Carson, S.D. 1989: Selecting radiata pine for resistance to Dothistroma needle blight. N.Z.J. For. Sci. 19(1):3-21.
Carson, S.D. 1991: Genotype x environment interaction and optimal number of progeny test sites for improving *Pinus radiata* in New Zealand. N.Z.J. For. Sci. 21(1):32-49.
Carson, S.D. and M.J. Carson. 1991 Realising gains in resistance to Dothistroma. *In* Dean, C. and C. Hanel. Proc. 11th Research Working Group 1 (Forest Genetics), Australian Forestry Council. March 11-15, 1991. Coonawarra, South Australia. Pp. 71-75.
Johnson, G.R. and R.D. Burdon. 1990: Family-site interaction in *Pinus radiata:* implications for progeny testing strategy and regionalised breeding in New Zealand. Silvae Genetica. 39:55-62.
Shelbourne, C.J.A. 1970. Genetic improvement in different tree characteristics of radiata pine and the consequences for silviculture and utilisation. Pp. 44-58. In Sutton, W.R.J. (Ed.). Pruning and Thinning Practice. Symposium Mar. 16-20. 1970, Rotorua. FRI Symposium No. 12.
Shelbourne, C.J.A., R.D. Burdon, S.D. Carson, A. Firth, and T.G. Vincent. 1986: Development plan for radiata pine breeding. Forest Research Institute, Rotorua. 142 p.
Shelbourne, C.J.A., and C.B. Low. 1980. Multi-trait selection and associated genetic gains of *Pinus radiata* progenies at five sites. N.Z.J. For. Sci. 10(2): 307-324.
Sweet, G.B., and Krugman. 1977. Flowering and seed production problems – and a new concept of seed orchards. Third World Consultation of Forest Tree Breeding, 1977. 8p.
Vincent. 1987: Certification system for forest tree seed and planting stock. NZFRI Bulletin No. 134.
Vincent. 1990: You choose the parents. NZFRI What's New No. 182. 4p.
Vincent. 1987: Which radiata pine seed should you use? NZFRI What's New No. 157. 4p.
West, G.G. 1993: managing stands of radiata pine using PC-STANDPAK. New Zealand Forest Research Institute, What's New in Forest Research No. 229.
Whiteside, I.D. 1990: STANDPAK Modelling system for radiata pine. In James, R.N.; Tarlton, G.L. (Ed.) New Approaches to Spacing and Thinning in Plantation Forestry: Proceedings of a IUFRO Conference held at the Forest Research Institute, Rotorua, April 10-14, 1989. Ministry of Forestry, FRI Bulletin No. 152.

Preferences for scenarios of land-use change in the Mackenzie/Waitaki Basin

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ABSTRACT

Earlier research on the effects of land-use change on a range of landforms in the Mackenzie/Waitaki Basin identified three dominant preference themes: for plantations, for a combination of grazing and trees, and for conservation (Fairweather and Swaffield, 1995). These themes were used to generate five scenarios of land-use change for the area, for each of which the detailed visual, economic, and social effects were modelled (Evison and Swaffield, 1994). This article reports on preferences for these scenarios.

The results suggest that preferences for the effects of land-use change are relatively stable, that detailed information on effects had only minor influence upon the ordering of preferences for scenarios, and that levels of acceptability for the preferred scenarios were high. Overall, there was support for a significant increase in plantations, shelterbelts and improved pasture, but wilding management was considered essential. The diversity of preferences suggests that a widening range of land uses can be expected to occur in the future.

INTRODUCTION

The Forest Research Institute's Planning for Rural Environments research programme has brought a number of research perspectives to bear on rural planning, with the overall aim of developing improved methods for managing land-use change. In particular, the programme has focused on potential land-use changes in the Mackenzie/Waitaki Basin study area, employing a suite of techniques useful for predicting and evaluating the visual, economic and social effects of particular combinations of agriculture and forestry (Evison and Swaffield, 1994). These techniques include GIS research and computer visualisation (Hock *et al.*, 1995; Bennison and Swaffield, 1994), attitude surveys (Fairweather and Swaffield, 1995), socio-economic analysis of forestry/agriculture options, and property-level economic analysis of land-use change. Findings on the effects of land-use change in the study area can be used by farmers and others involved in high-country management, whilst the improved planning procedures contribute generally to the development of decision support systems for rural planners throughout New Zealand.

