- Individuals are expected to conduct their affairs in compliance with the Foresters Act together with the ABCPF bylaws including the Code of Ethics.

Concluding Remarks

Table 2 summarises some of the key features of the different membership/registration models. The NZIF Registration Scheme fits midway along the spectrum of examples which have been considered in this paper. Given the current New Zealand regulatory environment and the broad membership base of the NZIF, this can be viewed as an appropriate place to be.

Table 2: Key features of different membership/registration models

Feature	Australia		NZ	UK	California	BC
	IFA	ACFA	NZIF	ICF	RPF	ABCPF
Criteria						
Formal qualifications	√	√	√	√	√	√
Experience		√	√	√	√	√
Knowledge and understanding/ professional exam.			√	√	√	√
Mandatory CPD			√	√		
Code of Ethics	√	√	√	√		√
Legal rights						
Legal Right to Title			?	√	√	√
Legal Right to Practise					√	√

The NZIF Registration Scheme has been introduced to enable the professional knowledge and skills, high standards of professional conduct, and commitment to ongoing learning demonstrated by suitable practitioners to be recognised within the industry. It represents an important step forward in the development and promotion of professional standards in New Zealand forestry. However, registration cannot be considered in isolation from other activities of the NZIF. Other initiatives to develop professional standards include:

- the production of Guidelines for Investments in Forest Growing Projects;
- the establishment of a Working Group to make recommendations on the role of the NZIF, with respect to protection of both consumer interests and the standing of the profession, in forestry investment promotion practices;
- the recent release of an Exposure Draft of Forest Valuation Standards. These have been developed to provide a set of standards and guidelines for the physical and financial description and the valuation of plantation forests.

Together these initiatives are meeting the roles of 'gatekeeping, maintaining standards and promoting the profession' suggested for professional institutes by Sutherland (1996). They can be seen as a positive step by the NZIF to provide an increased level of quality assurance on the advice and practice being offered within the forestry sector.

Acknowledgements

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Managing forest aesthetics in production forests*

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Summary

Intensively managed forest plantations are important to the New Zealand economy. These same plantations are essential components affecting the scenic beauty of the New Zealand landscape, key contributors to the quality of outdoor recreation experiences and to a growing tourism industry. Effective projection and assessment of the visual aesthetic consequences of alternative forestry practices is essential to efficient and balanced management policies and to facilitate compliance with the Resource Management Act (1991).

Forest growth models, GIS spatial analyses and analytic visualisation techniques were combined to guide the development of data-driven, photo-realistic visualisations of alternative paired management scenarios within a panoramic scene. A perceptual survey, using an intercept interview procedure that allowed respondents simultaneously to view and compare the full sequence of forest conditions projected to occur over a 20-year period, was conducted with 501 respondents.

Results of the paired-comparison/point allocation between the visualised management alternatives indicate that respondents were in substantial agreement on the visual aesthetic quality depicted for each view. Vertical versus contour planting schemes (simulating the reduction of hard visual elements in the landscape) produced small and inconsistent differences in ratings, while ratings of scenes showing visual buffers were consistently rated higher than the same scenes with no buffers. This response was repeated for residents and non-residents and for respondents indicating a high level of involvement in the forest industry versus those indicating membership in environmental groups. Non-residents indicated the greatest importance for plantation forestry to the visual quality of the landscape and frequently cited this as positively affecting visitors' enjoyment, while local residents rated plantation forestry as contributing little to the visual quality of the landscape.

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Introduction

A successful forest industry based on intensively managed *Pinus radiata* plantations has been an important part of the New Zealand agricultural economy for over 30 years. Currently the 1.5 million hectares of plantation forest is the third major contributor to the New Zealand economy. Forest products have a market value in excess of $2.6 billion annually and provide employment for 28,000 people.

Typically, management scenarios involve mechanical and/or chemical site preparation and planting of genetically improved seedlings, followed progressively by thinning and pruning, and then clearfell harvesting within rotation intervals of approximately 20 to 30 years (Maclaren 1993). However, commercial forestry practices are encountering increased public objections, particularly in areas with high visibility to tourists, recreation visitors and more sensitive local residents.

