

NGAKAWAU ECOLOGICAL DISTRICT

Survey Report for the
Protected Natural Areas
Programme



Department of Conservation
Te Papa Atawhai

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F. B. Overmars, M. J. Kilvington, R. S. Gibson,

C. L. Newell, T. J. Rhodes

New Zealand Protected Natural Areas Programme Survey Report No. 11

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Cover: View north-east up Upper Waimangaroa Valley. Snowy cap of Mt Frederick and associated sandstone pavements (800-1100 m asl) on the left, demarcated from the lower pavements and Waimangaroa River by the Kiwi faultline. Forests of the Mt William Range, and electricity pylon maintenance road, on the right. Beggs Dome (extensive coal prospecting tracks) in left foreground, Stockton-Webb open cast mine on pavements in centre-left distance, and Happy Valley red tussockland in right distance (forward of St Patricks dam/lake).

Photo: Institute of Geological and Nuclear Sciences, by D.L. Homer

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FOREWORD

This report forms part of the Protected Natural Areas Programme (PNAP) series of reports which describe the natural character of ecological districts throughout New Zealand and recommended areas for protection (RAPs) within them.

The survey was initiated in response to a recommendation in 1986 from the Protected Areas Scientific Advisory Committee (PASAC), a former governmental advisory committee, during its review of recommended ecological areas for the Ngakawau ecological district. This recommendation arose because of proposals for coal mining in the area where there was a lack of knowledge regarding the elevated coal plateau.

The largest RAPs described in this report are derived from the analysis of the results of a detailed field survey of the elevated coal plateau, using standard PNAP methods. The report also includes some recommendations for protection for other parts of the ecological district. On the basis of current information, the existing protected areas, and RAPs in Ngakawau ecological district are considered to adequately represent the full range of natural heritage of the ecological district.

The report describes seven RAPs: two largely on the elevated coal plateaux, two others on the margins of the plateaux, two on coastal hillslopes, and one on the Mokihinui River floodplain. The coal plateaux RAPs reflect the unique natural character of this part of the district, which hitherto had been largely regarded only as a barren or derelict wasteland or as sources of coal.

RAPs are the starting point for the implementation phase of the PNAP. This later phase will involve discussion and consultation with landholders and other parties involved in the use and protection of the land. These discussions will be aimed at securing protection of the natural values of the RAPs. Changes may occur following the consultation process, or after consideration of other values of the RAPs and surrounding areas may possess. The Department of Conservation recognises that effective conservation is a partnership between those involved in the use of the land, the Government of New Zealand, the local community and the wider public.

It is important to note that the PNAP methodology uses rapid ecological survey techniques, reflecting the urgency of identifying and protecting natural areas and habitats before further deterioration and loss. Subsequent work may show that other areas may have important values that also warrant protection.

This report contains a large amount of information about the components of natural character of Ngakawau ecological district. As such it is a significant reference work as well as a guide to conservation priorities. It will be of interest to land managers and resource developers, conservation managers and organisations, local and regional authorities, scientists, the tangata whenua, non-governmental organisations and the general public. Readers' comments about the report are welcome.



MIKE SLATER

Conservator

West Coast Tai Poutini Conservancy

Department of Conservation

SUMMARY

Ngakawau Ecological District, part of North Westland Ecological Region, lies on the west coast of the South Island to the north-east of Westport. The elevated coal plateaux and western coastal slopes of the ED were surveyed during the 1987/88 summer using the rapid ecological survey method of the Protected Natural Areas (PNA) Programme, and were then assessed to identify the highest priority areas for nature conservation. The survey covered approximately 21 440 ha of the 48 400 ha in the ED.

The survey was undertaken to implement a recommendation by the Government's Protected Areas Scientific Advisory Committee (PASAC) in 1986 to survey the coal plateaux in order to obtain more representative coverage of the ED. PASAC had recommended the Ngakawau Ecological Area (EA) (since approved but not yet gazetted) as the major representative reserve for the Ngakawau ED, and proposed this survey because the EA covered only a small proportion of the range of diversity present on the coal plateaux. PASAC noted that areas with the thinnest soils and high proportions of exposed rock, and the higher altitude areas, were not represented.

The elevated Stockton and Denniston coal plateaux lie at the southern end of the Ngakawau ED. The combination there of very acid and infertile soil parent materials (Brunner coal measures) on an exposed former peneplain, upper montane to subalpine altitude (400-1106 m above sea level), poor drainage, low sunshine hours, high wind exposure, and very high rainfall has produced dramatic landscapes and biota (including endemic species) that are different from anywhere else in New Zealand. Vegetation varies with soil parent material, drainage, slope, aspect and local topography, altitude, and disturbance history. The most extensive communities on exposed gently sloping rock "pavements" are dominated by prostrate shrub-tussocklands, while hill slopes support forests and shrublands dominated by species typical of infertile sites. Although other examples of elevated coal measure ecosystems occur in the north and west of the South Island, the Denniston and Stockton plateaux are by far the largest and most diverse.

The surveyed portion of the Ngakawau ED was divided into five land systems. Fourteen vegetation associations were derived by a computer classification technique and manual interpretation of data from 179 field plots.

Currently 39 300 ha, or 81.7%, of the Ngakawau ED is administered by the Department of Conservation. Existing protected areas on the elevated coal plateaux are limited to the Stockton, Denniston and Ngakawau Scenic Reserves (766 ha), and part of the Ngakawau EA (c.500 ha). To provide significant representation of the natural diversity of the coal plateaux, four major and three minor areas are recommended for protection. The total area of the RAPs is 5398 hectares (11.2 % of the ED). Of this, 3788 hectares (70.2%) is stewardship land and Water Conservation Land held by the Department of Conservation, 1462 hectares (27.1%) is Crown Land (under action or unallocated) held by Land Information New Zealand, 140 hectares (2.6%) is held by Solid Energy, 8 hectares (0.1%) is legal road held by Transit New Zealand.

The report also provides a full description of Ngakawau ED and its existing RAPs. Proposals for protection of specific habitats and scientific reference localities throughout the ED are noted, and includes recommendations for changes to the status of stewardship land.

1. INTRODUCTION

1.1 THE PROTECTED NATURAL AREAS PROGRAMME

The goals of the Protected Natural Areas Programme (PNAP)¹ are to identify and protect a network of areas which are representative of the full range of New Zealand's natural diversity. It is intended that intact, functioning examples of the natural ecological systems and landscape features that gave New Zealand its distinctive original character will be protected.

The PNAP was set up in 1983, under the auspices of the National Parks and Reserves Authority, in response to the objective expressed in the Reserves Act 1977 (section 3(1)(b)):

"...the preservation of representative samples of all classes of natural ecosystems and landscape which in the aggregate originally gave New Zealand its own recognisable character."

The variety of New Zealand's physical environment is reflected in the diversity of its indigenous plants, animals and ecosystems. A millennium of human settlement has seen many parts of the pre-human landscape modified or converted entirely so that only vestiges of the natural character remain. New Zealand's existing protected natural areas system has evolved with an emphasis on protecting mountain lands and other lands with little opportunity for alternative uses (Molloy *et al.* 1980). Fertile lowland forests, wetlands, shrublands, tussocklands, coastal areas and coastal measures ecosystems are much more poorly represented. There is a growing urgency to protect representative areas of all ecosystems before further important components of natural landscapes and biota are lost.

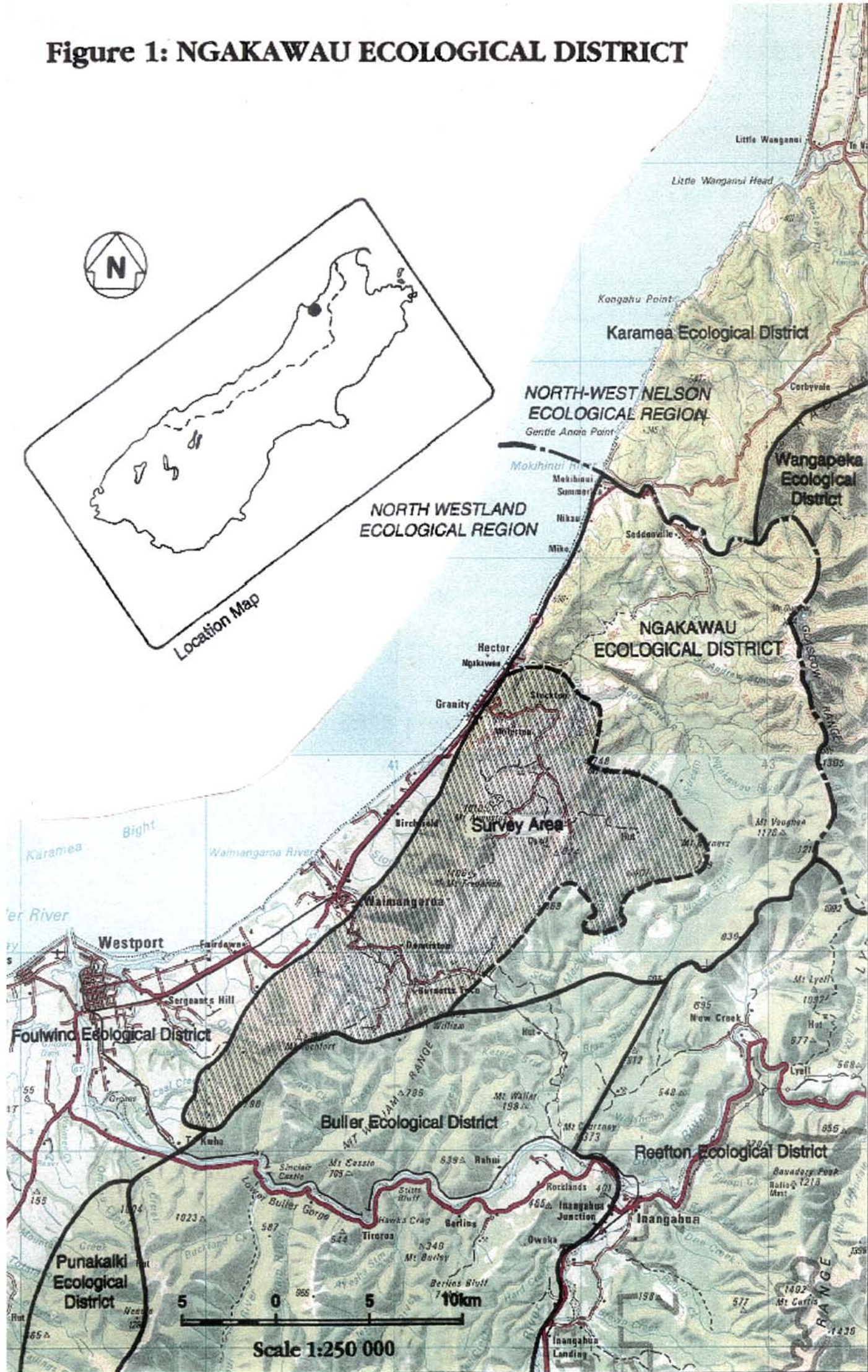
The conceptual framework of the PNAP is centred on the subdivision of New Zealand into 85 ecological regions and 268 ecological districts (McEwen 1987), and the development of a methodology to survey the ecological character of each ecological district (Myers *et al.* 1987). An ecological district is a local part of New Zealand where the features of geology, topography, climate and biology, plus the broad cultural pattern, interrelate to produce a characteristic landscape and range of biological communities unique to that area (Kelly & Park 1986).

The PNAP has two phases:

- (a) a rapid ecological survey of each ecological district to identify the full range of ecological variation (expressed principally as vegetation - landform units), to assess the adequacy of the existing protected area system, and to identify Recommended Areas for Protection (RAPs) needed to ensure full representation of the ecological variation.
- (b) a subsequent implementation phase directed toward securing the protection of these areas.

¹ Technical terms used in this report generally follow the definitions of Myers *et al.* (1987). A glossary of common and scientific names for plants and animals is provided in Appendix III

Figure 1: NGAKAWAU ECOLOGICAL DISTRICT



1.2 SELECTION OF THE NGAKAWAU ECOLOGICAL DISTRICT

The process of identifying and protecting representative natural ecosystems in Ngakawau ED (Figure 1), and elsewhere on the West Coast, was initiated by the New Zealand Forest Service in the mid 1970s as part of its "beech scheme" proposals. The Scientific Co-ordinating Committee for Beech Research (1978) recommended for ecological area status a large area of State Forest between the lower Ngakawau Gorge and Glasgow Range, with an extension into the upper Orikaka should the Blackburn State Coal Reserve be unavailable. Concurrently G.C. Kelly, undertaking the Biological Survey of Scenic and Allied Reserves for Nelson Land District, recommended much of the Denniston plateau for "provisional scenic reserve" status to represent the distinctive higher altitude coal measures heathland communities (Kelly in prep.; see Box 1).

BOX 1: COAL MEASURES ON THE WEST COAST

The term "coal measures", used frequently in this report, refers to geological sediments laid down in a depositional environment in which coal can form. They are typically found where muds, silts, quartz or conglomerates have been laid down in low-lying terrestrial environments, in which extensive peat formation has occurred (as in wetlands). These are then compressed and hardened by further deposition of other sediments. Coal measures may, or may not, contain coal.

On the West Coast, there are three coal measure formations:

- a) Paparoa coal measures, which predominate in the Greymouth coalfield. They are of Upper Cretaceous age (65-100 million years ago) and consist of four coal measure members alternating with three mudstone members. The coal measures members consist of rather similar assemblages of greywacke conglomerate, micaceous arkosic sandstone, carbonaceous shale, and coal seams (Nathan 1978a).
- b) Brunner coal measures, which are distinguished from Paparoa coal measures by the former's rapid but gradational change to quartz conglomerate. The formation consists predominantly of quartz-rich sandstone interbedded with quartz conglomerate, and is of Eocene age (40-50 million years) (ibid.). Brunner (and related) coal measures occur in Nelson and on the West Coast from Nelson city to Paringa (Cave 1992).
- c) Rotokohu coal measures, which occur in the Inangahua valley and Reefton areas (Nathan 1978b). They consist of arkosic sandstone interbedded with greywacke conglomerate, carbonaceous mudstone and scattered lenticular coal seams. They are of Miocene to early Pliocene age (5-15 million years old).

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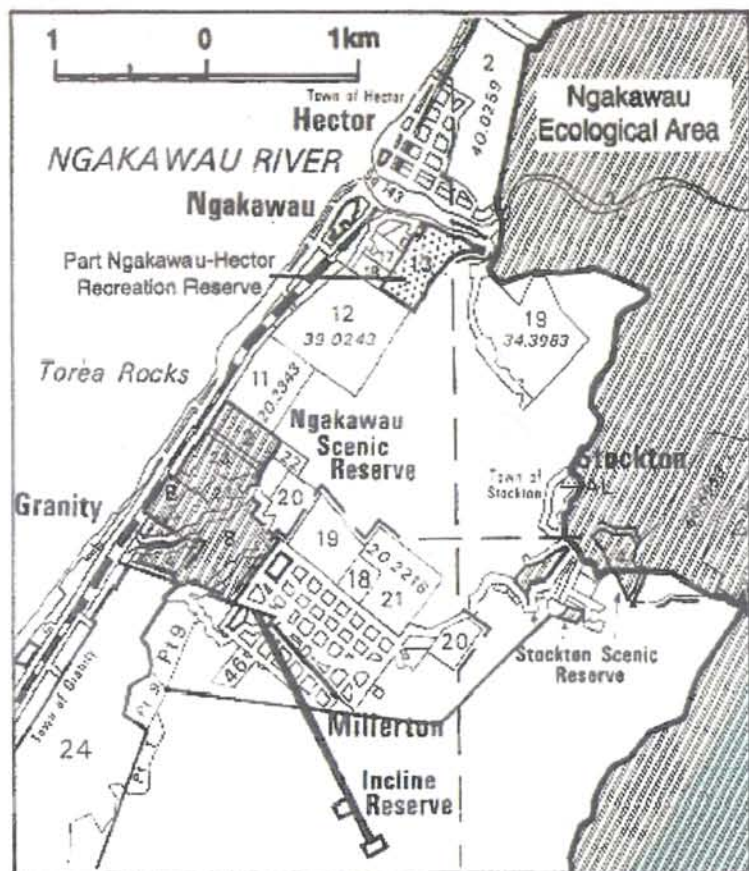
BOX 1: COAL MEASURES ON THE WEST COAST CONTINUED

As soil parent materials and a substrate for terrestrial ecosystems, Paparoa coal measures are distinguishable from Brunner coal measures by their complex, alternating exposures and generally finer, more erodible and dissected and slightly more fertile sediments. Rotokohu coal measures too tend to be slightly more fertile sediments, and are more dissected and better draining where exposed.

Compared with Paparoa and Rotokohu coal measures, the Brunner coal measures are the most resistant to erosion, and in a high rainfall environment, produce the most infertile parent material for soil formation (quartz is predominantly silicon dioxide). Their soils are very acid ($\text{pH} < 4$).

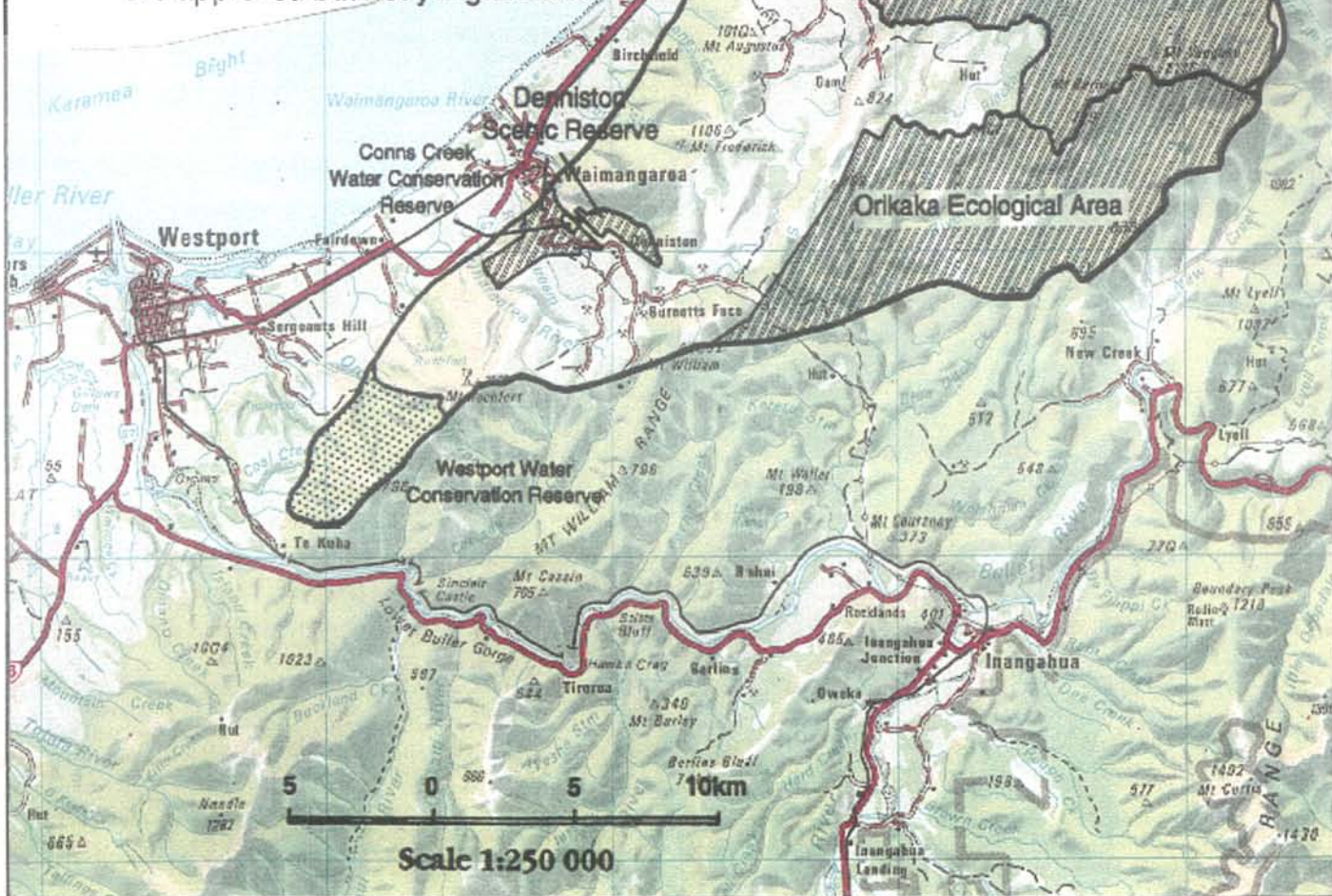
It is the interplay of high rainfall, extreme infertility and gentle, poorly draining slopes of the extensive areas of Brunner coal measures (c.14 000 ha), and their specialised vegetation and fauna, that give the Ngakawau ED its distinctive character. Although Brunner coal measures occur elsewhere on the West Coast and in Nelson, none are as extensive or have such profound dominance on the nature of the overlying ecosystems as those in the Ngakawau ED (cf Photos 1-4 and Appendix IX).

Figure 2: PNA's OF NGAKAWAU ECOLOGICAL DISTRICT



See 1:50 000 Enlargement

Note: Ngakawau and Orikaka Ecological Areas are approved but not yet gazetted.



There followed many reserve proposals to protect representative and special features of the Ngakawau ED (Given 1978, 1980a, Anon. 1979, DSIR 1983, Grant 1984, Walker 1986; see also NZFS 1985), culminating in a composite Ngakawau reserve proposal by Grant (1986).

In 1986 a government-appointed working party, known colloquially as the "Blakeley committee", agreed to a strategy for northern West Coast State Forests which provided for a large number of reserve proposals, the possibility of a small scale "beech scheme", and maintenance of the West Coast sawmilling industry until exotic timber species became available (Secretary for the Environment 1986). The strategy was endorsed by the Government in November 1986 and is now known as the West Coast Accord. In the Ngakawau ED, two large areas (Ngakawau and part of Orikaka) and one small area (Radcliffe) were subsequently approved for ecological area status by Government; and a further small area (Frank Stream) was covenanted.

These reserves, along with three existing scenic reserves (Denniston, Stockton, Ngakawau), provide adequate representation of the mountain and inland basin ecosystems of the Ngakawau ED (Figure 2, Appendix D). However they provide only limited representation of two significant and distinctive components of the district, the coastal hillslopes and the shrub-tussocklands on the elevated Tertiary sandstones of the Stockton and Denniston coal plateaux. Three local purpose reserves (Conns Ck and Westport Water Conservation reserves, and Ngakawau / Hector Recreation Reserve, Figure 2) contribute some representation of these components but are not considered secure protected natural areas.

When considering Grant's (1986) Ngakawau reserve proposal, the Protected Areas Scientific Advisory Committee (PASAC) noted that the area in the proposal between Burma Road and the (former) State forest boundary was:

"an important representative of the very distinctive coal measure country with locally endemic species and unusual communities, but does not cover the full range of diversity present on the plateaux. In particular the areas with thinnest soils and high proportions of exposed rock, and the higher altitude areas are not represented" (Anon. 1986, p.17).

PASAC then recommended:

"a survey to determine the biological values of the North Buller Coal Plateau with a view to protecting the scientific values in areas where there is no recoverable coal" (ibid.).

The coal plateaux of the Ngakawau ED have been a focus of coal mining since the 1870s. Over the last decade there has been renewed and intense interest in further coal exploration and development of coal mining on the plateaux (e.g., Anckorn *et al.* 1988, Barrell 1988, Barry & MacFarlan 1988, Todd 1989a, b). Most future coal mining prospects appear to be opencast. Some 2200 ha of the Stockton plateau were sold to Coal Corporation of New Zealand Ltd (Coalcorp²) in early 1988 for their existing Stockton mine and future nearby mining prospects (subject to conditions regarding work programmes and return of the land when mining is finished). In November 1988 the Ministry of Commerce (Energy) advertised a coal prospecting licence tender for the upper Waimangaroa valley. This advertisement, and plans to advertise other nearby

² Note that Coalcorp is now known as Solid Energy. In this document the name Coalcorp will be used to refer to past agreements etc. The name Solid Energy refers to the companies current status and activities.

areas, were subsequently restrained by Waitangi Tribunal consideration of Maori claims to coal resources, and other factors. Coalcorp obtained a coal exploration licence over the upper Waimangaroa valley in 1993. Since then it has undertaken environmental, coal transport and other investigations in preparation for expanding their existing Stockton mine and developing the upper Waimangaroa valley resources. It has also expanded its Stockton mine to the summit of Mt. Frederick. In 1995 Rangatira Investments Ltd sought resource consents to develop a largely open-cast coal mine above Te Kuha.

The Ngakawau PNAP survey was initiated in 1987 to define the primary nature conservation values of the coal plateaux, so that they may be taken fully into account in landuse planning and decision-making. The Denniston and Stockton coal plateaux were high priority for PNAP survey because of the limited information available on their specialised ecosystems, their limited representation in protected areas, and the imminent prospect of their large scale modification through coal mining. These elevated shrub-tussockland ecosystems on Brunner coal measures are largely confined in New Zealand to the Ngakawau ED. Other, smaller occurrences on the Greymouth and Pike River coalfields, 50-70 km to the south, are also subject to coal prospecting or coal mining interest.

1.3 SURVEY METHOD

1.3.1 *Preparation and Reconnaissance*

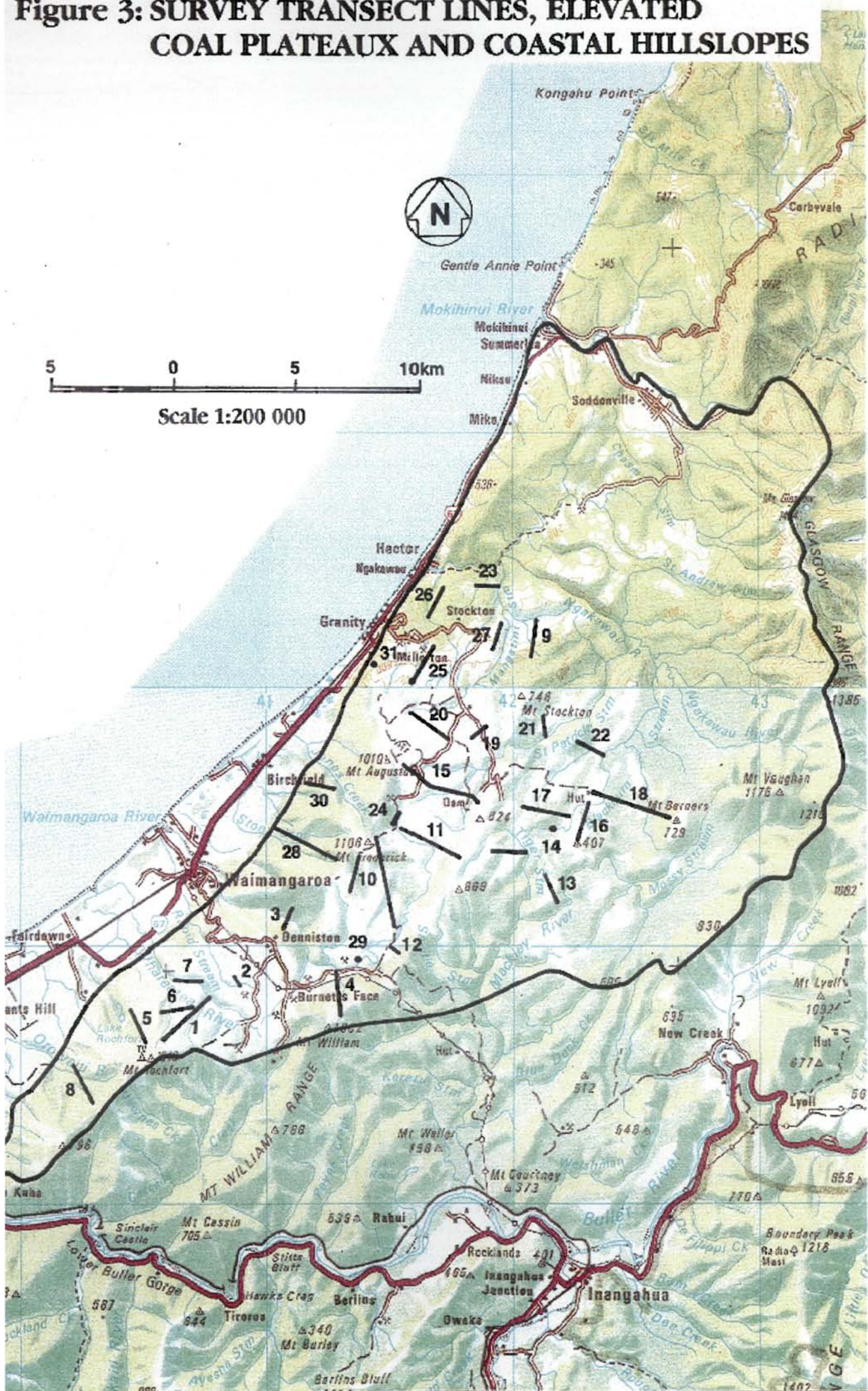
The pre-survey period was spent reviewing existing literature, consulting with people who had local knowledge of the district, contacting the land agencies and formulating an hierarchical landform classification system. A week was spent with scientific advisor Dr Peter Williams establishing survey technique and approach, and visiting typical and special interest sites. Natural areas worthy of further appraisal were identified and a reconnaissance flight was undertaken in late November 1987. Aerial photographs and topographical and geological maps were used to define land systems, and to gain familiarity with the boundaries of the survey area and the overall terrain.

1.3.2 *Field Survey*

The survey was carried out in December - April 1987/88. Data analysis and initial RAP selection and descriptions were carried out over the following six month period. Some refinement of RAP boundaries was subsequently undertaken in consultation with scientific advisor Dr David Norton.

The field survey followed the basic principles outlined in the PNAP survey guidebook (Myers *et al.* 1987). The relatively small size of the survey area enabled the use of a more intensive technique of sample site selection (compared with PNAP surveys in some other EDs). Aerial photographs, topographical maps and knowledge gained during the survey were used to establish 31 transects to cover the wide range of altitude, vegetation and landforms (Figure 3).

Figure 3: SURVEY TRANSECT LINES, ELEVATED COAL PLATEAUX AND COASTAL HILLSLOPES



A representative sample site was located and plot information recorded at intervals along each transect (usually 300-500 m). Additional sample sites were chosen to represent different ecological units (vegetation-landform combinations), local variations, and repeating patterns within ecological units (e.g., plateau-slope-gully bottom). Several plots were added during the survey at sites near the transect lines (lines 12 and 24). One hundred and seventy-eight plots in the ecological district, and one on the Birchfield pakihi in the adjoining Foulwind ED, were recorded.

1.3.2.1 Geomorphology and Land Systems

The land systems approach "provides a natural subdivision into areas with distinctive environments" (Christian 1957). Land systems help to clarify the relationship between the biotic and physical factors of the environment. They provide a framework for studying vegetation patterns, and are a possible criterion for assessing the representativeness of current protected areas in an ecological district.

The Ngakawau ED was divided into seven distinctive regions or land systems with similar physical attributes (Section 2.3). These are areas, or groups of areas, with distinctive or recurrent patterns of topography, geology, soils, landforms, climate, altitude and vegetation. The dominant distinguishing criteria were lithology (rock type), climate and coastal aspect.

Landforms at each sample site were described using an hierarchical landform classification developed for use in eastern Southern Alps PNAP surveys (cf. Arand & Glenny 1990, Shanks *et al.* 1990, Courtney & Arand 1994), described in Whitehouse *et al.* (1992). At a sample site the landscape was classified at three different levels, macro, meso and component landforms, to which various geometric and genetic descriptors were applied (Appendix II). This hierarchical classification provided a consistent and uniform interpretation of landforms throughout the survey and between surveyors.

1.3.2.2 Soils

Soil profiles were described at each survey site to establish a set of soil profile classes for analysis in conjunction with vegetation groups and landform types. The morphological criteria of Taylor & Pohlen (1970) were used to describe soil horizons. For each horizon, depth, colour (Munsell colour chart), structure, texture, mottle patterns and oxidation status were recorded. Samples of each horizon were collected for pH measurement. Skeletal rock type, its quantity, particle size and degree of weathering were described in addition to bedrock type and its degree of weathering.

1.3.2.3 Vegetation and Flora

Vegetation information at each variable area sample site was recorded on cards similar to those of Allen & McLennan (1983). A system of fixed tier heights was used:

TIER	HEIGHT CLASS
1	> 12 m
2	5 m - 12 m
3	2 m - 5 m
4	30 cm - 2 m
5	10 cm - 30 cm
6	0 cm - 10 cm

The tier 6 level was used only in low vegetation types (e.g., rushland, shrubland) with a canopy generally less than five metres high. As tier 6 in forest situations was frequently a repetition of tier 5, it was included within Tier 5 (which then extended from 0-30 cm).

Species percentage cover within each tier was recorded as:

COVER CLASS	% COVER
1	< 1
2	1 - 5
3	6 - 25
4	26 - 50
5	51 - 75
6	76 - 100

At each plot the cover classes were recorded for all species in each tier. Notes relating to the degree of naturalness, as well as biotic, physical and human factors influencing the area, and unusual features of the site were recorded.

A descriptive type name was given to the vegetation at each site, following Atkinson (1985). This information portrays major floristic and structural composition, and provided an immediate picture of the vegetation when later interpreting the data.

Detailed species lists of vascular plants for the Denniston and Stockton plateaux (Druce 1990b) and Charming Creek and the lower Ngakawau Gorge (Druce 1990c) formed a base species list for the ecological district. Some species distributions were extended by the present survey and other species added.

1.3.2.4 Plant Taxonomy and Identification

Plant nomenclature generally follows Allan (1961), Moore & Edgar (1970), Given (1980b), Healy & Edgar (1980) and Webb *et al.* (1988); but also Brownsey & Smith-Dodsworth (1989) for ferns, and Connor (1991), Edgar & Forde (1991) and Edgar (1995) for recently revised indigenous grass genera. Name changes suggested in Connor & Edgar (1987), Cameron (1994a, 1994b, 1995, 1996), and Wilson & Galloway (1993) for *Coprosma* species were also accepted, as were additional changes by Druce (1990a, 1990b, 1990c).

A combined list compiled from a 1987 edition of Druce (1990b, 1990c) was used as the base botanical species list. The only significant change to this list involved the *Celmisia coriacea* group, which followed Given's (1980b) published reference. Given recognised two species in the Ngakawau ED (*C. dubia* and *C. morganii*) within Druce's *C. monroi*.

All taxa recognised in this report were identified to species level with the exception of the genus *Parsonsia*. Most of the hybrid and morphological species variants recognised by Druce (1990b, 1990c) were not identified during the survey. Scientific equivalents of common plant (and animal) names in this report are listed in Appendix III. Vouchers for some species have been deposited in the University of Canterbury herbarium (CANU) and are listed in Appendix V.

1.3.2.5 Fauna

No formal vertebrate fauna survey was conducted. Team members recorded bird calls and sightings at each plot and any other observations worthy of note. Considerable information was collated from previous surveys by the New Zealand Wildlife Service and Ministry of Agriculture and Fisheries.

A limited survey of the carabid (ground beetle) fauna was undertaken. Pit traps were placed at 16 sites, 5-7 traps per site, each trap set 3-5 m apart to cover small-scale vegetation differences. Five sites were on a range of habitats on Mt. Rochfort, three west of the Whareatea mine, two on each of Mts William and Frederick, and four in the Repo Stream pakihi and associated forest. The traps were cleared after a one month period (early January-early February) and replaced for a second month.

Identification of beetles collected was undertaken by Ian Townsend (formerly Ministry of Agriculture and Fisheries, Levin) and Ian Millar (Department of Conservation, Nelson). Some species were not identified. Approximately 50% of traps were disturbed or rendered ineffective by interference by weka and flooding, including all traps at one site each on Mts Rochfort and Frederick. This combined with high within-site variation in the catch, particularly in those sites with a large total catch, made any statistical analysis questionable and only limited general conclusions could be drawn.

1.3.3 Categories of Rarity and Threat

Categories used in this report for plants are from Cameron *et al.* (1995). They are based on those used by the International Union for the Conservation of Nature (IUCN, also known as the World Conservation Union), with the addition of a "local" category. In this report, the term "threatened" is replaced by the IUCN equivalent "vulnerable".

1.3.4 Data Analysis

Vegetation and some landform (altitude, aspect, slope) information was entered on to the Ministry of Forestry VAX computer. The "indicator species analysis" program TWINSpan (Hill *et al.* 1975, Hill 1979) was used for analysis. This is a divisive (progressive division of groups), polythetic (based on the similarity of several attributes) method of classification using quantitative information.

Tiers were given equal weighting so that species cover at all heights was of equal importance, and were summed to produce a single abundance value per species per plot. Vegetation groups produced by TWINSpan corresponded well with field observations for natural vegetation communities but were less satisfactory for induced and disturbed communities.

Some handsorting was undertaken and some changes made following the computer analysis to ensure that the groups corresponded with field observations. This applied particularly to plots not fitting easily into general patterns. For each group the program RECCESUM (Allen & McLennan 1983) was used to summarise the most important species (in frequency and cover) and environmental factors such as altitude, aspect, drainage etc.

The information from the landform cards was entered into WANG 2020 Spreadsheet together with the derived vegetation groups. The combination of a vegetation group and landform type within each land system was considered an "ecological unit", the central focus of PNAP surveys (Myers *et al.* 1987). Soil groups were not used in the definition of ecological units but rather to aid overall understanding of them.

All plot sheets are held by the Department of Conservation in Hokitika. The vegetation data are also held on the Landcare Research Ltd National Inventory of Vegetation Surveys (NIVS) database at Lincoln.

1.3.5 Selection of Recommended Areas for Protection

Criteria used in the selection of RAPs were representativeness, naturalness, altitudinal and edaphic gradients, presence of nationally and/or locally threatened species, wildlife habitat, probable long-term viability, and proximity to existing protected natural areas.

After completion of the analysis and formulation of ecological units, existing protected areas and preliminary RAPs were examined in the field to ensure that the full range of ecological units was covered. Where ecological units were poorly or overly represented the preliminary RAPs were modified to provide more balanced coverage. Boundaries were sought to provide compactness and buffering and to follow features readily definable on the ground, so enhancing long-term viability.

There is growing recognition of the value of protecting scientific reference sites for future study (e.g., McSweeney 1986, McIntosh & Meurk 1986). The most common of these is the type locality: the location of the plant, animal or other feature (e.g., soil or geological unit) used in describing the species or unit. Information on type locality and other reference sites in the Ngakawau ED was sought from soil, botanical, geological and entomological sources and considered in defining RAPs. The poor locality definition of many early identifications (especially entomological) and lack of computerised records, means the sites identified in this report are by no means complete.

A range of sites listed in the landform (Priestley 1990), igneous (Weaver *et al.* 1990), structural geology (Nowell & Sporli 1991), sedimentary geology (Kenny & Hayward 1992), soil (Arand *et al.* 1991) and geologically-related historic (Black *et al.* 1991) components of the Geopreservation Inventory occur in the Ngakawau ED, and were also considered in formulating RAP proposals. There are no sites recorded on the fossil, active deformation, cave and karst, geothermal, metamorphic and mineral components (Stirling 1988, Hayward & Ward 1989, Houghton *et al.* 1989, Worthy 1990, Priestley *et al.* 1991, Watters *et al.* 1992).

In obtaining Ministry of Commerce (Energy) and Coalcorp co-operation for this PNAP survey, and consistent with the PASAC recommendation, the Department of Conservation committed itself to seeking alternative representative protected natural areas away from identified mining prospects, *where this was possible without substantial compromise of ecological values*. During the course of the survey, the Ministry of Commerce provided New Zealand Coal Resources Survey reports which firmly indicated the location and extent of coal resources (Anckorn *et al.* 1988, Barrell 1988, Barry & MacFarlan 1988, Todd 1989a, b).

Although some RAP boundaries were modified because of coal resource considerations, complete avoidance of coal resources in the RAPs proved to not be possible, because of the limited alternatives for RAPs on the coal plateaux and the overlap between RAPs and areas not previously exploited for coal. Areas with the highest conservation values on the coal plateaux today tend to be those areas that have not previously been exploited for coal, and hence have not been disturbed through mining, roading or other activities associated with coal exploration and mining. Because new coal exploration and mining is likely to focus on areas not previously mined, such activities will have a direct and substantial impact on the areas with the highest conservation values.

Following consideration of a draft of this report, Cave (1992), for the Ministry of Commerce, sought to clarify the nature of the overlap between the RAPs and the coal resources³. He identified the range of Brunner coal measure rocks in Nelson and on the West Coast, and asked :

- (a) whether there were other sites on Brunner coal measures (e.g., in Northwest Nelson) with ecosystems similar to those on the Buller coal plateaux (especially the Upper Waimangaroa valley);
- (b) whether this survey's use of landform-vegetation based ecological units was consistent with the PNAP methodology; and

³ Coalcorp advised in 1992 that Cave's report does not define Coalcorp's coal interest on its current Stockton coal mining licence (Murray McKee *pers. comm.*). The RAPs proposed in this report overlap only to a small degree with Coalcorp's Stockton licence.

(c) whether similar vegetation types might occur on other soil parent material or rock types.

Field work and data analysis in relation to these questions were undertaken in 1995-96, with the assistance of Shannel Courtney (Department of Conservation, Nelson). Several minor amendments to the Upper Waimangaroa-Mt. William RAP were subsequently made, although this survey's principal conclusion regarding the RAPs outstanding nature conservation value was sustained (Appendix IX). Nevertheless, consistent with the Department's commitment to seek alternative representative PNAs away from known coal resources, key features of the main RAPs are explicitly identified and alternatives listed *where they exist*.

When the survey was undertaken it was not the function of the PNAP to identify and recommend for protection *all* areas of high natural value, but to identify and recommend for protection only the *best* examples of the range of natural diversity for each ecological district which deserve protection. Consequently, large tracts of the Denniston and Stockton coal plateaux that are in natural or semi-natural condition and have high conservation values do not appear in this report.

2. NGAKAWAU ECOLOGICAL DISTRICT

2.1 LOCATION, TENURE AND BOUNDARIES

Ngakawau ED is the northernmost ecological district in the North Westland Ecological Region. At its nearest point, it is 7 km east of Westport. It is largely hilly, elevated or mountainous country. Most land in the ED is owned by the Crown through five agencies: two State Owned Enterprises (SOEs; Timberlands West Coast Limited and Solid Energy (previously CoalCorp)) and three Government departments (Ministry of Commerce, state coal reserves; Land Information New Zealand, unallocated Crown lands; Department of Conservation, conservation and reserve lands).

The boundaries of Ngakawau ED are largely defined by the criteria of geology, topography and vegetation (McEwen 1987). The district is bordered in the north-west by the coastline and in the south-west by Pleistocene raised marine terraces and the Kongahu faultline. The boundary in the north follows the Mokihiui River, and then turns east and south along the Glasgow Range. The southern boundary follows the scarps and limits of the Denniston plateau from Te Kuha to Mt. William, and then crosses the upper Orikaka catchment back to the Glasgow Range.

A possible alternative eastern boundary for the Ngakawau ED is the Glasgow Fault at the base of the Glasgow Range. This boundary would transfer the western flanks of the Range to the Wangapeka ED and reduce the Ngakawau ED more to its essence (coal measures). This area was not closely examined in this survey and no firm recommendation is offered (this would also require comparison with the Wangapeka ED).

Bordering ecological districts are Foulwind (west), Buller (south), Wangapeka (north-east), Karamea (north) and Reefton (south). Karamea and Wangapeka EDs lie in the Northwest Nelson Ecological Region.

Ngakawau ED lies within the rohe of Poutini Ngai Tahu. The local authority is the Buller District Council, and the regional authority is the West Coast Regional Council.

2.2 CLIMATE

The climate of the lower altitude parts of Ngakawau ED is characterised by high rainfall and humidity, small temperature ranges and sunshine hours comparable to the eastern South Island; it is considerably harsher at higher altitudes (Hessell 1982). There are few climatic records from within the district (e.g. Weir 1988), and knowledge of climate must be drawn from nearby climate stations (particularly Westport), from local observations, or by inference.

Mean annual rainfall along the coast is approximately 2200 mm and rises rapidly to over 6000 mm at higher altitudes inland (e.g., Stockton, 6300 mm) (New Zealand Meteorological Service 1973). Rainfall is evenly spread throughout the year, with only slight spring and autumn maxima. Intense rainfalls with a return period of five years rise from 200 mm per 24 hours at Denniston to 280 mm on the Glasgow Range (Tomlinson 1980). The average annual number of rain days is 169 at Westport. Considerably more would be expected in most of Ngakawau ED because of its higher altitude and proximity to mountains. Snowfalls in winter and spring are frequent on the coal plateaux and the Glasgow Range. Humidity is consistently high, averaging 80-90%.

Predominant winds are from the south-west, west and north-east. High winds are not characteristic of the lower altitude parts of the district. However the higher altitude plateaux are exposed to winds from all directions and are characteristically cold, wet and bleak, whilst the lower altitude basins, such as the Blackburn Pakihi, are sheltered and noticeably warmer than the plateaux. Katabatic air drainage occurs down the Mokihinui and Buller Valleys.

Despite the comparatively high rainfall on the West Coast, sunshine averages at coastal locations for all seasons except spring are similar to those on the east coast of the South Island. Average annual sunshine at Westport is 1937 hours, compared to 1974 at Christchurch. Sunshine hours are expected to be lower at higher altitudes in the district, especially in spring. Mean annual temperature at Westport is 12.1° C and it ranges seasonally from 8.2° C in July to 16.0° C in February. It is likely to decrease by 0.5° C per 100 m altitude at the higher elevations in the district (Norton 1985). Winter frosts are severe at higher altitudes.

A notable climatic feature is the fog that is prevalent for much of the year on the Denniston-Stockton uplands, particularly around Mts Rochfort and Frederick. This feature is caused by moist oceanic air ascending the western escarpments, with consequent cooling, condensation, increase in wind speeds and reduced sunshine.

2.3 LAND SYSTEMS

The surveyed portion of the Ngakawau ED was divided into five major land systems and one subsystem: coastal hillslopes (on bedrock and coal measures), coal plateaux plus Blackburn and Tiger pakihi, dissected hills on basement rocks, river gorges, and dissected hills and terraces on siltstone (Figure 4, Table 1). The profound influence of lithology and coastal aspect on the vegetation provides the primary criteria for these land systems and hence the ecological units of this survey (Chapter 3).

Two additional land systems and one subsystem may be recognised in the ecological district: the narrow coastal plain, dissected marine terraces and low alluvial Mokihinui River terraces in the north, the forested, lower altitude Brunner coal measures principally north of the Ngakawau River (Charming Creek plateau), and the Glasgow Range. As land system boundaries are largely geologically based, and there is not yet a definitive detailed geological map of the district, the boundaries shown on Figure 4 are approximate only.

2.4 TOPOGRAPHY AND GEOLOGY

The Ngakawau ED ranges in altitude from sea-level in the west up to 1480 m on the summit of the Glasgow Range. Coastal hills rise steeply from the coast to 536 m at Radcliffe Ridge, 1106 m on Mt. Frederick, 1010 m on Mt. Augustus and 1040 m on Mt. Rochfort. Between the coastal hills and Glasgow Range lies a broad eastwards tilted, dissected plateau, which rises gradually from the Mokihinui valley in the north to the Buller catchment in the south. The plateau is divided by the upfaulted north-east - south-west trending Mt. William Range, the summit of which rises to 1062 m (Mt. William). In the east-west direction, the plateau is cut by the deep gorges of the Waimangaroa and Ngakawau Rivers.

