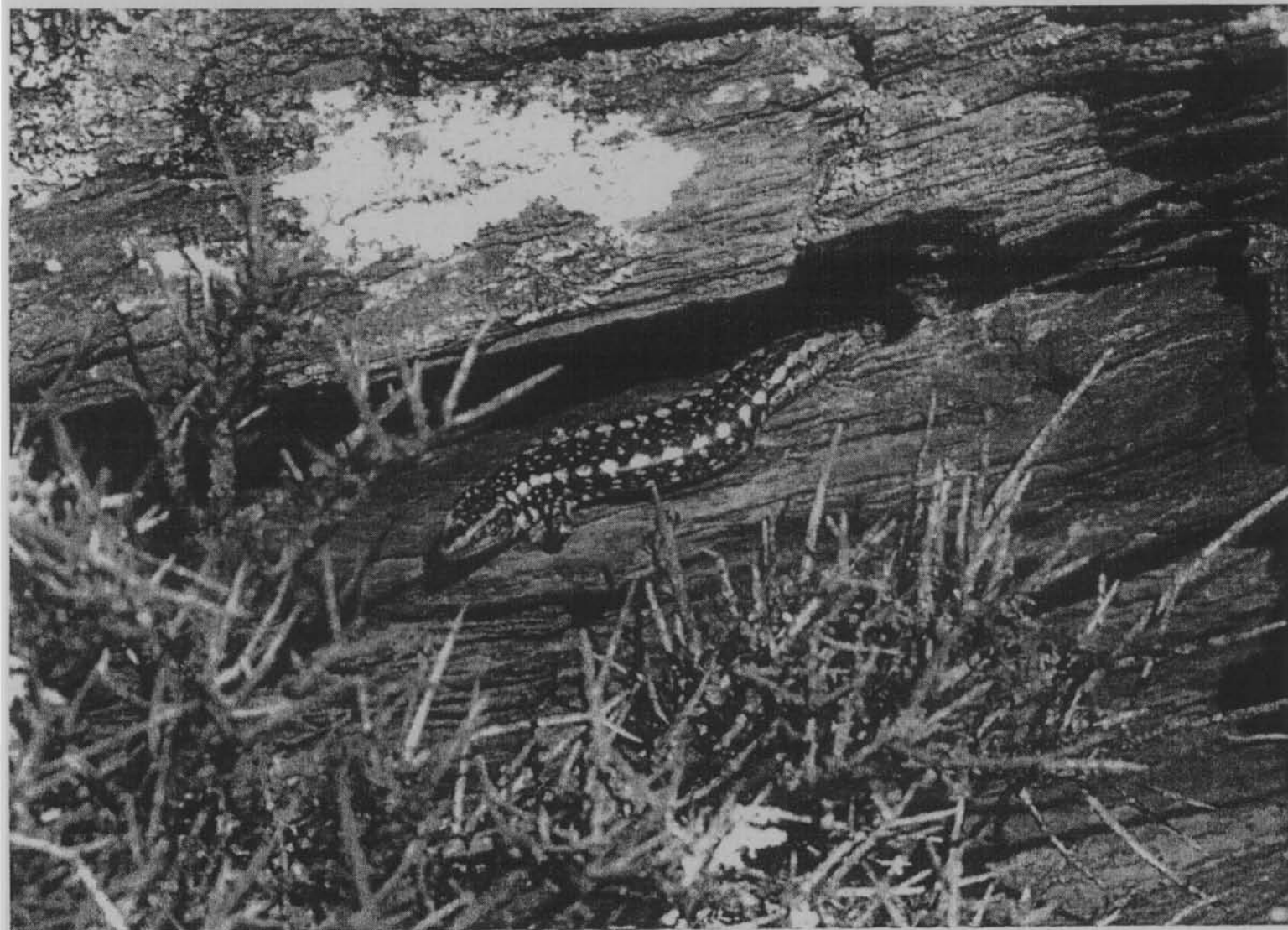




Macraes Ecological District

Survey Report for the Protected Natural
Areas Programme.

MAY 1997



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Te Papa Atawhai

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Survey Report for the Protected Natural Areas Programme.

Prepared by C. James Bibby.

Cover Photo : An Otago skink basks on a lichen-encrusted schist tor at Emerald Stream. The plant in the foreground is porcupine shrub *Melicytus alpinus*, which commonly grows on or around rock outcrops in the area. Photo: Neville Peat/DOC

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Foreword

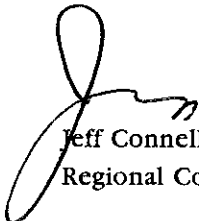
The Macraes Ecological District covers the eastern edge of Central Otago - an area of about 95,000ha comprising rolling mid-altitude hill country, dissected uplands, ridges and valley floors. The eastern boundary is a line through the middle of the Strath Taieri Valley, from Kokonga in the north to just south of Sutton. Dunback and Hindon are westernmost points, with the western boundary running through the upper reaches of the Waikouaiti catchment. The hills are predominantly built of schist, although there are a few scattered patches of volcanic rocks. Tussock grasslands dominate the flora.

Under a contract from the Department of Conservation, James Bibby carried out a survey of the district for the Protected Natural Areas Programme in the summer of 1994-95. It formed the basis of a Master of Science thesis. Bibby gathered advice from numerous scientific quarters to produce this report, which details the vegetation and landform features of the district. The main outcome of the survey and this report is a list of Recommended Areas for Protection (RAPs). Collectively, these represent the best remaining natural features and areas of ecological diversity in the district, given that human modification over time has made inroads across large tracts of the region. A total of 20 RAPs are identified and described in detail.

They are the starting point for the implementation phase of the PNA Programme in this district. Because the bulk of the RAPs lie on privately owned land, the implementation phase will necessarily involve an intensive round of discussion and consultation with landholders. Where appropriate and with the consent of the landholder concerned, the Department of Conservation will negotiate protective mechanisms for the RAPs.

Over the past 10 years, the Otago Conservancy has protected significant areas of inland Otago by this process and through the tenure review programme on pastoral leasehold land. A list of RAPs is as much a recommendation to the Department as from it. The RAP boundary lines are only notional at this point. Recommendations may be rejected or amended prior to their adoption as official proposals. Changes in recommendations may occur in the course of the consultation process.

This report contains considerable information on the ecological values of the Macraes-Middlemarch district. It represents the first comprehensive survey of the ecological values of the district, especially the vegetation and flora. In addition to its being a substantial reference work, it is a practical guide to conservation interests in the district. It will be of wide interest to landholders, local authorities and the general public as well as to conservation interests.



Jeff Connell
Regional Conservator

Abstract

A Protected Natural Areas (PNA) Programme survey of Macraes Ecological District, Lammerlaw Ecological Region, was carried out during the summer of 1994-95 using the methodology of Myers et al (1987).

A general reconnaissance of the district identified areas of potential value for conservation and provided the basis for a detailed study. Data on the vegetation was collected using fixed-area plots, with the cover of all vascular plant species in fixed height tiers being recorded. Landform and environmental data were recorded, and observations of fauna noted.

The data was analysed using the classification programme TWINSpan (Two-Way Indicator Species Analysis, Hill, 1979), with sixteen species classes and thirteen quadrat (community) groups being differentiated. The quadrat groups identified were: low turf ephemeral tarn, medium turf ephemeral tarn, purei wetlands, copper tussock wetlands, moist tussock-shrubland, narrow-leaved snow tussock grassland, moist copper tussock grassland, mixed shrubland, dry tussock-shrubland, kanuka woodland, broadleaf-*Pseudopanax* forest, mixed broad-leaved forest and broadleaf forest. A total of 427 vascular species, 22 lichens and 49 bryophytes were identified during the survey, 356 of the vascular species being native. Several threatened and local species were identified. A detailed survey of the faunal values was not undertaken as part of this survey. Seven species of lizard are known to occur within the district. Of particular note is the presence of the endangered grand skink (*Oligosoma grande*) and Otago skink (*Oligosoma otagense*). Patrick (1997) identified 367 invertebrate species in twelve orders within the district, the greatest majority of species being typical of the grasslands, shrublands and rock tors of eastern Otago.

Information on the vegetation, flora, fauna, landforms and soils values were assessed. Twenty Recommended Areas for Protection (RAPs), covering 4733ha, were identified to best represent the range of conservation values.

Concurrent with the PNA survey, a test of the ecographic system concept of Park (1994) was conducted. The ecographic system aims to delineate and predict the distribution of ecosystems on the basis geomorphic features of the landscape. In the Macraes Ecological District, however, no clear relationship between particular ecographic units and vegetation types could be identified. Several reasons were suggested: inaccuracies in the map, the minimum size of the ecographic units being larger than some vegetation types present within the district, and the fact that Polynesian and European modification has exerted greater influence over the distribution of vegetation than geomorphic characteristics of the landscape. It was concluded that in the Macraes Ecological District the concept of the ecographic system could not be applied as a means of determining the past or present distribution of ecosystems.

Acknowledgements

I would like to thank my supervisors Dr Janice Lord and Professor Alan Mark for their guidance, encouragement and assistance throughout this project.

I am indebted to the Department of Conservation for financial support and to DOC staff for their help. In particular, I would like to acknowledge the substantial contributions of Graeme Loh, Brian Patrick, Brian Sargeant and Neville Peat.

Many thanks are offered to Dr David Galloway, Dr Peter Johnson and Dr Ray Tangney for their considerable assistance in plant identification; Dr Peter McIntosh for his report on the soils; Dr David Murray and Associate Professor Bastow Wilson for their assistance in calculating solar radiation; Associate Professor Alan Cooper for explaining the geological history; Associate Professor Helen Leach for providing information on Maori activity within the District; Dr. Gillian Hamel for providing information on European activity; and Russell Coveney, Philip Grove, Philip Johnson and Neill Simpson for invaluable assistance in the field.

I am grateful to the landowners of the district, without whose permission I could not have undertaken this project. Special thanks to Mr and Mrs Philip, and Mr and Mrs Tisdall for allowing me to stay in their cottages.

To the staff and students of the University of Otago Botany Department I express my gratitude for the advice, facilities and help they have provided.

I would like to thank friends and family who have supported me both financially and spiritually throughout this project; in particular Greg Kerr who provided me with Maori names for the species list and Jenny Smith for reading over the final draft. Finally, the largest thanks have been saved for Femke, whose support, tolerance and most importantly love has seen me through my darkest hours.

1 Introduction

1.1 THE PROTECTED NATURAL AREAS PROGRAMME

The Protected Natural Areas Programme was initiated by the New Zealand Government in 1983 as a means of protecting representative examples of the indigenous ecosystems of New Zealand.

PNAP surveys are being carried out systematically on the basis of ecological regions and districts. These regions and districts have been defined by topographical, geological, soil, climatic and biological features. There are 268 ecological districts within 85 ecological regions in New Zealand (McEwen, 1988). The Macraes Ecological District is one of two districts in the Lammerlaw Ecological Region. For survey continuity, a methodology has been devised (Myers et al, 1987) involving two main phases - survey and implementation. The survey report is intended to provide the information necessary for the implementation phase. An important output of the survey report is a list of Recommended Areas for Protection (RAPs).

In Otago, to the end of 1996, 11 of the 30 ecological districts had been surveyed, and 11,347ha of land protected either through acquisition or covenant. A further 45,045ha had been conserved through the Crown Pastoral Land Tenure Review process.

1.2 PRESCRIPTION OF MACRAES ECOLOGICAL DISTRICT (M^CEWEN, 1986)

Recommended changes to the prescription are in square brackets.

- Criteria:** Climate (rather dry), topography (gentle relief, moderate elevation), vegetation (mostly strongly modified tussock grassland).
- Topography:** The NE-SW trending Taieri Ridge and a series of parallel smaller faulted ridges to the SE; complex dendritic drainage pattern; much of district gently sloping land below 600m a.s.l. with higher ridges rising to over 800m.
- Geology:** Mostly Paleozoic Haast Schists with small areas of Miocene sediments and basaltic cones and flows.
- Climate:** Cool, dry; rainfall 600-800 mm pa.; NW winds prevail; snow may lie for weeks in winter.
- Soils:** Deep to shallow soils from variable thickness of loess (depending largely on slope) over schist, sandstone: in lower rainfall areas, mainly in the west, soils have pale-coloured compact subsoils, some with poor winter drainage, droughty in summer; in high rainfall areas soils [strongly to extremely

acid] more strongly leached with friable yellowish brown subsoils, good drainage, droughts uncommon. Soils from basalt with overlying loess have heavy textured, dark coloured subsoils. [The simplified soils sequence from moist uplands to drier valleys is as follows: Whenga soils and Whenga hill soils; Pukerangi soils; Matarae soils; Middlemarch soils].

Vegetation: Montane short tussockland grading into subalpine tall tussockland (snow tussock, fescue and silver tussock), with some areas of *Coprosma*-flax scrub, some [remnant broadleaved/hardwood] forest (kohuhu, tarata) and kanuka woodland.

Birds: The coastal populations of many forest birds reach their western limit in Central Otago in the scrub remnants of this district, including; rifleman, yellow-breasted tit, wood [New Zealand] pigeon and bellbird; falcon widespread and common.

Reptiles: High reptile diversity with seven species of lizards (includes three sibling species in the skink *Leiopisma* [*Oligosoma*] *nigriplantare* species complex). By far the largest and best populations of the rare skinks, grand skink (*Leiopisma* [*Oligosoma*] *grande*) and Otago skink (*L. [O.] otagense* form *otagense*) occur near Macraes Flat and Nenthorn. Elsewhere *L. [O.] grande* is only known from the Wanaka E.D. and Lindis E.D. although there is an old museum specimen from the Remarkables E.D. Extant populations of *L. [O.] otagense* form *otagense* are known elsewhere only from the adjacent Waipori E.D. and the Lindis E.D.; old records indicate a wide distribution in Otago and South as far as the Hokonui Hills. Green skink (*Leiopisma chloronoton*) present.

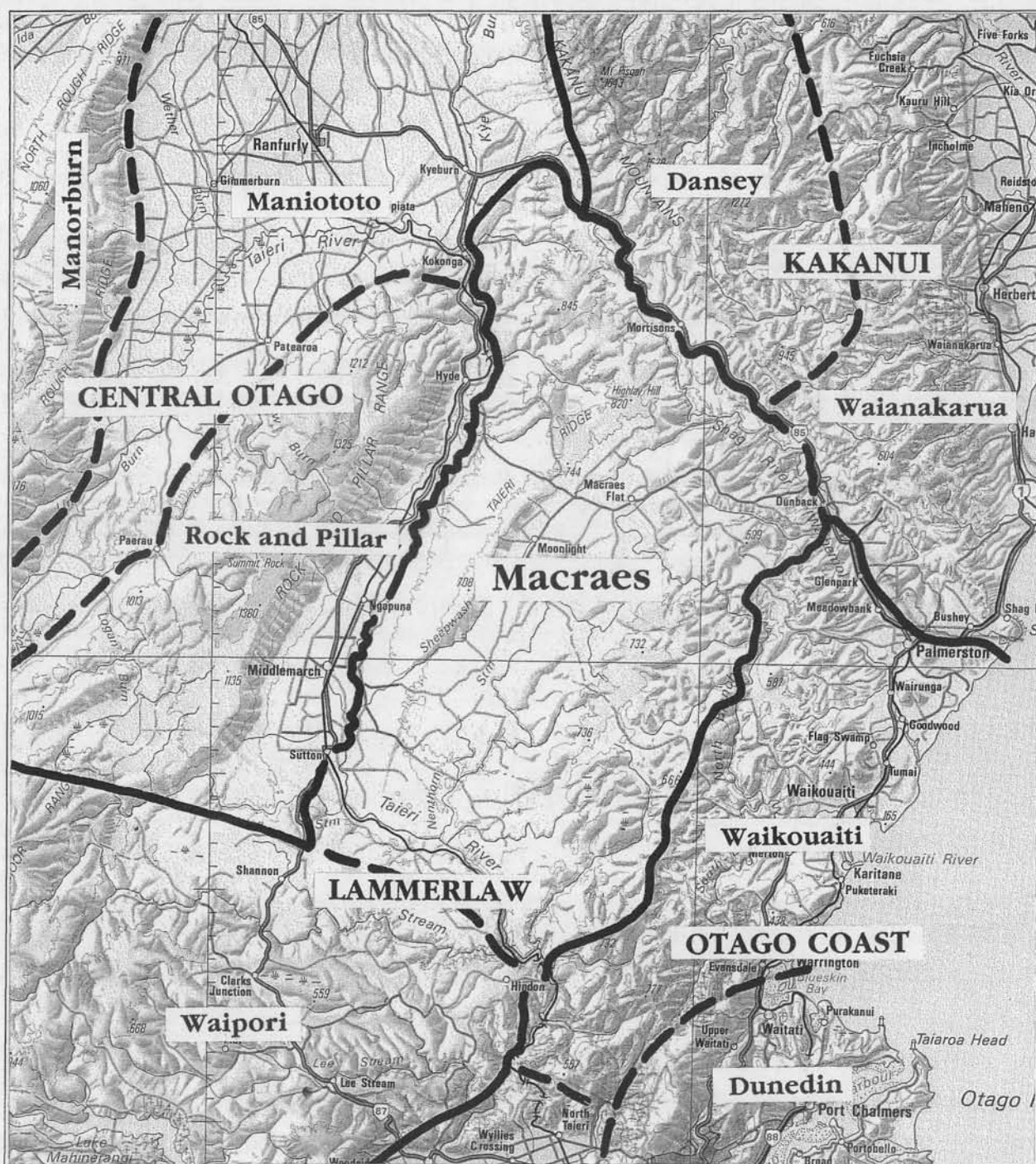
Modifications: [Burnt and] grazed (extensive sheep and cattle).

[Ecological District boundary changes: An extension was recommended in the Maniototo PNA report (Grove 1994) to include the area down to the Taieri River on the western boundary, previously in the Maniototo Ecological District. Removal of the upper reaches of some catchments of the Waikouaiti River on the eastern boundary to be included in the Waikouaiti Ecological District. The removal of these areas would result in the district having greater catchment integrity through the inclusion of complete catchments only.]

1.3 MACRAES ECOLOGICAL DISTRICT

1.3.1 *Boundary Definition*

Macraes Ecological District covers about 95,000ha. The northern boundary has been defined for the purpose of the survey as state highway 85, the 'Pigroot'. The Eastern boundary follows ridge crests along Stoneburn road, to Scratchback Hill, to Mt Scott then Mt Paul across to Lamb Hill Road through Mt Misery, Lamb



0 10 20
kilometres

ECOLOGICAL REGIONS eg LAMMERLAW

ECOLOGICAL DISTRICT eg Macraes

Hill, down to Hindon and across to Coal Stream. This defines the boundary in terms of catchment integrity. The southern half of the eastern boundary runs along ridge crests separating the South Branch of the Waikouaiti River from the Taieri catchment. The southern boundary has been defined in relation to the Waipori PNA survey (Carter, 1994), and follows no clear geomorphic features. The western boundary has been defined for the purposes of this survey as the Taieri River from Sutton to just south of Kokonga, where it cuts across the edge of the Maniototo Plain, at the foot of Swinburn Hill, up to State Highway 85 (Map 1.1).

1.3.2 *Geology and Phytogeography*

The basement rock of Macraes Ecological District is chlorite subzone 4 schist from the Haast schist group (Mutch, 1963; McKellar, 1966), a well foliated, coarse-grained quartz-feldspathic schist containing mica's and chlorite with a strike axis running north-west to south-east (Ragg & Miller, 1976). It was formed during the late Permian-early Jurassic through the metamorphosis of greywackes and argillites belonging to the Torlesse super group during the Rangitata Orogeny. This orogeny is characterised as a period of uplift and mountain building brought about by the collision of the Pacific Plate with the Australian Plate (Travis, 1965).

Immediately following the Rangitata Orogeny there was a period of crustal relaxation, (a moving apart of the tectonic plates) starting in the late Jurassic, about 140 million years B.P. (before present) (Dr. A. Cooper, pers. comm. 1997). It was during this period of crustal relaxation that the Waiheke fault system developed. The fault system ran through Shag Valley and out across the Maniototo Plain and is known as a normal fault (Bogie, 1978). As time progressed an infilling of the depressed area of the normal fault occurred through the erosion of material on the higher edges of the fault. This material formed the Kyeburn and Horse Range breccias (Clark, 1983), none of which are now present within the district. This period of erosion lasted through the Cretaceous up until about 65 million years B.P. resulting in the formation of a peneplain, an eroded flattened surface (Cotton, 1917). Non-marine deposits were formed during the late Cretaceous through river and fluvial deposition, covering the breccias and schist (Clark, 1983).

The peneplain was then inundated by a marine transgression, either through a rise in the sea level or subsidence of the rock, starting in the late Cretaceous (Travis, 1965; Clark, 1983). This inundation resulted in the formation of the Tertiary sediments, rocks derived from marine deposition. The sedimentary rocks formed here include limestone's, greensands and calcareous mudstones (McKellar, 1966; Mutch, 1963). It was also during this time that Lake Manuherikia, a large shallow inland freshwater lake, formed. Deposition here resulted in the formation of sediments known as diatomites, a part of the Manuherikia group of sediments (Travis, 1965). Foulden Hills, in the south of the district, is an example of such sedimentary rocks.

The period from 22 million years B.P. until now, following the retreat of the sea, has been characterised by the erosion of the sedimentary rocks and breccias (Travis, 1965). Sarsen stones (quartzite boulders) present today in some areas are all that remain from the layer of non-marine sedimentary rocks (Dr. A. Cooper, pers. comm. 1997). However, during the late Miocene there was period

of volcanism, lasting until about 9 million years B.P. (Sang Lyen, 1962). The volcanic vents were generally short lived, often experiencing only a single lava flow, but resulted in the formation of basalt rock outcrops. The most extensive volcanic area is in the north-west of the district, and is known as the Waipiata Formation. Where volcanic flows are present, the tertiary sediments that they overlie have often been preserved from erosion.

The cessation of the volcanic activity at 9 million years B.P. coincides with the start of the Kaikoura Orogeny, with a change of tectonic movement from extensional (crustal relaxation) to compressional (Dr. A. Cooper, pers. comm. 1997). As a result of this the normal faults now became reverse faults, resulting in uplifting of the basement rocks. This uplifting along the Waihemo fault system formed the Kakanui mountain range bordering the northern boundary of the district (Bogie, 1978). Through a similar mechanism the range and basin geomorphology of the Central Otago region developed (Sang Lyen, 1962). Within the district this faulting can be easily seen in the formation of the Taieri Ridge and Billys Ridge (Travis, 1965). The uplift continues right to the present day.

Slopes with various degrees of dissection, tarns, rock outcrops and tors are typical landscape features of the upland areas within the district (Ragg & Miller, 1976). The tors are relics of the Cretaceous peneplain, formed through weathering of the peneplain surface (Macpherson, 1969). Remnants of the Cretaceous peneplain are present on the back slopes of the Taieri Ridge (Macpherson, 1969), at Slip Hill, Bald Hill, Conical Hill, Craiglynn and The Sisters (Travis, 1961). In areas of Tertiary sediments extensive slumping is a common landscape feature (Macpherson, 1969). The drainage pattern of streams in schist areas is predominantly rectilinear with V-shaped valleys and tributaries, with the larger streams, such as the Nenthorn and Manuka Streams, following the north-east south-west strike axis of the schist (Brown, 1962)

The Inventory of Important Geological Sites and Landforms in the Otago Region (Kenny & Hayward, 1993) lists five sites of geological importance in the Macraes Ecological District. The Golden Point Battery near Macraes Flat is the best preserved stamper battery and the only authentic working example in Otago. It is reserved as part of the Otago Goldfields Park. Middlemarch Neogene diatomite at Foulden Hills contains excellent leaf flora. The site has been quarried in the past. A good example of the garnet zone of the greenschist facies is present in a tor on a hillside near Middlemarch and is unreserved. Mt Stoker basanite, an excellent example of a volcanic landform on the schist peneplain is also unreserved, while the Nenthorn Goldfield with its well exposed gold-bearing quartz veins and associated historic town site is reserved as part of the Otago Goldfields Park.

1.3.3 Soils

General soil maps covering the district have been compiled at a scale of 1:253,440 by the New Zealand Soil Bureau (1968), with parts of the district being covered in more detail by Campbell (1976) and Ragg & Miller (1976). In general, a sequence of soils can be identified from the moister uplands above 500m to the drier valley floors surrounding Middlemarch. Wehenga and Wehenga Hill soils (yellow-brown earths) are found in the moister uplands, following through Pukerangi and Matarae soils (yellow-grey earths) at mid-altitudes to the Middlemarch soils (yellow-grey earths) of the valley floors. Saddle soils (brown-granular loams), associated with areas of basalt rock outcrops, are mainly confined to the north west portion of the

district. They are associated with the Waipiata Volcanic Formation. In the New Zealand Classification (Hewitt, 1993) the soils are palic soils at lower altitudes and brown soils at higher altitudes, while soils associated with volcanic rocks are granular soils.

McIntosh (1995) provided more detail for some ecologically significant areas within the district, and found that the areas he surveyed were strongly to extremely acid (including podsolised soils) indicating the soils were very infertile. As such the options for continued pastoral management without improvement are very limited. Present erosion for the area of the district contained within the Taieri River catchment has been determined by the Otago Catchment Board and Regional Water Board (1983) to be slight.

McIntosh looked at five study areas: Lamb Hill, Manuka Stream, Redbank, Trimbells Gully and Flat Hill, ranking these five areas for their ecological value in respect to soil, landform and geological features. As can be seen in Table 1.1, Lamb Hill and Flat Hill had the highest scores, followed by Manuka Stream and Redbank, with Trimbells Gully scoring lowest.

Lamb Hill and Flat Hill score highly mainly due to their unique features. In terms of landscape, periglacial features such as nivation hollows, asymmetrical gullies and slumps are distinctive at Lamb Hill, with the amphitheatre landscape of Flat Hill being unique within the district. Geologically, Flat Hill is the most diverse of all surveyed sites. Volcanic outcrops here are underlain by Tertiary sediments. Lamb Hill also scores highly for geological features with evidence of Quaternary geological processes. Lamb Hill has the second highest score for the variety of soils present, reflecting a variety of parent materials and podsolisation, with Flat Hill having the highest score reflecting the largest diversity of soils associated with the range of parent materials present.

Manuka Stream and Redbank score highest for representativeness. Their rolling landscape and deeply incised gullies on schist parent material are more typical of the ecological district as a whole than either Flat Hill or Lamb Hill. Trimbells Gully scores lowest as landscape and soil features are repeated in the Manuka Stream and Redbank areas.

TABLE 1.1: STUDY AREA SCORES FOR SOIL AND GEOLOGICAL FEATURES.

STUDY AREA	SPECIAL LANDSCAPE FEATURES	REPRESENTATIVE LANDSCAPE AND SOILS	VARIETY OF SOILS	GEOLOGICAL FEATURES	TOTAL
Manuka Stream	3	5	1	1	10
Flat Hill	5	1	5	5	16
Redbank	3	5	1	1	10
Trimbells Gully	1	3	1	1	6
Lamb Hill	5	4	3	4	16

Scores are from 1 to 5, with 5 being of the highest value (McIntosh, 1995)

1.3.4 *Climate*

As there are no official climate stations within the district, the most detailed information is from the Taieri and Waikouaiti River Catchment resource inventories (Otago Catchment Board and Regional Water Board, 1983; Otago Regional Council, 1992).

Macraes Ecological District can be generally characterised as experiencing coastal climatic conditions. Westerly-moving depressions produce higher rainfall and more moderate temperatures than in Central Otago. The passage of cold fronts associated with southerly and south-westerly winds bring most of the rain and snow to the district. Precipitation in winter is more pronounced than during summer nearer the coast. Cool moist north-easterly winds predominate during the summer, however periods of high evapotranspiration are associated with the dry north-westerly winds which tend to occur during the late spring and summer. Climatic data from Garthmyl (Middlemarch) indicates a 2.0 to 2.4 year cycle of drought conditions. Eastern areas of the district above 600-800m can often be enveloped by low cloud, the product of moist sea breezes. This occurs on more than 100 days per year, but often without significant precipitation. Inversion fogs on the plains and stream valleys, particularly during winter, are the most common fogs recorded within the district. Predicted annual precipitation in the Taieri and Waikouaiti catchments shows a general pattern of decreasing precipitation with decreasing altitude, and a general decrease in precipitation as distance from the coast increases. Highest precipitation occurs in the Lamb Hill area in the south-east corner of the district with 800-1000mm per year, the driest area being the Strath Taieri in the north-west corner of the district with 500-600mm per year. Most of the district receives between 600-800mm per year.

1.3.5 *Land Systems*

Seven land systems were recognised within Macraes Ecological District (Map 1.2), and were delineated with the help of Dr A. E. Hewitt (Landcare Research). The land systems were identified as follows: Valley Incision, Alluvial Infill, Fault Block Ridges, Dissected Steeplands, Rolling Hills, Tor Plateau, and Volcanic Outcrops (Map 1.2). The landforms, soils, geology and climate of each land system are described briefly in Table 1.2. (See page 11).

