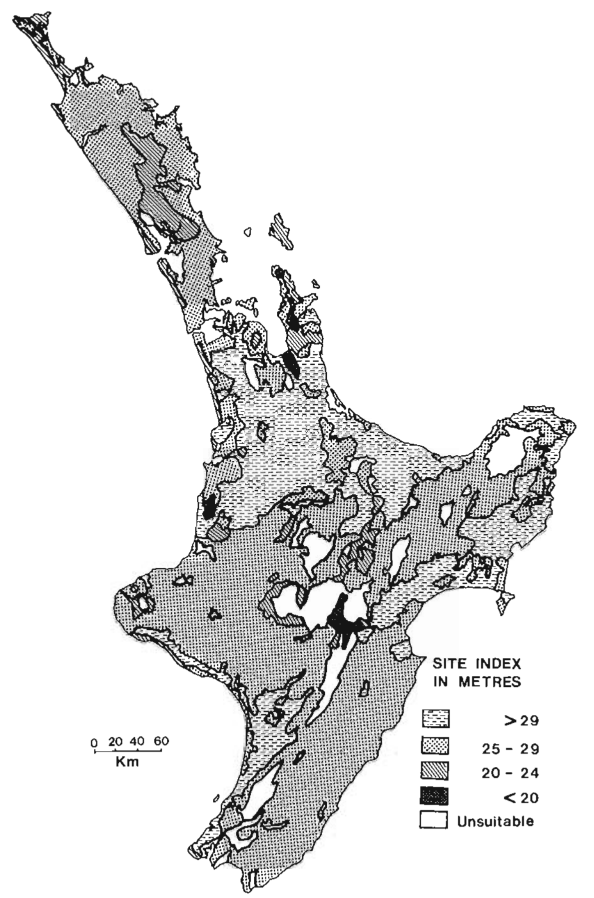


**FIGURE 3: Site index rankings for the North Island.**

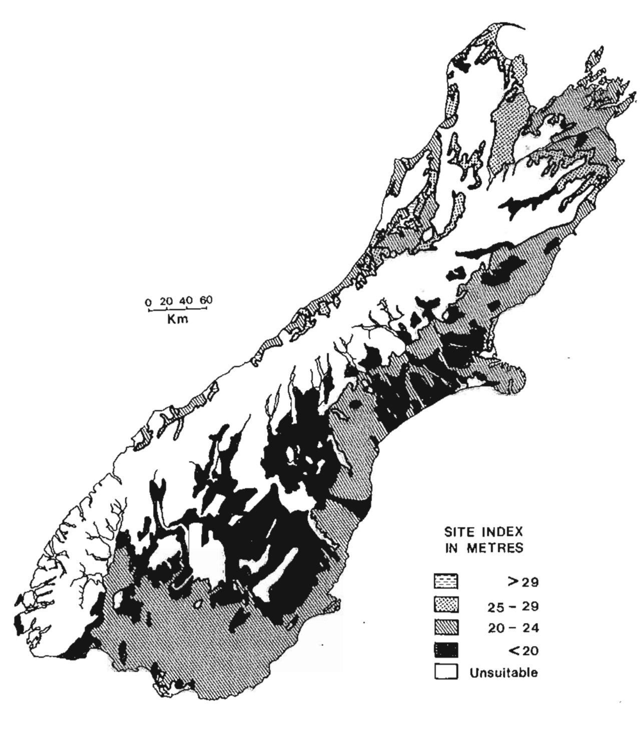


**FIGURE 4: Site index rankings for the South Island.**

detailed analysis of the relation between the site index values and environmental parameters in the NZLRI could be a fertile source of information, complementing more detailed studies such as those by Hunter and Gibson 1984.

TABLE 3: Areas in the North and South Island requiring erosion control forestry

| SITE INDEX m | NORTH ISLAND Area (ha) | NORTH ISLAND % of the site index group | SOUTH ISLAND Area (ha) | SOUTH ISLAND % of the site index group |
|---|---|---|---|---|
| >29 | 1,860,400 | 31% | — | |
| 25-29 | 281,600 | 10% | 344,400 | 38% |
| 20-24 | 362,200 | 35% | 284,300 | 7% |
| 15-20 | | | 47,200 | 2% |
| | 98,800 | 70% | | |
| <15 | | | 300,200 | 23% |
| | 2,603,000 | | 976,100 | |


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# Discount rates and forestry decisions


## Jeanette Fitzsimons



### ABSTRACT

*Net Present Value analysis, also known as Cost-Benefit analysis, has serious deficiencies as a framework for decision-making in forestry. It is argued that high discount rates do not reflect true social time preferences and lead to resource waste and disregard for the future. The principles of sustainability, end-use needs, and cultural and spiritual values are suggested as more useful, and neglected, tools in planning projects with very long-term implications.*


Economists have been telling me all my life that things I want to see accomplished, and which are generally agreed to be useful, are "not economic". I have reached the conclusion that if a project obviously makes sense in terms of resources, energy and human effort, and is "not economic", then it is the economic analysis which is wrong. I do not wish to argue for a discount rate of 10%, 5%, or 2% — but for a wider frame of reference and different criteria for making decisions.

Economics makes assumptions which are not always true in the real world, and which can lead to bad decisions. Some of them are:

- Price reflects value to society. This is now rarely true, in a world of constant government intervention in the market, manipulation of consumers by advertising, and the transition from a "free" resource provided by nature (virgin forests) to a planted one.
- Benefits which cannot be quantified are often acknowledged but must be left out of any numerical calculation. To include them in the criteria for decision making involves balancing a mix of precise numbers from the economic analysis with the qualitative analysis of other aspects. There is no scientific way of approaching this balancing.

> **"We need a broader definition of wealth, which includes the biological, social and cultural wealth on which economic wealth is based. These are fundamental not just to quality of life, but to survival. They will eventually have enormous economic effects, but in the meantime, economics cannot measure them."**

- Economics cannot deal with absolutes. It assumes everything has a replacement price, which is simply not true of the most fundamental resources in a finite world.
- It assumes the reason for forestry is to make money for the investors rather than to ensure a supply of appropriate timbers for the future.

We need a broader definition of wealth, which includes the biological, social and cultural wealth on which economic


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