Basement rocks of the Buller area are Palaeozoic sedimentary greywacke and argillite of the Greenland group, invaded by igneous Cretaceous Tuhua granite and Constant gneiss. These are exposed in gorges, along part of the coastal hillslopes, and on the Glasgow Range and isolated low hills (Mt. Berners, Mt. Stockton, Mt. William, and others) (Morgan & Bartrum 1915, Bowen 1964, Roder & Suggate 1990).

In the mid to late Eocene a broad erosion surface of low relief (peneplain) which extended from Northwest Nelson to Ross was covered by extensive sediments, initially fluviially deposited quartzose sandstone, grit, carbonaceous mudstone and basal conglomerate with coal seams (Brunner coal measures), and then, following basin subsidence and marine transgression, fossiliferous carbonaceous siltstone and mudstones (Kaiata Formation), and Oligocene limestone and calcareous sediments (Nile Group). Sedimentation was deepest in subsiding basins (Paparoa Trough, Reefton and Murchison basins). Except in the east and north-east of the ecological district, subsequent uplift and erosion have removed most of the softer Kaiata formation and younger beds, exposing the massive indurated quartzose sandstones which today characterise the Ngakawau ED (Bowen 1964, Barry & MacFarlan 1988, Nathan *et al.* 1986). The Brunner coal measures are exposed on a rising plateau in a near-continuous sequence from Chasm Creek in the north to near Te Kuha in the south. They range in thickness from 20 m in the east to more than 270 m at Mt. Rochfort. Isolated coal measures remnants also remain on the upfaulted Mt. William Range and other sites in the Orikaka Valley (e.g., Tiger Pakihi).

The upper Orikaka and Ngakawau basins are characterised by extensive flights of low gravel-capped fluvioglacial terraces not yet recorded on any geological map and are considered "regionally significant" (Grant 1986). The often narrow terraces were probably formed during repeated Pleistocene glacial episodes. Their elevation has prevented inundation and destruction by high interglacial sea levels. Pleistocene colluvial conglomerate and associated sand and silt occur along the flanks of the Mt. William Range. Glacial features occur on the Glasgow Range (Roder & Suggate 1990). The Blackburn Pakihi is possibly an alluvial plain formed on Kaiata mudstones by the meandering and cutting of the Blackburn and Mullochy Streams and the infilling of hollows with swamps (Simon Nathan *pers. comm.*). Minor Kaiata siltstone areas also remain on the lower north-western flanks of the Mt. William Range and at the base of the coastal slopes below the Denniston plateau.

**Figure 4: LAND SYSTEMS OF
NGAKAWAU ECOLOGICAL DISTRICT**

- 1a Coastal Hillslopes on Brunner Coal Measures
- 1b Coastal Hillslopes on Basement Rocks or Kaiata Mudstones
- 2a Elevated Coal Plateaux
- 2b Lower Coal Plateaux
- 3 Dissected Hills on Basement Rocks
- 4 River Gorges
- 5 Dissected Mudstone Hills and Fluvioglacial Terraces
- 6 Coastal Plain, Marine and Alluvial Terraces
- 7 Glasgow Mountain Range

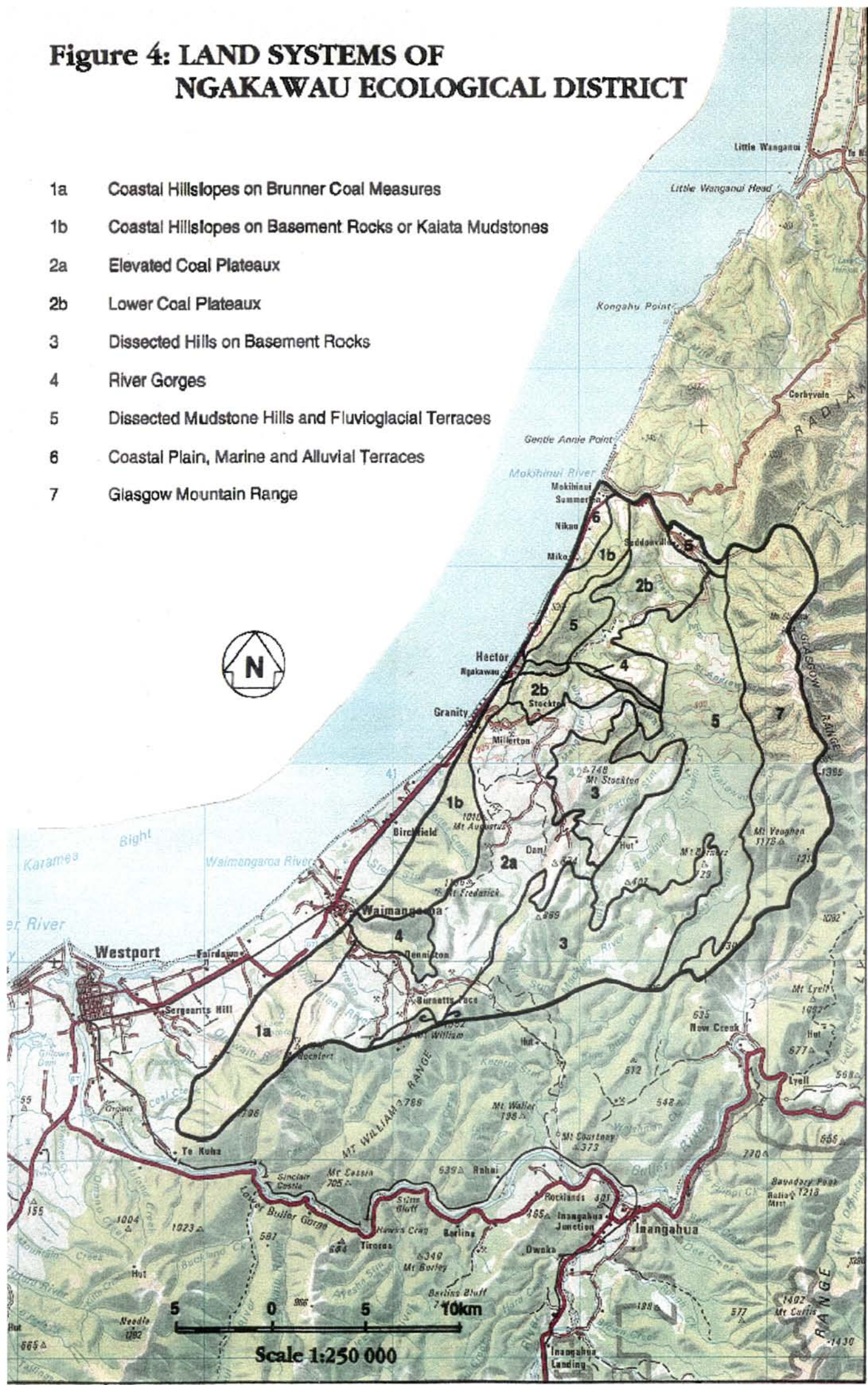


TABLE 1: LAND SYSTEMS OF NGAKAWAU ECOLOGICAL DISTRICT

UNIT	LAND SYSTEM	ALTITUDE (m)	LANDFORMS AND GEOLOGY	VEGETATION
1	Coastal Hillslopes	20-1106	West-facing steep hillslopes and dissected gullies; bedrock (granite, gneiss, greywacke), steeply dipping coal measures, minor siltstone.	Densely forested altitudinal sequence (hard beech-red beech - southern rata-kamahi - mountain beech-yellow silver pine) on coal measures; hard beech/kamahi - silver beech/kamahi - mountain beech-southern rata - pink pine-mountain beech-yellow silver pine on granite and gneiss; shrubland and low forest regenerating after fire, especially on coal measures.
2	Stockton and Denniston Coal Measures plateaux (including upper Waimangaroa Valley)	400-1106	Large uplifted faulted and distorted tableland of Brunner coal measures including minor areas of bedrock and siltstone; sandstone pavements, hilltops, fault scarps, alluvial flats, pools; rising in altitude from north to south.	Mosaic of dwarf shrub and tussock communities, and low forest at lower altitudes, in gullies, and on scarps and other steep slopes.
2a	Blackburn and Tiger Pakihi	350-420	Lower altitude eastwards extension of plateaux land system; flat basin fluvially cut out of Kaiata mudstones and siltstone (Blackburn); undulating plateau of highly eroded coal measures remnants, with steep dissected gullies (Tiger).	Grasses, sedges, rushes and red tussock with tanglefern (Blackburn); shrub rushlands and sedgelands, mountain beech-southern rata-kamahi in gullies (Tiger).
2b	Charming Creek plateau	200-500	Lower altitude northwards extension of plateaux land system, more fluvially incised.	Low forest of mountain beech and small podocarps (rimu, yellow silver pine, pink pine, silver pine); exotic forests.
3	Dissected Hills on Basement Rocks	400-1000	Exposed basement rocks (greywacke, granite) on summits and slopes of Mts Stockton and Berners, and part of mid Orikaka catchment; isolated coal measures remnants.	Mixed beech forest altitudinal sequences.
4	River Gorges	20-600	Steep incised gorges of major rivers (Waimangaroa, Ngakawau); coal measures, often eroded to underlying bedrock (gneiss, greywacke).	Beech forest altitudinal sequences; seral communities on talus slopes.
5	Dissected Hills and Terraces on Siltstone	100-600	Fluvially dissected plateau where Tertiary siltstone sequence has not been eroded to underlying coal measures; includes Pleistocene fluvioglacial terrace system in upper Ngakawau valley.	Mixed beech-podocarp forests, becoming lower, stunted and eventually pakihi on older terraces; exotic forests.
6	Coastal Plain, Marine and Alluvial Terraces	0-150	Post-glacial sand and alluvial deposits; dissected interglacial marine terraces.	Pasture; remnant, low altitude, mixed beech-podocarp forest.
7	Glasgow Range	200-1480	Steep west-facing mountain slopes on granitic bedrock.	Mixed beech-podocarp forest altitudinal sequence to silver beech treeline and alpine grasslands.

The major river systems are the Ngakawau, Waimangaroa, Lower Mokihinui tributaries, upper Orikaka and Whareatea. The first two have cut gorges through the coal measures plateaux and underlying basement rocks and are considered antecedent to the main uplift and tilting of the plateau (Morgan & Bartrum 1915).

Numerous faults cross the ecological district and their associated earth movements are responsible for the main physical features, the uplifted plateaux areas and the Mt. William and Glasgow Ranges. At the western and eastern margins of the district are the major Kongahu and Glasgow faults. The Kiwi fault and the parallel Mt. William fault which run north-south are prominent dislocations as well as the more obscure and more complex Blackburn fault (Morgan & Bartrum 1915). The Millerton and Mangatini faults on the lower Stockton plateau are the principal faults which run transversely to the major fault direction. Many landslides were created on the steep eastern slopes of the district by the 1968 Inangahua earthquake. The district continues to be tectonically active.

Drainage is dendritic over the Kaiata beds whilst over basement rocks it may be dendritic but is locally angulate where controlled by joints or faults. The plateau areas are highly variable with drainage most commonly angulate or contorted.

2.5 SOILS

The entire Ngakawau ED has been mapped by the reconnaissance survey of the soils of the South Island (New Zealand Soil Bureau 1969), and its northern and eastern parts by a more detailed survey and mapping at 1: 50 000 scale (Heine & Mew 1981).

The soils of the narrow coastal plain are primarily young accumulating Kamaka soils on young fans. Recent soils of the Mokihinui River flats (Hokitika and Harihari soils) are formed from Holocene alluvium. Soils of the terraces include well drained soils on lower river terraces (Ikamatua and Ahaura yellow-brown earths), and poorly to very poorly drained soils on intermediate and high river terraces (primarily Addison podzols). Most are formed on alluvium derived mainly from greywacke, granodiorite, porphyry and greywacke.

Ngakawau and Mackley weakly gleyed yellow-brown earths and associated hill soils predominate on the extensive lower altitude flat and rolling interfluvial remnants in the Ngakawau-Orikaka catchments. They are derived mainly from Tertiary strata and are poorly drained and infertile. Low fertility Bromielaw soils occur on Radcliffe Ridge and other gneiss outcrops in the north of the district.

The soils on the quartzose sandstones of the Brunner coal measures are primarily mapped as Denniston and Denniston Hill podzols. These are very infertile, acid to extremely acid (pH 3.5-5.6), and often poorly drained. They have grey silica rich layers in their topsoil and irregular to continuous iron pans in their subsoil. They occur at lower altitude sites at Chasm Creek and Blackburn and Tiger Pakihi, and predominate on the coal measures plateaux. At higher altitudes the soils become skeletal and in many areas the unweathered

parent rock is exposed on the surface, possibly in response to repeated firing of the previously peat soil (Mason & Moar 1955). Less podzolised Koranui soils occur on the softer siltstone and mudstone components of the coal measures (Geoff Mew *pers. comm.*). Compound soil profile sequences, where additions of material have covered an existing soil profile, are common on the plateaux. Millerton steepland soils on Brunner coal measures occur in the gorge of Chasm Creek.

Mokihinui, Henniker, Kaniere and O'Keefe steepland soils occur on the slopes of Radcliffe Ridge, on Tertiary sandy mudstone, silt sandstone, granite and gneiss, and Pleistocene alluvium slope detritus respectively. Orikaka hill soils from granite occur on Mt. Berners. Soils of the bedrock-incised deep gorges (e.g., Ngakawau, upper Orikaka) are Kaniere steepland soils.

Steep mountain soils on the Glasgow and Mt. William ranges are Tiroroa steepland soils derived from indurated breccia, Wakamarama and Tate steepland soils from greywacke, and Kaniere steepland soils from granite and gneiss.

All steepland soils have a very severe erosion potential, related to shear planes at the interface of the soil and parent material or proximity to major faultlines with shattered and crushed parent rocks (e.g., Mt. William).

2.6 VEGETATION

The earliest published botanical studies of the Ngakawau ED and adjoining areas are Townson's checklist of plants of the Westport district (Townson 1907) and Petrie's (1914) additions. Other accounts include studies of the vegetation of Mount Augustus (Mason & Moar 1955) and the Glasgow Range (Williams 1991), National Forest Survey reconnaissance survey and mapping (Naylor 1955, John Leathwick *pers. comm.*), assessments of the impact of a proposed Buller thermal power station (Park 1975, 1976, Given & Park 1975), a 1: 250,000 forest class map (New Zealand Forest Service 1978), the biological survey of scenic and allied reserves in Buller (Kelly in prep.), Druce's (1990b, 1990c) species lists, Regnier's (1986) survey of the Te Kuha area (and subsequent visits by D.A. Norton, S.P. Courtney and F.B. Overmars), various reserve proposals (e.g., Scientific Co-ordinating Committee for Beach Research 1978, Anon. 1979, Given 1978, 1980a, Department of Scientific and Industrial Research 1983, Grant 1984, 1986), and Newell's (1990) study of Mt. Rochfort forest. Scattered references to the district are found in other works, such as comparisons of coal measures and pakihi vegetation (Rigg 1962, Burke 1983), an inventory of tall podocarp stands on alluvial terraces in the Nelson Land District (Park & Walls 1978), and an account of *Karamea* ferns (Ballin 1977).

The majority of the district remains in indigenous vegetation, principally forest and tussockland. The broad vegetation patterns, which are closely related to the land systems (c.f. Figure 4), are described below. Detailed descriptions of the vegetation associations of the survey area are contained in Appendix IV.

(a) Coastal Hillslopes

On the more fertile gneiss and granite parent rocks (Mt. Frederick forest, Radcliffe Ridge, Orowaiti catchment), the steep, often fluviially incised slopes show a similar altitudinal progression from mixed hard beech-red beech-rimu lowland forest, to silver beech forest to mountain beech-southern rata forest, and reducing in stature to stunted mountain beech-yellow silver pine low forest and scrub at the highest elevations. Northern rata, rimu, nikau, mamaku and other broadleaved trees occur at lower elevations. Some beech-free areas occur on Radcliffe Ridge.

Related altitudinal sequences occur on the Kaiata siltstone and infertile Brunner coal measures below Millerton and the western edge of the Denniston plateau. These are best exemplified in the "Mt. Rochfort Forest", where they have been studied in detail by Newell (1990), on which the following account is based.

Three communities dominate the slopes below Lake Rochfort. The moderate slopes at the base of the forest sequence are covered by hard beech/kamahi/kiekie forest. Hard beech/kamahi/kiekie-crown fern forest inhabits the steep dissected slopes. A mixed hard beech-silver beech-red beech form of this community dominates the steep slopes on the upper section below the lake. The more moderate slopes in this upper section are covered by silver beech/kamahi-toro-quintinia forest. Hard beech, silver beech, *Coprosma rhamnoides*, kiekie and supplejack are common species in the forest below Lake Rochfort.

In contrast, the forest above the lake is dominated by mountain beech, southern rata, *Pittosporum rigidum*, and *Gabnia procera*. There are three broad community bands. Mountain beech/*Gabnia* forest inhabits the slopes directly above the lake. This community blends into mountain beech/*Astelia* forest as the slopes begin to flatten. *Archeria traversii* and *Pseudopanax simplex* are common here. With increasing altitude the forest reduces in stature and becomes particularly dense on the shallow undulating slopes at the top of the altitudinal sequence. This area is dominated by pink pine-mountain beech-yellow silver pine/*Gabnia* forest. Mountain flax, manuka, inanga and prickly mingimingi are common species.

(b) Stockton and Denniston Coal Measures Plateaux

On the Brunner coal measures rising from the Mokihinui Valley (200 m above sea level (asl)) to the coal plateaux summits there is an altitudinal sequence from stunted or dwarf podocarp-beech forests through the shrub and tussockland communities of the coal plateaux to the subalpine vegetation on the high points (Mts Rochfort, William, Augustus and Frederick). Coal measures vegetation outliers occur on the Blackburn and Tiger Pakihi. There are many complex transitions between the forest and tussockland vegetation on coal measures and the taller podocarp-beech forest on adjoining different parent materials.

The lower altitude stunted forests in the north of the ecological district are dominated by dense yellow silver pine, pink pine, mountain beech, toatoa, *Dracophyllum* spp., pahautea, and small rimu trees. The previous silver pine component has been largely extracted, although seedlings and saplings remain.

The flat pavements and gentle undulations of the Denniston and Stockton plateaux and Mt. William are covered in stunted shrub-tussock-wire rush vegetation. The principal species are stunted manuka, wire rush and *Chionochloa* species. *C. juncea* dominates on the Denniston plateau and Tiger Pakihi but is not such a dominant feature of the Stockton plateau. *Dracophyllum politum* is emergent over *C. juncea*, *C. australis* and *C. rubra* ssp. *occulta* sedge-tussocklands on the Stockton plateau. Stunted manuka, wire rush and tangle fern associations dominate the lower western slopes of the Denniston plateau, the northern half of the Mt. William Range and extensive areas of the lower Stockton plateau. The lower slopes of the Stockton plateau (e.g., Repo Stream) are dominated by *Baumea teretifolia*-bracken-tangle fern vegetation. The substantial differences in vegetation patterns between the upper and lower Stockton plateau appear to relate to the greater intensity of previous burning and recent conversion from forest on the lower slopes.

The gentle plateaux slopes contrast with the steep forested gullies and fault line slopes which dissect the plateaux. The gullies of the plateaux vary in depth and altitude and contain a range of vegetation such as stunted mountain beech-silver beech-southern rata forest at higher altitudes and mountain beech and silver beech forest with yellow silver pine and pink pine at lower altitudes.

The seepage areas, especially on the upper Denniston plateau, support a variety of montane and subalpine bog species (e.g., sundews, cushion plant, *Liparophyllum gunnii*, horizontal orchid, mountain bog daisy, *Utricularia novae-zelandiae* and *Astelia subulata*).

TABLE 2: PLANT SPECIES OCCURRING IN NGAKAWAU ECOLOGICAL DISTRICT ONLY OR MAINLY ON MTS ROCHFORD, WILLIAM, FREDERICK AND AUGUSTUS

SPECIES	MT. ROCHFORD	MT. WILLIAM	MT. FREDERICK	MT. AUGUSTUS
<i>Agrostis dyeri</i>	x			
<i>Anisotome baastii</i>	x	x		
<i>Carex acicularis</i>			x	
<i>Carex liberia</i>			x	
<i>Celmisia incana</i>	x		x	x
<i>Celmisia lateralis</i>	x		x	
<i>Celmisia parka</i>			x	
<i>Celmisia similis</i>	x	x	x	
<i>Chionochloa flavescens</i> ssp. <i>lupeola</i>	x	x	x	x
<i>Cyatbodes dealbata</i>	x	x	x	

Table 2 continued

<i>Deyeuxia aucklandica</i>			x	
<i>Deyeuxia avenoides</i>	x			
<i>Dracophyllum pubescens</i> (a)		x	x	x
<i>Drosera arcturi</i>	x		x	
<i>Exocarpus bidwillii</i>		x	x	x
<i>Gentiana gracilifolia</i>	x			
<i>Gentiana</i> sp. (aff. <i>G. montana</i>)	x			
<i>Geum uniflorum</i>			x	
<i>Grammitis givenii</i>	x	x	x	
<i>Grammitis magellanica</i> spp. <i>nothofageti</i> (b)	x			
<i>Grammitis poeppigiana</i>	x	x		
<i>Juncus antarcticus</i>	x			
<i>Lachnagrostis lyallii</i>			x	
<i>Luzula colensoi</i>			x	
<i>Lyperanthus antarcticus</i>	x		x	
<i>Microlaena colensoi</i>	x	x	x	
<i>Mitrasacme montana</i> var. <i>belmsii</i>		x	x	
<i>Olearia colensoi</i>	x	x	x	x
<i>Ourlisia macrocarpa</i> (b)	x			
<i>Parabebe lyallii</i> (b)	x			
<i>Pimelea longifolia</i>			x	
<i>Poa colensoi</i>	x		x	
<i>Raoulia grandiflora</i>	x	x	x	
<i>Raoulia tenuicaulis</i>	x			
<i>Rytidosperma setifolium</i>	x			
	24	12	22	6

(a) Also occurs in the Denniston SR extension RAP.

(b) Also recorded by Druce (1990b, 1990c) in lower Ngakawau Gorge.

Note: Table does not take account of more generalised distribution records of Druce (1990b, 1990c). Distributions may be extended by further searching.

The subalpine peaks of Mt. Rochfort (1040 m), Mt. William (1062 m), Mt. Augustus (1010 m) and Mt. Frederick (1106 m) are isolated outposts 15-20 km distant from the nearest such habitats on the Glasgow and Paparoa Ranges. Mt. Frederick, the highest peak, has the most extensive area of open subalpine sandstone pavement vegetation. The other peaks have a greater amount of shrubland and low forest in their vicinity. The open areas at those sites appear to have been extended by recent fire; the subalpine short stature vegetation was most likely more restricted to naturally open sites such as bluffs and windswept tops in pre-European or pre-Polynesian times.

The subalpine shrublands at the peaks are dominated by leatherwood, mountain flax and a variety of other shrub species. In the open vegetation broadleaved snowtussock is predominant on the few better drained slopes, usually on shrubland margins; red tussock is the predominant snowgrass elsewhere. They are accompanied by a range of herbs, grasses and prostrate shrubs (e.g., pink pine, *Dracophyllum politum*, *Carpina alpina*, wire rush and *Celmisia dallii*).

Steep rocky scarps and bluffs provide a distinctive habitat at all four peaks, particularly at Mt. Rochfort where there is a near vertical eastwards fall of 300 m. The scarps are in places inaccessible to introduced browsing animals and support at least three highly palatable species not found elsewhere in the survey area: *Anisotome haastii*, *Ourisia macrocarpa* and *Geum uniflorum* (c.f. Norton 1995). Other characteristic bluff species are *Mitrasacme montana* var. *helmsii*, *Dracophyllum pubescens*, *Microlaena thomsonii* and *Grammitis givenii*.

There are eight species recorded in the ecological district only from Mt. Frederick and a further seven only from Mt. Rochfort (Table 2). No species are confined to Mt. William or Mt. Augustus, although *Mitrasacme montana* var. *helmsii* is recorded only from both these peaks.

The red tussock-dominated open grasslands scattered alongside the upper Waimangaroa Valley are best developed in the "Happy Valley"⁴, a peat interfluvium extending between the Cypress Stream junction with the Waimangaroa River north to a small gorge on St Patricks Stm. Bog pine, *Olearia virgata* var. *implicita* and *Hebe canterburiensis* are prominent on the forest edge and along rivulets. A sphagnum moss flush site on the south-west margin of the main grassland, and streamsides, are particularly floristically rich, possibly in response to fertility influx from adjoining greywacke rocks. Thirteen species recorded in the Ngakawau Ecological District were found only in this grassland (*Olearia virgata* var. *implicita*, *Colobanthus apetalus*, *Coprosma* aff. *intertexta*, *Corybas macranthus*, *Crassula* sp., *Leptinella* sp. (*L. squalida* var. *mediana*), *Microseris scapigera*, *Nertera balfouriana*, *Pernettya macrostigma*, *Pittosporum anomalum*, *Plantago lanigera*, *Ranunculus gracilipes* and *R. sp. cf. foliosus*).

⁴ Colloquial name, not recognised by New Zealand Geographic Board.

The vegetation of the Blackburn Pakihi is fire-induced and dominated primarily by *Baumea teretifolia*, red tussock, tangle fern and *Rytidosperma gracile*, on an extremely boggy substrate. It has a greater predominance of introduced grasses than elsewhere in the survey area.

There is a history of burning of the open coal measures vegetation, as evidenced for instance by the mountain flax-manuka regenerating communities at lower altitudes and the loss of the former thin peat soils on the higher altitude sandstone plateau (Given & Park 1975). Repeated, extensive burning is documented up to the 1920s (Townson 1907, Mason & Moar 1955, Kelly in prep.). Despite the burning, the vegetation, although secondary, is intact at least compositionally and contains the characteristic pool of species of this infertile superhumid environment (Given & Park 1975), albeit with possible distribution changes and hybridisation. That the open coal measures vegetation has not recently replaced more wooded associations is strongly suggested by Burnett's (1862) account, written a decade before substantial coal mining activities, that "the country is spread out before you open, bare, and barren, a desolate wilderness of flat rocks" (p.75).

Abandoned burning underground coal mines at Ironbridge and Millerton and associated damaged vegetation are testament to the continuing influence of fire. At Millerton in particular, large scale earth moving has been carried out in attempts to contain the fires; the disturbed sites are now covered in gorse and rushland.

Much of the lower altitude forest on Brunner coal measures north of the Ngakawau Ecological Area (EA) has been logged for its indigenous timber species and/or converted to exotic plantations. Mining works on the Denniston and Stockton plateaux date back to the early 1870s. Parts of both plateaux have been extensively tracked and roaded, for powerline construction, coal exploration, etc. There are numerous past (e.g., Mt. William coal bins, Marshall's opencast, Ironbridge, Coalbrookdale, Escarpment, Whareatea, Mangatini) and present (Stockton-Webb opencast, Sullivan-Rapid Creek, Cascade) coal mining sites. The "lakes" on both plateaux lie behind mine dams.

(c) Dissected Hills on Basement Rocks

The open coal measures vegetation contrasts with the closed podocarp-mixed beech forest on the granite, gneiss and greywacke basement rocks exposed in some parts of the district. To the east of the Mt. William Range, the steep gully systems of the Orikaka are dominated by vigorous, high-biomass mixed hard beech, silver beech, mountain beech, southern rata, and rimu forest (Gleason 1982). Near the summit of Mt. Berners are southern rata and red beech, with tall rimu a little below. At Mt. Stockton, silver beech on lower slopes changes to mountain beech with rimu at higher altitude. Infertile sites are dominated by yellow silver pine.

(d) River Gorges

The steep often unstable river gorges (Ngakawau, Waimangaroa, Whareatea) are covered by open forests of rimu, southern rata, hard beech, kamahi, broadleaf, putaputaweta and other broadleaved tree species. There are localised areas of herbaceous vegetation, shrubs and stunted trees, with occasional talus and

rockfalls. Species characteristic of warmer sites (e.g., hinau, toro) occur in the lower and upper Ngakawau Gorges and there is a dense rimu/silver beech-mountain beech forest at the confluence of the Ngakawau River and Charming Creek. The steep walls and humid environment of the lower Ngakawau Gorge have resulted in a local flora rich in species adapted to damp, dark habitats, including the endemic *Celmisia morganii*; it is regarded as one of the best examples of this vegetation in the north-western South Island (Given & Park 1975). Silver beech predominates on the upper slopes of the main Waimangaroa Gorge and hard beech on the lower.

(e) Dissected Hills and Terraces on Siltstone

The vegetation on the Kaiata siltstone is mainly mixed podocarp-beech forest. Rimu, silver beech, hard beech, red beech, kahikatea, miro, and kamahi are common at lower altitudes. Mountain beech-pahautea-pink pine, and manuka form a forest-scrub mosaic on the basin between the Blackburn Pakihi and Mt. Berners. At higher altitudes on the more gleyed and podzolised soils in the Upper Orikaka Basin are the characteristic stunted silver beech, pahautea, rimu, pink pine and yellow silver pine forests, considered "regionally unique" (Anon. 1986).

Tall unmodified beech and podocarp-beech forests occur on the fluvio-glacial terrace system between the headwaters of the Ngakawau River, St George Stream and the upper Ngakawau Gorge (Grant 1984). These are typically dominated by rimu, silver and hard beech, with red beech and kahikatea generally restricted to the lowest terraces. On older surfaces (e.g., those dividing the Blackburn and Ngakawau catchments) there is a progressive reduction in canopy height and a change to forest species typical of lower fertility sites (e.g., yellow silver pine, Hall's totara, mountain toatoa, silver pine, mountain beech, pahautea and southern rata), and pakihī on the highest terraces.

On the western slopes of Mt. William and further north along the Mt. William Range there is a forest sequence that reflects changes in parent materials. On gentle Kaiata siltstone mountain beech-pahautea forest adjoining the Waimangaroa River changes to red beech-southern rata forest on colluvium at the base of the Mt. William fault line. On the exposed basement rock on the steep fault line slope hard beech-southern rata-rimu forest rises up to stunted subalpine mountain beech forest.

Much of the lower altitude forest on Kaiata siltstone north of the Ngakawau EA has been logged for indigenous timber species and/or converted to exotic plantations.

(f) Coastal Plain, Marine and Alluvial Terraces

The very narrow coastal plain and the alluvial terraces of the Mokihinui River have been mostly converted to exotic pasture. Some natural coastal vegetation remains along the foreshore, particularly at Mussel Rocks. Three small coastal forest fragments are present in Hector township, at Dufty Stream, and at Summerlea. Narrow alluvial forest fragments adjoin the Mokihinui River and Coal Creek. A larger area of northern rata, rimu, and kamahi on the south bank of the Mokihinui River three kilometres upstream of Seddonville was described by Park & Walls (1978) as grazed and very heavily logged.

(g) Glasgow Range

The slopes of the Glasgow Range are covered predominantly by silver beech - red beech forest, rising to a low silver beech treeline (1300 m). Alpine shrubland and grassland communities with a rich assemblage of species occur on the open tops (Given 1978, Druce *et al.* 1988, Williams 1991). Several beech-free patches (pink pine scrub) occur near the timberline on the north-west slopes of the range (e.g., Tate Stream) (Williams 1991).

2.7 FLORA

The Ngakawau ED lies at the south-west periphery of the concentration of endemic vascular plants that occurs in Northwest Nelson (McGlone 1985, Department of Conservation 1992). Given & Kelly (1976) described Northwest Nelson and North Westland, within which the Ngakawau ED occurs, as a poorly explored area botanically. Despite more recent investigations (Regnier 1986, Druce *et al.* 1988, Druce 1990b, 1990c, Williams 1991, this survey), botanical exploration of the ecological district is by no means complete.

Chionochloa juncea is the most widespread and distinctive of the species which are restricted to the Ngakawau ED and nearby areas (Given & Kelly 1976). Given (1981) described *C. juncea* as too abundant to qualify as an "at risk" species, but considered that further destruction of its habitat might easily cause it to become so. There was some difficulty during this survey in distinguishing *C. juncea* from *C. rubra* ssp. *occulta*. While "classic" *C. juncea* occurs on the pavement areas and *C. rubra* ssp. *occulta* on boggy valley bottoms and mountain summits, there was a range of intermediate forms whose often side-by-side occurrences are apparently related to environmental factors. Hybridisation in secondary habitats following fire may be a factor.

Celmisia morganii is now restricted to the Ngakawau River gorges (Given & Park 1975, Given & Kelly 1976) and is listed as a "local" species in the "New Zealand Botanical Society Threatened and Local Plant Lists" (Cameron *et al.* 1995). *C. dubia*, although centred on the coal plateaux, also extends from Northwest Nelson to the southern Paparoa Range. These two species have been included within *C. monroi* as subspecies by Druce (1990a). *Dracophyllum densum* is limited to Mt. Rochfort, Mt. William, Mt. Augustus, the Denniston plateau and Mt. Davy further south (Mason & Moar 1955, Allan 1961), although it is included by Druce (1990a, 1990b) within *D. politum*. *Carex dallii*, a Nelson-Westland species (Moore & Edgar 1970), occurs uncommonly on Mts Rochfort and Frederick and in the Cypress Stream tussocklands.

Pseudowintera traversii, a species found only in Northwest Nelson and North Westland (Eagle 1982), with its southern limit at Westport, is present at Mt. Rochfort forest, Cypress Stream, Mt. Frederick and, in particularly good numbers (David Given *pers. comm.*), around Mt. Augustus. In Northwest Nelson, it is not very common nor known to occur on coal measures (Shannel Courtney *pers. comm.*). An unnamed *Craspedia* sp., previously collected from the Glasgow Range and Mt. Frederick (Druce 1986), was recorded during this survey as abundant at Cypress Stream and present at Hut Stream. *Gentiana*

gracilifolia, found at Mt. Rochfort, is a further Northwest Nelson endemic (Druce 1986).

Microlaena thomsonii and *Astelia subulata*, previously thought to be endemic to the Buller-Paparoa area, are now also known from southern New Zealand (Given & Kelly 1976, David Given *pers. comm.*). *M. thomsonii* occurs on granites at Karamea (Peter Williams *pers. comm.*), and *Astelia subulata* at a few other sites in Northwest Nelson (Shannel Courtney *pers. comm.*) Species in the current New Zealand checklists of threatened and local vascular plants and conservation priorities for non-vascular plants, and which occur in the Ngakawau ecological district, are listed in Table 3.

TABLE 3: THREATENED AND LOCAL VASCULAR AND NON-VASCULAR PLANT SPECIES OCCURRING IN NGAKAWAU ECOLOGICAL DISTRICT

THREAT CATEGORY ¹	SPECIES
Vulnerable	<i>Peraxilla tetrapetala</i>
Rare	<i>Calochilus paludosus</i>
Local	<i>Celmisia morganii</i>
Category I	<i>Blindia lewinskyae</i>

¹ Threat categories for vascular taxa follow Cameron *et al.* (1995) and standard IUCN threat categories. Non-vascular plants follow conservation priorities of Molloy & Davis (1994): Category I = species about which little information exists, but which are considered threatened.

Five plants of the threatened mistletoe *Peraxilla tetrapetala* were found in the mountain beech-pahautea forest on the western flanks of the Mt. William Range in 1987-8 and 1990, and another in 1996. Several of the early records have not since been re-located. One plant host was collared with aluminium coil in 1995 to protect the mistletoe from possum browse. As an historical contrast, Townson (1907) reported the species was abundant from sea-level to 2000 feet (600 m), and described the beech trees in the Orowaiti catchment as "fairly ablaze with the scarlet flowers of *Elytranthe tetrapetala* (= *P. tetrapetala*) in the early summer".

The infrequently seen bearded orchid was found near Rome Creek in the Ngakawau EA and on Mt. Frederick.

Three small plateaux subalpine bog-herbfield species (*Euphrasia disperma*, *Mitrasacme montana* var. *helmsii* and *Utricularia novae-zelandiae*) were described as "rare" by Given (1981), although they are not confined to the Ngakawau ED and are no longer listed as threatened or local plant species (Cameron *et al.* 1995). Significant populations of all three of these minute plant species were found by this survey.

Other species with localised New Zealand distributions and occurring within the Ngakawau ED include *Actinotus novae-zelandiae*, *Olearia cheesemanii*, *Metrosideros parkinsonii*, *Centrolepis pallida* and the fern *Sticherus flabellatus*. *A. novae-zelandiae* occurs in seepage communities on the coal plateaux and is common only there and in southern New Zealand (Allan 1961). *Olearia cheesemanii*, a southern North Island and north-western South Island species, occurs in the Ngakawau ED within the lower Ngakawau Gorge (Given & Park 1975). *M. parkinsonii*, a species confined to Great Barrier Island and the

Northwest South Island, occurs frequently throughout the coal measures forests, for example, on the lower Denniston plateau, above Lake Rochfort, in the Denniston and Stockton Scenic Reserves (Kelly in prep.), below Mt. Frederick (Townson 1907) and Mt. William, in Mangatini Stream, on the Kiwi faultline and at Te Kuha. *Centrolepis pallida*, primarily a central North Island and southern New Zealand species, occurs uncommonly on the Glasgow Range, its only site in Northwest Nelson (Shannel Courtney pers. comm.).

Sticherus flabellatus, the "kauri forest umbrella fern", has an isolated and unusual occurrence in the Mangatini Stream catchment (Given 1982, D.A. Norton unpubl. data) and on the Kiwi faultline (Norton & Overmars 1990). These sites, at the species' highest known altitude in New Zealand, are two of three known South Island localities for a largely subtropical species otherwise restricted in New Zealand to the north of the North Island. *Metrosideros parkinsonii* (coal plateau forests), *Astelia trinervia* (Mt. Rochfort forest) and *Blechnum fraseri* (Denniston Scenic Reserve, Te Kuha) share a similar disjunct distribution, northern North Island and north-west South Island, with *A. trinervia* and *B. fraseri* now also known from northern Taranaki (Shannel Courtney pers. comm.). All three reach their southern limits not far south of the Ngakawau ED.

The sedge *Gabnia pauciflora*, a species restricted in this district to the slopes of Christmas Stream on the lower Mt. Rochfort forest (Newell 1990), Ngakawau Scenic Reserve (Kelly in prep.) and the toeslopes of the Mt. William Range, has a limited distribution in Westland although it is widespread in the North Island (Moore & Edgar 1970).

The occurrence of *Pittosporum anomalum* and *Exocarpus bidwillii* in Happy Valley and on the Denniston and Stockton plateaux respectively is of scientific interest as these are generally regarded as species of east of the Main Divide (Wilson & Galloway 1993). (*P. anomalum* is also known from Northwest Nelson (Druce 1988) and *Exocarpus bidwillii* from the southern Paparoa Range (D.A. Norton & F.B. Overmars unpublished data)). *Ranunculus* sp. cf. *foliosus*, also found in the Happy Valley, is distinct from described forms in that group and may be an undescribed species (David Norton pers. comm.).

Thirty-one species occur in the ecological district only on the four subalpine outposts (Mts Rochfort, William, Frederick and Augustus) (Table 2).

Lycopodium deuterodensum at Denniston (Druce 1986) and *Gabnia setifolia* on the Denniston plateau are at their known southern limits (David Norton pers. comm.). Steep coastal hillslopes approximately one kilometre south of Granity are the habitat of the fern *Arthropteris tenella*, near its southern limit on the West Coast (Cape Foulwind). Northern horopito, which has its southern limit at Westport, occurs at Coal Creek south-east of Seddonville. Similarly, *Olearia rani*, which has its southern limit at the Ohikanui River, occurs in the Ngakawau Scenic and Recreation Reserves.

Mt. Rochfort, the peak rising from the southern end of the Denniston plateau, is of particular botanical importance as the type locality for several species: *Gentiana townsonii*, *G. spencerii*, *Celmisia dubia* and *Euphrasia townsonii* (Allan 1961). Townson (1907) noted the orchid *Townsonia deflexa* on Mt. Rochfort (its type locality) and Mt. Frederick. This species has been included within *Acianthus viridis* by Moore & Edgar (1970). Mt. Rochfort is also the

type locality for several species that Druce (1990b) includes within other species. *Celmisia dubia* has already been mentioned. *Dracophyllum densum* (Allan 1961) has been included within *D. politum* while *D. oliveri* is included as part of a filiform variant of *D. longifolium*.

The "mountains near Westport" are the type locality for *Dracophyllum pubescens* (Allan 1961), which occurs on both the Denniston and Stockton plateaux. Mount Frederick is the type locality for *Gentiana montana* var. *stolonifera* (Allan 1961), a variety restricted to the coal plateaux and now described by Druce (1990b) as *G. montana*.

The Ngakawau ED flora includes as many as 22 undescribed vascular plant species (Appendix V, annotated "aff.", "unnamed" or "cf."). Two of these species (*Brachyglottis* sp., *Carphe* sp.) have a distribution which may be centred on the coal plateaux and Glasgow Range (Tony Druce *pers. comm.*).

A vascular plant species list and distribution notes, compiled from Regnier (1986), Druce (1990b, 1990c), Kelly (in prep.), this survey and several published records, are contained in Appendix V. Approximately 470 indigenous vascular plant species are recorded from the ecological district; and nearly 100 further species are recorded from the Glasgow Range (Druce *et al.* 1988), which straddles the boundary of the Ngakawau and Wangapeka EDs. A major omission in coverage is the Ngakawau Basin, for which flora checklists are unavailable. Although the list of adventive (and hybrid) species is cursory only, a notable feature of the coal plateaux vegetation generally is the low number of adventives (weeds): these are mostly confined to disturbed substrates.

The cryptogram flora of the Ngakawau Ecological District was not specifically covered by this survey. Existing information suggests the coal plateaux are rich in cryptograms, and have close phytogeographic links with Southwest Tasmania (David Galloway & David Glenn *pers. comm.*). A number of bryophytes recorded from the Denniston and Stockton plateaux are thought to be uncommon (Sue Gibb *pers. comm.*): three mosses, (*Blindia lewinskyae*, *Pleurophascum grandiglobum* var. *decurrans*, *Chorisodontium aciphyllum*), five hepatics (liverworts) (*Metzgeria bartlettii*, *Pallavicinia* sp. (undescribed), *Radula* sp. aff. *aneurismalis*, *Riccardia perspicua* and *Pachyglossa tenacifolia*) and three lichens (*Sipbula elixii*, *S. jamesii* and *Knightiella splachnirima*). Only *Blindia* have been listed as threatened by the Department of Conservation (Molloy & Davis 1994), and the apparent rarity may reflect a lack of knowledge on the distribution of species in these groups.

A number of hepatics have been recorded from the Glasgow Range that are known only from this range or from a very limited series of sites (e.g., *Riccardia alcornis*, *R. intercellula*, *R. pennata*, *R. perspicua*, *Acromastigum brachyphyllum*, *Cephalolobus* sp. (unnamed) and *Cheilolejeunea novae-zelandiae* (David Glenn *pers. comm.*)). The Glasgow Range is reported to have the highest diversity of alpine liverworts of anywhere in New Zealand (*ibid.*). Six lichens have disjunct distributions between Southwest Tasmania and the South Island (commonly the Denniston and Stockton plateaux) (Kantvilas 1994). This is also a feature of the bryophyte flora, and reflects the similarity of rock types, climate and biogeographical history (David Glenn *pers. comm.*).

Two lichens, *Austropeltum glareosum* and *Pycnothelia caliginosa* have been described based on specimens collected from coal plateaux, as has one aquatic moss, *Blindia lewinskyae*. The type locality of *Austropeltum glareosum*, a new monotypic genus, is sandstone pavement at c.900 m on the Stockton plateau (Henssen *et al.* 1992). *Pycnothelia caliginosa* was described in 1987 from sandstone pavements south of the Denniston township (David Galloway *pers. comm.*). *Blindia*'s type locality is Cedar Creek, and it is recorded from three other nearby sites upstream in the upper Waimangaroa River (Bartlett & Vitt 1986, Bryony Macmillan *pers. comm.*). It is reported to be abundant in streams near Seddonville, on the Denniston plateau and at the base of Mt. Rochfort. *Blindia* is known only from the west coast of the South Island (Bartlett & Vitt 1986).

2.8 FAUNA

The Ngakawau ED has a diverse range of habitats supporting a wide range of fauna, several of which are uncommon or threatened. There are both coastal and inland indigenous forests of diverse beech and podocarp composition, open areas of tussock and heathland as well as shrublands of manuka and yellow silver pine with dense tangle fern and bracken undergrowth. Streams, rivers, the rush and sedge communities of the Blackburn pakihi, subalpine seeps on Mt. Rochfort, and the artificial dams of the plateaux provide wetland habitats.

(a) Forests and Shrublands

The forested areas are rich in bird variety and numbers. Common native species are bellbird, tui, fantail, grey warbler, South Island robin, yellow-breasted tit, and silvereye. Shining cuckoo, yellow-crowned parakeet, brown creeper, rifleman, kereru, and morepork occur less frequently. Weka are common, particularly on forest margins, and their presence is often suggested by remains of predated *Powelliphanta* and koura. Common introduced species in forests are chaffinch and blackbird.

Great spotted kiwi have been recorded from the mid-Orikaka (Bull *et al.* 1985), upper Ngakawau (Anon. 1987) and near trig M above Te Kuha at the southern end of the ecological district (Garrick 1986). They were recorded during this survey in the upper Waimangaroa Valley and on the upper forested slopes of Mt. Rochfort, and kiwi probes were noted during the PNAP survey, in red tussockland in the Happy Valley.

Kaka were observed in the tall red beech forests of Mt. Berners and on the Mt. William Range; occurring in "good numbers" in the Mokihinui forests (Morse 1981). Kea were noted on Mt. Frederick, Mt. Rochfort and the Mt. William Range, and were also recorded from the Glasgow Range. Bats (probably long-tailed) have been recorded from the upper Orikaka (Morse 1981). Kakariki (parakeet) have been recorded from the Orowaiti River and the adjacent Little Cascade catchment, although the species has not been confirmed (Garrick 1986). The uncommon New Zealand falcon has been recorded from the district (Garrick 1986). Long tailed cuckoo are seasonally present.

The lowland Mokihiui forests are the principal habitat of two subspecies of the endemic large land snail genus *Powelliphanta* (Powell 1949, Morse 1981, Walker 1982, 1986). The habitat of *P. lignaria rotella* is now restricted to the St Andrews and upper Tate Streams, and a smaller area on the north and south side of Chasm Creek immediately south of Seddonville. The type locality is "land between St Andrews and Georges Streams at 1,200 feet" (Powell 1949). Its main habitat is rimu/yellow silver pine forest. *P.l. johnstoni* occurs in Charming Creek, Watson Creek, Chasm Creek and the northern Radcliffe Range, in a range of forest types. Although concentrated in the upper Mokihiui River, *P.l. unicolorata* also occurs in forest on both sides of the river downstream almost to the mouth.

The treeline tussocks, shrublands and forests of the Denniston and Stockton plateaux are the habitat and type locality of a fourth snail entity, previously known as the subspecies *P. rossiana patrickensis*. Recent genetic analysis of subspecies *P. r. patrickensis* suggests the Denniston-Stockton populations are genetically distinct from other populations on Northwest Nelson peaks, at subspecies and perhaps species level (Kath Walker *pers. comm.*). If these taxonomic changes are confirmed, *P. patrickensis* "Denniston" would become a localised endemic. Most shells seen on the coal plateaux had been predated.