1.3.6 *Vegetation*

About 3000 years B.P. the vegetation characterising Macraes Ecological District would have presented a radically different picture from what is there now. Evidence from charcoal, macrofossil remains, pollen and soil surface dimples suggest that there were extensive tracts of tall montane coniferous-broadleaved forest dominating the east coast of the South Island (McGlone, 1989). On fertile soils of drier areas (600-1000mm rainfall) McGlone (1989) describes coniferous-broadleaved forests with matai (*Prumnopitys taxifolia*), totara (*Podocarpus totara*) and kahikatea (*Dacrycarpus dacrydioides*) as the dominant podocarps. Such a forest type may have been present in the eastern parts of the district. The western side of the district is drier and may have been characterised by inland coniferous-broadleaved forest, described by McGlone (1989) as toatoa (*Phyllocladus alpinus*), Hall's totara (*Podocarpus hallii*) and a number of small hardwood trees such as broadleaf (*Griselinia littoralis*), kowhai (*Sophora microphylla*), kanuka (*Kunzea ericoides*) and red mapou (*Myrsine australis*).

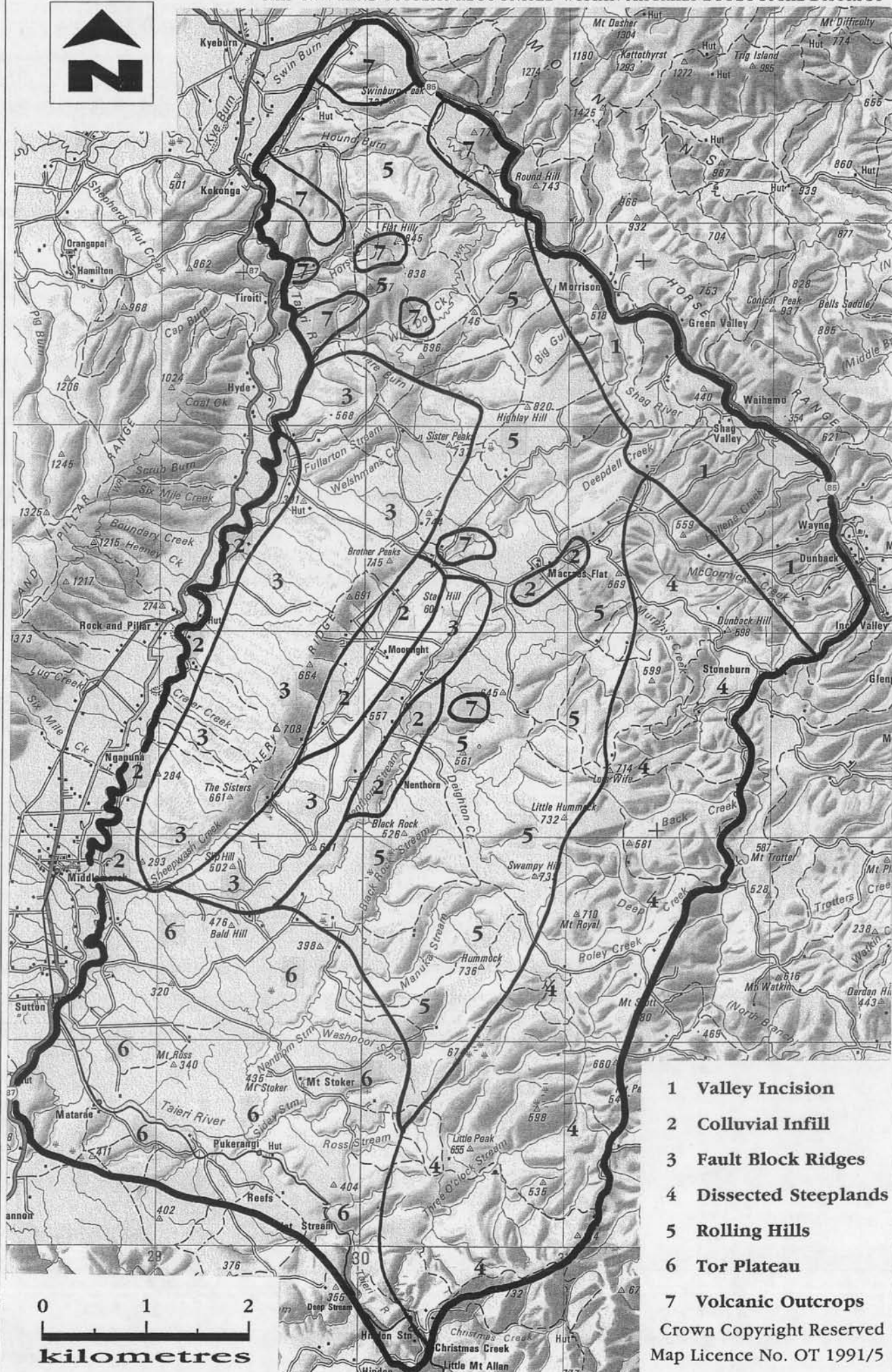
TABLE 1.2 LAND SYSTEMS RECOGNISED WITHIN MACRAES ECOLOGICAL DISTRICT WITH GENERALISED DESCRIPTIONS OF THE LANDFORMS, SOILS, GEOLOGY AND CLIMATE THAT CHARACTERISE EACH SYSTEM.				
LAND SYSTEM	LANDFORMS	SOILS	GEOLOGY	ALT. RANGE
Valley Incision	Moderately sloping hill-slopes and valley floor terraces Waihero fault system	Yellow-grey earths Yellow-grey to yellow-brown earths intergrade..	Late Triassic-mid Jurassic Haast schist predominates. Minor Tertiary mudstone, sandstone and siltstone component.	60-500m
Alluvial Infill	Colluvial terraces and fans present on valley floor.	Yellow-grey earths. Recent soils.	Quaternary colluvial gravels.	200-500m
Fault Block Ridges	Gently sloping dip slope and associated steep scarp slope. Extensive rock outcrops and tors. Deeply incised streams on dip slope.	Yellow-grey earths.	Late Triassic-mid Jurassic Haast schist	240-700m
Dissected Steeplands	Moderate relief steep to very steep sided hills and mountains with sharp ridge crests and V-shaped valleys. Rock outcrops and tors common. Periglacial landforms (slumps and asymmetric valleys) on high altitude rolling mountain tops	Upland high country yellow-brown earths. Lowland yellow-grey earths.	Late Triassic-mid Jurassic Haast schist.	140-760m
Rolling Hills	Fluvially dissected rolling hills of moderate relief, broad ridge crests and sloping planer hill tops common. Rock outcrops and tors common.	Upland high country yellow-brown earths. Lowland yellow-brown earths.	Late Triassic-mid Jurassic Haast schist.	300-800m
Tor Plateau	Extensive rock outcrops and tors with deeply incised streams and rivers, low relief.	Yellow grey earths.	Late Triassic-mid Jurassic Haast schist.	60-430m
Volcanic Outcrops	Basalt boulder outcrops on slopes, extensive slumping in areas of Tertiary mudstones. Volcanic crater and plugs present	Brown granular loams and clays	Tertiary siltstone, mudstone and sandstone overlain with late Tertiary basalt.	500-600m

The presence of podocarp charcoal (Molloy *et al.*, 1963), small areas of broadleaf dominated forest in steep-sided gullies, and the occurrence of totara, toatoa and scattered kowahi provide evidence of previous forest cover throughout the district.

The destruction of the forest cover began 2500 years B.P. with evidence of natural fires in Central Otago (McGlone 1989). By 1700 years B.P., deforestation through natural fires had spread to Clarks Junction, some 10km beyond the south-west corner of the District (McGlone, 1983). Permanent deforestation appears to have been confined to drier valley floors and lower slopes in inland Otago and Canterbury (McGlone 1989).

The next major period of deforestation can be attributed to Polynesian fires 800 to 400 years ago. (McGlone 1983). By the time of European settlement around 1840 AD, about half of the pre-Polynesian forest had been destroyed. This destruction, however, was not evenly distributed through all forest types. The inland drier coniferous-broadleaved forests were the most affected, being nearly eliminated (McGlone 1989). Buchanan (1863) in his essay on Otago wrote: *"...the vegetation of the province, on its eastern watershed, is grassy; the*

MAP 1.2 : LAND SYSTEMS RECOGNISED WITHIN MACRAES ECOLOGICAL DISTRICT



greater area being open grassland, with comparatively smaller areas of bush along the coastline, and in the gullies of the mountain ranges.....It is evident, that at no distant time the greater part of the province was covered in forest."

At the time of European settlement, the areas previously covered in forest would probably have been dominated by tussock grassland or shrubland. On the flats, in the Colluvial Infill land system, there existed extensive populations of purei (*Carex secta*) (Thompson 1949). This vegetation has been further modified through extensive pastoralism and in more recent times through intensive agricultural practices.

Much of the present vegetation within the district is of a highly modified nature. Approximately 50% of the district has been either ploughed and sown or grazed, burnt and oversown to such an extent that it may be considered exotic pasture grassland.

Exotic pasture land dominates the Tor Plateau, Colluvial Infill and Valley Incision land systems, covering approximately 90% of their area. Highly modified narrow-leaved snow tussock (*Chionochloa rigida*) grassland exists in gullies within these land systems, however most of the inter-tussock cover here has been replaced by exotic grasses. In the Valley Incision land system, many of the gullies have been invaded by gorse (*Ulex europaeus*) and broom (*Cytisus scoparius*), in places reaching over 90% of total cover.

Invasion by gorse and broom is also a prominent feature of the Taieri Gorge in the Tor Plateau land system. Ephemeral tarns are common on sloping planer surfaces of the Tor Plateau land system but are again heavily modified through stock trampling and invasion by exotic grasses and rushes. There are some areas of tussock grassland on sloping planer surfaces south of the Taieri Gorge consisting of a mixture of narrow-leaved snow tussock (*Chionochloa rigida*) and hard fescue (*Festuca novae-zelandiae*) generally at less than 50% cover, with the inter-tussock cover again dominated by exotic species.

The Fault Block Ridges land system contain a more diverse range of vegetation types, but is also of a highly modified nature. Most of the lower-mid slopes on the dip slopes are ploughed pasture grassland, extending in some cases up through the more gentle upper slopes to the crests. The ridge crests are pasture grassland in areas that are broad and flattened. In steeper more rocky areas a mix of hard fescue and narrow-leaved snow tussock grassland occurs. In the deeply incised gullies of the scarp slope some remnant broadleaf (*Griselinia littoralis*) individuals occur, along with a mix of matagouri (*Discaria toumatou*) and *Coprosma* spp. shrublands, and remnant tussock grasslands. Predominantly in the northern part of the dip slope a mixed association of matagouri shrubland and hard fescue tussock grassland occurs on the side-slopes. Ephemeral tarns occur on the ridge crests.

The scarp slope of the Fault Block Ridges land system presents a slightly different pattern in that its steepness tends to preclude intensive agricultural practices such as ploughing. Decades of grazing and burning, however, have modified much of the side-slopes into pasture grassland. The gullies are generally not as deeply incised in comparison to the dip slope, with shrublands contributing to less of the cover. Degraded tussock grassland accounts for much of the cover here.

Vegetation on the Volcanic outcrop land system tends to follow the vegetation patterns of the Rolling Hills land system. The area in which the two land systems differ is in the basalt rock boulder slopes. These areas are characterised by *Coprosma* shrubland.

It is within the Dissected Steeplands and Rolling Hills land systems that most of the indigenous vegetation within the district persists. In both of these land systems narrow-leaved snow tussock grassland is the dominant vegetation type, occurring on broad and sharp ridge crests, mountain and hill tops, upper, mid- and lower-slopes, and toe-slopes. As a general rule for both land systems, areas that are broad and flattened, such as hill tops and ridge crests, which can be accessed by farm machinery, have been developed into pasture grassland.

Within the Dissected Steeplands land system, remnant broadleaf forest and kanuka woodland occur in some steep rocky gullies. These vegetation types would account for less than 1% of the total land area within the land system. Most of the side-slopes, crests and valley floors have been modified and present a mosaic of tussock grassland in varying states of degradation, from pasture grassland with scattered tussock species through to areas of dense tussock cover with a high component of indigenous species in the inter-tussock area. This mosaic of tussock vegetation would account for about 75% of the land system. The less common ecological units include moist tussock-shrubland on side-slopes, purei wetland on gully floors, copper tussock (*Chionochloa rubra* ssp. *cuprea*) wetland on gully floors and dry tussock-shrubland on rock outcrops.

Narrow-leaved snow tussock grassland is again the predominant vegetation type occurring in the Rolling Hills land system, accounting for about 70% of the total cover. The next most prevalent vegetation type is ploughed pasture grassland. The tussock grassland again forms a mosaic of varying states of degradation. A more prominent feature of degradation within this land system is mouse-ear hawkweed (*Hieracium pilosella*). As a general pattern, the most degraded areas occur on the drier north-facing slopes and ridge tops. In some areas such as the old Nenthorn township site, the north-facing slopes of Trimbells Gully and Flat Hill basin the inter-tussock cover is dominated by hawkweed with a sparse occurrence of hard fescue. Ephemeral tarns are a common feature on ridge tops and planer sloping hill tops along with shrub and tussock communities on rock outcrops. In the southern area of the land system, large areas of copper tussock grassland are predominant on sloping planer hill and mountain tops, plus broad ridge crests. Other ecological units include mixed shrubland on side-slopes; moist tussock-shrubland in gullies; dry tussock-shrubland on side-slopes; copper tussock wetland on side-slopes; and purei wetlands in gullies and on valley floors.

1.3.7 Cultural Influences

The arrival of Polynesians about 1000 years ago heralded the start of human modification of New Zealand's natural environment. Depending on the locality, deforestation through fire by Maori began about 800 to 400 years ago (McGlone 1989). Although it is commonly believed that most fires were lit for the purpose of moa hunting, McGlone (1983) argues fire was not essential for hunting, as moa disappeared from unburnt forests as quickly as from burnt forest. The most likely hunting method was the pursuit of individual birds with dogs. Accidental fires

combined with clearance for bracken, cultivation, travel, and for dwellings and security are seen by McGlone to be the main reasons for forest destruction.

Maori activity within the district was probably quite limited. As permanent settlements were coastal only temporary camps were made inland (Anderson, 1983). Vegetation destruction in the district was probably the result of accidental fire or clearing for ease of travel (H. Leach, pers. comm. 1997). Archaeological evidence within the district indicates the hunting of ground dwelling birds such as weka and moa. Seven species of moa have been recorded from a butchery and secondary processing site at Coal Creek near Hyde and one species from Nenthorn (Anderson, 1989). Other archaeological evidence from Nenthorn, Kokonga, Fullerton Creek and Ross Stream indicates that quarrying for silcrete occurred within the district (Anderson, 1989). Silcrete provided the raw material from which flaked stone tools could be made, many of which were tools used in the butchering of moa (H. Leach, pers. comm. 1997).

With the arrival of Europeans in the mid-nineteenth century a new phase of human modification began. The first Europeans to settle in the district were pastoralists in the mid-1850s, who began to extensively graze sheep and cattle (Thompson 1949). As a part of the management regime, the runholders burnt the vegetation to reduce shrub cover and promote new growth in tussocks. This new growth was more palatable to the stock.

Livestock numbers throughout the eastern South Island increased through the 1860s and 1870s. They reached a peak in the early 1880s after which a decline in stock numbers occurred as result of tussock grassland depletion (O'Connor, 1982). As Buchanan (1863) observed: *"Nothing can show greater ignorance of grass conservation, than the repeated burning of pasture in arid districts, which is so frequently practiced...Much of the grass land of Otago has been thus deteriorated since its occupation, by fire, and it is no wonder that many of the runs require eight acres to feed one sheep...It is a fallacy to suppose that grass country requires repeated burning to clear the surface of the excess of plants..."*

This degradation of the tussock grassland coincided with a rapidly expanding rabbit population, the control of which became a major concern to runholders (Thompson, 1949).

Up until this time nine crown pastoral leases covered the entire Macraes Ecological District and were held by a handful of people. The next phase of modification started in the mid-1880s when agriculturalists started to settle and till the valley floors and flat land surrounding Middlemarch. As time progressed these areas became increasingly infertile until, in the early 1900s, farmers began to apply fertiliser to the land. The large runs were subdivided and more people settled in the district in the early 1900s (Inder, 1992)

Agricultural modification of the land is continuing. One of the major developments in the latter half of this century has been aerial oversowing and topdressing. Topdressing increases soil fertility and can induce matagouri shrublands. Oversowing is also a modifying factor as it introduces exotic species into the inter-tussock communities. The development of land through ploughing is still occurring.

The other major human impact within the district has been gold mining. A gold rush occurred at Murphys Flat and Macraes Flat in the mid-1860s. The township at Macraes rapidly expanded to 300 people in 1865, but the poor returns from the

diggings saw the population decrease to 130 in 1871. The richest pickings were in alluvial deposits, such as Trimbells Gully, Highlay Creek, and McCormicks Creek, where gold was recovered through ground sluicing and paddocking then by treatment in sluice boxes, puddling machines and cradles (Thompson, 1949). The Nenthorn gold rush started in 1888 and the township of Nenthorn developed rapidly. However, a mere two years later the township had collapsed (Hearn, 1988). By 1900 only three miners remained. Relics from mining such as water races, open pits and ponds from alluvial workings, can still be seen today.

Quartz mining continued near Macraes at Golden Point, with the incorporation of the 'Golden Point Quartz Mining Company' in late 1889 and the installation of a stamping battery (Macraes Mining Company, 1993). Regular mining stopped in 1917 with sporadic mining continuing until 1954. In 1990 Macraes Mining Company Ltd. commenced mining at Round Hill, encompassing an area of 1522ha (Macraes Mining Company, 1993). Each year some 3 million of tonnes of ore is processed with, on average, five tonnes of waste rock produced for every tonne of ore processed. Whitaker (1987b), in looking at the terrestrial biology of the area, found there were no rare species present and that the long history of modification through mining had rendered the vegetation uncharacteristic of Macraes Ecological District. Whitaker made the point, however, that an expansion of mining operations to other ore reserves, for processing at the Round Hill plant, could pose a risk to other plant and animal communities, both rare and characteristic, present to the south of Macraes Flat.

1.4 ECOGRAPHIC MAPPING

In the interests of conserving biodiversity, the Department of Conservation has a particular need for information on indigenous ecosystems. The present PNAP methodology provides a starting point for a spatial framework on which the assessment of biodiversity could be based. However, the PNAP framework does not provide a well-defined framework for depicting, naming, delineating and mapping remaining areas of New Zealand's indigenous ecosystems. The spatial level at which ecosystems would be defined, between ecological districts and ecological units, is at present served by a land systems approach developed in Australia by Christian and Stewart (1953), where a land system is defined as "*an area, or groups of areas, throughout which there is a recurring pattern of topography, soils and vegetation*". The approach is rather loosely defined in the PNAP, with no specific methodology given for its application in the PNAP guidebook (Myers *et al*, 1987). Formalising this level into a national system could provide the basis for assessing biodiversity at the ecosystem level (G. Park, pers. comm. 1994).

The ecographic system concept of Park (1994) aims to provide a mapping system at the spatial level between ecological districts and ecological units that will allow for the identification of ecosystems. It encapsulates ideas such as maintaining the intactness of processes determining ecosystem function and linkage between contiguous ecological units (G. Park, pers. comm. 1994). The identification of ecographic units themselves are based on those geomorphic characteristics of the land that indirectly affect the biota through their influence on ecological processes, particularly soil processes (Harrison, 1995). It is

envisaged that there would be about 40 different ecographic units for New Zealand, with an average of five to eight units occurring in any one ecological district. The New Zealand Land Resource Inventory (NZLRI) database provides a pre-existing nation-wide source of geographic data from which ecographic units can be derived (Harrison 1995). Landcare Research New Zealand Ltd. has produced a trial ecographic system map for Macraes Ecological District. It is based on the interpretation of NZLRI Land Use Capability (LUC) units as six ecographic units.

One of the central ideas behind the ecographic systems concept is the depiction of ecosystems - that is, an ecographic unit will predict the presence and limits of an ecosystem or ecosystems associated with a particular ecographic unit's set of geomorphic characteristics. Theoretically this would allow the past extent of a particular ecosystem to be assessed in relation to its present extent. In assessing the ecographic systems concept it is necessary to define the ecosystems of Macraes Ecological District. Ecosystem is a term used to "describe a discrete [functional] unit that consists of living and non-living parts, interacting to form a stable system....fundamental concepts include the flow of energy and the cycling of nutrients" (Oxford Dictionary of Ecology 1994). An ecosystem can be described at a range of scales, from a small pond to a lake or an ocean. In this assessment, vegetation types have been used as surrogates for ecosystems. The present assessment focuses on the extent to which individual ecographic units are associated with particular vegetation types. However, an assessment of concepts such as linkage and the main processes determining ecosystem function is beyond the scope of this report.

To test for a relationship between Park's (1994) ecographic systems map and the Macraes Ecological District vegetation pattern, a contingency table was constructed and analysed using the log linear model procedure in SPSS for Windows, Release 6.1 (SPSS Inc. 1994). This analysis tests the goodness of fit of the independence model and poses the question: are ecographic units and vegetation types independent? An analysis using the 13 vegetation types identified in the TWINSpan analysis was not possible as there were too few data for the analysis to be valid. To overcome this, TWINSpan groups were conglomerated to form five generalised vegetation types, wetlands (A, B, C); moist copper tussockland communities (D, E, G); narrow-leaved snow tussock grasslands (F); shrublands (H, I) and forest (J, K, L, M).

The log-linear analysis, using these five generalised vegetation types, showed that vegetation and ecographic units were not independent ($P < 0.05$; Table 1.3).

TABLE 1.3 THE GOODNESS-OF-FIT STATISTICS FROM THE LOG-LINER ANALYSIS OF THE ECOGRAPHIC UNIT AND VEGETATION DATA.			
	CHI-SQUARE	DF	SIGNIFICANCE
Likelihood value	50.7503	12	1.0^{-6}

However, it should be noted that individual relationships were not assessed in the analysis. Rather, the analysis tested the hypothesis that ecographic units and vegetation types are independent. Therefore statistical conclusions as to whether particular ecographic units are associated with particular vegetation

types are unable to be reached, although it may be possible to gain some general picture of the relationship between the two from the contingency table (Table 1.4).

TABLE 1.4 THE ECOGRAPHIC UNIT AND VEGETATION GROUPING CONTINGENCY TABLE USED FOR THE LOG-LINEAR ANALYSIS. SCORES INDICATE THE NUMBER OF SAMPLE SITES PRESENT IN THE ECOGRAPHIC UNIT.				
ECOGRAPHIC UNITS TABLELAND/ROLLING TOPS	VEGETATION TYPE	LAVA FLOW	STEEP HILLS	ROLLING HILLS
Wetland	0	1	0	13
Moist copper tussock communities	1	9	13	20
Narrow-leaved snow tussock grassland	1	15	16	18
Shrubland	0	8	0	0
Forest	0	9	2	1

The contingency table does not present a clear picture of any easily identifiable, consistent relationship between ecographic units and vegetation types. Some vegetation types seem to be more specifically associated with a particular ecographic unit. Shrubland and forest groupings tend to occur on steep hills whereas narrow-leaved snow tussock grassland seems relatively evenly spread over three of the four recognised ecographic units. This would suggest that no definite association exists between specific ecographic units and particular vegetation types in Macraes Ecological District. There are several possible reasons for this. The map of ecographic units in Macraes Ecological District (Map 5.1) was produced using information from the New Zealand Land Resource Inventory (NZLRI) with each ecographic unit being derived from Land Use Capability units (Dr. P. Newsome, pers. comm. 1994). Such units are the smallest sub-division in the land use capability classification, produced through the assessment of individual inventory criteria in the Land Resource Inventory Maps (Ministry of Works, 1971). Each inventory map unit contains information on the geology, soil type, slope, erosion and vegetation of land within the unit. As ecographic units are intended to be based on geomorphic characteristics of the landscape (Harrison, 1995), the choice of Land Use Capability units which do not exclude vegetation brings into question the objectivity and validity of the ecographic units. Although it is clearly stated in the Land Use Capability Handbook (Ministry of Works, 1971) that LUC units "should be based as far as possible on fundamental physical characteristics" this is not always the case. For example, the ecographic systems map concurrently produced for the Southland Plains Ecological District contains some examples of ecographic units delineated on the basis of vegetation alone and not physical differences.

The minimum polygon size (i.e. minimum mapping unit) for a LUC unit is approximately 40ha (Dr. P. Newsome, pers. comm. 1996). As all occurrences of Quadrat Groups A (low turf ephemeral tarns), B (medium turf ephemeral tarns) and many occurrences of D (copper tussock wetland), are less than the minimum polygon size, scale becomes an issue in Macraes Ecological District. If, as is implied,

these vegetation types are linked to particular geomorphic features that operate at a similar scale, ecographic units for those particular areas cannot be expected to be delineated on the map. This may explain why wetland and copper tussockland communities are both dominant in the 'Tableland/rolling tops' ecographic unit (see Table 3.4). Both of these vegetation groupings occur on areas less than the minimum polygon size. Even if they were associated with different geomorphic features, they would not have been distinguished as separate ecographic units.

Allen & Wilson (1991) studied the application of relationships between simple environmental factors and vegetation types in determining the species composition for re-vegetation of modified areas. The assessment was based on the use of Jackknifed Discriminant Function Analysis to predict forest type from simple environmental factors. The result was a 60% success rate of accurately predicting forest type. However, successful prediction was dependent on, among other things, indigenous vegetation remnants surviving on sites that represent the range of environments present in the area and a strong relationship between the physical environment and vegetation. While the methodology in Allen & Wilson's study is different, the concept of predicting vegetation distribution from ecographic units (abiotic environmental factors) has a similar basis. This leads to the issue of the high degree of vegetation modification in Macraes Ecological District. The ecographic units themselves do not relate directly to a particular vegetation type. The degree of association between vegetation type and ecographic unit can be inferred either from present vegetation-geomorphological relationships or known historical associations.

Historical information on the vegetation of Macraes Ecological District is scant, and none of it is detailed or specific. Therefore the relationship between ecographic units and vegetation can only be determined from present-day information. A relevant statistical technique known as Constrained Canonical Analysis (using CANOCO ver.3.2, Agricultural Mathematics Group DLO, 1991) showed a poor overall relationship between vegetation type and a range of environmental variables (altitude, slope, aspect, solar radiation, soil wetness, hydrological system, soil, rainfall, bare rock, bare ground and open water), with only 10% of the species variation being explained. Such a low level of explanation indicates that there is some other factor(s) determining the present distribution of vegetation in the district. For Macraes Ecological District it is suggested that human modification, both pre-European disturbance and also pastoral farming over the last 150 years, is the dominant factor controlling the present distribution of vegetation. For instance, the association between forest vegetation and steep rocky areas is almost certainly a result of human influences, notably the impacts of Polynesian fires, since the rock outcrops provide a refuge from fire. Moreover, steep areas limit stock access and are more likely to survive European pastoralism.

Consequently, while the accuracy of the ecographic map can probably be improved, the limitations of scale (i.e. the minimum LUC polygon size) and ecosystem modification cannot be overcome. It is concluded that in an area such as Macraes Ecological District, the concept of ecographic units cannot be applied as a means of assessing the past i.e. natural (or present) distribution of individual ecosystems (or vegetation types).

2 Methods

Land holders were contacted in person during November and December 1994 to gain consent for access to their properties to carry out the survey. Concurrent with this, the reconnaissance phase was undertaken on a property by property basis if access was granted. Map 2.1 shows the areas where access was denied. Qualitative information was collected on the types of vegetation present within the district and the condition of indigenous vegetation. Generalised vegetation types were compiled using NZMS 260 topographic maps as the base. General notes were also made on flora, fauna, landforms and any special features.

Areas for further study were identified on the basis of naturalness, special features, landform, diversity of indigenous vegetation types, and to reflect the range of natural vegetation identified during the reconnaissance phase. Areas defined by catchment boundaries were sought where possible.

2.1 VEGETATION AND FLORA

Within a given study area vegetation types were subjectively assessed and sampled over the range of landforms. For a given landform-vegetation combination, referred to henceforth as an ecological unit, a 20m x 10 m study site was randomly located within a 100m x 100m area of each the unit. If the ecological unit occupied less than 100m x 100m, the study site was defined by the unit's spatial limits.

