# ASSESSMENT OF RADIATA PINE STANDS USING LOG GRADES

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## ABSTRACT

*A set of standard cruising quality codes has been developed to allow the assessment of the composition of stands in terms of proposed standard log grades, using the MARVL pre-harvest inventory system. MARVL assessments have been carried out using this set of quality codes in stands in Kaingaroa and Golden Downs Forests. MARVL estimates of total recoverable volume and volume by log-grade aggregations compared closely with actual stand outturn. As MARVL assessments consider only external tree features, a complementary assessment is required to evaluate pruned log quality.*

KEYWORDS: Pinus radiata, conversion planning, MARVL, cruising, log grades, pruned log quality, defect core.

## INTRODUCTION

A standard set of log grades has been proposed by Whiteside and Manley (1987). Should these gain national acceptance, estimates of the quantity of forest outturn in terms of these log grades will be required at all levels of planning.

Harvesting involves three stages of planning, given that a strategy exists for the management of the forest enterprise. Different methods are required to provide the information needed for each level.

1. Long-term: A plan of the long-term annual allowable cut (e.g., the New Zealand Forest Service's "Harvesting and Marketing Strategy") specifies the yield from each region, using broad log categories for aggregations of similar stands (such as crop types).

   For long-term planning, resource data should be derived by stand growth prediction, starting from management inventory data. The stand prediction model STANDMOD (Whiteside et al. 1987) can be used to predict stand outturn in terms of log grades or log-grade aggregations.

2. Medium-term: A "Production Forecast" is a plan which forecasts production, by detailed log type in individual stands, for the following 10-15 years.

   For medium-term planning, aggregated resource data are usually required. These data can be obtained from MARVL (Deadman and Goulding 1979) inventories, using a simplified assessment of the stem qualities (e.g., pruned height, and malformation up to between 17 m and 20 m). The assessment allows the prediction of stand outturn according to the five log-grade aggregations (Whiteside and Manley 1987) suggested for longer-term planning purposes.

3. Short-term: This involves detailed planning of the harvest for the following 3-5 years. It includes an operational logging plan.

   For short-term planning, detailed information about stand composition is required.

This paper discusses how the MARVL inventory system can be used for short-term planning, allowing stands to be assessed in terms of log grades or log-grade aggregations.

## STAND ASSESSMENT BY LOG GRADES USING MARVL

The MARVL inventory system was developed to allow the assessment of recoverable volume, by log types, in a stand shortly before harvesting. Although it was initially developed for and tested on untended old-crop stands, it has since been adopted by the New Zealand Forest Service and some forest companies as the standard pre-harvest inventory procedure for both tended and untended stands.

The MARVL system is a two-stage process, comprising a field cruise and a computer analysis.

1. The field cruise. This involves the assessment of a sample of trees for size and quality. The stem of each tree is cruised by subdividing it into

sections of uniform quality, beginning at the butt. Each section is assessed in terms of height and length. (The aim of this cruising procedure is to describe the quality of the stem. Accordingly, the sections do not necessarily correspond to logs.)

2. The computer analysis. During computer analysis the cross-cutting of trees into logs is simulated. Logs are defined by size (i.e., diameter and length) and cruise quality codes.

MARVL quality codes for log grades

A standard set of log grades, used for resource description, has been proposed by Whiteside and Manley (1987). A standard set of quality codes has also been developed, to allow the composition of stands to be assessed in terms of these log grades.

The standard quality codes have been incorporated into a cruising procedure, called a decision tree (Figure 1).

FIG. 1: Cruising decision tree

| | | | | Code |
|---|---|---|---|---|
| Pruned | | Straight | Peeler Quality... | A |
| | | | Not Peeler....... | B |
| | | Moderate Sweep | Peeler Quality... | C |
| | | | Not Peeler....... | D |
| Internodal | Branches ≤6 cm.................................... | | | I |
| | Branches 6-14 cm.................................... | | | J |
| Unpruned | Branches ≤6 cm | Straight | Peeler Quality... | N |
| | | | Not Peeler....... | E |
| | | Moderate Sweep.................... | | G |
| | Branches 6-14 cm | Straight.......................... | | L |
| | | Moderate Sweep.................... | | K |
| Industrial.......................................................... | | | | P |
| Waste............................................................... | | | | W |

In this procedure, a sequence of decisions is applied during the field cruise, and the quality code for each part of a stem is derived accordingly. The quality codes are then used during the computer analysis to define log grades.

Full details of the cruising decision tree, and the results and reconciliations of MARVL assessments obtained by using it in stands in Kaingaroa and Golden Down Forests, are reported by Manley et al. 1987).

The decision tree involves a sequence of four decisions:

1. General quality: The first decision is whether the section of stem under assessment is pruned or unpruned and, if unpruned, whether it is of internodal quality. (Sections of internodal quality have at least 60% of their length in internodes of 0.6 m or longer.) If the section of stem is defective, it is downgraded either to industrial quality or, if non-merchantable, to waste.