Powelliphanta generally are dependent on high humidity and plant cover for survival. They are of limited mobility and are susceptible to habitat disturbance.

(b) Coal Plateaux Shrub-Tussocklands

The vertebrate fauna of the coal measures plateaux is sparse. Shrubby forest edges and the open heathlands provide habitat for the South Island fernbird, and the New Zealand pipit is a frequent sight on these open lands. *P. patrickensis* "Denniston" occurs on the higher Denniston and Stockton plateaux lands.

A southern black-backed gull breeding colony is an unusual feature of the Millerton burning mine area. Seeds carried by the birds have resulted in the growth of a green "island" in the otherwise barren and disturbed landscape.

(c) Rivers and other Wetlands

Black shag and little shag are characteristic of the major rivers (note that Ngakawau can mean *many shags* in Maori); little shags also occur on the St Patricks dam and probably also on other small wetlands. Blue duck are recorded from the upper Orikaka and upper Ngakawau Rivers (Bull *et al.* 1985). The southern black-backed gull is recorded as breeding at both Lake Rochfort and St Patricks Dam.

The limited available data suggest fish life is sparse in the major waterways draining the coal measures plateaux, but more diverse in streams at lower altitudes or having separate access to the sea (Tweed 1986, McDowall & Richardson 1986, McDowall *et al.* 1977, Fisheries Research Division Fish Distribution Data Base, Paul Lambert *pers. comm.*). Many coal plateau rivers have been polluted by coal mining effluent and acid mine drainage, and typically have low pH, and are contaminated with coal fines and silt. Poor water quality in the lower reaches prevents diadromous fish (requiring access from the sea) from migrating upstream into unpolluted tributaries.

Banded kokopu, inanga and koura are recorded from the lowest reaches of the Ngakawau River. The upper parts of the Waimangaroa catchment support only brown trout, koaro and koura. Granity Creek lacks fish and invertebrates. In contrast, the lower altitude forested Chasm Creek, only part of which drains coal measures, has koaro, eels and the threatened shortjawed kokopu. The large mountain-sourced Mokihinui River and tributaries support a comparatively rich fish fauna of brown trout, redfinned bully, torrentfish, shortjawed kokopu, common bully, bluegilled bully, koaro, and longfinned eel. Banded kokopu are common in the short, steep streams in the Mt Frederick coastal forest.

Koura are common in small creeks in the district and in seeps on higher altitude parts of the Denniston and Stockton plateaux.

(d) Modified Pastoral and Coastal Habitats

The modified coastal and river flat habitats support welcome swallow, pukeko, kingfisher, spurwinged plover, red-billed gull, black-billed gull and southern black-backed gull, paradise shelduck, and Australasian harrier, as well as a range of introduced passerines (Bull *et al.* 1985).

(e) Reptiles and Amphibians

There are two introduced species of frog recorded in the district, the green tree frog and the whistling tree frog. Reptiles are represented by the brown skink and the forest gecko (Pickard & Towns 1988). The brown skink is an inhabitant of boulder beaches and reaches its known southern limit on the West Coast near Seddonville. However other species are likely to be present. The common gecko occurs at Gentle Annie Point north of the Mokihinui River mouth, and the speckled skink occurs on the Karamea coast under stones amongst low coastal herbage (Walker 1987). A gecko skin found under a large rock on the Stockton plateau in December 1995 could not be identified to species.

(f) Invertebrate Fauna

Although invertebrates are the richest component of the New Zealand biota, little is known of them in the Ngakawau ED (apart from koura and *Powelliphanta*). The district is on the periphery of the Northwest Nelson zone of endemism (Walker 1987) and considerable endemism in the invertebrate fauna may be expected. The montane forest beetle fauna (Coleoptera) in Buller is described as rich (DSIR 1983).

Mt Augustus is the type locality for two invertebrate species, the elaterid alpine beetle *Elatichrosis* sp. (Coleoptera: Elateridae, click beetles) and the rare cicadellid *Paracephalus curtus* (Hemiptera: Cicadellidae, slender plant hoppers) (DSIR 1983, John Dugdale *pers. comm.*). Specimens (paratypes) of *P. curtus* are also recorded from the Denniston plateau and Mt Ruapehu. The plant communities of the Mt Augustus - Mt Frederick summits and slopes are regarded as having high faunal (invertebrate) values (Dugdale *ibid.*). The seeps and tarns of the plateau are probably also rich in invertebrate life.

The ecological district lies within the range of the common tree weta and the Northwest Nelson endemic weta *Hemideina broughi* (Meads 1990). Crosby & Hall (1984) record the invertebrates remaining in a former beech-podocarp area of Mokihinui forest cleared for exotic plantation by an intense fire. Alpine grasshoppers were commonly seen on the upper coal measures shrub-tussock lands.

Freshwater invertebrate surveys of the Stockton plateau by Coal Corporation of New Zealand Ltd (1989) found depauperate aquatic communities, even in unmodified control catchments. This was attributed to the lack of organic layers in the streambed, naturally low pH, high rainfall, and large variations in stream flows.

Although micro-land snails are present in the ecological district, no species are known to be restricted to it (Frank Climo *pers. comm.*).

From the limited beetle fauna survey (section 1.3.2.4), twelve carabid and two scarabaeid species were identified to species level, and a third scarabaeid to genus level. In addition, a weevil (Curculionidae), two rove beetles (Staphylinidae) and two Helodidae species were collected, along with a further dozen or so species of mostly very small beetles which were not assigned to families (Table 4). Approximately twenty-two species were taken at single sites only, and a further five at only two sites each. Only four species (*Mecodema metallicum*, *Neoferonia integrata*, *N. sp.* ("with mucro"), *Saphobios setosus*) were collected from a wide spread of sites. *Saphobios setosus* was the most ubiquitous species: it occurred in all but the most open short vegetation sites.

TABLE 4: PIT-TRAPPED CARABIDAE AND OTHER BEETLES IDENTIFIED FROM THE STOCKTON AND DENNISTON COAL PLATEAUX

SPECIES	MT ROCHFORD	WHAREATEA	MT WILLIAM	MT FREDERICK	REPO STM
	(4 sites)	(3 sites)	(2 sites)	(1 site)	(4 sites)
<i>Carabidae</i>					
<i>Mecodema metallicum</i>	x	x	x	x	
<i>Mecodema ducale</i>					x
<i>Plocamostethus plantusculus</i>	x			x	
<i>Neoferonia integrata</i>	x	x	x		
<i>Neoferonia</i> cf. <i>integrata</i>		x			
<i>Neoferonia praignis</i>	x				
<i>Neoferonia</i> sp. ("with mucro")	x	x		x	
<i>Neoferonia</i> sp. ("flat intervals")	x				
<i>Neoferonia</i> sp. (female) 1	x	x	x		x
<i>Agonum helmst</i>	x				
<i>Zolus femoralis</i>	x	x			
<i>Molopsida ?puncticollis</i>		x			
<i>Neocicindela helmst</i> (Cicindelidae)		x			

Table 4 continued on next page

Table 4 continued

SPECIES	MT ROCHFORD	WHAREATEA	MT WILLIAM	MT FREDERICK	REPO STM
<i>Scarabaeidae</i>					
<i>Saprobobtus setosus</i>	x	x	x		x
<i>Odontria</i> sp.	x				
<i>Sericospilus advena</i>		x			
<i>Other Beetles 2</i>					
"Species 10" (Staphylinidae)		x			
"Species 25" (Staphylinidae)					x
"Species 15" (Helodidae)					x
"Species 26" (Helodidae)					x
"Species 13" (Curculionidae)	x				
"Species 5"	x				
"Species 8"		x			
"Species 11"		x			
"Species 17"					x
"Species 18"					x
"Species 19"					x
"Species 20"					x
"Species 21"					x
"Species 22"					x
"Species 23"	x				
"Species 24"	x				
"Species 25"					x

1 Unaccompanied *Neoferonia* females are not reliably referable to species.

2 The small unnamed beetles recorded by number only were divided cursorily into species. Some may represent more than one species, and some identified as separate may be the same species.

The sites which displayed the greatest beetle species richness through pitfall trapping were the Mt Rochfort summit (fourteen species, including eight carabids), the tall forest south of the Repo Stream pakihi (thirteen species, including two carabids), and forest and open habitats west of the old

Whareatea coal mine (twelve species, including seven carabids). Mts William and Frederick produced no species that were not found on the Denniston plateau. Numbers of specimens were generally highest on Mt Rochfort.

Of particular interest was the pattern, for most species, of generally low abundance and restricted distribution. *Mecodema metallicum*, which occurred at all sample sites except Repo Stream, is regarded as "quite a rare species - there are not very many records in collections" (Ian Townsend *pers. comm.*).

(g) Threatened Species

Several threatened animal species (Molloy & Davis 1994) have been recorded from the Ngakawau ED, although this survey did not formally quantify the abundance or distribution of these. These include: short-jawed kokopu (Category A), great spotted kiwi or roa (Category B), long-tailed bat (Category B), western weka (Category B), New Zealand pigeon or kereru (Category B), blue duck or whio (Category B), New Zealand falcon (Category B), South Island kaka (category B), kea (Category B), the snails *Powelliphanta lignaria johnstoni*, *P. l. rotella* and *P. l. unicolorata* (all Category B), koaro (Category C) and the snail *Powelliphanta rossiana patrickensis* (Category C). Should recent taxonomic investigations into *Powelliphanta* taxonomy confirm a subspecific or specific status for populations previously referred to *P. r. patrickensis*, a higher conservation status may be appropriate for what would then be a localised endemic species. Although Garrick (1986) was not able to confirm the species of kakariki present, he suggests that they might be yellow-crowned kakariki (Category C). There is no information on the conservation status of invertebrates other than snails within the Ngakawau Ecological District.

Introduced Mammals

Red deer occur throughout the forests and subalpine communities, but they or their sign were not observed on the coal plateaux except at Te Kuha. Feral goats occur in high numbers on the Glasgow Range and smaller herds may be expected throughout (Terry Farrell *pers. comm.*). They were observed on parts of the bluff outcrops below Mt Rochfort. Wild pigs occur behind Waimangaroa and Seddonville, in the lower Ngakawau Gorge and on the Blackburn pakihi. Possums are likely to occur throughout all forest habitats although not, on the evidence of unbrowsed normally highly palatable plant species (e.g., *Pseudopanax colensoi*), in high numbers.

Smaller mammals (ship rat, Norway rat, mouse, rabbit, hare, mustelids and feral cat) may be expected in suitable habitats. Vespulid wasps are frequent in season in lower altitude beech forests (e.g., Mt Rochfort forest).

In general, all introduced animals impact unfavourably on the indigenous biota through grazing, predation, competition and/or habitat modification.

2.9 PRE-HISTORIC AND HISTORIC USE OF THE BULLER COAL PLATEAUX

There is evidence of Maori occupation along the Buller coast dating back to the 14th century AD, and Burnett (1862) reported a Maori trail up the Orikaka and over the range to the Waimangaroa as an alternative to the lower Buller Gorge. The area covered by the Ngakawau PNAP report contains areas of significance to Maori. As Maori view the natural world holistically it is important to keep this in mind when investigating smaller areas as total units. The Ngakawau area must be viewed in its relationship to the Paparoa area. It contains spiritual significance (which leaves nothing tangible on the ground to examine). The peaks themselves *are* the spiritual tupuna from the waaka Aotearoa and Aotearangi. The area contains old waahi tapu places of significance, waters and water systems of significance, traditional birding and mahinga kai areas, traditional rongoa material, and is part of the supportive structure of the Maori principles pertaining to Paparoa, Tiropahi, Alpha and Waggon Creeks.

Neither Heaphy in 1846 (Heaphy 1846), Brunner in 1846-1847 (Brunner 1851) nor Mackay in 1857 (May 1962) were inclined to scale the high coastal escarpment or explore the various rivers which emerged. Rochfort's survey party ascended the escarpment in 1859 (Rochfort 1862).

The first group to direct attention to the mineral wealth of the area were a group of Maori prospectors who discovered gold in the Waimangaroa in early 1860 (May 1962). According to the European prospector Davie Stephenson (Munro 1950), the first discovery was made by John Mawhika [Hoani Mahuika]. A number of European miners followed and the Waimangaroa was the main focus for Buller settlement until the Lyell Creek goldfield was opened up in 1863. It is possible that gold prospectors were the first to explore the plateaux as small gold workings were established in the headwaters of Whareatea, Cascade and Cedar Creeks.

The first systematic exploration was undertaken by Julius Haast, James Burnett and party in mid 1860. Haast searched for and located a substantial coal seam in a valley he named Coal Brook Dale. He also named Mounts Rochfort, Frederick and William, and Burnetts Face, the rocky cliff behind Coalbrookdale (Haast 1861). James Burnett returned the following year and continued the Denniston survey and extended it to include the Stockton-Mokihinui plateaux (Burnett 1862). His report estimated 72,600,000 tons of recoverable coal on the Denniston plateau alone. He predicted "... in a few years Nelson [Buller] will be the great coaling station of the southern hemisphere" (Burnett 1863).

The first coal mine opened was at Mokihinui in 1862 by Batty and Hunter. The mine site itself, from the description given, was on the north bank of the river 1.5 km below Seddonville. The trial shipment of coal was punted down to the mouth where a small ship then carried it to Nelson. The coal, of good quality, met a ready market. Batty and Hunter proceeded to form a road from the mine to the river mouth but following massive flood damage appear to have abandoned this mine in 1863. They then prospected outcrops in Chasm Creek (Burnett 1863).

A party of miners opened up a seam of coal near the mouth of the Ngakawau River in 1862. The coal was of poor quality and appears to have been abandoned in 1863. The altitude of the main seams on the plateau, the lack of transport along the coastal lowlands and poor port facilities hindered development. In 1872 the Ngakawau mine was reopened by the Albion company but after a few months again ceased operations (Morgan & Bartrum 1915).

A second survey of the Denniston plateau by William Cooper and R. B. Denniston was undertaken in 1873. Following this survey three parties opened up seams at Waimangaroa in 1874. One of these became the Wellington Mine which in 1877 produced 1468 tons of coal. This coal, like other low level seams in the vicinity, was of inferior quality (Morgan & Bartrum 1915).

Interest in the plateau coal seam quickened following Denniston's survey, also no doubt related to the building of the coastal railway north of Westport and associated port development.

The Wellington Company joined adjacent lease holders to form the Koranui Coal Company. Several other leases were amalgamated at the head of the Waimangaroa to form Westport Collieries in 1878, reformed in 1881 to the Westport Coal Co. Westport Collieries commenced construction of the Denniston Incline in 1878. The first mine opened up on the plateau was the Fisher Mine (name changed to Bunbury soon after) in 1880 near Coal Brook Dale (Miller n.d.).

Associated with the incline construction, the tramway from incline top to mine and mine development were two settlements, the Brakehead and the Camp. Denniston township soon incorporated both settlements and the space between. The Denniston Incline became operational in April 1880.

The Koranui company commenced building their own incline in 1880. This was completed and commenced operations in 1883. However the mine changed hands in 1885 and passed to the Westport Coal Company a year later, after which the incline and mine were closed down (Meyer 1989).

In 1882 first development of the Burnetts Face mine commenced and the nearby settlement was established. Subsequently the Iron Bridge and Coalbrookdale mines were developed. A subsidiary town of Marshal Vale was established west of Burnetts Face. A foot track up the Waimangaroa gorge to Denniston was completed in 1885, a dray track in 1902 and a fully formed road in 1915 (Openshaw n.d.).

The Westport Coal Co. turned its attention to the Stockton plateau coal in 1890. Over the following four years the Millerton Incline was constructed and the Old Dip Mine opened up and connected via tramway to the incline. The Mine Creek mine was opened up about 1898 and subsequent operations extended beyond Mangatini Creek. Settlements associated with these Westport Coal Company operations were initially Millerton and, around the turn of the century, Mangatini and Mine Creek (Morgan & Bartrum 1915).

To exploit coal deposits north and east of the Westport Coal Company leases the Westport Stockton Coal Company was formed in 1905. The Stockton-Ngakawau Incline and an electric tramway atop the plateau were completed by 1908 (Morgan & Bartrum 1915). Plateau settlements associated with this company were Stockton at the top of the incline, Darlington at the head of Weka Creek and a small camp between B and C tunnels at Mangatini Creek.

The last engineering feat in the old style was development of the Rockies Mine south of Millerton. An incline from the railway to escarpment crest, and associated tramways extending north and south-east of the incline, operated between 1924 and 1934.

Coal production from the Buller coalfield peaked at nearly 850,000 tons p.a. between 1910 and 1914; a production nadir of 300,000 tons occurred in 1933.

Burnetts Face and Mine Creek populations peaked in 1911, and Denniston and Millerton in 1927. At its peak the plateaux had a combined population of around 3 000 inhabitants. A decline in production and improved access, transport and aerial ropeways resulted in the abandonment of both townships and original transport systems by the 1960s.

The legacy of 120 years of human settlement and industry is a wealth of historic sites. A great number of these sites (those dating prior to 1900) are protected under the Historic Places Act 1993; many other pre-Depression era sites warrant long term protection.

3. CHECKLIST OF ECOLOGICAL UNITS

Table 5 summarises the vegetation associations in the surveyed portion of the Ngakawau ED, and the land systems and landform units on which they occur. The coastal plain, marine and alluvial terraces (unit 6) and Glasgow Range land systems (unit 7) were not surveyed and are not listed. The table summarises the base survey data in Appendix VI. The number of plots is an indicative measure of how common each ecological unit is in the survey area.

The table also shows the degree to which ecological units are currently represented within PNAs, and those units represented in RAPs. Protection is regarded as adequate when more than 10-20% of each vegetation association in each land system is included within secure PNAs. Although the local purpose reserves are not considered secure, their importance for some of the coastal hillslope vegetation units is apparent.

Although fire has probably modified many of the vegetation associations, they are still relatively natural. Only the manuka scrub and *Baumea* - tanglefern associations and some of the kamahi-southern rata-inaka forest on the lower Stockton plateau are obviously seral.

TABLE 5: CHECKLIST OF ECOLOGICAL UNITS SURVEYED IN NGAKAWAU ECOLOGICAL DISTRICT

PNAs:		SURVEY RAPs:
DSR=	Denniston SR	1 = Upper Waimangaroa Valley
SSR =	Stockton SR	2 = Mt Rochfort
NSR=	Ngakawau SR	3 = Mt Frederick - Mt Augustus
OEA=	Orikaka EA	
NEA=	Ngakawau EA	
NRR=	Ngakawau-Hector RR*	
WWCR=	Westport Water Conservation Reserve*	
CCWCR=	Conns Ck Water Conservation Reserve*	

* Local purpose reserves, not secure PNAs

**TABLE 5: CHECKLIST OF ECOLOGICAL UNITS SURVEYED IN NGAKAWAU
ECOLOGICAL DISTRICT**

1 Coastal Hillslopes a) On basement or Kaiata siltstone rocks	1 Rimu/Broadleaved forest	Colluvial hillslope	7	Inadequate, small areas, DSR, NSR,NRR*, WWCR*	3
		Fluvial terrace	2		
	2 Mixed beech-southern rata forest (red or silver beech dominant)	Colluvial hillslope	4	Inadequate, small areas, WWCR*	3
	3 Hard beech-southern rata-rimu forest	Colluvial hillslope	5	Inadequate, NSR, WWCR*	3
	5 Mountain beech/yellow silver pine-pink pine forest	Ridgeline	2	Nil	3
b) On Brunner Coal Measures	4c Southern rata-mountain beech forest	Colluvial hillslope	1	Inadequate, WWCR*	2
	5 Mountain beech/yellow silver pine-pink pine forest	Colluvial hillslope	2	Inadequate, WWCR*	2
2 Stockton and Denniston Coal Measures Plateau + Kaiata siltstone	2 Mixed beech-southern rata forest (red or silver beech dominant)	Colluvial hillslope+	1	Adequate, OEA,NEA	1
		Plateau gully		None known	2
	4a Rimu/mountain beech forest	Colluvial hillslope	3	Adequate, NEA, OEA DSIR,NSR	2
		Plateau gully	3		-
	4c Southern rata-mountain beech forest	Colluvial hillslope	6	Inadequate,fragment DSR	-
		Plateau gully	3		1
	5 Mountain beech/yellow silver pine-pink pine forest	Colluvial hillslope	1	Inadequate, fragments DSR,small areas OEA, WWCR*	1
		Plateau gully	6		2
	6 Mountain beech-silver beech forest and shrubland	Colluvial hillslope	3	small areas, WWCR,possibly OEA	1, 2
		Plateau gully	4		1
	7 Leatherwood scrub	Plateau	2	Nil	1, 2, 3
		Scarp	2		2
	8 Mountain beech-manuka scrub	Plateau gully	1	None known, possibly OEA	1
		Plateau scarp	2		1

Table 5 continued on next page

Table 5 continued

	9 Pink pine - Chionochloa juncea-manuka tussock-shrubland *	Plateau hillslope	3	Nil	1
		Plateau hilltop / pavement	4		1
		Plateau scarp	2		1
	10 Manuka-Dracophyllum politum/wire rush-rush- shrubland *	Plateau hillslope	4	Inadequate, fragments NEA, OEA	1
		Plateau/pavement	16		1
		Hilltop	2		-
	11 [Manuka]/wire rush- Chionochloa juncea tussock-rushland with subalpine bog species	Plateau hillslope	11	Inadequate, small lower altitude patches, OEA	1, 2
		Plateau pavement	4		1
	12a [Manuka]/wire rush-tangle fern shrub-rushland	Hilltops and ridgeline	3	Adequate, OEA, WWCR*	-
		Plateau gully	1		-
	12b Manuka/Baumea teretifolia -wire rush shrub-rushland	Hilltop	3	Adequate NEA, OEA	2
		Plateau hillslope	2		-
		Plateau gully	2		2
	13 Baumea teretifolia- Rytidosperma gracile rushland	Plateau hillslope and hilltop	6	Adequate, NEA, OEA	-
		Fluvial plain	7		-
		Fluvial terrace	1		-
	14 Red tussock-bog pine shrub-tussockland	Alluvial flat	2	None known	1
3 Dissected Hills on Basement rocks	2 Mixed beech-southern rata forest (red, hard and/or silver dominant)	Colluvial hillslope	7	Adequate, NEA, OEA	1
	3 Hard beech-southern rata-rimu forest	Colluvial hillslope	2	Adequate, OEA, NEA	-
	4a Rimu/mountain beech forest	Colluvial hillslope	5	Adequate, NEA, OEA	-
	4c Southern rata-mountain beech forest	Colluvial hillslope	2	Adequate, OEA	-
	5 Mountain beech-yellow silver pine-pink pine forest	Colluvial hillslope	1	Adequate, OEA, NEA	-
		Ridgeline	1		-

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Table 5 continued

	6 Mountain beech-silver beech forest and shrubland	Colluvial hillslope	4	Adequate, OEA, NEA	1
		Plateau gully	1		1
	8 Mountain beech-manuka scrub	Fluvial surface	2	Adequate, NEA, OEA	-
		Colluvial hillslope	1		-
	10 Manuka-Dracophyllum politum/wire rush rush-shrubland	Hilltop	1	None known	-
	12b Manuka-Baumea teretifolia -wire rush shrub-rushland	Plateau hilltop and ridgeline	3	Adequate, NEA	-
4 River Gorges	1 Rimu/broadleaved forest	Colluvial hillslope	1	Adequate, DSR, NEA, CCWCR*	-
	2 Mixed beech-southern rata forest	Colluvial hillslope	1	Adequate, DSR, NEA	-
	3 Hard beech-southern rata-rimu forest	Colluvial hillslope	1	Adequate, DSR, NEA	-
5 Dissected Hills and Terraces on Siltstone forest	3 Hard beech-southern rata-rimu	Colluvial hillslope	1	Adequate,	-
		Fluvial plain	1	NEA, OEA	-
	4a Rimu/mountain beech forest	Colluvial hillslope	2	Adequate, NEA, OEA	-
	4b Mountain beech-pahautea forest	Fluvial floodplain	3	Adequate, NEA, OEA	-
	5 Mountain beech/yellow silver pine-pink pine forest	Fluvial valley/riverbed	2	Adequate, NEA, OEA	-
	8 Mountain beech/manuka scrub	Alluvial surface	1	Adequate, NEA, OEA	-
		Colluvial hillslope	2	Adequate, NEA, OEA	-

4. RECOMMENDED AREAS FOR PROTECTION

Three major areas and four small ones are recommended for protection (Figure 5, Table 6). These total approximately 5398 ha (25% of the survey area; c. 11% of the ecological district). Existing PNAs total approximately 22 870 ha (42.3% of the ecological district) (Figure 2, Table 6).

Of the RAPs, some 3788 hectares (70.2%) is stewardship land, administered by the Department of Conservation; 140 hectares (2.6%) are held by Solid Energy as part of their Stockton coal mining licence; and 1462 hectares (27.1%) are Crown Land (unallocated or underaction) currently administered by Land Information New Zealand. Approximately 8 ha (0.1%) at Summerlea Bush is on legal road (administered by Transit New Zealand).

In accordance with the Department's arrangement with Ministry of Commerce (Energy) and Coalcorp to seek representative protected natural areas away from known coal resources wherever possible (section 1.3.4), initially selected RAP boundaries were checked against information on coal deposits and development proposals supplied by the Ministry of Commerce (Barrell 1988, Barry & MacFarlan 1988, Todd 1989a, b, Cave 1992, David Lavill *pers. comm.*). The initial Mt Rochfort-Denniston plateau RAP proposal was modified slightly to exclude identified coal resources. There remains a small overlap at Mt Augustus in the Mt Frederick-Mt Augustus RAP (in Solid Energy's current Stockton coal mining licence), and a considerable overlap in the Upper Waimangaroa-Mt William RAP (in Coalcorp's coal exploration licence).

It was not possible to exclude all areas with known coal resources as these areas often had the highest ecological values by virtue of their not having been mined. The significance of the Buller coal plateau ecosystems, and the RAPs in particular, was confirmed by an assessment of other Brunner coal measures sites in Nelson and the West Coast (Appendix IX). This showed the shrub-tussockland associations of the elevated Denniston and Stockton coal plateaux are not replicated elsewhere in Nelson or the West Coast or indeed New Zealand. Particular consideration was given to the possibility of excluding areas adjoining the Waimangaroa River which have the greatest coal resources from the Upper Waimangaroa-Mt William RAP. This finally was not pursued because it would represent a substantial compromise of nature conservation values. It would split the RAP, exclude several key features and substantially reduce its representative value.

Eleven features listed in the Geopreservation Inventory occur in Ngakawau ED and are tabulated in Appendix VII. Two sites (Torea Rocks and Denniston Scenic Reserve) are of national significance; the others are of regional or regional/local significance only. Torea Rocks are presumed to be Maori owned, the Granity coke ovens are now owned by the Buller District Council, and the Denniston Road conglomerate units are on legal road. The other eight sites are on either ecological area, scenic reserve or stewardship land in the care of the Department of Conservation. All sites are considered adequately protected given their low level of threat and current legal status.

Soil unit type localities and other reference sites for the Ngakawau ED have been defined by Dr Geoff Mew (*pers. comm.*) (Appendix VIII). Designation in management plans and on the ground sign posting is considered adequate protection for the three sites not included in existing protected natural areas, other protected areas, or the RAPs proposed in this report.

TABLE 6: RECOMMENDED AREAS FOR PROTECTION AND EXISTING PROTECTED NATURAL AREAS IN NGAKAWAU ECOLOGICAL DISTRICT

	RAPS	SIZE (HA)
1	Upper Waimangaroa - Mt William	2 110
2	Mt Rochfort	1 335
3	Mt Frederick - Mt Augustus	1 050
4	Ngakawau Scenic Reserve Addition	23
5	Denniston Scenic Reserve Addition	100
6	Pt Westport Water Conservation Reserve	770
7	Summerlea Bush	10
	Total area	5 398

EXISTING PNAS (APPENDIX I)

1	Stockton Scenic Reserve (excluding section 4)	13
2	Ngakawau Scenic Reserve	69.2
3	Denniston Scenic Reserve	683.7
4	Radcliffe Ecological Area (360 ha) and Frank Stream stewardship land (142.4 ha)	502.4
5	Ngakawau Ecological Area	13 601
6	Orikaka Ecological Area	c. 8 000
7	Stewardship land (DOC)	2 995
	Total area	25 864

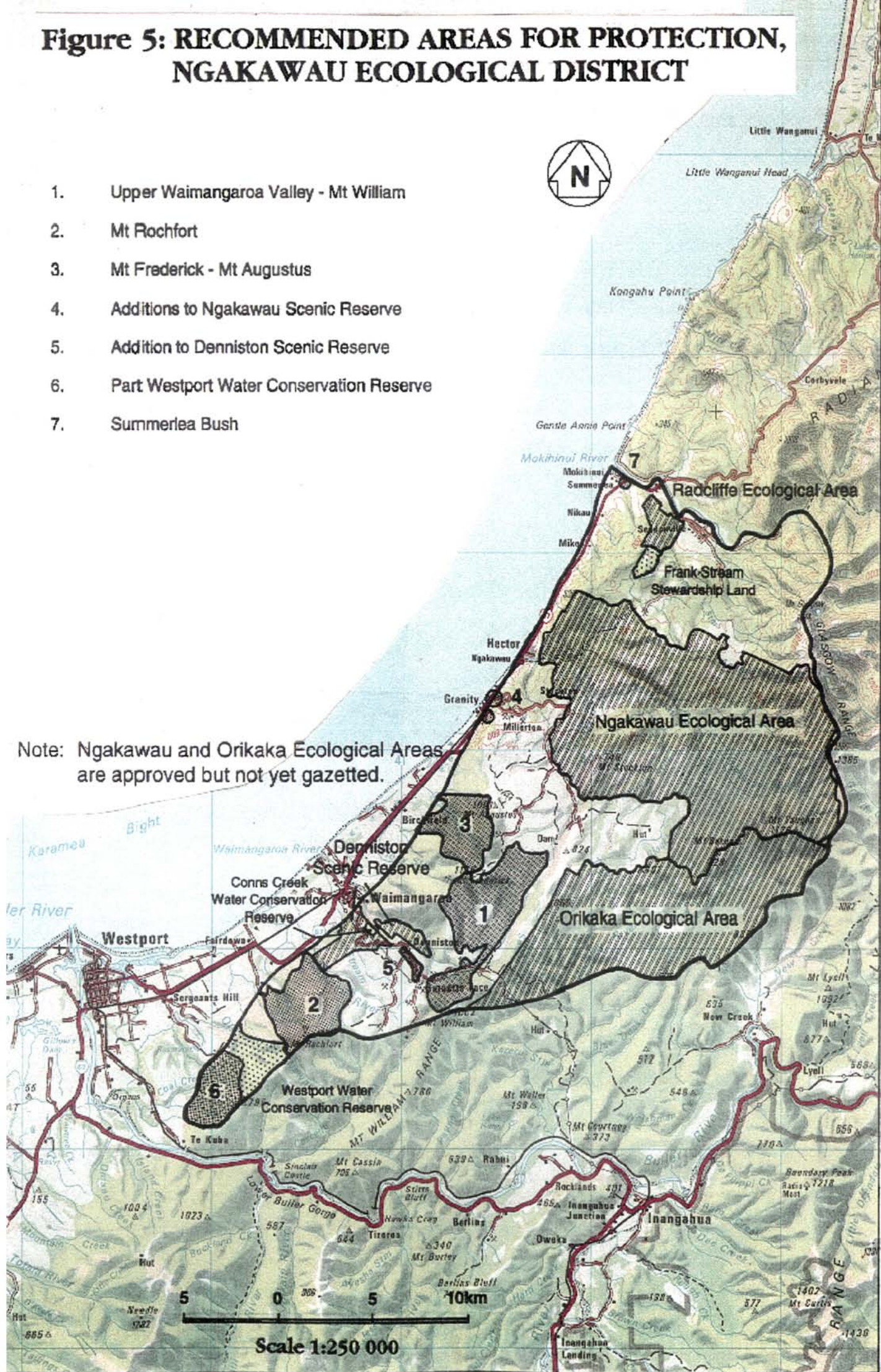
OTHER RESERVES

1	Ngakawau Recreation Reserve	16.64
2	Westport Water Conservation Reserve	1825.3
3	Conns Creek Water Conservation Reserve	33.88

Figure 5: RECOMMENDED AREAS FOR PROTECTION, NGAKAWAU ECOLOGICAL DISTRICT

1. Upper Waimangaroa Valley - Mt William
2. Mt Rochfort
3. Mt Frederick - Mt Augustus
4. Additions to Ngakawau Scenic Reserve
5. Addition to Denniston Scenic Reserve
6. Part Westport Water Conservation Reserve
7. Summerlea Bush

Note: Ngakawau and Orikaka Ecological Areas are approved but not yet gazetted.



Kelly (in prep.) noted "that a considerable portion of the (Westport) water conservation reserve is entirely beyond the actual water catchment boundaries. Since the area is a mosaic of coal measures vegetation, if this non-catchment portion is at any time released from water reserve, it should without doubt be added to the adjoining (Lower Buller Gorge) scenic reserve". The water conservation reserve is presently vested in the Buller District Council and subject to the Reserves Act 1977. However, its protection for nature conservation purposes is not secure as shown by a recent (1995) application for resource consents to operate an opencast coal mine near trig M at the southern end of the Ngakawau ED. Similar mid-altitude moderately sloping coal measures forest and shrub-tussockland is present in the Denniston SR and Mt Rochfort RAP, but the area of the proposed mine appears to be substantially less modified by recent fire than areas in Denniston SR or the Mt Rochfort RAP, especially the higher altitude stunted forest-shrubland-heathland mosaic. Accounts of the flora and fauna of the southern part of the water conservation reserve are provided by Garrick (1986) and Regnier (1986).

Specific protection (through designation in the management plan) is desirable for the three soil reference localities present in the Westport water conservation reserve (section 4.4.4, Appendix VIII).

Although the Blackburn Pakihi is a geologically distinctive feature in the Ngakawau ED, it does not merit RAP status because its vegetation is fire-induced (replacing low forest) and not high in native plant species richness. There is unmodified forest and shrubland on a comparable landform directly to the east in the Ngakawau EA, and similar open shrub-tussockland communities occur on the Tiger Pakihi in the Orikaka EA.

The southern most of the three areas which constitute the Stockton Scenic Reserve (Pt Sec 6) lacks significant conservation value and is recommended for revocation of reserve status.

This survey of the Ngakawau ED, at a rapid reconnaissance scale, has sought to consolidate a broadly representative system of protected natural areas. Ideally, management of all natural and semi-natural areas in the ecological district should recognise the natural values present. Protection of the RAPs together with the current PNAs cannot be guaranteed to protect every native species occurring in the district. Invertebrate populations, for instance, are often discrete with only a limited geographic range (Duncan & Johns 1989).

There may be other areas in the Ngakawau ED worthy of protection for reasons other than nature conservation (e.g., heritage, historic, recreation, amenity). Also, the few remnant natural habitats on the coastal plains and Mokihinui river flats, though not surveyed, may prove to be significant.

The following section describes the characteristics and values of each RAP, using the nature conservation criteria of O'Connor *et al.* (1990).

4.1 NGAKAWAU RAP 1: UPPER WAIMANGAROA VALLEY - MT WILLIAM

Introduction

Of any area on the Denniston and Stockton coal plateaux, the Upper Waimangaroa - Mt William RAP (frontispiece, photos 2 & 3) has the greatest ecological diversity in the least modified condition, particularly of the endemic coal measure communities. It is an outstanding, and fragile, natural area (and landscape) and its values should be recognised in all future management.

The RAP comprises extensive sandstone pavement areas south and east of Mt Frederick, the upper reaches of the Waimangaroa River valley, part of the headwaters of St Patricks Stream, the western slopes of the Mt William Range, and the summit of Mt William and part of Mt Frederick. It excludes heavily modified areas adjoining the summit of Mt Frederick.

Summary

Area:	2 110 ha
Altitudinal Range:	500-1106 m asl
Tenure:	Solid Energy (90 ha) Land Information New Zealand (Crown Land unallocated or underaction) (1 320 ha) Department of Conservation (stewardship land) (700 ha)

Boundaries

From spot height 865 south-west of Mt Frederick, the boundary descends generally down the south-western lip of the Billo Stream - Deep Stream gully to the Kiwi Faultline. It proceeds 600 metres north-east at the base of the Kiwi Faultline, and then follows a stream south-east to the Waimangaroa River and up the Waimangaroa River (true left) to the Marshall's open cast road/hydro road. It follows the hydro road south-west to rejoin the Waimangaroa River, which it follows to its junction with Cedar Stream. It climbs to Mt William and the Orikaka EA boundary via the high voltage electricity line and the ridge south of Hut Stream, and continues north-eastwards along the Orikaka EA boundary (generally below the ridgeline of the Mt William Range) to St Patricks Stream. It descends St Patricks Stream to the dam lake, then ascends a western tributary to the Webb fault scarp. It then follows a small ridge to trig L41, the Coalcorp mining licence boundary to Herbert Stream, and a ridge towards the Mt Frederick summit.

Around Mt Frederick the boundary is generally 20 metres upslope of the bluffs around the east and south sides of the mountain, except that the relatively unmodified (as at 1991) stone pavements and grasslands on the eastern and south-western sides respectively are included. From spot height 1053 the boundary ascends directly to the summit and returns along the catchment ridge to the starting point at spot height 865.

**Figure 6: UPPER WAIMANGAROA VALLEY-MT. WILLIAM
RECOMMENDED AREA FOR PROTECTION**

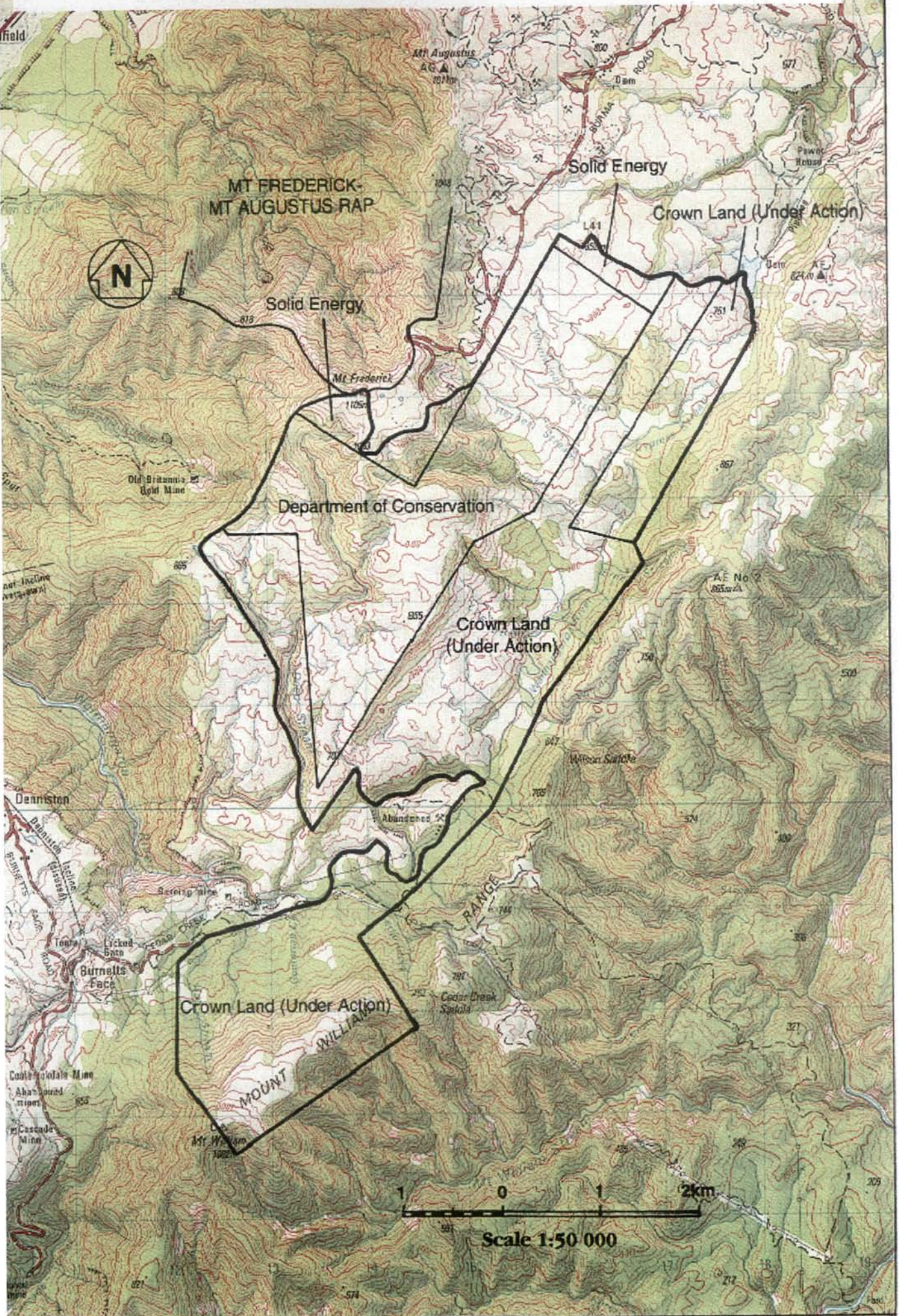




Photo 2: Cross-section of Upper Waimangaroa Valley (from east). Forests on the Mt William Range in foreground (Orlikaka Ecological Area); Happy Valley red tussockland at lower right and uppermost Waimangaroa River Gorge at left middle; extensive sandstone pavements, deep gullies and snow-capped Mt Frederick in distance. Stockton-Webb opencast mine at far right top. (Since this photo was taken, coal mining has commenced at Mt Frederick and extended at Stockton-Webb).

Photo: Institute of Geological and Nuclear Sciences, by D.L. Homer



Photo 3: Mt William uplifted sandstone plateau (mid-right centre) (from west). Elevated shrub-tussocklands on summit, and a range of forest communities on its northwestern slopes, on Kaiata siltstone, granite exposed on the Mt William fault scarp, and eroded sandstone colluvium. Lowermost gorge of Waimangaroa River on far left, and electricity pylon and servicing roads across centre of photo. Orikaka Ecological Area beyond Mt William; Brunner (right) and Glasgow Ranges (left) in middle distance; and Travers and Spencer Ranges in far distance.

Photo: Institute of Geological and Nuclear Sciences, by D.L. Homer

Land Systems and Landforms

Land System: Stockton Brunner Coal Measures Plateau.

On the Stockton plateau are the characteristic "stonescapes" (large blocks of sandstone) and dissecting gullies, together with major and minor fault scarps and outcrops that visually express the strong tectonic influences in the area. Pre-Tertiary granites and greywacke outcrop amongst the dissected sandstone and colluvial slopes.

To the south and east of Mt Frederick the plateau descends gently from its westerly scarps, with deep gorging gullies dividing the stone pavements into strips. The steep scarp of the Kiwi fault line dissects the otherwise gently sloping plateau on the south-eastern slopes of Mt Frederick. The Upper Waimangaroa has cut a striking gorge upstream of its junction with Webb Stream.

The Waimangaroa River flows south-west and westwards at the western base of the Mt William Range and Mt William. To the east of the river are the forests of the Mt William Range on gently sloping Kaiata siltstone, and on more steeply sloping fault scarp granitic slopes and colluvial coal measures boulderfields higher up. Mt William itself is a small, uplifted coal measures tableland fragment, 2.1 km long and up to 700 m wide, rising 5-10° upwards towards the south, from 850 to 1060 m asl. Steep lie on its north-western flanks.

TABLE 7: ECOLOGICAL UNITS IN UPPER WAIMANGAROA VALLEY-MT WILLIAM RAP

LAND SYSTEM	VEGETATION ASSOCIATION	LANDFORM	PLOT NO.
Stockton plateau	2 Mixed beech-southern rata forest	colluvial hillslope	4/2
	4b Mountain beech-pahautea forest	fluvial floodplain	12/1
	4c Southern rata-mountain beech forest	plateau gully	24/1
	5 Mountain beech/yellow silver pine-pink pine forest	colluvial hillslope	4/3
	6 Mountain beech-silver beech forest and shrubland	colluvial hillslope plateau gully colluvial hillslope (on basement rocks)	4/1, 4/7, 10/2, 10/1
	8 Mountain beech/manuka scrub	plateau scarp, hilltop plateau gully	24/2, 24/5, 24/3, 24/4
	9 Pink pine-Chionochloa juncea-manuka tussock-shrubland	plateau hillslope and hilltop plateau scarp	10/3, 10/4, 11/4, 24/9, 24/10, 24/11
	10 Manuka-Dracophyllum politum/ wire rush rush-shrubland*	plateau hillslope and pavement	11/3, 11/5, 24/6, 24/7
	11 Manuka/wire rush-Chionochloa juncea tussock-rushland with subalpine bog species	plateau hillslope plateau pavement	4/4, 4/6, 24/2, 4/5, 24/8
	14 Red tussock-bog pine shrub-tussockland	alluvial flat	11/6

Soils

The complex array of soils in the RAP is related to the wide variety of parent rocks and landforms. Shallow rankers (soils composed predominantly of humus lying directly on bare rock) developed from coarse sandstone, with a high percentage of bare rock, are a feature of the plateau landform, as are shallow, well-oxidised soils on granitoid outcrops. In the basins and alluvial flats there are compound soils of carbonaceous siltstone washed over sandstone. Organic soils are found in the gullies of the plateau and on the colluvial slopes of Mt William.

Vegetation and Flora

(a) Mt Frederick-Upper Waimangaroa Valley

Mt Frederick (1106 m asl) has the highest example of tussock-rushland association on coal measures in the Ngakawau ED. The RAP here includes representation of the common prostrate pink pine/*Chionochloa juncea* vegetation south of the summit trig (association 9, Table 7), a fractured, sparsely vegetated stone pavement community east of the summit, and all the bluffs and steep slopes around the summit (where most of the distinctive subalpine species on Mt Frederick are located e.g., leatherwood, broadleaved snowtussock, *Geum uniflorum*).

The sandstone pavement area to the south-east of Mt Frederick (800-1100 m) is covered in dense tussock-rushland with various cushion species common to the coal measures plateau (association 9). There is a large and vigorous red tussock stand approximately 1 km south of the summit. Tarns and seeps supporting subalpine bog species are common. Prostrate pink pine is more abundant than manuka. Manuka gradually gains dominance over pink pine on the lower slopes and basins below Mt Frederick.

Below c.850-900 m are the large sandstone pavements or "stonescapes", dissected with deep cleavages. The rock surfaces are sparsely covered by creeping *Dracophyllum politum* and manuka, carpet grass and small herbs (association 10).

Approximately 500 m south-east of Trig L41 is the best tarn and seep wetland system known on the Stockton plateau. This ribbon wetland and its environs are dominated by wire rush, dwarf manuka, carpet grass, cushion plant, *Chionochloa juncea*, *Carpina alpina*, *Oreobolus impar* and *O. pectinatus*.

The less deeply cut gullies of the plateau contain dense manuka whereas the more clearly defined gullies on lower slopes have short forest containing yellow silver pine, manuka, pink pine, mountain toatoa, mountain beech, southern rata, pahautea, kamahi and, on lower gully slopes, silver beech.