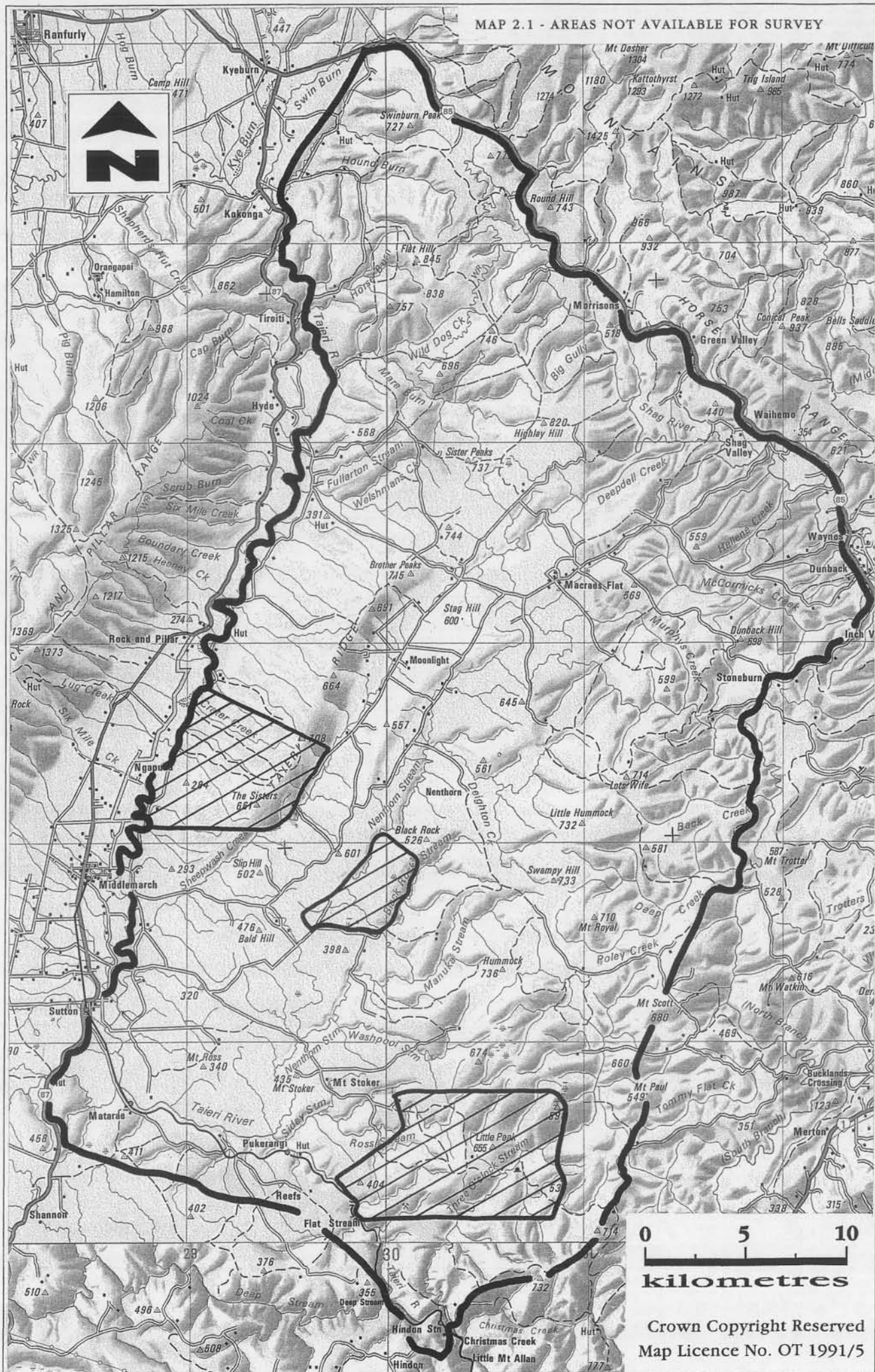
Within a study site the abundance of all vascular species was assessed and ranked for cover and abundance on a 1-6 scale (1: under 1%; 2: 1-5%; 3: 5-25%; 4: 25-50%; 5: 50-75%; 6: over 75%) for each species in fixed height strata (tier 1: under 0.1m; 2: 0.1-0.3m; 3: 0.3-2m; 4: 2-5m; 5: 5-12m and 6: over 12m. A ranked cover/abundance value was also given for rock cover, bare ground, litter and overall plant cover. Any species not identifiable in the field were collected and pressed for later identification. Many lichens and bryophytes were collected for identification. General notes were also made on the relationship of the study site to the rest of the ecological unit, its condition, any modifying factors and the possible

Management requirements needed to maintain the vegetation. Plant species occurring within an ecological unit, but not in the study site, were also noted.

2.2 ENVIRONMENTAL VARIABLES

For each study site the altitude, aspect (degrees magnetic), slope, general topographic features, soil wetness, grid reference, the area of the ecological unit, hydrologic system and landform were each recorded on a site description card. Landforms were described following the methodology of Whitehouse *et al* (1990). Soil wetness was ranked on a scale of 1-4 (1: dry; 2: moist; 3: wet; 4: saturated). Parent material for the site was identified from Mutch (1963) and

MAP 2.1 - AREAS NOT AVAILABLE FOR SURVEY



McKellar (1966), soil type from New Zealand Soil Bureau (1968), and rainfall estimated from the Taieri and Waikouaiti River resource inventories (Otago Catchment Board and Regional Water Board, 1983; Otago Regional Council, 1992).

Soils were ranked numerically from 1-9 as an expression of their developmental age. The total yearly income of solar radiation was estimated for each site using a computer modeling programme. The programme was based on Fuggle (1970) which required an input for the latitude, the angle of declination of the sun and atmospheric transmissivity. This programme was modified to give the estimated yearly budget by removing the input for the angle of declination and including its calculation within the programme, looping it from day 1 to day 356 and calculating a running total.

2.3 DATA ANALYSIS

Both the floristic and environmental data were entered into the ecological data handling package DECODA (Minchin 1990). A total abundance value for a given species in a given sample was calculated by combining the ranked cover/abundance over all tiers for that species. Bryophyte and lichen information were not used in the analysis, as the data set was not considered comprehensive.

Data was analysed both in a quantitative form and as floristic (i.e. presence/absence) data using a polythetic divisive clustering technique in the programme TWINSpan (Hill, 1979a). As the programme is based on an idea that is essentially qualitative (Hill, 1979a), it requires the identification of pseudospecies. Pseudospecies are essentially quantitative equivalents, i.e. pseudospecies are species differentiated on the basis of their cover value. Pseudospecies cut levels were set at 0, 1%, 5%, 25%, 50%, 75% and 100%, covering the range of abundance values attained. The maximum number of species to be displayed in the final tabulation was set at 500 to cover all species, with default settings retained for the rest of the options. The two-way table and dendrogram output from this programme allows for an objective assessment of the vegetation types present within Macraes ecological district. At each division in the dendrogram, a list of indicator species are given.

2.4 SELECTION OF RECOMMENDED AREAS FOR PROTECTION (RAPs)

The results from the computer analyses were combined with field notes to identify and define Recommended Areas for Protection (RAPs). Assessment was based on the seven selection criteria given in Myers et al. (1987) and an additional criteria, landform. Representativeness is the primary selection criterion. Catchment boundaries were sought where possible as it was felt this would increase a RAP's ecological viability and integrity. The eight selection criteria are as follows:

- 1 **Representativeness:** the extent to which the area's vegetation or plant ecology represents or exemplifies the components of the natural diversity within the ecological district.
2. **Diversity:** the range of natural species and communities present within the area.
3. **Naturalness:** the degree to which indigenous species are present in a given area or habitat, taking into account modification by humans and the presence of exotic species.
4. **Special features:** the presence of rare or uncommon plant and animal species
5. **Viability:** the ability of the area's plant communities (or particular species) to maintain themselves in the long-term without human intervention or management. This takes into account present management regimes, the regeneration and vigour of particular species, the size of the community and inter-species competition (particularly in respect to exotics).
6. **Buffering:** the degree to which the area's plant and animal communities are protected from modifying influences by natural features such as catchment boundaries, surrounding vegetation or, in some instances, by artificial structures such as fences.
7. **Threats:** factors that may cause adverse changes to the area's naturalness, such as a decrease in the size of an individual population or community and/or an increase in the abundance of exotic species at the expense of indigenous species.
8. **Landform:** Primarily an assessment of the representativeness of the landform within the context of the landsystem, but also including other physical features of the area.

2.5 ECOLOGICAL UNITS FOR MACRAES ECOLOGICAL DISTRICT

Broadleaf forest on lower-slope of truncated spur.

Broadleaf forest on lower-slopes.

Broadleaf forest on toe-slope.

Broadleaf-Pseudopanax forest in gully.

Broadleaf-Pseudopanax forest on toe-slope.

Copper tussock grassland in asymmetric gully floor on rolling mountain top.

Copper tussock grassland on ridge crest.

Copper tussock wetland on basin floor.

Copper tussock wetland on gully floor of rolling mountain top.

Copper tussock wetland on gully floor.

Copper tussock wetland on ridge crest.

Dry rocky tussock-shrubland on upper-slopes.

Dry tussock-shrubland on rock bluff.

Dry tussock-shrubland on rock outcrop.
 Dry tussock-shrubland on upper-slope of truncated spur.
 Kanuka woodland on gully side-slope.
 Kanuka woodland on lower-slopes.
 Kanuka woodland on side-slope.
 Kanuka woodland on toe-slope.
 Low turf ephemeral tarn on broad ridge crest.
 Low turf ephemeral tarn on ridge crest.
 Medium turf ephemeral tarn mid-slope.
 Medium turf ephemeral tarn on broad ridge crest. .
 Medium turf ephemeral tarn on ridge crest.
 Mixed broadleaved forest on lower-slopes.
 Mixed broadleaved forest on toe-slope.
 Mixed shrubland on gully floor.
 Mixed shrubland on lower-slopes.
 Mixed shrubland on side-slope.
 Mixed shrubland on toe-slope.
 Mixed shrubland on upper-slope.
 Modified narrow-leaved snow tussock grassland on broad ridge crest.
 Modified narrow-leaved snow tussock grassland on ridge crest.
 Modified narrow-leaved snow tussock grassland on upper-slopes.
 Moist copper tussock grassland on broad ridge crest.
 Moist copper tussock grassland on ridge crest.
 Moist copper tussock grassland on upper-slopes.
 Moist tussock-shrubland in gully on lower-slopes.
 Moist tussock-shrubland on basalt boulder outcrop mid-slope.
 Moist tussock-shrubland on basalt boulder slope on mountain plateau.
 Moist tussock-shrubland on basalt boulder slope.
 Moist tussock-shrubland on extensive rock outcrop.
 Moist tussock-shrubland on gully floor.
 Moist tussock-shrubland on lower-slopes.
 Moist tussock-shrubland on rock outcrop.
 Moist tussock-shrubland on side-slopes.
 Moist tussock-shrubland on upper-slope with scattered rock outcrops.
 Narrow-leaved snow tussock grassland on asymmetric gully side-slopes on rolling mountain top.
 Narrow-leaved snow tussock grassland on broad ridge crest.
 Narrow-leaved snow tussock grassland on extensive rock outcrops.
 Narrow-leaved snow tussock grassland on gully side-slope.
 Narrow-leaved snow tussock grassland on hilltop.
 Narrow-leaved snow tussock grassland on mountain crest.
 Narrow-leaved snow tussock grassland on ridge crest.

Narrow-leaved snow tussock grassland on rock bluffs.
Narrow-leaved snow tussock grassland on rock outcrop.
Narrow-leaved snow tussock grassland on rolling mountain top.
Narrow-leaved snow tussock grassland on side-slope.
Narrow-leaved snow tussock grassland on toe slope.
Narrow-leaved snow tussock grassland on upper-slopes.
Olearia shrubland on rocky mid-slope.
Pasture grassland on gently sloping planar surface.
Purei wetland on gully floor.
Purei wetland on ridge crest.
Red tussock wetlands on gully floor.
Salt pan on gently sloping planar surface.

3 Results

3.1 VEGETATION

Through a quantitative TWINSpan analysis, 13 Quadrat (community) Groups and 16 Species Classes were identified, both at division four of the classification (Figure 3.1). A floristic analysis of the data using TWINSpan was also carried out and gave generally similar groupings to that of the quantitative analysis.

3.1.1 TWINSpan Species Classes

The following are brief descriptions of the species that characterise each of the 16 Species Classes identified in the quantitative TWINSpan analysis (Figure 3.1). The numbering of the following descriptions corresponds to the Species Classes number down the right hand side of Fig. 3.1, with the number of species present in each group given as (n)

1) Wetland species group (n=59)

The most abundant and common species in this group are the exotic grasses *Agrostis stolonifera* and *Alopecurus geniculatus*, and the rushes *Juncus articulatus* and *Juncus effusus* along with a limited number of indigenous species such as the rush *Elaeocharis acuta* and the herb *Ranunculus glabrifolius*. Other less abundant indigenous species that are characteristic of wetland areas include the sedge *Carex gaudichaudiana*, the herbs *Callitriche petriei* and *Myriophyllum propinquum*, and the moss *Sphagnum cristatum*.

2) Moist flushes species group (n=56)

The indigenous grass *Chionochloa rubra cuprea* characterises this group along with the native rush *Schoenus pauciflorus*, the grass *Hierochloa redolens* and the herb *Pratia angulata*. Other characteristic indigenous species at lower occurrences include the herbs *Aciphylla glaucescens*, *Potentilla anserinoides* and *Rumex crispus*.

3) Characteristic tussock grassland species group (n=112)

This group is characterised by a range of indigenous tussock grassland inter-tussock species, including the herbs *Anisotome aromatica*, *Celmisia gracilentia* and *Wahlenbergia albomarginata* with the woody sub-shrubs *Gaultheria macrostigma* and *Leucopogon fraseri*. *Festuca nova-zelandiae* is the only indigenous grass present in this group.

4) Widely distributed tussock grassland species group (n=15)

This group contains many species that have a high occurrence throughout the sampled areas. Narrow-leaved snow grass *Chionochloa rigida* characterises the group in terms of abundance, with other frequently occurring natives including the grass *Poa colensoi* and the herbs *Geranium microphyllum* and *Ranunculus multiscapus*. Of the weedy exotic species present, the grass *Anthoxanthum odoratum* and the herb *Hieracium pilosella*, are both widely spread and abundant.

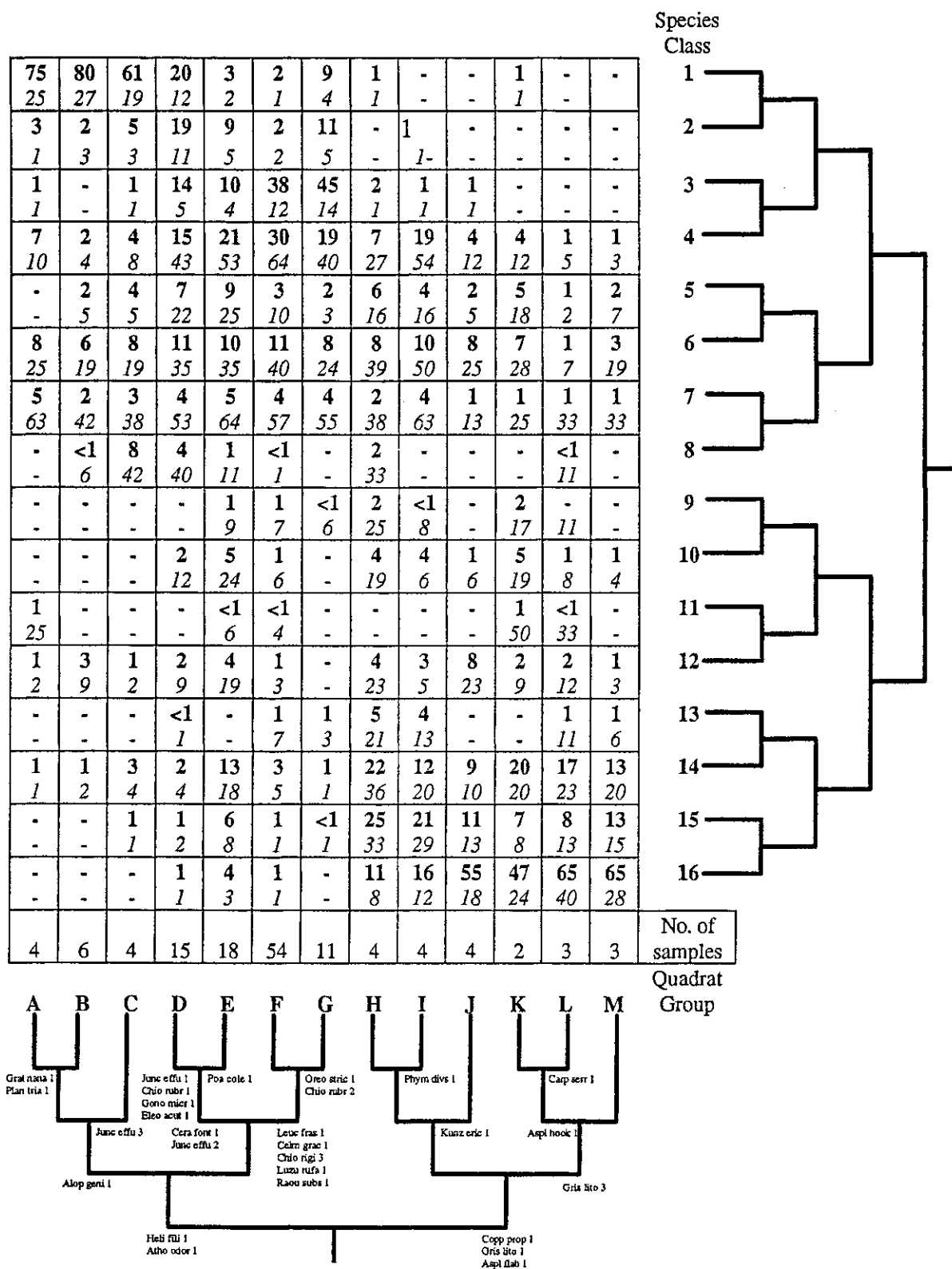


Figure 3.1

Two-way table including dendrograms for the TWINSpan Quadrat and Species Classifications based on abundance data summed across tiers. The bold type in the matrix represents the cover for a given Species Class as a percentage of the total cover for the Quadrat Group it occurs in. Numbers in italics represent the occurrence of species within each cell as a percentage of the maximum number of occurrences possible for that cell (i.e. if all species occur in all quadrats for a particular cell, it would have a value of 100%). Indicator species for each division in the Quadrat Group dendrogram are shown, the number beside it giving its cover class (i.e. pseudospecies).

5) Scrub/ damp gully species group (n=14)

Abundant species in this group include the indigenous shrub species *Discaria toumatou*, *Muehlenbeckia complexa* and *Olearia bullata* and the herb *Geranium sessiliflorum* with the exotic herb *Cerastium fontanum* also abundant.

6) Widely distributed weedy tussock grassland species group (n=9)

This group is characterised by the weedy exotic grass *Holcus lanatus* and the herbs *Hieracium lepidulum*, *Hypochoeris radicata* and *Trifolium repens*. The most abundant native in this group is the herb *Viola cunninghamii*.

7) Widely distributed weed species group (n=2)

The exotic weedy herb *Rumex acetosella* and grass *Agrostis capillaris* are the only two species in this group.

8) Wet fertile soils species group (n=3)

The three species contained in this group are the native sedge *Carex secta* and the exotic herb *Stellaria alsine* and grass *Cynosurus cristatus*.

9) Moist shrubland/forest species group (n=3)

The indigenous shrub *Coprosma cheesemanii* is the most abundant of the three species in this group. The other two native species, the fern *Blechnum* sp. 2 and herb *Viola filicaulis* combine to make this group free of exotic species.

10) Moist fertile soils species group (n=8)

The indigenous grass *Poa cita* and herbs *Oreomyrrhis ramosa* and *Phormium cookianum* are the most abundant species in this group.

11) Uncommon herbaceous species group (n=1)

The indigenous herb *Centella uniflora* is the only species in this group. It is of low occurrence and abundance.

12) Widely distributed, low abundance scrub and forest species group (n=11)

This group is characterised by a mix of exotic herbs *Cirsium vulgare* and *Verbascum thapsus*, and native herb *Oxalis exilis* and grass *Dichelachne crinita*.

13) Shrubland species group (n=6)

All the species in this group are natives. It is characterised by a high occurrence of the shrubs *Leptospermum scoparium* and *Cassinia leptophylla*, with the sporadic appearance of *Leucopogon colensoi*.

14) Moist rocky shrubland species group (n=25)

The indigenous ferns *Polystichum vestitum* and *Asplenium richardii* with the grass *Rytidosperma gracile* are the most abundant species present in this group. The indigenous shrub species *Aristotelia fruticosa*, *Coprosma rugosa*, *Hebe*

rakaiensis and *Melicytus alpinus* are present along with the scramblers *Fuchsia perscandens* and *Muehlenbeckia australis*.

15) Dry rock outcrops and rocky shrublands species group (n=25)

The indigenous shrubs *Carmichaelia petriei* and *Coprosma propinqua* are the most abundant species in this group. Other indigenous shrub species include *Carmichaelia kirkii*, *Coprosma rugosa*, *Coprosma virescens*, *Corokia cotoneaster* and the exotic shrub *Rosa rubiginosa*. The native herb *Gingidia montana*, a typical rock outcrop species, is also present.

16) Forest species group (n=62)

Griselinia littoralis is the most abundant native tree species of this group. Other native tree species, including *Melicytus ramiflorus*, *Pittosporum eugenioides*, *Pseudopanax colensoi* and *Sophora microphylla*, are less common. Forest understorey species include the native shrubs *Coprosma areolata*, *C. crassifolia* and *Helichrysum aggregatum*. Characteristic native species in the herb layer include the herb *Libertia ixioides*, the climber *Parsonsia heterophylla* and the ferns *Asplenium hookerianum* and *Polystichum richardii*.

3.1.2 TWINSpan Quadrat (community) Groups: Vegetation Types

The analysis identified 13 Quadrat Groups labeled A to M on Figure 3.1. The first division of the dendrogram (Fig. 3.1) created a group of forest and shrub communities (Quadrat Groups H to M), with the indicator species *Coprosma propinqua* 1¹ (The number given at the end of the indicator species refers to the pseudospecies class assigned during the TWINSpan analysis.), *Griselinia littoralis* 1 and *Asplenium flabellifolium* 1; and a group of tussock grassland communities (Quadrat Groups A to G) characterised by *Helichrysum filicaule* 1 and *Anthoxanthum odoratum* 1 as the two indicators.

Following the forest and shrub communities through to the second division we see *Griselinia littoralis* 3 again characterising one side of the split, the numeral 3 indicating a higher pseudospecies class or abundance than the previous level where it occurred with a ranked cover abundance of 1. Following down to level three from the group indicated by *Griselinia*, the indicator species *Asplenium hookerianum* 1 suggests that the differentiation being made is based on species composition in the herb layer. Quadrat Group M is distinguished at level three, with the *Asplenium* group being further divided into Groups L and K. This, the fourth division, shows Group L as characterised by *Carpodetus serrata* 1, suggesting differentiation on the basis of canopy composition.

Going back to the second split of the forest and shrub grouping, Group J is distinguished at the third level, with the indicator species being *Kunzea ericoides* 1, suggesting forest distinguished by the presence of kanuka. The other group is split at the fourth division into Group I, with the herbaceous species *Phymatosorus diversifolius* 1 as the indicator, and into Group H.

Going back to the tussock grouping at the first level, the next division creates a group (Quadrat Groups A to C) characterised by the indicator species

Alopecurus geniculatus 1 suggesting a wetland group. This group is divided at the third level to form Group C, distinguished by *Juncus effusus* 3, indicating wetlands characterised by a high abundance of *J. effusus*. Groups A and B are distinguished at level four, with the indicator species *Gratiola nana* 1 and *Plantago triandra* 1 for Group A.

The second grouping distinguished at level two in the tussock communities group, without any indicator species (Quadrat Groups D to G), is split into a group (Quadrat Groups D & E) with the indicator species *Cerastium fontanum* 1 and *Juncus effusus* 2, suggesting a mix of wetlands (*J. effusus*) and grasslands (*C. fontanum*). This is further divided at level four into Group E with the indicator species *Poa colensoi* 1 suggesting a tussock grassland community; and Group D, with the indicator species *Juncus effusus* 1, *Chionochloa rubra cuprea* 1, *Gonocarpus micranthus* 1 and *Elaeocharis acuta* 1, suggesting *C. rubra cuprea* wetland.

Going back to the third division of the previous grouping (Quadrat Groups F & G), the indicator species (*Leucopogon fraseri* 1, *Celmisia gracilentia* 1, *Chionochloa rigida* 3, *Luzula rufa* 1 and *Raoulia subsericea* 1) suggest this is typical *Chionochloa rigida* tussock grassland. This group is then split at level four into Groups G and F, with the indicator species for group G, *Oreobolus strictus* 1 and *Chionochloa rubra* 2, indicating moist copper tussock grassland. Group F has no indicator species.

The following are descriptions of the TWINSPLAN Quadrat Groups. They are characterised according to the percentage cover the different Species Class contribute to the group. The number of quadrats per group is given as (n).

A) Low turf ephemeral tarns (n=4)

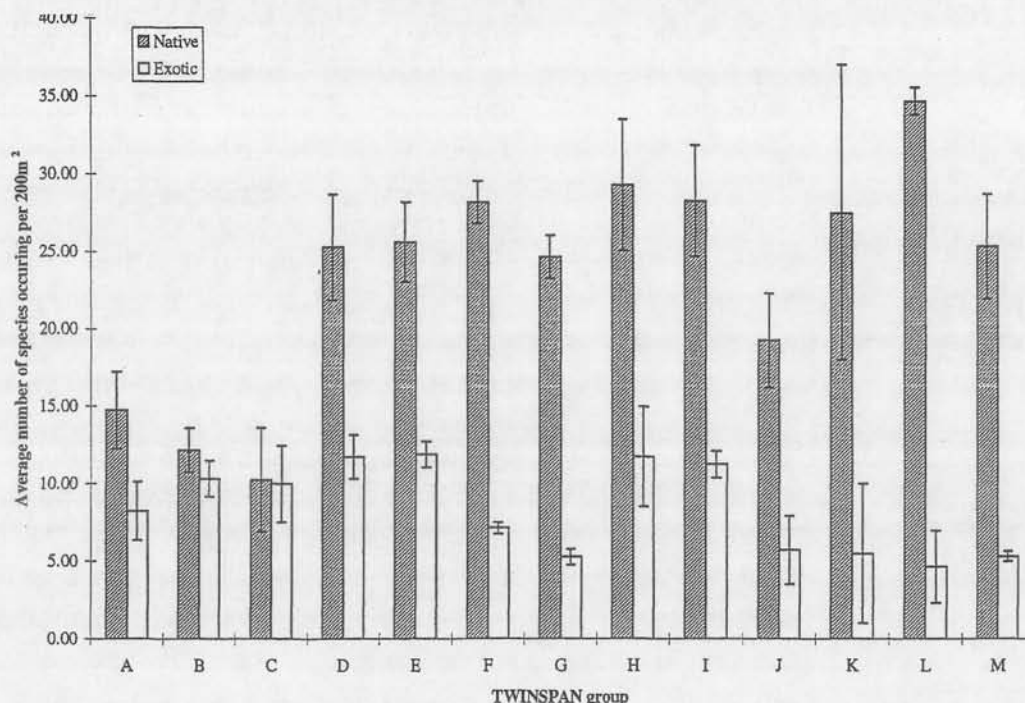
This group is characterised by Species Class 1 (75%), which reaches its second highest occurrence here. Prominent species occurring in this group include the exotic grass *Alopecurus geniculatus* and the native herbs *Gratiola nana*, *Plantago triandra* and grass *Lachnagrostis glabra*; the exotic rush *Juncus effusus* is present in the 0.3-2m height class in very low abundance. Of particular note in Species Class 1 is the occurrence of the indigenous threatened herb *G. nana* and the local herb *Tetrachondra hamiltonii* (Cameron *et al.*, 1995), present only in this Quadrat Group.

Attaining their maximum abundances in this Quadrat Group are Species Class 11 (1%), containing only the one native herb *Centella uniflora*, and Species Class 7 (5%), containing the two exotics the grass *Agrostis capillaris* and the herb *Rumex acetosella*. Species Class 11 also reaches its maximum abundance in one other group (K). The high percentage occurrence for Species Class 7 (63%) reflects its widespread occurrence throughout sites within this Quadrat Group.

Species Class 6 (8%), especially the exotic herb *Hypochoeris radicata* and the native herb *Viola cunnighamii*, and Class 4 (7%) also contribute to this group.

An average of 23 species occurred per quadrat, with the average number of indigenous species being significantly higher than exotics (Figure 3.2). The vegetation is of low stature with the under 10cm height class accounting, on average, for 98% of the cover. This vegetation type occurs in three study areas. Ephemeral tarns are defined here as small hollows (under 0.05ha) situated on

flattened areas that are periodically inundated with water. The quadrats have a mean altitude of 586 $\pm$ 16m (standard error). All quadrats are flat. Annual rainfall is estimated at 600mm, with all sites being ranked 4 for soil wetness. All sample sites occurred on debris-mantled hill tops.



(Figure 3.2

Species richness, shown as the mean number of exotic and indigenous species found per 200m² quadrat area, for each of the thirteen TWINSpan Quadrat Groups. Error bars show the standard error, * indicates a significant difference ($p > 0.05$) between the number of exotics and natives for that particular Quadrat Group.)

B) Medium turf ephemeral tarns (n=6)

Species Class 1 is present at its highest abundance (80%) and characterises this group. The group contains a mixture of the exotic grasses *Agrostis stolonifera*, *Alopecurus geniculatus* and *Glyceria fluitans*. *A. geniculatus* occurs here in higher abundance than in group A). Indigenous species from Species Class 1 include the rush *Elaeocharis gracilis* and the herbs *Callitriche petriei* and *Myriophyllum propinquum*. The exotic rush *Juncus effusus* is again dominant (0.3-2m) but is joined by the native rush *J. gregiflorus*.

Species Class 6 (6%) with the exotic grass *Holcus lanatus* and herb *Trifolium repens* is the only other Species Class above 3%.

Again the vegetation is of low stature, with an average of 92% of the cover occurring in the under 10cm height class. The 0.3-2m layer here accounts for more of the total quadrat cover than in Group A. Bare ground varied between 10-50%, with the average cover similar to Group A. An average of 22.5 species occur per quadrat, similar to Group A. However here there is no significant difference ($p < 0.05$) between the number of native and exotic species occurring.

Three study areas contained this vegetation type occurring at lower altitudes on average than in Group A (mean altitude being 472 $\pm$ 37m). All quadrats had a slope of 0° and an average estimated annual rainfall of 550mm, with three of the six quadrats having surface water present. Soil wetness was ranked 4 in all sites. Again, all sample sites occurred on debris mantled flat hill tops.