The responsibilities of private commercial forest industry for protection of visual/aesthetic values have been unclear in New Zealand's past. Nevertheless, forest managers have historically forgone scheduled harvests in some visually sensitive areas or have used such techniques as landscape screening and amenity planting in an effort to mitigate visual effects and maintain desirable public relations (Moore *et al.* 1991; Anon 1991). The more recent dedication of the forest industry in New Zealand to the improvement of environmental quality can be largely attributed as a response to comply with the Resource Management Act (RMA 1991). Thus provision of tools capable of effectively projecting and assessing the visual aesthetic consequences of alternative forestry practices is a challenge for researchers and essential for the modern forest manager to aid the development of appropriate policies and practices.

The RMA controls activities such as use, development or protection of the natural and physical resources of New Zealand and is based heavily on the investigation of the 'effects' of a proposed activity, rather than on prescribing which activities shall or shall not be allowed. It includes the ethnic philosophy of *Kaitiakitanga* – the exercise of guardianship of the land and, in relation to a resource, includes the ethic of stewardship based on the nature of the resource itself. In addition to consideration of 'effects', any mitigation efforts must be communicated clearly among the forest operator, regulatory authorities and other interested parties.

The reasons for public objections to commercial forestry practices are diverse and complex, and visual impacts are a very substantial contributor (Kilvert and Hartsough 1993). Abrupt alterations of scenic environmental settings (Thompson and Weston 1994) may pose direct threats to tourist and recreation industries, as well as residents' environmental quality expectations. In addition, visual effects often precipitate public concern for other potential environmental and cultural impacts.

Generally the public are able to readily identify visual change in the landscape (Benson and Ullrich 1981; Kilvert 1995a, b; Swaffield 1994) and visual images are considered an excellent medium for communicating the effects of forestry operations to the public (Daniel and Boster 1976; Daniel *et al.* 1990; Orland 1988, 1992). The idea of using images calibrated to known resource attributes to derive human values is not a new one. Malm *et al.* (1981) used image processing techniques to develop images of pollution plumes in the Grand Canyon, based on the output of numerical models of atmospheric dispersion, that were used to derive human values for the impacts predicted on scenic resources in the Canyon. The study established the effectiveness of computer techniques but used computing resources beyond the means of typical natural resource agencies. Orland (1988) described the availability of micro-computer-based tools capable of the same range of manipulations, but at much lower cost. The basic technique was to digitise photographic images and then use either editing or image processing software to make changes to the base image to represent anticipated changes.

Specific applications with forestry relevance include Baker and Rabin's (1988) study of the visual effects of limb rust damage on national forest settings in northern Utah, the study of Orland *et al.* (1993) on the impacts of insect damage and silvicultural responses on the scenery of the Dixie National Forest in southern Utah and the Orland *et al.* (1994) application to the visualisation of forest harvesting in northern Ontario. By projecting the visual effects of pine forest management, the focus of current research aims at providing data and integrated systems that enable accurate depiction of future effects of forest operations at the landscape scale. The images are used to determine the public response to current and alternative forestry practices, and to develop tools for the forest industry to facilitate resource planning for production forestry. This paper describes a case study which demonstrates the capabilities of modern computer-based, data-visualisation tools and perceptual survey techniques for managing forest aesthetics in production forests in New Zealand.

Methods

Visualisations

The New Zealand forest industry uses sophisticated forest management decision support systems (DSS) for growth and yield predictions, valuation and estate modelling. For our study, future forest stand conditions were predicted using STANDPAK (Whiteside 1990), a DSS designed to model individual stand growth and yield while optimising silvicultural management alternatives. Forest harvesting plans were developed in consultation with the forest managers. However, despite having carefully developed harvesting plans, and projected future plantation conditions, to portray that information in a visual medium by constructing accurate data-driven visualisations is a complex task.

Using a simple 3-D projection from GIS data does not adequately display the height of "layers" of trees on the landscape so that visibility can be verified, and the thickness of linear graphical elements is such that boundaries seen at oblique angles cannot be differentiated. In our study, a great number of attributes need to be represented visually but equally significant is interaction of those attributes in the visual display. For example, the size of a forest cutting operation cannot be separated from the forest type where it occurs, the shape and location of the cut, what is left as residual, or the stage of recovery of the cut. This distinction made it necessary to use a software system to create schematic analytic visualisations to match specifications from the experimental design and to verify that the appropriate attributes could be seen concurrently.

SmartForest II (Orland 1994) is a landscape-visualisation software package capable of displaying a schematic representation of tree density, size and homogeneity of stand composition in correct visual perspective and was designed to deal with planning forest landscapes at large scale but at the same time to be able to develop specific management strategies at a small, tree-by-tree scale. The program is available via the World Wide Web at *http://imlab9.landarch.uiuc.edu/SF/SF.html*. Each of the three component data sets necessary to drive SmartForest II simulations were provided by integration of the outputs from other software systems.