The major gullies of Webb and Herbert Streams which carve their way down the eastern slopes of Mt Frederick are forested with silver beech, mountain beech, southern rata, mountain neinei, pink pine and yellow silver pine, with some pahautea. The rivers have exposed an outcrop of greywacke basement rock. On the scarp line of the Kiwi fault dividing the upper and lower pavements of Mt Frederick is a band of mountain beech and silver beech forest and shrubland. Yellow silver pine and pink pine forest is present below the bluffs of the fault.

The Happy Valley (on the interfluvium between Cypress Stream and St Patrick's Stream) and small alluvial flats beside the Waimangaroa River are the only examples of river terrace and flat vegetation (association 14) included in RAPs on the Denniston and Stockton plateaux. The basin and flat land eroded and deposited by streams provide habitat for dense red tussockland with manuka scrub on adjoining land.

The upper Waimangaroa River and environs has a concentration of natural values. The river has a rich aquatic moss flora, including the moss *Blindia lewinskyae*, recorded from three sites as well as its type locality at Cedar Stm. The mountain beech-pahautea forest adjoining the river is a distinctive and aesthetically attractive community, not noted elsewhere on the coal plateaux. There are several small, deeply incised gorges. The upper limit of rimu in the valley occurs alongside the river about 500 metres below Ernest Stream.

There are eight species present on the peak of Mt Frederick and thirteen in the Happy Valley grassland that are not recorded elsewhere in the district (Table 2, section 2.6). Nineteen other subalpine or alpine species occur on Mt Frederick. The southern limit of the northern kauri fern, *Sticherus flabellatus*, occurs on the Kiwi Faultline (Norton & Overmars 1990). The type locality of the lichen *Austropeltum glareosum* is sandstone pavement at c.900 m on the Stockton plateau.

(b) Mt William

A visually striking altitudinal and drainage gradient occurs on the slopes of Mt William and the Mt William Range. Mountain beech/pahautea forest on the toeslopes blends quickly into mountain beech with emergent rimu and red beech on the ridgelines, and silver beech and southern rata at higher altitudes. *Cordyline indivisa* is present on ridgelines and there are good examples of mixed pahautea-mountain beech-red beech-hard beech forest on lower colluvial slopes. On the steep colluvial rubble slopes below the Mt William plateau is characteristic coal measures forest of southern rata, yellow silver pine, mountain beech, and pink pine.

Vegetation patterns on the Mt William plateau are similar to those on the slopes below Mts Frederick and Rochfort, but with some significant differences. The northerly aspect of Mt William contrasts with the southerly and westerly aspects of the other two peaks. *Chionochloa rubra* ssp. *occulta* is much more dominant relative to *C. juncea* than elsewhere. Other dominant species are yellow silver pine-pigmy pine hybrid, prostrate manuka and pink pine, wire rush, carpet grass, cushion plant, *Celmisia dubia* and *Carpha alpina*. A small-scale mosaic of vegetation elements reflects the range of microtopography; cushion bogs and tarns on seeps and peat, low forest and scrub-filled gullies, and mixed shrub-tussockland associations on plateau, stonefields and boulderfields. The Mt William plateau exhibits a more woody character than comparable sites on Mts Frederick and Rochfort, possibly because of a lower fire frequency on this isolated subalpine outcrop, and perhaps because of the higher natural timberline further inland from the sea. However despite burn scars and mountain flax communities as evidence of recent fires, soil and drainage conditions on parts of the plateau are likely to have always limited vegetation development to low open communities.

Six plants of the threatened mistletoe *Peraxilla tetrapetala* were recorded during this survey on mountain beech trees on the lower slopes of Mt William near Cedar Creek and in the upper Waimangaroa Valley.

Fauna

Kaka occur in the Mt William Range forests, and great spotted kiwi occur both there and in the Happy Valley red tussockland. Fernbirds are abundant in the shrublands of the Upper Waimangaroa Valley. The type locality of the large land snail *Powelliphanta patrickensis* "Denniston" occurs near St Patricks Stream, and low density colonies are scattered throughout the RAP.

Evaluation

Representativeness: Diversity

This RAP is the best area available to represent the diversity of vegetation communities, landforms and soil types of the coal measures of the Stockton plateau and upper Waimangaroa valley (particularly vegetation associations 9 & 10, endemic to the Stockton plateau). It includes all the landforms and vegetation communities, threatened and local species and other key features of this area, as well as linking the Orikaka EA inland with the coastal forests of the Mt Frederick - Mt Augustus RAP. This area is nationally significant as the least modified example of this type of coal measures ecosystem in New Zealand.

Other parts of the Stockton plateau and Waimangaroa valley have a more modified character reflecting the greater human impact associated with mining (especially fires and substrate disturbance). The communities of the lower Stockton plateau lacking *Chionochloa juncea*, excluded from this RAP, are present in the Ngakawau EA and in Tiger Pakihi and other coal measures remnants in the Orikaka EA.

Rarity and Distinctive Features

a) Mt Frederick-Upper Waimangaroa Valley

- i) *Sticherus flabellatus* southern limit.
- ii) Type locality for *Powelliphanta patrickensis* "Denniston" (St Patricks Stream).
- iii) Eight plant species recorded in Ngakawau ecological district only on Mt Frederick and 13 in the Happy Valley tussockland (including a possible undescribed species).
- iv) Nationally threatened red mistletoe (*Peraxilla tetrapetala*) and rare bearded orchid.
- iv) Type locality for rarely collected *Blindia lewinskyae* (Cedar Stream), and *Austropeltum glareosum* (Stockton plateau).
- v) one of only two known West Coast occurrences of the shrub *Pittosporum anomalum* (in Happy Valley).

b) Mt William

- i) Nationally threatened mistletoe species (*Peraxilla tetrapetala*).
- ii) Isolated uplifted coal measures tableland fragment.

Naturalness

The RAP has a predominantly natural character despite the presence of some old burn scars, limited roading and tracking, transmission pylons and an abandoned small opencast coal mine. However, the structural and compositional diversity of plant communities suggests that fire impacts have been relatively minor compared with other areas of the coal plateaux. Adventive plant species are few and uncommon. The highly modified parts of the Mt Frederick summit are excluded. This RAP contains the largest area of relatively intact natural communities within the coal plateaux and is particularly outstanding because of the diversity of community types within a small area.

Long-term Viability: Size, Shape and Spatial Surroundings

The area is generally well-buffered. It adjoins an ecological area to the east and steep stewardship land (Mt Frederick forest) to the west. To the north and south the boundary largely follows natural or readily defined features. The steep slopes encircling the Mt William summit plateau provide outstanding buffering for the isolated coal measures community.

The large size of this RAP aids its long-term viability, for instance by the inclusion of some common community replicates and by reducing vulnerability to fire. Potential threats to the natural values of the area include fire, grazing by goats and possums, and possibly weeds and coal mining. Dust from adjoining coal mining areas may alter soil chemical composition, particularly if it is from more fertile rock sources (e.g., greywacke).

Management

The few modified sites within the RAP should be actively rehabilitated. Natural recovery is slow under the harsh environmental conditions prevailing. Tracking and roading on the skeletal soils have caused erosion which at many sites is continuing. Sites to be rehabilitated include the roads and tracks below Mt Frederick descending south-west from the summit and south-east to Webb Stream, the track to the Kiwi fault bluff, and the abandoned Marshall's opencast coal mine.

Possible Alternatives for Protection

1 Upper Stockton plateau pavement vegetation

*No alternative available to represent the mid-higher altitude pink pine, manuka and *Chionochloa juncea* dominant associations (9, 10) and stonescapes characteristic of the upper Stockton plateau.

2 Subalpine communities and species of limited distribution on Mt Frederick and Mt William coal measures

* Related communities on Mts Rochfort and Augustus, though of different composition and lacking as many as eight of the plant species present on Mt Frederick.

3 Happy Valley red tussockland

* Small pockets alongside the Waimangaroa River (also in the RAP) are the only other examples but lack Happy Valley's floristic richness. No other alternatives within the Ngakawau ED.

4 Ribbon wetland

* No better such wetlands known on Denniston and Stockton coal plateaux.

5 Mt William plateau heathland and shrub forest

* No significant alternative known for this distinctive red tussock-dominated and infrequently burnt high altitude coal measures association (11), with shrub forest.

6 Threatened and Local Species

* Threatened mistletoe *Peraxilla tetrapetala* on Mt William Range flanks and Upper Waimangaroa valley is not known to remain elsewhere in ecological district. No alternative for *Sticherus flabellatus* southern limit or *Blindia lewinskyae* and *Powellipbanta patrickensis* "Denniston" type localities.

4.2 NGAKAU RAP 2: MT ROCHFORD

Summary

Area:	1335 ha
Altitudinal Range:	50-1040 m asl
Tenure:	Department of Conservation (stewardship land)
	The peak and coastal slopes of Mt Rochford and the adjoining part of the upper Denniston plateau (Figure 7).

Boundaries

The boundary in the south-east follows the border of the ecological district along the base of the scarps below Mt Rochford, and similarly in the north-west at the base of the coastal hillslopes (but excluding the exotic plantation areas). The northern and eastern edges of the large gully cut by the Whareatea River and Conglomerate Stream marks the north-east boundary, and the south-west boundary follows a prominent ridge between Myers Stream and Christmas Stream to a high point south of Mt Rochford (spot height 1010).

Land Systems and Landforms

Land Systems: Coastal Hillslopes and Denniston Coal Measures Plateau

The area consists of Brunner coal measures and a minor band of Kaiata siltstone at the base of the coastal slopes. The Tertiary beds are flexed over the uplifted basement; hence the coastal faces are sloping beds not a section through them. Geologically the Kongahu faultline defines the western margin.

The coastal faces rise steeply to meet the western edge of the Denniston Plateau. The flat sandstone pavements of the lower plateau give way to more steeply undulating contours as the land rises in altitude to the peak of Mt Rochford at 1040 m. The slopes below Mt Rochford and above Lake Rochford, in particular, are littered with large quartz sandstone boulders. On the lower area of the plateau the Whareatea River and its tributaries have dissected the flat sandstone pavements to form steep gullies. The south-eastern edge of the RAP (at Mt Rochford) is marked by high and steep cliffs, the scarp slope of the plateau landform.

Soils

The Denniston Plateau soils are generally shallow. The extremely shallow soils found on the Stockton Plateau are not represented here, and this is reflected in the generally denser vegetation cover. Compound soils of coarse sandstone over siltstone are found around areas of siltstone outcrops. The gullies and coastal slopes are either organic soils formed on sandstone or, in areas of deposition, compound soils of carbonaceous siltstone washed over sandstone.

Figure 7: MT ROCHFORD RECOMMENDED AREA FOR PROTECTION



Vegetation and Flora

The vegetation around Mt Rochfort is distinct from that on the lower undulating landscape to the north. The rugged scarps are covered in subalpine shrubland dominated by leatherwood (association 7, Table 8) and include two highly palatable species which elsewhere have been largely removed by browsing (*Ourisia macrocarpa* and *Anisotome baastii*). The peak itself and the small tarns and seepages below are rich in subalpine and alpine species such as *Raoulia grandiflora*, *Celmisia incana*, broadleaved snow tussock and *Celmisia dallii* (association 11). Small tarns and seepage areas support herbfields of subalpine bog species such as *Euphrasia disperma*, and *Utricularia novae-zelandiae*.

On the lower plateau the shrub-tussock associations of stunted manuka and *Chionochloa juncea* form a mosaic with dissected forested gullies and basins. *Baumea teretifolia* and wire rush (association 12) become more common at the lower altitudes. The coastal faces of the plateau became increasingly forested (Mt Rochfort bush) as they steepen into colluvial slopes (associations 2, 4a, 4c, 5 and 6).

Seven species were recorded in the ecological district only on Mt Rochfort (Table 2).

Fauna

Great spotted kiwi are known from below Mt Rochfort. Common forest birds (including robin) occur in the Mt Rochfort bush. Black-backed gulls breed at Lake Rochfort. Of all the sites surveyed for invertebrates (section 2.8), Mt Rochfort was found to have the greatest abundance and a comparatively high species richness of ground beetles. One colony of *Powelliphanta patrickensis* "Denniston" is known in the RAP, near V70 stream, at its known southern limit.

Evaluation

Representativeness: Diversity

This RAP has the best remaining representation of the coal measures landform and vegetation patterns of the Denniston plateau and its coastal hillslopes, in a full altitudinal sequence from c. 50 m asl to 1040 m asl at Mt Rochfort. The Mt Rochfort forest is the most complete altitudinal sequence in the ecological district of coastal slope coal measures forest, from lowland beech-podocarp to the dense subalpine scrub below Mt Rochfort. The plateau portion has a range of communities typical of the Denniston plateau; lower altitude rush-sedge land in the north of the RAP rises through prostrate manuka-*Chionochloa juncea* shrub-tussockland to subalpine herbfield and seepage zones on the slopes of Mt Rochfort.

Rarity and Distinctive Features

- i) *Astelia trinervia* on the lower frontal slopes of Mt Rochfort forest (Newell 1990) is near its southern limit in the Tiropahi Valley (Shannel Courtney *pers. comm.*).
- ii) *Gabnia pauciflora*, an uncommon species in Westland, occurs on the slopes of Christmas Stream below Lake Rochfort, one of its three known sites in the ecological district.
- iii) *Metrosideros parkinsonii* probably has its best representation in the ecological district in the higher altitude forests of this RAP.

TABLE 8: ECOLOGICAL UNITS IN MT ROCHFORD RAP

LAND SYSTEM	VEGETATION ASSOCIATION	LANDFORM	PLOT NO.
a) Coastal hillslope (on coal measures)	4c Southern rata-mountain beech forest	colluvial hillslope	5/1
	5 Mountain beech/yellow silver pine-pink pine forest	colluvial hillslope	5/2, 5/3
b) Denniston plateau	2 Mixed beech-southern rata forest (silver beech dominant)	plateau gully slopes	7/6
	4a Rimu/mountain beech forest	colluvial hillslope	7/5
	5 Mountain beech/yellow silver pine-pink pine forest	plateau gully	1/10, 6/2, 6/3
	6 Mountain beech-silver beech forest and shrubland	plateau gullycolluvial hillslope	1/3, 1/5, 5/4
	7 Leatherwood scrub	plateauscarp	1/1, 1/21/11, 1/12
	11 [Manuka]/wire rush-Chionochloa juncea tussock-rushland with subalpine bog species	plateau hillslope	1/4, 1/6, 1/7, 1/8, 1/9, 1/13, 7/1
	12 Manuka/Baumea teretifolia -wire rush shrub-rushland	plateau hillslopeplateau gully	6/4, 7/3, 7/4, 6/1
	14 Red tussock-bog pine shrub-tussockland	alluvial flat	11/6

Naturalness

Past modifications include fire, the old Lake Rochfort dam, water channels and pipeline, the Mt Rochfort road and telecommunications tower (with weeds), and one coal prospecting track. Nevertheless the RAP has a predominantly natural character. It stands in marked contrast to the remainder of the Denniston plateau, a much scarred landscape which may take centuries to recover.

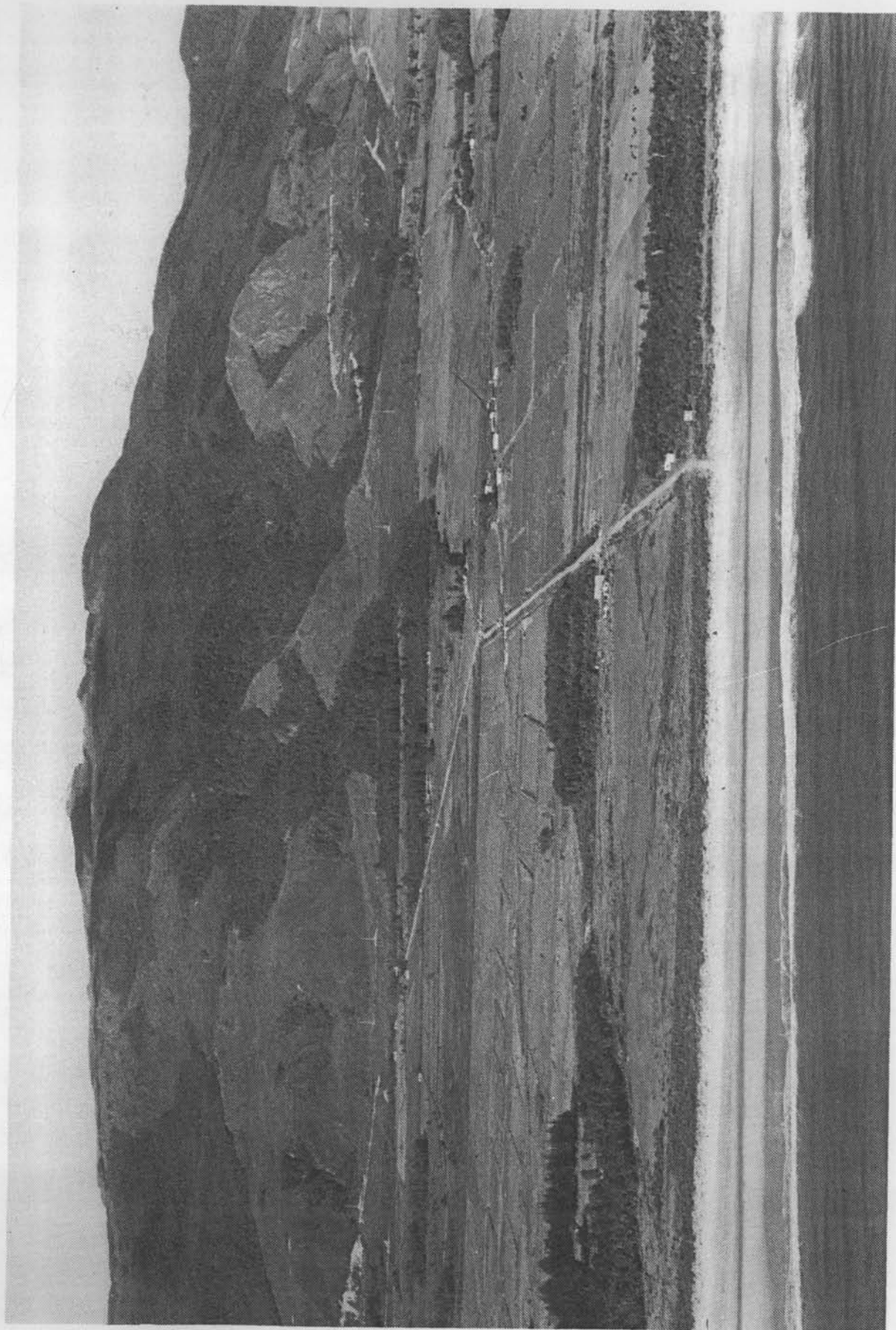


Photo 4: The coastal slopes of Mt Rochfort, and the Westport coastal sand dune flats at Fairdown (from west). "Rochfort Bush", centred on Myers and Lake Streams, extends in a full altitudinal sequence on down-flexed coal measure slopes from c. 100 m asl to the Mt Rochfort summit at 1040 m asl. The recently burnt open areas in the photo (taken in 1981) across the base of the slopes are now covered by nutrient-deficient exotics.

Photo: Institute of Geological and Nuclear Sciences, by D.L. Homer

Long-term Viability: Size, Shape and Spatial Surroundings

Although buffering from surrounding areas is only moderate, the large extent of the proposal and the limited opportunities for other uses should ensure its long term viability. The RAP abuts the Denniston Scenic Reserve to the north. To the south-east it is separated from the Orikaka EA by the steep, forested Cascade valley (stewardship land). Other adjoining tenures are stewardship land (west, east and north) and Timberlands West Coast Limited (north-west).

Allowing natural regeneration once the unthrifty pines on the lower slopes are harvested would improve the RAPs spatial integrity and aesthetic appeal from State Highway 67.

Potential threats to the natural values of the area include erosion from the Mt Rochfort access road, fire, grazing by goats and possums, wasps, weeds, and possibly coal mining.

Other Values

Lake Rochfort and associated water races are a registered historic site (K29/32) (Ray Hooker *pers. comm.*). There is a track from the power station to the lake.

The upthrust scarps of Mt Rochfort are a dramatic feature in the district. The peak of Mt Rochfort commands a panoramic view of the entire district, the Paparoa, Brunner and Glasgow ranges, the Buller valley, the Berlin Bluffs and the snow peaked distant Southern Alps.

Note: The Lake Rochfort area was proposed for scenic reserve status in the late 1970s, on account of its visual, historical and biological values (Lands and Survey file 13/117).

Possible Alternatives for Protection

- 1 Coastal altitudinal sequence of coal measures and siltstone communities from 50-1040 m asl, including original (i.e. unburnt) forest sequence
 - * Truncated alternatives and/or remnant fragments in Denniston SR (c. 50-600 m), Westport Water Conservation Reserve (100-800 m), and stewardship land north of Millerton (20-400 m asl). The forest and shrubland communities in the Westport Water Conservation Reserve is the only alternative in relatively unmodified condition, although this area is not securely protected for conservation purposes.
- 2 Scarp vegetation on coal measures, parts not browsed by introduced animals and supporting highly palatable plant species
 - * Limited areas on Mts Frederick, Augustus and William, though not of the scale (300 metres) or grandeur of Mt Rochfort.
- 3 Leatherwood and subalpine communities on coal measures
 - * Subalpine communities and some leatherwood on Mts William, Frederick and Augustus, although of different plant species composition; seven species found in ecological district only on Mt Rochfort.
- 4 Denniston Plateau vegetation (association 11)

* Small area in Denniston SR and proposed RAP extension; otherwise Denniston Plateau is mostly greatly modified by tracking and probably a greater frequency of past burning.

5 Mt Rochfort's type locality role for four or more plant species (section 2.7)

* No alternative.

6 Threatened and Local Species

* *Metrosideros parkinsonii* is present in Upper Waimangaroa Valley RAP, Denniston SR, Te Kuha and elsewhere. *Astelia trinervia* also occurs in the Denniston Scenic Reserve.

4.3 NGAKAU RAP 3: MT FREDERICK - MT AUGUSTUS

Summary

Area:	1 050 ha
Altitudinal Range:	100-1106 m asl
Tenure:	Solid Energy (50 ha) Land Information New Zealand (Crown Land unallocated or underaction) (80 ha) Department of Conservation (stewardship land) (920 ha) The coastal catchment of Jones Creek and its tributary Worley Stream, plus a small eastwards extension over Mt Augustus (Figure 8).

Boundaries

From the coastal boundary of the ecological district where it crosses Fan Stream, the boundary ascends the ridgeline immediately north of Fan Stream and then between Jones Creek and Stony Creek to Mt Frederick. It proceeds northwards 20 m south and east of the ridgeline to the former Mt Frederick State Forest cadastral boundary, then along this cadastral boundary towards Mt Augustus. Around Mt Augustus the boundary is the base of the steep slopes approximately 200-300 m east of the ridgeline. It returns to the ecological district boundary and the starting point via the spur north of the Worley Stream catchment, and the boundary between Crown-owned and privately held land.

Land Systems and Landforms

Land Systems: Coastal hillslopes (on basement rocks); Stockton Coal Measures Plateau

The very steep coastal faces rise from Pleistocene terraces and fans at less than 100 m asl to meet the coal plateau scarp at over 1000 m asl. The colluvial slopes, particularly as they steepen in their ascent to the peak, are littered with scree and major blocks of talus. The bedrock, unlike the coal measures coastal slopes of the Mt Rochfort RAP, is pre-Tertiary basement granite, gneiss and Greenland greywacke (Bowen 1964). Various organic soils occur in the catchments of the Mt Frederick coastal faces.

Vegetation and Flora

An altitudinal sequence from the mild coastal climate to the subalpine slopes of the coal plateau escarpment is reflected in the changes in soil and vegetation types (Table 9). Hard beech forest with some red beech on the terraces is joined by emergent rimu and occasional southern rata at higher altitudes. Silver beech appears with increasing altitude, with mountain beech and yellow silver pine forest on the ridges. The forest gradually reduces in stature to a high altitude scrub.

Figure 8: MT FREDERICK-MT AUGUSTUS RECOMMENDED AREA FOR PROTECTION

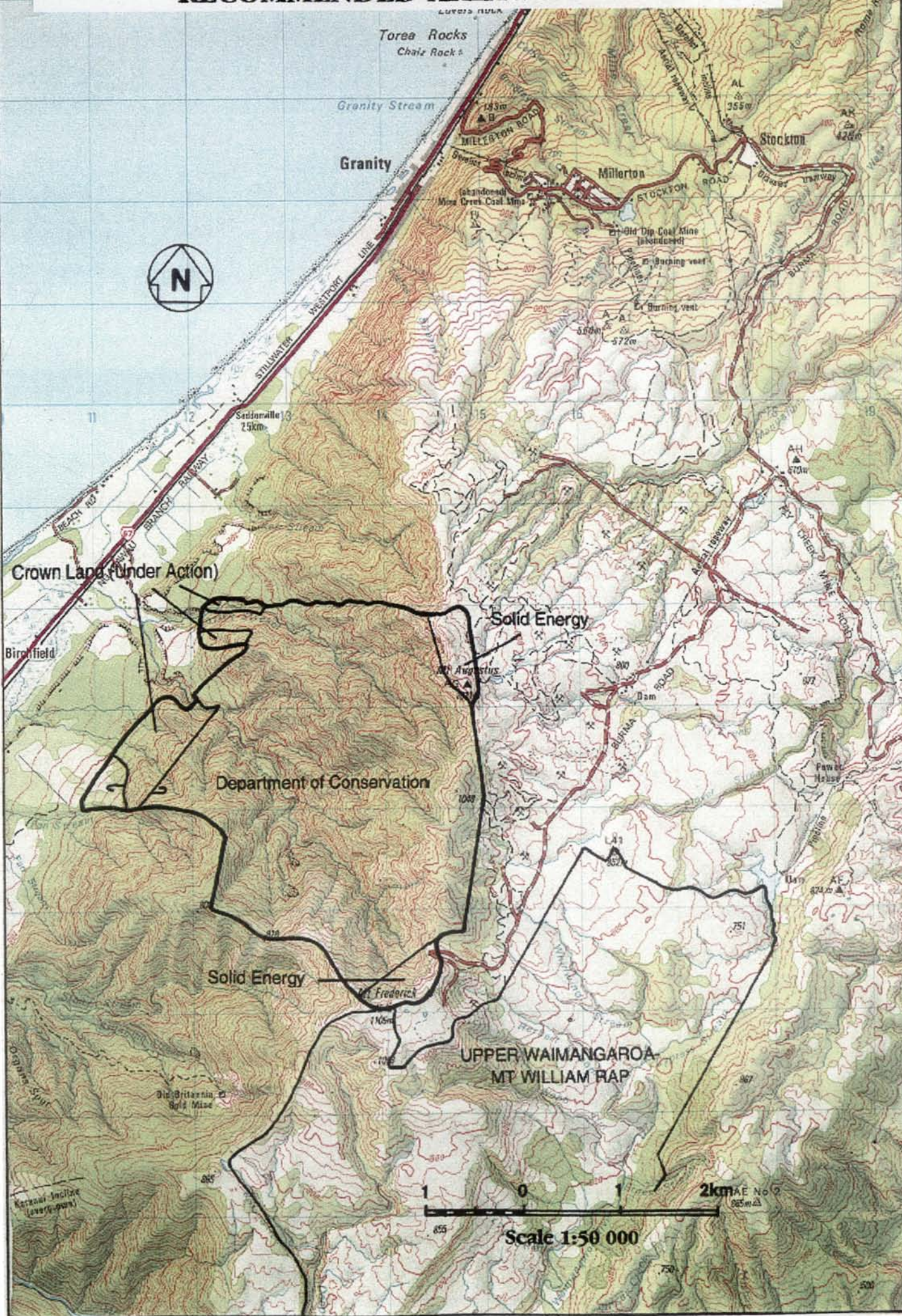


TABLE 9: ECOLOGICAL UNITS IN MT FREDERICK-MT AUGUSTUS RAP

LAND SYSTEM	VEGETATION ASSOCIATION	LANDFORM	PLOT NO.
a) Coastal hillslope (bedrock)	1 Rimu/broadleaved forest	colluvial hillslope/fluvioglacial terrace	-
	2 Mixed beech-southern rata forest	colluvial hillslope	-
	3 Hard beech-southern rata-rimu forest	colluvial hillslope	30/2, 30/3, 30/4
	5 Mountain beech/yellow silver pine-pink pine forest	ridgeline	30/5, 30/6
b) Stockton plateau	6 Mountain beech-silver beech forest and shrubland	colluvial hillslope	-
	9 Pink pine/ <i>Chionochloa juncea</i> -manuka tussockland-shrubland	plateau hillslope and hilltop	-

At Mt Augustus is the characteristic upper altitude coal measures shrub-tussockland, dominated by *Chionochloa juncea*, carpet grass, prostrate manuka and pink pine, *Dracophyllum poltium*, yellow silver pine-pigmy pine hybrid, wire rush and cushion plant. On this subalpine outpost are various species found only on the other coal plateau summits in this ecological district: leatherwood, broadleaved snowtussock, *Celmisia dallii*, *C. incana*, *Dracophyllum pubescens* (abundant), *Microlaena thomsonii*, and *Mitrasacme montana* var. *helmsii*.

There are several small tarns and a small silver beech dominant forest remnant. The Northwest Nelson endemic shrub *Pseudowintera traversii* is present in particularly good numbers around Mt Augustus.

Fauna

Mt Augustus is the type locality for two invertebrate species: *Elatichrosis* sp. (Coleoptera: Elateridae, click beetles) and *Paracephalus curtus* (Hemiptera: Cicadellidae, slender plant hoppers) (John Dugdale *pers. comm.*). Both species were collected on the north-eastern slopes near the former TV translator site south of the trig, *Elatichrosis* sp. on tussock and *P. curtus* on the damper swards/cushion bogs. Rifleman, tui, kereru and other common forest birds occur in the forest (Morse 1981).

Evaluation

Representativeness: Diversity

This RAP offers the most complete sequence of the steep forested coastal bedrock faces of the ecological district, from the summits of Mts Frederick (1106 m) and Augustus (1016 m) to the Birchfield flats.



Photo 5: The Worley Ck (left) and Jones Ck (centre-right) catchments below Mt Augustus (top left) and Mt Fredrick (top right). The steep forested coastal sequence on basement granites drops onto the Westport coastal plain (foreground).
Glasgow, Travers and Spencer Ranges in distance.

Photo: Institute of Geological and Nuclear Sciences, by D.L. Homer

Rarity and Distinctive Features

The small extension onto coal measures at Mt Augustus is intended principally to protect two insect species at their type locality. Botanically the area is valuable in being the northernmost subalpine coal measures vegetation in the ecological district. The bluffs provide suitable micro-habitat as well as protection from introduced browsers for some palatable species. The entire bluff system from Mt Frederick to north of Mt Augustus should be protected on account of its specialised habitat, aesthetic value and the soil and water protection it gives to the uppermost portions of the coastal forest catchments.

Naturalness

The coastal faces have had little previous disturbance with the exception of introduced wild animals. No adventive plant species were observed in the area.

The Mt Augustus extension is slightly modified by old tracking in the northern part. A wide road through the silver beech remnant to the Coalcorp radio transmitter on the peak scars the southern part of the extension. The inclusion of this forest is essential to protect the habitat of the Northwest Nelson endemic *Pseudowintera traversii*. All clearings not essential to vehicular access should, desirably, be rehabilitated and the remains of the old TV translator removed.

Long-term Viability: Size, Shape and Spatial Surroundings

The area is generally large and well buffered except at Mt Augustus. Potential threats include wild animals and off-site impacts of nearby coal mining.

Other Values

The forested slopes provide catchment protection for the Birchfield swamp system on the coastal plain below.

Possible Alternatives for Protection

- 1 Coastal hillslope altitudinal sequence of communities on basement rocks
 - * Similar but truncated sequences on Radcliffe Ridge and Orowaiti catchment, lacking the wide range of communities present here, particularly at higher altitudes.
- 2 Mt Augustus invertebrate type locality
 - * No alternative.

4.4 SMALL RAPs

4.4.1 Ngakawau RAP 4: Summerlea Bush

A colony of hybrid *Powelliphanta* of considerable scientific interest inhabits a narrow band of regenerating forest (10 ha) between the Mokihinui River and State Highway 67 at Summerlea, near the mouth of the Mokihinui River. Kahikatea and rimu are emergent over a canopy dominated by kowhai, mahoe, raurekau, toro, *Muehlenbeckia australis* and *Dicksonia squarrosa*. A number of small baches are present and consequently the vegetation includes many garden escapes (such as wandering jew and montbretia).

There were no snails in this area prior to the 1929 "Murchison Earthquake". During the earthquake, a landslide dammed the Mokihinui River upstream and when it burst there was a massive flood which apparently swept live snails from both the true left bank (*P. lignaria unicolorata*) and the right bank (*P. l. lignaria*) of the river and deposited them both at Summerlea. Powell (1949) hypothesised that if there were no more large-scale infiltrations by flood-borne stock, another subspecific form of *Powelliphanta lignaria* could evolve at the Summerlea site.

The Summerlea colony was the source of much of Powell's theories on speciation in land snails: there were no other comparable situations. The bush is small and modified, and modification continues through whittling away by road-maintenance and garden rubbish dumping. Rat predation has a major impact on the snail population. However the site is worth every protection for the light it sheds on the evolutionary processes in land snails.

The land is legal road and Crown land (being the bed of the Mokihinui River). The baches in the area are excluded from the proposal.

4.4.2 Ngakawau RAP 5: Ngakawau Scenic Reserve Additions

Legal Description: Secs 10, 20, 22 Blk I and Pt Sec 8 Blk VI, Ngakawau SD (23 ha)

"...Revoking the 3.5 ha Pt Sec 8 south of the Incline in 1965 was a mistake. This area is 'inside' the road, and is thus an inseparable part of the roadside scenery. The forest remnant on it is more of the plateau forest type, compared with the more lowland and taller scrub types in the balance of the reserve, and would thus add diversity and interest to the reserve, and secure a seed source for the scrub type ... on the plateau. It should be re-reserved, and any mining requirements accommodated, but with due regard to the scenery... Though burnt-through, there are a number of original trees surviving, in a cover of rimu, southern rata, hard beech, mountain totara/kamahi, yellow silver pine, broadleaf, lancewood, kiekie."

"Sections 10, 22, 20, and Pt 8 referred to immediately above are part and parcel of this scenic drive, and should ideally be reserved" (Kelly in prep.).

Though similar coal measures and siltstone coastal slope forests are present in the Denniston SR and Mt Rochfort RAP, the addition of these small areas to the scenic reserve would improve its ecological diversity as well as its scenic value. They are presently stewardship land held by the Department of Conservation.

Figure 9: SMALL RECOMMENDED AREAS FOR PROTECTION

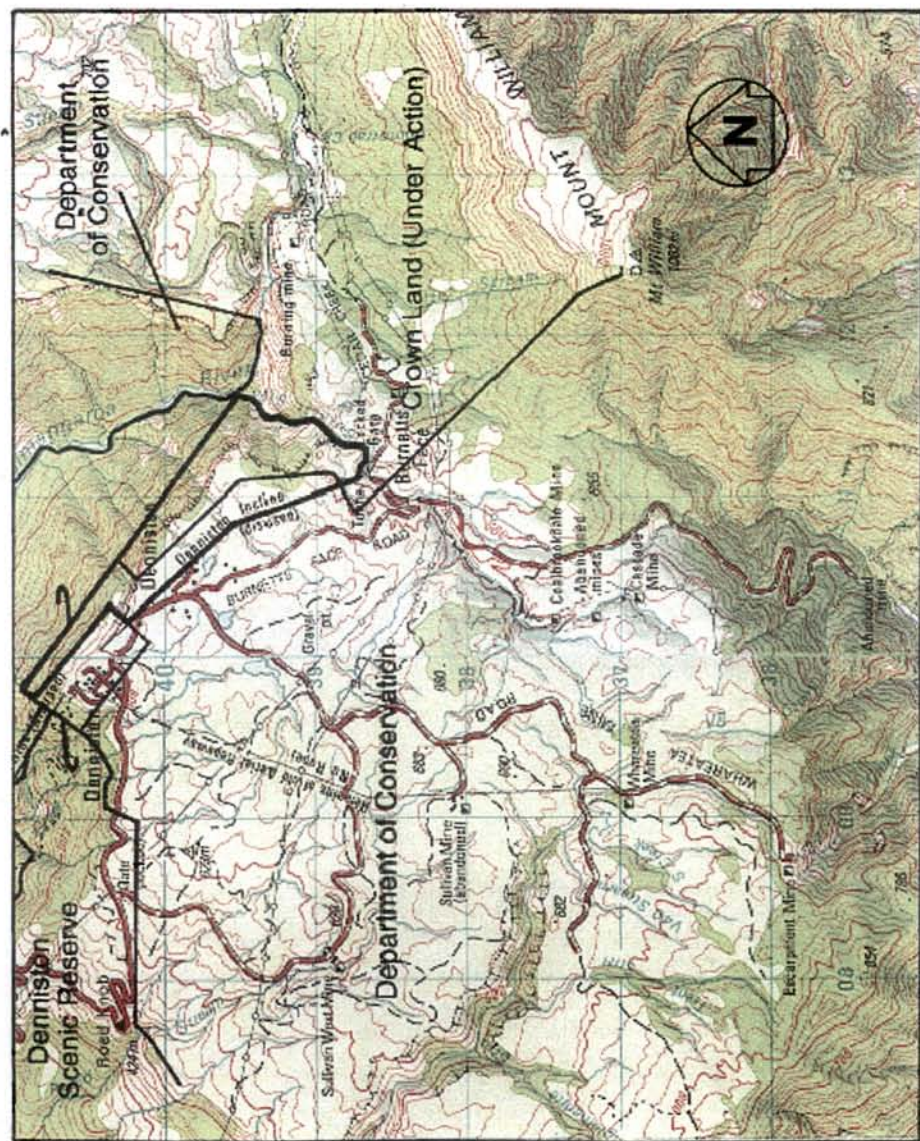


Figure 9A: RECOMMENDED ADDITION TO DENNISTON SCENIC RESERVE

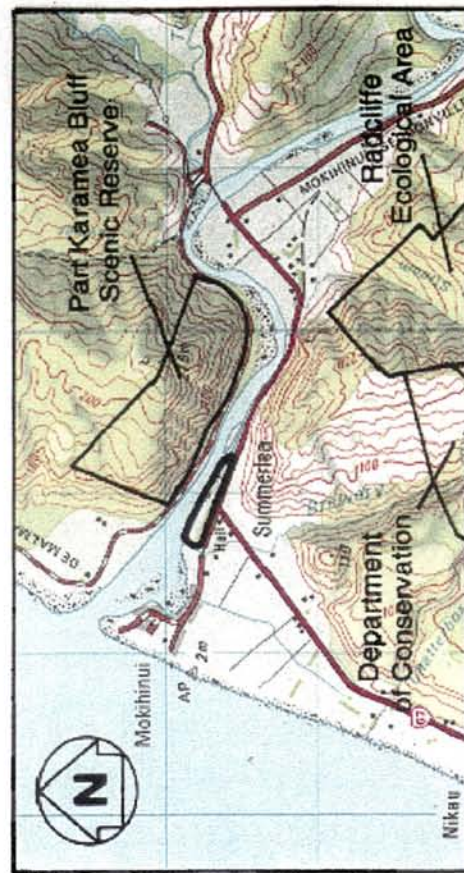


Figure 9B: SUMMERLEA BUSH



Scale 1:50 000

Figure 10: SMALL RECOMMENDED AREAS FOR PROTECTION

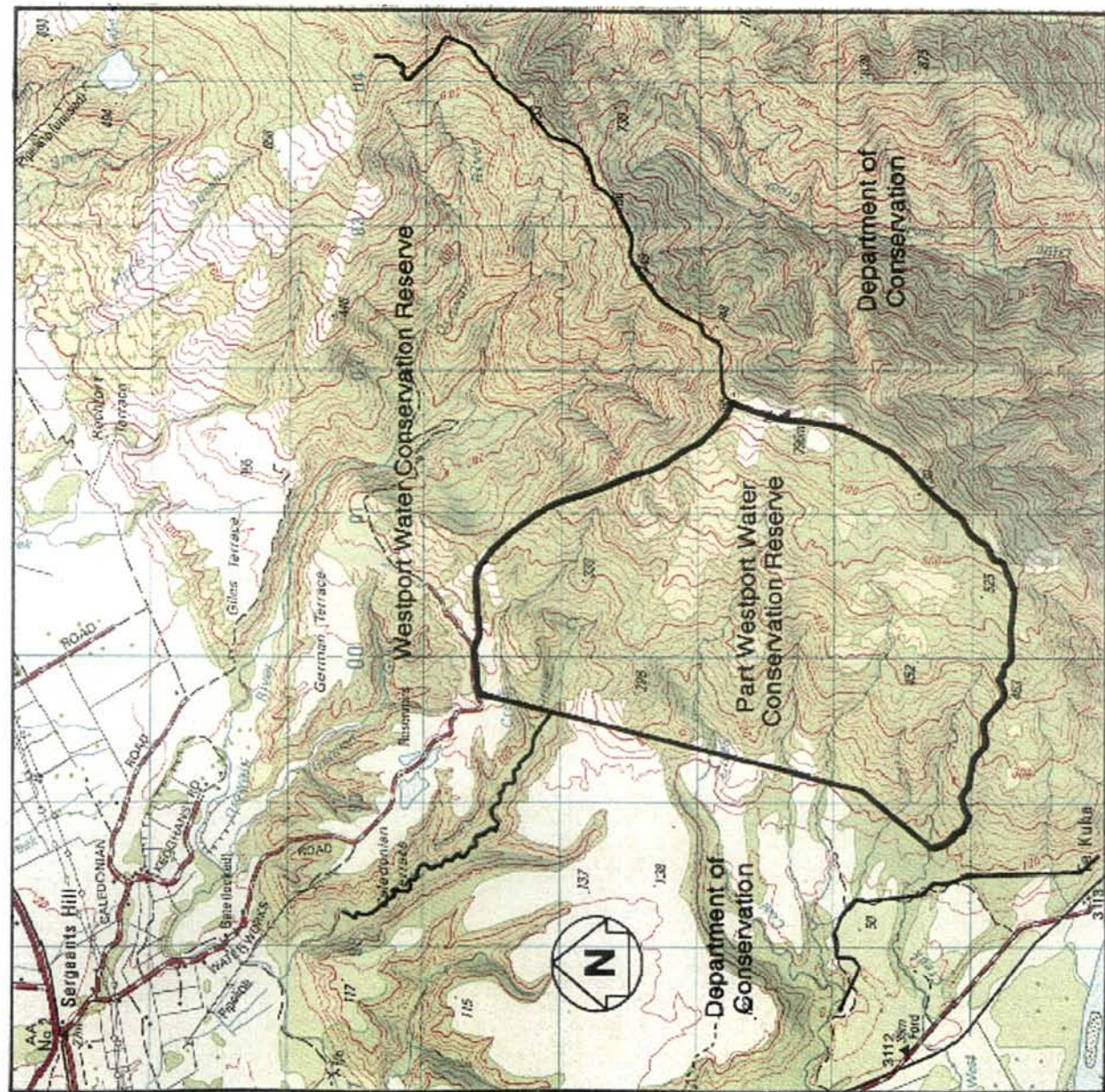
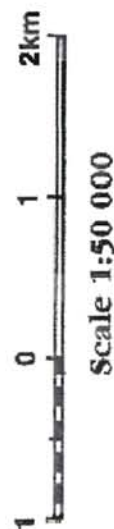


**Figure 10A: PART WESTPORT WATER
CONSERVATION RESERVE**



**Figure 10B: RECOMMENDED ADDITION TO
NGAKAWAU SCENIC RESERVE**



Podocarp-broadleaved gully forest predominates in Sections 10, 20 and 22. The pine and other exotic trees in Pt Sec 8 will be replaced by broadleaved forest regeneration in time. The area also has historic values associated with the former Millerton incline. The spectacular Granity Creek waterfall visible from the Ngakawau-Millerton Road lies on legal road upstream of Pt Sec 8 and also warrants inclusion in the reserve.

The possibility of linking the Ngakawau Scenic Reserve with the Ngakawau EA inland via the stewardship lands corridor across Mine Creek was not fully evaluated, however it is a key issue. These mainly steep, dissected siltstone slopes support a diverse broadleaved forest.

4.4.3 Ngakawau RAP 6: Denniston Scenic Reserve Addition

"...A good step would be to extend the reserve onto all the vacant plateau top land east of the Coalbrookdale tramway formation, and north of Burnetts Stream, where good examples of the stunted herb, tussock, and shrub communities on quartzite are found" (Kelly in prep.).

Though these coal measures plateau communities are included in the proposed Mt Rochfort RAP, their inclusion in the Denniston Scenic Reserve would significantly improve its ecological diversity and increase representation of the lower Denniston plateau communities.

Although burnt in the past, the area is in good biological condition. Two plants uncommon in the ecological district are present: *Dracophyllum pubescens* and *Celmisia dallii*. The area would complete protection for the bluffs and earthquake slips on the south side of the Waimangaroa Gorge. The former tramway associated with the Denniston Incline provides a readily identifiable boundary and facilitates access.

The area is presently stewardship (40 ha) and Crown Land unallocated or underaction (60 ha) (total area 100 ha). One of the early Denniston underground mines (Banbury) was present in the western part of the proposed addition.

Integrated management of the scenic, historical, recreational and nature conservation values of the Denniston Scenic Reserve and proposed historic reserve, and this RAP, is desirable.

4.4.4 Ngakawau RAP 7: Part Westport Water Conservation Reserve

"... a considerable portion of the (Westport) water conservation reserve is entirely beyond the actual water catchment boundaries. Since the area is a mosaic of coal measures vegetations, if this non-catchment portion is at any time released from water reserve, it should without doubt be added to the adjoining (Lower Buller Gorge) scenic reserve" (Kelly in prep.).

Although the Mt Rochfort RAP has been proposed as the principal representative of these communities because it spans a greater altitudinal range, the coal measure associations in this RAP are of particular significance because of the absence of recent fire, and their degree of intactness. This relatively natural condition can be attributed to the isolation of the area, its tenure over an extended period of time as a water conservation reserve (from which public access has been discouraged) and the buffering provided by adjoining natural habitats. This RAP also lies at the southern-most extreme of the Buller elevated coal plateaux.

4.4.5 Soil Reference Sites

Of the twelve soil series reference sites identified in the Ngakawau ED (Appendix VIII), nine are located within existing protected natural areas, other protected areas, the RAPs proposed herein, or stewardship land held by the Department of Conservation. They are:

PNA/RAP/PA	SOIL SERIES NAME
a) Radcliffe EA	Millerton (site 2)
b) Ngakawau EA	Ngakawau, Mackley
c) Orikaka EA	Denniston (site 2)
d) Westport WCR	Christmas, Trent, Vee Forty
e) Mt Rochfort RAP	Denniston (Site 3)
f) Stewardship land (Denniston Plateau)	Koranui

The three unprotected soil reference sites are therefore recommended for protection. "Current thinking is that a soil reserve would need to be a minimum area of 10 ha. Experience has shown that anything less can suffer from edge effects, particularly from topdressing drift, drainage, logging nearby, and windthrow" (Dr Geoff Mew *pers. comm.*).