C) *Purei (Carex secta) wetlands (n=4)*

This type of vegetation was found in four study areas. It is characterised by the highest occurrence of Species Class 8 (8%) containing the indigenous sedge *Carex secta* as the physiognomic dominant with the exotic herb *Stellaria alsine* and grass *Cynosurus cristatus*. However, with reference to cover, the group is dominated by Species Class 1 (61%) in which the exotic grass *Alopecurus geniculatus* and rush *Juncus effusus*, combined with the indigenous rush *Elaeocharis acuta* and herb *Ranunculus glabrifolius*, are distinctive. *Juncus effusus*, the indicator species for this group, reaches its highest abundance over all groups in the 0.3-2m height class. Species Class 6 (8%), with the exotic grass *Holcus lanatus*, is also prominent.

The under 10cm height class cover ranged between 25% and 50% of the total cover with bare ground averaging 4%, considerably less than the previous two vegetation types. Mean altitude is the highest of any group at 645m $\pm$ 27m, reflecting the occurrence of three sites on the crests of hill tops. The other site occurred on a gully floor within a hill side slope. Mean annual rainfall is estimated to be 700mm, with soil wetness ranked 4.

D) *Copper tussock (Chionochloa rubra cuprea) wetlands (n=15)*

Again Species Class 1 (20%) is most prominent within this group, however Species Class 2 at 19% is more characteristic. Class 2 contains the indigenous grass *Chionochloa rubra cuprea*, the sedge *Schoenus pauciflorus* and the herb *Aciphylla glaucescens* in the 0.3-2m height tier, the native grass *Hierochloa redolens* in the 0.1-0.3m tier; and the native herbs *Myriophyllum propinquum*, *Pratia angulata* and *Potentilla anserinoides* in the <10cm height tier. Of particular note from this Species Class, are the indigenous herbs *Potentilla anserinoides* and *Neopaxia australasica*, the grass *Rytidosperma thomsonii* and the sedge *Carex tenuiculmis* occurring only in this Quadrat Group

Species Class 4 (15%), especially the indigenous herbs *Bulbinella angustifolia* and *Geranium microphyllum*, the fern *Blechnum penna-marina*, and the exotic grass *Anthoxanthum odoratum*; Class 3 (14%), with the native herbs *Anisotome aromatica* and *Celmisia gracilentia* and the woody sub-shrub *Gaultheria macrostigma*; and Class 6 (11%), containing the exotic herbs *Hypochoeris radicata* and *Trifolium repens* and the grass *Holcus lanatus*, are also prominent in this group.

Species Class 6 attains its maximum abundance here, with one of two occurrences at 11% total cover. Species Class 5 (7%), with the native shrub species *Olearia bullata* and the herbaceous species *Ranunculus foliosus*, reaches its second highest abundance here.

This group is found in 12 study areas at an altitude of 594m $\pm$ 22m, generally occurring on very gentle slopes (2° mean). Annual rainfall averages about

750mm. The mean soil wetness has a ranking of 3.7. This Quadrat Group occurs over a range of landforms but tends to occur predominantly on gully floors. Other landforms include rolling hill tops, ridge crests

and hill top swales. There was an average occurrence of 25 indigenous species and 12 exotic species per quadrat, a considerably higher occurrence of natives over exotics than the previous two groups.

E) Moist tussock-shrubland (n=18)

This group is characterised by Species Class 4 (21%) in which the indigenous grasses *Chionochloa rigida* and *Poa colensoi*, herbs *Aciphylla aurea* and *Bulbinella angustifolia*, and the exotic grass *Anthoxanthum odoratum* are distinctive.

Species Class 14 (13%) is also characteristic, with the native ferns *Asplenium richardii* and *Polystichum vestitum*, the grass *Rytidosperma gracile*, the shrub species *Coprosma rugosa* and *Melicytus alpinus*, and the scramblers *Fuchsia perscandens* and *Muehlenbeckia australis*.

Three Species Classes attain their maximum abundance here. Class 5 (9%), containing the native shrubs *Olearia bullata* and *Discaria toumatou*, the scrambler *Muehlenbeckia complexa*, the grass *Elymus solandri* and the exotic weed *Cerastium fontanum*, Class 7 (5%), with the two exotic weeds *Agrostis capillaris* and *Rumex acetosella*, and Class 10 (5%), in which the indigenous herbs *Oreomyrrhis ramosa* and *Phormium cookianum* are distinctive.

Species Class 3 (10%), with the native herb *Wahlenbergia albomarginata*, woody sub-shrub *Leucopogon fraseri* and grass *Festuca novae-zelandiae*, Class 6 (10%), with the exotic grass *Holcus lanatus* and herbs *Hypochoeris radicata* and *Trifolium repens*, and Class 2 (9%), containing the exotic herb *Trifolium dubium* and native herb *Hydrocotyle novae-zeelandiae*, are also prominent.

This group is represented in twelve study areas occurring on slopes with an average gradient of 22° and bare rock accounting for, on average, 18% of the ground cover. Both the dendrogram and field notes indicate that this group could be split into two sub-groups based on topography: 1) Rock outcrop tussock communities and 2) south-facing hill-slope tussock communities. Most of the quadrats occurred foot- to mid-slope of hills with areas of scattered rock outcrops present, three quadrats occurring on basalt boulder slopes and three on extensive rock outcrops. Two of the sites occurred in gullies on hill-slopes. Mean altitude was 519 ± 33m.

F) Narrow-leaved snow tussock (*Chionochloa rigida*) grasslands (n=54)

This is the largest Quadrat Group with 54 quadrats. It is characterised by Species Class 3 (38%) having the highest abundance within the group, and Class 4 (30%) both predominant within the group and attaining its highest abundance across all Quadrat Groups.

Distinctive species in Class 4 include the indigenous grass *Chionochloa rigida* as the physiognomic dominant and the native herbs *Geranium microphyllum*, *Helicbrysum filicaule* and *Ranunculus multiscapus*. Also contained within this group are the exotic grass *Anthoxanthum odoratum* and herb *Hieracium pilosella*.

Species Class 3 is characterised by the native grass *Festuca nova-zelandiae*, and the native herbs *Anisotome aromatica*, *Celmisia gracilentia* and *Luzula rufa* and the woody sub-shrubs *Gaultheria macrostigma* and *Leucopogon fraseri*.

Present here as one of two occurrences at its highest abundance is Species Class 6 (11%). This group is dominated by the exotic grass *Holcus lanatus* and herbs *Hieracium lepidulum*, *Hypochoeris radicata* and *Trifolium repens*.

This Quadrat Group is represented in 13 study sites. It occurs at an average altitude of 589 ± 13m on slopes with a mean gradient of 14°. The majority of sites occurred on the side-slopes of debris-mantled hard rock hills, with debris-mantled hill crests and mountain slopes being the next most common landform types. Less common were occurrences on rock outcrops (although the majority of sites had scattered rock outcrops associated with them), hollows on hill-slopes and toe-slopes. Quadrats contained a mean of 28 indigenous species and 7 exotics.

G) Moist copper tussock (*Chionochloa rubra cuprea*) grassland (n=11)

Species Class 3 (45%) is characteristic of this community, attaining maximum cover for both the Quadrat Group and Species Class. Important species in class 3 include the native herb *Anisotome aromatica* and *Oreostylidium subulatum*, the woody sub-shrub *Gaultheria macrostigma* and the sedge *Oreobolus strictus*.

Species Class 4 (19%) is the next highest contributor, in which the indigenous herb *Bulbinella angustifolia* and grass *Poa colensoi* with the exotic grass *Anthoxanthum odoratum* are characteristic.

Species Class 2 (11%) with the native tussock *Chionochloa rubra cuprea*, the sedge *Schoenus pauciflorus* and the herb *Pratia angulata*; Species Class 1 (9%) especially the native lily *Herpolirion novae-zelandiae*; and Species Class 6 (8%) also contribute characteristically to this group.

This group is present in five study areas with an average soil wetness ranking of 2.8. Sites typically occurred at 939 ± 22m altitude on flat or gently sloping areas with an average gradient of 2°. The crests of debris mantled hard rock hill tops were the predominant landforms accounting for half of the sites sampled. The remainder occurred on ridge crests of hard rock hills and mountains. On average 25 natives and 5 exotics occurred per quadrat.

H) Mixed shrubland (n=4)

The native shrub species *Carmichaelia petriei*, *Coprosma propinqua*, *Corokia cotoneaster* and the scrambler *Rubus schmidelioides* are distinctive species in Class 15 (25%), the class most characteristic of this group. Species Class 15 is also present here in its highest occurrence over all groups. Of particular note from Class 15 is the presence in this group of the threatened indigenous shrub *Carmichaelia kirkii* (Cameron *et al.*, 1995).

Species Class 14 (22%) is also distinctive in this group and occurs here in its highest abundance. Predominant species in Class 14 include the native shrubs *Coprosma rugosa* and *Melicytus alpinus*, the scramblers *Clematis marata* and *Muehlenbeckia australis*, the grass *Rytidosperma gracile* and the ferns *Polystichum vestitum* and *Asplenium richardii*.

Mean slope for this group is 31° reflecting the group's tendency to occur on steep debris-mantled gully. Field notes suggest that the group also tends to be associated with areas of extensive or scattered rock outcrops. Mean altitude is 401 ± 68m, the largest variation in altitude of any group. On average 12 exotic and 30 indigenous species occurred per quadrat.

I) Dry tussock-shrubland (n=4)

The group is characterised by Species Classes 15 (21%) and 4 (19%), with no Species Class reaching its highest abundance in the Group. Species Class 15 is characterised by the native shrubs *Carmichaelia petriei*, *Coprosma propinqua* and *Corokia cotoneaster*, the herbs *Anisotome brevistylis* and *Gingidia montanum*; exotic species in this class include the shrub *Rosa rubiginosa* and the herbs *Senecio jacobaea* and *Trifolium arvense*.

Species Class 4 contains the indigenous grasses *Chionochloa rigida* and *Poa colensoi* and the herb *Helichrysum filicaule*. The exotic grass *Anthoxanthum odoratum* and herb *Hieracium pilosella* are also prominent.

Also of prominence in this group are Species Classes 6 (10%), with the exotic grass *Holcus lanatus* and herbs *Hypochoeris radicans* and *Trifolium repens*, and Class 14 (12%), especially the native grass *Rytidosperma gracile* and fern *Pteridium esculentum*.

This group has the steepest mean slope of any group at 39°, with a mean altitude of 219 ± 41m. Average rock cover of 11% is the third highest of any group. All sites occur on steep rocky bluffs. An average quadrat contained 28 indigenous species and 11 exotics.

J) Kanuka (*Kunzea ericoides*) forest (n=4)

Species Class 16 (55%), with the native tree species *Kunzea ericoides* and *Griselinia littoralis*, the shrub species *Helichrysum aggregatum* and *Coprosma crassifolia* and the ferns *Asplenium flabellifolium* and *A. hookerianum*, is the dominant class in this group.

Reaching its maximum abundance here is Species Class 12 (8%) with the native grass *Dichelachne crinita* and herb *Oxalis exilis* with the exotic herbs *Cirsium vulgare* and *Verbascum thapsus*. Also of prominence are Species Classes 15 (11%), especially the native shrubs *Coprosma propinqua* and *Carmichaelia petriei* and the exotic grass *Dactylis glomerata*, Class 14 (9%) and Class 6 (8%)

This Quadrat Group tends to occur at an average altitude of 304 ± 58m on steep (average gradient of 32°) mid-lower side slopes of hills. An average quadrat contained 6 exotics and 19 natives. Soil wetness ranking for the group is the lowest with a mean of 1.25 (indicating dry soils) and bare ground is reasonably high at 17 % of cover. Field notes indicate that this Quadrat Group is often associated with scattered rock outcrops.

K) Broadleaf (*Griselinia littoralis*)-*Pseudopanax* forest (n=2)

This group is dominated by Species Class 16 (47%), with the native trees *Fuchsia excorticata*, *Griselinia littoralis*, *Pseudopanax colensoi* and *P. simplex* characterising the canopy. The native shrub species *Coprosma parviflora*, the

herbs *Astelia fragrans* and *Libertia ixioides* and the grass *Microlaena avenacea* are also prominent.

Species Class 14 (20%) is also characteristic with the indigenous ferns *Polystichum vestitum* and *Blechnum procerum* being distinctive. Reaching their highest abundances in this group are Species Classes 11 (1%), containing the one native herb *Centella uniflora*, Class 10 (5%), especially the native herb *Phormium cookianum* and Class 9 (2%) with the native fern *Blechnum* sp2.

On average, 28 natives and 6 exotic species occurred in a quadrat. The group has a mean altitude of 410 $\pm$ 10m, with one site occurring on the toe-slope of a mountain and the other in a gully on the upper-slope of a hill. The average slope is 15° with a soil moisture ranking of 2.5; the wettest of all forest groups.

L) Mixed broadleaved forest (n=3)

Species Class 6 (65%) dominates this group and reaches its highest occurrence over all groups. The Class is characterised by the co-dominance of the native trees *Griselinia littoralis*, *Pittosporum tenuifolium* and *Carpodetus serratus* in the canopy, with the shrubs *Coprosma areolata* and *C. rotundifolia*, the herb *Schizellema trifoliata*, the grass *Microlaena avenacea* and the climber *Parsonsia heterophylla*.

Other predominant Species Classes include Class 14 (20%), containing the native ferns *Blechnum procerum* and *Polystichum vestitum*, and Class 15 (7%), especially the native shrub *Coprosma propinqua* and scrambler *Fuchsia perscandens*.

With an average altitude of 273 $\pm$ 38m, and a mean slope of 23°, this group tended to occur on the toe-slopes of hard rock hill slopes. Field notes indicate the group tends to be associated with areas of scattered or extensive rock outcrops, although bare rock only accounted for 5% of cover on average in the quadrats. On average, 35 native and 5 exotics occurred per quadrat, the highest number recorded for natives.

M) Broadleaf (*Griselinia littoralis*) forest (n=3)

Species Class 6 (65%) also dominates this group, and shares co-dominance in terms of overall abundance with the previous group. Class 6 contains the native tree *Griselinia littoralis*, which is the dominant canopy tree. Other native canopy trees of lower occurrence include *Carpodetus serratus*, *Melicytus ramiflorus* and *Myrsine australis*. Native shrub species include *Coprosma crassifolia* and *C. linariifolia*, with the sedge *Carex raoulii*, the herb *Scandia geniculata* and the fern *Phymatosorus diversifolius* in the herb layer.

Species Classes 15 (13%) and 14 (13%) are the only other Classes above 3% total cover for the group. The native shrubs *Carmichaelia virgata* and *Coprosma propinqua* and the exotic grass *Dactylis glomerata* are distinctive in Species Class 15, while Class 14 is characterised by the native fern *Pteridium esculentum* and herb *Aristotelia fruticosa*.

This group has the highest cover of bare rock at 54% of ground cover on average. All the sites occurred on the side-slopes of hills with the bedrock exposed and were described on the site description cards as extensive areas of rock outcrop. The group had a mean slope of 35° with a mean altitude of 197 $\pm$ 26m, the lowest of all Quadrat Groups. An average of 25 native and 5 exotic species occurred per quadrat.

3.2 ENVIRONMENT-VEGETATION RELATIONSHIPS

The wetlands grouping tends to occur on the Tablelands/Rolling Tops ecographic unit (see Table 3.1), with the shrublands and forest groupings tending to occur on steep hills. For the moist copper tussock communities and narrow-leaved snow tussock grassland groupings a different picture emerges. There is no clear association with a particular ecographic unit. Tableland/Rolling Tops scores highest for moist copper tussock communities, however there is also a high occurrence on Rolling Hills. For narrow-leaved snow tussock grassland, occurrence seems relatively evenly spread over steep hills, rolling hills and tablelands/rolling tops.

TABLE 3.1 THE ECOGRAPHIC UNIT AND VEGETATION GROUPING CONTINGENCY TABLE USED FOR THE LOG-LINEAR ANALYSIS.

ECOGRAPHIC UNIT	LAVAFLOW	STEEP HILLS	ROLLING HILLS	TABLELAND/ ROLLING TOPS
Wetland	0	1	0	13
Moist copper tussock communities	1	9	13	20
Narrow-leaved snow tussock grassland	1	15	16	18
Shrubland	0	8	0	0
Forest	0	9	2	1

3.3 FLORA

A total of 427 vascular species were identified during the sampling. Of these 356 are indigenous species and 71 are exotics. Of the indigenous species 226 (64%) are dicotyledons, 99 (28%) are monocotyledons, 4 (1%) are gymnosperms, 23 (6%) are pteridophytes and 4 (1%) are lycophytes. Of the exotic species 49 (69%) are dicotyledons, 20 (28%) are monocotyledons and 2 (3%) are gymnosperms. There were 22 lichens and 49 bryophytes identified. However, these groups are probably under-represented, as lichens and bryophytes were not collected from all sites. The lichens collected were typical of the rock outcrops and inter-tussock communities, common environments in Eastern Otago (Dr D. Galloway, pers. comm. 1997). Bryophytes were also typical of the eastern Otago habitats, including broadleaved forest, wetland, grassland and shrubland habitats (Dr R. Tangney, pers. comm. 1997).

Seven of the indigenous species are classified as threatened among five categories, while a further two indigenous species are classified as local (Cameron *et al.*, 1995). Of the threatened species *Carmichaelia kirkii* is listed as 'critical', *Cardamine* "tarn" and *Simplicia laxa* are 'endangered', *Gratiola nana* and *Myosurus minimus* ssp. *novae-zelandiae* are 'rare', *Crassula peduncularis* is 'vulnerable' and *Carex* "tenuiculmis" is 'insufficiently known'. The local species are *Celmisia hookeri*

and *Tetrachondra hamiltonii*. Two of the native species, *Sophora prostrata* and *Carmichaelia kirkii*, reach their southern-most limits of distribution within the district.

Carmichaelia kirkii occurred in two areas. A single plant occurred in the Golden Bar study area on a small, damp rock overhang with the native herbs *Celmisia hookeri* and *Phormium cookianum* (mountain flax) surrounded by *Chionochloa rigida* (narrow-leaved snow tussock) grassland. The other occurrence was in the Sheepwash Creek study area, where there were a few individuals in a *Coprosma* shrubland. The gully sides are steep and rocky, with extensive rock outcrops. The surrounding vegetation is highly modified snow tussock grassland containing much *Discaria toumatou* (matagouri). The Sheepwash Creek site is also the southern-most known occurrence of this species (B. Patrick, pers. comm. 1996).

Simplicia laxa populations in the Emerald Creek study site have been documented by Johnson (1993). Two populations were found occurring under rock overhangs, in shady moist conditions. The rocky overhangs occurred on the gully side, mid-slope. The gorge vegetation included *Kunzea ericoides* (kanuka) shrubland and *Chionochloa rigida* (narrow-leaved snow tussock) grassland in varying states of degradation. Wilson and Given (1989) note that *Simplicia laxa* is easily overlooked.

Five of the seven threatened plants and one local species are wetland species, and they are all of limited distribution within the District. Four of these species occur in ephemeral tarns on flattened areas on hill tops or ridge crests. The tarns are relatively small, and all have been modified by stock disturbances and invaded by exotic species. The tarns are generally surrounded by *Chionochloa rigida* grassland, often with a *Chionochloa rubra cuprea* (copper tussock) component. *Cardamine* "tarn" occurred in two tarns in the Glenwye study area and one tarn in the Trig J study area. In both instances only a few individuals were present. *Gratiola nana* occurred in four study areas: Glenwye, Trig J, Manuka Stream and Redbank. It reached its highest abundance in the Glenwye area at around 1% of total cover. *Myosurus minimus* ssp. *novae-zelandiae* occurred in two tarns, one at Glenwye and the other at Redbank. A few individuals of the local species *Tetrachondra hamiltonii* were recorded in the Manuka Stream ephemeral tarn.

Crassula peduncularis occurred in the Emerald Creek study area in a gully floor wetland characterised by the exotic rush *Juncus effusus* (soft rush) and sedge *Carex ovalis* (oval carex) and the native sedge *Carex geminata* (cutty grass). The population is very small, with the total cover of the sample quadrat being less than 1%. *Carex* "tenuiculmis" also occurred only once, in the Trimbells Gully study area, but with the total cover greater than 1%. It occurred on the gully floor in an area that has been highly modified by gold mining. The vegetation is characterised by *Chionochloa rubra cuprea*, *Carex secta* (purei) and *Schoenus pauciflorus* (bog rush).

Of the local plants *Celmisia hookeri* is the most widely distributed, occurring in six study areas: Redbank, Bonanza Mine, Payton's Gully, Hound Burn, Trimbells Gully and Flat Hill. The populations tend to occur on rock outcrops surrounded by *Chionochloa rigida* grassland. In the sample quadrats total cover exceeded 5% in four of the six quadrats, indicating good population size.

Only one individual of *Sophora prostrata* was found during the survey. It occurred on a small rock outcrop surrounded by *Chionochloa rigida* grassland on a gully

side in the Trimbells Gully catchment. This is the southern-most occurrence of this species (Dr. A. Whitaker, pers. comm. 1992).

Table 3.2 shows species not mentioned above that occurred in one study site only or were found to be of limited distribution within the District. There are 79 species in total that fall into this category.

Macraes Ecological District is not on the edge of a major biogeographic area and does not contain any distinctive geographic system such as an alpine range. This is reflected in a generally indistinctive flora with, as far as is known, none of the species being endemic to the district.

The exotic species *Hypochoeris radicata*, *Antboxanthum odoratum*, *Holcus lanatus*, *Agrostis capillaris* and *Trifolium repens* are the most widely spread of the 68 recorded exotic species, occurring in 113, 108, 100, 91 and 89 of the study sites respectively. Indigenous species with high occurrences include *Helicbrysum filicaule* (80), *Chionochloa rigida* (76), *Bulbinella angustifolia* (70), *Leucopogon fraseri* (67), *Celmisia gracilentia* (66) and *Poa colensoi* (78).

TABLE 3.2 PLANT SPECIES OF LOW OCCURRENCE WITHIN MACRAES ECOLOGICAL DISTRICT AND THE STUDY AREA THEY ARE LOCATED IN.

SPECIES	STUDY AREA
<i>Abrotanella caespitosa</i>	Trig O
<i>Acaena fissistipula</i>	Lots Wife
<i>Aciphylla scott-thomsonii</i>	Hound Burn
<i>Agrostis muscosa</i>	Redbank
<i>Agrostis pallescens</i>	Redbank
<i>Apium</i> sp	Murrays Road
<i>Aristotelia serrata</i>	Deep Creek
<i>Blechnum discolor</i>	McCormicks Creek
<i>Botrychium australe</i>	Emerald Creek
<i>Brachyscome longiscapa</i>	Filly Burn
<i>Calystegia tuguriorum</i>	Deep Creek
<i>Carex forsteri</i>	Deep Creek
<i>Carex raoulii</i>	McCormicks Creek
<i>Carex secta</i> var. <i>tenuiculmis</i>	Trimbells Gully
<i>Coprosma areolata</i>	Deep Creek
<i>Coprosma cuneata</i>	Lots Wife
<i>Coprosma linariifolia</i>	McCormicks Creek
<i>Coprosma perpusilla</i>	Sheepwash Creek
<i>Coprosma pseudocuneata</i>	Lots Wife
<i>Coprosma virescens</i>	Sheepwash Creek
<i>Corallospartium crassicaule</i>	Emerald Creek
<i>Coriaria lurida</i> complex	Hound Burn
<i>Crassula peduncularis</i>	Emerald Creek
<i>Deyeuxia aucklandica</i>	Emerald Creek
<i>Einadia allanii</i>	McCormicks Creek
<i>Elatine gratioloides</i>	Nenthorn Ridge
<i>Epilobium billardierianum</i>	Hound Burn
<i>Epilobium glabellum</i>	Redbank
<i>Epilobium hectori</i>	Hound Burn 2

<i>Epilobium insulare</i>	Filly Burn
<i>Epilobium macropus</i>	Flat Hill
<i>Gingidia montana</i>	Deep Creek/McCormicks Creek
<i>Glossostigma</i> sp	Nenthorn Ridge
<i>Gunnera prorepens</i>	Lamb Hill
<i>Haloragis erecta</i>	McCormicks Creek
<i>Halocarpus bidwillii</i>	Redbank/Lots Wife
<i>Hierochloe equisetia</i>	Manuka Stream
<i>Hoberia angustifolia</i>	McCormicks Creek
<i>Lachnagrostis filiformis</i>	Redbank
<i>Lachnagrostis semiglabra</i>	McCormicks Creek
<i>Lycopodium australianum</i>	Swampy Hill
<i>Lycopodium varium</i>	Lots Wife/Emerald Creek
<i>Lycopodium scariosum</i>	Trig O
<i>Mazus radicans</i>	Lots Wife
<i>Microlaena avenacea</i>	Trig O
<i>Myosurus novae-zelandiae</i>	Glenweye/Redbank
<i>Myriophyllum triphyllum</i>	Payton's Gully
<i>Myrsine divaricata</i>	Deep Creek
<i>Nertera balfouriana</i>	Lamb Hill
<i>Nertera scapanioides</i>	Manuka Stream
<i>Olearia virgata</i> var. <i>lineata</i>	Lots Wife
<i>Oreobolus impar</i>	Deep Creek
<i>Phyllocladus alpinus</i>	Lots Wife
<i>Plantago spathulata</i>	Redbank 2
<i>Plantago novae-zelandiae</i>	Lamb Hill
<i>Plantago uniflora</i>	Sheepwash Creek
<i>Poa maniototo</i>	Nenthorn Ridge
<i>Poa pusilla</i>	Manuka Stream
<i>Podocarpus hallii</i>	Mt Misery
<i>Podocarpus nivalis</i>	Redbank outcrop
<i>Potamogeton cheesemanii</i>	Payton's Gully
<i>Pratia perpusilla</i>	Glenweye
<i>Pseudopanax colensoi</i> var. <i>ternatus</i>	Lots Wife
<i>Rytidosperma pilosum</i>	Flat Hill
<i>Rytidosperma racemosum</i>	Trimbells Gully
<i>Rytidosperma setifolium</i>	Filly Burn
<i>Rytidosperma thomsonii</i>	Flat Hill
<i>Rytidosperma unarede</i>	Lamb Hill
<i>Selleria microphylla</i>	Murrays Road
<i>Senecio dunedinensis</i>	Deep Creek
<i>Simplicia laxa</i>	Emerald Creek
<i>Sophora microphylla</i>	Deep Creek/Redbank
<i>Sophora prostrata</i>	Trimbells Gully
<i>Tetrachondra hamiltonii</i>	Manuka Stream
<i>Trisetum youngii</i>	Mt Misery
<i>Uncinia egmontiana</i>	Trig E
<i>Uncinia filiformis</i>	Manuka Stream
<i>Uncinia sinclairii</i>	Hound Burn
<i>Uncinia uncinata</i>	Lots Wife

3.4 FAUNA

3.4.1 Vertebrates

Lists of reptiles, birds and introduced mammals found within the district are given below. Those species observed during the survey are marked with an asterisk (*).

Avifauna

A detailed survey of avifauna was not undertaken for this survey and, as such, the following list cannot be considered comprehensive or exhaustive. The list of bird species occurring in Macraes Ecological District has been compiled from the Atlas of Bird Distribution in New Zealand (Bull et al., 1985). Bellbird and brown creeper were identified by Mr Neill Simpson in the McCormicks Creek study area. These species do not appear in the Atlas of Bird Distribution and are specially noted (#) in the list. McEwen (1986) in her prescription of Macraes Ecological District includes rifleman and NZ pigeon (kereru) as present. These species were not noted in either the Atlas of Bird Distribution or in field notes during the survey. The New Zealand falcon (*Falco novaeseelandiae*) in Macraes Ecological District is part of the Central Otago population, the largest population of falcons in New Zealand (Mr Graeme Loh, pers. comm. 1997). Taxonomic Orders, Sub-orders and Families follow Turbott et al. (1990). Field notes indicate that remnant bush areas are the most diverse areas for bird life.