An essential part of the FRI study has been the presentation of data on predicted effects of land-use change involving forestry to a range of interested parties, in order to assess the acceptability of the options available. The procedure adopted in the early stages of the research in 1993-94 was to disaggregate and simplify the complex of variables potentially involved, in order to present relevant information in a cost-effective and meaningful way. Landform and rainfall were selected as key biophysical variables determining the viability of land-use options. A Geographic Information System (GIS) database was developed for the study area, from which four landform categories were defined and for which the effects of different land-use options were estimated. The landforms were: hills slopes between 16° and 35°, lower slopes between 8° and 16°, and flats less than 8° (all three with greater than 800 mm annual rainfall), and flats less than 8° with less than 800 mm annual rainfall. The analysis highlighted a number of operational issues involved in applying GIS to an extensive study area with complex landforms. As a result, some expert interpretation of anomalies in the data set was needed (for example, to distinguish 'lower' slopes, which were taken to be slopes and debris flows adjacent to the basin floor, from small areas of modest slope angle located at higher elevations). Similarly, given the goal of broad-scale categorisation, small areas of distinct landform with an area of less than 10 ha (for example, small moraines, or flatter hill tops) were aggregated with the adjacent landform type. Detailed explanation of the derivation of these categories is given in Hock *et al.* (1995).

For each landform a set of information cards had been pre-

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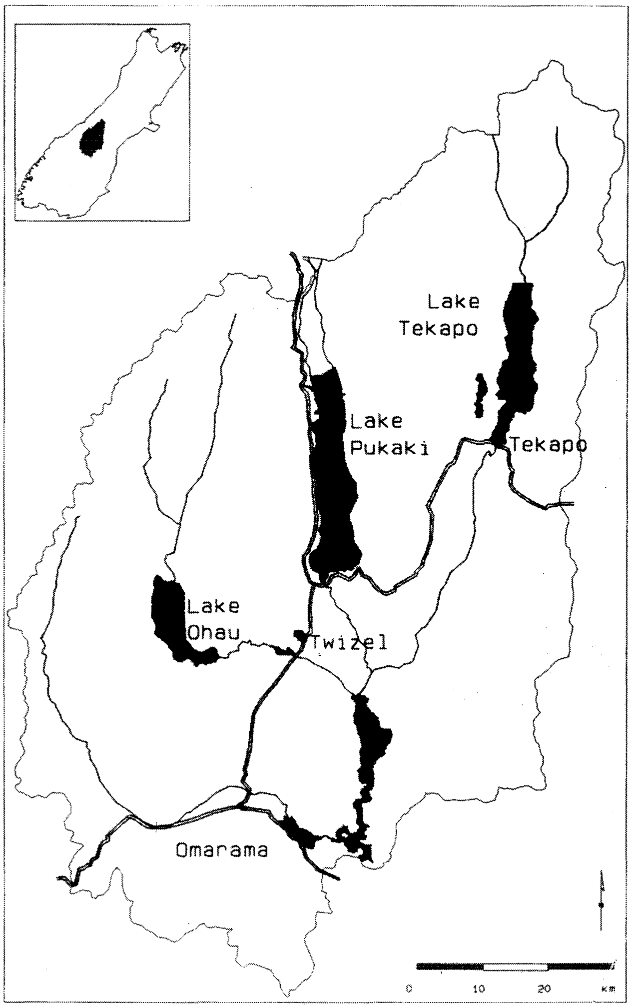
pared showing the predicted visual, socio-economic and soil status effects after 50 years for a range of technically feasible extensive land uses. While the predicted visual effects, shown as visual images, were quite detailed, the other effects were preliminary estimations. The land uses modelled included commercial plantations on either 15% or 70% of the available land (i.e., either limited or widespread afforestation); improved pasture associated with productive woodlots or with shelterbelts; non-commercial afforestation for soil conservation in drier areas; irrigated pasture and shelterbelts in drier areas; destocking, in order to facilitate restoration of tussock grasslands; or no change (i.e., continued extensive grazing). As the effects of any particular land-use change could vary across landforms, we aimed to find out what people thought about land-use change for each typical landform. Once preferences for the range of possible effects had been assessed, these would be used as the basis for more detailed modelling of visual, economic and social effects associated with the land uses that were most generally acceptable to the community.

The first stage of research into preferences for the effects of land use had been based on Q sort analysis[1] (Brown, 1980). This assessed the preferences of 77 respondents for information cards showing predicted effects on each of the four landforms. The results (see Fairweather and Swaffield, 1995) had shown that there were some distinctive overall patterns among the variety of individual preferences. These summary patterns were described as preference themes. It should be noted that individual respondents did not necessarily apply the same preference themes across all landforms. In other words, an individual might typically express a preference for plantations on one landform, but for a combination of improved pasture and woodlots on another. Furthermore, there were no clear patterns of preference for particular interest groups. Despite this detailed variability, however, there were highly significant aggregate preference themes for particular land-use effects on the hills, lower slopes and higher-rainfall flats landforms. We have labelled these themes as: 'Plantations', 'Grazing/Trees' and 'Conservation'.