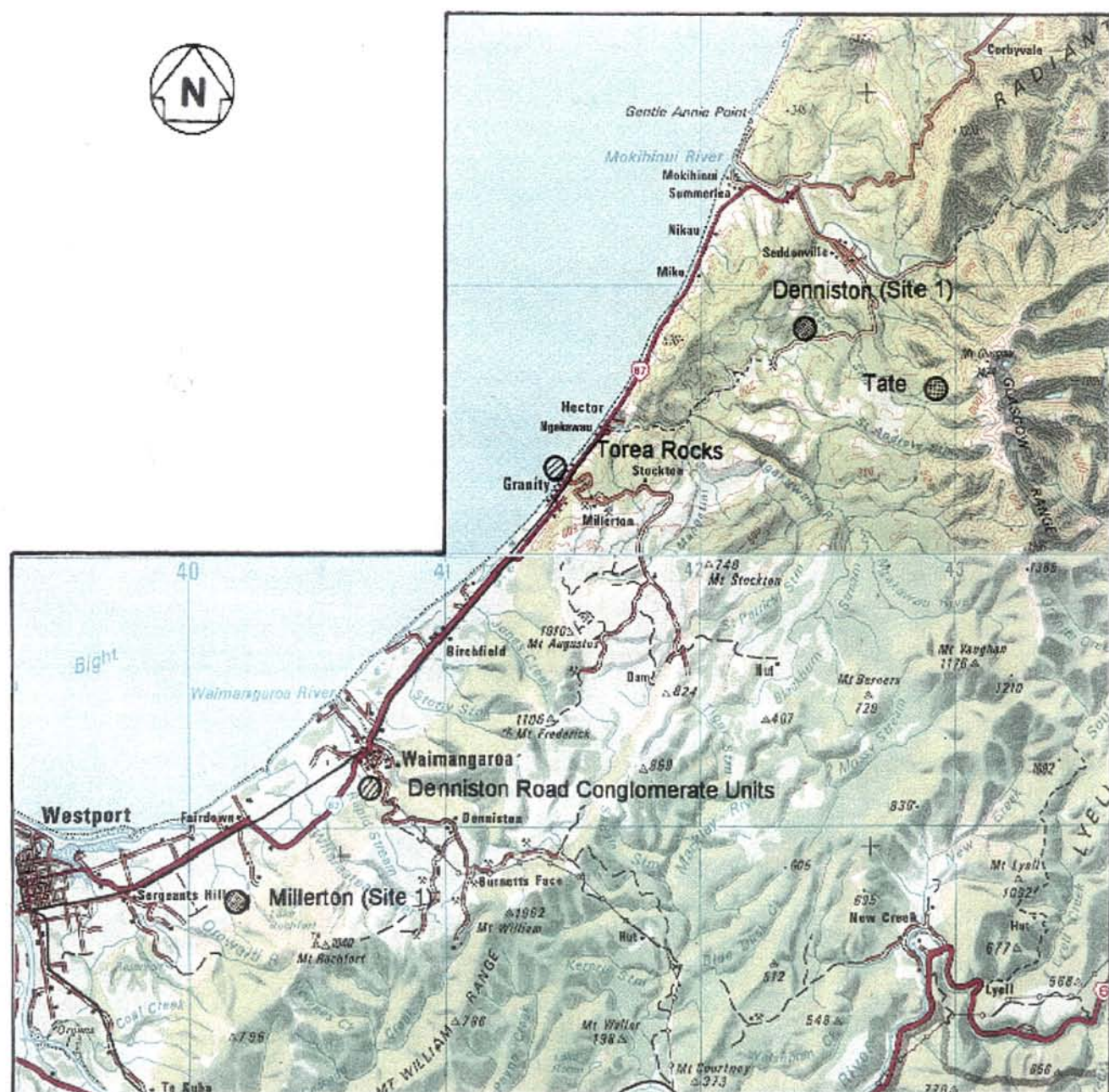
SOIL SERIES	GRID REFERENCE	LAND MANAGER & LOCATION
i) Denniston (Site 1) reference locality	L28: 227580	Timberlands West Coast Ltd
ii) Millerton (Site 1) type locality	K29:022370	Timberlands West Coast Ltd
iii) Tate type locality	L28: 289559	Timberlands West Coast Ltd

Designation in management plans and on-the-ground signposting is considered sufficient protection.

**Figure 11: GEOPRESERVATION INVENTORY
AND SOIL REFERENCE SITES**

REFERENCE

- Geopreservation Inventory Sites
- Soil Reference Sites



1 0 1 2km

Scale 1:50 000

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GLOSSARY OF SCIENTIFIC TERMS USED

- alluvial fan:** a mass of sediment (alluvium) deposited by a river where there is a decrease in gradient.
- alluvial terrace:** terrace formed from accumulation of alluvium. An alluvial terrace is a portion of the former floodplain of a river, now abandoned and left at a higher level as the river downcuts through it.
- alluvium:** rock or soil material that has been transported primarily by flowing water.
- argillite:** a hard, dark grey to black mudstone which, in New Zealand, is commonly associated with greywacke.
- bluff:** a precipitous bedrock outcrop which is at least 15m high, and usually has a broad face.
- boulderfield:** an hill/mountain slope area of large, rounded boulders with little or no fine-textured soil or rock infill.
- buffering:** protection of an area from the introduction of exotic plant and animal species and human activities provided by natural features (e.g. rock barriers, catchment boundaries and surrounding vegetation) or artificial structures (e.g. fences).
- butress:** a steep bedrock outcrop which is approximately 3-15m high, and usually has a broad face.
- cirque:** a gently sloping or flat-floored, half bowl-like recess or hollow, situated high on the side of a mountain, commonly at the head of a glacial valley. Includes the steep cirque walls and gently sloping floor of the cirque. A cirque floor is usually occupied by rockfall scree and/or moraine, as well as a tarn(s) or wetland(s).
- colluvial slope:** a slope that has a debris mantle (soil or scree) to a depth of at least 0.3m and few bedrock outcrops.
- colluvium:** rock or soil material that has been transported downslope primarily by gravity.
- conservation:** the preservation and protection of natural and historic resources for the purpose of maintaining their intrinsic values, providing for their appreciation and recreational enjoyment by the public, and safeguarding the options of future generations (*Conservation Act 1987*, Section 2 (1)).
- debris flow:** the rapid movement of water-saturated soil, rock and organic debris down a stream channel or across a slope. Debris flow deposits are typically hummocky, unsorted and usually lobate-shaped with high leaved edges and a high front.
- diversity:** the range of natural physical and biotic components in an area (land systems, landforms, soils, plant and animal communities, ecological units and ecosystems).
- ecological district:** a local part of New Zealand where geological, topographical, climatic and biological features and processes, including the broad cultural pattern, interrelate to produce a characteristic landscape and range of biological communities. New Zealand has been divided into 268 ecological districts.
- ecological region:** a group of adjacent ecological districts with closely related ecological characteristics or, in some cases, a single very distinctive ecological district. New Zealand has been divided into 85 ecological regions.
- ecological unit:** the ecological unit is the linking, in tandem, of a natural community type (usually a vegetation type) and a physical environment type (usually a landform type). For example, mountain beech forest on colluvial mountain sideslopes or red tussockland on moraine.
- endangered:** (referring to conservation status) a plant or animal species in danger of extinction and whose survival is unlikely if causal factors continue to operate.
- endemic:** a native plant or animal species which is found only in an area (e.g. Marlborough or New Zealand).
- exotic:** introduced; a plant or animal species which has been brought to New Zealand by humans, either by accident or by design (*c.f.* native).

fan: a landform composed of sedimentary deposits with an approximately half-cone shaped form which is generally fan-shaped in plan view, formed at a valley or gully mouth.

fault line: a ground surface displacement caused by tectonic movement

fluvial: of, or pertaining to, a river

fluvioglacial: relating to meltwater streams flowing from glaciers

floodplain: flat or gently sloping surface of alluvium, adjacent to a river or stream channel and covered by water during floods when flow is no longer confined to channels.

footslope: the gentle, concave slope at the base of the sideslope and above the toeslope and valley floor. This is where colluvial material is redeposited after having been moved downslope.

gley soils: mineral soils of flat wetlands with a grey coloured (usually pale greenish or bluish-grey) G horizon below a dark brown to black A horizon containing organic matter in various stages of decomposition. The properties of gley soils are a result of slow drainage and the high content of moisture, with consequent low temperatures and anaerobic, reducing conditions prevailing.

gorge: a relatively deep and narrow valley passage with steep, often with rocky sides.

greywacke: an indurated grey sandstone, mostly comprising quartz and feldspar, which is the most abundant rock in New Zealand.

holotype (type): a reference plant or animal specimen used to formally describe and name a species.

humus: decomposed organic component of soils.

indeterminate: (referring to conservation status) a plant or animal species thought to be extinct, endangered, vulnerable or rare, but for which there is insufficient information to allow an allocation one of these categories.

indigenous: native; a plant or animal species which occurs naturally in New Zealand (*c.f.* introduced).

indurated: hardened by the action of heat and pressure (as in the case of greywacke and argillite), or the introduction of some cementing material not commonly contained in the original mass.

introduced: exotic; a plant or animal which has been brought to New Zealand by humans, either by accident or by design (*c.f.* indigenous).

Kaikoura Orogeny: the second mountain building period in New Zealand, which began approximately ten million years ago and is continuing today. The present shape and topography of New Zealand has been formed over this period.

land system: an area throughout which there is a general coherence and unity of physical and biological attributes.

local: (referring to conservation status) a plant or animal species not presently at risk but potentially so, and hence deserving some level of monitoring and possibly protection.

monotypic: a term usually applied to a genus that contains only one species.

moraine: landforms, usually ridges or hummocks, composed of till.

mudstone: a sedimentary rock composed of mud-sized particles (*e.g.* argillite).

native: indigenous; a plant or animal species which occurs naturally in New Zealand (*c.f.* exotic).

naturalised: applied to a species that originally was imported from another country but now behaves like a native in that it maintains itself without further human intervention and has invaded native populations.

naturalness: an assessment of how closely the physical and biotic components of an area reflect the condition before human occupation (in New Zealand, approximately pre-AD 700).

Otiran glaciation: the period approximately 80 000 to 14 000 years ago in New Zealand, marked by three major episodes of relatively cold temperatures and associated glacial advances.

outwash: stratified rock material, boulder to sand-sized, deposited by meltwater streams in front of a glacier's snout.

periglacial: non-glacial processes and features of cold climates, especially those involving frost activity, i.e. frost heave, solifluction, patterned ground, freeze-thaw.

plateau: an area of fairly level high ground (plural plateaux)

Pleistocene: the period 2 000 000 - 10 000 years ago on the geological timescale. The Pleistocene Period was characterised by marked fluctuations in climate which resulted in the occurrence of several episodes of glaciation (*i.e.* the "Ice Ages").

plot: a sample site from which vegetation and landform data have been recorded.

podzol, podzolised: a soil often formed in a wet temperate climate under forest; characterised by strong leaching (podzolisation).

Protected Natural Area (PNA): a legally protected area, characterised by indigenous species or ecosystems, in which the principal purpose of management is retention of the indigenous state. The term may also be applied to areas legally protected for their soil, geological and/or landform values.

Quaternary: the period 2 000 000 years ago to the present day on the geological timescale.

ranker: a shallow soil profile comprising a dark coloured surface horizon over siliceous parent material.

rare: (referring to conservation status) a plant or animal species with small world populations that are not presently endangered or vulnerable but are at risk.

Recent: the 12 000 year period between the end of the Pleistocene glaciations and the present day; the Holocene period.

Recommended Area for Protection (RAP): an area identified as priority for protection because it is one of the best remaining natural areas in an ecological district. An RAP is intended to be the basis of a proposal for a new protected natural area.

representativeness: an assessment of how well an area (*e.g.* a RAP) shows the overall characteristics of a larger area (*e.g.* a land system or ecological district).

riparian: of or on a riverbank or streambank.

sag pond: a body of water which lies in a depression caused by fault trace down-faulting.

sandstone: a sedimentary rock composed of sand-sized particles (*e.g.* greywacke).

scarp: a steep slope of cliff found at the margin of a flat or gently sloping area.

scree: a sloping pile of angular rock fragments, with little or no surface soil, at the foot of a cliff (*i.e.* talus), mantling a hill/mountain slope (*i.e.* sheet scree), confined to a narrow channel or gully (*i.e.* scree chute or gully scree) or forming a steep, cone-shaped accumulation of colluvium below a chute/gully (*i.e.* cone scree).

sideslope: the midslope part of hill and mountain slopes between the summit/shoulder and footslope. It may be linear or concave throughout its length.

soil profile: a vertical section of soil through its organic and mineral horizons, extending into the parent material.

summit/shoulder slope: the slope above a sideslope, comprising ridge tops and convex slopes leading up to them.

survey area: the total area surveyed, using Protected Natural Areas Programme methodology, within the Ngakawau Ecological District. This includes the coastal hillslopes and elevated coastal measures land systems.

tarn: a relatively small lake or pool in a mountain landscape. Tarns frequently occupy cirques, moraine and outwash hollows.

tectonic landform: a landform produced primarily by earth crustal movements (*c.f.* those produced by fluvial, volcanic, glacial or mass movement processes).

terrace: a flat or gently sloping surface (*i.e.* the tread), generally composed of alluvial deposits, bounded on one side by a steeper descending slope (*i.e.* the riser) and, on the other, by a steeper ascending slope.

Tertiary: the period 65 to 2 million years ago on the geological timescale. The Tertiary period was marked initially by sea transgression until, about 25 million years ago, renewed uplift caused the seas to retreat.

till: material transported by a glacier. Till deposits are unsorted, unstratified and generally unconsolidated, and range in size from clay to boulders.

toeslope: the gentle, evenly sloped, downslope portion of the footslope; usually adjoins an alluvial terrace or floodplain.

tread: the flat or gently sloping broadly planar surface of a terrace. The tread marks the position of a former floodplain of a river or stream, now abandoned and left as a higher level as the river downcut through it.

type locality: the place where a plant or animal holotype was collected, or where a geological feature was first recognised and described.

viability: the ability of an area's plant and animal communities (or, in some cases, individual species) to maintain themselves in the long term without any special effort to perpetuate them.

vulnerable: (referring to conservation status) a plant or animal species believed likely to become endangered in the near future if the causal factors continue to operate.

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APPENDIX I EXISTING PROTECTED NATURAL AREAS OF NGAKAWAU ECOLOGICAL DISTRICT

Introduction

The Ngakawau Ecological District has three existing protected natural areas and three ecological areas approved by the Government in November 1986 following the West Coast Accord (Secretary for the Environment 1986). One of the approved ecological areas, Radcliffe, was gazetted in April 1997. The other two (Ngakawau and Orikaka) are still in the process of gazettal at the time of publication, and currently remain as Stewardship land. The Frank Stream covenanted area, originally allocated to Timberlands West Coast Limited, was transferred to the Department of Conservation as stewardship land in 1991 (subject to Timberlands retention of an access right).

Although not strict protected natural areas, two water conservation reserves and part of one recreation reserve have significant nature conservation values and are described herein. All are administered by the Buller District Council, subject to the Reserves Act 1977. Scenic, historic, natural and geological features are protected to the extent compatible with the primary purposes of the reserves.

Stewardship areas administered by the Department of Conservation under section 25 of the Conservation Act 1987 are a further category having a measure of protection. In the Ngakawau ED outside the RAPs, they occur on the Denniston plateau, Mt. Frederick forest, Radcliffe Ridge, the slopes and the tops of the northern Glasgow Range, and in the vicinity of Millerton, Stockton and Seddonville townships. They are not discussed any further here.

Under the West Coast Accord, much of the lower altitude forests north of the Ngakawau River was allocated for sustained yield timber production to Timberlands West Coast Ltd. These forests are subject to a management agreement which requires their retention in indigenous forest species.

Ngakawau-Hector Recreation Reserve (Part)

Administering Authority: Buller District Council, section 17, Reserves Act 1977 (New Zealand Gazette 1982 p3402, 1989 p2521)

Location: South bank of Ngakawau River, hillslope behind Ngakawau township.

Legal Description: Sec 13 Blk I Ngakawau S.D..

Area: 16.64 ha

Altitude: 7-135 m above sea level

Topography: Coastal slopes of the northeast tending spur behind Ngakawau, with the ridge the upper boundary and the lower boundary cutting diagonally across lower slopes.

Geology: Kaiata siltstones and Brunner coal measures sandstones.

Soils: Millerton steep-land podzolised yellow-brown earths (New Zealand Soil Bureau 1969). Fairly deeply weathered clays when in situ; more friable and fertile better drained semi-colluvial soils on steeper coastal slopes. Few bluff outcrops.

Vegetation:

- (a) In the northeast and southwest, semi-original northern rata, rimu/hard beech, Hall's totara/hinau, kamahi, toro, quintinia/mahoe, broadleaf/kiekie forest on more fertile sediments, some recovering from fire.
- (b) On steeper, generally more fertile lower coastal slopes, mixed broadleaved shrubland and low forest of mahoe, mamaku, large-leaved karamu, kamahi, wineberry, pigeonwood, kiekie and other species.
- (c) Majority of the hillslopes is a mosaic of species-rich, mixed second growth broadleaved and treefern shrubland. More recently grazed parts still with gorse, blackberry, bracken and Himalayan honeysuckle.

Wildlife: Common forest birds (Morse 1981); possums

History of Modification: Grazed, history of burning, bisected by Stockton-Ngakawau aerial ropeway and associated service road, and former Stockton Incline (now derelict).

Nature Conservation Values: Small, typical, modified fragment of coastal forest on siltstones and coal measures; value enhanced by contiguity with stewardship land and then Ngakawau EA to the east.

Recreation and Amenity Values: Backdrop to Ngakawau township; Charming Creek walkway on northern boundary; present and historic coal mining features. Grazing license previously used to raise revenue for sporting facilities on the remainder of the recreation reserve.

Reference: Kelly (in prep.)

Stockton Scenic Reserve

Administering Authority: Department of Conservation, section 19, Reserves Act 1977 (New Zealand Gazette 1979 p1204)

Location: Three small areas adjoining former coal mining township of Stockton.

Legal Description: Secs 3, 4 and Pt Sec 6 Blk VII Ngakawau S.D. (Much of section 4 (7.1832 ha) is to be added to the Ngakawau EA, and the balance is included in Coalcorp's Stockton coal mining license.)

Area: 13.16 ha (6 ha for Secs 3 & Pt 6 only)

Altitude: 275-400 m above sea level

Topography: Small valley head, hillslope and flat respectively

Geology: Coarse quartzite, Brunner coal measures

Soils: Denniston hill soils, podzolised yellow-brown earths and podzols (New Zealand Soil Bureau 1969); very infertile peat on easy slopes, infertile soils on gullies and at toe of steeper slopes.

Vegetation:

- (a) Semi-original characteristic coal measures forest in Sec 4 (rimu, hard beech/ yellow silver pine, mountain beech, southern rata/kamahi; manuka in advanced regeneration).

(b) Extensive areas of younger regenerating manuka and occasional broadleaved shrubs and podocarps (kamahi, toro, rimu) with coal measures herbs and fern understorey.

(c) On better drained slopes, broadleaved shrub regeneration (hard, silver and mountain beech/kamahi, toro, quintinia, southern rata, manuka).

Wildlife: Common forest birds (Morse 1981); possums in small numbers.

History of Modification: History of burning, bisected by roads and Stockton-Ngakawau aerial ropeway.

Nature Conservation Values: Small, typical modified fragment of low-mid altitude coal measures forest and shrubland; value enhanced by contiguity with Ngakawau EA (to which sec 4 is to be added). Pt Sec 6 lacks significant nature conservation value and should be deleted from the reserve.

Recreation and Amenity Values: High waterfall (23 m) in section 3; periphery to old coal mining township of Stockton; present and historic coal mining interest.

Reference: Kelly (in prep.)

Note: Stockton Scenic Reserve (as Stockton Creek Scenic Reserve) is listed in the NZ Geopreservation Inventory as a Soil Site of National Significance (Arand *et al.* 1991).

Ngakawau Scenic Reserve

Administering Authority: Department of Conservation, section 19, Reserves Act 1977 (New Zealand Gazette 1979 p1461, 1981 p1136)

Location: On coastal hills between Granity and Millerton, adjoining Granity-Millerton road.

Legal Description: Secs 2, 6, 7, 7a, 14, 23, 24, 26, 27, 31 and Pts Sec 8 Blk I and Sec 4 Blk VI Ngakawau S.D.

Area: 69.2 ha

Altitude: 6-280 m

Topography: Steep coastal hillslopes below Millerton-Stockton plateau, dissected by Granity Creek. Several bluffs.

Geology: Kaiata siltstones; quartz sandstones, Brunner coal measures. Underlying Constant gneiss exposed by erosion in Granity Creek.

Soils: Millerton steepland podzolised yellow-brown earths and podzols (New Zealand Soil Bureau 1969). Soils generally extremely infertile except on steeper slopes and colluvium.

Vegetation:

(a) Semi-original rimu, northern rata, miro, hard beech, hinau/kamahi, mahoe, toro, kiekie, in east and northeast, some modified by fire.

(b) Hard beech on ridges and steeper slopes, with northern and southern rata in some places.

- (c) Mixed broadleaved second growth forest and shrubland (kamahi, toro, broadleaf, heketara, large-leaved karamu, northern rata) in gullies. Additional mahoe, mamaku, fuchsia, wineberry, broadleaf, putaputaweta, pigeonwood, pate, shiny karamu, supplejack and kiekie on steeper more fertile colluvial slopes.
- (d) On steep coastal faces, mahoe-dominated broadleaved shrubland and forest.
- (e) On steep rocky slopes below the coal plateau edge, young northern and southern rata, kamahi, toro and other broadleaved trees.
- (f) On coal measures plateau, manuka shrubland with inanga, tumingi/umbrella fern.
- (g) Gorse, bracken and many weed species on road margin.

Wildlife: Common forest birds and South Island fernbird (Morse 1981).

History of Modification: Parts burnt, bisected by road, regenerating well.

Nature Conservation Values: Low-mid altitude, mainly modified vegetation associations on coastal siltstones and coal measures; contiguity with stewardship land and then Ngakawau EA eastwards.

Recreation and Amenity Values: Backdrop to Granity township; roadside views; outstanding coastline views to the north; waterfalls; historic Millerton Incline on south boundary.

Reference: Kelly (in prep.)

Denniston Scenic Reserve and Conns Creek Water Conservation Reserve

Administering Authority: Scenic Reserve: Department of Conservation, section 19, Reserves Act 1977 (New Zealand Gazette 1979 p700).

Water Conservation Reserve: Buller District Council, section 23, Reserves Act 1977 (New Zealand Gazette 1955 p1531, 1971 p813, 1989 p2521).

Location: On south side of Waimangaroa River gorge, and north edge of Denniston plateau, between Waimangaroa and Burnetts Face.

Legal Description: Scenic Reserve: Secs 44, 45 and 46 Blk VI and Sec 75 Blk V Kawatiri S.D. Water Conservation Reserve: Secs 14 and 46 Blk VI Kawatiri S.D.

Area: Scenic Reserve: 683.72 ha; Water Conservation Reserve: 33.88 ha

Altitude: 25-610 m

Topography: North edge of the Denniston plateau, falling away in northwest down to dissected Pleistocene marine terraces, and in northeast down the steep slopes of the Waimangaroa Gorge. Bluffs.

Geology: Underlying Tuhua granite and Greenland group greywacke exposed in the Waimangaroa gorge; Pleistocene marine terraces on lowest slopes (outside ecological district); Kaiata siltstones and quartzose sandstones and coal beds of Brunner coal measures on plateau top and northwestern slopes.

Soils: Denniston and Millerton podzolised yellow-brown earths and podzols on plateau and western coal measures slopes; Wakamarama podzolised

yellow-brown earths on bedrock in gorges; Okarito podzolised yellow-brown earths on the marine terraces (New Zealand Soil Bureau 1969). Soils on the quartzite are extremely infertile and slow draining, but fertility increases with increasing instability.

Vegetation:

- (a) Rimu/hard beech/kamahi, quintinia and broadleaf forest on dissected marine terraces, modified by fire and logging.
- (b) Rimu/hard beech, southern rata/kamahi on lower slopes of Waimangaroa gorge; red beech above 300 m; and rimu, Hall's totara/silver, red and mountain beech, southern rata/kamahi, broadleaf above 425 m. Broadleaved tree species on recent sites.
- (c) Plateau-edge coal measures forest and shrubland (southern rata/mountain beech, pink pine, yellow silver pine, toatoa, mountain neinei, silver beech, Hall's totara/kamahi, quintinia, *Archeria traversii*, manuka).
- (d) Hillslope coal measures forest of rimu/mountain beech, hard beech, Hall's totara, southern rata/kamahi, yellow silver pine and toatoa, with very rich undergrowth including *Metrosideros parkinsonii*.
- (e) Low heath and peat moorland on coal measures plateau, of low manuka, yellow silver pine, pink pine, pigmy pine, *Chionochloa juncea*, *C. australis*, wire rush, umbrella fern and herbs. Moss and turf communities in wet sandy hollows. Related, induced pakihi and pakihi-shrubland communities on sloping coal measures (tumingi, *Baumea teretifolia*/umbrella fern, wire rush/*Carphe alpina*, *Celmisia dubia*/*Lycopodium ramulosum*).
- (f) Regenerating broadleaved shrubland, dominated by kamahi, on dissected terraces and low alluvial gorge slopes. Young broadleaved shrub regeneration on rocky slips from 1968 Inangahua earthquake.

Wildlife: Common forest birds and South Island fernbird (Morse 1981). Introduced animals scarce.

History of Modification: Reserve bisected by famous Denniston Incline, new Denniston road (not legal) and new Coalcorp road to Rapid Stream mine entrance (not legal). History of burning, forest logging at lower altitudes. Roadside weeds.

Nature Conservation Values: Valuable reserve for its representation, albeit fragmentary, of open coal measures shrub and heathland (first such area protected), and the range of other ecosystems; abundant *Metrosideros parkinsonii*; generally in exceptionally good biological condition.

Recreation and Amenity Values: Outstanding views, backdrop to coastal plain, historic coal mining and early European settlement features, reopened Conns Creek-Denniston foot track, striking landscape.

Reference: Kelly (in prep.)

Notes:

- (a) The Conns Creek Water Conservation Reserve is included in the treatment of the scenic reserve because it is contiguous and part of the same natural

system. Like the Westport Water Conservation Reserve, it lacks secure protected status.

(b) Denniston Scenic Reserve is listed in the NZ Geopreservation Inventory as Soil Site of National Significance (Arand *et al.* 1991).

Westport Water Conservation Reserve

Administering Authority: Buller District Council, section 23, Reserves Act 1977 (New Zealand Gazette 1951 p1185).

Location: Southern tip of Buller coal plateaux, 6 km east of Westport.

Legal Description: Pt Sec 13 and Sec 14 Blk VIII Kawatiri S.D., Sec 1 Blk I Kawatiri S.D., Sec 17 Blk II Ohika S.D.

Area: 1825.33 ha

Altitude: 40-805 m

Topography: Fluvially-incised terraces, westward-dipping coal plateau, steep Orowaiti River headwaters.

Geology: Brunner coal measures, Constant gneiss exposed in Orowaiti catchment, Porikan and Albion glacial and interglacial terraces, Pliocene siltstone and sandstone in Ballarat Creek and German Gully (terraces and siltstones/sandstones are not in ecological district).

Soils: Matiri and Millerton steepland podzolised yellow-brown earths and podzols on coal measures and basement rock, Okarito gley podzols on terraces (New Zealand Soil Bureau 1969). All soils very infertile.

Vegetation and flora:

- (a) Abundant rimu/hard, red and silver beech/kamahahi in upper Orowaiti catchment.
- (b) Open canopy rimu/hard beech, miro, hinau/ Hall's totara, southern rata, kamahahi, quintinia, with kiekie and supplejack on lower coal measures slope and steep gullies.
- (c) On upper (above 250-300 m) coal measures hill slopes, a mosaic of conifer rich montane forest (mountain beech, silver beech, southern rata, yellow silver pine, pink pine, toatoa, mountain neinei), and coal measures shrubland (manuka, mountain beech, inanga, mingimingi, kamahahi, southern rata, yellow silver pine, quintinia, *Epacris pauciflora*, mountain flax/umbrella fern, *Lycopodium ramulosum*, wire rush). Some barer areas upslope include many smaller typical coal plateau species.
- (d) Terrace pakihi (*Baumea teretifolia*/umbrella fern, wire rush/*Lycopodium ramulosum* and many other species). Upslope, extensive manuka shrubland from repeated burning.

220 indigenous vascular plant species and only two adventives recorded (Regnier 1986, D.A. Norton & F.B. Overmars unpubl. data)

Wildlife: Common forest birds and South Island fernbird (Morse 1981).

History of Modification: Roading and pipeline for Westport's water supply, long history of fire but biological quality remains high except in "works" areas.

Nature Conservation Values: Larger area and wider range of vegetation associations on coal measures (up to 800 m) than Denniston SR, and little modified especially at higher altitudes, but lacks secure protected natural area status.

Recreation and Amenity Values: Backdrop to Westport and Buller Gorge.

Reference: Kelly (in prep.)

Radcliffe Ecological Area And Frank Stream Stewardship Land

Administering Authority: Ecological Area: Department of Conservation, section 21, Conservation Act 1987 (New Zealand Gazette 1997 p881)

Stewardship land: previously with Timberlands West Coast Ltd, now stewardship land (suitable for addition to the Radcliffe EA). Timberlands retains an access right.

Location: Northern end of Mokihinui forest, 2 km southwest of Seddonville.

Legal Description: Ecological Area: Sections 1 & 2 S.O. 15 376, Blks XI and XV Mokihinui S.D. Stewardship Land: Section 3 S.O. 15 376, Blks XI and XV Mokihinui S.D.

Area: Ecological Area: 360 ha; Stewardship land: 142.4 ha

Altitude: 20-413 m

Topography: Plateau sloping down to Mokihinui valley, steeper slopes on Radcliffe Range and Chasm Creek Gorge.

Geology: Quartzose sandstone and siltstone, Brunner coal measures, Constant gneiss in northwest.

Soils: Primarily peaty Denniston and Denniston hill podzols, Millerton steepland soils in Chasm Creek Gorge, Kaniere steepland yellow-brown earths on gneiss (Heine & Mew 1981).

Vegetation:

- (a) Primarily stunted podocarp-beech forest (rimu/yellow silver pine, pink pine, toatoa, mountain beech), manuka shrubland and pakihi.
- (b) Mixed beech-podocarp forest on steeper slopes.
- (c) A small area of beech-free forest (i.e. rimu-southern rata) east of Marris Stream, one of few such occurrences in ecological district and the only site known to be reserved.

Wildlife: Reserve and stewardship land protected to conserve populations of *Powelliphanta lignaria johnstoni* and *P.l. unicolorata* around their type localities (Anon. 1986). Common forest birds and South Island fernbird expected (Morse 1981). Possums, pigs.

History of Modification: Parts burnt, early silver pine logging, stewardship area logged for rimu and other podocarps and with some blackwood interplanting, early coal mining.

Nature Conservation Value: Representative of lower altitude coal measures and hill country podocarp-beech forest and, in small measure, beech-free forest on Radcliffe Ridge. Key locality for large native land snails.

Recreation and Amenity Values: Roadside scenery, hunting

References: Walker 1986, Anon. 1986, 1987

Ngakawau Ecological Area

Administering Authority: Department of Conservation, section 21, Conservation Act 1987 (awaiting gazettal).

Location: A near complete transect of the Ngakawau ED between the Glasgow Range and the coast at Ngakawau.

Legal Description: Former Crown land and State Forest in Blk XIV Mokihiui S.D., Blks II, III, IV, VII, VIII, IX, XI, XII, XIII Ngakawau S.D., Blks XIII, XVII Marina S.D., allocated to Department of Conservation and shown on S.O. 15 258.

Area: 13 601 ha

Altitude: 10-1480 m

Topography: Mountain slopes, inland fluviially-dissected plateau and basins, Ngakawau gorges, coastal hills, river terraces.

Geology: Brunner coal measures, Kaiata siltstones, Constant gneiss and Tuhua granites, Greenland group greywackes.

Soils: Wide range of soils reflecting parent materials and landform; primarily Denniston and Denniston hill podzols on coal measures, Ngakawau and Mackley yellow-brown earths on siltstones and gravels, Addison gley podzols on terraces, various steep-land soils on Glasgow Range, Radcliffe Ridge and other hills and gorges (Heine & Mew 1981).

Vegetation: (see also section 2.6)

- (a) Mountain-land podocarp-beech forest and alpine grasslands, but excluding beech-free areas on northern end of Glasgow Range.
- (b) Mixed podocarp-beech forest sequences on basement rocks (Mt Stockton, Mt Berners, Radcliffe Ridge).
- (c) Tall unmodified red and silver beech forest with emergent podocarps on alluvial terraces of mid-Ngakawau River, grading to stunted forest and pakihi on the highest terraces.
- (d) Mosaic of coal measures heathland, shrubland and dwarf forest on coal measures north and south of Ngakawau Gorge, between 300-600 m altitude, much fire-induced.
- (e) Yellow silver pine and mountain beech dominant associations east of Blackburn pakihi, on lower slopes of Mt Berners, and on high terraces.
- (f) Ngakawau Gorge communities, with *Celmisia morganii*.

Wildlife: Extensive habitat supports a wide range of forest and shrubland birds, including the less common South Island fernbird, kaka, yellow-crowned parakeet and great spotted kiwi. Key sites for two large landsnails, *Powelliphanta*

lignaria rotella near St Andrews Stream (type locality) and *P.I. johnstoni* near Watson Stream (Powell 1949, Walker 1982).

History of Modification: Pine plantation on St Andrews pakihi, old farming, railway and coal mining at Charming Creek, fire history on pakihi and coal measures vegetation, some forest logging, vehicle tracks, peripheral coal mining activities, introduced herbivores and predators, waterway pollution by coal mining.

Nature Conservation Values: Large, compact altitudinal sequence of coastal, plateau and mountain landforms and little modified vegetation associations from near sea-level to tops of Glasgow Range. Primary representative reserve for Ngakawau ED, although not complete in its coverage. High wildlife values.

Recreation and Amenity Values: Historic Charming Creek coal mine, Charming Creek walkway on line of former railway to coal mine, tramping and hunting.

References: Given 1978, 1980a, Department of Scientific and Industrial Research 1983, Grant 1984, 1986, Anon. 1986, 1987.

Orikaka Ecological Area (Part)

Administering Authority: Department of Conservation, section 21 Conservation Act 1987 (awaiting gazettal).

Location: From opposite Berlins on north side of Buller River, to Glasgow Range; based on Orikaka catchment. Adjoins northern boundary of Ngakawau EA along ridge through Mt Berners and Mt Vaughn.

Legal Description: Former State Forest and Crown land in Blks X, XI, XII, XIII, XIV, XV, Orikaka S.D., Blk IX, Lyell S.D., allocated to Department of Conservation, and shown on S.O. 15 261.

Area: c.15 000 ha total, c.8 000 in Ngakawau ED.

Altitude: 50-1210 m

Topography: Steep, finely dissected hill country on basement rocks, dissected plateau in upper Orikaka basin, and Glasgow Range and Mt William Range mountain slopes.

Geology: Greenland group greywackes, Constant gneiss and Berlins porphyry basement rocks, Kaiata mudstone in upper Orikaka Basin, fringing bands and remnants of Brunner coal measures (e.g., Tiger Pakihi).

Soils: Kaniere, Wakamarama and Tate steepland yellow-brown earths on Glasgow Range; Denniston and Denniston hill podzols on Tiger Pakihi and other coal measures; poorly drained Addison gleyed podzols and Orikaka podzols in upper Orikaka Basin; smaller areas of Ngakawau and Mackley yellow-brown earths also present in upper Orikaka; Blue Duck yellow-brown earths on granite hills (Heine & Mew 1981).

Vegetation:

(a) Stunted pahautea-silver beech-rimu in cold wet upper Orikaka Basin.

- (b) Red, silver and hard beech/kamahī, quintinia, toro, with and without podocarps (rimu, miro, Halls totara) on steep hill country (high biomass, large and vigorous trees).
- (c) Rimu, kahikatea/yellow silver pine, pink pine, Hall's totara, pahautea, silver pine/mountain and hard beech, southern rata, toatoa, quintinia, mountain neinei on easier slopes.
- (d) On easier terrain (e.g., Tiger Pakihi), mosaic of shrubland (manuka, bog pine, yellow silver pine, tumingi, *Epacris pauciflora*/wire rush, *Gleichenia* spp., *Lycopodium fastigiatum*), dwarf forest (rimu/yellow silver pine, pink pine, bog pine), and pakihi (wire rush, *Dracophyllum palustre*, *Gleichenia* spp., *Gabnia rigida*, *Chionochloa rubra* ssp. *occulta*, *C. australis*, *Epacris alpina*, *E. pauciflora* and many other species).
- (e) Red beech-silver beech forest altitudinal sequence on Glasgow Range.

Wildlife: Extensive habitat supports a wide range of forest and shrubland birds, including the less common yellow-crowned parakeet, kaka, robin, great spotted kiwi, South Island fernbird, New Zealand falcon and blue duck (Anon. 1987, Morse 1981). High goat population.

History of Modification: Electricity transmission pylon and servicing road, some burning of pakihi communities, introduced herbivores and predators.

Nature Conservation Values: Fully covers the vegetation and landforms of the southeast of the Ngakawau ED, including distinctive pakihi-shrubland associations and vigorous beech forests; part of tract of low and mid altitude forest between Buller and Mokihinui Rivers, of high value for forest birdlife.

Recreation and Amenity Values: Hunting and tramping

References: Anon. 1979, 1987

APPENDIX II LANDFORM CLASSIFICATION USED IN THE PNAP SURVEY

MACROLAND FORM	1 UNDULATING PLATEAU (vegetated rolling terrain)			
Meso Landform	1 Hilltop	2 Hillslope	3 Gully	4 Step
Component Landform	1 Interfluv 2 Seepage Slope 3 Both	1 Sideslope 2 Footslope 3 Toeslope 4 Entire Slope		5 Channel bed 6 Interfluv 7 Seepage slope 8 Scarp 9 Basin
Geometric Descriptors	1 Sharp 2 Rounded 3 Flat	1 Planar 2 Hummocky 3 Dissected		4 Gullied

MACROLAND FORM	2 FLUVIAL VALLEY SYSTEM			
Meso Landform	1 Terrace	2 Fan	3 Riverbed	4 Lake or Tarn
Component Landform	1 Riser 2 Tread	1 Fan-head 2 Mid-fan 3 Toe 4 Backswamp 5 Channel 6 Non-channel	1 Channel 2 Floodplain 3 Floodplain bars 4 F.P. channels 5 F.P. backswamps	1 Beach 2 Spit 3 Delta 4 Lakebed 5 Lagoon 6 Littoral Zone 7 Island
Geometric Descriptors	1 Single 2 Multiple (2-4) 3 Flights (>4) 4 Dissected	1 Inset Fan 2 Overstep fan	1 Single thread- straight 2 Single thread-sinuuous 3 Single thread-meandering 4 Braided	1 Single 2 Multiple 3 Large (>1 km 2) 4 Medium (0.1-1 km 2) 5 Small (<0.1 km 2) 6 Deep (>10 m) 7 Shallow (<10 m) 8 Ephemeral 9 Permanent
Additional Descriptors	1 Alluvial terrace (>3 m gravel) 2 Thin alluvial terrace (1-3 m) 3 Bedrock terrace (<1 m)	1 Fluvial 2 Fluvial/debris flow 3 Debris flow	1 Rock-bound 2 Boulder-bound 3 Gravel-bound 4 Veg/Soil bound 5 Creek 6 Stream 7 Small river/big river	1 Fan dammed 2 Landslide demand 3 Glacially excavated 4 Kettle holes 5 Moraine dammed 6 Fault sag ponds

MACRO LANDFORM	3 SOFT ROCK HILLSLOPE SYSTEMS TERTIARY ROCKS (<1000 m asl or <300 m relief)			
Meso Landform	1 Vegetated colluvial slopes	2 Non-vegetated colluvial slopes	3 Bedrock 'colluvial' slopes (scree)	4 Hilltops
Component Landform	1 Interfluvies 2 Sideslopes 3 Basin floor			
Geometric Descriptors	1 Planar 2 Hummocky 3 Dissected	7 Cone 8 Sheet 9 Chute	1 Bluff 2 Buttress 3 Scattered outcrops	1 Sharp 2 Rounded 3 Flat
Additional Descriptors	1 Dipslope 2 Scarp slope	1 Rockfall scree 2 Snow avalanche 3 Debris flow 4 Scree 5 Blockfield 6 Pavement scree 7 Landslide scar 8 Dipslope 9 Scarp slope	1 Dipslope 2 Scarp slope	1 Periglacial 2 Erosional 2 Slumped

APPENDIX III GLOSSARY OF COMMON AND SCIENTIFIC NAMES FOR PLANTS AND ANIMALS

Plants

bearded orchid	<i>Calocylus paludosus</i>
blackberry	<i>Rubus fruticosus</i> agg.
blackwood	<i>Acacia melanoxylon</i>
bog pine	<i>Halocarpus bidwillii</i>
bracken	<i>Pteridium esculentum</i>
broadleaved snowtussock	<i>Chionochloa flavescens</i> ssp. <i>lupeola</i>
broadleaf	<i>Griselinia littoralis</i>
bush rice grass	<i>Microlaena avenacea</i>
carpet grass	<i>Chionochloa australis</i>
pahautea, kaikawaka, cedar	<i>Libocedrus bidwillii</i>
comb fern	<i>Schizaea australis</i>
crown fern	<i>Blechnum discolor</i>
cushion plant	<i>Donatia novae-zelandiae</i>
fuchsia	<i>Fuchsia excorticata</i>
gorse	<i>Ulex europaeus</i>
Hall's totara	<i>Podocarpus hallii</i>
hard beech	<i>Nothofagus truncata</i>
heketara	<i>Olearia rani</i>
Himalayan honeysuckle	<i>Leycesteria formosa</i>
hinau	<i>Elaeocarpus dentatus</i>
horizontal orchid	<i>Lyperanthus antarcticus</i>
horopito	<i>Pseudowintera colorata</i>
inanga	<i>Dracophyllum longifolium</i>
kahikatea	<i>Dacrycarpus dacrydioides</i>
kamahi	<i>Weinmannia racemosa</i>
kidney fern	<i>Trichomanes reniforme</i>
kiekie	<i>Freycinetia baueriana</i> ssp. <i>banksii</i>
kowhai	<i>Sophora microphylla</i>
lantern berry	<i>Luzuriaga parviflora</i>
leatherwood	<i>Olearia colensoi</i>
mahoe	<i>Melicytus ramiflorus</i>
mamaku	<i>Cyathea medullaris</i>
manuka	<i>Leptospermum scoparium</i>
midribbed snow tussock	<i>Chionochloa pallens</i>
mingimingi	<i>Leucopogon fasciculatus</i>
miro	<i>Prumnopitys ferruginea</i>

montbretia	<i>Crocasmia x crocosmitiflora</i>
mountain bog daisy	<i>Celmisia alpina</i>
mountain beech	<i>Nothofagus solandri</i> var. <i>cliffortioides</i>
mountain flax	<i>Phormium cookianum</i>
mountain neinei	<i>Dracophyllum traversii</i>
mountain toatoa	<i>Phyllocladus alpinus</i>
nikau	<i>Rhopalostylis baueri</i>
northern horopito	<i>Pseudowintera axillaris</i>
northern rata	<i>Metrosideros robusta</i>
parasol fern	<i>Gleichenia microphylla</i>
pate	<i>Schefflera digitata</i>
pigeonwood	<i>Hedycarya arborea</i>
pigmy pine	<i>Lepidothamnus laxifolius</i>
pink pine	<i>Halocarpus biformis</i>
pokaka	<i>Elaeocarpus bookerianus</i>
prickly mingimingi	<i>Cyatodes juniperina</i>
putuputaweta, marbleleaf	<i>Carpodetus serratus</i>
quintinia	<i>Quintinia acutifolia</i>
raurekau	<i>Coprosma grandifolia</i>
red beech	<i>Nothofagus fusca</i>
red tussock	<i>Chionochloa rubra</i> ssp. <i>occulta</i>
rimu	<i>Dacrydium cupressinum</i>
rohutu	<i>Neomyrtus pedunculata</i>
shiny karamu	<i>Coprosma lucida</i>
silver beech	<i>Nothofagus menziesii</i>
silver pine	<i>Manoao (= Lagarostrobos) colensoi</i>
southern rata	<i>Metrosideros umbellata</i>
stinkwood	<i>Coprosma foetidissima</i>
sundews	<i>Drosera</i> spp.
supplejack	<i>Ripogonum scandens</i>
tanglefern	<i>Gleichenia dicarpa</i>
toro	<i>Myrsine salicina</i>
tumingi	<i>Epacris pauciflora</i>
umbrella fern	<i>Gleichenia cunninghamii</i>
wandering jew	<i>Tradescantia fluminensis</i>
weeping mapou	<i>Myrsine divaricata</i>
wineberry, makomako	<i>Aristotelia serrata</i>
wire rush	<i>Empodisma minus</i>
yellow silver pine	<i>Lepidothamnus intermedius</i>

Birds

Australasian harrier, kahu	<i>Circus approximans</i>
bellbird, korimako	<i>Anthornis melanura melanura</i>
black shag, kawau	<i>Phalacrocorax carbo novaehollandiae</i>
black-billed gull, tarapunga	<i>Larus bulleri</i>
blackbird	<i>Turdus merula</i>
blue duck, whio	<i>Hymenolaimus malacorbynchus</i>
brown creeper, pipipi	<i>Mohoua novaeseelandiae</i>
chaffinch	<i>Fringilla coelebs</i>
fantail, piwakawaka	<i>Rhipidura fuliginosa fuliginosa</i>
great spotted kiwi, roa	<i>Apteryx baastii</i>
grey warbler, riroriro	<i>Gerygone igata</i>
kea	<i>Nestor notabilis</i>
kingfisher, kotare	<i>Halcyon sancta vagans</i>
long-tailed cuckoo, koekoea	<i>Eudynamys taitensis</i>
morepork, ruru	<i>Ninox novaeseelandiae novaeseelandiae</i>
New Zealand falcon, karearea	<i>Falco novaeseelandiae</i>
New Zealand pigeon, kereru	<i>Hemiphaga novaeseelandiae novaeseelandiae</i>
New Zealand pipit, pihoihoi	<i>Anthus novaeseelandiae novaeseelandiae</i>
paradise shelduck, putangitangi	<i>Tadorna variegata</i>
pukeko	<i>Porphyrio porphyrio melanotus</i>
red-billed gull, tarapunga	<i>Larus novaehollandiae scopulinus</i>
silvereye, tauhou	<i>Zosterops lateralis lateralis</i>
shining cuckoo, pipiwharauoa	<i>Cbrysococcyx lucidus lucidus</i>
South Island fernbird, matata	<i>Bowdleria punctata punctata</i>
South Island kaka	<i>Nestor meridionalis</i>
South Island rifleman, titipounamu	<i>Acanthisitta chloris chloris</i>
South Island robin, toutouwai	<i>Petroica australis australis</i>
South Island tomtit, ngirungiru	<i>Petroica macrocephala macrocephala</i>
southern black-backed gull, karoro	<i>Larus dominicanus dominicanus</i>
spur-winged plover	<i>Vanellus miles novaehollandiae</i>
tui	<i>Prosthemadera novaeseelandiae novaeseelandiae</i>
western weka	<i>Gallirallus australis australis</i>
welcome swallow	<i>Hirundo tabitica neoxena</i>
yellow-crowned parakeet, kakariki	<i>Cyanoramphus auriceps auriceps</i>

Lizards

brown skink	<i>Oligosoma zelandicum</i>
common gecko	<i>Hoplodactylus maculatus</i>
forest gecko	<i>Hoplodactylus granulatus</i>
speckled skink	<i>Oligosoma infrapunctatum</i>

Invertebrates

koura, freshwater crayfish	<i>Paraneobrooks planifrons</i>
common tree weta	<i>Hemideina crassidens</i>
wasps	<i>Vespula</i> spp.