Order: PELECANIFORMES

Sub-order: PELECANI

Phalacrocoracidae (shags or cormorants)

Phalacrocorax carbo novaehollandiae Black shag

Order: CICONIIFORMES

Sub-order: ARDEAE

Ardeidae (herons, egrets and bitterns)

**Ardea novaehollandiae* White-faced heron

Order: ANSERIFORMES

Sub-order: ANSERES

Anatidae (ducks, geese and swans)

<i>Anas gibberifrons gracilis</i>	Grey teal
* <i>Anas platyrhynchos</i>	Mallard
<i>Anas rhynchotis variegata</i>	New Zealand shoveler
<i>Anas superciliosa superciliosa</i>	Grey duck
* <i>Branta canadensis</i>	Canada goose
* <i>Cygnus atratus</i>	Black swan
* <i>Tadorna variegata</i>	Paradise shelduck

Order: FALCONIFORMES

Sub-order: ACCIPITRES

Falconidae (falcon)

**Falco novaeseelandiae* New Zealand falcon

Accipitridae (Harrier-hawks and eagles)	
<i>*Circus approximans gouldi</i>	Australasian harrier
Order: GALLIFORMES	
Phasianidae (pheasants, quail and partridges)	
<i>Lophortyx californica brunnescens</i>	California quail
Order: GRUIFORMES	
Rallidae (Rails, Gallinules, Coots)	
<i>*Porphyrio porphyrio melanotus</i>	Pukeko
Order: CHARADRIIFORMES	
Sub-order: CHARADRII	
Haematopodidae (oystercatchers)	
<i>*Haematopus osteralegus finschi</i>	South Island pied oystercatcher
Charadriidae (plovers and dotterels)	
<i>Charadrius bicinctus</i>	Banded dotterel
<i>Vanellus miles novaehollandiae</i>	Spur-winged plover
Recurvirostridae (stilts and avocets)	
<i>Himantopus himantopus leucocephalus</i>	Pied stilt
Sub-order: LARI	
Laridae (gulls, terns and noddies)	
<i>*Larus bulleri</i>	Black-billed gull
<i>Larus dominicanus</i>	Southern black-backed gull
<i>*Larus novaehollandiae scopulinus</i>	Red-billed gull
<i>Sterna albobriata</i>	Black-fronted tern
Order: COLUMBIFORMES	
Sub-order: COLUMBAE	
Columbidae (pigeons and doves)	
<i>Columba livia</i>	Rock pigeon
Order: STRIGIFORMES	
Strigidae (Owls)	
<i>Athene noctua</i>	Little owl
Order: PASSERIFORMES	
Sub-order: PASSERES	
Alaudidae (larks)	
<i>Alauda arvensis</i>	Skylark
Hirundinidae (swallows and martins)	
<i>Hirundo tabitica neoxena</i>	Welcome swallow
Muscicapidae (flycatchers)	
<i>*Rhipidura fuliginosa penitus</i>	South Island fantail
<i>*Petroica macrocephala</i>	Tomtit
Sylviidae (warblers)	
<i>*Greygone igata</i>	Grey warbler
<i>*Finschia novaeseelandiae</i>	Brown creeper
Turdidae (thrushes)	
<i>*Turdus merula</i>	Blackbird

<i>Turdus philomelos</i>	Song thrush
Prunellidae (accentors)	
<i>Prunella modularis</i>	Hedge sparrow
Motacillidae (pipits and wagtails)	
<i>Anthus novaeseelandiae novaeseelandiae</i>	New Zealand pipit
Meliphagidae (honey eaters)	
Prothemadera novaeseelandiae	
<i>novaeseelandiae</i>	Tui
<i>#Anthornis melanura</i>	Bellbird
Zosteropidae (silvereyes)	
<i>*Zosterops lateralis lateralis</i>	Silvereye
Fringillidae (finches and buntings)	
<i>Carduelis chloris</i>	Greenfinch
<i>Carduelis carduelis</i>	Goldfinch
<i>Carduelis flammea</i>	Redpoll
<i>Fringilla coelebs</i>	Chaffinch
<i>Emberiza citrinella</i>	Yellowhammer
Ploceidae (sparrows and weavers)	
<i>Passer domesticus</i>	House sparrow
Sturnidae (starlings)	
<i>Sturnus vulgaris</i>	Starling
Corvidae (crows)	
<i>Corvus frugilegus</i>	Rook
Cracticidae (australian bell-magpies)	
<i>*Gymnorhina tibicen tibicen</i>	White-backed magpie

Lizards

The grand skink (*Oligosoma grande*) and the Otago skink (*Oligosoma ottagense*) are probably the most well-known faunal feature of Macraes Ecological District. They are among New Zealand's largest and rarest lizards (Whitaker, 1985). The current conservation status, based on IUCN criteria, ranks the Otago skink regionally vulnerable, and the grand skink is vulnerable (Whitaker and Loh, 1995).

Although populations of these 'giant' skinks were once spread across the dry schist country of Otago from Queenstown to Macraes, populations are now known from just two areas, the Macraes Flat-Middlemarch district and the Lindis Pass-Lake Hawea district (Whitaker, 1987a). Populations occur on well-creviced rock outcrops.

Part of the reason for the decline in population of these species is believed to be the loss or degradation of the indigenous vegetation between outcrops (Whitaker and Loh, 1995). The surrounding vegetation provides the skink populations with food, in the form of berries and invertebrates. The loss of cover may also make them more vulnerable to predation.

Populations of these skinks occur in the Emerald Creek, Manuka Stream and Redbank study areas. A recent report by Whitaker (1995) identifies the herpetological value of the upper Manuka Stream catchment as high. This is based on good populations of both the grand and Otago skinks, the presence of the regionally uncommon green skink (*Oligosoma chloronoton*), and an unusually high diversity of lizard species overall.

The Otago and grand skink recovery plan (Whitaker and Loh, 1995) has identified key sites to achieve the plan's conservation objectives. Two of the sites correspond with two study areas, Emerald Creek and Redbank.

The speckled skink (*Oligosoma inconspicuum*) is known from a small area on the Emerald Creek - Waikouaiti watershed and is the north-eastern extremity of this species distribution. This is the only known population in Macraes Ecological District.

Field notes indicate that the common skink (*Oligosoma nigriplantare polychroma*) is widely distributed. It predominantly occurs in the drier tussock grasslands and open rocky shrublands. The following is a list of lizard species known to occur in the district compiled from Whitaker (1995), Middlemiss (1995), and field notes taken during the PNA survey.

Skinks

**Oligosoma otagense* Otago skink

**Oligosoma grande* Grand skink

Oligosoma chloronoton Green skink

Oligosoma maccanni McCann's skink

**Oligosoma nigriplantare polychroma* Common skink

**Oligosoma inconspicuum* Cryptic skink

Geckos

**Hoplodactylus* n.sp.aff. *maculatus* 'Eastern' Otago gecko

Introduced mammals

There are 12 species of introduced feral mammals found within the district. Of particular concern to the populations of grand and Otago skinks is the presence of feral cats, stoats and ferrets, all which have been found to predate the skinks (Middlemiss, 1995). Goats appeared to be severely grazing the understorey of all forest remnants studied. The following is a list of introduced feral mammals known to be present in the district, compiled from Middlemiss (1995), G. Loh (pers comm. 1997) and field notes taken during the PNA survey.

**Felis catus* Cat

Mustela furo Ferret

M. nivalis Weasel

M. erminea Stoat

**Erinaceus europaeus* Hedgehog

**Capra hircus* Goat

**Sus scrofa* Pig

* *Cervus elaphus* Red deer

**Oryctolagus cuniculus* Rabbit

**Lepus europaeus* Hare

<i>Trichosurus vulpecula</i>	Possum
<i>Rattus rattus</i>	Ship rat
* <i>Mus musculus</i>	Mice

3.4.2 Invertebrates

Patrick (1997) described Macraes Ecological District as having 'a distinctive mix of insect species including several species at their geographical limit of distribution'. There were a total of 367 species of insect in 12 orders identified by Patrick from Macraes Ecological District (Table 3.3). The majority of species belong to the order Lepidoptera (moths). As Patrick points out, however, the large number of Lepidoptera recorded is probably reflects his greater experience with this order, with the strong possibility other groups are under-represented. Most species were native.

TABLE 3.3: SUMMARY OF THE ORDERS, NUMBER OF FAMILIES AND NUMBER OF SPECIES OF INVERTEBRATES IDENTIFIED BY PATRICK (1997) WITHIN MACRAES ECOLOGICAL DISTRICT.

ORDER	NAME	NO. OF FAMILIES	NO. OF SPECIES
Blattodea	Cockroaches	1	2
Coleoptera	Beetles	9	27
Ephemeroptera	Mayflies	4	6
Hemiptera	Bugs	1	2
Lepidoptera	Moths	27	257
Mecoptera	Scorpionflies	1	1
Megaloptera	Dobsonfly	1	1
Neuroptera	Lacewings	1	3
Odonata	Dragonflies	4	4
Orthoptera	Weta/Cricket	5	9
Plecoptera	Stoneflies	3	12
Trichoptera	Caddis	10	43
Total		67	367

Several local populations of nationally rare species were identified within the district. These include the geometrids *Gingidiobora nebulosa* and *Cephalissa siria* which are nationally uncommon. *G. nebulosa* is found on steep rocky faces where its larvae feed on the leaves of *Gingidia montana* and is only known elsewhere in Marlborough. The noctuid moth *Tmetolophota* n.sp is present in less than six locations throughout Otago and Southland. The only occurrence of the diurnal moth *Asterivora antigrapha* in Otago and possibly southern New Zealand, is on the Taieri Ridge. Two of only four known populations of the eastern Otago endemic caddis *Neurochorema pilosum* occur in the district.

As well as rare species, the district contains many endemic species of insect and species at their geographical limits. The Otago endemic moth *Eurythecta zelaea* is at its eastern limit in the district. The southern moth *Sabatinea quadrijuga* and the grasshopper *Paprides dugdali* reach their northern limit in the district. *S. quadrijuga* is a grassland species and is present at 650m near Lots Wife and the alpine species *Notoreas paradelpha* is present at its lowest recorded altitude. The mix of species is described by Patrick as 'quite unlike that of anywhere else in New Zealand'. The large black clapping cicada *Amphipsalta strepitans* occurs in the Taieri Gorge, its southern limit of distribution. It has a very localised distribution within Otago.

4 Recommended Areas for Protection

4.1 EXISTING PROTECTED NATURAL AREAS

The land inventory in the draft Otago Conservation Management Strategy (DOC, 1997) lists 31 protected areas managed by the Department of Conservation within the district. Of these, 15 are marginal strips of value for riparian protection, nine are quarries or closed roads (to be disposed of or exchanged), one is a quarry at Mt Stocker which is to be retained for its geological value and four are areas of historic value. Only two of the of the 31 areas are considered to have botanical conservation values and both are presently stewardship land. These two areas, referred to as I43079 Redbank and I43080 Deighton Creek in the land inventory, include the Redbank and Emerald Creek RAPs. They are also mentioned in volume II of the Otago Conservation Management Strategy (DoC, 1997) as one of 41 special places in Otago. Here, they are combined and named 'Emerald Stream', with the conservation of the grand and Otago skinks given as the primary conservation value.

4.2 RECOMMENDED AREAS FOR PROTECTION (RAPs)

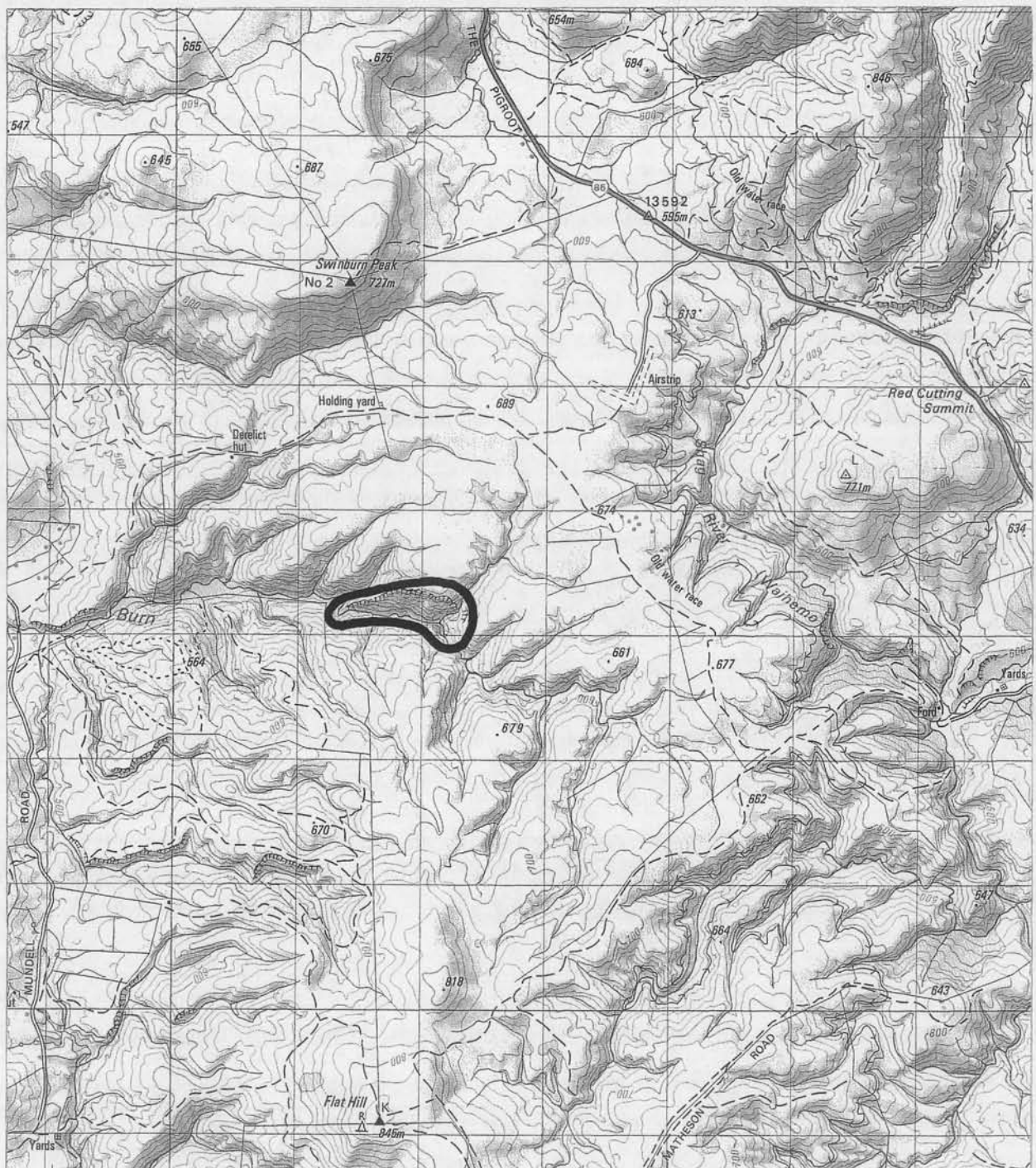
A total of 20 RAPs have been identified within Macraes Ecological District. They are separately described and numbered in order from north to south. Each description contains information on area (hectares), a grid reference from the Infomap 260 (1:50 000) series of the approximate centre, the altitudinal range, the land system, quadrat (community) groups and ecological units present within the RAP. At the end of each ecological unit the approximate cover of the unit within the RAP is given. Following on from this are descriptions of the landform and soil, as well as vegetation, flora and fauna contained within the RAP. A brief discussion summing up the values and any associated issues complete the description. In the descriptions of non-forest vegetation, the layer above 30cm will be referred to as the canopy and under 30cm as the herb layer. In some cases a ground layer (under 10cm) is referred to, in which case the herb layer covers the range 10-30cm. For forest vegetation the canopy refers to species over 5m, the sub canopy 2-5m, the shrub layer 0.3-2m and the herb layer below 30cm.

A summary table of the eight selection criteria used to assess each RAP is given at the end of each description. RAPs are assessed on the basis of representativeness, diversity, naturalness, special features, buffering, viability, threat and landforms as described in the methods. Each criteria is ranked to be of high (H), medium (M) or low (L) status for the RAP. In some cases a combination of these rankings may be used. At the end of the descriptions a map of the district showing all RAPs (Map 4.21) and a summary table of the criteria rankings for all 20 RAPs is given. These rankings are subjective, and can only be used to compare the RAPs within Macraes Ecological District.

Vegetation information was analysed for 18 of the RAPs, as described in the methods, to determine the quadrat (community) groups present. This, together with the landform information, allowed the ecological units within each RAP to be categorised. Because data cards were not filled out for the Murrays Road and Taieri Gorge RAPs, the ecological units for these two have been determined instead from field observations and species lists.

The RAPs that have been identified only contain examples of the range of ecological units present within Macraes Ecological District that are considered adequate to represent the range. It is emphasised that there are other areas outside of the RAPs with conservation values nearly, or even equally, as high as many of the RAPs described below.

MAP 4.1 : MACRAES RAP 1 - HOUND BURN



GRID REFERENCE : I42 018532

AREA : 50 ha

ALTITUDE : 480m - 640m

TENURE : Freehold

A horizontal scale bar with the word "KILOMETRES" written below it. The bar has tick marks at 0, 1, and 2, with an additional tick mark between each integer.

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MACRAES RAP 1 : HOUND BURN

Area	50ha
Grid Reference	I42-018 532
Altitudinal Range	480-640m
Land System	Rolling Hills
Quadrat (community) Groups	E and F
Tenure	Freehold
Ecological Units	Moist tussock-shrubland on basalt boulder outcrop mid-slope. (5%) Narrow-leaved snow tussock grassland on toe slope. (10%) Narrow-leaved snow tussock grassland on side-slope. (75%) Narrow-leaved snow tussock grassland on ridge crest. (10%)

Landform and Soil

Mutch (1963) shows the area to consist solely of Haast schist chlorite sub-zone IV. However, a boulder rock outcrop within the RAP appears to be composed of basalt. As the RAP is small, taking in one steep slope, it does not contain a great diversity of landform. The steep, bluff nature of the slope is not typical of the Rolling Hills land system. Eweburn recent soil covers the area (N. Z. Soil Bureau, 1968), the only occurrence of a recent soil recommended for protection.

Vegetation and Flora

Moist tussock-shrubland (Quadrat Group E) occurs on a small (about 0.1ha) area of basalt boulders. It is dominated by the native scrambler *Muehlenbeckia complexa* (pohuehue) and the shrub *Coprosma cheesemanii* in the canopy, with other common natives including the herb *Aciphylla scott-thomsonii* (giant aciphylla), the scrambler *Clematis marata* and the fern *Hypolepis millefolium*. A few individuals of the exotic shrub *Ribes uva-crispa* (gooseberry) are present in this height class. In the herb layer the mosses are dominant, with both native and exotic vascular species present at less than 1%. Indigenous species include the grasses *Elymus solandri* (blue wheat grass), *Koeleria novo-zelandica* and *Poa colensoi* (blue tussock), the herb *Anisotome brevistylis* and the fern *Asplenium richardii*, with the exotic grasses *Anthoxanthum odoratum* (sweet vernal) and *Holcus lanatus* (yorkshire fog). Bare rock accounted for 60% of the sample area.

Narrow-leaved snow tussock grassland (F) is the dominant vegetation type, accounting for over 95% of the RAP. The condition of this grassland varies, usually in association with topography. The most modified areas are those that are most accessible to stock, such as the toe-slope and ridge crest, and the least modified areas are generally associated with rock outcrops which also provide a fire refuge. The modified areas are dominated in the canopy by a mix of the

native grasses *Chionochloa rigida* (narrow-leaved snow tussock) and *Festuca novae-zelandiae* (hard tussock) with the shrub *Discaria toumatou* (matagouri). The herb layer cover is provided mostly by the exotic weedy herb *Hieracium pilosella* (mouse-ear hawkweed), but other common exotics include the grasses *Agrostis capillaris* and *Anthoxanthum odoratum* and the herbs *Hieracium lepidulum* (tussock hawkweed), *Hypochoeris radicata* (catsear) and *Trifolium repens* (white clover). Common indigenous species of the herb layer are the herbs *Anisotome brevistylis*, *Celmisia gracilentia*, *Helichrysum filicaule* (slender everlasting daisy), *Raoulia subsericea* (mat daisy) and *Wahlenbergia albomarginata* (N. Z. bluebell), the rush *Luzula rufa* (red woodrush), the grasses *Deyeuxia avenoides*, *F. novae-zelandiae* and *Poa colensoi*, the fern *Blechnum penna-marina* and the woody sub-shrubs *Gaultheria macrostigma* (pink snowberry) and *Leucopogon fraseri* (dwarf heath).

The less modified areas are located on steep rocky areas of the mid- to upper-slopes, with the narrow-leaved snow tussock grassland dominated by the native grass *Chionochloa rigida* in the canopy. Other common native canopy species include the herbs *Aciphylla aurea* (golden spaniard), *Celmisia bookeri* and *Phormium cookianum* (mountain flax) plus the shrubs *Discaria toumatou* (matagouri), *Gaultheria antipoda* (fool's beech) and *Olearia bullata*. Exotic species in the herb layer are similar to those in modified areas, however here *Hieracium pilosella* is less abundant, sharing dominance with the other exotic grasses and herbs. Total abundance of exotic species is less in this area, with common natives present in greater abundance's. Common indigenous species in the herb layer include the herbs *Anisotome brevistylis*, *Brachyglottis haastii* (haast's groundsel), *Celmisia densiflora*, *Geranium microphylla*, *Helichrysum bellidioides* (everlasting daisy) and *Raoulia subsericea*, the grasses *Poa colensoi* and *Deyeuxia avenoides*, the rush *Luzula picta* var. *limosa*, and the woody sub-shrubs *Gaultheria depressa* (snowberry) and *Leucopogon fraseri*.

Three indigenous species of limited distribution with the district occur here. The herb *Aciphylla scott-thomsonii* in the Moist tussock-shrubland and in the narrow-leaved snow tussock grassland on the steep rocky side-slope area, the herb *Epilobium billardierianum* and the sedge *Uncinia sinclairii*. The local plant *Celmisia bookeri* (Cameron et al., 1995) also occurs in this area.

Fauna

Common skink (*Oligosoma nigriplantare polychroma*) were observed in the narrow-leaved snow tussock grassland.

Discussion

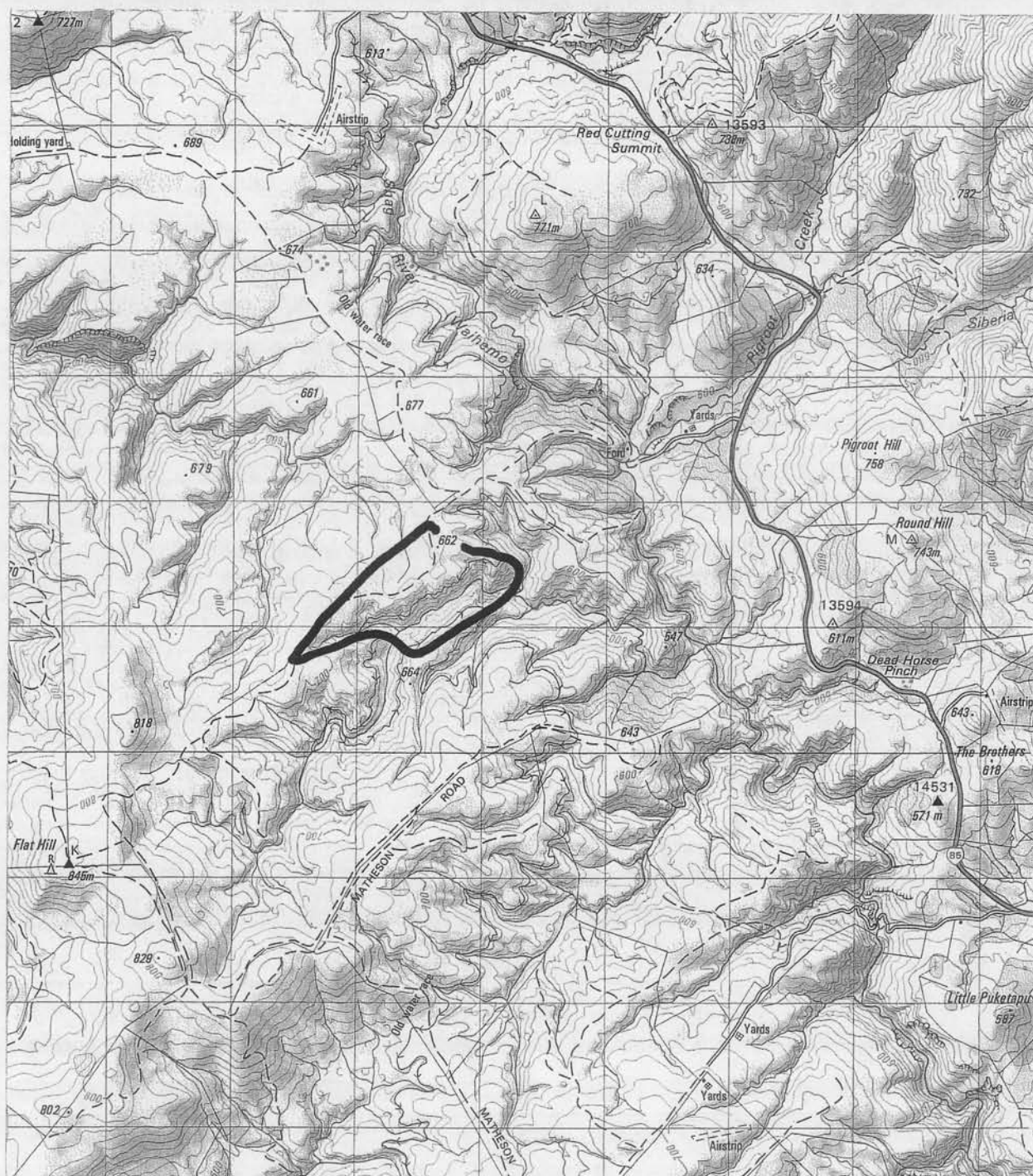
The Moist tussock-shrubland on basalt boulder slope is one of the few examples of this ecological unit in the District. It is also the only one to contain a population of the native herb *Aciphylla scott-thomsonii*, making it a unique variation of the ecological unit. This combines with narrow-leaved snow tussock grassland in very good condition on the steep rocky mid to upper -slopes to give the Hound Burn RAP a high conservation value. The botanical values are complemented by the presence of a recent soil, the only such example in the district to be recommended for protection.

Of concern is the presence of the weedy exotic shrubs *Ribes uva-crispa* and *Rosa rubiginosa* (sweet briar), and wilding pines which may increase in abundance without control. Wilding pines seem to be more frequent in the Flat Hill, Hound Burn, Swinburn Peak area of the district, perhaps associated with the extensive pine plantations of the Nasbey area about 25km to the north-west.

Selection Criteria Macraes RAP 1 : Hound Burn

Representativeness	M	The dominance of narrow-leaved snow tussock grassland is representative of Rolling Hills land system.
Diversity	L-M	Few vegetation types present.
Naturalness	M	Areas accessible to stock and fire are considerably modified.
Special Features	M	Presence of several species of limited distribution within the district, one of few Moist tussock-shrublands on basalt boulder slopes.
Buffering	M	Low catchment integrity, surrounding areas heavily modified.
Viability	M	Relatively small area.
Threat	M	Wilding pines and <i>Rosa rubiginosa</i> , stock browsing, oversowing and burning.
Landforms	H	The only RAP with a recent soil; landform is not representative of the Rolling Hills land system.

MAP 4.2 : MACRAES RAP 2 - PATON'S GULLY



0 1 2
KILOMETRES

GRID REFERENCE : 142 045513

AREA : 126 ha

ALTITUDE : 520m - 700m

TENURE : Freehold

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MACRAES RAP 2 : PATON'S GULLY

Area	126ha
Grid Reference	I42-045 513
Altitudinal Range	520-700m
Land System	Rolling Hills
Quadrat (community) Groups	D, F and H
Tenure	Freehold
Ecological Units	Copper tussock wetland on gully floor. (3%) Copper tussock wetland on ridge crest. (<1%) Narrow-leaved snow tussock grassland on ridge crest (50%) Narrow-leaved snow tussock grassland on side-slopes (30%) Narrow-leaved snow tussock grassland on rock bluffs (3%) Narrow-leaved snow tussock grassland on extensive rock outcrops. Narrow-leaved snow tussock grassland on toe-slope. (5%) Mixed shrubland on lower-slopes. (3%) Mixed shrubland on toe-slope. (2%)

Landform and Soil

Paton's Gully RAP includes an area of broad ridge crest which runs down into a steep sided incised gully, a landform not typical of the Rolling Hills land system. Extensive rock bluffs occur on the slopes of both sides of the gully, but are more extensive on the south-east facing slope. Geologically the area consists of Haast schist chlorite sub-zone IV (Mutch, 1963), the dominant and typical parent material throughout the district. The schist is overlain by a Wehenga upland and high country yellow-brown earth (N. Z. Soil Bureau, 1968).

Vegetation and Flora

As is typical of the Rolling Hills land system, narrow-leaved snow tussock grassland (F) is the dominant vegetation of the RAP. The condition of the grassland varies, notably in association with aspect. The most degraded areas are present on the north-west facing slopes where the cover of the native grass *Chionochloa rigida* (narrow-leaved snow tussock) is reduced to less than 25% in the canopy and the exotic herb *Hieracium pilosella* (mouse-ear hawkweed) is co-dominant in the herb layer. However, grassland in such a condition is not dominant throughout the RAP.

In the more natural areas of narrow-leaved snow tussock grassland, particularly on the south-east facing slopes and associated ridge crests, *Chionochloa rigida* is

dominant, accounting for over 50% of the canopy. Other natives present in the canopy at lower abundances include the herb *Aciphylla aurea* (golden spaniard), the shrub *Discaria toumatou* (matagouri) and the grass *Festuca novae-zelandiae* (hard tussock). In the herb layer, exotics are common with the herbs *Hieracium pilosella*, *Hypochoeris radicata* (catsear) and *Trifolium repens* (white clover), and the grasses *Agrostis capillaris* (brown top), *Anthoxanthum odoratum* (sweet vernal) and *Holcus lanatus* (yorkshire fog). Although individual indigenous species tend to be less abundant their total abundance exceeds the exotic species. Common herb layer natives include the herbs *Acaena caesiiglauca*, *A. aurea*, *Geranium microphylla*, *Geum leiospermum*, *Helichrysum filicaule* (slender everlasting daisy) and *Ranunculus multiscapus*.

Narrow-leaved snow tussock grassland occurring on the rock bluffs and extensive rock outcrops is notably different. *Chionochloa rigida* is still dominant although its cover is reduced to 25%, with the native grass *Festuca novae-zelandiae*, the herb *Aciphylla aurea* and the shrubs *Coprosma rigida*, *Gaultheria antipoda* (fools beech) and *Leucopogon colensoi* additional sub-dominant species in the canopy. In the herb layer the native herbs *Celmisia bookeri*, *Celmisia densiflora*, *Helichrysum bellidioides* (everlasting daisy) and *Wahlenbergia albomarginata* (N. Z. bluebell), the grasses *Deyeuxia avenoides* and *Poa colensoi* (blue tussock) and the woody sub-shrubs *Gaultheria depressa* (snowberry), *Leucopogon fraseri* (dwarf heath) and *Pimelea pseudolyallii* share dominance with the exotic grasses *Agrostis capillaris* and *Anthoxanthum odoratum*, and the herbs *Hieracium lepidulum* (tussock hawkweed) and *Trifolium repens*.