A detailed analysis of the methods used and results is presented in Fairweather and Swaffield (1995). In summary however, the findings are as follows. In the 'Plantation' theme the important feature was a preference for the role of large plantations for economic production on the hills and lower slopes, and for soil conservation on the higher-rainfall flats. In the 'Grazing/Trees' theme the key element was preference for a combination of trees and grazing for economic production, comprising plantations and grazing on the hills, and shelterbelts on the lower slopes and higher-rainfall flats. In the 'Conservation' theme the essential features were preference for small plantations and destocking on hills, with larger plantations and destocking acceptable on lower slopes and higher-rainfall flats, although retention of views was a concern on the higher-rainfall flats. For the latter two themes management to control wildings was very important. Preferences relating to the fourth landform, the lower-rainfall flats, were significantly different from the other three landforms, and emphasised different combinations of grazing and trees.

These preference themes identified in the 1993-94 study were then used as a basis for more detailed modelling of the visual, economic and social effects of potential land-use change. The intention was to undertake an evaluation of the acceptability of different combinations of land-use effects, in order to both develop a better understanding of the pattern of preferences amongst respondents, and to assess the effectiveness and validity of the first round of preference surveys based on separate landform predictions. However, while it may have been technically possible to model all combinations of land uses and landforms, this would have been expensive to develop and would have required a complex and extremely time-consuming reassessment by respondents. For operational reasons therefore, in the second round of appraisal we wanted to have a small set of combined options, with their associated economic and social predictions. We therefore used the preference themes (derived from data based on landforms) to develop five scenarios of different land uses over the study area as a whole. Scenarios are widely recognised in planning and management as a useful way of exploring a range of possible future situations. Three of the scenarios we developed were based directly on the dominant preference themes identified in the first survey, of Plantations, Grazing/Trees, and Conservation. In addition, another two scenarios were developed based on land-use options which respondents appeared to find acceptable but were not necessarily enthusiastic about. In effect, these represented the least unacceptable options, and therefore constituted compromise scenarios.



Location of study area.

The research reported in this article focuses on the results related to this second stage of scenario modelling. The main objective of the field research was to assess preferences for a range of possible scenarios for the study area. In addition, it examined stability of land-use preferences and addressed the issue of whether preferences for separate landform options were a valid basis for developing overall scenarios. The underlying questions were: Did respondents find acceptable any of the scenarios? Did this acceptability change when they considered the associated economic and social effects? Were scenario preferences related systematically to the land-use preferences from which they were derived? If they did, we could be reasonably confident that the landform by landform assessment of land-use change and their effects was a valid and useful way of tackling complex land-use change. In addressing these questions the research also began to feed back to respondents some of the data derived from the earlier phase of research.

SCENARIOS AND ASSOCIATED INFORMATION

The study area used for the scenario modelling comprised the catchment of the Mackenzie and Waitaki Basins upstream from Benmore Dam. However, large areas were excluded from detailed analysis, for a range of reasons. The GIS analysis separated out all land over 1100 metres in altitude as being normally unsuited to forestry (Belton, 1991), and also excluded high-priority conservation and agricultural areas. These included Mt Cook National Park and other land identified by DOC as being of conservation significance due to the presence of representative, rare or unique species, and land either already converted to, or with potential for, intensive agriculture. The validity of any such process of exclusion is clearly open to debate over detailed application of criteria and areal delimitation of available land. However, given the overall planning focus of the study, it was decided to utilise earlier work in the study area rather than undertaking entirely new empirical analysis. Exclusions were therefore based upon the recorded outcomes of a series of community consultations and analysis that had been undertaken by government agencies and consultants in association with the Rabbit and Land Management Programme (Belton, 1991) and the proposed District Council scheme change (Boffa Miskell Partners, 1992). Full details of the geographic delimitations are available from B. Hock, NZFRI. The result of the filtering process was that the remaining land considered available for change constituted 215,504 ha (28%) of the total study area, classified into the four different landform types noted above.

Five scenarios of land-use change were then developed:

1. **Scenario A, Plantations:** 12 different regimes of production forestry are planted across 70% of the available land in all four landforms. It is assumed that no plantations or shelterbelts currently exist and that all trees are planted in equal annual amounts over the next 50 years, using the lower-quality land first, before being harvested at age 45. Species, spacing and pruning are selected to maximise returns under current predictions of productivity and market conditions. On the dry flats the plantations are designed for soil conservation with little commercial value. Wilding management is undertaken to prevent tree spread.
2. **Scenario B, Grazing/Trees:** Shelterbelts and improved pasture are developed on 70% of available land on lower slopes and higher-rainfall flats. Plantations are planted on 15% of the hills with the remainder in extensive grazing. Shelterbelts and irrigated pasture are introduced on 15% of the dry flats. Wilding management is undertaken to prevent tree spread.
3. **Scenario C, Conservation:** the total area *available* for change is destocked over 10 years, starting with the land with lowest carrying capacity. (No wilding control is modelled because it is assumed that no trees exist.)
4. **Scenario D, Compromise I:** 12 different regimes of production forestry are planted across 15% of available land in all four landforms. There is no wilding management and by year 12, new self-sown forests begin to emerge, ultimately yielding harvestable timber on another 15% of the available area in each landform. Unplanted land remains in extensive grazing.
5. **Scenario E, Compromise II:** 12 different regimes of productive forestry are planted across 15% of all four landforms. However, in this case wilding management is undertaken to prevent tree spread, and extensive grazing therefore continues upon the balance of 85% of available land.

