THE USE OF SOIL SURVEY INFORMATION IN SIEVE PLANNING FOR FORESTRY: AN EXAMPLE FROM THE WEST COAST, SOUTH ISLAND

G. MEW* and A. D. JOHNSTON†

ABSTRACT

Sieve planning has not been described in detail previously as a method for aiding forestry planning in New Zealand. The stages leading to the production of a combination overlay that ranks potential uses or values for exotic forestry, indigenous forest management and recreation are outlined. Special emphasis is placed on the way in which information from soil surveys is used to derive the sieve overlay for exotic forest ranking.

INTRODUCTION

The concept of sieve planning outlined in this paper is a modification of that described by McHarg (1969). As a tool for guiding land-use decisions it has found widespread application in the United States for several years but has not been previously described in a practical forestry example from New Zealand.

Until recently the usual form of forestry planning has been through working plans or documents released to the public for discussion (N.Z. Forest Service, 1971, 1973; Kirkland, 1973) which have aimed at integrating all relevant information about the forests. These plans have included basic material on potential production, geology, soil and climatic data, have assessed scenic and/or recreational values, and have stressed the need for protection of soil and water values. However, in both these documents and plans the process of making value judgements has had to be largely explained in words. Sieve planning, using overlays (like those illustrated in Figs. 3 to 5), allows the stages in the decision-making process to be studied, and more objective methods of assessment to be developed. This paper highlights the use of soil information as a significant part of the process in planning for exotic forestry, which is one of the land-use options for present West Coast forests.

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THE SIEVE PLANNING METHOD

Sieve planning employs transparent overlays (sieve overlays), one for each use or value. For each particular use or value a hierarchical ranking is established, incorporating all available information. The three rankings (high, medium or low) are depicted by different degrees of intensity of line shading (e.g., as in Fig. 3). The relative importance of all uses and values can be seen when all overlays are placed one on top of each other to form a combination overlay, as in Fig. 6. Further, as explained by Kirkland (1974), it is possible to identify areas best suited to a particular use or having a particular value, areas where various uses are co-dominant and to some degree compatible, and areas where there is unresolved conflict.

GENERAL METHOD OF ASSEMBLING SOIL DATA

Soil surveys in New Zealand are normally published in the form of maps and reports which describe physical, morphological and chemical properties of the soils identified. Interpretation of this information for a variety of potential land uses such as pastoral, cropping, urban, and forestry is usually in the form of generalised statements, in tables by broad suitability classes, or occasionally by interpretative maps. Because of the specific need for more detailed information to aid planning for exotic afforestation on the West Coast, emphasis was placed on an evaluation of those soil and environmental factors considered most likely to influence exotic forest growth.

Recent soil surveys on the West Coast were carried out using the methods outlined in Soil Survey Method (Taylor and Pohlen, 1970), and recording profile descriptions on standardised cards (Lee et al., 1976). All data were assembled in the form of soil unit sheets, for example those of Ross and Mew (1975). Assessments of the physical and nutrient limitations for exotic forestry were made from these sheets, as described by Adams and Mew (1976) for the Grey Valley region. The tables presented in the Grey Valley report show six limitation classes, from negligible (A) through to severe (F), to one of which each individual soil mapping unit is assigned. Each soil is rated in terms of degree of limitation (also ranked from negligible (0) to severe (5)) for each of several limiting factors, the highest degree of all the factors determining which class the soil is put into.

The maps which accompany the West Coast soils and forestry reports, such as that on the Grey Valley (Adams and Mew 1976), are in the same form as those with other
Soil Bureau publications. Soil mapping units are shown on maps (at 1:50 000 scale) as geographically named units, either singly, in complexes, or in associations. Complexes consist of two or more soils which are intricately mixed, whereas soils in an association are related to some characteristic of the topography but cannot be shown separately at the particular scale in use. In an attempt to differentiate some of the complex units containing mixtures of hill and steepland soils, and also to discover the extent and location of extremely steep areas that cannot be otherwise shown, use was made of slope class maps produced from contoured topographic maps using a photomechanical technique described by O’Leary (1973).

AREA USED TO ILLUSTRATE SIEVE PLANNING

The 37.5 km² area used as an example to illustrate the sieve planning technique is situated on the west coast of the South Island approximately 1.5 km south-west of Reefton (Fig. 1). The detailed soil pattern is shown in Fig. 2 (from Adams and Mew 1976). Soil mapping units and their physiographic positions, as well as physical limiting factors and ranks for exotic forestry, are listed in Table 1.