SmartForest II requires a digital elevation model (DEM) to provide topographical data for creating the landform features. The forest managers, from Fletcher Challenge Forests collaborating on this project, use ARC/INFO® (ESRI 1991) as their map database system with elevation data stored as contour coverages. To derive a DEM involved stepping through the procedures CREATETIN to make a triangulated net from the contour data; TINLATTICE to convert the net to a regular lattice; and LATTICEDEM to convert the lattice to a grid of data in the USGS DEM format supported by ARC/INFO® and SmartForest II. In operation many problems were encountered in making the final transformation to the DEM, largely because of the differences in coordinate systems, units, and completeness of metadata in the NZ records versus the expectations of the ARC/INFO® process. Work-arounds were developed that involved manual editing of the DEM file header to ensure an adequate DEM input.

Smart/Forest II uses a Stand File to provide information about the location of stand boundaries to superimpose on the DEM. Vector files containing data for each of the landscape management scenarios in our experimental design were initially developed using TerraSoft® GIS (PCI 1996) before being translated to ARC/INFO® stand boundary coverages. As SmartForest II uses gridded data (where grid cells are assigned stand identifiers that determine the Tree List attribute data to be placed at that location) the stand boundary coverages were converted, within ARC/INFO®, using POLYGRID and then to ASCII format using GRIDASCII for each age step to be visualised. Finally, the Tree List Files which provide records of the vegetation to place in each stand cell location were generated by substitution of STANDPAK mensuration data in ASCII format.

SmartForest II was then used to generate analytical simulations for each viewpoint and scenario within the experimental design. We made extensive use of the analytical simulations to guide the image editing necessary to produce the photorealistic visualisations. This approach provided a data-driven and defensible linkage to the image product. The image editing tasks were facilitated by using Adobe Photoshop™ software, the *de facto* standard for this task. Full detail of the generation of the analytical visualisations and final calibrated photo-realistic images (Fig. 1), are described by Thorn *et al.* (1997) and Orland *et al. (1997).*

Perceptual Survey

Visualisations of alternative forest plantation management scenarios were used in a systematic assessment of public perceptions of the visual consequences of each scenario. The perceptual assessment was approached in two formats: 1) a paired-comparison format in which overall visual effects of alternative management plans were represented across a full rotation for a single stand; and 2) a single-scene format in which the visual quality of individual views (each depicting only one stage of the progression from harvest to

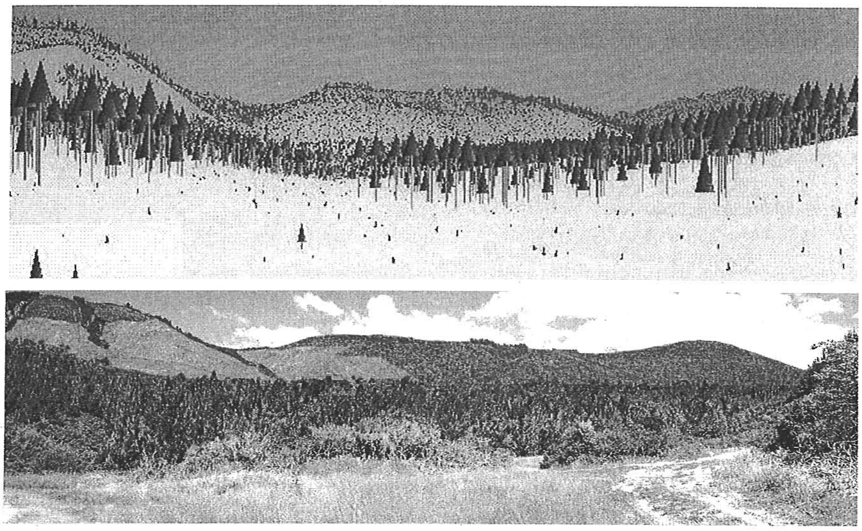

Figure 1. SmartForest II data-driven analytic visualisation projected for 1999 (upper) and Adobe Photoshop™ edited image (lower), for the Inwoods scene.

re-establishment to final mature growth) was rated in the context of a sampling of typical New Zealand plantation forest scenes. The rationale for the two procedures was that the paired comparison procedure provides the most sensitive assessment of perceived overall differences between the management options represented, while the single scene procedure more closely approximates the typical context in which a forest visitor might encounter the effects of forest management on the landscape.