In both scenarios D and E, plantations on the dry flats were treated as non-commercial.

A variety of techniques were used to prepare information relating to the scenarios to be presented to respondents (Evison *et al.*, 1995; Hock *et al.*, in preparation). The full list of the available information, including images, and predictions of economic and social effects, included:

1. The location of all four landforms areas shown on a colour-coded map of the study area.
2. Economic estimates for livestock units, wood volumes, gross household income and employment in primary production for each of the scenarios, presented as tables (giving the current level, the 45-year steady-state level and the increases for each scenario) or as graphs (giving annual figures). Data for income and employment were estimated for the basin, district and region. In addition, net processing impacts were estimated for employment and income in the basin, district and region. However, because of the uncertainty associated with predicting the nature of possible industrial development and its location, we have not focused on the processing effects in our modelling.
3. Social estimates for a range of indicators related to population: for example, school rolls, teaching and housing numbers, etc.
4. Computer generated images of the predicted character and appearance of each scenario; one set for the hills, lower slopes and higher-rainfall flats combined, and one set for the lower-rainfall flats (see Bennison and Swaffied 1994). The separation was necessary, due to the impracticability of visually modelling all four landforms within the same view.

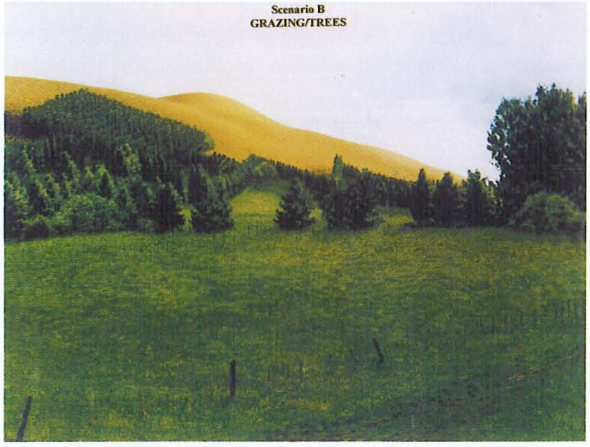
The data for items 2 (graphs) and 4 (the first set of images) are presented on pages 21 and 20 respectively.

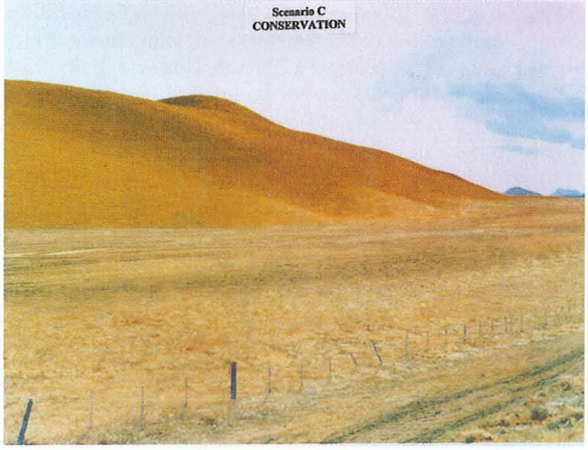
RESEARCH DESIGN AND METHOD OF PRESENTING INFORMATION

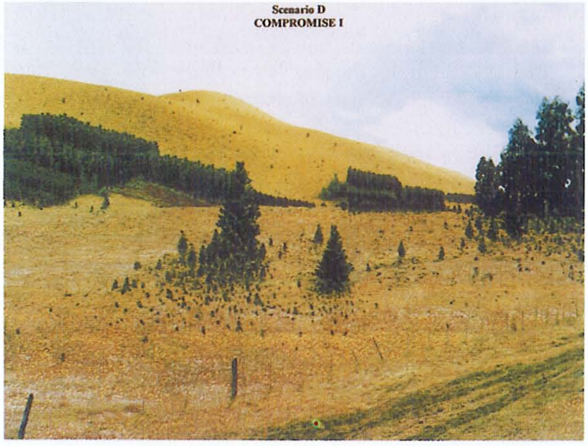
The main objective of the field research was to assess preferences for scenarios. Given the variety of available data it was important to consider carefully how the images and data should be presented. We thought it best to establish a baseline link to the earlier Q sort by having selected respondents first undertake the landform based Q sort again, using the original image cards. In this way we could assess whether preferences had changed between May/June 1993 and May 1995. If these preferences had changed then preferences for scenarios may also have changed. We also used the original land-use preferences for specific landforms to predict preferences for scenarios. If, for example, a stakeholder preferred the grazing/trees theme on hills, lower slopes and higher-rainfall flats, then we expected that respondent to prefer the grazing/trees scenario. If our predictions were poor, then it would suggest that people did not find the scenarios to be acceptable representations of their preferred outcomes.