![Location Diagram](image.png)

*Fig. 1: Location map showing area chosen to illustrate sieve planning technique.*
**TABLE 1: PHYSICAL SOIL LIMITATIONS FOR EXOTIC FOREST GROWTH**

Key: Limiting factors:
- **p** = iron pan in soil or underlying gravels
- **r** = higher rainfall than average
- **sh** = shallow profiles
- **st** = stones or boulders
- **u.r.** = relatively impenetrable underlying rock
- **w.t.** = high water table or soil drainage restriction

<table>
<thead>
<tr>
<th>Class</th>
<th>Soil mapping units</th>
<th>Map symbol</th>
<th>Physiographic position</th>
<th>Degree of limitation for each limiting factor</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td>0 = negligible</td>
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<td>1 = slight</td>
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<td>2 = slight to moderate</td>
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<td>3 = moderate</td>
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<td>4 = moderate to severe</td>
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<td>5 = severe</td>
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<td>C</td>
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<tr>
<td>Soils with slight to moderate physical soil limitations</td>
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<tr>
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<td>Bbh</td>
<td>Hill country</td>
<td>0</td>
<td>1(sh)</td>
</tr>
<tr>
<td>Soldiers hill soils</td>
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<td>Hill country</td>
<td>0</td>
<td>2(st)</td>
</tr>
<tr>
<td>Carton hill soils</td>
<td>CtH</td>
<td>Hill country</td>
<td>0</td>
<td>2(sh)</td>
</tr>
<tr>
<td>Mahoneys steep-land soils</td>
<td>Mhs</td>
<td>Steep land</td>
<td>0</td>
<td>1(sh)</td>
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</table>

Key to rank for exotic forestry:
- I = high ranking
- II = medium ranking
- III = low ranking
### D
Soils with moderate physical soil limitations

<table>
<thead>
<tr>
<th>Ahaura soils</th>
<th>Ah</th>
<th>Low glacial outwash terraces</th>
<th>Ahm</th>
<th>Low glacial outwash terraces</th>
<th>InH</th>
<th>Hill country</th>
<th>WkS</th>
<th>Steep land</th>
<th>OeS</th>
<th>Steep land</th>
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<td>Ahm</td>
<td>Low glacial outwash terraces</td>
<td>InH</td>
<td>Hill country</td>
<td>WkS</td>
<td>Steep land</td>
<td>OeS</td>
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<td>Inangahua hill soils</td>
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<td>Wakamarama steepland soils</td>
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### E
Soils with moderate to severe physical soil limitations

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<th>Kumara soils</th>
<th>Ku</th>
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<th>3</th>
<th>2 (sh)</th>
<th>0</th>
<th>4 (w.t.)</th>
<th>0</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahaura soils, mottled phases</td>
<td>InH</td>
<td>Hill country</td>
<td></td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>II</td>
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<tr>
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Soils with severe physical soil limitations

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<th>Okarito soils</th>
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<th>Intermediate and high glacial outwash terraces</th>
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<th>1 (sh)</th>
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<th>4 (w.t.)</th>
<th>0</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Ahm</td>
<td>Low glacial outwash terraces</td>
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<td>2 (sh)</td>
<td>1 (p)</td>
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<td>Inangahua hill soils</td>
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<td>Hill country</td>
<td>WkS</td>
<td>Steep land</td>
<td>OeS</td>
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<tr>
<td>Ahaura soils, mottled phases</td>
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</tr>
<tr>
<td>Inangahua hill soils</td>
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<td>Hill country</td>
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<tr>
<td>Oriental steepland soils</td>
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<td>0</td>
<td>0</td>
<td>3</td>
<td>II</td>
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<tr>
<td>Oriental steepland soils</td>
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<td>0</td>
<td>0</td>
<td>3</td>
<td>II</td>
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</tbody>
</table>

#### Soil Surveys and Site Planning

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About half the area consists of finely dissected hill country interspersed with steep slopes and covered in beech/podocarp forest dominated by hard beech. Soils are mainly complexes of Blackball hill soils either with Mahoneys steepland soils ($BbH + MhS$) or with Inangahua hill soils and Mahoneys steepland soils ($BbH + InH + MhS$). The south-eastern part of the area has longer, more uniform steep slopes, largely with complexes of Wakamarama steepland soils and Oriental steepland soils ($WkS + OeS$). Red beech and rimu are the main forest trees. High glacial outwash terrace remnants, some under treeless pakihi vegetation and some still forested, with Okarito (Ok) or Okarito and Kumara soils ($Ok + Ku$), are located on the tops of a few of the hills. Farmed alluvial flats and terraces occur in the larger valleys but are chiefly outside State forest and hence the study area. A number of the flats have been worked for gold.

In the exercise described here, three potential options for forest use were considered:

(1) Indigenous forest management.
(2) Conversion to exotics.
(3) Use of forests for recreation.
Basic information on soils was used mainly in formulating ranking criteria for the conversion to exotics option.

DEVELOPMENT OF CRITERIA FOR EXOTIC FOREST SUITABILITY RANKING

The three-rank system for the sieve overlay shown in Fig. 3 was developed, through liaison between N.Z. Forest Service and Soil Bureau staff, on the basis of information gained from regional exotic forest plantings on various soils, together with the improved definition of soils that resulted from the 1:50 000 scale West Coast soil surveys. Definitions of the three ranks were made, as far as possible, mutually exclusive, and the soils originally arranged in 6 classes by Adams and Mew (1976) were reclassified using the ranking criteria given below. Only soil physical factors were considered, as Will and Leamy (1977) had indicated that topdressing with fertiliser could overcome most nutrient limitations. The definitions for the three-rank system (with figures in parentheses being the allowable degrees of limitation; see Table 1) are as follows:

**Fig. 3: Sieve overlay showing ranking for exotic forestry.**
Mainly well drained (0-2 for excessive moisture) stable soils (0-2 erosion hazard) with negligible to slight to moderate degrees of limitation (0-2) for the other physical factors listed in Table 1 except for stoniness or flooding where a moderate degree of limitation (3) is allowable. Stoniness and flooding limitations apply to soils on flat land; stoniness also applies to soils on rolling land and hills. Soils having four or more physical limiting factors which are regarded as cumulative are placed in Rank II although no individual degree of limitation is greater than prescribed for Rank I.