The paired-comparison survey was presented in an individual interview procedure applied to both New Zealand residents and to samples of foreign visitors. The single-scene assessment was presented to groups of New Zealand residents and to one small group of foreign visitors.

Paired-Comparison Format

Visualisations for each management scenario for each represented site were laid out as individual colour prints arrayed on single A4 pages of a test "booklet" (photo-album). For each site-management scenario individual scenes were arrayed in a sequence from: [i] original condition (mature forest); [ii] immediately after harvesting; [iii] new forest (two years after planting; [iv] young forest (eight years); [v] after thinning and pruning (10 years); and [iv] back to mature forest (20 years).

For four of the five forest sites represented (Rai Valley, Wai-iti Road, Inwoods, and Kerr's Hill) the management plans compared differed only in whether the re-establishment of the forest following initial clear-cut harvest was accomplished by planting new trees in vertical rows (running up the slope) or in horizontal rows (following the contours of the slope), (Fig. 2). For the fifth site (Norris Gully) two pairs of scenarios were created, the first comparing vertical planting with and without a buffer of trees (in this case larch), screening the harvested-planted area (Fig. 3), and the second comparing contour planting with and without the screening buffer.

The resulting six visualisation pairs were incorporated into the test booklet so that the two alternatives for each depicted forest site (vertical vs contour planting, or buffer vs no buffer) were displayed on facing pages of the booklet. Thus, participants were presented with pairs of visualisation pages, with each page presenting the six developmental steps (pre-harvest through cutting, planting and regrowth) for one of the management approaches

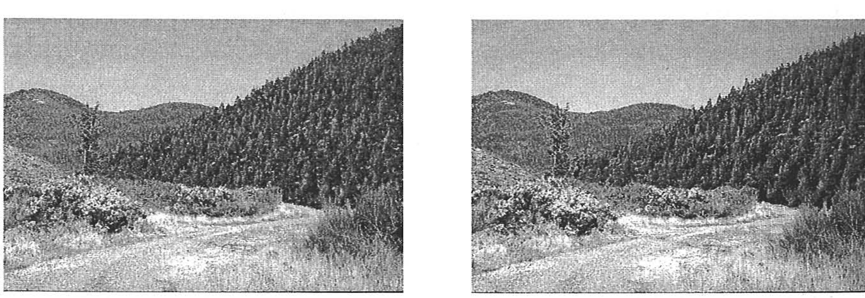

Figure 2. Photorealistic visualisations, age eight, of contour (left) and vertical (right) planting schemes, at the Rai Valley site.

If you **think** this looks
wait until **you see**

Forests For Tomorrow

impressive, what we made from it

Spectacular, isn't it? Not only does it make a stunning panorama, it also delivers some pretty impressive returns.

Last year, Carter Holt Harvey Forests produced 4.5 million tonnes of radiata pine – in 50 grades – for both domestic and export processing. And because our forests are a renewable resource, the future looks even more promising.

As one of the largest forest and building product companies in the Southern Hemisphere, our forests support several more thriving industries in downstream processing.

These industries produce a wide range of wood based products including lumber, panel products and pulp and paper.

And our company will continue to provide first class products, export earnings and employment for the future benefit of all New Zealanders.

Our forestry is one of this country's most valuable resources.

We all stand to make something from it.

Carter Holt Harvey
Forests

(e.g. vertical or contour planting) simulated for a specific site (e.g. the Rai Valley site). Comparisons always involved different management plans applied to a single site. Participants were not presented with any comparisons between the different forest sites. For each pair of visualised alternatives (facing pages), the participants were required to select the one alternative which in their judgement represented the best overall visual effects.

Figure 3. Photorealistic visualisations, age two, vertical planting scheme with buffer (left) and no buffer (right), at the Norris Gully site.

Single-Scene Format

A selection of the individual scenes that composed the overall visualisations for each management alternative at each site were chosen for presentation to groups of New Zealand residents. For each site/management option scenes were generally selected to represent forest conditions at pre-harvest, immediately after harvest, after two years, after 10 years and at full regrowth (20 years post-harvest). These individual visualisation scenes were rendered into colour slides, divided into two presentation sets (Table 1) and mixed with 30 additional colour slides depicting different scenes of typical forest plantation sites in various stages of harvest and regrowth.