The scenarios were then introduced to the selected respondents and described briefly by means of a small card on which were placed labels (A to E), title, and brief summary of key elements of the scenario. The selected respondents were asked to *rank* in order the five scenarios from most acceptable to least acceptable to them, for the study area as a whole. Then they were asked to *rate* each scenario separately on a five-point acceptability scale, in order for us to gain some idea of the degree of acceptability of each scenario.

After this initial assessment of the five scenarios, additional information on predicted effects was introduced sequentially, and the ordering and rating of the five scenarios was repeated as the respondents considered their preferences in the light of the newly supplied data. The data for most variables were presented on graphs, colour-coded for scenarios, to the year 2082, while a bar chart was used for the population projections. Information was presented in an order that started with basin total livestock units, then moved to basin total harvested wood volumes, basin total employment and basin total income. Only one social variable was







used and that was basin total population[2]. Two approaches were used to assess visual preferences. First, for each scenario the four separate landform images that corresponded to the regimes used in the scenario were attached to an A4 card and these composite cards were rank ordered and rated by respondents. Next, the new composite scenario images (including hills, lower slopes, and higher-rainfall flats) were presented at A4 size and ordered and rated. Finally, the selected respondents were asked to give a final assessment of the five scenarios taking into account *all* of the information presented. In total there were 22 selected respondents, each of whom made nine assessments of the scenarios, making a total of 198 decisions.

This design meant that only some of the images and data available were formally presented to respondents. For example, the scenario images for the lower-rainfall flats were not presented unless requested. We knew from earlier experience that there was a limit to the amount of information that respondents could integrate when expressing preferences. However, the full set of images and data was available at the interview in case questions were asked by respondents that required more detailed answers. In practice only two or three respondents asked questions of detail, and even in these cases only a small proportion of the available data was needed. Thus nearly all of the scenario preferences expressed were based on the key data actually presented. The level of data supplied appeared to be appropriate because the interviews were completed relatively easily. Questions asked about the overall research approach at the end of the interview resulted in typically very positive comments about the research, and no adverse comments about the format of the interview.

Interview respondents were selected from the 77 representatives of interested parties who had been interviewed in the earlier phase of research. Initial selection was based on results in that earlier interview. First, we selected clear proponents of each of the three land-use preference themes as 'typical' cases. There were ten such respondents. A further eight respondents were then selected who had not been clear proponents of any preference theme. To these were added four respondents who had been used for pre-tests, two of whom were typical of the overall themes and two of whom were not. The total of 22 respondents therefore covered those for whom the scenarios should be similar to their landform preferences, and those for whom the scenarios were unlikely to be so similar to their landform preferences. It should be noted that sample selection for Q method does not use statistical sampling methods. The analysis assumes that the sample is selected theoretically, to cover the range of likely preferences being expressed, rather than being representative of a population. This type of theoretical sample is also most suited to test reactions to the five scenarios. There were nine categories of respondents included in the initial sample (farmer, service provider, commercial adviser, local business, politician, Takata Whenua, recreation/conservation, statutory adviser and regional adviser) and respondents were selected from each category for the second round of interviews. All selected respondents were interviewed during May 1995.

RESULTS AND DISCUSSION

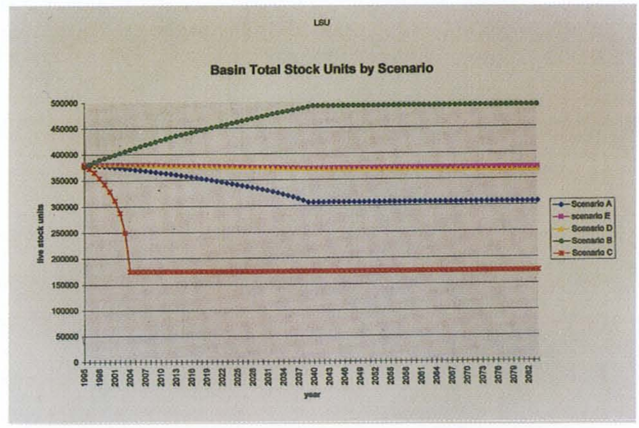
Stability of preferences found from successive Q sorts