Copper tussock wetland (D) is present in two ecological units. The first of these is in combination with the gully floor and, has been extensively modified through burning and grazing. On the broader flat areas scattered *Carex secta* (purei) and *Chionochloa rubra cuprea* (copper tussock) remain, with exotic species dominating the herb layer. In the narrower areas, lower in the catchment, the vegetation is more natural. The canopy is dominated by a mix of the native grasses *Chionochloa rubra cuprea*, *Festuca novae-zelandiae* and *Poa cita* (silver tussock), the sedges *Carex secta* and *C. buechananii* and the shrubs *Discaria toumatou* and *Olearia bullata* with the exotic rush *Juncus effusus* (soft rush). In the herb layer the native herbs *Epilobium komarovianum* (creeping willowherb), *Hydrocotyle microphylla*, *Oreomyrrhis ramosa* and *Ranunculus reflexus* (grassland buttercup) and the sedge *Isolepis aucklandica* share dominance with the exotic herbs *Cerastium fontanum* (mouse-ear chickweed), *Cirsium vulgare* (scotch thistle), *Hieracium lepidulum*, *Mimulus moschata* (musk) and *Trifolium repens* and the grasses *Agrostis capillaris*, *Anthoxanthum odoratum* and *Holcus lanatus*. Present in the stream are the native herbs *Myriophyllum triphyllum* and *Potamogeton cheesemanii* (red pondweed).

The second Copper tussock wetland ecological unit, on the ridge crest, is dominated in the canopy by the native sedge *Schoenus pauciflorus* (bog rush), with the native shrub *Olearia bullata*, the exotic rush *Juncus effusus* and the grass *Holcus lanatus* sub-dominant. Exotics are prominent in the herb layer, including the grasses *Agrostis capillaris*, *Anthoxanthum odoratum* together with the herbs *Hypochoeris radicata* and the rush *Juncus articulatus* (jointed rush). Common natives include the sedges *Isolepis aucklandica*, the herbs *Epilobium alsinoides* and *E. brunescens* plus the woody sub-shrub *Gaultheria macrostigma* (pink snowberry).

The final vegetation type present here is mixed shrubland (H) on the lower- and toe-slopes of a steep rocky area in the lower catchment of the RAP. The canopy is dominated by the native fern *Pteridium esculentum* (bracken), the scramblers *Muehlenbeckia australis* (bush pohuehue) and *Rubus schmidelioides*, plus the shrubs *Coprosma cheesemanii* and *C. propinqua* (mingimingi). Other common canopy natives include the shrubs *Aristotelia fruticosa* (mountain wineberry), *Coprosma ciliata*, *Carmichaelia virgata* and *Discaria toumatou*, with few of individuals of the weedy exotic shrub *Rosa rubiginosa* (sweet briar). There is very little vegetation in the herb layer, total cover being 10%. The commonest species are the native fern *Asplenium richardii* and the herb *Hydrocotyle moschata* with the exotic herb *Hypochoeris radicata*.

The aquatic herbs *Myriophyllum triphyllum* and *Potamogeton cheesemanii* were recorded only from this site, and as such are considered to be uncommon within the district. The local plant *Celmisia hookeri* (Cameron et al., 1995) occurred within this RAP, being present on the rocky bluffs in the narrow-leaved snow tussock grassland. This population is the most extensive within the district.

Fauna

Insects are abundant.

Discussion

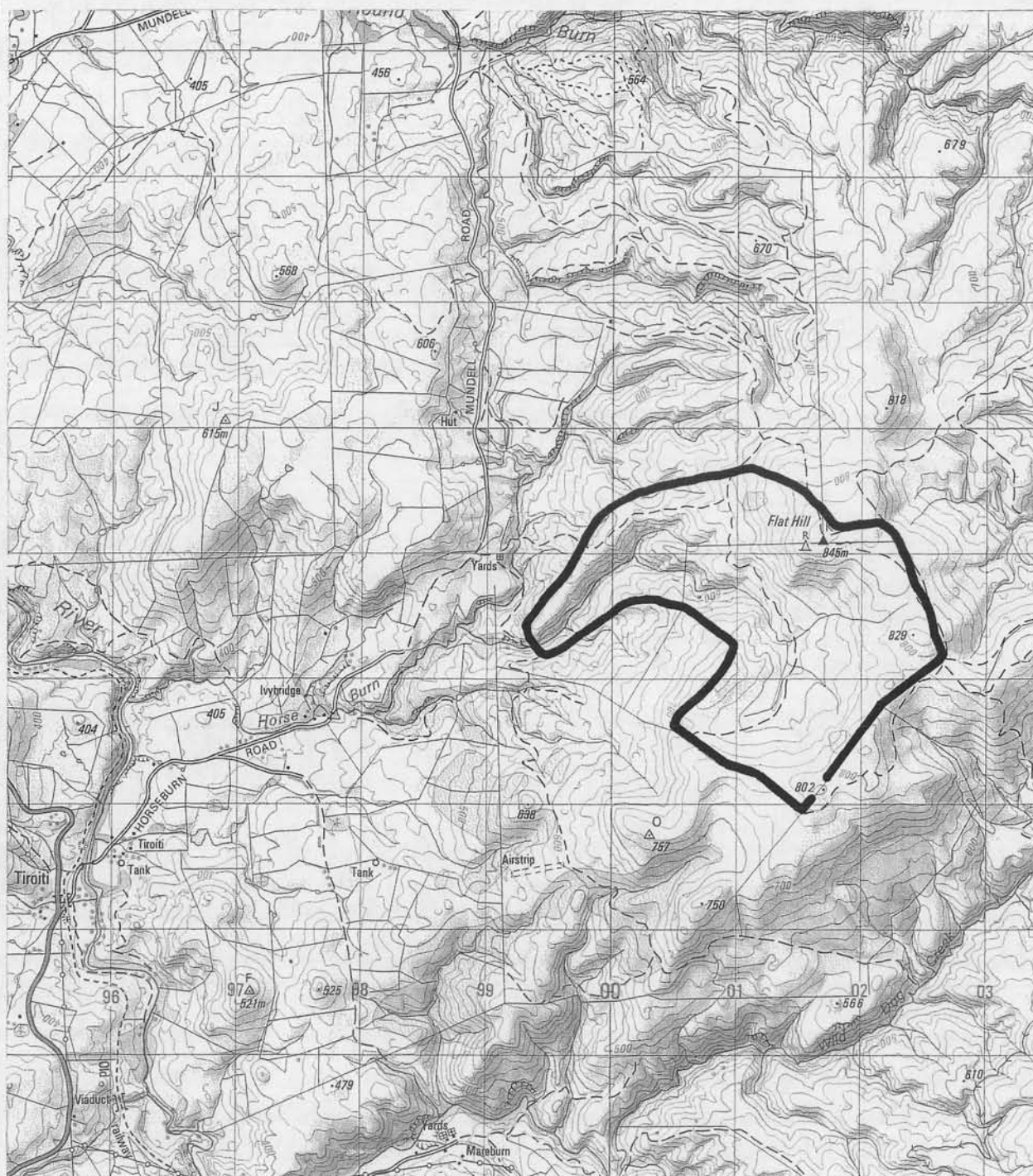
Paton's Gully contains by far the largest populations of both *Celmisia hookeri* (a local species) and *C. densiflora*. Extensive rock bluffs and outcrops support these species amidst narrow-leaved snow tussock grassland - a system that is the most valuable conservation asset of this RAP. Other values include the mixed shrubland, one of only four examples of this vegetation type to be recommended for protection. The combination of mixed shrubland with narrow-leaved snow tussock grassland and copper tussock is repeated in the Emerald Creek RAP, however the overall naturalness of this RAP is higher.

The presence of the weedy exotic shrub *Rosa rubiginosa* is of concern as it may increase in abundance in the long term, without control. Wilding pines are present in the immediate vicinity of the RAP and are also a potential long-term problem.

Selection criteria Macraes RAP 2 : Paton's Gully

Representativeness	H	Representative vegetation of the Rolling Hills land system.
Diversity	M-H	A good diversity of both vegetation types and native plants within narrow-leaved snow tussock grassland.
Naturalness	M	North-west facing slopes and valley floor modified.
Special Features	M-H	The largest populations of <i>Celmisia bookeri</i> and <i>C. densiflora</i> within the Ecological District.
Buffering	M	Does not include upper catchment
Viability	M	Relatively small area, however extensive areas of rock provide fire refuge and decrease access to stock.
Threat	M	Oversowing, burning and grazing. The presence of several exotic weeds.
Landforms	M	Not representative of the Rolling Hills land system, but the best example of extensive rock bluffs.

MAP 4.3 : MACRAES RAP 3 - FLAT HILL



0 1 2
KILOMETRES

GRID REFERENCE : I42 016481

AREA : 450 ha

ALTITUDE : 620m - 845m

TENURE : Freehold

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MACRAES RAP 3 : FLAT HILL

Area	450ha
Grid Reference	I42-016 481
Altitudinal Range	620-845m
Land System	Volcanic Outcrops
Quadrat (community) Groups	B, D, E and F
Tenure	Freehold
Ecological Units	Moist tussock-shrubland on basalt boulder slope. (<1%) Moist tussock-shrubland on gully floor. (5%) Medium turf ephemeral tarn mid-slope. (<1%) Copper tussock wetland on basin floor. (5%) Narrow-leaved snow tussock grassland on side-slopes. (75%) Narrow-leaved snow tussock grassland on mountain crest. (5%) Narrow-leaved snow tussock grassland on ridge crest. (10%).

Landform and Soil

The landform of Flat Hill is unique within the district, with the most striking visual feature being the amphitheatre appearance of the basin. Besides being the best example of the Volcanic Outcrops land system. Extensive areas of slumping are prominent, particularly on the western side of the basin. The placement of boundaries on the watersheds of the RAP provide for an area of high catchment integrity.

Geologically the RAP is the only one not to be dominated by Haast schist chlorite sub-zone IV. This is present in the lower altitude gully extending to the west of the main basin, with the latter containing mudstones and sandstones in the lower slopes and basalt from the Waipiata Volcanics on the upper slopes (Mutch, 1963).

Of all the areas sampled by McIntosh (1995), the Flat Hill RAP contains the most diverse array of soils and rock. There is a clear relationship between soils, landform and the range of rock types present. Acidic Mafic Brown and Acid Brown Soils are present on the basalt of the upper slopes, while Pallic Firm Brown Soils are present on the dry stable slopes with Typic Mafic Brown Soils on the unstable basaltic colluvium slopes. On the gully floor Gley Soils are associated with bogs and Typic Brown Acid Soils occur on the schist of the lower altitude gully. In his assessment of the RAP, McIntosh (1995) found the area to be of high conservation value as an example of the diversity of soils and rocks associated with the coastal Otago volcanic region. Flat Hill ranks highly as a special feature of the district rather than as a typical feature.

Vegetation and Flora

Four vegetation types occur within the RAP, Medium turf ephemeral tarns (B), Copper tussock wetland (D), Moist tussock-shrubland (E) and the dominant vegetation type of the district, Narrow-leaved snow tussock grassland (F).

One medium turf ephemeral tarn occurs in a flattened area mid-slope in the main basin area. It is dominated in the ground layer by the native herb *Galium* sp. aff. *perpusillum* and rush *Elaeocharis acuta*. The exotic grass *Alopecurus geniculata* (marsh fox tail), the native rush *Juncus pusillus* and the exotic grass *Glyceria fluitans* (floating sweet grass) are the next most common species in the height class. In comparison to other medium turf ephemeral tarns in the district, this one is species poor. The exotic rush *Juncus effusus* (soft rush) and the native sedge *Carex geminata* are the only species to occur in the herb layer and they do so at low abundances. The tarn looks to have been extensively grazed since it has a high occurrence of sheep droppings.

Moist tussock-shrubland is present in two ecological units. The first of these is Moist tussock-shrubland on a basalt boulder slope. It is dominated by the native shrubs *Coprosma rigida* and *Discaria toumatou* (matagouri) in the canopy, and by the native scrambler *Muehlenbeckia complexa* (pohuehue) in the herb layer. Other common natives include the scrambler *Rubus schmidelioides* in the canopy, and in the herb layer the grasses *Dichelachne crinita* (plume grass) and *Poa colensoi* (blue tussock), the herbs *Geranium microphyllum* and *Oxalis exilis* (yellow oxalis) and the shrub *Melicactus alpinus* (porcupine shrub). The most common of the exotic species are the herbs *Cerastium fontanum* (mouse-ear chickweed) and *Verbascum thapsus* (woolly mullein) plus the grass *Anthoxanthum odoratum* (sweet vernal). The total plant cover is relatively low, with 60% of the sample area being bare rock and gravel.

The second Moist tussock-shrubland ecological unit is in combination with the floor of the schist gully at lower altitude. The vegetation here is dominated in the canopy by the native shrubs *Coprosma propinqua* (mingimingi) and *Discaria toumatou* plus the grass *Poa cita* (silver tussock), with the exotic grasses *Agrostis capillaris* (brown top) and *Anthoxanthum odoratum* co-dominant in the herb layer. Indigenous species at lower abundance in the canopy include the grass *Festuca novae-zelandiae* (hard tussock), the sedge *Carex coriacea* and the shrubs *Carmichaelia virgata* and *Olearia bullata*. Common canopy exotics include the rush *Juncus effusus* and the herb *Cirsium arvense* (Californian thistle). *C. arvense* is again common in the herb layer along with the exotic herbs *Trifolium repens* (white clover) and *Hypochoeris radicata* (catsear) plus the grasses *Dactylis glomerata* (cocksfoot), *Festuca rubra* (Chewing's fescue) and *Holcus lanatus* (Yorkshire fog). Common herb layer natives include the shrub *Coriaria sarmentosa* (tutu), the grass *Elymus solandri* (blue wheat grass) and the herbs *Acaena caesiiglaucula*, *Oreomyrrhis ramosa* and *Ranunculus multiscapus* (grassland buttercup). The abundance of exotics in the herb layer is high, however the natives account for a larger proportion of the species diversity.

Copper tussock wetland occurs on the gully floor of the basin. It is dominated by the grass *Chionochloa rubra cuprea* (copper tussock) in the canopy, with the sedge *Schoenus pauciflorus* (bog rush) being the next most abundant species. Other common species in this height class include the natives sedges

Carex secta (purei) and *Carex buechananii*, with the occasional occurrence of the native herb *Aciphylla glaucescens*, plus the exotic grass *Holcus lanatus* and rush *Juncus effusus*. In the herb layer exotics are most abundant and include the grasses *Agrostis capillaris*, *Festuca rubra* and *H. lanatus*, plus the herbs *Myosotis laxa caespitosa* (water forget-me-not), *Stellaria graminea* (stitchwort) and *Trifolium repens*. Common herb layer natives include the herbs *Bulbinella angustifolia* (Maori onion), *Gonocarpus micranthus*, *Myriophyllum pedunculatum* ssp. *novae-zelandiae*, *Potentilla anserinoides* (silverweed) and *Ranunculus foliosus*, the rush *Elaeocharis acuta* and the sedges *Carex buechananii*, *Carex gaudichaudiana* and *Carex inversa*. Again the indigenous species account for the greater proportion of the species diversity.

Narrow-leaved snow tussock grassland is the predominant vegetation cover, accounting for about 90% of the RAP. The condition of this grassland varies, with the most extensive areas of degradation being the north facing slopes in the basin and schist gully. These areas account for about 15% of the RAP, and are dominated by the exotic herb *Hieracium pilosella* (mouse-ear hawkweed) in the herb layer, with scattered individuals of the native grasses *Chionochloa rigida* and *Festuca novae-zelandiae*, plus the shrub *Discaria toumatou* in the canopy. The grassland on the south facing schist gully side-slopes is in reasonable condition, although there are scattered patches dominated by exotic grasses. The most natural grassland is present on the steep south-facing slopes below Flat Hill.

Generally the narrow-leaved snow tussock grassland is dominated by *Chionochloa rigida* in the canopy with the native grasses *Festuca novae-zelandiae* and *Poa colensoi* (blue tussock), the herb *Aciphylla aurea* (golden spaniard) and the shrub *Discaria toumatou* being sub-dominant. A variation of this occurs on the east facing slope of the basin where *D. toumatou* is more abundant than elsewhere. Exotic species are prominent in the herb layer, especially the exotic grasses *Agrostis capillaris* and *Anthoxanthum odoratum*, and the herbs *Hieracium pilosella*, *Hypochoeris radicata* and *Trifolium repens*. Indigenous species common in the herb layer include *Anisotome aromatica*, *Helichrysum filicaule* (slender everlasting daisy), *Ranunculus multiscapus*, *Raoulia subsericea* (mat daisy) *Wahlenbergia albomarginata* (N. Z. bluebell), the grasses *P. colensoi* and *Rytidosperma pilosum*, and the woody sub-shrubs *Gaultheria depressa* (snowberry), *Leucopogon fraseri* (dwarf heath), and *Pimelea pseudolyallii*. In an overall assessment of the quality of the grassland, whilst the exotics are abundant, there is a high diversity of native species.

Narrow-leaved snow tussock grassland occurring on the steep slope below Flat Hill is notably different. Rocky outcrops are more common in this area and, while the canopy composition is the same as previously described, composition in the herb layer is different. Common natives here include the herbs *Acaena caesiiglauca*, *Anisotome aromatica*, *Celmisia hookeri*, *Geranium microphyllum*, *Geum leiospermum*, *Helichrysum bellidioides* (everlasting daisy), *H. filicaule*, the fern *Blechnum penna-marina*, the grasses *Lachnagrostis lyallii* (tumble grass) and *Rytidosperma gracilis*, plus the woody sub-shrubs *Gaultheria depressa* and *Pimelea pseudolyallii*. The exotic species previously described are less abundant in this area, but the herb *Hieracium lepidulum* (tussock hawkweed) is common.

Moister narrow-leaved snow tussock grassland, particularly in areas of slumping, is the final variation present. *Chionochloa rigida* is the dominant, with the native sedge *Schoenus pauciflorus* the next most abundant canopy species. Exotics

are the most dominant group in the herb layer, with the grasses *Agrostis capillaris*, *Anthoxanthum odoratum* and *Holcus lanatus*, and the herb *Hieracium pilosella*, the most abundant. The herbs *Anisotome aromatica*, *Bulbinella angustifolia*, *Celmisia gracilentia*, *Geranium microphyllum*, *Helicbrysum filicaule* and the woody sub-shrub *Leucopogon fraseri* are the common natives in the herb layer.

The local species *Celmisia bookeri* (Cameron et al., 1995) was found occurring on the steep slopes below the crest of Flat Hill amongst rocky outcrops in narrow-leaved snow tussock grassland. Three species of limited distribution within the district were also identified, the grasses *Rytidosperma pilosum* and *R. thomsonii* in narrow-leaved snow tussock grassland with the herb *Epilobium macropus* occurring in copper tussock wetland.

Fauna

Information on the invertebrate fauna has been provided by B. Patrick (pers. comm. 1997). Moist herb-rich grasslands support an impressive array of native insects including the yellow and orange geometrid moth *Asaphodes prasinias* and the crambid *Orocrambus crenaeus*. The latter has a flightless female that greatly limits the dispersal ability of the species. An orange-coloured diurnal geometrid *Aponotoreas insignis* is also common in these grasslands. These three moth species are indicative of good quality native grassland and herb field.

Discussion

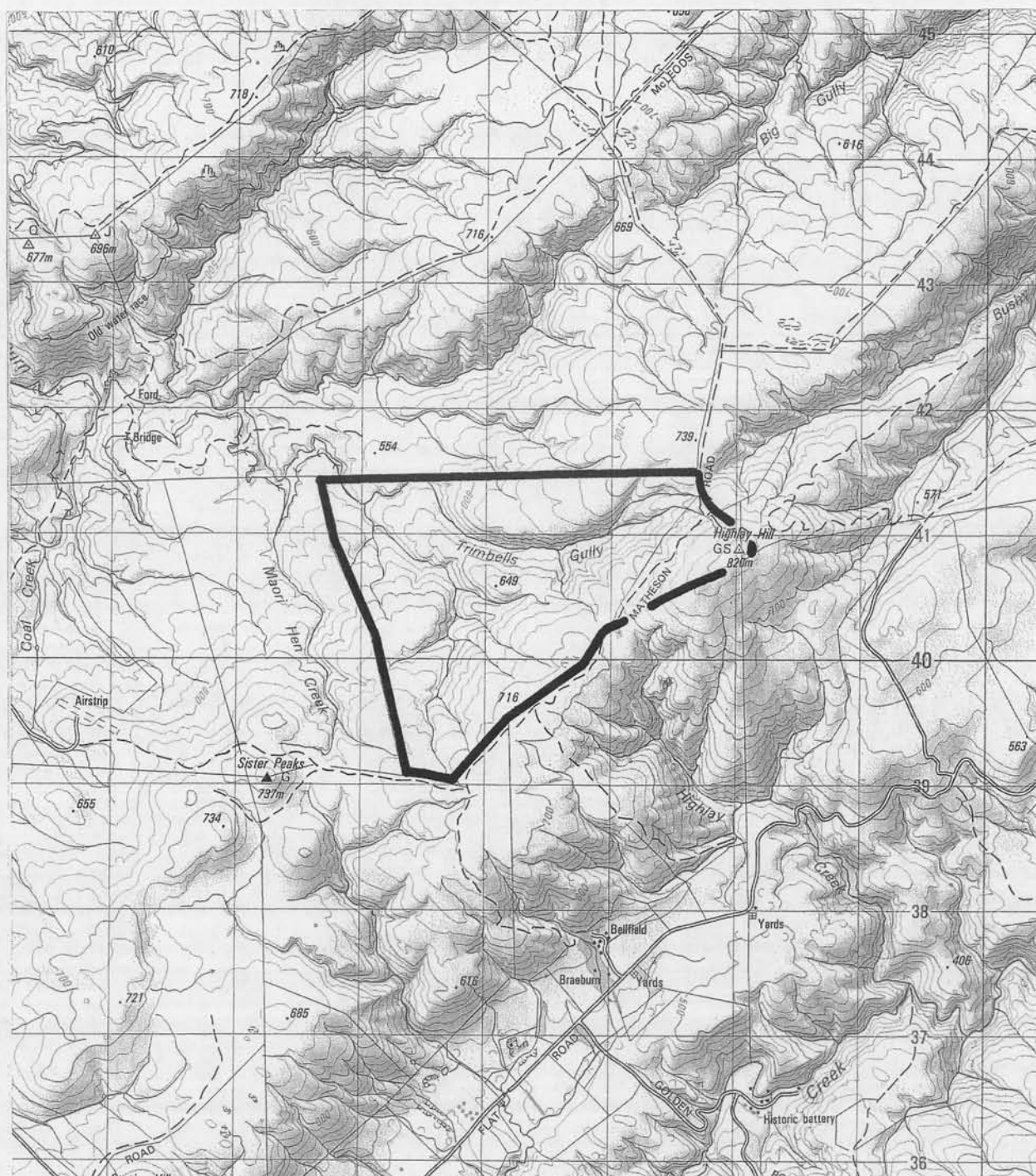
The uniqueness of the landform, the geological and pedological diversity and relatively natural narrow-leaved snow tussock grassland, together give the Flat Hill RAP a high conservation value. The Moist tussock-shrublands on basalt boulder slopes are an uncommon ecological unit within the ecological district, and the examples present here are among the most natural in the district. There is another example of this ecological unit near Tiroiti, visible from State Highway 87 (I42 964 454). However, it is considered much less valuable as it is much more disturbed. The addition of narrow-leaved snow tussock grassland in the schist gully provides the RAP with the most diverse geological, pedological and vegetational sequence, from high to low altitude and from basalt through tertiary mudstones and sandstones to Haast schist.

Of concern is the occurrence within the RAP of a few individuals of the exotic shrub *Rosa rubiginosa* (sweet briar) and a wilding pine. At such low numbers, control of these weedy species could be achieved now, but left alone they may become a problem in the long term. The north-facing slope of *Hieracium pilosella* dominated narrow-leaved snow tussock grassland in the basin is the most degraded area to be included in an RAP. However, to exclude this area would compromise the catchment integrity of the RAP. Furthermore, its condition may be improved with more conservative management, and it could become a reference site to provide a comparison against degraded areas managed for pastoralism.

Selection criteria Macraes RAP 3 : Flat Hill

Representativeness	H	The dominance of narrow-leaved snow tussock grassland is representative of the land system.
Diversity	H	Good diversity of vegetation types and insect species
Naturalness	M	Some highly degraded areas; exotic species in the herb layer are abundant.
Special Features	H	A high diversity of rocks and soils.
Buffering	H	Excellent catchment integrity; surrounding vegetation not developed.
Viability	M-H	Some degraded areas; high catchment integrity.
Threat	M	Burning and grazing; the presence of <i>Rosa rubiginosa</i> and a <i>Pinus</i> sp tree.
Landforms	H	Unique within the district.

MAP 4.4 : MACRAES RAP 4 - TRIMBLES GULLY



0 1 2
KILOMETRES

GRID REFERENCE : 142 061405

AREA : 564 ha

ALTITUDE : 520m - 820m

TENURE : Freehold

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MACRAES RAP 4 : TRIMBELLS GULLY

Area	564ha
Grid Reference	I42-061405
Altitudinal Range	520-820m
Land System	Rolling Hills
Quadrat (community) Groups	C, D, E and F
Tenure	Freehold
Ecological Units	Moist tussock-shrubland on basalt boulder slope on mountain top plateau. (<1%) Narrow-leaved snow tussock grassland on broad ridge crest. (15%) Narrow-leaved snow tussock grassland on side-slopes. (65%) Narrow-leaved snow tussock grassland on toe-slope. (5%) Narrow-leaved snow tussock grassland on gully side-slopes. (10%) Copper tussock wetland on gully floor. (5%) Purei wetland on ridge crest. (<1%)

Landform and Soil

A generally gently sloping gully system and broad ridge crests are typical features of the Rolling Hills land system. The mountain top plateau with steep basalt boulder slopes grading down to moderately steep side-slopes is not, however, a typical feature and is found only here in the district. Geologically most of the area is Haast schist chlorite sub-zone IV, except for the summit of Highlay Hill which is sandstone, siltstone and mudstone overlain by a basalt cap from the Waipiata Volcanics (Mutch, 1963).

McIntosh (1995) found the soils to be uniformly Typic Acid Brown Soils, typical of Rolling Hills schist terrain on which they occur. In assessing the soils values of Trimbells Gully McIntosh (1995) found the RAP to be the least special of the areas he visited. The landform-soils relationships are repeated in the Redbank and Manuka Stream RAP's, and the protection of those two RAP's would provide adequate soil reference sites. However, it should be noted that McIntosh (1995) did not sample the basalt colluvium of Highlay Hill. He says: "Inclusion of basaltic soils and basalt landforms in any proposed protected natural area could be an advantage in that these features would add variety to the reserve". This area has been included within the Trimbells Gully RAP.

Vegetation and Flora

Narrow-leaved snow tussock grassland (F) is the predominant vegetation type, accounting for about 95% of the RAP. Condition of the grassland varies, most notably with aspect. Slopes that are north facing are in the poorest condition, with extensive patches of the exotic herb *Hieracium pilosella* (mouse-ear hawkweed) in the herb layer accounting for up to 50% of the total cover. Scattered individuals of the native grasses *Chionochloa rigida* (narrow-leaved snow tussock) and *Festuca novae-zelandiae* (hard tussock) are still present in the canopy of these areas, with the native woody sub-shrub *Leucopogon fraseri* (dwarf heath) the most abundant native in the herb layer. Grassland in this condition accounts for about 30% of the RAP. The area of grassland immediately below the summit of Highlay Hill is also modified, containing extensive patches of exotic grasses.

The other areas of narrow-leaved snow tussock grassland are dominated by *Chionochloa rigida* with an average cover of 60% and an average height of 1m. Other indigenous species present in the canopy are the native grasses *Festuca novae-zelandiae* and *Poa colensoi* (blue tussock), the shrub *Discaria toumatou* (matagouri), the scrambler *Muehlenbeckia complexa* (pohuehue) and the herb *Aciphylla aurea* (golden spaniard). Exotics are a prominent feature of the herb layer, with the herbs *Hieracium pilosella*, *Hypochoeris radicata* (catsear) and *Trifolium repens* (white clover) plus the grasses *Agrostis capillaris* (brown top), *Anthoxanthum odoratum* (sweet vernal) and *Holcus lanatus* (Yorkshire fog). However, in terms of species diversity, by far the greater proportion are natives, the most common being the herbs *Geranium microphyllum*, *Helichrysum filicaule* (slender everlasting daisy), *Raoulia subsericea* (mat daisy) *Ranunculus multiscapus* (grassland buttercup) and *Wahlenbergia albomarginata* (N. Z. bluebell) together with the woody sub-shrubs *Gaultheria depressa* (snowberry), *G. macrostigma* (pink snowberry) and *Leucopogon fraseri*.