Table 1. Scenes selected for group presentation sets.

Site	Presentation A	Presentation B
Rai Valley	Immediate post harvest	Regrowth - 20 years
	Vertical - 2 years	Contour - 2 years
	Vertical - 10 years	Contour - 10 years
Wai-iti Road	Pre-harvest	Regrowth - 20 years
	Immediate post harvest	Contour - 2 years
	Vertical - 2 years	Vertical - 8 years
	Contour - 8 years	Contour - 10 years
	Vertical - 10 years	
Inwoods	Regrowth - 20 years	Pre-harvest
	Vertical - 2 years	Immediate post harvest
	Vertical - 10 years	Contour - 2 years
	Contour - 8 years	Contour - 10 years
Kerr's Hill	Pre-harvest	Immediate post harvest
	Vertical - 2 years	Contour - 2 years
	Contour - 10 years	Vertical - 10 years
	Regrowth - 20 years	
Norris Gully	Buffer/Immediate post harvest	Pre-harvest
	No Buffer/ Vertical - 2 years	No Buffer/ Immediate post harvest
	Buffer/Vertical - 10 years	Buffer/Vertical - 2 years
	No Buffer/ Vertical - 20 years	No Buffer/ Vertical - 10 years
		Buffer/Vertical - 20 years

Individual participant groups were shown either presentation set A or set B, so that each group saw between three and five "versions" (harvest/regrowth stages) of a given forest site, randomly mixed with three to five versions of each of the other visualisation sites, and 30 other scenes. The goal of this procedure was to better represent the context in which forest management effects are typically experienced by forest visitors, e.g. many different sites are encountered, and each site is in one or another stage of development. Participants were required to rate each of the 50 scenes on a ten-point scale that extended from "very low scenic quality" to "very high scenic quality".

Table 2. Location of survey points and number of respondents identified as resident or visitors.

Location	Number of Residents	Number of Visitors
The Town Centre, Nelson	21	4
Visitor Information Centre, Nelson	12	2
Nelson Airport	114	12
Nelson Polytechnic Institute	51	0
Picton to Wellington InterIslander Ferry	83	100
Christchurch	26	0
Rotorua	32	14
Other	29	1
Total	368	133

Participants and Procedures

No attempt was made to achieve a formal "representative random sample" of either New Zealand residents or of foreign visitors for this perceptual assessment. Rather, a "convenience sample" procedure was employed, which has proven adequate in similar previous studies (e.g. Daniel and Boster 1976; Malm *et al.* 1981). Participants for the paired-comparison portions of the survey were intercepted by two female interviewers at highly frequented locations in the region of the forest sites represented and asked to participate voluntarily (no remuneration or other incentives were offered). For the individual scene presentations to groups, an attempt was made to sample a cross-section of New Zealand resident groups that were *a priori* expected to have different perspectives and values regarding forest plantation management.

Paired-Comparison Sample

The paired-comparison assessment was conducted by individual intercept interviews carried out in the Nelson Region and in Christchurch in the South Island and in Rotorua in the North Island of New Zealand. Locations for the interviews were chosen to provide a target number of 500 participants, divided between New Zealand residents and foreign visitors. Thus, interview sites were chosen where there was expected to be a relatively rapid turnover of people (such as a town centre or a visitor information facility), and where people would be expected to have time available to complete the survey (such as the InterIslander Ferry and the airport). Given these criteria, a list of locations was selected as shown in Table 2.

The town centre, the Polytechnic, and the airport locations were primarily aimed at the local resident population. The Inter-Islander Ferry was chosen as likely to provide a higher proportion of overseas visitors. Christchurch and Rotorua locations provided mostly New Zealand residents who lived outside the immediate area of the study. Other locations included the town centre in Richmond, flea markets in several towns near the study area, and nearby beaches and other recreation areas (where individuals proved reluctant to interrupt their play to participate). The interviews were all conducted between February 9 and 24, 1996. Interview times were selected to concur with observed peak times of occupancy which was typically around midday. The most successful areas in terms of number of participants were the airport (Nelson) and the InterIslander Ferry, both due to the number of people passing through and to the relatively large amounts of time people spend at these locations. Also, people in these areas were typically seated, which apparently made them more willing to participate.