2. Branch size: Three branch categories exist, defined on the basis of size (i.e., whether the branch is 6 cm in diameter or less, between 6 and 14 cm, or greater than 14 cm). If the branch diameter is greater than 14 cm, that section of the stem is down-graded to either industrial wood or waste.

3. Straightness: Deviation from straightness has to be assessed for the section of stem being considered. The straightness category allocated to a long section must be consistent with the straightness of any shorter length of that section.

   Three categories of sweep are distinguished in the cruising tree:

   (a) straight

   (b) moderately swept

   (c) swept.

   Straight sections of the stem are allocated to Sweep Class 1 (Whiteside et al. 1987), and can be cut into either short logs (i.e., 7.6 m or less) or long logs (i.e., greater than 7.6 m). Moderately swept sections of the stem cannot be used for long logs and are cut, instead, into short logs which will meet the requirements of Sweep

Class 1. Swept sections of the stem can be coded for industrial wood, provided they can be assigned to Sweep Class 2. Excessive sweep, which makes the stem unmerchantable, is coded as waste. Internodal sections would generally be restricted to the straight category, Sweep Class 1.

4. Peeler quality: Peeler quality refers to a set of characteristics (e.g., roundness, lack of surface defects) which identify sections of the stem from which peeler logs can be produced.

The new cruising procedure, involving these four decisions, should be used in conjunction with the regular MARVL cruising procedure (which incorporates structural malformation such as forks, broken tops, or merchantable side branches).

Relationship of codes to log grades

Before the MARVL computer analysis, the cruise quality codes for each log type have to be specified. A log type can be cut only from sections of a stem which are coded with a corresponding quality code.

The number of corresponding codes increases as the hierarchy progresses from the "P" grades, through the "S" grades, to the "L" grades (Table 1). The "S" log grades can include pruned sections, and the "L" log grades can incorporate pruned and small branch sections. Peeler logs can only incorporate sections of A,C (pruned peelers), I,N (constructional and industrial peelers), or I,J (internodal peelers) - see Figure 1. These cruising codes are flexible enough to accommodate other products such as current A-grade export logs (ABIJNEL).

Examples of MARVL cruising using the decision tree

1. Kaingaroa Forest, Compartment 1036

A log-grading trial was carried out in 9.1 ha of Compartment 1036. The primary purpose of this trial was to investigate the practicality of log sorting, using the proposed log grades, in commercial clearfelling operations. Logs produced during the trial (pulp logs excepted) were subsequently sawn in commercial sawing trials.

TABLE 1: Acceptable cruise quality codes for log grades

| | |
|---|---|
| P1, P2 | ABCD |
| S1, S2, S3, S4 | ABCDINEG |
| L1, L2, L3, L4 | ABCDIJNEGLK |
| I | IJ |
| R | ABCDIJNEGLKP |

As part of the trial, the stand was assessed using the MARVL cruising decision tree. A total of 180 trees in 12 plots, each comprising 0.05 ha, (i.e., 6.7% sample intensity) were cruised. A MARVL reconciliation exercise was then carried out, in which the MARVL estimates of volume were compared with the stand outturn measured at the weighbridge (Tables 2 & 3).

There is a close agreement between the MARVL estimate of stand total recoverable volume and actual stand outturn (Table 2).

TABLE 2: Comparison of MARVL estimate of total recoverable volume and stand outturn from Kaingaroa Forest, Cpt 1036

| | |
|---|---|
| 1. MARVL estimate | |
| (a) Volume below predicted breakpoint | 646 |
| (b) 50% of volume above predicted breakpoint | 31 |
| | 677 $m^3$/ha |
| 2. Stand outturn | |
| Weighbridge | 657 $m^3$/ha |

The MARVL estimates of the percentage volume by log sort compare closely with the actual percentage outturn (Table 3).

TABLE 3: Comparison of MARVL estimates of percentage volume by log sort and actual stand outturn from Kaingaroa Forest, Cpt 1036

| Log sort | MARVL* estimate (%) | Weighbridge (%) |
|---|---|---|
| Long pruned logs+ | 17.5 | 18.6 |
| Short pruned sawlogs | 6.6 | 5.9 |
| Long S | 18.0 | 19.9 |
| Long L | 14.9 | 11.3 |
| Short S1 + L1 | 1.4 | 5.1 |
| Short S2 | 8.9 | 7.5 |
| Short L2 | 3.1 | 3.5 |
| Short S3 | 14.4 | 11.3 |
| Pulp | 15.2 | 16.9 |
| | 100.0 | 100.0 |

* 50% of the volume above the predicted breakpoint has been included in the pulp sort.

\+ Includes pruned peelers and long pruned sawlogs.

2. Golden Downs Forest, Compartment 112.

After the Kaingaroa Forest trial, a log-grading exercise was carried out (on a smaller scale) in 4.7 ha of Compartment 112, Golden Downs Forest. The decision tree was used in a MARVL assessment of 10% of the trees in the study area. (The same assumptions were made about the recovery of wood above predicted stem breakpoint as in the Kaingaroa study.)

Again, the MARVL estimates of total recoverable volume and volume by log sorts compare closely with actual stand outturn (Tables 4 & 5).