Moist tussock-shrubland (E) occurs on the basalt boulders below the plateau of Highlay Hill. It is a small ecological unit, accounting for less than 1% of the RAP. The canopy is dominated by a mix of the native grasses *Chionochloa rigida* and *Poa colensoi*, the shrubs *Coprosma propinqua* (mingimingi), *Discaria toumatou* and *Hebe rakaiensis*, the scramblers *Muehlenbeckia complexa* and *Rubus schmidtioides* with the herb *Aciphylla aurea*. The two scramblers again dominate the herb layer, with other less abundant natives including the grasses *Dichelachne crinita*, *Elymus solandri* (blue wheat grass) and *P. colensoi*, the shrubs *Discaria toumatou* and *Hebe rakaiensis*, the herbs *Helichrysum filicaule*, *Oxalis exilis* (yellow oxalis), *Pseudognaphalium luteoalbum* and *Wahlenbergia albomarginata* and the fern *Blechnum penna-marina*. The common exotics are the grasses *Anthoxanthum odoratum* and *Holcus lanatus* with the herbs *Trifolium repens* and *Galium aparine* (cleavers). 50% of the sample site consisted of bare rock.

The Purei wetland (C) occurs on the broad ridge crest below and to the south-west of Highlay Hill. It has been highly disturbed by cattle trampling, with the exotic rush *Juncus effusus* (soft rush) dominant over the native grass *Chionochloa rubra cuprea* (copper tussock) in the canopy. Many raised 'lumps' were observed and assumed to be the remains of dead plants of *C. rubra cuprea*. Dominance in the herb layer is shared by the native moss *Sphagnum cristatum*

and the native sedge *Carex gaudichaudiana*, with other common natives in this layer being the rush *Elaeocharis acuta* and the herbs *Myriophyllum propinquum* and *Ranunculus glabrifolius*. Common exotics in the herb layer include grass *Alopecurus geniculatus* (marsh fox tail) and the rushes *Juncus articulatus* (jointed rush) and *J. bufonius* (Toad rush).

The final type of vegetation present is copper tussock wetland (D), occurring on the gully and valley floors, which contribute c. 5% of the RAP. Copper tussock wetland present on Trimbells Gully floor (the stream with the name 'Trimbells Gully' on the map, grid reference I42: 065409) is highly modified due to the area having been mined for alluvial gold. The canopy layer is dominated by the native sedges *Carex geminata* (cutty grass), *Carex secta* (*purei*) and *Schoenus pauciflorus* (bog rush), the native grass *Chionochloa rubra* ssp. *cuprea* and the exotic rush *Juncus effusus*. Exotic species are the most prominent feature of the herb layer (below 30cm) with the grasses *Agrostis capillaris*, *Anthoxanthum odoratum* and *Holcus lanatus*, the herbs *Hypochoeris radicata*, *Mimulus moschata* (musk), *Stellaria alsine* (bog stitchwort) and *Trifolium repens* plus the rush *Juncus articulatus*. Natives are less abundant, the most common being the herbs *Bulbinella angustifolia* (maori onion) and *Ranunculus glabrifolius*, the rush *Elaeocharis acuta* and the fern *Blechnum penna-marina*.

The threatened species *Carex secta* var. *tenuiculmis* (Cameron et al., 1995) is found in copper tussock wetland on the valley floor, while the local species *Celmisia bookeri* is present in narrow-leaved snow tussock grassland on the steep south facing slope above the Trimbells Gully stream, occurring around rocks scattered throughout the grassland.

Two species of limited distribution within the district, *Rytidosperma racemosum* and *Sophora prostrata* (prostrate kowhai), appear in narrow-leaved snow tussock grassland. *S. prostrata* is particularly relevant, as it is the southern-most known occurrence of the species (Dr. A. Whitaker, pers. comm. 1992).

Fauna

Numerous insects were seen. A common skink (*Oligosoma nigriplantare polychroma*) was observed in the narrow-leaved snow tussock grassland.

Discussion

The modification of the copper tussock wetlands in Trimbells Gully may seem to reduce the area's conservation value, but there is historic value to be considered as well. The pot-holed nature of the alluvial workings have the characteristics of an early gold rush site from the period 1861-63. Only one other site in the district, at Murphy's Flat, shows these signs. The workings have a high conservation value in themselves (Dr G. Hamel, pers. comm. 1997).

The landform-vegetation combination of the Moist tussock-shrubland on the basalt boulder slope is the most important natural feature of conservation value within the RAP. This ecological unit is repeated to some extent in the Flat Hill RAP, however the basalt boulder slope there occurs on a different landform. The plateau nature of the basalt on the summit of Highlay Hill is a unique landform within the ecological district. This combines with the presence of *Sophora prostrata* to increase the conservation value of an otherwise mediocre area of narrow-leaved snow tussock grassland.

With reference to the generally mediocre condition of the snow tussock grassland, as McIntosh (1995) pointed out, the removal of grazing and burning would probably lead to an increase in naturalness over the long term. The south-facing steep slopes contain snow tussock grassland in good condition - as good as anywhere else within the land system. The overall ranking of condition is influenced by the extensive patches of *Hieracium pilosella*-dominated grassland.

The continued grazing of the land without fertilisation and oversowing is likely to lead to further degradation, but such inputs may not be economically viable (McIntosh, 1995)

Selection criteria Macraes RAP 4 : Trimbells Gully

Representativeness	H	Representative vegetation of the Rolling Hills land system.
Diversity	H	A good diversity of vegetation.
Naturalness	L-M	Many exotics present below 30cm; highly degraded areas on north facing slopes.
Special Features	M	The southern-most known occurrence of <i>Sophora prostrata</i> .
Buffering	H	Excellent catchment integrity; surrounding vegetation modified narrow-leaved snow tussock grassland.
Viability	M-H	<i>Hieracium pilosella</i> is prevalent in some areas.
Threat	M-H	Burning and grazing; exotic species are abundant.
Landforms	H	Representative of the Rolling Hills land system with the basalt boulder slope below the plateau of Highlay Hill providing a unique feature.

MACRAES RAP 5 : FILLY BURN

Area	76ha
Grid Reference	I42-997 355
Altitudinal Range	500-600m
Land System	Fault Block Ridges
Quadrat (community) Groups	D and F
Tenure	Freehold
Ecological Units	Narrow-leaved snow tussock grassland on rock outcrop. (<1%) Narrow-leaved snow tussock grassland on broad ridge crest. (85%) Narrow-leaved snow tussock grassland on gully side-slope. (12%) Copper tussock wetland on gully floor. (3%)

Landform and Soil

The Filly Burn RAP is one of two to occur on the Fault Block Ridges land system. The broad gently sloping ridge with scattered rock outcrops and incised gully is typical of the dip slope of the Taieri Ridge. Geologically the RAP consists of Haast schist chlorite sub-zone IV (Mutch, 1963), the dominant parent material of Macraes Ecological District. The schist is overlain by a Matarae yellow-grey earth (N. Z. Soil Bureau, 1968).

Vegetation and Flora

Two vegetation types are present here, narrow-leaved snow tussock grassland (F) and copper tussock wetland (C). Narrow-leaved snow tussock grassland is the dominant vegetation type covering about 97% of the RAP. As is the pattern over most of the district, the condition of the tussock grassland varies. On the gully sides it is particularly lush, whilst on the broad crest it is somewhat patchy, with small areas dominated by the native grass *Festuca novae-zelandiae* (hard tussock) and the exotic herb *Hieracium pilosella* (Mouse-ear hawkweed).

On the broad crest the narrow-leaved snow tussock grassland is dominated by *Chionochloa rigida* (narrow-leaved snow tussock) in the canopy, with *Festuca novae-zelandiae* and the native shrub *Discaria toumatou* (matagouri) co-dominant but at lower abundances. The herb layer is dominated by the exotic grasses *Agrostis capillaris* (brown top), *Anthoxanthum odoratum* (sweet vernal) and *Holcus lanatus* (Yorkshire fog) with the herbs *Hieracium pilosella*, *Hypochoeris radicata* (catsear) and *Trifolium repens* (white clover). However while the exotic species have the highest individual covers, the less abundant natives contribute a greater number of species. Indigenous species in the herb layer include the herbs *Anisotome aromatica*, *Helicbrysum filicaule* (slender everlasting daisy), *Stackhousia minima* and *Wahlenbergia albomarginata* (N. Z. bluebell), the grasses *Dichelachne crinita* (plume grass), *Rytidosperma*

pumilum, the woody sub-shrub *Leucopogon fraseri* (dwarf heath) and *Poa colensoi* (blue tussock) together with the scrambler *Muehlenbeckia complexa* (pohuehue).

On the gully side-slope narrow-leaved snow tussock grassland differs in that individuals of *Chionochloa rigida* are larger, *Festuca novae-zelandiae* decreases in abundance while *Discaria toumatou* increases. In the herb layer the exotic species are less prominent and the diversity of indigenous species increases. Natives present in this layer include the woody sub-shrubs *Gaultheria depressa* (snowberry), *Kelleria dieffenbachii*, *Pimelea oreophila* and *P. pseudolyallii*, the herbs *Brachyglottis bellidioides*, *Geum leiospermum* and *Nertera setulosa*, and the ferns *Blechnum penna-marina* and *Polystichum vestitum* (prickly shield fern). The presence of species such as *B. penna-marina* and *N. setulosa* suggests that the grassland here is relatively moist.

The narrow-leaved snow tussock grassland on the rock outcrop is quite distinctive. Here *Chionochloa rigida* is present in the canopy at half the abundance of the other area, sharing dominance with the native herb *Aciphylla aurea* (golden spaniard) and the shrubs *Gaultheria antipoda* (fools beech) and *Melicactus alpinus* (porcupine shrub). Other native canopy species include the shrubs *Corokia cotoneaster* and *Myrsine divaricata* (weeping mapou) plus the scramblers *Clematis marata* and *Muehlenbeckia complexa*. In the herb layer the exotic grasses and herbs previously mentioned, are again the most abundant species. However, they are present here in lower abundances than in the other tussock grassland areas. Indigenous species in the herb layer not identified from the other areas include the grasses *Deyeuxia avenoides*, *Elymus solandri* (blue wheat grass) and *Rytidosperma setifolium*, the ferns *Asplenium flabellifolium* and *Asplenium terrestre* plus the herbs *Brachyscome longiscapa* and *Scleranthus uniflorus* (mat daisy). Bare rock accounts for 30% of the total area sampled with a further 50% covered with lichens.

Copper tussock wetland (D) occurs on the gully floor and, in the sample plot the canopy was dominated by the native sedge *Carex secta* (purei) and the shrub *Olearia bullata*. Other sub-dominant natives in the canopy include the native grasses *Chionochloa rubra cuprea* (copper tussock), *Cortaderia richardii* (toetoe) and *Hierochloa redolens* (holy grass), the shrubs *Coprosma propinqua* (mingimingi) and *Discaria toumatou*, and the rush *Elaeochloa acuta*. Two exotic species are also present, the rushes *Juncus articulatus* (jointed rush) and *Juncus effusus* (soft rush). The herb layer is dominated by the native herb *Montia fontana* (blinks), with other common natives, including the ferns *Blechnum penna-marina* and *Hypolepis millefolium* plus the orchid *Corybas macranthus* also present. Exotics are again a prominent feature here, with the herbs *Mimulus moschatus* (musk), *Stellaria alsine* (bog stitchwort) and *Trifolium repens*, and the grasses *Agrostis capillaris*, *Anthoxanthum odoratum* and *Holcus lanatus* all present.

Three species of limited distribution within the District occur here. The herb *Brachyscome longiscapa* and the grass *Rytidosperma setifolium* are present on the rock outcrop while the herb *Epilobium insulare* is in the Copper tussock wetland.

Fauna

Nothing was noted.

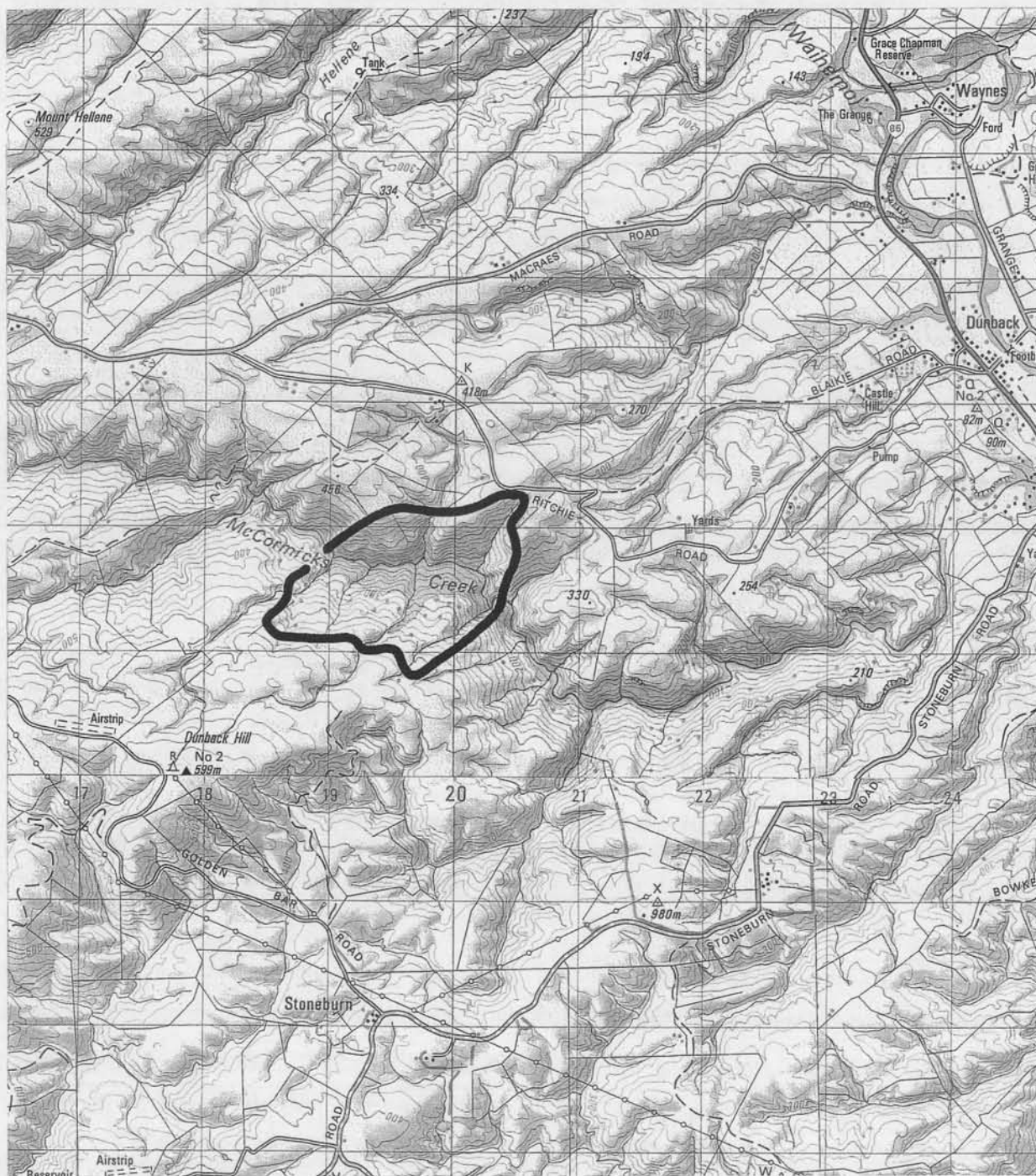
Discussion

The Filly Burn RAP is one of the few areas on the Taieri Ridge to retain most of its narrow-leaved snow tussock grassland cover. While some areas are of a degraded nature, it was noted that small *Chionochloa rigida* tussocks were present throughout. Over time, with the removal of grazing, these should increase in stature, restoring a more continuous cover of tussock over the RAP. In areas of denser tussock cover (particularly the gully side-slope) it was noted that the abundance of individual exotic species decreased. It is assumed that with an increase in tussock stature and cover, the present high abundance of individual exotics will decrease on the broad ridge. Although there is not a great diversity of vegetation types present within the RAP, the ones that do exist are representative of the land system. Being adjacent to the Macraes-Hyde road, the RAP can be easily seen from the road. The representativeness of the vegetation combined with its accessibility give the RAP a high conservation value.

Selection criteria Macraes RAP 5 : Filly Burn

Representativeness	H	The dominance of narrow-leaved snow tussock grassland is representative of the Fault Block Ridges dip slope.
Diversity	L-M	Few vegetation types, but a reasonable floristic diversity exists.
Naturalness	M	Exotic species tend to be abundant in the inter-tussock spaces, however many indigenous species are present at low abundances.
Special Features	L-M	Three species of limited distribution within the district.
Buffering	L-M	Surrounding vegetation modified.
Viability	M	Relatively small area; present landowner does not burn.
Threat	L-M	Browsing by stock, oversowing.
Landforms	M	Typical of the land system.

MAP 4.6 : MACRAES RAP 6 - McCORMICKS CREEK



0 1 2
KILOMETRES

GRID REFERENCE : I42 196314

AREA : 215 ha

ALTITUDE : 160m - 460m

TENURE : Freehold

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MACRAES RAP 6 : MCCORMICKS CREEK

Area	215ha
Grid Reference	I42-196 314
Altitudinal Range	160-460m
Land System	Dissected Steeplands.
Quadrat (community) Groups	E, I, J and M
Tenure	Freehold
Ecological Units	Moist tussock-shrubland on lower-slopes. (7%) Dry rocky tussock-shrubland on upper-slopes. (3%) Kanuka woodland on toe-slope. (2%) Kanuka woodland on lower-slopes. (18%) Broadleaf forest on toe-slope. (2%) Broadleaf forest on lower-slopes. (8%) Modified narrow-leaved snow tussock grassland on upper-slopes. (60%)

Landform and Soil

McCormicks Creek is the northern most RAP to occur in the Dissected Steeplands land system, bordering on the Valley Incision land system. Silver peaks lowland yellow-brown earth (N. Z. Soil Bureau, 1968) overlies Haast schist chlorite sub-zone IV basement rock (Mutch, 1963). This RAP is just one of two to include the Silver Peaks Soil type. The incised valley in which this RAP occurs is typical of the Dissected Steeplands land system, however, as the RAP occurs half way down the McCormicks Creek catchment it has a low catchment integrity.

Vegetation and Flora

Broadleaf forest (M) occurs only here and in the Hindon RAP at the southern end of the district. This population is the more extensive of the two, occurring from lower- to mid- slopes, on toe-slopes and extending up some of the gullies on the northern side of the creek while on the southern slope it tends to occur in incised gullies. The canopy is dominated by the native tree *Griselinia littoralis* (broadleaf) which reaches up to 8m in height and contributes 35% of the total 45% cover. The relatively low total cover in the canopy is indicative of the open nature of this mixed-aged forest. Other native trees in the canopy include *Myrsine australis* (red mapou), *Pittosporum eugenioides* (lemonwood) and *Pseudopanax crassifolium* (lancewood). The sub-canopy is again dominated by *G. littoralis*, with the native trees *Coprosma linariifolia* (yellow-wood), *C. propinqua* (mingimingi), *Cordyline australis* (cabbage tree), *Melicytus ramiflorus* (whitey wood) and *M. australis* present at lower abundances. In the

shrub layer the native shrubs *Coprosma crassifolia* and *Helichrysum lanceolatum* are dominant over *Coprosma propinqua* and *Hebe salicifolia*, with the climber *Parsonsia heterophylla* (Maori jasmine) also present. The presence of the native trees *Carpodetus serratus* (marble leaf), *Cordyline australis*, *Melicytus ramiflorus*, *Myrsine australis* and *Pseudopanax crassifolium* in the shrub layer suggests that the forest is regenerating. Common natives in the herb layer include the ferns *Asplenium bulbiferum* (hen and chickens fern), *Asplenium flabellifolium* (necklace fern), *Phymatosorus diversifolius* (hound's tongue) and *Polystichum richardii* (common shield fern), together with the herbs *Arthropodium candidum* (star lily), *Libertia ixioides* (native iris) and *Scandia geniculata* (climbing aniseed). Seedlings of the trees *C. serratus*, *G. littoralis*, *M. ramiflorus* and *M. australis* were also identified in very low numbers.

The dominant vegetation on the southern lower-slopes is kanuka woodland (J). The native tree *Kunzea ericoides* (kanuka) is the only species present in the canopy, reaching a maximum height of 7m with an average cover of 70%. In contrast to the broadleaf forest, the canopy here is closed and apparently even-aged. The absence of *Kunzea ericoides* in any other height class, and the presence of the native trees *Griselinia littoralis* and *Myrsine australis* in the sub-canopy and as seedlings suggests that the *Kunzea ericoides* canopy may eventually be replaced by a broadleaf canopy. The shrub layer is dominated by *Helichrysum lanceolatum*, with *Coprosma crassifolia* and *C. propinqua* also present at lower abundance. Indigenous species present in the herb layer are similar to the broadleaf forest, with the ferns *Phymatosorus diversifolius* and *Polystichum vestitum* plus the herbs *Arthropodium candidum* and *Scandia geniculata* the most common. However, overall species diversity is lower here than in the broadleaf forest.

Occurring on a steep west-facing slope in a gully above the broadleaf forest on the northern side of the catchment is a small area of dry rocky tussock-shrubland (I). It is dominated by the native grass *Poa cita* (silver tussock) with the native shrub species *Carmichaelia virgata*, *Coprosma propinqua*, *Helichrysum lanceolatum*, *Melicytus alpinus* (porcupine shrub) plus the fern *Pteridium esculentum* (bracken) occurring at lower abundances. In the herb layer exotics are a prominent feature with the grasses *Agrostis capillaris* (brown top), *Anthoxanthum odoratum* (sweet vernal) and *Dactylis glomerata* (cocksfoot) present together with the herbs *Cerastium fontanum* (mouse-ear chickweed) and *Trifolium repens* (white clover). Indigenous species in the herb layer include the woody sub-shrubs *Leucopogon fraseri* (dwarf heath) and *Pimelea oreophila*, the herbs *Helichrysum filicaule* (slender everlasting daisy), *Ranunculus multiscapus* (grassland buttercup) and *Viola cunninghamii* (N. Z. violet) plus the grasses *Elymus solandri* (blue wheat grass) and *Rytidosperma gracilis*. The presence of *Griselinia littoralis* and *Myrsine australis* on rock bluffs in the surrounding area, and the proximity of the broadleaf forest suggest that this vegetation has been induced through forest clearance.

Moist tussock-shrubland (E) occurs in a small, patchy band above the broadleaf forest on the northern slope. A mix of the native grass *Chionochloa rigida* (narrow-leaved snow tussock), the shrub *Coriaria sarmentosa* (tutu) and the fern *Pteridium esculentum* dominate the canopy, with scattered individuals of the native herb *Aciphylla aurea* (golden spaniard) present. In the herb layer *C.*

sarmentosa and *P. esculentum* share dominance with the exotic grasses *Anthoxanthum odoratum*, *Dactylis glomerata* and *Holcus lanatus* (Yorkshire fog). Other indigenous species present at lower abundances include the fern *Polystichum vestitum* (prickly shield fern) and the herbs *Gnaphalium audax*, *Oreomyrrhis ramosa* and *Ranunculus multiscapus*. Evidence of burning was observed, while the presence of *Griselinia littoralis* and *Coprosma propinqua* seedlings suggest the regeneration of forest is possible in the absence of fire.

Modified narrow-leaved snow-tussock grassland occurs on the upper-slopes, being dominated by exotic grasses in the herb layer with scattered individuals of the native grasses *Chionochloa rigida* and *Festuca novae-zelandiae* (hard tussock) in the canopy layer.

Eight species of limited distribution within the district were located here. Seven of these species, the trees *Coprosma linariifolia* and *Hoberia angustifolia* (narrow-leaved lacebark), the sedge *Carex raoulii*, the grass *Lachnagrostis semiglabra*, the herbs *Gingidia montana* (mountain anise) and *Haloragis erecta* (toatoa) plus the fern *Blechnum discolor* (crown fern), occur in the broadleaf forest. The fifth species, *Einadia allanii* occurs in dry rocky tussock-shrubland. The local herb *Celmisia bookeri* (Cameron et al., 1995) was found to occur here in the moist rocky tussock-grassland above the forest.

Fauna

Bellbird (*Anthornis melanura*), South Island fantail (*Rhipidura fuliginosa penitus*), tomtit (*Petroica macrocephala*), brown creeper (*Finschia navaeseelandiae*) and grey warbler (*Gerygone igata*) were all observed in the forest. A white faced-heron (*Ardea novaehollandiae*) was also seen wading in the creek. Droppings of rabbits, hares and sheep were found in the dry rocky tussock-shrubland area, with signs of goats and pigs in the forest.

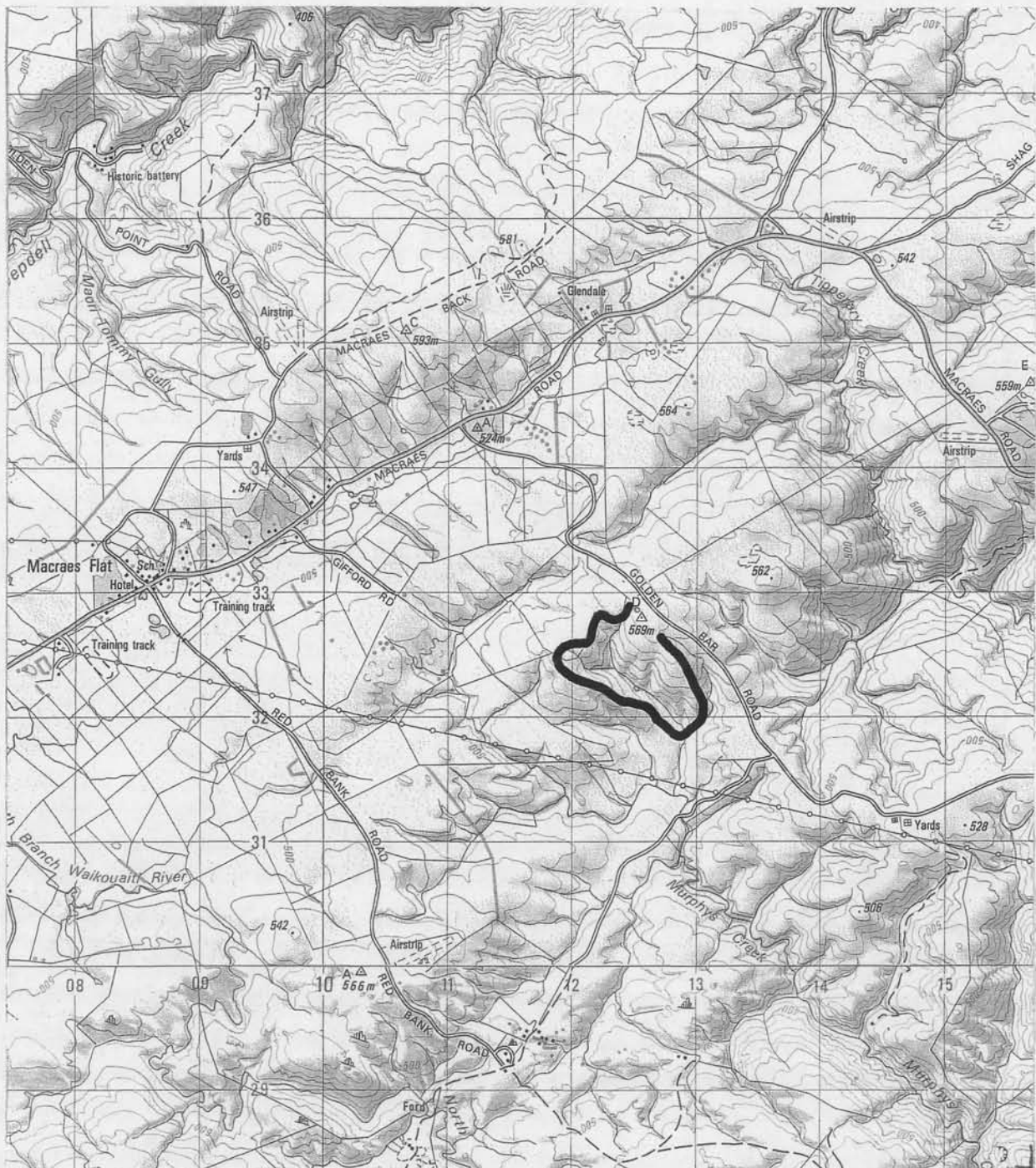
Discussion

The conservation values of McCormicks Creek lie with the kanuka and broadleaf forests, both of which are the most extensive examples identified within the ecological district. Within the district several species are known only from this RAP, in particular the native narrow-leaved lacebark *Hoberia angustifolia*. This adds to the conservation value of the forest. The broadleaf forest in particular is in relatively good condition, showing signs of only minor grazing at present. It should be noted, however, that without control of the goat population the effects of grazing could become more serious. The signs of broadleaf forest regeneration in all vegetation types suggest that in the long term the RAP could become dominated by this vegetation. The modified upper-slopes of the RAP are included to provide for expansion of the forest in the long term.

Selection criteria Macraes RAP 6 : McCormicks Creek

Representativeness	H	Excellent examples of kanuka and broadleaf forest in the Dissected Steeplands land system.
Diversity	M-H	Both in terms of vegetation types and species.
Naturalness	M	Exotics present in the non-forest vegetation.
Special Features	M	Several species of limited distribution within the District, particularly <i>Hoberia angustifolia</i> .
Buffering	M	Relatively large area of forest, although surrounding vegetation highly modified; low catchment integrity.
Viability	H	Good sign of forest regeneration and expansion.
Threat	M	Browsing by exotic animals and burning.
Landforms	M	Incised valley representative of the Dissected Steeplands land system.