The intercept interviews were carried out with the use of the "booklet" (photo-album) of forest management visualisations described above. It was found that the most effective way of interviewing the public was to approach them as they were waiting and ask them if they would like to participate. For their ease, the participants were given a clipboard and pen so they could take all the time required to study and complete the questionnaire. The questionnaire and answer sheet were designed to be as logical and as simple as possible so that it would apply to the greatest cross section of the public. For each visualisation-pair, participants were required to first choose the alternative which they judged as presenting the best overall visual quality, and then to allocate 100 "points" to indicate how much better the preferred alternative was. An allocation of 50/50 indicated no perceptible difference – the participant was simply guessing – and an allocation of 100/0 indicated that there was the maximum possible difference between the alternatives.

Some of the participants had difficulty understanding the printed instructions, and so it was necessary for the interviewer to take them verbally through the procedure, resulting in more time being devoted to some respondents than to others. Each interviewer used two or more booklets, allowing the participation of more than one person simultaneously.

Individual-Scene Group Sample

The group presentations complemented the intercept interviews by purposely targeting different sectors of the overall survey population (e.g. forest industry groups, community political groups, and environmental interest groups). Letters were sent out to local interest groups in the Nelson area, with the aim of contacting a wide spectrum of interests related to forest plantation management. The groups that finally participated are listed in Table 3.

Table 3. Group presentation participants by affiliation.

Group	Number of participants
Presentation set A	
The National Council of Women	12
The Keep Nelson Beautiful Society & The Nelson Tree Planters	14
Presentation set B	
The New Zealand Federation of University Women	16
The Youth Hostel Association	7
The Federated Farmers	12
The Friends of Nelson City	6
Foreign visitor group	5

The group presentations were each about three-quarters of an hour in length. Each session comprised a brief introduction and instructions (postponing discussion of the objectives of the study) followed by presentation and rating of the 50 slides. Only after all the ratings had been completed was there an explanation of how the visualisations were produced and the objectives of the study.

Demographic and Other Information

Each participant in both the paired-comparison and the single-scene presentation groups completed a brief questionnaire about themselves and the nature of their experiences and relationships to the New Zealand forests and landscape. Resident participants provided information about place of residence, ethnicity, frequency and contexts of visits to forest areas, family involvement with forest industry, and environmental group memberships. Non-residents provided information about country of residence, number of visits to New Zealand, purpose of present visit, and memberships in environmental interest groups.

In addition, residents provided an estimate of the 'contribution of the pine forests to the quality of the New Zealand landscape' by marking a line that extended from 'extremely negative' to 'extremely positive'. Non-residents indicated three factors (from scenery/landscape, food/accommodation, people, adventure activities, Maori culture, wildlife, horticulture, weather/climate) that 'made the greatest positive contribution to quality of your visit', and also indicated their judgement of the contribution of the "pine forests to the quality of the New Zealand landscape" using the same line-marking procedure as used by residents.

Results and Discussion

Visualisations

As part of the intent of this project was to provide new forest management tools, and to guide forest managers in satisfying multiple resource objectives, it is important to evaluate the usefulness of the tools used in relation to operational forest management practices. Although the development of the visualisations was successful, the complex nature of the data and tools utilised for the process would require customisation, integration with individual databases and operator training before they could be used routinely.

We recognised that to achieve photorealistic, defensible, data-driven visualisations issues of integration and accuracy of each of the diverse data sources would be critical. Several factors contributed to our success in providing visualisations of future forest conditions on a complex landform involving a number of individual forest stand components. These include the accuracy of the spatial data, availability of well-validated forest modelling systems, and suitable landscape visualisation software. The synergy of all these factors is not generally available for much of the New Zealand forest estate at present. The key for forest managers, however, is to realise what is possible with the increasing use of integrated GPS, digital camera and computing technologies and to simply start collecting the data.

The image-editing processes were time-consuming and expensive. Despite the extensive preparation work, it was difficult for the image-editors to achieve a good fit between image parts. It was also intellectually taxing to synthesise the multiple concurrent demands of the study design into a single image. However, realism currently achievable by more directly data-driven visualisation tools is not good enough to support choices involving the appearance of scenic resources.

A 'spin-off' benefit during the image-editing phase was the perceived need to generate a consensus view among a panel as to the representation of conditions on the ground. We found that this view may in fact be more valuable information than a precise biological description. While there is an obvious need to supply the management process with better information, the collected judgements of experienced managers are also a valuable source of data. A possible by-product of such collaborative reviews may be a better grasp of the salient issues and a better shared understanding within a management group. This speculation is untested, but based on our interpretations of observing other review processes.