Indigenous Mammals

long-tailed bat	<i>Chalinolobus tuberculatus</i>
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Introduced Mammals

black rat	<i>Rattus rattus</i>
feral cat	<i>Felis catus</i>
feral goat	<i>Capra hircus</i>
feral pig	<i>Sus scrofa</i>
hare	<i>Lepus europaeus occidentalis</i>
kiore, Polynesian rat	<i>Rattus exulans</i>
mouse	<i>Mus musculus</i>
mustelids	<i>Mustela</i> spp.
Norway rat	<i>Rattus norvegicus</i>
possum	<i>Trichosurus vulpecula</i>
rabbit	<i>Oryctolagus cuniculus cuniculus</i>
red deer	<i>Cervus elaphus scoticus</i>

Amphibians

whistling tree frog	<i>Litoria ewingi</i>
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Fish

banded kokopu	<i>Galaxias fasciatus</i>
bluegilled bully	<i>Gobiomorphus bubbsi</i>
brown trout	<i>Salmo trutta</i>
common bully	<i>Gobiomorphus cotidianus</i>
inanga	<i>Galaxias maculatus</i>
koaro, mountain trout	<i>Galaxias brevipinnis</i>
longfinned eel	<i>Anguilla dieffenbachii</i>
redfinned bully	<i>Gobiomorphus buttoni</i>
shortfinned eel	<i>Anguilla australis</i>
shortjawed kokopu	<i>Galaxias postvectis</i>
torrentfish	<i>Cheimarrichthys fosteri</i>

1 *Rimu/Broadleaved Forest*

This low altitude (100-300 m asl) forest has a mixed open canopy dominated by rimu and kamahi, with red beech, hard beech and silver beech forest present at some sites. Kamahi, quintinia and toro, in conjunction with supplejack and kiekie dominate the subcanopy and lower tiers. The climbing ratas *Metrosideros fulgens*, *M. diffusa* and *M. perforata* are present to a lesser extent. Pigeonwood, large-leaved karamu and the tree fern *Dicksonia squarrosa* are common in the understorey.

This is the only association in which northern rata and the fern *Arthropteris tenella* are present. It is predominant on the lower steep well-drained hillslopes of the lower Waimangaroa gorge, the coastal slopes of Mt Frederick forest and northwards, and the fluvial hill systems of the upper Orowaiti valley.

2 *Mixed Beech-Southern Rata Forest*

Silver beech dominates over red beech and southern rata in the canopy. Kamahi and quintinia dominate the subcanopy and throughout the understorey. Mountain neinei and stinkwood are common shrub species. The forest floor is covered by a wide range of species but is usually dominated by crown fern, bush rice grass, *Grammitis billardierei*, and the filmy fern *Hymenophyllum demissum*. The fern *Asplenium flaccidum* is the only common epiphytic species.

This association occupies similar steep hill systems to group 1 but at higher altitudes (generally 500-800 m asl); and also some of the steep gullies and slopes of the Stockton plateau, the coastal coal measures slopes, and the gullies of the inland basin system in the east of the ecological district.

Red beech is emergent over this association in some places, specifically at the base of the steep slopes of Mt Berners, within the Orowaiti catchment, and on the slopes of Mt William.

3 *Hard Beech-Southern Rata-Rimu Forest*

Hard beech in association with southern rata, rimu and silver beech are the major canopy species. Kamahi and hard beech, with quintinia to a lesser extent, dominate the subcanopy and understorey. Hall's totara, stinkwood and mingimingi are major shrubs. Both *Gahnia procera* and umbrella fern dominate the forest floor, with *Nertera depressa* and *Hymenophyllum bivalve* also present.

Species of interest in this association include the hybrid *Myrsine divaricata* x *M. salicina* on the western forest slopes above Tiger Stream, and the two ground ferns *Dicksonia lanata* and *Cyathea colensoi* on the slopes of Isolated Hill.

This association occurs on low altitude (120-400 m asl) coastal hillslopes on basement rocks. It is also found in the east of the ecological district on the slopes of Isolated Hill, the steep eastern slopes of Mt William and the Mt William Range, and the forest east of Blackburn pakihi, on basement rocks and Kaiata siltstones.

4a Rimu/Mountain Beech Forest

Rimu is emergent above a canopy of mountain beech. A variety of species dominate the understorey, including kamahi, yellow silver pine, mountain neinei, quintinia, weeping mapou, and *Gabnia procera*. These provide cover over a mixed forest floor in which *Blechnum procerum*, *Luzuriaga parviflora* and *Libertia pulchella* are most common.

This low-mid altitude (340-500 m asl) forest occupies gullies and isolated slopes on the north and east of the Stockton plateau, both slopes of Mt William and the eastern slopes of the Mt William Range. It also forms part of the low forest mosaic on the flat area between the Blackburn pakihi and Mt Berners.

Of special interest is an occurrence of the fern *Grammitis ciliata* on the slopes of Isolated Hill.

4b Mountain Beech-Pahautea Forest

Mountain beech and pahautea dominate an otherwise floristically diverse forest structure. The shrub rohutu is common, along with *Gabnia procera*, *Uncinia rupestris* and *Blechnum procerum* on the forest floor.

This distinctive vegetation is uncommon in the ecological district. It covers the toeslopes of the Mt William Range flanking the Waimangaroa River, and occurs as part of a complex forest-scrub mosaic on the flat forested area east of the Blackburn pakihi. Species composition in the lower tiers is variable, with species such as manuka, *Isolepis aucklandica* and *Carex carsei* present.

Notable species include several sightings of the greatly reduced red mistletoe *Peraxilla tetrapetala* in the upper Waimangaroa valley, and of *Pterostylis irsoniana* and *Grammitis ciliata* in the forest-scrub mosaic west of Mt Berners.

4c Southern Rata-Mountain Beech Forest

Southern rata and mountain beech dominate the canopy with kamahi and quintinia present to a more limited extent. There is only a light cover of mountain neinei, mountain toatoa and weeping mapou in the lower tiers. *Archeria traversii* and pokaka are present at some sites. Mountain beech is absent and manuka present at some disturbed sites on the Stockton plateau.

This vegetation generally occurs at higher altitudes (480-840 m asl) than the other mountain beech groups. It forms the montane forest on the slopes of the Mt William Range and is present in the Mt Rochfort forest altitudinal sequence. Short forest occupies gullies on the upper Stockton plateau.

The uncommon epiphytic filmy ferns *Trichomanes strictum* and *Hymenophyllum lyallii* are present in the taller forest. *Gentiana spenceri* is widespread.

5 Mountain Beech/Yellow Silver Pine-Pink Pine Forest

A stature forest type, canopy attaining 9 metres. Mountain beech dominates the canopy, with yellow silver pine, pink pine and southern rata. These species along with quintinia, kamahi, inanga, manuka and mountain toatoa are prominent throughout the lower tiers. Mingimingi, *Pittosporum rigidum* and *Gabnia procera* are common in the understorey.

This forest association forms an upper belt on the coastal bedrock slopes in the west of the ecological district. It is part of the upland forest in the Mt Rochfort sequence and on the other coal measures coastal slopes. In the forested gullies on the lower Stockton plateau, yellow silver pine with mountain beech are prominent in the canopy. In the southern half of the ecological district pink pine with mountain beech is prominent in the midslope belt of the forested gullies. There, the forest grades into taller southern rata-mountain beech down slope while on upper gully slopes stunted forms grade into manuka scrub (group 8).

Hymenophyllum armstrongii, uncommon in the district, is sometimes present in this community. There are a variety of orchids (*Aporostylis bifolia*, *Corybas acuminatis*, *C. oblongus*, *Pterostylis banksii*, *P. venosa*, and *Thelymitra pulchella*) which are uncommon elsewhere in the ecological district. *Gentiana spenceri* is present.

6 Mountain Beech-Silver Beech Forest and Shrubland

Mountain beech and/or silver beech form a mixed canopy with pink pine and mountain neinei. The dense understorey is dominated by a mixture of *Pseudopanax linearis*, manuka, and the shrubs *Coprosma pseudocuneata*, *C. colensoi*, stinkwood, weeping mapou, *Pittosporum rigidum*, inanga and mountain toatoa. Mountain flax, *Astelia* sp. (aff. *A. nervosa*), *Gabnia procera* and the herbaceous lantern berry are present on the forest floor.

This is the shortest stature beech forest community, with a canopy rarely over 7 metres high. It is distinguished from the other mountain beech associations by the number of high altitude species, such as mountain flax, *Pseudopanax linearis*, *Pittosporum rigidum*, *Coprosma pseudocuneata* and occasionally leatherwood. The importance of shrubs reflects its high altitude distribution (580-980 m asl) and its close association with scrub and shrub communities.

Mountain beech-silver beech low forest forms extensive communities on the western slopes of Mt William and is part of the upland forest in the Mt Rochfort altitudinal sequence. This community also occupies the steep forested gully systems on the upper Denniston and Stockton plateaux.

Pseudowintera traversii is confined largely to this community.

7 Leatherwood Scrub

This vegetation is dominated by leatherwood, mountain flax and *Brachyglottis rotundifolia*, together with silver beech, inanga, *Coprosma* aff. *parviflora*, *Pseudopanax colensoi* and *Chionochloa flavescens* ssp. *lupeola*. The subcanopy and ground layers comprise mainly *Dracophyllum uniflorum*, *Astelia* sp. (aff. *A. nervosa*), *Schoenus pauciflorus*, broadleaved snowtussock and *Forstera mackayi*.

Leatherwood scrub forms the subalpine scrub belt on the peak of Mt Rochfort on the southern end of the Denniston plateau. It occurs on the steep scarps on the east of the peak and on the more gentle sloping north and west faces. It also occurs to a limited extent on Mts William, Frederick and Augustus.

Within this association there are a number of species that are uncommon elsewhere in the ecological district, including the monocotyledons

Rytidosperma setifolia, *Poa colensoi* and *Schoenus pauciflorus*, and shrubs *Coprosma crenulata*, *Coprosma* aff. *colensoi* and the filiform inanga variant. On the shale surface of the Mt Rochfort scarp shoulder are species such as *Raoulia grandiflora*, *Celmisia incana*, *Gentiana* sp. (*G.* aff. *montana*), *Kelleria dieffenbachii*, *Deyeuxia avenoides* and *Hymenophyllum* & *villosum*. Broadleaved snowtussock is restricted to this community.

8 [Mountain Beech]/Manuka Scrub

Mountain beech is occasionally emergent over a low (2-4 m height) manuka canopy, also containing toatoa and mountain beech. There is a mixture of other shrub species such as mountain flax, inanga, pink pine, leatherwood, yellow silver pine and rohotu. The undergrowth is dominated by *Gabnia procera* and wire rush.

This vegetation occupies gullies and fault scarps on the Stockton plateau. In the north of the plateau it is interspersed with areas of group 13. It also forms part of the Blackburn-Mt Berners forest scrub mosaic with groups 4b and 5. Within this mosaic, it contains a number of species not found elsewhere within the ecological district: *Carex carsei*, *C. coriacea*, *C. echinata*, and *Juncus pusillus*.

9 Pink Pine - Chionochloa juncea - Manuka Tussock-Shrubland

A low community (less than 1 metre in height) in which pink pine, with *Chionochloa juncea* and low growing manuka and mountain flax provide an open cover over a diverse range of species. *C. rubra* ssp. *occulta* replaces *C. juncea* at some higher altitude sites. The lower tiers are dominated by *Brachyglottis* cf. *bellidtoides*, carpet grass, *Carphe alpina*, *Celmisia dubia*, *Dracophyllum politum*, *Drosera spathulata*, *Forstera mackayi*, *Pentachondra pumila*, and wire rush.

This vegetation association occupies high altitude sites (740-1106 m) on the sandstone pavement slopes of the Stockton plateau. The range of alpine and subalpine herbs present reflects the association's altitudinal distribution. The peak of Mt Frederick is particularly rich in these species: for example, *Abrotanella linearis*, *Aporostylis bifolia*, *Celmisia lateralis*, *Celmisia sessiliflora*, *Cyathodes dealbata*, *Gentiana townsonii*, *Herpolirion novae-zelandiae*, *Kelleria dieffenbachii*, *Luzula colensoi*, *Lyperanthus antarcticus*, *Microlaena thomsonii*, and *Raoulia grandiflora*.

10 Manuka-Dracophyllum politum/Wire Rush Rush-Shrubland

A low community with variable shrub cover dominated by prostrate manuka and *Dracophyllum politum*. Other cover species include wire rush, carpet grass *Celmisia dubia* and *Drosera spathulata*. The tussocks *Chionochloa juncea*, *C. australis* and *C. rubra* ssp. *occulta* occur in varying degrees of abundance. *Oreobolus strictus*, *Donatia novae-zelandiae* and *Lycopodium laterale* are characteristic of some sites.

This is the most frequent community on the Stockton plateau. *Chionochloa juncea* is a common component on the gentle northern slopes of Mt Augustus.

and nearby on the upper Stockton plateau. It also occurs on the lower eastern slopes of Mt Frederick. *Chionochloa australis* is abundant on the Tiger pakihi, the northern end of the Mt William Range and some areas in the northern half of the Stockton plateau. Red tussock-dominated areas occur on the upper slopes of Mts Frederick and Augustus.

Exocarpus bidwillii is present within this community below Mts Frederick and Augustus.

11 [Manuka]/Wire Rush-Chionochloa juncea Tussock-Rusbland

Prostrate manuka provides open shrub cover over *Chionochloa juncea*, wire rush, cushion plant, *Carphe alpina* s.s., *Celmisia dubia*, *Lycopodium laterale*, and *Oreobolus strictus*.

This association differs from group 10 by having generally denser cover, greater dominance of *Chionochloa juncea* and *C. australis*, and less cover of *Dracophyllum politum*. There are also a number of other species which are not generally found in the previous group. These include *Dracophyllum palustre*, the hybrid yellow silver pine $\times$ pigmy pine and a range of species commonly associated with montane and subalpine bogs and seepage areas (e.g., *Utricularia novae-zelandiae*, combfern, *Drosera arcturi*, *Celmisia alpina*, *Liparophyllum gunnii* and the monocotyledonous *Microlaena thomsonii*, *Oreobolus pectinatus*, *Centrolepis ciliata*, *Gaimardia setacea*, *Herpolirion novae-zelandiae* and *Astelia subulata*. The orchids *Thelymitra venosa* and *Prasophyllum colensoi* are present.

This vegetation association occupies the upper slopes of the Denniston plateau where it is interspersed with large coarse sandstone pavements in some areas. It dominates the lower slopes of the Denniston plateau and the ridgeline of the Mt William Range, and is also present on parts of the tussock slopes on Mt William and in limited areas on the slopes of Mt Frederick. Altitudinal range is 520-1020 m asl, and landforms are characteristically flat with poor drainage.

12 [Manuka]/Wire Rush-Tanglefern Shrub-Rusbland

Stunted manuka with mountain flax and *Gabnia rigida* form an open canopy over a dense cover of wire rush and tanglefern.

This vegetation association occupies generally lower altitude sites than the other open communities. It dominates an extensive area in the north of the Stockton plateau and also occurs at the northern end of the Mt William Range.

It is a variable association. A taller variant forms mosaics with southern rata-mountain beech and mountain beech/podocarp forest on the western edge of the Denniston plateau. On the Tiger pakihi, tumingi forms low shrubland over *Baumea teretifolia*, wire rush and parasol fern.

This is the only association where tumingi and *Gabnia rigida* are physiognomically conspicuous species.

13 *Baumea teretifolia*-*Rytidosperma gracile*/Tanglefern Rusbland

Baumea teretifolia, *Rytidosperma gracile* and tanglefern dominate this dense association. *Celmisia dubia*, *Drosera spatulata*, *Gonocarpus micranthus*, *Lycopodium laterale*, and *Thelymitra venosa* are prominent.

This community, with red tussock, inhabits the highly modified Blackburn Pakihi. There are varying levels of other prominent species: for example, *Lepidosperma australe*, *Juncus canadensis* and bracken. Other species of interest include *Carex carsei*, *Centrolepis ciliata*, *Drosera binata*, *Euphrasia disperma*, *Gaimardia setacea*, *Isolepis aucklandica*, *Nertera scapanioides*, and *Schoenus maschalinus*.

Baumea teretifolia, bracken and tanglefern dominate extensive areas of the community recently disturbed by fire at the northern end of the Stockton plateau. Similar vegetation, without red tussock, occurs on the terrace and fan slopes of Birchfield Pakihi on the western margin of the ecological district.

The uncommon bearded orchid was found within this community as well as *Nertera scapanioides* and *Schoenus maschalinus*.

14 Red Tussock-Bog Pine Shrub-Tussockland

A tall grassland community dominated by red tussock with some wire rush, manuka, tanglefern and *Carpina alpina* s.s.. Bog pine, *Dracophyllum palustre*, *Hebe canterburiensis* and other shrubs occur scattered throughout but particularly on the margins and along rivulets.

This distinctive association occurs on alluvial and colluvial flats on the peaty, frosty margins of the upper Waimangaroa River. The largest and most distinctive site is the Happy Valley on the eastern edge of the Stockton plateau. A sphagnum moss flush on the southwest margin, and the rivulet and forest margins, were particularly species-rich sites; thirteen species at these sites are not known to occur elsewhere in the ecological district (section 2.6).

APPENDIX V LIST OF VASCULAR PLANT SPECIES RECORDED IN NGAKAWAU ECOLOGICAL DISTRICT

All indigenous, naturalised exotic and hybrid plant species known to occur in the Ngakawau ED are listed below. This list has been compiled from unpublished lists prepared by Druce (1990b, 1990c), Kelly (in prep.), Newell (1990), Regnier (1986) and this survey (including unpublished species lists of D.A. Norton, S.P. Courtney and F.B. Overmars), and several published references. Also noted are which, if any, of Druce's lists they are recorded upon, and distribution notes (from this survey unless otherwise indicated). Voucher numbers for specimens deposited in the University of Canterbury herbarium (CANU) are indicated after species names where appropriate.

Site Location and Other Abbreviations

D=	Denniston Plateau	S=	Stockton Plateau
N=	Ngakawau Gorge	C=	Cypress Stm Red Tussockland
B=	Blackburn Pakihi	T=	Tiger Pakihi
Mt A=	Mt Augustus	Mt B=	Mt Berners
Mt F=	Mt Frederick	Mt FF=	Mt Frederick Forest
Mt R=	Mt Rochfort	Mt RF=	Mt Rochfort Forest (Newell 1990)
Mt W=	Mt William	Mt WR=	Mt William Range
DSR=	Denniston Scenic Reserve		
NRR=	Ngakawau-Hector Recreation Reserve		
NSR=	Ngakawau Scenic Reserve		
SSR=	Stockton Scenic Reserve		
TK=	Te Kuha (proposed coal mine site and access route)		
+	species recorded by others but not found by the PNA survey and associated work.		
aff. =	has affinities to		
agg.=	an aggregate of species		
c.f. =	compare with		
s.s.=	<i>sensu stricto</i> , in the narrow sense		
<i>sensu</i> =	in the sense of		
sp. =	species		
ssp.=	subspecies		
syn. =	synonymous with		
var. =	variety		
x=	hybrid between two species		
" "	tag name		

BOTANICAL NAME	DRUCE LISTS	DISTRIBUTION NOTES
INDIGENOUS		
<i>Abrotanella linearis</i>	D, S	forest and scrub, moist, D, S, C, Mt W, Mt A, TK
<i>Acaena anserinifolia</i>	N	TK; DSR, NRR, NSR
<i>Acianthus sinclairii</i>		+, DSR
<i>Acianthus viridis</i>		uncommon in scrub, D
<i>Aciphylla anomal</i>		Glasgow Range (June 1997)
<i>Aciphylla hectori</i>		Glasgow Range (June 1997)
<i>Aciphylla indurata</i>		Glasgow Range (June 1997)
<i>Actinotus novae-zelandiae</i>	D, S	seepages, tussockland, D, S, C, T, Mt W, Mt A, TK; DSR
<i>Adiantum cunninghamii</i>	N	+
<i>Agrostis dyeri</i> (CANU 35847)	D	roadside, Mt R, Mt W
<i>Agrostis personata</i>	D, S, N	riparian, Waimangaroa River
<i>Alseuosmia pusilla</i>		+, DSR
<i>Anaphalis keriensis</i>	N	+
<i>Anaphalis trinervis</i>		
<i>Androstoma empetrifolia</i> (syn. <i>Cyathodes empetrifolia</i>)	D, S	common scrub and tussockland, D, S, C, TK, uncommon rushland Mt W, shrubland Mt B; DSR
<i>Anisotome aromatica</i> (CANU 32524)	D, S	tussock herbfield, upper D, upper S, C, Mt W, Mt A; DSR
<i>Anisotome flexuosa</i>		S
<i>Anisotome haastii</i> (CANU 35170)	D	Mt W, Mt R
<i>Aporostylis bifolia</i>	D, S, N	tussockland, upper D, upper S, C, forest B, T, Mt W, TK; DSR
<i>Archeria traversii</i> (CANU 32510)	D, S, N	scrub and montane to subalpine forest, D, S, Mt W, T, TK; DSR
<i>Aristotelia serrata</i>	N	TK; DSR, NRR, NSR
<i>Arthropodium candidum</i>	N	+
<i>Arthropteris tenella</i>		epiphytic fern in coastal slope forest near Granity
<i>Ascarina lucida</i> (CANU 31921)		TK; Mt RF, DSR,
<i>Asplenium bulbiferum</i> ssp. <i>bulbiferum</i>	N	disturbed floor, Mt F, TK; DSR, NRR, NSR
<i>Asplenium flaccidum</i> (CANU 32522)	N	common forest epiphyte throughout; DSR, NRR, NSR
<i>Asplenium polyodon</i>	N	TK; DSR, NRR, NSR
<i>Astelia fragrans</i>	N	uncommon, forest, Mt WR, D, Mt FF near Britannia mine, TK; DSR, NSR
<i>Astelia grandis</i>	N	uncommon, forest; DSR, NSR, SSR
<i>Astelia linearis</i> (CANU 32527)	D, S	boggy tussockland, herbfield, D, S, C, B, T, Mt W, TK; DSR
<i>Astelia solandri</i>	N	forest epiphyte, D, TK; DSR, NRR, NSR
<i>Astelia</i> sp. (A. aff. <i>nervosa</i> bronze leaf back)		forest, shrubland, Waimangaroa River
<i>Astelia</i> sp. (A. aff. <i>nervosa</i> leaves broad-)		Mt WR, S, TK, Waimangaroa River
<i>Astelia</i> sp. (A. <i>nivicola</i> var. <i>moriceae</i>)	N	forest, scrub, tussockland, D, S, Mt WR, Cedar Stm
<i>Astelia subulata</i>	D, S	rushland, cushion bogs, D, S, Mt W
<i>Astelia trinervia</i>		+, Mt RF, DSR
<i>Baumea rubiginosa</i>	S, N	uncommon
<i>Baumea tenax</i>	N	uncommon, open manuka shrubland Mt W, Mt B, TK; DSR, SSR
<i>Baumea teretifolia</i>	N	common, often dominates boggy sedgeland and areas previously burnt, C, D, S, B, TK; DSR, NSR, SSR
<i>Blechnum chambersii</i>	N	forest hillslopes, Orowaiti catchment, TK, uncommon, creek banks, swampy forest, shrubland on Mt B; DSR, NRR, NSR
<i>Blechnum colensoi</i>	N	TK
<i>Blechnum discolor</i>	D, S, N	common in montane forest, D, S, Mt W, Mt B, TK; DSR, NRR, NSR
<i>Blechnum fluviatile</i> agg.	D, S, N	steep hillslope forest, stony ground, throughout; DSR, NRR
<i>Blechnum fraseri</i>		TK, DSR
<i>Blechnum membranaceum</i>		TK
<i>Blechnum minus</i>	D, S, N	forest, D, S, TK; DSR, NSR, SSR
<i>Blechnum nigrum</i>		Mt FF, steep hillslope forest on rocky bank; DSR
<i>Blechnum penna-marina</i>	D, N	Mt R, B, C
<i>Blechnum procerum</i> (CANU 32488)	D, S, N	common, forest, D, S, Mt B, Mt W, TK, burnt sedgeland, B
<i>Blechnum procerum</i> x <i>B.</i> sp. 1		forest, Waimangaroa River
<i>Blechnum</i> sp. 1 (kiokio) (CANU 32514)	D, S, N	forest, Waimangaroa River, B, TK; DSR, NRR, NSR, SSR
<i>Blechnum</i> sp. 2 (mountain kiokio)	D	forest B, D, S
<i>Blechnum vulcanicum</i> (CANU 32516)	D, N	S; DSR, NSR
<i>Brachyglottis bidwillii</i>		+, DSR
<i>Brachyglottis repanda</i>	N	coastal hillslopes, broadleaf forest; NSR
<i>Brachyglottis rotundifolia</i> (<i>B. bennettii</i> <i>sensu</i> Allan 1961)	D, S	shrubland, upper D, upper S, Mt W
<i>Brachyglottis</i> sp. (unnamed <i>Senecio bellidioides</i> var. <i>crassus</i> <i>sensu</i> Allan 1961) (CANU 32525)	N	herbfield, tussockland, upper D, upper S, Mt W, Mt A, TK, also burnt sedgeland B; DSR
<i>Bulbinella modesta</i>	SN	disturbed open vegetation, S, B; SSR
<i>Bulbophyllum pygmaeum</i>		+, DSR
<i>Caladenia catenata</i>	N	+, DSR
<i>Calochilus paludosus</i>	D	Mt F, Rome Stm, manuka scrub previously burnt
<i>Cardamine debilis</i> agg.	N	hillslope forest, Waimangaroa River, TK
<i>Carex acicularis</i>	S	Mt F, tussockland
<i>Carex carsei</i>		limited distribution, disturbed boggy rushland, previously burnt B, manuka shrubland Mt B

BOTANICAL NAME	DRUCE LISTS	DISTRIBUTION NOTES
<i>Carex cockayneana</i>	D	+
<i>Carex comans</i>		TK
<i>Carex coriacea</i>	D	limited distribution, tall dense manuka shrubland, Mt B
<i>Carex dallii</i>	D	limited distribution, tussockland, upper S, dense manuka shrubland, B, C
<i>Carex dissita</i>	N	manuka scrub, seepages and pink pine - mtn beech forest, Mt B, D, TK
<i>Carex echinata</i>		limited distribution, seepage in tall manuka shrubland, Mt B
<i>Carex gaudichaudiana</i>		C
<i>Carex geminata</i>	N	limited distribution, disturbed sedgeland, B, TK; DSR
<i>Carex lessoniana</i>		+, NRR, NSR, SSR
<i>Carex libera</i>	S	tussockland, Mt F
<i>Carex secta</i>		TK
<i>Carex sinclairii</i>	N	boggy manuka scrub, upper S, D
<i>Carex virgata</i>	N	+, NRR
<i>Carmichaelia odorata</i>	N	+
<i>Carpha alpina</i> s.s. (CANU 32504)	S	common in tussockland, upper D, upper S, Mt W, TK, C; DSR
<i>Carpha</i> sp. (unnamed - slender form)	D, S	uncommon, D, S
<i>Carpodetus serratus</i>	N	uncommon, steep montane hill forest, Mt B; DSR, NRR, NSR
<i>Cassinia leptophylla</i> (C. <i>vauvilliersii</i> <i>sensu</i> Allan 1961)	D, S	roadsides, other disturbed sites, D, S, tussockland, C
<i>Celmisia alpina</i>	S	herbfield, tussockland, upper S, upper D, uncommon Mt W, C; DSR
<i>Celmisia armstrongii</i>		Glasgow Range (Jane 1997)
<i>Celmisia dallii</i>	D, S	common upper S, Mt A, Denniston SR RAP; DSR
<i>Celmisia dubia</i> (CANU 32526)	D, S, N	common, upper D, S, C, Mt W, B, T, TK; DSR, SSR
<i>Celmisia incana</i>	S	limited distribution, tussockland Mt R, Mt F, Mt A
<i>Celmisia lateralis</i>	D, S	uncommon, Mt R, common, Mt F, riparian, Waimangaroa River
<i>Celmisia monroi</i> $\times$ <i>similis</i> (CANU 35174)	Mt F	
<i>Celmisia morganii</i> (CANU 35193)		Ngakawau Gorge
<i>Celmisia parva</i>	D	Mt F
<i>Celmisia setacea</i>		C
<i>Celmisia similis</i> (CANU 33736)	D, S	limited distribution, Mt R, Mt F (common), Mt W (rare)
<i>Celmisia</i> sp. (aff. <i>C. gracilentia</i> - rhizomatous)	D, S, N	seepages and rushland, C, D, S, B, T
<i>Celmisia</i> sp. (aff. <i>C. gracilentia</i> - tufted)	D	open scrub, rushland B, D, Mt W;
<i>Centella uniflora</i>	D, N	common rushland D, TK, previously burnt B; DSR, NRR, NSR, SSR
<i>Centrolepis ciliata</i> (CANU 32528)	D	seepages, boggy herbfield, rushland D, S, C, B, T, TK; DSR
<i>Chiloglottis cornuta</i>	D, N	common in places on forest floor Mt B
<i>Chionochoa australis</i>	D, S	forms swards in herbfield, tussockland, upper D, upper S, Mt W, Mt A, T, TK; DSR
<i>Chionochoa conspicua</i> ssp. <i>conspicua</i>	N	tracks, roadsides, creek margins, Mt W, D, S
<i>Chionochoa flavescens</i> ssp. <i>lupeola</i>	D, S	limited distribution, scarps, Mt F, Mt R, Mt A, Mt W (1 plant), riparian Waimangaroa River
<i>Chionochoa juncea</i> (CANU 35422)	D, S	common, tussockland, D, S, Mt W; DSR
<i>Chionochoa rubra</i> ssp. <i>occulta</i> (CANU 35443)	D, S	common, C, upper D, S, B, T, Mt W
<i>Clematis paniculata</i>	N	TK; Mt RF, NRR
<i>Collospermum hastatum</i>	N	+, NRR, NSR
<i>Colobanthus affinis</i>		C
<i>Colobanthus apetalous</i>		flush, upper grassland, C
<i>Coprosma</i> aff. <i>colensoi</i> (creeping)	D, S	scrub, upper S, Mt W, shrubland Mt R
<i>Coprosma</i> aff. <i>intertexta</i> (CANU 35183, 35184)		uncommon, streamside, C
<i>Coprosma</i> aff. <i>parviflora</i> (<i>Coprosma</i> "paludosa")	D, N	scrub, D, S, tussockland, C
<i>Coprosma areolata</i>		TK
<i>Coprosma cheesemani</i> (CANU 35472)	D	uncommon forest, D, streamside C, Mt W
<i>Coprosma ciliata</i>	D	uncommon forest, Mt WR
<i>Coprosma colensoi</i> (including <i>C. banksii</i>) (CANU 32498)	D, S	montane forest, D, Waimangaroa River, Mt W, TK; D, SR
<i>Coprosma crenulata</i> (CANU 35187)	D, S	uncommon, shrubland Mt R, Mt W, upper S, Mt F, TK
<i>Coprosma foetidissima</i> (CANU 32533)	D, S, N	common in forest, scrub, D, S, T, Mt W, Mt B, TK; DSR, NRR, NSR, SSR
<i>Coprosma grandifolia</i>	N	coastal hill slopes, Mt FF, TK; Mt RF, DSR, NRR, NSR, SSR
<i>Coprosma linariifolia</i>		TK
<i>Coprosma lucida</i>	N	forest; DSR, NRR, NSR, SSR
<i>Coprosma parviflora</i> var. <i>dumosa</i> (of Cheeseman 1926)	S	forest, S, D, B, Mt W, TK
<i>Coprosma propinqua</i>	N	forest; NRR
<i>Coprosma propinqua</i> $\times$ <i>robusta</i>	N	
<i>Coprosma propinqua</i> $\times$ <i>rugosa</i>	N	
<i>Coprosma pseudocuneata</i>	D, S	montane to subalpine forest, uncommon, Mt W, T, wider distribution Mt B; DSR
<i>Coprosma rhamnoides</i>	N	uncommon forest, Waimangaroa, Mt B, TK; DSR
<i>Coprosma robusta</i>	N	TK; DSR, NRR, NSR
<i>Coprosma rotundifolia</i>		TK
<i>Coprosma rugosa</i>	N	+

BOTANICAL NAME	DRUCE LISTS	DISTRIBUTION NOTES
<i>Coprosma tenuicaulis</i>	N	B, TK
<i>Cordyline australis</i>	SN	Cedar Stm, TK; DSR, NRR, NSR, SSR
<i>Cordyline banksii</i>	N	roadside, Cedar Ck, TK; DSR, NRR, NSR, SSR
<i>Cordyline indivisa</i>	D, S	uncommon track edge Mt W, TK; DSR
<i>Coriaria arborea</i>	N	Summerlea Bush, TK; DSR, NRR, NSR
<i>Coriaria sarmentosa</i>	N	+
<i>Cortaderia richardii</i> (CANU 31942)	D, S, N	road edges, D, S, riparian Waimangaroa River; DSR, NRR, NSR, SSR
<i>Corybas acuminatis</i>	N	limited distribution in forest, scrub, Mt B, TK
<i>Corybas macranthus</i>		flush, upper grassland, C
<i>Corybas oblongus</i>	N	limited distribution in forest, scrub, D, Mt B, Mt W; NSR
<i>Corybas rivularis</i>		tussockland, C
<i>Corybas trilobus</i>		tussockland, C
<i>Craspedia</i> sp. (unnamed - "long-hairs")		uncommon, shrubland, Mt W, Mt F, Hut Stream, common, C
<i>Crassula</i> sp.		upper grassland, C
<i>Ctenopteris heterophylla</i>	N	epiphytic in forest, D, S, TK, Mt W, B; DSR
<i>Cyathea colensoi</i>	N	montane forest, Waimangaroa River, Mt WR, Mt FF, Orowaiti River, TK, B, Mt B; DSR, SSR
<i>Cyathea medullaris</i>	N	steep hillslope, coastal forest, Mt FF, TK; DSR, NRR, NSR
<i>Cyathea smithii</i>	N	coastal hillslope forest, TK, Mt FF, Mt B; DSR, NRR, NSR, SSR
<i>Cyathodes dealbata</i> (syn. <i>C. pumila</i>)	D, S	uncommon, Mt R, upper S, Mt W, TK
<i>Cyathodes juniperina</i> agg. (CANU 32529)	D	common, forest, scrub, shrubland, D, S, Mt B, Mt W, TK, B, T; DSR, SSR
<i>Cyperus ustulatus</i>		+, NRR
<i>Dacrycarpus dacrydioides</i>	N	limited distribution, S, riverflats Mt FF, tall forest shrubland Mt B, TK; DSR, NRR, NSR
<i>Dacrydium cupressinum</i>	D, S, N	common in forest, D, S, Mt W, Mt B, TK, T; DSR, NRR, NSR, SSR
<i>Dendrobium cunninghamii</i>		epiphytic in forest, D, S, Mt B, TK; DSR, NRR, SSR
<i>Deyeuxia aucklandica</i>	D, S	common, Mt F
<i>Deyeuxia avenoides</i>	D, S	uncommon, scarp face Mt R
<i>Dianella nigra</i>	D, S, N	forest, Mt W, D, S, Mt B, TK, rushland previously burnt S, B; DSR, NRR, NSR, DSR
<i>Dichelachne crinita</i>	N	+
<i>Dichondra</i> sp.	N	+
<i>Dicksonia lanata</i>	N	forest, limited distribution, Isolated Hill, lower Ngakawau Gorge, TK
<i>Dicksonia squarrosa</i> (CANU 31922)	D, S, N	forest, limited distribution, D, T, TK; DSR, NRR, NSR, SSR
<i>Donatia novae-zelandiae</i> (CANU 32502)	D, S	herbfield, cushion bogs, tussockland, C, D, S, Mt W, B, T, TK; DSR
<i>Dracophyllum longifolium</i> var. "filifolium" (syn. <i>D. oliveri</i>) (CANU 32515)	D, S	forest remnants, upper D, Waimangaroa River, Mt W; DSR, NSR, SSR
<i>Dracophyllum longifolium</i> var. <i>longifolium</i>	N	montane, subalpine forest, D, S, Mt W, B, Mt B, TK
<i>Dracophyllum longifolium</i> x <i>politum</i>		TK
<i>Dracophyllum palustre</i> (CANU 32500)	D, S	scrub, open shrubland & boggy pink pine - mtn beech forest, S, B, Mt W, C
<i>Dracophyllum politum</i> (including <i>D. densum</i>)	D, S	common, tussockland, D, S, Mt W, T, TK; DSR
<i>Dracophyllum pubescens</i> (CANU 35169)	D, S	common on cliffs, Mt F, Mt A, Mt W, DSR extension RAP; DSR
<i>Dracophyllum townsonii</i>		Ngakawau-Hector (Eagle 1982)
<i>Dracophyllum traversii</i>	D, N	common, montane forest, scrub, D, S, Mt W, B, Mt B, TK; DSR, SSR
<i>Dracophyllum uniflorum</i>	D, S	shrub tussockland, D, S, Mt W, TK; DSR
<i>Drosera arcturi</i>	D, S	cushion bogs, S, C, Mt R, Mt F
<i>Drosera binata</i>	D	uncommon, bogs, S, D, B; DSR
<i>Drosera spathulata</i> (CANU 32506)	D, S, N	boggy scrub, tussock sedgeland, common, B, D, S, T, Mt W, TK; DSR, NSR, SSR
<i>Drosera stenopetala</i>	D, S	boggy scrub, tussock sedgeland, uncommon, D, S, TK; DSR
<i>Earina autumnalis</i>	N	forest epiphyte, Orowaiti River, Mt W, Mt B, D, TK; DSR, NRR, NSR, SSR
<i>Earina mucronata</i>		forest epiphyte, Orowaiti River, TK, coastal hillslope Mt R, Mt B; Granity; DSR
<i>Elaeocarpus dentatus</i>	N	+, DSR, NRR, NSR
<i>Elaeocarpus hookerianus</i>	D, S	scrub and forest, D, S, Mt B, T, Mt W, TK; DSR, SSR
<i>Eleocharis acuta</i>		TK
<i>Eleocharis gracilis</i>	N	C
<i>Empodisma minus</i> (CANU 32541)	D, S	very common, scrub, rushland, sedgeland, tussockland, D, S, B, C, T, B, Mt W, Mt B, TK; DSR, NSR, SSR
<i>Epacris alpina</i> (CANU 32501)	D, S	tussockland, upper D, S, Mt W, TK; DSR
<i>Epacris pauciflora</i>	D, S	tussockland, shrubland, B, D, Mt W, T, TK; DSR, NSR, SSR
<i>Epilobium brunnescens</i>	D	C, TK
<i>Epilobium glabellum</i>	D	+
<i>Epilobium linnaeoides</i>	D	+
<i>Epilobium pernitens</i>	D, S	stony ground, road banks, D, Mt F, Mt R
<i>Epilobium pubens</i>	N	+
<i>Epilobium rotundifolium</i>	N	+

BOTANICAL NAME	DRUCE LISTS	DISTRIBUTION NOTES
<i>Epilobium</i> sp. (unnamed <i>E. brunescens</i> ssp. <i>minutiflorum</i>)	N	+
<i>Euphrasia cuneata</i>		TK
<i>Euphrasia disperma</i>	D	cushion bogs, herbfields, sedgeland, D, upper S, uncommon B, C; DSR
<i>Euphrasia townsonii</i>	D, S	tussockland herbfields, upper D, S
<i>Exocarpus bidwillii</i> (CANU 35176)	D, S	uncommon, shrub tussockland, upper S, Mt F, Mt A, Mt W, TK
<i>Forstera mackayi</i> (CANU 32505)	D, S	herbfield, tussockland, scrub, upper D, S, Mt W, T; DSR
<i>Forstera tenella</i>		stream side, Waimangaroa River
<i>Freycinetiabaueriana</i> ssp. <i>banksii</i>	N	extensive in low altitude coastal hill forest, Mt R, TK; DSR, NRR, NSR
<i>Fuchsia excorticata</i>	N	TK; DSR, NRR, NSR
<i>Gahnia pauciflora</i>		toe slope mtn beech-manuka scrub Mt W, TK; Mt RF, NSR
<i>Gahnia procera</i> (CANU 32531)	D, S, N	common in forest, scrub, tussockland, D, S, B, Mt W, Mt B, TK; DSR, NSR, SSR
<i>Gahnia rigida</i> (CANU 31945)	D, S	sedgeland, tussockland, S, Mt WR, Mt W, B, T, TK; DSR, NSR, SSR
<i>Gahnia setifolia</i>	N	forest, upper S, upper D, Mt W, TK
<i>Gahnia xanthocarpa</i>	N	boggy forest, S, TK; Mt RF, DSR, NRR, NSR, SSR
<i>Gaimardia setacea</i>	D, S	cushion bogs, sedgeland, tussockland, D, B, Mt W, T, Waimangaroa River
<i>Gastrodia cunninghamii</i> (CANU 35167)	D, N	Ngakawau River
<i>Gaultheria antipoda</i>	D, S, N	scrub, D, S, Mt W, B, Mt B, TK; DSR, NSR
<i>Gaultheria antipoda depressa</i> var. <i>novae-zelandiae</i> x		S
<i>Gaultheria depressa</i> var. <i>novae-zelandiae</i>	D, S	herbfield, tussockland, D, S, Mt W; DSR, SSR
<i>Gaultheria macrostigma</i> (CANU 35259)		forest and upper grassland, C
<i>Gaultheria rupestris</i> (CANU 32485)	D, S, N	shrubland, S (common on old over-burden); DSR
<i>Gaultheria</i> sp. x <i>G. macrostigma</i>	N	
<i>Gentiana gracilifolia</i> (including <i>G. vernicosa</i>)	S	tussockland, Mt R
<i>Gentiana grisebachii</i>		TK
<i>Gentiana montana</i>	D, S	tussockland, D, Mt W
<i>Gentiana</i> sp. (aff. <i>G. bellidifolia</i>)	S	+
<i>Gentiana</i> sp. (aff. <i>G. montana</i>)	D, S	tussockland, Mt R
<i>Gentiana spenceri</i>	D, S	forest, D, S, T, Mt W, TK; DSR
<i>Gentiana townsonii</i> (CANU 32542)	D, S	tussockland, sedgeland, upper D, upper S, B, Mt W, TK; DSR
<i>Geum uniflorum</i> (CANU 35260)		uncommon, bluffs, Mt F
<i>Gleichenia dicarpa</i>	D, S, N	common, rushland, shrubland, D, S, C, Mt W, B, T, TK; DSR, NSR, SSR
<i>Gleichenia microphylla</i>	N	common in shrubland D, Mt W, Mt WR, T, TK; SSR
<i>Gnaphalium audax</i>	N	Birchfield Pakihi, Mt R
<i>Gnaphalium</i> sp. (aff. <i>G. limosum</i>)	N	limited distribution, burnt sedgeland, B
<i>Gnaphalium sphaericum</i>		TK
<i>Gonocarpus aggregatus</i>		limited distribution, burnt sedgeland, B, C
<i>Gonocarpus micranthus</i>	D	rushland, sedgeland, seepages, streamsides, C, D, S, B; DSR, NSR
<i>Grammitis billardieri</i>	D, S, N	common in forest, D, S, Mt B, T, Mt W, TK; DSR, NRR, NSR, SSR
<i>Grammitis ciliata</i>	N	forest epiphyte, limited distribution, Orowaiti River, Mt W, Isolated Hill; DSR
<i>Grammitis givenii</i> (CANU 33897)		uncommon, Mt F, Mt W, Mt R
<i>Grammitis magellanica</i> spp. <i>nothofageti</i>	N	Mt R
<i>Grammitis poeppigiana</i>	S	rock crevice, Mt R, Mt W
<i>Griselinia littoralis</i>	D, S, N	forest, D, S, Mt W, T, Mt B, B, TK; DSR, NRR, NSR, SSR
<i>Griselinia lucida</i>		TK; Mt RF, DSR, NRR, NSR
<i>Gunnera monoica</i>	N	exposed banks, S, Mt FF, TK; SSR
<i>Halocarpus bidwillii</i> (CANU 35256)	D, S	shrubs tussockland, upper D, upper S, lower and upper C
<i>Halocarpus biformis</i> (CANU 32511)	D, S, N	very common, shrubland, subalpine forest, D, S, Mt W, T, B, Mt B, TK; DSR, SSR
<i>Hebe canterburiensis</i> (CANU 35482)	D, S	widespread, C, forest, Waimangaroa River
<i>Hebe gracillima</i> (CANU 35163, 35186)		creek margins, Waimangaroa River, B, Mt B, Ngakawau River
<i>Hebe mooreae</i>		Mt R, S, Mt WR, tussockland, C
<i>Hebe salicifolia</i>	D, N	S, creek margins, B, Mt B, TK; DSR, NSR
<i>Hedycarya arborea</i>	N	hillslope forest, D, TK; DSR, NRR, NSR
<i>Helichrysum bellidioides</i>	D	roadsides, Mt R, flush, C
<i>Herpolirion novae-zelandiae</i>	D, S	herbfields, tussockland, C, D, S, Mt R, B, Mt W
<i>Hierochloa novae-zelandiae</i>	D, S	uncommon tussockland, Mt R, B, S, C
<i>Histiopteris incisa</i>	D, S, N	disturbed sites, road banks, B, D, S, TK; DSR, NSR, SSR
<i>Hoheria populnea</i>	N	+, DSR
<i>Hydrocotyle microphylla</i>	D, N	flush, upper grassland, C
<i>Hydrocotyle moschata</i>		+, NSR
<i>Hydrocotyle</i> sp. (<i>H. novaezeelandiae</i> var. <i>montana</i>)		C
<i>Hymenophyllum armstrongii</i>	D, N	epiphytic in forest, scrub, D, S, Mt W, Mt B, T; DSR
<i>Hymenophyllum atrovirens</i>		+, DSR
<i>Hymenophyllum bivalve</i>	N	uncommon, Mt FF, Mt B, Mt W often in hard beech forest, TK; DSR, SSR
<i>Hymenophyllum</i> cf. <i>villosum</i>	D, S, N	uncommon forest epiphyte, D, S, Mt W, TK