Well to imperfectly drained (0-2) soils with moderate stability (3) limitations or imperfectly and poorly drained (3-5) soils that are capable of drainage and with moderate (3) or lower (0-2) degrees of limitation for the remaining limiting factors. In rare instances, soils with up to 6 limiting factors are placed in Rank III because of their cumulative effect, although their individual degrees of limitation do not exceed 3.

Poorly drained (4-5) soils which cannot be easily drained, soils with moderate to severe (4) or severe (5) erosion hazard, or other soils with either moderately severe (4) or severe (5) degrees of limitation for the remaining limiting factors.

Complex mapping units with components that could not be separated on the basis of slope were ranked according to the most severe limitation or combination of limitations of any member of that complex.

Final rankings for the individual soils are shown in Table 1.

DEVELOPMENT OF CRITERIA FOR INDIGENOUS FOREST MANAGEMENT AND RECREATION SUITABILITY RANKING

Criteria for ranking indigenous forest management were based mainly on species composition (as shown on unpublished 1:15 840 scale forest type maps) and the known regenerative potential of particular tree species. Thus forests containing high quality timber trees with good regenerative potential were ranked highest. This method of ranking conforms with the recently revised management policy for indigenous State forests (N.Z. Forest Service, 1977).
Because of the multiplicity of possible recreational pursuits available in the West Coast region, sub-ranking was first employed for map units. Thus three class-ranking systems were evolved for each of the following sub-ranks:

1. Aesthetic value of State forest visible from highways and major county roads.
2. Presence and condition of historic relics, sites, tracks, etc.
3. Present and potential use in terms of recreational outlets such as hunting, fishing and tramping.

The final ranking assigned to an area was based on the three individual sub-rankings. Any area which had a high sub-ranking for one or more of the above values or uses was given a high final ranking.

Sieve overlays were then prepared for both indigenous forest management and recreation for the study area (Figs. 4 and 5).

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Fig. 4: Sieve overlay showing ranking for indigenous forest management.
FIG. 5: Sieve overlay showing ranking for recreation.

DISCUSSION

As illustrated in Fig. 3, Blackball hill soils dominate complexes in the north-western portion of the study area and have the best rank (Rank I) for exotic afforestation. Some parts of the complexes where Mahoneys steepland soils occur on steep slopes have been distinguished by slope mapping. Much of the remaining area is a complex of Wakamarama steepland soils and Oriental steepland soils, both of which have a medium exotic forestry ranking. Extremely steep land within this complex, also identified from slope class maps, has a low exotic forestry ranking (Rank III), as have the very poorly drained Kumara and Okarito soils. In places where flat and steep areas of similar rank are in contact, boundaries between them are not shown on the sieve overlays although they are present on soil and forest type maps.

When the exotic forestry sieve overlay is combined with those for indigenous forest management and recreation, a complex array of potential uses becomes evident, as shown in Fig. 6. In some areas conflicts arise—for example, the potential use of forest immediately south of the major road
FIG. 6: Combination overlay resulting from integration of sieve overlays.

(area labelled A in Fig. 6) which is highly ranked for recreation and exotic afforestation, or the area of medium ranking for both indigenous management and exotics (labelled B). Areas of no conflict for recreation (C), or exotic afforestation (D), are more easily resolved. Where indigenous management and recreation are closely ranked (E), then both uses should be possible without strong conflict. However, where recreation and exotic forestry are equally ranked, careful planning must be carried out (for example, to minimize the fire danger from visiting parties). Where visual considerations are dominant, it may not be possible to combine both uses.

The final stage in formulating forest management options depends on the objectives considered most desirable for the region as a whole.

CONCLUSIONS

Planning for future management of forests is often complicated by the multiplicity of potential uses that must be assessed not just for their economic benefits but also in terms of non-monetary values. Previous methods of planning have
not allowed stages in reaching decisions to be clearly followed. The sieve planning method as illustrated in this paper, by the progressive build-up of sieve overlays using all available information, allows individual stages to be studied.

The method for incorporating information from soil surveys relevant to the potential option of growing exotic trees has been described in detail, showing that it is possible to combine both site and soil factors. Refinement of soil complex mapping units using photomechanically derived slope maps can follow. Methods for development of criteria for other potential uses have also been established but are only briefly discussed.

Thus, by using an input of specialist information such as that derived from soil surveys, a sound base for generalised planning appreciable by specialists and non-specialists alike can be established.

ACKNOWLEDGEMENTS

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REFERENCES