Perceptual Survey

The primary results of interest were the expressed preferences among the visualised alternative management scenarios in the paired-comparison interviews, and the scenic quality ratings provided by the groups in the single-scene assessment. Comparisons were made in the assessments of residents and non-residents, and among the various sample locations and interest groups represented.

Paired-Comparison Results

Participants did not exhibit differential preferences for the visualisations of vertical planting as compared to contour planting methods (Fig. 4). At the Rai Valley,

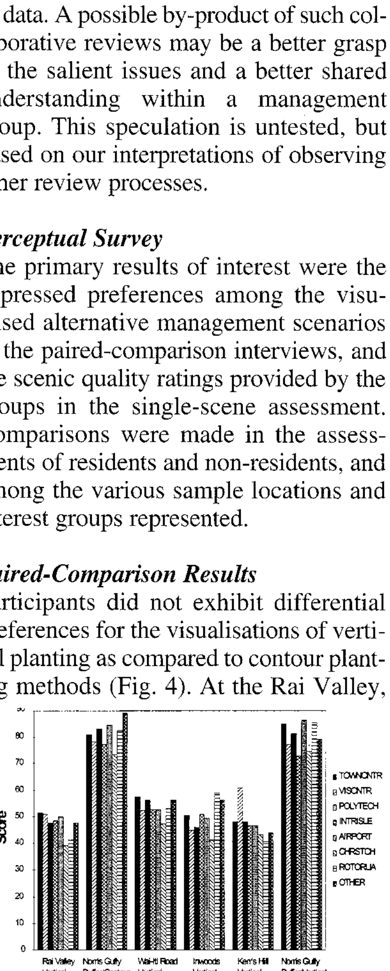

Figure 4. Paired comparison scores by location and site.

Wai-iti Road, Inwoods Lookout and Kerr's Hill sites all average point allocations for the Vertical option were not significantly different from 50/50. With regard to the comparisons of buffer vs no buffer (the Norris gully site), the visualisations that retained the buffer of larch trees screening the harvested area were consistently and substantially preferred for both the vertical and the contour planting options represented, with point allocations averaging 80/20 in favour of buffers in both cases.

Figure 4 also shows no significant variation in the responses of participants interviewed at the various locations, nor were there any differences between residents and foreign visitors. The assessments of participants who indicated different relationships to the forest landscape – those with direct personal or family involvement in forest industry, membership of environmental interest groups, and others were similar (Fig. 5).

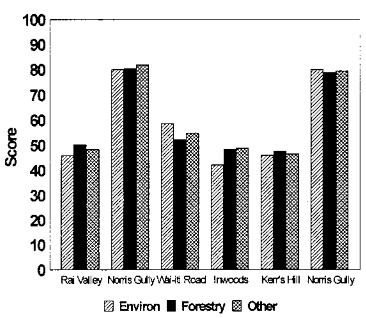

Figure 5. Scores by relation to forest landscape groupings and site.

Single-scene Results

Average rating, across all interest groups, for each of the single scenes for two representative sites show no difference in preference for the overall visual effects of vertical and contour planting (Fig. 6), but there is some indication that contour planting was judged to produce higher scenic

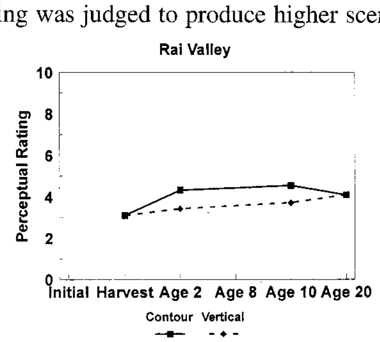

Figure 6. Perceptual rating for contour versus vertical planting schemes, at Rai Valley site.

quality at the two points (age two and age 10 – post thinning and pruning) where the two planting patterns would be the most visually conspicuous. The ratings for the individual scenes depicting buffer and no buffer conditions (Fig. 7) is consistent with the overall preferences expressed in the paired-comparison assessment – buffered scenes were consistently preferred.

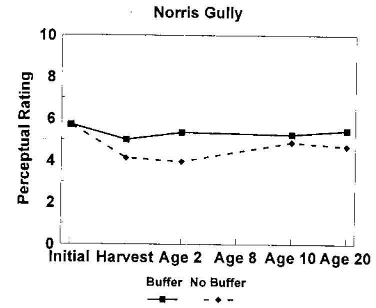

Figure 7. Perceptual ratings for buffer versus no-buffer for vertical planting schemes, at Norris Gully site.