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<i>Hymenophyllum demissum</i> (CANU 31925)	N	common in forest, epiphyte & terrestrial; DSR, NRR, NSR, SSR
<i>Hymenophyllum dilatatum</i>		forest epiphyte, Orowaiti River, Waimangaroa River, upper D
<i>Hymenophyllum ferrugineum</i>	N	forest epiphyte, Orowaiti River, TK; DSR, NRR
<i>Hymenophyllum flabellatum</i>	D, S, N	forest epiphyte, D, S, Mt W, Mt B, TK; DSR, NRR, NSR
<i>Hymenophyllum lyallii</i>	D, N	forest epiphyte, D, S, Mt R, Mt W, Mt B, TK; DSR, SSR
<i>Hymenophyllum malingii</i> (CANU 32544)	D, N	forest epiphyte, limited distribution, D, Mt B, Waimangaroa River, Webb Stream; Burnetts Face (Ballin 1977)
<i>Hymenophyllum minimum</i>	N	+
<i>Hymenophyllum multifidum</i> (CANU 32530)	D, S, N	common, forest epiphyte & terrestrial, D, S, Mt B, T, B, Mt W, TK; DSR
<i>Hymenophyllum pulcherrimum</i>		forest, Waimangaroa River
<i>Hymenophyllum rarum</i>	D, S, N	uncommon, forest epiphyte, D, S, Mt W; DSR
<i>Hymenophyllum revolutum</i>	N	common, montane forest epiphyte, D, S, Mt W, T, Mt B, TK; DSR, NSR, SSR
<i>Hymenophyllum rufescens</i>	D	uncommon, S, Mt B, Mt W, T, D, TK; DSR
<i>Hymenophyllum sanguinolentum</i>		uncommon forest epiphyte, D, Mt B, TK; DSR, NRR
<i>Hymenophyllum scabrum</i>		gully base forest, Orowaiti River, Mt FF
<i>Hymenophyllum</i> sp. (unnamed - <i>H. aff. flexuosum</i>)	N	forest epiphyte, Orowaiti River hillslopes, TK
<i>Hypericum japonicum</i>	N	+
<i>Hypolepis ambigua</i>		TK; NRR, NSR
<i>Hypolepis distans</i>		+, DSR
<i>Hypolepis rufobarbata</i>	D	forest, D, TK; NSR
<i>Hypsela rivalis</i>	D	uncommon, C, common, B
<i>Isolepis aucklandica</i>	D, S	boggy manuka scrub, seepages, D, S, Mt B, B, C
<i>Isolepis habra</i>	N	+
<i>Isolepis pottsii</i>	N	+
<i>Isolepis prolifer</i>	N	TK
<i>Isolepis reticularis</i>		TK
<i>Isolepis subtilissima</i>	D	C
<i>Jovellana repens</i>	D	TK
<i>Juncus antarcticus</i>	D, S	small swards, road sides, Mt R
<i>Juncus gregiflorus</i>	N	seepage lower D, common C, TK; DSR
<i>Juncus novae-zelandiae</i>		S, Mt WR, TK, C
<i>Juncus pallidus</i>		+, NRR, NSR
<i>Juncus planifolius</i>	D, S, N	disturbed road and track edges, D, B; DSR
<i>Juncus pusillus</i>	S	manuka shrubland seepages, Mt B
<i>Juncus sarophorus</i>		+, SSR
<i>Kelleria dieffenbachii</i> (syn. <i>Drapetes dieffenbachii</i>) (CANU 33737)		herbfield, tussockland, Mt R, upper S, Mt W; DSR
<i>Kelleria laxus</i> (syn. <i>Drapetes laxus</i>)	D	+
<i>Kunzea ericoides</i>		TK
<i>Lachnagrostis lyallii</i> (CANU 35439)		uncommon, disturbed ground, Mt F
<i>Lagenifera pumila</i>	N	TK; NSR
<i>Lagenifera strangulata</i>	N	limited distribution, sedgeland, B
<i>Lastreopsis glabella</i>		gully base forest Orowaiti River, near Britannia mine Mt FF, TK
<i>Lastreopsis hispida</i>	N	lower S, D, uncommon gully base Orowaiti River, Mt FF, TK; DSR, NRR, NSR
<i>Lepidosperma australe</i> (CANU 32507)	D, S	boggy rushland, D, lower S, C, B, TK; DSR
<i>Lepidothamnus intermedius</i>		shrub & scrub & montane forest, D, Mt W, Mt B, B, T, TK; DSR, NSR, SSR
<i>Lepidothamnus intermedius x laxifolius</i>		tussockland upper D, S, Mt W, TK
<i>Lepidothamnus laxifolius</i> (CANU 32543)	D, S	tussockland, D, S, Mt W, TK; DSR
<i>Leptinella</i> sp.	D	+
<i>Leptinella</i> sp. (<i>L. squalida</i> ssp. <i>mediana</i>) (CANU 35263)		flush, upper grassland, C
<i>Leptolepia novae-zelandiae</i>		forest, Orowaiti catchment, TK
<i>Leptopteris hymenophylloides</i>	D, S, N	TK; NSR, SSR
<i>Leptopteris superba</i>	D, S, N	forest, D, S, Mt W, TK, creek margins Mt B; DSR
<i>Leptospermum scoparium</i> (CANU 32499)	D, S, N	common in shrubland, scrub, D, S, Mt B, prostrate in tussockland, D, S, B, C, Mt W, TK; DSR, NSR, SSR
<i>Leucopogon fasciculatus</i>	D, S, N	common in forest and scrub, D, S, Mt W, Mt B, T, TK; DSR, NRR, NSR, SSR
<i>Libertia ixioides</i>		Mt WR, riparian, Waimangaroa River
<i>Libertia pulchella</i>	D, N	common in forest, D, S, Mt W, Mt B, B, T, TK; DSR, SSR
<i>Libocedrus bidwillii</i> (CANU 32545)	D, S, N	uncommon, forest, Mt W, R, D, S, Mt B, TK; DSR
<i>Lindsaea trichomanoides</i>	N	forest, Orowaiti River, TK, Waimangaroa River, D, S, Mt B, Mt W; DSR, NRR, NSR, SSR
<i>Liparophyllum gunnii</i> (CANU 32523)	D, S	boggy herbfields, cushion bogs, C, D, S, Mt W, sedgeland B, T; DSR
<i>Lophomyrtus obcordata</i>		+, DSR
<i>Luzula colensoi</i>	S	tussockland Mt F
<i>Luzula picta</i>	N	+
<i>Luzula</i> sp. (unnamed - included in <i>L. picta</i> as var. <i>limosa</i>)	D, N	C

BOTANICAL NAME	DRUCE LISTS	DISTRIBUTION NOTES
<i>Luzuriaga parviflora</i>	D, S, N	common in forest & scrub, D, S, B, Mt W, Mt B, TK; DSR
<i>Lycopodium australianum</i>	D, S	limited distribution in manuka shrubland, S, Mt B, Mt W, C
<i>Lycopodium cernuum</i>	D	+, NRR, NSR, Millerton, Denniston (David Norton pers. comm.)
<i>Lycopodium deuterodensum</i>		+, Denniston (Druce 1986)
<i>Lycopodium fastigiatum</i>		C, Mt F, Mt W; DSR
<i>Lycopodium laterale</i> (including <i>L. ramulosum</i>)	D, S, N	common in tussockland and sedgeland, C, D, S, B, Mt W, TK; DSR, NSR, SSR
<i>Lycopodium scariosum</i>	D, S, N	Mt R, Mt W, Waimangaroa River, TK, tussockland, C; DSR, NRR, NSR, SSR
<i>Lycopodium varium</i>	D, S	forest & scrub, D, S, B, Mt W, TK; DSR, NSR, SSR
<i>Lycopodium volubile</i> (CANU 32491)	N	uncommon forest, D, S, B, Mt W, TK; DSR, NRR, NSR, SSR
<i>Lyperanthus antarcticus</i>	D, S	common Mt R, Mt F
<i>Macropiper excelsum</i>	N	forest margin, coastal hillslopes; NRR, NSR
<i>Manoa colensoi</i> (syn. <i>Lagarostrobos colensoi</i>)	N	uncommon in forest & scrub, Mt R, upper S, Mt W, Mt B, TK; DSR, SSR
<i>Melicope simplex</i>	N	TK; DSR, SSR
<i>Melicytus alpinus</i>	S	uncommon, S
<i>Melicytus lanceolatus</i>	N	gully base Orowaiti River; DSR, NSR
<i>Melicytus ramiflorus</i> ssp. <i>ramiflorus</i> (CANU 31940)	N	coastal hillslopes, Waimangaroa River; DSR, NRR, NSR
<i>Metrosideros diffusa</i> (CANU 31943)	N	forest liane, Mt FF, coastal hillslopes, Waimangaroa River, Orowaiti River, TK; DSR, NRR, NSR, SSR
<i>Metrosideros fulgens</i>	D, N	forest liane, Mt FF coastal hillslopes, Waimangaroa River, Orowaiti River, TK; DSR, NRR, NSR, SSR
<i>Metrosideros parkinsonii</i> (CANU 35177)	D, S, N	shrub, D, S, Mt F, Mt W, TK; DSR, SSR
<i>Metrosideros perforata</i>	N	forest liane, Mt FF, coastal hillslopes, TK, Waimangaroa River; DSR, NRR, NSR, SSR
<i>Metrosideros robusta</i>	N	coastal hillslopes; NRR, NSR
<i>Metrosideros umbellata</i>	D, S, N	common in scrub, shrubland & forest, D, S, Mt W, Mt B, TK; DSR, NSR, SSR
<i>Microlaena avenacea</i> (CANU 31944)	D, S, N	common in forest, creek margins, D, S, Mt W, TK; DSR, NRR, NSR, SSR
<i>Microlaena colensoi</i>	D, S	Mt R, Mt F, Mt W, tussockland
<i>Microlaena thomsonii</i> (CANU 32533)	D, S	herbfields, S, D, Mt W, Mt A; DSR
<i>Microseris scapigera</i> (CANU 35188)		streamsides, C
<i>Microtis oligantha</i>		tussockland, C
<i>Microtis unifolia</i>	D, N	tussocklands, herbfields, D; NRR, NSR
<i>Mitrasacme montana</i> var. <i>helmsii</i>	D	uncommon, Mt A, Mt W
<i>Mitrasacme novae-zelandiae</i>	D, S	+
<i>Muehlenbeckia australis</i>	N	forest, Waimangaroa River; DSR, NRR, NSR, SSR
<i>Myosotis</i> sp. (cf. <i>M. forsteri</i>)	N	+
<i>Myriophyllum pedunculatum</i>		C
<i>Myrsine australis</i>	N	forest, D, S; DSR, NSR
<i>Myrsine divaricata</i> (CANU 32512)	D, S, N	common in forest, D, S, Mt B, Mt W, T, TK; DSR, SSR
<i>Myrsine divaricata</i> x <i>salicina</i>	N	limited distribution, steep hard beech-silver beech forest, Mt W
<i>Myrsine salicina</i>	N	common in forest, D, S, Mt B, B, TK; DSR, NRR, NSR, SSR
<i>Neomyrtus pedunculata</i>	D, N	common, forest & scrub, D, S, Mt W, Mt B, T, TK; DSR, NSR, SSR
<i>Nertera balfouriana</i>		uncommon, streamside, C
<i>Nertera ciliata</i>	D	uncommon in forest throughout
<i>Nertera depressa</i>	D, N	forest, coastal hillslopes, Mt FF, D, S, Mt W, Mt B, B, TK; DSR, NSR
<i>Nertera scapanioides</i>		C, Mt W, B, Waimangaroa River
<i>Nertera villosa</i>	N	forest, Mt B, D, S, Mt W, TK; Mt RF, DSR
<i>Nothofagus fusca</i>	N	forest, Orowaiti River, Mt FF, Mt WR, Mt B, TK; Mt RF, DSR
<i>Nothofagus menziesii</i>	D, S, N	forest & scrub, D, S, Mt W, Mt B, TK; DSR, NSR, SSR
<i>Nothofagus solandri</i> var. <i>cliffortioides</i> (CANU 32513)	D, S, N	common in scrub, forest & shrubland, D, S, Mt B, B, Mt W, T, TK; DSR, SSR
<i>Nothofagus truncata</i>	N	forest, coastal hillslopes, Mt FF, Orowaiti River, TK, Isolated Hill, Mt W, T, Mt B; DSR, NRR, NSR, SSR
<i>Olearia arborescens</i>	D, N	uncommon, Mt R, Mt W, Mt A, creek edges, D, S, C; DSR
<i>Olearia arborescens</i> x <i>ilicifolia</i>	D	uncommon creek margins, Mt W; DSR
<i>Olearia avicenniifolia</i>	N	uncommon, D; DSR
<i>Olearia cheesemani</i>	N	coastal hillslopes, Ngakawau Gorge
<i>Olearia colensoi</i>	D, S	shrubbyland, scrub, Mt R, S, Mt W, Mt A, TK
<i>Olearia ilicifolia</i>		+, uncommon, Mt RF
<i>Olearia rani</i> (CANU 35191)	N	+, NRR, NSR, Mt F (Townson 1907), Ngakawau River
<i>Olearia virgata</i> var. <i>implicita</i> (including var. <i>laxiflora</i>) (CANU 35262)		lower and upper grassland at forest edge, C
<i>Oreobolus impar</i> (CANU 32503)	D, S	uncommon C, D, S, Mt W, TK; DSR
<i>Oreobolus pectinatus</i>	D, S	tussock, herbfields, C, upper D, upper S, Mt W, B; SSR
<i>Oreobolus strictus</i> (CANU 33738)	D, S	most common oreobolus, tussock, herbfield D, S, C, B, T, TK; DSR, NSR, SSR
<i>Oreostylidium subulatum</i>	S	tussockland, upper S, lower grassland C

BOTANICAL NAME	DRUCE LISTS	DISTRIBUTION NOTES
<i>Orthoceras novae-zeelandiae</i>	S	+
<i>Ourisia lactea</i> ssp. <i>lactea</i>	D	forest-streamside, S, C
<i>Ourisia macrocarpa</i>	D, N	Mt R
<i>Oxalis magellanica</i> agg.	N	flush, upper grassland, S, C
<i>Paesia scaberula</i> (CANU 32486)	D, S, N	road banks, D, S, Mt W, B, Mt F; DSR, NRR, NSR, SSR
<i>Parahebe lyalli</i>	N	Mt R
<i>Parsonsia heterophylla</i>		NRR, NSR, SSR
<i>Parsonsia</i> sp.	N	forest, Mt B, D, S, TK
<i>Pennantia corymbosa</i>		forest, Waimangaroa River, TK
<i>Pentachondra pumila</i>	D, S	common, tussockland, herbfield, D, S, Mt W, T, TK
<i>Peraxilla tetrapetala</i> (CANU 33743)		very limited distribution, pahautea-mtn beech, forest basin below Mt WR, Cedar Stream (c. 5 plants on mtn beech), Upper Waimangaroa (1 plant on mountain beech)
<i>Phormium cookianum</i>	D, S, N	common, shrubland, scrub, S, D, B, C, T, Mt W, TK; DSR, NSR, SSR
<i>Phormium tenax</i>		TK; DSR, NRR, SSR
<i>Phyllachne colensoi</i>	D, S	herbfield, D, S, Mt W
<i>Phyllocladus</i> aff. <i>alpinus</i> (large-leaved tree)	D, S, N	common, scrub & forest, D, S, Mt W, Mt B, T, B, TK; DSR, NSR, SSR
<i>Phymatosorus pustulatus</i>	N	uncommon, Waimangaroa River, TK; DSR, NRR, NSR
<i>Phymatosorus scandens</i>	N	uncommon, Waimangaroa River, coastal hillslopes
<i>Pimelea gnidia</i>	D, S	tussockland, scrub, D, S, Mt W, TK; DSR
<i>Pimelea longifolia</i> (CANU 33757)	D, S	D, Mt W, Mt F, tussockland
<i>Pittosporum anomalum</i> (CANU 35255)		one plant seen, upper grassland, C
<i>Pittosporum divaricatum</i>		+, DSR, SSR
<i>Pittosporum eugenioides</i>	N	TK
<i>Pittosporum rigidum</i> var. (<i>P. crassicaule</i>) (CANU 32569)	D, S, N	forest, scrub, shrubland, Mt W, Mt B, B, C, D, S, T, TK; DSR
<i>Pittosporum tenuifolium</i>	N	TK; DSR, NSR
<i>Plantago lanigera</i> (CANU 35179)		uncommon, streamside, C
<i>Plantago raoulii</i>		C
<i>Plantago triandra</i>	D	C
<i>Plantago uniflora</i>		C
<i>Pneumatopteris pennigera</i>	N	gully base forest Orowaiti River, TK; NRR
<i>Poa colensoi</i>	S	uncommon, Mt R, Mt F
<i>Podocarpus acutifolius</i>	N	forest, D
<i>Podocarpus hallii</i> (CANU 31923)	D, S, N	forest, uncommon, D, Waimangaroa River, B, Mt W, T, Mt B, TK; DSR, NRR, NSR, SSR
<i>Podocarpus totara</i> var. <i>waihoensis</i>		creek margins, Mt B
<i>Polystichum vestitum</i> (CANU 32489)		uncommon, forest, D, S, TK; D, SR
<i>Potamogeton suboblongus</i>		stream B
<i>Prasophyllum colensoi</i>	D, S	tussockland, upper D, upper S
<i>Pratia angulata</i> agg. (CANU 32 570)	D, N	uncommon, D, S, B, C, TK; DSR, NRR, NSR, SSR
<i>Prumnopitys ferruginea</i>	N	uncommon forest, D, S, Mt F, Mt B, Isolated Hill, TK; Mt RF, DSR, NRR, NSR
<i>Prumnopitys taxifolia</i>		+, DSR, NRR
<i>Pseudognaphalium</i> sp. (<i>P. aff. luteoalbum</i>)	N	Mt R
<i>Pseudopanax anomalus</i>	N	forest, shrubland, creek margins, Mt B, D, Waimangaroa River
<i>Pseudopanax anomalus</i> x <i>simplex</i>		forest, S
<i>Pseudopanax crassifolius</i>	N	forest, coastal hillslopes, Waimangaroa River, Mt B, B, TK; DSR, NRR, NSR, SSR
<i>Pseudopanax linearis</i> (CANU 32508)	D, S	common, forest, D, S, Mt W, Mt B, T, TK; DSR
<i>Pseudopanax simplex</i>	D, S	forest, D, S, Mt W, T, Mt B, TK; DSR, SSR
<i>Pseudopanax</i> sp.	D, S	forest, D, S, Mt B, Mt W, TK; DSR, NRR, NSR, SSR
(unnamed - included in <i>P. colensoi</i> as var. <i>ternatus</i>) (CANU 32487)		
<i>Pseudowintera axillaris</i>		Coal Creek, Mokihinui; DSR, NRR, NSR
<i>Pseudowintera colorata</i>	N	forest, creek margins, D, Waimangaroa River, Mt B, B, TK; DSR
<i>Pseudowintera traversii</i> (CANU 35181)	D, S	forest, scrub, D, Waimangaroa River, C, Mt W, Mt F, Mt A
<i>Pteridium esculentum</i>	N	burnt sedge land, lower S, B, Mt W, TK; DSR, NRR, NSR, SSR
<i>Pterostylis banksii</i>	D	uncommon D, forest Mt B; DSR, NRR, NSR, SSR
<i>Pterostylis cyanea</i>		S, tussockland, C
<i>Pterostylis graminea</i>		+, DSR
<i>Pterostylis irsoniana</i>	D, S	limited distribution D, Mt B, tussockland, C; DSR, NSR
<i>Pterostylis montana</i>		+, DSR
<i>Pterostylis venosa</i>	D, S	forest, scrub, D, streamside, C
<i>Pyrrosia eleagnifolia</i>	N	coastal hillslopes, TK; NSR
<i>Quintinia serrata</i>	D, S, N	common in forest & scrub, D, S, Mt W, Mt B, T, B, TK; DSR, NSR, SSR
<i>Ranunculus</i> cf. <i>foliosus</i> (CANU 33915)		flush, upper grassland, C
<i>Ranunculus glabrifolius</i>		C
<i>Ranunculus gracilipes</i> (CANU 33914)		common, grassland, C
<i>Ranunculus reflexus</i>	N	+
<i>Raoulia eximia</i>	S	+
<i>Raoulia glabra</i>	D	Mt R, S, C
<i>Raoulia grandiflora</i>	D, S	herbfield, Mt R, Mt W, S

BOTANICAL NAME

DRUCE DISTRIBUTION NOTES

LISTS

<i>Raoulia tenuicaulis</i>	D	roadside, Mt R
<i>Rhopalostylis baueri</i>		TK, NSR
<i>Ripogonum scandens</i>	N	common, forest coastal hillslopes, D, Mt FF, TK; Mt RF, DSR, NRR, NSR
<i>Rubus australis</i>	N	forest D; NRR, NSR, SSR
<i>Rubus cissoides</i>	N	forest, coastal hillslopes, Waimangaroa River, shrubland Mt B; DSR, NRR, NSR
<i>Rubus schmidelioides</i>	N	Mt FF, manuka shrubland, Mt B; DSR, NRR
<i>Rumohra adiantiformis</i>	N	forest epiphyte, D, D, Mt FF, TK; DSR
<i>Rytidosperma gracile</i> (CANU 31941)	D, S, N	tussockland D, B, T, Mt W, TK, riparian, Waimangaroa River
<i>Rytidosperma nigricans</i>	D, S	herbfield, tussockland, Mt R, S, Mt W, Mt F, TK; DSR
<i>Rytidosperma setifolium</i>	D, S	tussockland Mt R, riparian, Waimangaroa River
<i>Schefflera digitata</i>		forest coastal hillslopes, Orowaiti River, TK; DSR, NRR, NSR
<i>Schizaea</i> sp. (cf. <i>S. australis</i>) (CANU 33898)	D, S, N	cushion bogs, scrub, shrubland & rushland, C, D, S, B, T, Mt F, Mt W, TK; DSR, SSR
<i>Schoenus maschalinus</i>	N	sedgeland, B, Birchfield pakihi
<i>Schoenus pauciflorus</i> s.s.	D, S	seepages, shrubland, D, S, C, Mt W, riparian, Waimangaroa River; DSR
<i>Senecio minimus</i>	N	+
<i>Solanum aviculare</i>		+, NSR
<i>Solanum laciniatum</i>	S	coastal hillslope
<i>Sophora microphylla</i>		Summerlea Bush
<i>Stellaria decipiens</i>	N	+
<i>Sticherus cunninghamii</i> (CANU 31931)	D, N	forest, Mt FF, B, S, Mt W, TK; Mt RF, DSR, NSR, SSR
<i>Sticherus flabellatus</i> (CANU 33912)	S	locally common, Mangatini Sum (Given 1982, D.A. Norton unpublished data), Kiwi fault (Norton & Overmars 1990)
<i>Streblus heterophyllus</i>		+, NSR
<i>Tetralia capillaris</i>	S	tussockland, S
<i>Thelymitra cyanea</i>	D, S, N	common, bogs and seepages; DSR
<i>Thelymitra longifolia</i>	N	+, DSR, NRR, NSR
<i>Thelymitra pauciflora</i>	N	uncommon, tussockland, sedgeland, Mt R, C; DSR, NRR, NSR
<i>Thelymitra pulchella</i>	D, S, N	common sedgeland, D, ground previously burnt, S, B
<i>Tmesipteris elongata</i> (CANU 31924)	N	DSR
<i>Tmesipteris tannensis</i> (CANU 33913)	D	forest, D, Mt W, Mt F, TK, T, B; DSR, NSR, SSR
<i>Trichomanes elongatum</i>	N	+, SSR
<i>Trichomanes reniforme</i>	N	forest epiphyte, D, S, Mt W, Mt B, TK; DSR
<i>Trichomanes strictum</i>	D, S	forest, limited distribution, B, D, S; DSR, NSR, SSR
<i>Trichomanes venosum</i>		forest epiphyte, uncommon Mt W, TK; DSR, SSR
<i>Uncinia angustifolia</i>		TK
<i>Uncinia banksii</i>	N	+
<i>Uncinia ferruginea</i>		TK; DSR
<i>Uncinia filiformis</i>	D, S, N	montane forest, Mt W, Mt B, D, S, TK; DSR
<i>Uncinia gracilentia</i>	N	montane forest, D, S, Mt W, Mt B
<i>Uncinia involuta</i>	S	+
<i>Uncinia nervosa</i> s.s.	S	forest S, shrubland Mt B
<i>Uncinia rupestris</i>	D, N	common in forest, D, S, Mt W, T, Mt B; Mt RF, DSR, NSR
<i>Uncinia uncinata</i>	N	forest, Waimangaroa River, Mt FF, Mt B, TK; DSR, NRR, NSR
<i>Uncinia zotovii</i>		TK; Mt RF, DSR
<i>Utricularia novae-zelandiae</i>	D, S	seepages, sedgeland, cushion bogs, D, S, Mt R, T; DSR
<i>Viola cunninghamii</i>		common, grassland, C, B
<i>Viola filicaulis</i>	N	uncommon Mt F, upper grassland C, B
<i>Weinmannia racemosa</i>		common, forest, scrub, D, S, Mt W, Mt B, B, T, TK; DSR, NRR, NSR, SSR

Adventive

<i>Acacia melanoxylon</i>		Frank Stream
<i>Agrostis capillaris</i>		disturbed ground, D, B
<i>Anthoxanthum odoratum</i>		uncommon, tussockland, C, TK
<i>Buddleja davidii</i>		+, NRR, NSR, SSR
<i>Calystegia silvatica</i>		+, NSR
<i>Cirsium arvense</i>		+, NSR
<i>Cirsium vulgare</i>		+, NSR
<i>Crocosmia x crocosmiiflora</i>		Summerlea Bush; DSR, NRR, NSR, SSR
<i>Cupressus macrocarpa</i>		+, NSR, SSR
<i>Cytisus scoparius</i>		+, NRR, NSR, SSR
<i>Digitalis purpurea</i>		+, SSR
<i>Festuca arundinacea</i>		+, NSR
<i>Hedera helix</i>		+, NSR
<i>Holcus lanatus</i>		disturbed sites D, B, TK
<i>Hypochoeris radicata</i>		sedgeland, B
<i>Juncus bulbosus</i>		disturbed ground, Mt R, S
<i>Juncus canadensis</i>		disturbed sites, B

BOTANICAL NAME

Juncus effusus
 Juncus squarrosus

 Leycesteria formosa
 Lonicera japonica
 Lupinus arboreus
 Nardus stricta
 Paraserianthes lophantha
 Ranunculus repens
 Rubus fruticosus agg.
 Salix fragilis
 Senecio mikanioides
 Tradescantia fluminensis
 Ulex europaeus

DRUCE DISTRIBUTION NOTES LISTS

disturbed road edges, Mt R, uncommon, tussockland, C
 dense swards on disturbed ground along road edge, D, S; Marshall's
 mine (Given & Park 1975)
 +, DSR, NRR, NSR, SSR
 +, DSR, NRR, NSR, SSR
 +, NSR
 Burnett Face (Jane 1996)
 +, NRR, NSR
 +, NRR, NSR
 +, DSR, NRR, NSR, SSR
 +, SSR
 +, NSR
 Summerlea Bush, NSR
 road edges, B, D, S; DSR, NRR, NSR, SSR

APPENDIX VI SAMPLE SITE SUMMARIES

The following table summarizes information gathered at each sample site in the surveyed parts of Ngakawau ED. For each sample site, the following information is recorded:

- the plot transect and plot number along that transect;
- the main species and their abundance, and the structural class name (after Atkinson (1985), see section 1.3.2.1). Species are denoted by six letter abbreviations the first three letters are from the beginning of the genus name and the second three letters are from the beginning of the species name. Underlined names indicate species of more than 50% cover; square brackets indicate species of less than 5% cover; a diagonal bar (/) separates species into decreasing height classes; and a dash (-) connects species of similar heights.
- the landform on which the vegetation is recorded;
- grid reference (metric NZMS 260 series);
- altitude;
- aspect;
- vegetation association (refer Appendix IV); and
- land system (refer Section 2.3).

Abbreviations

- A = Plots added to transect line subsequent to completion of the main line
- * = Sample sites with 2 plots in close proximity (to sample local variation)

PLOT	VEGETATION NAME	LANDFORM	GRID REFERENCE	ALTITUDE (m)	ASPECT	VEGETATION ASSOCIATION	LAND SYSTEM
1/1 *	Chifla-Olecol/Schpau tussockland	Plateau hilltop, rounded	K29 053357	1040	Nil	7	2
1/2 *	Phocoo-Olecol-Chifla flaxland	Plateau hilltop, rounded	K29 053357	1040	10	7	2
1/3	Notmen/Dralon-Olecol forest	Plat. gully entire slope	K29 053359	980	na	6	2
1/4	Lepscu/(Chijun)-Empmin shrub-rushland	Plateau basin	K29 059360	900	280	11	2
1/5	Notcli-Halbif-[Lepscu] scrub	Plateau gully sideslope	K29 061365	860	10	6	2
1/6	Lepscu/Empmin-(Chijun) shrub-rushland	Plateau hilltop, rounded	K29 065368	780	340	11	2
1/7	Lepscu/Empmin shrub-rushland	Plateau hilltop, rounded	K29 069371	740	45	11	2
1/8	Lepscu-Leplax/Empmin-Chijun shrub-rushland	Plateau hilltop, rounded	K29 071375	680	40	11	2
1/9	[Lepscu]/Empmin/Orepec shrub-rushland	Plateau, toeslope	K29 074378	na	10	11	2
1/10	Notcli-Halbif forest	Plateau gully sideslope	K29 075378	na	65	5	2
1/11 *	Notmen-Drauni-[Olecol] shrubland	Plateau scarp	K29 057358	1020	185	7	2
1/12 *	Notcli-Notmen/Olecol shrubland	Plateau scarp	K29 057358	1000	220	7	2
1/13	[Chirub]/Empmin-Lepscu-Donnov cushionfield	Plateau step	K29 058358	960	Nil	11	2
2/1	Lepscu-Empmin-(Chijun) rushland	Plateau seepage slope	K29 085380	640	20	11	2
2/2	[Chijun-Lepaus]/Lepscu-Empmin rushland	Plateau seepage slope	K29 084385	620	360	11	2
3/1	Weirac-Notmen forest	Colluvial sideslope	K29 101405	560	25	2	4
3/2	Notru-Daccup/[Quiacu] forest	Colluvial sideslope	K29 102408	280	60	3	4
3/3	Ripsca-Cyamed scrubland	Colluvial sideslope	K29 108411	140	340	1	4
4/1	[Notcli]/Lepscu forest	Colluvial sideslope	L29 125389	630	335	6	2
4/2	Notmen-Metumb-[Daccup] forest	Colluvial slopes, basin floor	L29 127380	570	220	2	2/4
4/3	Notcli-[Halbif] forest	Colluvial sideslope	L29 127374	700	320	5	2
4/4 *	Lepscu-Empmin-(Chijun) rushland	Plateau steps	L29 126375	900	325	11	2
4/5 *	Phocoo-[Chirub]/Empmin tussockland	Plateau hilltop, rounded	L29 126375	900	5	11	2
4/6	[Chijun]/Empmin-Lepscu rushland	Plateau step	L29 127370	1020	80	11	2
4/7	Notmen-[Notcli] scrub	Colluvial sideslope	L29 128376	860	320	6	2
5/1	Notcli-Metumb forest	Colluvial sideslope	K29 041371	480	280	4c	1
5/2	Lepint-[Halbif]-[Notcli] scrub	Colluvial sideslope	K29 044366	600	320	5	1
5/3	Notcli/[Halbif] forest	Colluvial sideslope	K29 045363	760	260	5	1
5/4	Halbif/Notmen-[Draura] scrub	Colluvial sideslope	K29 048357	920	320	6	2
6/1	Lepscu/Gatpro/Bauter-Empmin shrubland	Plateau gully toeslope	K29 068372	740	45	12b	2
6/2	Notcli-[Halbif] forest	Plateau hillslope interfluvial	K29 063372	740	360	5	2
6/3	Notcli-[Halbif] forest	Plateau gully sideslope	K29 058371	720	250	5	2
6/4	Lepscu/Empmin shrub-rushland	Plateau hilltop flat	K29 054370	745	25	12b	2
7/1	Lepscu-Empmin/Donnov-Lipgun shrub-herbfield	Plateau step	K29 070383	600	225	11	2
7/2	Halbif/Notcli forest	Plateau gully sideslope	K29 066386	540	70	5	2
7/3	Lepscu-Drapat/Phocoo-Epapau/Empmin-Gledic shrubland	Plateau hilltop rounded	K29 065384	560	340	12b	2
7/4	[Lepscu]/Gledic-Empmin shrub-fermland	Plateau interfluvial	K29 061383	500	325	12b	2
7/5 *	Daccup-Notcli forest	Plateau gully, entire slope	K29 058384	520	320	4a	2
7/6 *	Daccup-Notmen forest	Plateau gully sideslope	K29 058384	520	360	4	2

PLOT	VEGETATION NAME	LANDFORM	GRID REFERENCE	ALTITUDE (m)	ASPECT	VEGETATION	LAND SYSTEM
8/1	Notfus-[Daccup]-[Notmen] forest	Fluvial terrace	K29 017349	140	320	1	1
8/2	Notfus-[Daccup] forest	Ridgeline	K29 020344	300	320	1	1
8/3	[Notfus]-[Metumb]-[Daccup] forest	Ridgeline	K29 023343	520	na	2	1
8/4	Notfus-Metumb forest	Ridgeline	K29 025335	700	320	2	1
9/1	[Lepscu]-Bauter/Empmmin shrub-rushland	Plateau toeslope	L28 205528	340	130	12b	2
9/2	Bauter-Gledic/Empmmin rushland	Plateau hillslope interfluvial	L28 202512	360	330	13	2
9/3	Daccup-Notcli forest	Plateau sideslope	L28 204515	na	290	4a	2
9/4	Daccup-Notcli forest	Plateau	L28 207525	340	320	4a	2
9/5	Daccup-Notcli forest	Plateau gully base	L28 204513	340	140	4a	2
10/1	Notcli-Halbif scrub	Plateau gully sideslope	L29 133433	920	175	6	3
10/2	(Notcli)/Olecol-[Halbif] shrubland	Plateau gully sideslope	L29 132429	920	165	6	2
10/3	Halbif/Lepscu-Chiaus shrub-tussockland	Plateau footslope	L29 132423	820	165	9	2
10/4	[Chijun]-Lepscu-[Halbif] shrub-tussockland	Plateau hilltop, rounded	L29 130419	740	165	9	2
11/1	[Lepscu]/[Chirub]-[Gahpro]/Empmmin shrub-tussockland	Plateau step	L29 148445	930	100	10	2
11/2	Halbif-Lepscu scrub	Plateau gully, entire slope	L29 150444	900	70	6	3
11/3	[Chijun]/ Lepscu-[Halbif] tussockland	Plateau hilltop rounded	L29 152443	840	90	10	2
11/4	[Chijun]-Lepscu-[Chiaus] tussock-shrubland	Plateau step	L29 159440	840	90	9	2
11/5	[Chijun]-Lepscu-Halbif/Empmmin tussock-shrubland	Plateau footslope	L29 162438	760	320	10	2
11/6	Chirub-[Lepscu]/Empmmin tussockland	Alluvial flat	L29 168437	720	Nil	10	2
11/7	Lepscu/Dralon-Halbif/Gahpro shrubland	Alluvial terrace	L29 168435	620	Nil	8	3
11/8	Notmen-Metumb-Weirac forest	Colluvial sideslopes	L29 172432	750	300	2	3
11/9	Notcli-Metumb-Weirac forest	Ridge	L29 175434	840	Nil	4c	3
12/1	Notcli-Libbid forest	Alluvial flat	L29 149397	535	265	4b	5
12/2	Daccup/Notcli forest	Colluvial sideslope	L29 151395	580	230	4a	3
12/3	Notfus-Weirac forest	Colluvial sideslope	L29 152395	630	360	2	3
12/4	Metumb-[Notcli]-[Notmen] forest	Colluvial hillslope interfluvial	L29 152394	660	280	4c	3
12/5	Halbif-Notcli forest	Colluvial sideslope	L29 153393	685	360	5	3
12/6	Lepscu-Lepint-[Libbid] scrub	Colluvial sideslope	L29 159379	640	210	6	3
13/1	Notcli-Daccup forest	Plateau gully sideslope	L29 211429	380	135	4a	2
13/2	[Lepscu]-Bauter/Empmmin-Glemic rushland	Plateau sideslope	L29 212423	380	250	12b	2
13/3	[Lepscu]-[Gahrig]/Bauter-Gledic rushland	Plateau basin	L29 210424	380	Nil	13	2
13/4	Epapau/Bauter-Glemic-Empmmin rushland	Plateau gully sideslope	L29 213418	380	295	12b	2
13/5	Notcli-Metumb forest	Plateau gully interfluvial	L29 214416	380	95	5	2
13/6	Chiaus-Lepscu-Empmmin grassland	Plateau step	L29 209428	380	Nil	10	2
14/1	Lepscu-Gledic-Oestre-Drospa herbfield	Ridge	L29 213445	420	305	12a	2
14/2	Nottru-Notmen forest	Colluvial sideslope	L29 203436	400	190	3	3
14/3	Epapau/Glemic-Empmmin shrubland	Ridge	L29 202436	460	360	12a	2
14/4	Lepscu-Empmmin-Drapal shrubland	Ridge	L29 198437	560	350	12a	2
14/5	Nottru forest	Colluvial hillslope	L29 193437	660	35	2	3
14/6	Notmen-Notcli forest	Colluvial hillslope	L29 187435	760	na	2	3
14/7	Chijun-Lepscu/Empmmin tussockland	Hilltop flat	L29 187435	760	na	11	2
15/1	[Chijun]/[Lepscu]-[Chiaus] tussock-grassland	Plateau steps	L29 161461	830	85	10	2
15/2	Notcli-Metumb forest	Plateau gully base	L29 162461	805	85	4c	2
15/3	Lepscu-[Chirub] tussock-shrubland	Plateau sideslope	L29 163461	785	345	10	2

PLOT	VEGETATION NAME	LANDFORM	GRID REFERENCE	ALTITUDE (m)	ASPECT	VEGETATION	LAND SYSTEM
15/4	Notcli-Weirac-Metumb-Pesim forest	Plateau gully sideslope	L29 169460	760	85	4c	2
15/5	Lepint-[Lepsco]/[Chirub] shrubland	Plateau steps	L29 175458	715	Nil	10	2
15/6	[Lepint]-[Chirub]/[Lepsco] tussock-shrubland	Plateau steps	L29 179457	690	210	10	2
15/7	[Chirub]/[Lepsco] tussock-shrubland	Plateau steps	L29 182455	680	85	10	2
15/1A	Lepsco-[Chijun] shrubland	Plateau hillslope	L29 156463	890	10	10	2
15/2A	[Metumb]-Notmen forest	Plateau gully base	L29 152466	900	160	6	2
15/3A	[Chijun]-Empmin-Chiaus rushland	Plateau steps	L29 153469	910	na	10	2
5/4A	[Halbif]-[Chijun]-[Lepsco] shrubland	Plateau scarp	L29 151465	960	270	9	2
16/1	Bauter-Rygra-[Lepaus] rushland	Fluvial valley floodplain	L29 227456	360	Nil	13	2
16/2	Rygra-Juncan-Bauter rushland	Fluvial valley floodplain	L29 227456	na	na	13	2
16/3	Nottru-Daccup forest	Colluvial sideslope	L29 225454	370	345	3	5
16/4	Daccup-Notcli forest	Ridge	L29 227455	380	220	4a	5
16/5	Bauter-Rygra rushland	Fluvial valley floodplain	L29 226453	360	Nil	13	2
16/6	Bauter-[Rygra]/[Pteesc] rushland	Plateau seepage slope	L29 225445	380	350	13	2
16/7	Notcli-Daccup forest	Plateau gully sideslope	L29 223442	380	260	5	2
17/1	Bauter-[Rygra]/[Gledic] rushland	Plateau sideslope	L29 222450	360	20	13	2
17/2	Metumb-Nottru-Notcli forest	Ridge	L29 217451	390	145	3	3
17/3	Epapau/Glemic/Empmin shrubland	Interfluv	L29 216451	420	65	12b	3
17/4	Lepsco/Empmin/Lycram shrubland	Colluvial sideslopes	L29 214452	460	220	12b	3
17/5	Notcli-Daccup forest	Colluvial sideslopes	L29 208453	480	110	4a	3
17/6	Lepsco-Chijun shrubland	Hilltop flat	L29 208454	500	320	10	3
17/7	Lepint/Chiaus-Empmin rushland	Hilltop flat	L29 204454	520	85	11	2
17/8	Lepint-[Drapoll]/Chiaus-Celsim-Lepsco herbfield	Hilltop flat	L29 198454	670	na	10	2
18/1	[Rygra]-[Gahrig]/Bauter-Gledic rushland	Fluvial valley floodplain	L29 228460	340	Nil	13	2
18/2	[Chirub]-Rygra-Bauter rushland	Fluvial valley floodplain	L29 235458	340	Nil	13	2
18/3	Daccup-Notcli-Notmen-[Nottru] forest	Fluvial valley floodplain	L29 238458	365	200	3	5
18/4	Libbid-Notcli forest	Fluvial valley floodplain	L29 243457	340	na	4b	5
18/5	Halbif-Notcli-[Lepint]-[Libbid] forest	Fluvial valley floodplain	L29 248454	340	na	5	5
18/6	Lepint-Notcli forest	Fluvial valley floodplain	L29 252453	340	na	5	5
18/7	Daccup-Notcli forest	Colluvial hillslope	L29 257453	420	185	4a	5
18/8	Notcli-Daccup forest	Colluvial hillslope	L29 262451	500	265	4a	3
18/9	Notfus-Metumb forest	Colluvial hillslope	L29 264450	620	295	2	3
18/10	Notfus-Metumb forest	Colluvial hillslope	L29 265449	680	275	2	3
18/11	Notcli-Lepsco-[Libbid] forest	Fluvial valley floodplain	L29 236458	na	Nil	4b	5
18/12	Lepsco/Gahnia-Empmin-Cardis shrubland	Fluvial valley floodplain	L29 237458	na	na	8	5

PLOT	VEGETATION NAME	LANDFORM	GRID REFERENCE	ALTITUDE (m)	ASPECT	VEGETATION	LAND SYSTEM
19/1	Metumb-Weirac forest	Plateau hillslope	L29 185485	610	45	4c	3
19/2	Lepscoc/Emmpin-Chiaus tussock-shrubland	Plateau step	L29 181482	625	na	10	2
19/3	[Chijun]/Lepscoc-Emmpin shrub-tussockland	Plateau step	L29 178480	700	85	10	2
20/1	Weirac-Dralon-Phocoo shrubland	Plateau gully	L29 169479	740	160	4c	2
20/2	[Chijun]/Lepscoc-[Emmpin] shrubland	Plateau interfluv	L29 162480	780	40	10	2
20/3	[Chijun]/Emmpin-Chiaus-Lepscoc rushland	Plateau interfluv	L29 160485	790	50	10	2
20/4	[Lepscoc]/Gledic-Weirac/Emmpin shrubland	Plateau gully, seepage slope	L29 156487	800	80	12a	2
20/5	Lepscoc-Emmpin-Drapol-Caralp shrubland	Plateau interfluv	L29 152490	800	30	10	2
21/1	Notmen forest	Colluvial hillslope, sideslope	L29 209479	355	145	2	2
21/2	Notcli-Daccup forest	Colluvial hillslope, sideslope	L29 207484	480	80	4a	3
21/3	Lepscoc-Lepint shrubland	Colluvial hillslope, sideslope	L29 207489	540	125	8	3
22/1	Bauter-Rytgra rushland	Fluvial valley, floodplain	L29 234474	340	na	13	2
22/2	Bauter-[Rytgra]/Gledic rushland	River terrace, tread	L29 230476	360	na	13	2
22/3	Lepscoc-Halbif-[Notcli] shrubland	River terrace, tread	L29 228478	350	130	8	3
22/4	Daccup/Notcli/Lepint forest	Colluvial hillslope, sideslope	L29 225477	420	90	4a	3
22/5	Notcli-[Daccup] forest	Ridge	L29 223478	520	210	5	3
23/1	[Halbif]/Lepscoc shrubland	Colluvial hillslope	L28 183540	210	60	8	5
23/2*	Lepscoc-Blespl/Glenic shrubland	Plateau hilltop, rounded	L29 188540	310	40	8	5
23/3*	Bauter-Preesc/Gledic rushland	Plateau, toeslope	L28 188540	300	305	13	2/4
23/4	Bauter-Preesc/Gledic fern-rushland	Plateau, seepage slope	L28 178540	310	305	13	2/4
24/1	Metumb-Notcli forest	Plateau, gully, sideslope	L29 149405	600	120	4c	2
24/2	[Drapol]/Chiaus-Lepscoc-Emmpin shrub-grassland	Plateau hilltop, rounded	L29 148410	640	140	8	2
24/3	Lepint-Lepscoc [Halbif] shrubland	Plateau gully, entire slope	L29 148412	680	200	8	2
24/4	Lepscoc-Dralon-Phocoo shrubland	Plateau gully sideslope	L29 146414	680	120	8	2
24/5	Lepscoc-Notcli forest	Fault scarp	L29 146415	740	125	8	2
24/6	Lepscoc/Emmpin shrubland	Plateau scarp	L29 145419	840	205	10	2
24/7	Chijun/Lepscoc-Chiaus-Emmpin tussockland	Plateau hillslope	L29 144423	840	200	10	2
24/8	Lepscoc-Chijun-Caralp-Emmpin tussock-shrubland	Plateau gully basin	L29 144428	900	Nil	11	2
24/9	Chirub-Halbif/Emmpin tussock-shrubland	Plateau toeslope	L29 143433	960	110	9	2
24/10*	Chijun-Halbif/Chiaus tussock-shrubland	Plateau hilltop, rounded	L29 140441	1106	Nil	9	2
24/11*	Chijun-Halbif/Lepscoc-Chiaus tussock-shrubland	Plateau scarp	L29 140441	1090	340	9	2
24/12	Chijun-Halbif tussock-shrubland	Plateau gully	L29 144441	1060	105	9	2
24/13	[Chijun]/Chiaus-Emmpin tussockland	Plateau tarn	L29 142438	1040	na	9	2
24/1A	Notcli-Lepint forest	Colluvial hillslope	L29 150450	880	120	6	3
24/2A	Notmen-Grilit forest	Colluvial hillslope	L29 148440	980	150	6	3

PLOT	VEGETATION NAME	LANDFORM	GRID REFERENCE	ALTITUDE (m)	ASPECT	VEGETATION	LAND SYSTEM
25/1	Gahpro-Prees-Bauter-Uleaur fern-tussockland	Plateau sideslope	L29 161517	330	360	13	2
25/2	[Metumb]/Lepsc-[Weirac] shrubland	Plateau sideslope	L28 160512	420	340	4c	2
25/3	[Myrsal]-Weirac forest-shrubland	Plateau sideslope	L28 158509	580	70	4c	2
25/4	[Metumb]/Lepsc-[Weirac] shrubland	Plateau interfluv	L28 155505	620	230	4c	2
25/5	Weirac-[Metumb] shrubland	Plateau gully sideslope	L28 153500	640	40	4c	2
26/1	Quiacu-Dicsqu/Freban forest	Colluvial hillslope	L28 165540	160	180	1	1
26/2	Metumb/Weirac forest	Colluvial hillslope	L28 163535	200	180	1	1
26/3	Notfus/Weirac forest	Colluvial hillslope	L28 162528	180	260	1	1
26/4	Nottru/Weirac forest	Colluvial hillslope	L28 158527	180	60	1	1
27/1	[Bauter]-Gledic-Empmin rushland	Plateau hilltop, rounded	L28 190525	300	na	12b	3
27/2	[Lepint]-[Lepsc]-[Bauter]/Glemic-Empmin-Chiau shrub-fernland	Plateau hilltop, rounded	L28 189518	400	na	10	2
27/3	Daccup-Podhal forest	Plateau gully sideslope	L28 185514	400	220	4a	2
28/1	Notfus/Weirac forest	Alluvial terrace	K29 098443	100	220	1	1
28/2	Daccup-Nottru forest	Colluvial hillslope ridgeline	L29 105440	200	270	3	1
28/3	Nottru-Weirac forest	Colluvial sideslope	L29 108438	240	360	3	1
28/4	Notmen-Weirac forest	Colluvial sideslope	L29 120432	500	290	2	1
28/5	[Quiacu]/Coppgra-Cyasm forest	Colluvial sideslope	L29 125431	700	340	2	1
29/1	Chirub/Empmin-Gledic tussockland	Colluvial flat	L29 133393	500	Nil	10	2
30/1	Bauter/Gledic/Gonmic-Gnaud rushland	Alluvial fan	L29 103465	40	280	13	NotinED
30/2	Nottru forest	Colluvial hillslope	L29 108462	120	300	3	1
30/3	Nottru-Daccup forest	Colluvial hillslope	L29 114461	240	235	3	1
30/4	Nottru/Metumb-[Daccup] forest	Bedrock hillslope, ridge	L29 115461	350	250	3	1
30/5	Notcli-Lepint-[Metumb] forest	Bedrock hillslope, ridge	L29 118460	480	235	5	1
30/6	Lepint-Notcli shrubland	Hilltop	L29 123458	630	000	5	1
31/1	Hedarb-Oleche shrubland	Colluvial hillslope	L28 137509	70	275	1	1
31/2	[Metrob]/[Myrsal]/Cyamed/Orilit shrubland	Colluvial hillslope	L28 138508	100	295	1	1

APPENDIX VII GEOPRESERVATION INVENTORY SITES IN NGAKAWAU ECOLOGICAL DISTRICT

GEOLOGICALLY-RELATED HISTORIC SITES

(after Black *et al.* 1991, Kenny & Hayward 1993)

Charming Creek coal mine

SIGNIFICANCE: A good example of an early coalmine and tramway.