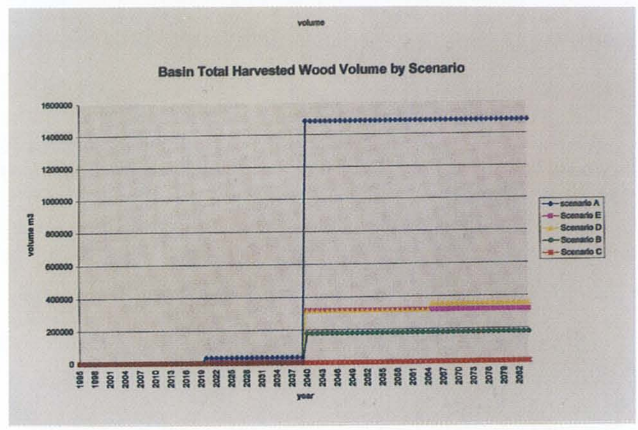
The results indicate the degree of change in respondents preferences over the two-year interval between the first and second survey. Of the 22 respondents there were 12 whose 1995 Q sorts of the landform-based image cards were relatively unchanged compared to the first (1993) Q sort, having statistically significant correlations[3] between Q sorts for the hills, lower slopes and higher-rainfall flats. In fact, for 11 of these 12 respondents their Q sorts were identical for all three landforms, while for the remaining one respondent the Q sorts were identical for two of the three landforms. There were 10 respondents whose second Q sorts were different: however, for seven of these cases the second Q sort expressed a more consistent pattern of preference than in the first survey and they expressed the same preference in the second Q sort for either two or three of the four landforms. Overall, there were 19 out of 22 respondents whose preferences appeared to be stable. However, we note that the greater coherency in the second round of preferences may have been due to the shorter time given to the second Q sorts, which meant that respondents reacted mostly to the visual effects (the images) rather than the written information about the predicted social and ecological effects. (We had observed in the first Q sort that in some cases the order of preference originated from assessing the visual images and was then modified when attention was given to the written information on the image card.) Finally, there were three respondents whose second Q sorts were significantly different from their first Q sorts. These respondents had unstable and inconsistent landform preferences. Respondents who had changed their preferences either partially or completely included a politician, a service provider, three local business operators, a commercial adviser, three statutory advisers, but only one farmer.

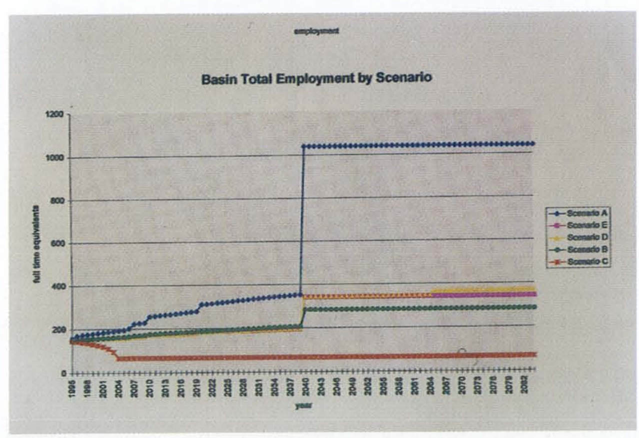
Responses to sequential information about effects

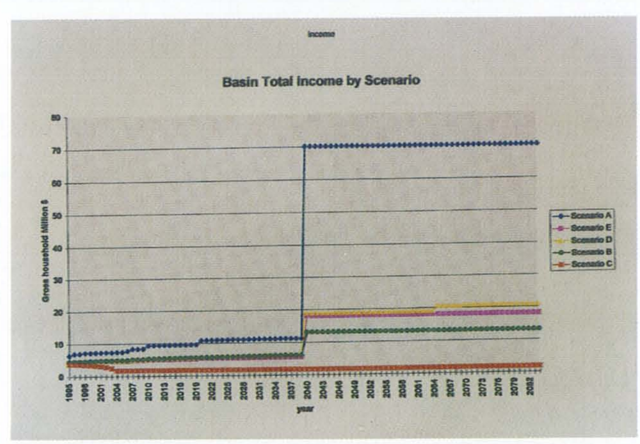
Each selected respondent was asked to sort and rate the scenarios both before and after considering the information (economic, social and visual) about the estimated effects of the scenarios. To simplify the results we focus on the three scenarios rated most highly and their order of preference. There were 21 out of 22 respondents who ranked the same scenario in first place both with and without information on effects. Further, of these 21 respondents there were five respondents who ranked the top three scenarios in the same order of preference (two of these five ranked all five scenarios in the same order), seven who ranked the top two in the same order, and nine for whom only the top-ranked scenario was the same in each ranking. Generally then, the presentation of the additional information on effects influenced the rankings of the second- and third-placed scenarios, but not the first-placed (i.e., most preferred) scenario.

Data are also available on the number of changes in scenario order that occurred as the information was presented, and on what types of information were more likely to provoke a change in order. The presentation of information stimulated a change in scenario order at some point through the process of providing the seven items of information to each stakeholder. In eight cases the order was changed one or two times, in 10 cases the order was changed three times,and in four cases it was changed four or five times. However, despite these changes, as indicated above, the final choice for the first-ranked scenario was relatively unchanged. Table 1 shows the frequency with which each item of infomation led to a change in scenario order. The landform images and the scenario images were clearly important influences









on scenario order, and to a lesser degree were stock units, wood volume and employment. Population and income had little influence on scenario order.