Questionnaire Results

Table 4 presents some of the more important results from the brief demographic-forest experience questionnaire. Of particular interest is a comparison of the importance ascribed to the contribution of 'pine forests' to the quality of the New Zealand landscape by residents and visitors. These data were derived by measuring the location of the marks on the line provided on the response form, and then transforming that measurement to a scale that extended from 0 at the lowest end to 10 at the highest. Nelson area residents (closest to the study area) indicated the lowest (slightly negative) opinions, followed by other New Zealand residents (slightly positive). The foreign visitors tended to ascribe very similar, and substantially higher values.

Table 4. Contribution of pine forest to the New Zealand landscape, by resident type and resident origin.

Resident Type	Resident Origin	No. of Respondents	Average score for contribution of pine forest to the New Zealand landscape
Residents	Nelson and District	185	4.75
	South Island	85	6.10
	North Island	66	5.94
Non-Residents	Europe	81	7.40
	North America	32	7.60
	South America	12	7.5
	Asia & Others	9	7.9

Non-resident visitors were also asked to indicate what factors contributed most to their enjoyment of their visit. Based on the number of positive responses recorded, scenery was the most important positive factor (109 responses), followed by people (76 responses) and weather/climate (62 responses).

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ARTICLES

Vegetation recovery and indicative sediment generation rates by sheetwash erosion from hauler-logged settings at Mangatu Forest

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ABSTRACT

Soil disturbance, vegetation recovery and sediment generation by sheetwash erosion on hauler-logged settings were evaluated at Mangatu Forest. Three disturbance indices were recognised: undisturbed, shallow disturbance and deep disturbance. The latter is here referred to as areas of exposed mineral soil (EMS). Groundcover vegetation recovery was slowest on sites of EMS. Based on plot-sized areas (9 m²), EMS per cent cover averaged 31%, two years after clearfelling. Setting-based measurements showed that overall groundcover recovery was rapid, and resulted in an 83% reduction in areas of EMS within two years of clearfelling.

Mean rate of sediment generation from areas of EMS averaged 11 (SE 3.5) kg/m² for the first year and 4 (SE 2.4) kg/m² during the second year after logging. Annual rates of sediment generation from areas of EMS on logged setting were 8 (SE 2.5) tonnes/ha in year one and one (SE 0.5) tonne/ha in year two. Most sediment mobilised from areas of EMS was relocated on slopes immediately downslope of source areas, where it was effectively entrapped by surviving groundcover vegetation and slash and in microtopographic hollows. Only those riparian areas of EMS with a direct connection to a watercourse contributed much sediment to stream channels, from which 2 (SE 0.6) tonnes of sediment per hectare of logged setting was generated in the first year after logging, declining to 0.2 (SE 0.1) tonnes/ha within two years. Sediment generated by sheetwash erosion from logged settings one year after clearfelling was at least several orders of magnitude less than that generated from non-forestry-related sources, especially gullies; it was not therefore particularly significant, given the high background rates of sediment production within Mangatu Forest. Similar amounts of forest-related sediment entering streams where background rates of sediment production are low would, however, be regarded as unacceptable. It would be advantageous for the forest industry to minimise soil disturbance and consequent sediment production from hauler-logged settings, particularly within 10 m of stream channels.

INTRODUCTION

The clearance of indigenous forest from unstable hill country of the North Island's East Coast 70-100 years ago to provide pastureland heralded the beginning of a period of accelerated erosion. The principal sediment-producing mechanisms were mass movement (e.g. slumps and earthflows) and gullying. Within three decades major stream channels had become severely aggraded, thus increasing the risk and severity of flooding. With erosion control as the primary objective, much of this hill country has, since the early 1960s, been reforested with exotic conifers, principally *Pinus radiata*. Slope stability research undertaken in the East Coast Region clearly shows that reforestation has greatly reduced the rate of slope erosion through the combined processes of root reinforcement of soil, canopy interception of rainfall, and extraction and utilisation of soil moisture. The net effect is increased soil strength and enhancement of slope stability (Pearce *et al.* 1987). As a consequence, sediment delivery to stream channels by mass movements has declined significantly, although gullies continue to be the major contributor of substantial volumes of sediment, and account for the high background rates of sediment yield in this region today.

Harvesting of these forested areas commenced in 1990, renewing fears that forest removal would result in the reactiva-

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