## PRUNED RESOURCE DESCRIPTION

Assessment by MARVL will provide estimates of volume by log grade, based on the visual assessment of external characteristics and measurement. However, the internal characteristics of pruned logs also need to be described.

TABLE 4: Comparison of MARVL estimate of total recoverable volume and stand outturn from Golden Downs Forest, Cpt 112

| | |
|---|---|
| 1. MARVL Estimate | |
| (a) Volume below predicted breakpoint | 431 |
| (b) 50% of volume above predicted breakpoint | 14 |
| | 445 $m^3$/ha |
| 2. Stand outturn | 433 $m^3$/ha |

TABLE 5: Comparison of MARVL estimates of percentage volume by log sort and actual stand outturn from Golden Downs Forest, Cpt 112

| Log sort | MARVL* estimate (%) | Stand outturn (%) |
|---|---|---|
| Peelers | 27.0 | 24.0 |
| Pruned sawlog | 2.5 | 2.4 |
| Long S | 9.1 | 12.2 |
| Short S1 + S2 | 19.0 | 17.1 |
| Short L1 + L2 | 20.6 | 19.8 |
| Short S3 + L3 | 14.2 | 17.3 |
| Pulp | 7.6 | 7.2 |

* 50% of the volume above the predicted breakpoint has been included in the pulp sort.

Approaches to pruned resource evaluation are discussed by Somerville et al. (1986). Out of the three different levels described in that paper, two can be used for the description of a mature pruned resource. Both of these involve pre-harvest inventory, to assess log volumes and external properties.

Somerville et al. state that, as a precursor of any detailed stem analysis, internal quality (diameter over pruned branch stubs (DOS) and the related defect core for each pruning lift) and the potential value of the logs can be predicted using the stand history and inventory data. This allows the stands to be stratified and provides an indication of expected log size and quality. A decision can then be made as to whether a detailed investigation, involving stem analysis, is justified.

A pruned stand quality classification system has been proposed by Whiteside and Manley (1987) as a minimum level of description for pruned stands. The classification index is the difference between the mean pruned log small-end diameter (SED) and the mean defect core. A MARVL inventory can provide an estimate of SED, while defect core can be predicted from DOS estimates.

Somerville et al. state that the use of predicted DOS is limited by the following considerations:

(1) unreliable stand records, which prevent accurate DOS predictions

(2) that fact that DOS (and hence defect core) is only one indicator of internal pruned log quality. Other factors, such as resin pockets, eccentric or wandering pith, atypical occlusion, adventitious shoots, and concealed production thinning damage, are ignored.

Accordingly, Somerville et al. recommend that a detailed assessment be carried out when an accurate evaluation of a potentially valuable pruned resource is needed.

Three-dimensional log descriptions (both internal and external) can be obtained from a sample of logs by either a sawing study (Park and Leman 1983) or by cross-sectional analysis (Somerville 1985). (The sample is taken from a population which can be defined as a single stand or a group of stands.) These assessments outline the internal characteristics of the pruned logs sampled. They provide a profile of the defect core; locations of resin pockets, pith, atypical occlusion, adventitious shoots, and production thinning damage; as well as the branch size and distribution within the defect core.

In order to predict the future stand condition and describe the internal quality of pruned stands, silvicultural quality control and the keeping of stand records must be improved. Records at the time of pruning should include stand basal area, stocking, and height; and individual tree DOS and actual pruned height.

For the next 15 years, at least, the information obtained from stand records of mature stands may be unreliable. Therefore, the implementation of a detailed internal pruned log assessment (i.e., by either sawing study or cross-sectional analysis) will often be necessary - especially if the seller expects to receive a premium for high quality logs, and the penalties for inaccurate description are high.

## CONCLUSIONS

The MARVL pre-harvest inventory procedure can be used to assess stands by log grades. The results reported in this paper indicate that stand assessment by MARVL, using a cruising decision tree, can provide reliable estimates of total recoverable volume and volume by log sorts, based on the proposed log grades. The decision tree is not presented as an absolute. Depending on requirements, either a reduced or an expanded version of it may be applied.

The full MARVL inventory procedure is best carried out in stands 3-5 years ahead of planned clearfelling. For the assessment of stands 5-15 years before harvest it is suggested that a "mid-MARVL" assessment will provide information for logging and marketing. The proposed "mid-MARVL" requires the cruising of a set of features, including pruned height, which are likely to remain unchanged until the time of harvesting. Estimates of volumes at later ages can be made by using "grow-MARVL" to project inventory results. Pruned log quality over this 5-15 year time horizon would be assessed by prediction.

Pruned logs must be given an accurate description for sale purposes. It is inadequate to simply label such logs as "pruned", or even as "P1" and "P2" grades (whether these are combined or left separate). Internal characteristics of pruned logs can vary widely between stands, particularly if different silvicultural regimes have been applied. Accordingly, some information must be provided about the internal quality of these logs - especially as it is this which determines their value.

The short-term sale of pruned logs on a stand-by-stand basis is supported by technical arguments. This would allow the seller to provide detailed qualitative (as well as quantitative) information about pruned logs, giving him the opportunity to match the resource to each buyer's specific requirements.

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