Table 1

Frequencies of Response to Information

Stock units	5
Wood volume	6
Employment	7
Income	0
Population	3
Landform images	19
Scenario images	17

The predicted economic effects for Scenario A (Plantations) clearly indicates significant economic development for the study area, and for many respondents the presentation of this information encouraged them to move Scenario A to a higher position in the final ordering of scenarios. Table 2 shows the frequency with which each scenario was listed in the top three rankings for the first and final ordering of scenarios.

Table 2

Frequency in First Three Rankings for Each Scenario

Scenario	First Ordering (no information on effects)	Final Ordering (information on effects)	
A (70% Plantations)	11	17	
B (Grazing Trees)	22	19	
C (Conservation)	8	6	
D (15% Plantations)	7	4	(No wilding control)
E (15% Plantations)	18	20	(Wilding control)

For Scenario A (70% Plantations) the influence of information upon effects changed the frequency with which it occurred in the top three rankings from 11 to 17, which was the largest change for all the scenarios. In the other four scenarios, however, the addition of effects information had relatively fewer overall impacts. It should be noted that not all respondents accepted the projections associated with Scenario A. In total there were five respondents who refuted, rejected, or were sceptical of the data. Nonetheless, in four of these cases they moved Scenario A up in their order of preference.

Scenario preferences

In addition to the data in Tables 1 and 2 we can report that the ratings for the preferred scenarios were very high, with 17 respondents in their final assessment choosing 'very acceptable', four choosing 'acceptable' and one choosing 'neutral'. Further, some respondents gave a 'very acceptable' rating to their second-ranked scenario. Table 3 shows the frequency with which each scenario was rated both before and after the presentation of information on effects. Scenario B clearly leads the other four scenarios with very few finding it unacceptable.

Table 3

Assessments of Scenarios Before and After Presentation of Information on Effects

	Scenarios									
	A 70% Plantations		B Grazing/ trees		C Conservation		D 15% Plantations		E 15% Plantations	
	Before	After	Before	After	Before	After	Before	After	Before	After
Frequency rated as:										
1=very acceptable	4	5	12	10	3	3	1	0	3	5
2=acceptable	6	8	5	8	3	4	4	3	13	11
3=neutral	1	5	3	2	4	2	8	7	3	6
4=unacceptable	8	4	2	2	3	5	7	11	3	0
5=very unacceptable	3	0	0	0	9	8	2	1	0	0
	22	22	22	22	22	22	22	22	22	22

The patterns across the five-point scale show that Scenarios A (70% Plantations), C (Conservation) and D (15% Plantations with no wilding control) received a wide range of assessment: while some selected respondents found them acceptable, others found them unacceptable. In contrast, Scenarios B (Grazing/Trees) and E (15% Plantations *with* wilding control) were acceptable to most, but Scenario E, true to its compromise nature, received secondary support with most selected respondents rating it as acceptable.

The patterns in Table 3 are suggestive of general preferences only and do not indicate the distribution of preferences in any population. However, the patterns exhibited by selected respondents who approve of any given scenario are of particular relevance and indicate how preferences can be expected to work in the population. The findings show the range and character of preferences of typical cases, and when such cases occur among the population as a whole it is very likely that similar patterns of preference will occur. In effect, the research delineates the structure of typical preferences. We can thus examine the general pattern of response to scenarios. Results of this analysis are shown in Table 4.

Table 4

Ratings of Scenarios Compared

Scenario rated very acceptable	Other scenarios rated very acceptable or acceptable		Other scenarios rated neutral, unacceptable or very unacceptable	
A	B	E	C	D
5	5	4	4	4
B	A	E	C	D
10	7	9	9	9
C		E	A	B
3		3	2	3

Table 4 data show that selected respondents who preferred Scenario A also supported Scenarios B and E, while selected respondents who preferred Scenario B also supported Scenarios A and E. In both cases they disliked Scenarios C and D. Those who preferred Scenario C showed the opposite pattern: Scenario E was clearly the favoured compromise, frequently selected in second place behind the first preference, and they disliked Scenarios A and B. For two out of the three times that Scenario C was rated as very acceptable, Scenario E was rated as acceptable.

Predictions of Scenario Preference

One of the aims of this phase of the NZFRI Research was to test the value of using landform-based Q sorts as a way to assess overall preferences for land-use change, that is, across landforms. We therefore compared our predictions of combined preference, based on the landform Q sorts, with the actual scenario preferences.

Table 5 shows both our predictions and actual scenario preferences, with the latter recorded after all the data were presented.

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to be less than that which would arise from planning intervention in favour of a single land use. Clearly, it is not feasible for planning in rural areas experiencing land-use change to be based on a single planning solution, as it is inevitable that at least some preferences would not be addressed.