DESCRIPTION: The Charming Creek area was mined for coal from the late 1920's up to mine closure in 1987. A railway, originally laid for timber extraction, was used to transport coal from the Charming Creek Mine from the early 1920's until 1959, when a road was built. Numerous coalmining and sawmilling relics can be found in the area.

LOCALITY: Charming Creek, south of Seddonville. L28: 229 572.

ACCESS: By foot from the end of the Charming Creek-Seddonville Road.

CLASSIFICATION: Importance regional.

VULNERABILITY: Moderately vulnerable to modification by humans.

HAZARDS: Continued coalmining (Charming Creek coal mine closed in 1987).

OWNERSHIP: Principally stewardship land, Department of Conservation.

INFORMANT/DATE OF INFORMATION: R. Hooker, 1991.

REFERENCES:

Anon. 1982. Charming Creek Reflections. *New Zealand Coal* 26(4): 18-2 (Photos).

Anon. 1982. In, Out and Roundabout. *New Zealand Coal* 26(3): 6-8 (Photos).

Denniston Incline and coal workings

SIGNIFICANCE: One of the earliest and most famous inclines in New Zealand.

DESCRIPTION: Opened 1880. Provided access to coal for Westport coal company. Retaining walls use local coal measures sandstone.

LOCALITY: Conns Creek, approximately 15 km NE of Westport. K29: 098 406.

ACCESS: The incline crosses the road from Waimangaroa to Burnetts Face (off State Highway 67) at Denniston.

CLASSIFICATION: Importance - regional.

VULNERABILITY: Moderately vulnerable to modification by humans.

OWNERSHIP/RESERVE STATUS: Denniston scenic reserve (proposed historic reserve).

INFORMANT/DATE OF INFORMATION: S. Nathan, 1990.

REFERENCES:

- Thornton, G.G. 1982. *New Zealand's Industrial Heritage*. Reed Publishers: p.100, 102.
- Gregorie, D. 1985. Old mines never die, they attract tourists. *New Zealand Coal* 29(2): 30-32 (Photo).
- Morgan, P.G.; Bartrum, J.A. 1915. *The geology and mineral resources of the Buller-Mokihinui Subdivision, Westport Division*. New Zealand Geological Survey Bulletin 17.

Granity coke ovens

SIGNIFICANCE: Example of local stone use in coke oven construction.

DESCRIPTION: Coke ovens built using local sandstone, ovens are obscured by Coalcorp buildings.

LOCALITY: Adjacent to main road, Granity. L28: 145 524.

ACCESS: By foot from the end of the Charming Creek-Seddonville Road.

CLASSIFICATION: Importance - regional

VULNERABILITY: Moderately vulnerable to modification by humans.

HAZARDS: Demolition.

OWNERSHIP: Buller District Council (managed by Granity Historical Group)

INFORMANT/DATE OF INFORMATION: R. Hooker, 1991.

IGNEOUS GEOLOGY SITES

(after Weaver *et al.* 1990)

Berlins Porphyry

SIGNIFICANCE: Good accessible and fresh exposures.

LOCALITY: Burnett's Stream, Denniston Plateau. L29: 110 382

GEOLOGICAL UNIT: Berlins Porphyry

DESCRIPTION: Widespread exposures of porphyry, fresh in road cutting and stream bed where pylons cross new and old roads to Cascade Creek Coal Mine. Intrusive contact with Greenland Group is exposed, and porphyry contains exceedingly abundant xenoliths of Greenland Group.

FEATURE TYPE: Pluton.

MAJOR PETROLOGICAL COMPOSITION: Dacite

EPOCH: Cretaceous

CLASSIFICATION: Importance - Regional/Local

VULNERABILITY: Moderately vulnerable to modification by humans.

HAZARDS: Coal mining activities.

OWNERSHIP: Stewardship land, Department of Conservation

Torea Rocks brecciated granite

SIGNIFICANCE: Type of breccia unique in New Zealand.

LOCALITY: Sea stacks and minor wave-cut platforms on the coast, near Granity.
L28: 152 535

GEOLOGICAL UNIT: Ngakawau Breccia

DESCRIPTION: Igneous and metamorphic sedimentary protolith, internally brecciated but with limited movement between blocks.

FEATURE TYPE: Intrusive breccia.

MAJOR PETROLOGICAL COMPOSITION: Granite

EPOCH: ?Cretaceous

CLASSIFICATION: Importance National

VULNERABILITY: Unlikely to be damaged by humans.

OWNERSHIP: Maori/Crown

REFERENCES: Shaw, D.G. 1990 The Ngakawau Breccia; description, origin and geological significance. Unpublished B.Sc. (Hons.) project, University of Canterbury.

LANDFORMS

(after Priestley 1990, Kenny & Hayward 1993)

Denniston Plateau

SIGNIFICANCE: A well-defined barren rocky weakly dissected plateau. An attractive feature, it was formed due to existence of a near horizontal resistant rock layer. Classified as an extremely well defined landform of scientific / educational and scenic value.

LOCALITY: A large plateau directly south of Denniston. K29: 090 380.

ACCESS: Appreciable from road or public place.

MORPHOGENIC PROCESS: Multiple.

LANDFORM TYPE: Plateau

MATERIAL: Coal measures, sandstone.

AGE: Tertiary

CLASSIFICATION: Importance - Regional/Local

VULNERABILITY: Unlikely to be damaged by human activities.

LANDUSE: Mainly derelict, the plateau contains some active coal mines.

OWNERSHIP: Stewardship land, Department of Conservation.

INFORMANT/DATE: G. Mew, 1990

Ngakawau Gorge

SIGNIFICANCE: A well-defined deeply incised (100-500 m) gorge extending 6 km cut into coal measures on the Ngakawau River. The deepest coastal gorge on the West Coast. Classified as an extremely well defined landform of scientific / educational and scenic value.

LOCALITY: Extending 6 km along the Ngakawau River. L28: 220540.

ACCESS: Walking track from Ngakawau township.

MORPHOGENIC PROCESS: Fluvial/Pluvial.

LANDFORM TYPE: Gorge.

MATERIAL: Arnold series coal measures.

AGE: Arnold series (Eocene).

CLASSIFICATION: Importance - Regional/Local.

VULNERABILITY: Unlikely to be damaged by human activities.

OWNERSHIP: Ngakawau Ecological Area, Department of Conservation.

INFORMANT/DATE OF INFORMATION: G. Mew, 1990.

SEDIMENTARY GEOLOGY SITES

(after Kenny & Hayward 1992)

Denniston Road conglomerate units

SIGNIFICANCE: Contrasting section to Cape Foulwind, indicative of tectonic activity on Paparoa Tectonic Zone.

DESCRIPTION: Coarse sands and gravel interbeds (some with very rare rafts of older Tertiary units) intercalated in Kaiata Mudstone.

GEOLOGICAL UNIT: Kaiata mudstone member, Torea Breccia

AGE: Eocene

NZ STAGE: Ak

LOCALITY: Denniston Road. K29: 077 413.

ACCESS: Along main road to Denniston.

EXPOSURE TYPE: Roadside.

CLASSIFICATION: Importance - regional

VULNERABILITY: Could be improved by human activity.

HAZARDS: Overgrowth

OWNERSHIP: Legal road (Buller District Council)

INFORMANTS/DATE OF INFORMATION: D.W. Lewis, M.G. Laird, 1987.

REFERENCES:

Lewis, D.W.; Laird, M.G. 1986. *Gravity flow deposits: processes and tectonics subaerial to deep marine, northern South Island Cretaceous to Recent, New Zealand*. Geological Society of New Zealand Miscellaneous Publication 36B.

SOIL SITES

(after Arand *et al.* 1991)

Denniston Scenic Reserve

LOCALITY AND GRID REFERENCE Southern bank of Waimangaroa River running back to Whareatea River, between Denniston and Waimangaroa.

K29: 085415

AREA: 684 ha

ALTITUDE: 25-610 m

RAINFALL: 3800-5700 mm

TOPOGRAPHY: Steep colluvial hillslopes leading to plateau; gorges; bluffs

PARENT MATERIAL: Granite, gneiss, greywacke and Tertiary rocks including coal measures and derived colluvium

VEGETATION: podocarp-beech-broadleaved forest; beech forest; pakihi community; rockland; low scrub; moorland

SOILS: Upland podzolised yellow-brown earths and podzols (Millerton, Wakamarama, Denniston), lowland podzolised yellow-brown earths and podzols (Okarito), upland yellow-brown earths, gley soils.

IMPORTANCE: National

SIGNIFICANCE: (i) Contains a moderate range of soils including Millerton soils which are only represented at one other site on the inventory (ii) Soils on coal measures are nationally uncommon.

VULNERABILITY: Site is formally protected; no foreseeable threat to soil and/or vegetation.

MODIFICATIONS: History of coal mining and settlement; crossed by road

TENURE: Scenic reserve

OWNER/MANAGER: Department of Conservation

CONTACT PERSON/DATE OF INFORMATION: Geoff Mew, May 1990.

REFERENCES:

Department of Lands and Survey 1984. *Register of Protected Natural Areas in New Zealand*. Department of Lands and Survey, Wellington.

McCaskill, L.W. 1975. *Scenic reserves of Westland*. Department of Lands and Survey, Wellington. 26 p.

Stockton Creek Scenic Reserve

LOCALITY AND GRID REFERENCE: Three small areas at Stockton, 29 km NE of Westport. L28: 185520

AREA: 13 ha

ALTITUDE: 275-385 m

RAINFALL: 3800 mm

TOPOGRAPHY: Plateau, colluvial hill slopes

VEGETATION: podocarp-beech/broadleaved forest; manuka shrubland; beech-broadleaved shrubland.

SOILS: Upland podzolised yellow-brown earths and podzols (Denniston, Millerton), gley soils (Trent), upland yellow-brown earths (Koranui).

IMPORTANCE: Regional

SIGNIFICANCE: A good example of Denniston and Millerton soils under native vegetation.

VULNERABILITY: Site is formally protected; no foreseeable threat to soil and/or vegetation.

TENURE: Scenic reserve

OWNER/MANAGER: Department of Conservation

CONTACT PERSON/DATE OF INFORMATION: Geoff Mew, May 1990.

REFERENCES:

Department of Lands and Survey 1984. *Register of Protected Natural Areas in New Zealand*. Department of Lands and Survey, Wellington.

McCaskill, L.W. 1975. *Scenic reserves of Nelson*. Department of Lands and Survey, Wellington. 26 p.

STRUCTURAL GEOLOGY SITES

(after Nowell & Sporli 1991)

Stockton structural detachment

SIGNIFICANCE: An example of structural detachment.

DESCRIPTION: Structural detachment in coal seams with associated imbricate shear structures.

LOCALITY: On road between Stockton and Mt William mine (L28: 177 526 to L29: 194 460).

ACCESS: Via Coalcorp road.

EXPOSURE TYPE: Road cutting.

CLASSIFICATION: Importance - regional

VULNERABILITY: Moderately vulnerable to modification by humans.

HAZARDS: Road widening.

OWNERSHIP: Stewardship land, Department of Conservation (subject to Coalcorp ancillary coal mining license).

INFORMANT/DATE OF INFORMATION: J.D. Bradshaw, 1989.

APPENDIX VIII SOIL REFERENCE SITES, NGAKAWAU ECOLOGICAL DISTRICT

Prepared by G. Mew, DSIR Land Resources, Lower Hutt, October 1990

SOIL SERIES NAME	GRID REFERENCE AND LOCATION	REASON FOR SITE REQUIRING PROTECTION	VEGETATION COVER AT TIME OF DESCRIPTION	TOPOGRAPHY	SOIL CLASSIFICATION AND PARENT MATERIAL	INFORMATION RECORDED ABOUT SOIL/SITE				
						FULL DESCRIPTION	PARTIAL DESCRIPTION	FULL ANALYSES	PARTIAL ANALYSES	NO ANALYSES
CHRISTMAS	K29 012328 Slopes below Trig M	Type locality for soil series	Pakihi vegetation including manuka	Upper third of steep slope	Skeletal soil (lithosol) from bouldery colluvium of sandstone and some mudstone	✓				✓
DENNISTON										
SITE 1	L28 227580 NW of Charming Creek coal mine	Reference locality for soil series (hill soil)	None. Burnt in preparation for exotic forestry	Upper third of hilly slope	Podzol from quartzose sandstone, with related slope deposits	✓	✓		✓	
SITE 2	L28 229436 SSE of Isolated Hill	Type locality for soil series	Pakihi vegetation	Rolling country	Podzol from quartzose sandstone	✓				✓
SITE 3	K29 043383 Western slopes of Mount Rochfort	Reference locality for soil series	Podocarp/hardwood forest remnant	Bench within steep land	Podzol from quartzose sandstone		✓			✓
KORANUI	K29 102393 SSE of Denniston	Type locality for soil series	Alpine vegetation (Celmisia sp. etc.) along rock joints	Lower third of slope on dissected plateau	Yellow-brown earth from mixed colluvium of sandstone, mudstone and coal		✓			✓
MACKLEY	L28 280545 Between Tate Creek and St Andrew Stream	Type locality for soil series	Beech/podocarp forest, cutover for rimu	Midslope of hilly slope	Weakly gleyed yellow-brown earth from mixed granite and greywacke gravels over sandy mudstone	✓				✓
MILLERTON										
SITE 1	K29 022370 1 km S of old Fairdown Power Station	Type locality for soil series	Pakihi vegetation with isolated Pinus radiata	Midslope on broken slope in steep land. Hilly at site.	Strongly gleyed humus podzol from mixed colluvium of sandstone, mudstone and coal	✓		✓		
SITE 2	L28 240616 Near Chasm Creek, Seddonville	Reference locality for soil series	Podocarp forest	Upper third of slope on gully side in steep land	Gleyed humus podzol from mixed colluvium of sandstone, mudstone and coal, over sandstone	✓				✓

SOIL SERIES NAME	GRID REFERENCE AND LOCATION	REASON FOR SITE REQUIRING PROTECTION	VEGETATION COVER AT TIME OF DESCRIPTION	TOPOGRAPHY	SOIL CLASSIFICATION AND PARENT MATERIAL	INFORMATION RECORDED ABOUT SOIL/SITE				
						FULL DESCRIPTION	PARTIAL DESCRIPTION	FULL ANALYSES	PARTIAL ANALYSES	NO ANALYSES
NGAKAWAU	L29 255475 NE of Mullochy Stream	Reference locality for soil series	Beech/podocarp forest	Undulating terrace remnant	Weakly gleyed yellow-brown earth from consolidated sandy mudstone and siltstone	✓				✓
TATE	L28 289559 N of Tate Creek/Chasm Creek headwaters	Type locality for soil series	Beech/podocarp forest (silver and mountain beech, rimu)	Upper third of spur in steep land	Moderately gleyed podzol from greywacke, with related slope deposits	✓				✓
TRENT	K29 010354 Caledonian Terrace in Westport Waterworks Reserve	Type locality for soil series	Pakihī vegetation with 1.7 m high manuka	Lower third of hilly slope	Gley soil from sandstone, mudstone and coal, with related slope deposits		✓			✓
VEE FORTY	K29 016326 NNW of Trig M	Type locality for soil series	Semi-pakihī vegetation with manuka, southern rata and Dracophyllum spp.	Upper third of broken hilly slope	Moderately gleyed skeletal soil (Lithosol) from quartz sandstone		✓			✓

APPENDIX IX ECOLOGICAL ASSOCIATIONS ON BRUNNER AND PAPAROA COAL MEASURES OUTSIDE THE BULLER COAL PLATEAUX

Introduction

This PNAP survey for the Ngakawau ED was conducted within the framework of an understanding between Ministry of Commerce, Coalcorp and the Department of Conservation that the Department would seek to identify representative areas for conservation outside areas of known coal resources wherever possible (section 1.3.4).

In the event this has proved not possible to achieve in full. Of the six proposed recommended areas for protection (RAPs), one, the Upper Waimangaroa, also contains valuable coal resources (Barry & MacFarlan 1988). This survey in general found that the least modified ecosystems on the Buller coal plateaux correlated with the absence of coal production and hence the absence of substantial human disturbance (such as fire, tracking and substrate disturbance).

Following the preparation of a draft Ngakawau PNAP survey report, Cave (1992) (for the Ministry of Commerce) outlined the nature of the coal resources in the areas of resource overlap. He noted: "The Upper Waimangaroa PNA programme may have validity (sic.), however, this cannot be established until the other (Brunner coal measures) areas containing similar rocks and vegetation have also been examined in the same programme. Since large areas occur which do not contain such valuable (coal) resources, it is quite possible that such areas could provide the features identified as being of interest in the Upper Waimangaroa." To facilitate such comparison, he identified the full range of Brunner and equivalent coal measures in the Nelson and West Coast regions.

Cave also suggested (p. 15) that whereas the basis of the PNAP is the protection of **representative ecosystems**, the draft Ngakawau PNAP report modified the original PNA criteria in using the **association** of a natural community with a specific set of rock types as the basis for its analysis (original emphasis).

This Appendix tabulates and compares the environmental features of the Brunner coal measures sites identified by Cave (1992), and examines the question he has raised about the basis of the Ngakawau PNAP survey.

Brunner Coal Measures Sites in Nelson and on the West Coast

For each of the coal measures occurrences cited by Cave (1992), Table 1 lists the dominant environmental factors: approximate area, altitudinal range, rainfall, lithology, landform and vegetation (plus ecological district, McEwen 1987). These are then compared with the ecological units occurring on the Buller coal plateau generally, and in the Upper Waimangaroa valley in particular, as identified in this PNAP report.

These environmental factors were chosen because of their considerable influence on vegetation patterns in Nelson and on the West Coast (e.g., Druce, Williams & Heine 1987, Wardle 1980, 1991, Norton 1991, Williams 1991, 1993).

Rainfall and altitude (the latter a functional measure of temperature and exposure) provide the principal climate parameters. Lithology and landform (including slope) are strong determinants of soil fertility, drainage and stability. The ecological district provides an indication of the broader ecological patterns and relationships of the area surrounding each coalfield.

The coal measures occurrences cited by Cave were located on recent, detailed geological maps (where available), and otherwise on 1: 250 000 reconnaissance geological maps (Grindley 1961, Beck 1964, Bowen 1964). They were enlarged (where necessary) and drawn onto 1: 50 000 topographic maps. Approximate area (sum of 100 ha grid squares or parts thereof), altitudinal range and in some cases vegetation data were sourced from these maps. Other vegetation data comes from cited references or personal knowledge.

In some cases, some of the data are of a lesser quality than desired. For instance, topographical information for the Karamea and Mokihinui catchments on the Northwest Nelson 1: 250 000 geological map (Grindley 1961) is inaccurate, and has made translation of the Garibaldi coal measures rocks to 1: 50 000 topographical maps open to considerable uncertainty. The overall range of data available however gives a sufficiently robust picture of the nature of the vegetation-landform system of each site.

Like Cave (1992), this analysis covers only coal measures rocks exposed at the land surface (cf. Figure 11 of Anckorn *et al.* (1988), which also shows coal measures rocks without surface expression).

Results

All 17 Brunner coal measures sites listed in Table 1 have a similar geological origin. Since the uplifting of the north-west Nelson ranges began at the beginning of the Kaikoura Orogeny c.15 million years ago, the softer later Tertiary rocks (e.g., limestones, mudstones and siltstones) which were deposited above the Brunner coal measures have been progressively eroded away, leaving the coal measures exposed.

Today the largest surface expression of these rocks is the Denniston and Stockton coal plateaux (c.14 000 ha). The coal plateaux is a stripped peneplain surface (Korsch & Wellman 1988) whose compressed coarse quartzose sandstones have resisted the erosional forces of the West Coast's high rainfall. The thin quartz sand soils which develop on these gently sloping, impervious capping beds are water retentive and extremely infertile. Peat is quickly produced, leading to even lower fertility. Such soils, combined with the 600-1000 m altitude, exposure, high rainfall (generally 4000-6400 mm per annum) and poor drainage, lead to the characteristic short-stature plant assemblages which characterise the plateaux (section 2.6).

For comparative purposes, the other "Brunner coal measures" occurrences cited by Cave (1992) can be grouped into five broad classes (not mutually exclusive).

TABLE 1 ENVIRONMENTAL FACTORS AND VEGETATION OF BRUNNER COAL MEASURES, NELSON AND THE WEST COAST

Locality	Ecological District	Approx. Area (ha)	Altitudinal Range (m)	Rainfall (mm) ¹	Lithology 2	Landform and Slope	Vegetation
1 Takaka coalfield	Golden Bay	700 (15 scattered sites)	0-520	1600-4000	Motupipi CM 3	Gentle to steep hillslopes	Exotic pine forest, gorse-manuka scrub, manuka-Baumea teretifolia-tanglefern rush-shrubland (Shannel Courtney pers. comm.)
2 Nelson City	Bryant, Motueka	300 (1 very elongated site)	??	??	Marsden CM 4	n.d.	Exotic pasture, residential (Shannel Courtney pers. comm.)
3 Baton River	Arthur	4 000 (1 main, 6 peripheral sites)	180-700	1400-2400	Motupipi CM 3	Steep hillslopes, ridges, incised valleys	Gorse scrub, bracken fernland, rimu/hard beech-silver beech forest, exotic pine forest (Shannel Courtney pers. comm.)
4 Mt Garibaldi	Wangapeka	750 (mainly long, narrow exposure)	500-1157	4000-4800+	Brunner CM 5; much overlain by colluvial limestone debris	Steep sideslopes of Garibaldi Ridge and Mt Pyramid	Red tussockland, midribbed snow tussockland, midribbed snow tussock/carpet grass tussock-grassland, mountain beech-Dracophyllum traversii forest and treeland (Shannel Courtney pers. comm.)
5 Heaphy	Heaphy	500 (2 sites, mainly long, narrow exposures)	10-400	2800-4000	Brunner CM 5	Moderately steep lowland mid-hillslopes	Lowland podocarp-mixed beech-broadleaved forests (New Zealand Forest Service 1978, Newsome 1987)
6 Karamea	Karamea, Wangapeka	400? (long, narrow exposure) 6	240-900 6	4000-4800+	Kaiaia siltstone, smaller areas of Brunner CM 6	Moderately steep to steep hillslopes, ridges and valleys	Lowland and highland podocarp-mixed beech-broadleaved forest (New Zealand Forest Service 1978, Newsome 1987)
7 Matiri Range & Pike Peak	Matiri	- 7	300-1100 7	4000-4800+	Kaiaia siltstone 7	Moderately steep hillslopes, ridges and incised gullies; some scarps overlain by limestone colluvium	Mixed beech forests; scral, subalpine and valley shrublands and grasslands; and rock, scree and shingle (Rose 1985, Davis & Orwin 1985)
8 Charleston	Foulwind, Punakaiki	<200(10 sites)	10-200	2400-2800	Brunner CM 8	Dissected gully, planed marine terraces, hillslopes, scarp bottoms	Fire-induced pakihī, shrublands and regenerating forest; rimu-mountain beech forest in unburnt areas.
9 Punakaiki	Punakaiki	<200(4 sites)	10-350	2800-3200	Brunner CM 9	Mid and lower hillslopes	Fire-induced manuka shrublands and regenerating forest; intact rimu and mixed beech-podocarp forest.

10 Inangahua Coalfield	Reefon, Buller Maimai	400 (c.12 sites)	200-400	2000-4000	Brunner CM 10	Moderately steep hillslopes and incised gullies; scarps at Fletcher Ck; some gentle slopes in Orikaka forest	Short mountain and silver beech and small podocarps (silver, yellow silver and pink pines) on gentle slopes in Orikaka forest (Gleason 1982). Taller mixed beech-podocarp forests with species characteristic of better drained sites (e.g., hard beech) likely on better drained hillslopes.
11 Flat Creek	Reefon	- 11	230-1020	2400-4000	Kaiata siltstone ¹¹	Ridges, moderately steep hillslopes and incised gullies	Red and silver beech forest, bracken fernland on cleared slopes.
12 Murchison	Rotorua, Reefon	<100 (5 outcrops) 12	140-440	2000-2400	Kaiata siltstone; thin slivers of Brunner CM 12	Moderately steep hillslopes and incised gullies	Mixed beech forest, bracken fernland
13 Reefon-Garvey Ck	Reefon, Totara Flat	2000(13 sites)	200-1200	2000-4000	Brunner CM (Bowen 1964)	Hillslopes, dissected gullies (some steep), ridges	Fire induced shrublands and regenerating forest (especially at lower altitudes); mountain beech-yellow silver pine-pink pine-southern rata forest on montane ridges (e.g., Island block); mixed beech forest on Victoria Range and other hillslopes.
14 Pike River	Maimai, Punakaiki	<50(2 sites)	800-1000	5000	Island Sandstone (Laird 1988)	Scarp, hillslope	Primarily cliff vegetation (not shown on Craig et al.'s (1989) detailed part map of the upper Pike River catchment).
15 Greymouth Coalfield	Blackball	600(c.30 occurrences)	10-1047	2800-4000	Brunner CM 13	Plateau tilted to west, dissected hill country, sandstone outcrops	Subalpine open heathland communities on Mt Davy plateau (above 750-900 m, <150 ha); lowland podocarp-beech forest or fire-induced manuka shrublands at lower altitudes (Applied Geology Associates 1985)
16 Paringa	Paringa	100	0-200	4000	Marine breccia (Mutch & McKellar, 1964)	Coastal hillslopes	Coastal podocarp-broadleaved forest

17 Buller coalfield	Ngakawau	14 000(south of Ngakawau Gorge)	10-1106	2800-6400	Brunner CM	Gently sloping sandstone pavements, dissected gullies and gorges, fault scarps, steeply dipping coastal faces	a) Rimu/Broadleaved forestb) Mixed beech-southern rata forest (red or silver beech dominant)c) Hard beech-southern rata-rimu forestd) Rimu/mountain beech forest, mountain beech-pahautea forest, southern rata-mountain beech foreste) Mountain beech/yellow silver pine-pink pine forestf) Mountain beech-silver beech forest and shrubland g) Leatherwood scrubh) [Mountain beech]/manuka scrubi) Pink pine - Chionochloa juncea-manuka tussock-shrublandj) Manuka-Dracophyllum politum/wire rush rush-shrublandk) [Manuka]/wire rush-Chionochloa juncea tussock-rushland with subalpine bog speciesl) [Manuka]/wire rush-tangle fern shrub-rushlandm) Baumea teretifolia-Rytidosperma gracile/ tanglefern rushlandn) Red tussock-bog pine shrub-tussockland(Appendix IV, this report)
18 Upper Waimangaroa valley RAP	Ngakawau	2075	500-1106	4000-6400+	Brunner CM; limited areas of Kaiata siltstones in valley bottom	Gently sloping sandstone pavements, dissected gullies and gorges, fault scarps	a) Mountain beech/yellow silver pine-pink pine-pahautea forestb) Prostrate pink pine-Chionochloa juncea - prostrate manuka tussock-shrublandc) Manuka-Dracophyllum politum-wire rush rush-shrublandd) Manuka/wire rush-Chionochloa juncea tussock-rushland with subalpine bog speciese) Red tussock-bog pine shrub-tussockland (Table 7, this report)

Notes:

1 Source: Isobyt map accompanying New Zealand Meteorological Service (1973).

2 CM = coal measures

3 Source: Grindley (1961), Coleman (1981); equivalent to Brunner coal measures (Cave 1992).

4 Source: Beck 1964; equivalent to Brunner coal measures (Cave 1992).

5 Source: Grindley (1961)

6 Cited as Brunner coal measures by Cave (1992). Shown as Arnold series (dark calcareous siltstone, algal limestone, glauconitic sandstone, thin coal measures at base) by Grindley (1961); and as Kaiata siltstone (carbonaceous siltstone interbedded with sandstone) and a narrow base of Brunner coal measures by Bowen (1964). The actual extent of Brunner coal measures is unknown from these sources of data, but appears to be considerably less than that shown by Cave (1992). If the proportion of Kaiata siltstone to Brunner coal measures shown by Bowen (1964) holds for the entire area, perhaps 400 ha of Brunner coal measures, in long, narrow slivers, are exposed. Altitudinal range shown is for entire Arnold series.

7 Cave's (1992) Figure 2 shows extensive bands of "Brunner coal measures", centred on the Matiri Range and Pike Peak. These areas are shown by Grindley (1961) as Arnold series (dark calcareous siltstone, algal limestone, glauconitic sandstone, thin coal measures at base), and by Bowen (1964) as entirely Kaiata siltstone and carbonaceous siltstone interbedded with sandstone. The small part of this formation shown on Suggate's (1984) map includes a 200 m wide band of Brunner coal measures. The Arnold/Kaiata formation is exposed largely below the extensive limestone plateau of the Matiri Range and Pike Peak; small exposures of Brunner coal measures at its base are likely to be overlain by limestone colluvium unleashed by the 1929 Murchison earthquake. Notably, Cave (1992) does not include the Matiri Range-Pike Peak occurrence in his detailed descriptions of Brunner coal measures occurrences.

8 Nathan's (1975) 1: 63 360 map shows less Brunner coal measures exposed than Cave's (1992) Figure 2. The data here follow Nathan's more detailed map. Cave appears to have included Kaiata mudstone and/or Little Totara sand, overlying the Brunner coal measures. These are a fine muddy calcareous sandstone and white mica-feldspar-quartz sand respectively, and weathers to distinctly different soils than compressed quartzose sandstones associated with Brunner coal measures.

9 Laird's (1988) 1: 63 360 map shows less Brunner coal measures exposed than Cave's (1992) Figure. The data here follow Laird's more detailed map. As at Charleston, Cave appears to have included Kaiata mudstone and Island Sandstone on his Figure 2.

10 Cave (1992) describes the Inangahua coalfield as the Fletcher Ck and Heaphy mine deposits. His Figure 2 evidently follows Bowen's (1964) reconnaissance geological map, whereas his Figure 3 follows the more detailed recent geological map of Nathan (1978b). The latter shows Brunner coal measures totalling c.400 ha scattered in about twelve locations.

Nathan also shows considerable areas of Rotokobu coal measures (2500 ha, 11 sites) not shown by Bowen (1964). Rotokobu coal measures consist of medium to coarse arkosic sandstone interbedded with conglomerate, carbonaceous mudstone and scattered lenticular coal seams, of late Miocene age (Nathan 1978b). They are less hardened than Brunner coal measures, and landforms are generally dissected hill country. Vegetation cover is lowland podocarp-broadleaved-beech forest, much of it logged (Newsome 1987).

11 Although Cave (1992) maps Flat Ck as Brunner coal measures, Bowen (1964) maps it entirely as Kaiata siltstone. On the basis of the detailed mapping by Suggate (1984) and Bowen (1964) of these rocks in the nearby Murchison basin, it seems likely there are exposures of Brunner coal measures but the majority of the Flat Ck-Coffee Ck area is Kaiata siltstone.

12 The Murchison coal exposures are referred by Cave (1992) to Brunner coal measures but are not shown on his Figure 2 (although that may be a cartographic artifact). Bowen (1964) maps the area entirely as Kaiata siltstone. Suggate's (1984) and Roder & Suggate's (1990) detailed maps (followed here) show very narrow slivers of Brunner coal measures amounting to less than 100 ha.

Cave (1992) maps (Figure 2) but does not describe slivers of "Brunner coal measures" in a line stretching from Glenhope through Gowanbridge, Nuggety Ck, Tiraumea and Mammoth to Upper Glenroy. Suggate (1984) shows the Nuggety Ck occurrence in more detail, and another at Te Peta. These sites are generally steep to very steep hillslopes clothed by mixed beech forest.

13 Nathan (1978a) also maps extensive areas of Paparoa coal measures in the Greymouth coalfield. These consist of seven formations, of four coal measures members alternating with three mudstone members. The coal measures are described as consisting of greywacke conglomerate, micaceous arkosic sandstone, carbonaceous shale, and coal seams (*ibid.* p. 9). They are distinguished from Brunner coal measures by the latter's predominance of quartz-rich sandstone interbedded with quartz conglomerate. As soil parent materials and a host for vegetation, Paparoa coal measures are distinguishable from Brunner coal measures by their complex, alternating exposures and their generally finer, more erodable and dissected nature. They tend to support podocarp and beech forest rather than shrub and tussocklands.

These are primarily sites that are well inland, some in the rain shadow of the North Westland and Buller Ranges. They are generally hillslopes, and, where the native vegetation is still intact, are covered by mixed beech forest. None of the ecosystems they support are in any significant way comparable to the coal measures vegetation-landform systems on the Dennistown and Stockton coal plateaux or in the Upper Waimangaroa valley (although short forest types on Island sandstones at Pike River are comparable with those in the Upper Waimangaroa).

- (a) Non-Brunner Coal Measures Sites (Karamea, Matiri Range and Pike Peak, Punakaiki, Flat Creek, Murchison, Pike River)

Six of the 17 sites shown by Cave (1992) as Brunner coal measures were found by reference to detailed geological maps to either lack or have only narrow exposures of Brunner coal measures rocks. Rather they predominantly or totally comprised Kaiata mudstones and siltstones, Totara sands or Island sandstones.

- (b) Sites East of Main NW Nelson Ranges (Takaka, Nelson City, Baton River, Murchison)

These sites lie in the rain shadow of the Northwest Nelson ranges. Only the Baton River area rises to within the altitudinal range of the Buller coal plateau (700 m), and a small part of the Takaka coalfield to the Buller coalfield's rainfall level. The sites are all hillslopes, ridges and gullies, covered either by mixed beech forest or converted vegetation associations (e.g., bracken fernlands, shrublands, exotic forests). None have the mountain beech/yellow silver pine-pink pine-pahautea forests of the upper Waimangaroa basin, or the open tussock, rush and shrubland communities of the sandstone plateau slopes rising to Mt Frederick or Mt William.

- (c) Low Altitude Sites on West Coast (Heaphy River, Charleston, Punakaiki, part Greymouth coalfield, Paringa)

These low altitude sites (from near sea-level to c.400 m asl) support lowland podocarp and beech forest where the native vegetation is intact, and manuka-dominant shrubland and other regenerating shrublands and forest where it has been modified. Rainfall is generally lower than the Buller coal plateau. Soil parent material at Paringa is marine breccia. Although the lithology and hence infertile soils of these sites does have an influence on forest composition, they are quite different to the open tussock, shrubland and montane forest associations in the Upper Waimangaroa valley.

- (d) Montane Brunner Coal Measures Sites (Inangahua, Reefton-Garvey Ck)

Most of these sites are on hillslopes. The limited areas which are flat or gently sloping do support forest vegetation similar to that occurring in the bottom of the Upper Waimangaroa valley (predominantly on Kaiata siltstone). Forests dominated by mountain beech, yellow silver pine, pink pine, southern rata, etc. are known to occur at Island block, Pensini Ck and Merrijigs. Other parts of these sites are clothed by regenerating manuka dominated shrublands (where the native vegetation has been modified), or by mixed beech associations (on slopes).

Although parts of these sites are comparable to forests of the upper Waimangaroa valley, they are primarily on hillslopes, and lack any of its open shrublands and tussocklands. Rotokohu coal measures in the Inangahua valley support low altitude (100-400 m asl) mixed podocarp-broadleaved-beech forests on hillslopes, and are dissimilar too.

- (e) Upper Montane to Subalpine Sites (Garibaldi Ridge, part Greymouth coalfield Mt Davy)

The coal measures of Garibaldi Ridge are overlain in part by colluvial limestone deposited by the 1929 Murchison earthquake. The site itself

comprises hillslopes. In respect of soil parent material, landform and vegetation, it is quite different to the Upper Waimangaroa.

The Mt Davy Brunner coal measures plateau has the most similar environmental influences to the upper Buller coal plateau; exposure, upper montane to subalpine altitude, tilted Brunner coal measures substrate, low heathland vegetation. However it is considerably smaller (<200 ha, 1.4%) than the Upper Waimangaroa and lacks the range of coal measures vegetation communities found there (e.g. those dominated by *Chionochloa juncea*). The vegetation too is greatly influenced by guano from a well-established black-backed gull colony. Fire would appear to have been a greater influence.

The Paparoa coal measures in the Greymouth coalfield largely lack the resistant quartz-rich sandstone rocks which characterise the Brunner coal measures. They are mostly at lower altitudes and their landform and vegetation patterns too are not directly comparable with the Upper Waimangaroa.

The ecological unit, the basis of the PNAP

Cave (1992) has questioned (a) whether this PNAP report's use of the association of a natural community with a specific set of rock types is consistent with the PNAP, and (b) whether the same vegetation type could occur on landforms different to, and could then be used in substitution for, the Upper Waimangaroa-Mt William RAP).

- (a) The essence of the PNAP survey methodology for determining the ecological character of an ecological district, and then representativeness, is the **ecological unit** (Myers *et al.* 1987). The ecological unit uses the two most readily recognisable properties of land, landform and vegetation pattern. The ecological unit is a link, in tandem, of a natural community type (usually a vegetation type) and a physical environment type (usually a landform type) (e.g., kahikatea-puriri forest on riverflats).

The Ngakawau PNAP survey's use of the association of vegetation and landform in its analysis is entirely consistent with the key principle of the survey methodology recommended by the PNAP Guidebook (Myers *et al.* 1987).

In practice too, there is a strong relationship between coal measures lithology and slope (both indicative of geomorphological history) and the character of the vegetation it supports. Stunted forests and heathlands are typical of areas with very infertile soils and impeded drainage resulting from low slopes on the plateaux, whereas steeper mid-slope exposures typically have less obvious direct influences on the vegetation.

- (b) The question of whether the same vegetation type could occur on a different landform and substrate was considered during the development of the PNAP survey methodology. As an example, in many parts of the country, seral kanuka forest and shrublands occur both on moderately fertile hillslopes and on fertile valley bottoms. In many cases such communities are floristically very similar. Are these the same? Because of the influence of landform, the

answer is generally no. Disturbance regimes and hence regeneration patterns on the two substrates are different, and will ultimately result in two different associations, of kahikatea, pukatea and other species typical of valley floors, or of tawa, rimu, hard beech and other species typical of hillslopes.

In the context of the Ngakawau PNAP survey, Cave's (1992) question translates to whether there are other sites of different parent material but vegetation and flora similar to the Buller coal plateau? There are two possibilities to consider.

- (i) **Pakihi:** Pakihi are characterised by flat to undulating topography on outwash surfaces from 10 000 to 250 000 years old, > 2200 mm rainfall annually, and strongly leached and gleyed soils with organic stained upper horizons (Williams *et al.* 1990). Their soils are often derived from highly siliceous parent materials but can also be peat (Norton 1989).

Previous observers (e.g., Townson (1907), Rigg (1962), Butler (1983)) have commented upon the similar floristic composition of pakihi and coal measures communities, including the presence of normally subalpine and alpine species in both. This survey has found that although similarities between the two can be discerned, the vegetation associations of lowland pakihi and upland coal measures are different. The greatest similarities with pakihi occur in the lower altitude coal measures vegetation, where the dominant pakihi species (*Empodisma minus*, *Gleichenia dicarpa*, *Baumea teretifolia*, *Lepidosperma australe*, shrubby manuka) are also common (association 12, Appendix IV). It is important to note, however, that these lower altitude coal measures communities have been substantially modified by fire and their floristic composition and structure appears more simple than less modified areas. Above 600-700 m, the vegetation structure and composition of coal measures vegetation changes to dominance by prostrate yellow silver pine-pygmy pine hybrid, pink pine, manuka and *Dracophyllum politum*, the coal plateau tussock (*Chionochloa juncea*), *Empodisma minus*, and a much wider range of smaller shrubs, herbs, orchids and sedges than most pakihi. Possibly others who have compared the coal measures and pakihi communities did not familiarise themselves with coal measures vegetation at the upper end of its altitudinal range.

- (ii) **Associations on poorly drained, siliceous rocks (e.g., granites):** Similar forest and shrubland communities to those found on Brunner coal measures do occur on areas of gently sloping granite and related rock types (e.g., Wardle, Mark & Baylis 1973, Wilson 1987, Lee, Ward & Wilson 1991, Williams 1991), although the composition and structure of these communities, especially for the shrublands, is not identical and often different combinations of species dominate. For example, on Stewart Island *Olearia colensoi* is a common component of low forest and scrub communities (Wilson 1987), but is uncommon in the Ngakawau Ecological District. Similarly, the *Halocarpus biformis* scrub of western Nelson granite ranges (Williams 1991) lacks the floristic diversity of similar communities at Ngakawau.

There are also other communities (principally on granites) which are similar to the shrubland and tussock grassland communities of the coal plateaux (e.g., on Stewart Island, Wilson 1987, at West Cape, Wardle *et al.* 1973, and

the granitic peneplains of NW Nelson), but again these differ in composition and structure. For example, *Chionochloa acicularis* dominates the grassland at West Cape (Wardle *et al.* 1973), and the shrublands includes species such as *Dracophyllum menziesii* and *Sprengelia incarnata*, species not present at Ngakawau. The most comparable sites to Ngakawau are probably the granitic peneplains 75-100 km to the north in Northwest Nelson. Red tussock, *Baumea teretifolia*, wire rush and tanglefern are dominant at Goulard Downs (600-800 m asl) (Druce & Simpson 1979). Gunner Downs (900-1231 m asl) and Mackay Downs (700-850 m asl) have a mosaic of red tussockland and short forest (mountain beech, leatherwood, pink pine, cedar, *Dracophyllum* spp.) (Wardle & Buxton 1986). Although the Goulard Downs and Mackay vegetation has counterparts at lower parts of the Stockton plateau and the upper Waimangaroa valley, a number of plants that are distinctive of the elevated coal measures open vegetation at Ngakawau are not present in these other communities (e.g., the coal plateau endemic tussock, *Chionochloa juncea* and the shrub *Dracophyllum politum*).

While it might be tempting to suggest that these non-coal measures communities can in some way represent the communities present in the Ngakawau Ecological District, this misses the importance of conserving the full range of ecological diversity present within New Zealand (Kelly & Park 1986). Such an assumption of similarity is akin, for example, to saying that the *Nothofagus* forests of North Westland are equivalent to the *Nothofagus* forests of Fiordland. The Brunner coal measures ecosystems are characterised by a distinctive underlying geology with associated landforms and a particular range of climatic conditions. These environmental factors together with the biogeographical relationships of this area (e.g., affinities with northwest Nelson) have lead to the development of the unique ecological patterns present within this area, ecological patterns that are not repeated elsewhere in New Zealand.

Conclusions

1. The Buller coal plateaux, at 14 000 ha, contain by far the largest occurrence of Brunner coal measures in New Zealand (Suggate, Stevens & Te Punga 1978), with the greatest diversity of vegetation types on coal measures, including endemic communities and species. No other examples of its extensive montane to subalpine open heathlands occur elsewhere in Nelson or the West Coast; nor are there similar rocks and landscapes at elevated, exposed and high rainfall sites elsewhere in New Zealand (*ibid.*). Other potential sites in Nelson and the West Coast can be discounted on the basis of major differences in one or more major environmental factors. Even among the upper montane to low alpine possibilities (Garibaldi, Matiri, Karamea, Reefton-Garvey Ck, Pike River and Greymouth), none except the Mt Davy part of the Greymouth coal plateau contains a gently tilted Buller coal measures plateau with open vegetation communities. The Mt Davy plateau is small, lacks the diversity of communities in the Buller.

Ngakawau ED is the only ecological district in New Zealand defined by the presence of extensive elevated coal measures rocks and associated landforms

and vegetation (McEwen 1987), and as such could be regarded as a nationally outstanding natural landscape in its entirety.

2. Of the five major communities of the Upper Waimangaroa-Mt William RAP:
 - (a) red tussock associations such as found in the Happy Valley basin occur elsewhere in Northwest Nelson and on the West Coast;
 - (b) the mountain beech/yellow silver pine-pink pine-pahautea forests are found elsewhere (e.g., on the montane coal measures of Mt Rochfort, Te Kuha and Reefton, and on other substrates);
 - (c) associations 9, 10 and 11, which include the locally endemic coal measures tussock (*Chionochloa juncea*) as a dominant constituent of the vegetation, are by this reason alone confined to the Buller coal plateaux. Their uniqueness is emphasised by the lack of similar open montane to subalpine shrub and tussocklands on all the other coal measures sites cited by Cave (1992) (except for limited areas on the Greymouth coalfield) and on granite substrates. Two of these associations (9 & 10) are confined to the Stockton plateau; association 11 also occurs on the Denniston plateau (Table 5, this report).
3. Although related in structure, forest, shrubland and tussockland ecosystems on pakihis and on poorly drained siliceous rocks elsewhere in the South Island differ floristically from those on the elevated Buller coal measures plateaux.
4. This survey's use of the association of vegetation and landform to define ecosystems is entirely consistent with the PNAP survey methodology.
5. The dominant plant communities and associated landforms and landscapes that are present in the Upper Waimangaroa-Mt William RAP occur nowhere else in New Zealand and thus cannot be represented in any other protected natural area. Of the other communities in the RAP, the red tussock community in the Happy Valley is the only significant occurrence in the Ngakawau ED, and the forest communities on coal measures and Kaiata siltstones are essential to the overall functional and spatial integrity of the RAP.