The results show that the selected respondents' choice of their most preferred scenario is not significantly influenced by additional information about the predicted economic and social effects of the land uses. This suggests that preferences are stable despite the presentation of data that could be interpreted as being incompatible. Or, to be more precise, respondents maintain their views in the short term: we do not know what changes in their views may occur in response to such information in the long term. As noted in the earlier stages of the research (Fairweather *et al.*, 1994:108), respondents tend to use the information that is supportive of their preference to justify that preference, and when the information is not supportive they criticise the information and disagree with projections. In a similar vein, selective bits of information in that survey were interpreted in ways that were consistent with preferences. For example, where a less favoured land use would lead to population increase, this increase was interpreted as undesirable for the study area. Generally, visual information was most important in influencing scenario preference, at least for the second- and third-placed scenarios. Both landform and scenario images were responded to in most cases. However, the positive economic benefits of forestry were also noted by respondents, and appeared to be responsible for Scenario A (70% Plantations) moving to a higher position in the final ordering of scenarios.

The fact that additional information on effects did not appear to greatly influence scenario preference has implications for the role of such information in land-use planning. It may be that not only respondents, but other people, such as planners, are reluctant to change preference quickly. Thus, in our research, the negative reactions to the information on effects that was contrary to the initial beliefs of the respondents may have been quite rational, but also may have been just a first reaction. Wider appreciation of the predicted economic effects of forestry may gradually lead to support for plantations as a land use, and later exposure to the information may bring a more favourable reception. This issue will be addressed in future research in the study area which will be used to study how people respond to the results of the research to date, and examine more fully the role that research results can play in land-use change. Such an approach will require giving more attention to the social aspects of land-use change.

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REFERENCES

Bennison, T. and S.R. Swaffield. (1994). Visualisation of land-use scenarios using digital terrain models and image rendering techniques. Proc. Image and Vision Computing Society New Zealand 94, Massey University 16-17: 1994.

Brown, S.R. (1980) Political subjectivity: applications of Q methodology in political science. Yale University Press: New Haven.

Evison, D., B. Hock, L. Langer, B. Manley, L. Te Morenga, S. Swaffield, J.R. Fairweather and T. Bennison. (1995) Bringing community preferences into land-use planning. NZFRI, Rotorua, What's New in Forest Research No. 240.

Evison, D. and S.R. Swaffield. (1994) Planning for rural land-use change in the South Island High Country. NZ Forestry, February 1994: 38-39.

Fairweather, J.R. and S.R. Swaffield. (1995). Preferences for land-use options involving forestry in the Mackenzie/Waitaki Basin. N.Z. Journal of Forestry Science 25(1).

Fairweather, J.R. and S.R. Swaffield, L. Langer, J. Bowring and N. Ledgard. (1994) Preferences for land-use options in the Mackenzie/Waitaki Basin: A Q method analysis of respondents' preferences for visual images of six land uses on four landforms. Research Report No. 224, Agribusiness and Economic Research Unit, Lincoln University, Canterbury, New Zealand.

Hock, B., T. Bennison and S.R. Swaffield. (1995) Using GIS and visualisation techniques for rural planning. NZ Forestry 40(1): 28-32.

Hock, B., J.R. Fairweather, L. Langer, N. Ledgard, B. Manley, S. Swaffield, L. Te Morenga and A. Wilson (in preparation). Methods to assess the economic and social impacts of land-use change in the unimproved pastoral lands of the New Zealand high country. FRI Bulletin, Rotorua.

McKeown, B. and D. Thomas. (1988) Q methodology. Sage University Paper Series: Quantitative applications in the social sciences. Sage Publications: Newbury Park.

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[1] The Q Sort is a process whereby subjects model their point of view by rank ordering stimuli along a continuum for a particular condition of instruction, and the resulting data are factor analysed to identify patterns among the individual expressions of subjectivity (McKeown and Thomas, 1988).

[2] Unfortunately, a design error meant that the population data presented included processing effects, unlike the other variables, and this point was not made known to the respondents. The population estimates were relatively high because of this inclusion. However, we believe it is unlikely that these inflated population figures significantly affected the selected respondents' preferences because it appeared that respondents considered only the relative level for each scenario, not the absolute level. As all population figures were inflated, the relative levels were consistent. None of them appeared to pay attention to the actual population number.

[3] Since all respondents' Q sorts have the same distribution, with identical means and standard deviations, a suitable equation for correlation is Pearson's product-moment correlation coefficient (Brown, 1980:204) which is:

$$r = 1 - \frac{\sum d^2}{2Ns^2}$$

The $\sum d^2$ is the squared differences in scores for the items in the two Q sorts, and N is the number of items in the Q sort. For the eight item Q sort:

$$s^2 = \frac{\sum fx^2}{N} = 2, \text{ and for the ten item Q sort } s^2 = 3.6.$$

The standard error for a correlation is σr. $\sigma r = SEr = \frac{1}{\sqrt{N}}$

where N is the number of items in the Q sort (Brown, 1980:283). For $p<0.05$ and eight items, 1.96 SEr

$$= 1.96 \left(\frac{1}{\sqrt{8}}\right) = 0.69, \text{ and for ten items } = 0.62$$