MAP 4.7 : MACRAES RAP 7 - GOLDEN BAR



0 1 2
KILOMETRES

GRID REFERENCE : I42 125325

AREA : 81 ha

ALTITUDE : 440m - 560m

TENURE : Freehold

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MACRAES RAP 7 : GOLDEN BAR

Area	81ha
Grid Reference	I42-125 325
Altitudinal Range	440-569m
Land System	Rolling Hills
Quadrat (community) Groups	C, E and F
Tenure	Freehold
Ecological Units	Purei wetland on gully floor. (4%) Moist tussock-shrubland on rock outcrop. (1%) Narrow-leaved snow tussock grassland on side-slopes. (90%) Narrow-leaved snow tussock grassland on toe-slope. (5%)

Landform and Soil

The Golden Bar RAP takes in the upper catchment of a tributary to Murphys Creek. It occurs in the Rolling Hills land system, with the basement rock being Haast schist chlorite sub-zone IV. Rock in the surrounding area contain reefs of gold-bearing quartz which have been previously worked for gold (Mutch, 1963) and are presently being surveyed by Macraes Mines Ltd. The soil is a Wehenga upland and high country yellow-brown earth (N. Z. Soil Bureau, 1968).

As the RAP is small in size it does not contain a range of landforms that are typical of the Rolling Hills land system. The predominant landform features are the gully side-slopes with scattered rock outcrops and the gully floor. The broad ridge crests typical of the Rolling Hills land system have all been developed into pasture. The gully floor-purei wetland and side-slope-tussock grassland associations are typical of the land system.

Vegetation and Flora

Condition of the purei wetlands (C) varies throughout the RAP, with the best stand at the head of the gully. In this area the canopy is dominated by *Carex secta* (purei) at an average height of 1.1m and with a cover value of about 65%. The exotic rush *Juncus effusus* (soft rush) and the grasses *Dactylis glomerata* (cocksfoot), *Holcus lanatus* (Yorkshire fog) and *Pbleum pratense* (Timothy grass) are the next most abundant species in the canopy, with the native grasses *Chionochloa rubra cuprea* (copper tussock) and *Hierochloe redolens* (holy grass) contributing only 1% of the cover. In the herb layer the exotic species are again abundant, including the herbs *Hypochoeris radicata* (catsear), *Myosotis laxa* ssp. *caespitosa* (water forget-me-not) and *Trifolium repens* (white clover), the grasses *Agrostis stolonifera* (creeping bent), *Alopecurus geniculata* (marsh fox-tail), *Glyceria fluitans* (floating sweet grass) and *H.lanatus*, and the rush *Juncus articulatus* (jointed rush). The herbs *Nertera depressa*, *Ranunculus glabrifolius*, *Ranunculus reflexus* (hairy buttercup) and *Stellaria parviflora*

(native chickweed) are the only natives recorded in the sample site, indicating the modified nature of the pure wetland. There are many visible signs of stock damage, particularly trampling by cattle.

Narrow-leaved snow tussock grassland (F) is the dominant vegetation type and accounts for 95% of the RAP. The condition of the grassland varies greatly, from rough pasture to dense stands of *Chionochloa rigida* (narrow-leaved snow tussock). The better stands of narrow-leaved snow tussock grassland are present on the south facing slope. The canopy is dominated by *C. rigida* with an average height of 1.5m and a cover of 75%. Other native canopy dominants include the grasses *Festuca novae-zelandiae* (hard tussock) and *Poa colensoi* (blue tussock), the scrambler *Muehlenbeckia complexa* (pohuehue) and the shrub *Melicytus alpinus* (porcupine shrub), all present with low cover. In the herb layer it is the exotics which dominate, the most abundant of these being the grasses *Agrostis capillaris* (browntop) and *Anthoxanthum odoratum* (sweet vernal) plus the herbs *Cerastium fontanum* (mouse-ear chickweed) and *Trifolium repens*. Natives are present at lower abundances, and include the grass *Elymus solandri* (blue wheat grass), the woody sub-shrub *Leucopogon fraseri* (dwarf heath) and the herbs *Anisotome aromatica*, *Bulbinella angustifolia* (Maori onion) and *Helicrysum filicaule* (slender everlasting daisy).

Moist tussock-shrubland (E) is present on a rock outcrop midway up the gully side. The canopy is dominated by a mix of the native climbers *Muehlenbeckia complexa* and *Rubus schmidelioides*, the shrubs *Coprosma propinqua* (mingimingi), *C. rigida* and *Discaria toumatou* (matagouri), the grasses *Chionochloa rigida* and *Poa colensoi* plus the fern *Pteridium esculentum* (bracken). In the herb layer the exotic herb *Trifolium repens* together with the grasses *Anthoxanthum odoratum* and *Dactylis glomerata* share dominance with the native grass *Dichelachne crinita* (plume grass) and the fern *P. esculentum*. Other natives with a low abundance include the ferns *Asplenium flabellifolium* (necklace fern) and *Asplenium terrestre* and the herbs *Acaena anserinifolia* and *A. novae-zelandiae* (red bidibid).

One individual of the threatened shrub *Carmichaelia kirkii*, listed as critically threatened, and a small population of the local herb *Celmisia bookeri* (Cameron et al., 1995) occur on a toe-slope rock overhang surrounded by narrow-leaved snow tussock grassland.

Fauna

Paradise shelduck (*Tadorna variegata*) were observed in the general vicinity, and a frog was heard near the headwaters of the catchment.

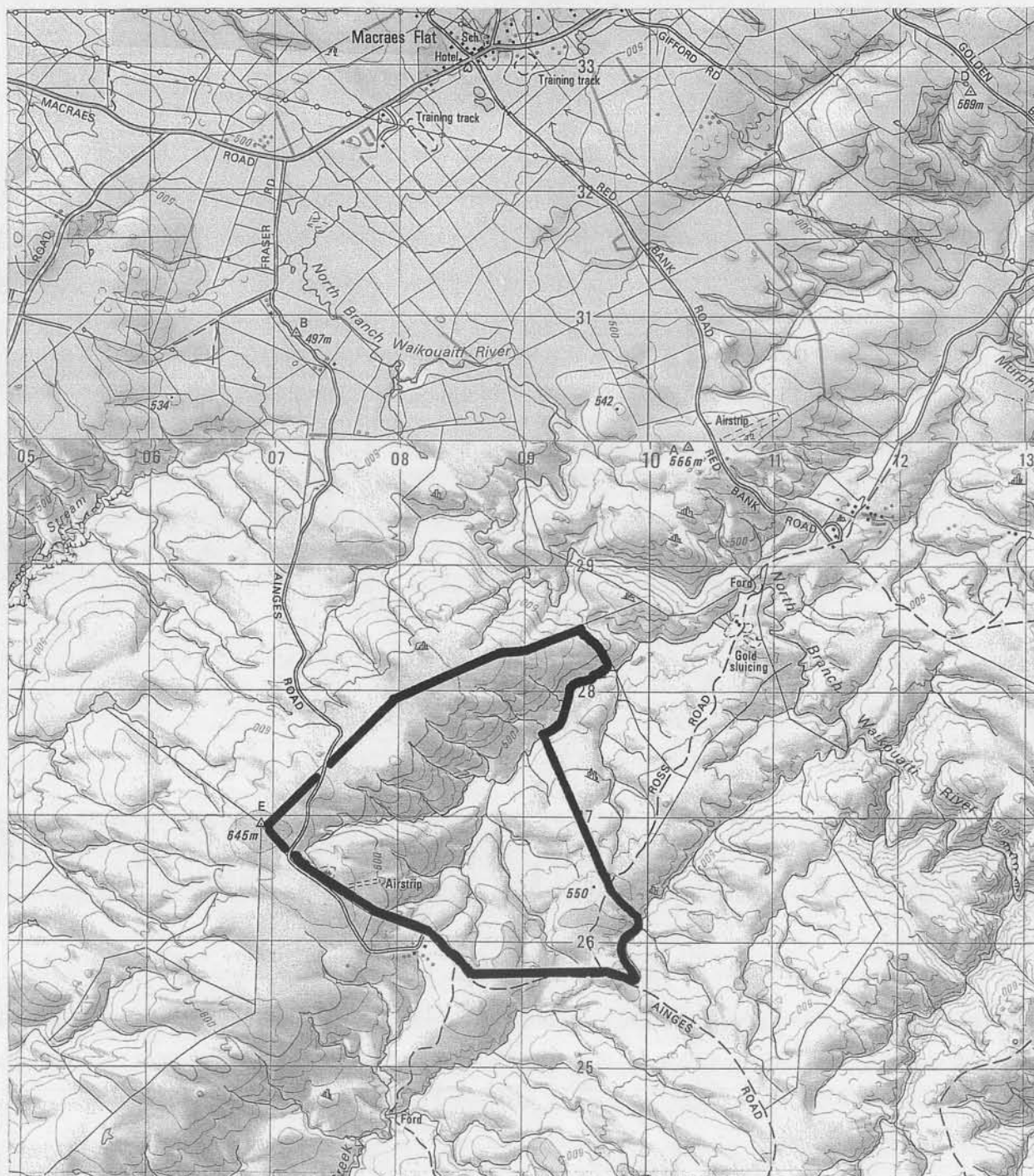
Discussion

The main conservation value of this RAP is the presence of the critically threatened species *Carmichaelia kirkii*. The presence of the local species *Celmisia bookeri*, increases the conservation value, however there are more extensive populations of this species in at least five other RAPs. The three vegetation types within this RAP are of average condition and extent. On their own they would not warrant protection.

Selection criteria Macraes RAP 7 : Golden Bar

Representativeness	M	Narrow-leaved snow tussock grassland is representative of gullies in the Rolling Hills land system.
Diversity	L	Few vegetation types; replacement of indigenous species by exotics.
Naturalness	L	Most of the vegetation below 30cm is dominated by exotic species; extensive areas of modified narrow-leaved snow tussock grassland.
Special Features	H	The presence of the critically threatened shrub <i>Carmichaelia kirkii</i> .
Buffering	L	Most of the surrounding vegetation has been developed.
Viability	M	Relatively small area; extensive areas of modification.
Threat	H	Gold mining activity in the immediate surrounding area.
Landforms	L	Does not contain a high diversity.

MAP 4.8 : MACRAES RAP 8 - RED BANK



0 1 2
KILOMETRES

GRID REFERENCE : 143 085270

AREA : 558 ha

ALTITUDE : 470m - 645m

TENURE : Conservation Land (Subject to
Section 7, Conservation Act 1987)

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MACRAES RAP 8 : REDBANK

Area	558ha
Grid Reference	I43-085 270
Altitudinal Range	470-645m
Land System	Rolling Hills
Quadrat (community) Groups	A, D, E, F and G
Tenure	Freehold; DoC
Ecological Units	Narrow-leaved snow tussock grassland on ridge crest. (25%) Narrow-leaved snow tussock grassland on side-slopes. (45%) Narrow-leaved snow tussock grassland on toe-slopes. (5%) Narrow-leaved snow tussock grassland on gully side-slopes. (10%) Copper tussock wetland on ridge crest. (<1%) Copper tussock wetland on gully floor. (5%) Low turf ephemeral tarn on ridge crest. (<1%) Moist tussock-shrubland on gully floor. (3%) Copper tussock grassland on ridge crest. (7%)

Landform and Soil

Redbank RAP encompasses the entire upper catchment of a side tributary to the North Branch of the Waikouaiti River, presenting an area of high integrity with respect to hydrological processes. A gently undulating ridge crest on the western border of the RAP is extensively studded with rock tors and other outcrops. Moving across the RAP to the east, the side-slope of this ridge is dissected with many incised gullies, often with exposed bedrock bluffs on the gully sides. The opposite side-slope presents a marked contrast to the east-facing side-slope, rising gently to a low ridge crest with fewer rock tors and outcrops. The spurs on this slope are broader and more rounded than those on the east-facing slope. Such landforms are typical of the Rolling Hills land system. The bedrock of this catchment consists solely of Haast schist chlorite sub-zone IV (Mutch, 1963).

MacIntosh (1995) found the soils of the Redbank RAP (referred to as Ainges Rd. ESA in McIntosh's report) to contain minimal soil variation. The soils are mostly extremely or strongly acid with some isolated areas of organic soils. They are typical of medium altitude soils in schist country under similar landforms. MacIntosh (1995) found the area to be of considerable value as a soil reference site.

Vegetation and Flora

Narrow-leaved snow tussock grassland (F) is the predominant vegetation type, covering about 85% of the RAP. As with many areas throughout the district, the condition of the tussock grasslands varies with degradation often being associated with aspect and stock access. Gently sloping north-facing slopes tend to be in a more degraded state, with some extensive areas of *Hieracium pilosella* (mouse-ear hawkweed) in the herb layer and partial replacement of *Chionochloa rigida* (narrow-leaved snow tussock) with *Festuca novae-zelandiae* (hard tussock) in the canopy. The total *Hieracium pilosella* cover never exceeded 25% in any of the sample quadrats, and average canopy cover was 57%. The main exotic species other than *H. pilosella* in the more degraded areas are the grasses *Agrostis capillaris* (brown top), *Anthoxanthum odoratum* (sweet vernal) and *Holcus lanatus* (Yorkshire fog). Indigenous species are numerous in the degraded areas, although most individual species are not abundant. Common natives include the herbs *Anisotome aromatica*, *Gonocarpus micranthus* and *Helichrysum filicaule* (slender everlasting daisy), the woody sub-shrubs *Gaultheria macrostigma* (pink snowberry), *Leucopogon fraseri* (dwarf heath) and *Pentachondra pumila* (little mountain heath) plus the orchid *Microtis oligantha* (small onion orchid). The native shrub *Leptospermum scoparium* (manuka) becomes an increasingly prominent component of the narrow-leaved snow tussock grassland on the gentle slopes of the eastern half of the RAP, being present mainly in the herb layer. Narrow-leaved snow tussock grassland on ridge crest on the western side of the RAP is slightly different. Here *Chionochloa rigida* shares canopy dominance with *Chionochloa rubra cuprea* (copper tussock), with total cover of tussock about 70%. However, the herb layer follows a similar pattern to that described above with similar species involved. Exotic species are few but abundant, whilst indigenous species are much more numerous but less abundant.

A small area (about 2.5ha) of narrow-leaved snow tussock grassland on the ridge crest to the east of the RAP is markedly different. The canopy is dominated by *Leptospermum scoparium*, with *Chionochloa rigida* and the native shrub *Dracophyllum longifolium* (inaka) the next most abundant species. The native tree *Halocarpus bidwillii* (bog pine) is present in low numbers. Common sub-dominant natives in the herb layer include the shrub *L. scoparium*, the woody sub-shrub *Leucopogon fraseri* and the herbs *Raoulia subsericea* (mat daisy), *Helichrysum bellidioides* (everlasting daisy) and *Luzula rufa* (red woodrush). The most abundant herb layer species is the native moss *Racomitrium lanuginosum*.

A low turf ephemeral tarn (A) occurs on the western ridge crest of the RAP. The exotic rush *Juncus effusus* (soft rush) is the only canopy species, but with a low abundance. Only 5% of the vegetation cover occurs above the ground layer. The ground layer is characterised by the native herb *Myriophyllum propinquum* and the exotic grass *Alopecurus geniculatus* (Marsh fox tail). Other common species include the exotic rush *Juncus articulatus* (jointed rush), the native herbs *Limosella lineata* and *Lilaeopsis ruthiana*, and the native sedge *Carex gaudichaudiana*.

Copper tussock wetland (D) occurs on two different landforms, on a ridge crest and on gully floors, with both vegetation-landform associations containing different combinations of species. The wetland on the ridge crest occurs on a

humic organic soil (McIntosh, 1995) the canopy being dominated by the native grass *Chionochloa rubra cuprea* with a mean height of 1.6m and a cover of about 75%. Sub-dominants in the herb layer include the native mosses *Polytrichum commune* and *Sphagnum cristatum*. Other common natives are the sedges *Carex dissita* and *C. gaudichaudiana*. On the gully floors *C. rubra cuprea* shares dominance in the wetland with the native rush *Schoenus pauciflorus* (bog rush) and the exotic rush *Juncus effusus*. The herb layer is heavily modified and dominated by the exotic grasses *Holcus lanatus* and *Anthoxanthum odoratum*. The exotic grass *Agrostis capillaris*, the herbs *Hypochoeris radicata* (catsear) and *Trifolium repens* (white clover) plus the sedge *C. ovalis* (oval sedge) are also common. Of the natives the herbs *Gentiana grisebachii* (marsh gentian), *Gonocarpus micranthus* and *Luzula picta* var. *limosa* (woodrush) and the sedges *Carex gaudichaudiana* and *C. sinclairii* are the most numerous.

Moist copper tussock grassland (G) occurs on ridge crests, characterised by *Chionochloa rubra cuprea* in the canopy. Other sub-dominant natives in this layer include the grass *Chionochloa rigida*, and the rush *Schoenus pauciflorus*. Prominent natives in the herb layer include the herbs *Anisotome aromatica*, *Bulbinella angustifolia*, *Gentiana grisebachii* and *Oreobolus strictus* along with the woody sub-shrubs *Gaultheria macrostigma* and *Pentachondra pumila*. Exotics are common in the herb layer contributing up to 20% of the cover, with the grasses *Agrostis capillaris* and *Anthoxanthum odoratum* plus the herbs *Lotus pedunculatus* (birdsfoot trefoil) and *Hypochoeris radicata*.

Present in some of the more deeply-incised gullies on the side of the western ridge is moist rocky tussock-shrubland (E). The shrubs are dense with some individuals reaching up to 2.5m in height. The main shrub species are the natives *Aristotelia fruticosa* (mountain wineberry), *Coprosma rugosa* (needle-leaved coprosma) and *Olearia bullata* with a single occurrence of the tree *Griselinia littoralis* (broadleaf). Sub-dominants occurring in and around the shrubs include the native herbaceous species *Phormium cookianum* (mountain flax), the climber *Muehlenbeckia australis* (bush pohuehue), the grass *Chionochloa rigida*, the sedge *Carex geminata* (cutty grass) and the ferns *Polystichum vestitum* (prickly shield fern) and *Hypolepis millefolium* (thousand-leaved fern). Exotic species are most prominent in the herb layer, and include the herbs *Hypochoeris radicata*, *Stellaria graminea* (stitchwort), *Mimulus moschatus*, the grass *Holcus lanatus* and the rush *Juncus articulatus*. Although the indigenous species are present at lower abundances, the total number of species is greater. These natives include the herbs *Bulbinella angustifolia*, *Oreomyrrhis ramosa* and *Schizeilema trifoliolatum* with the ferns *Asplenium flabellifolium*, *Blechnum penna-marina* and *Phymatosorus diversifolius*. Occurring outside the sampled area were populations of the local herbaceous species *Celmisia bookeri* on steep rock bluffs.

The threatened species *Myosurus minimus novae-zelandiae* is present in the low turf ephemeral tarn while the local species *Celmisia bookeri* occurs on rocky bluffs. Six other species of limited Distribution within the district were identified in this RAP. Two species of the grass *Agrostis*, *A. muscosa* and *A. pallescens*, were identified from the small area of narrow-leaved snow tussock grassland where *Leptospermum scoparium* dominated. The most extensive population of *Halocarpus bidwillii* also occurs in this area. Only one other

individual was located during the survey - at the rock outcrops at Lots Wife. An individual of the native tree *Sophora microphylla* (kowhai) occurs in the narrow-leaved snow tussock grassland on the lower-slope of the western ridge. The herbaceous species *Epilobium glabellum* occurred in the moist tussock-shrubland, while the native grass *Lachnagrostis filiformis* was found in the copper tussock wetland on the ridge crest.

Fauna

The western ridge of the Redbank RAP, with its many rock tors providing lizard habitat, contains a large population of the rare grand skink (*Oligosoma grande*). In total, seven species of lizard have been found on this ridge, additional species being the green skink (*Oligosoma chloronoton*), McCann's skink (*Oligosoma maccanni*), common skink (*Oligosoma nigriplantare polychroma*), cryptic skink (*Oligosoma inconspicuum*), 'Eastern' Otago gecko (*Hoplodactylus* n.sp.aff. *maculatus*) and the rare Otago skink (*Oligosoma otagense*) (Mr G. Loh, pers. comm. 1997). There are few green and Otago skinks compared to a relatively large gecko population. The Australasian harrier (*Circus approximans*) has been seen nesting in the copper tussock wetland on the ridge crest, and New Zealand galcons (*Falco novaeseelandiae*) were observed in the general vicinity (Mr G. Loh, pers. comm. 1997).

Information on the invertebrate fauna has been provided by Mr B. Patrick (pers. comm. 1997). Invertebrate values are high in this area with a large diversity of native invertebrates. Of note is the aquatic insect fauna in the seepages and creeks. The brown caddis *Psilochroma tautoru*, local in Otago, is fairly common here, particularly in seepages and wetlands. It is joined by a large array of bugs, beetles, crickets, grasshoppers and diurnal moths in these habitats. Rock tors support an important group of insects including cave weta, beetles and moths in the genus *Dichromodes*, including *D. ida*.

Present in the grassland and shrubland are a diverse range of herbivores and litter-feeding insects including shield-bugs, katydids, weevils and moth larvae. Of particular note are the occurrence of the superbly-coloured grasshopper *Paprides dugdali*, the diurnal moths *Arctesthes catapyrrha* and *Dasyuris transaurea*, plus the carabid beetle *Holcaspis ovatella*.

Low alpine insects are a feature, including the diurnal moths *Notoreas paradelpha*, *Orocrambus tritonellus*, *Harmologa petrias* and butterfly *Argyrophenga janitae*. All are indicative of a diverse and functioning native ecosystem.

Discussion

The conservation values of the Redbank RAP are many and varied. It is the most diverse RAP without forest vegetation, containing five vegetation types. It contains the threatened species *Myosurus minimus novae-zelandiae* and the local species *Celmisia bookeri* plus six species of limited distribution within the ecological district. While much of the narrow-leaved snow tussock grassland is modified to varying degrees, the grassland on the western ridge crest is one of the best examples of this vegetation in the district. Presence of the *Halocarpus bidwillii* population is also very significant as it is the only such population within the district.

Regarding landscape values of the RAP, the landforms contained within the RAP are typical of the Rolling Hills land system. The boundaries of the RAP also present an area of high catchment integrity, encompassing an entire upper catchment. The conservation value of the soils in this RAP is supported by McIntosh (1995) who assessed the area as worthy of protection as a soil reference site associated with the mid-altitude coastal Otago rolling uplands landscape.

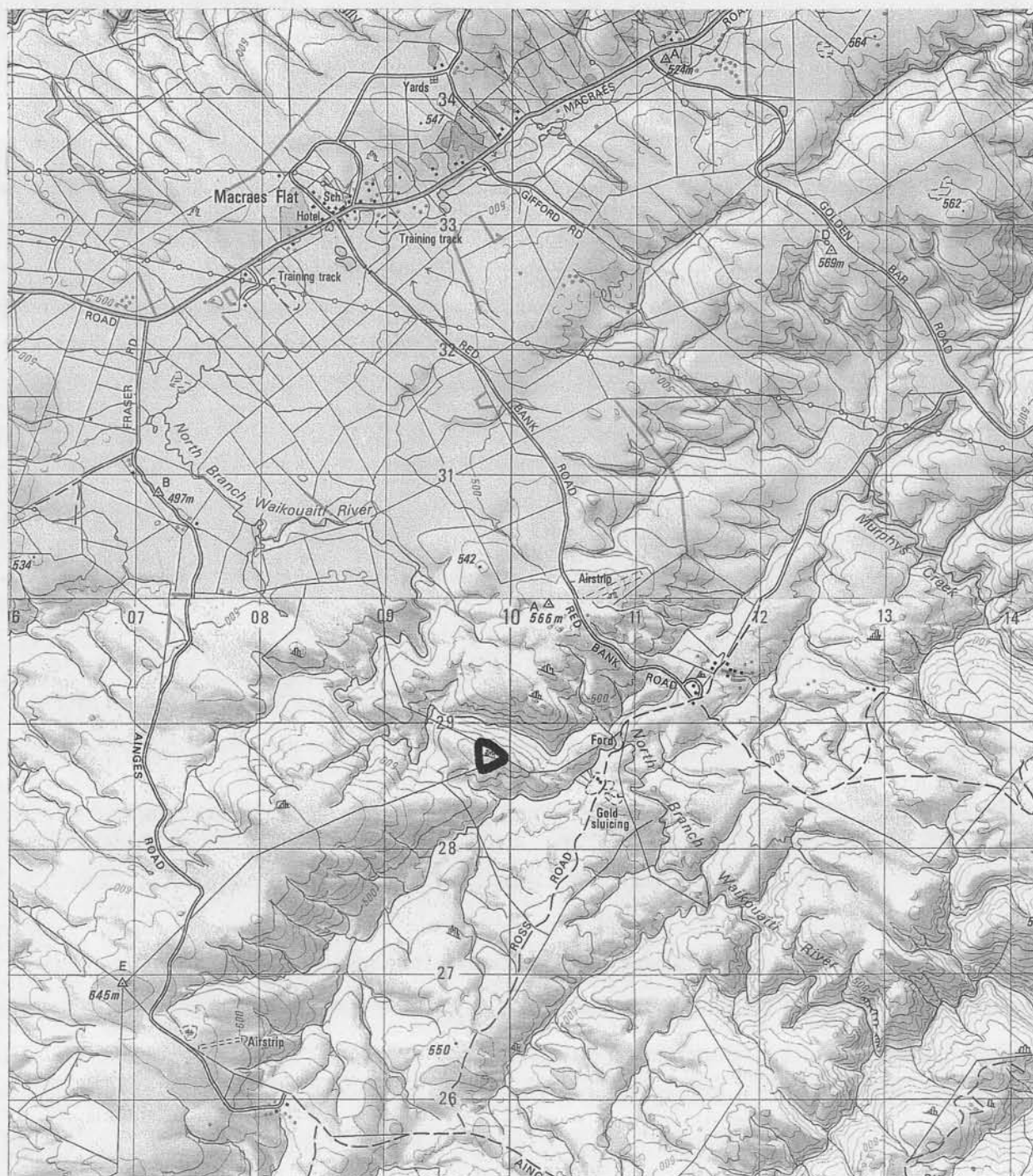
Both the high diversity of lizard species and the presence of the threatened grand and Otago skink are features present in only one other RAP (Manuka Stream). The western ridge of the Redbank RAP has been identified in the Otago and grand skink recovery plan as one of three key sites important for their conservation. Combined with a high diversity of invertebrate species, the value of the area for faunal conservation can be considered very high.

The presence of *Leptospermum scoparium* in the narrow-leaved snow tussock grassland on the west-facing gentle slopes raises questions as to the long-term dynamics of this grassland. It is probable that with the removal of burning in particular, *L. scoparium* will become more abundant and may eventually replace the narrow-leaved snow tussock grassland.

Selection criteria Macraes RAP 8 : Redbank

Representativeness	H	The vegetation is representative of the Rolling Hills land system.
Diversity	H	High diversity of vegetation types and insect species.
Naturalness	M	Exotic species present; some extensive patches of <i>Hieracium pilosella</i> .
Special Features	H	The presence of the rare Otago and grand skinks, the threatened plant species <i>Celmisia hookeri</i> and <i>Myosurus minimus novae-zelandiae</i> , and the best population of <i>Halocarpus bidwillii</i> .
Buffering	M-H	Excellent catchment integrity; bordered by developed pasture land on some sides.
Viability	H	Long-term dynamics of <i>Leptospermum scoparium</i> in the narrow-leaved snow tussock grassland needs to be considered.
Threat	M	Stock grazing; predation of lizard species.
Landforms	H	Representative of the Rolling Hills land system.

MAP 4.9 : MACRAES RAP 9 - RED BANK ROCK OUTCROP



0 1 2
KILOMETRES

GRID REFERENCE : I43 098287

AREA : 3 ha

ALTITUDE : 520m - 540m

TENURE : Freehold

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MACRAES RAP 9 : REDBANK ROCK OUTCROP

Area	3ha
Grid Reference	143-098 287
Altitudinal Range	520-540m
Land System	Rolling Hills
Quadrat (community) Groups	E
Tenure	Freehold
Ecological Units	Moist tussock-shrubland on rock outcrop (65%) Modified narrow-leaved snow tussock grassland on ridge crest. (35%)

Landform and Soil

This RAP is a site of special interest and is focused on a large rock outcrop of Haast schist chlorite sub-zone IV (Mutch, 1963) occurring in the Rolling Hills land system. Thus the landform represented is neither diverse nor typical of the district. The soil surrounding the rock outcrop is a Pukerangi yellow-grey earth (N. Z. Soil Bureau, 1968) while on the rock outcrop itself it is only in the crevices that a soil formed from humus and rock debris is present.

Vegetation and Flora

The Moist tussock-shrubland (E) occurs on a large rock outcrop with most of the taller species, shrubs and tussocks, occurring in large crevices. The canopy is dominated by *Podocarpus nivalis* (snow totara) and *Chionochloa rigida* (narrow-leaved snow tussock), with other less abundant species including the shrubs *Leucopogon colensoi*, *Melicytus alpinus* (porcupine shrub), *Coprosma cheesemanii* (sprawling coprosma), *C. rubra* and *Corokia cotoneaster*. On the more exposed surfaces the canopy layer is absent, with the exotic herb *Hieracium pilosella* (mouse-ear hawkweed) sharing dominance with the native woody sub-shrub *Leucopogon fraseri* (dwarf heath) in the herb layer. Other indigenous species in this layer include the herbs *Celmisia hookeri*, *Scleranthus biflorus* and *Colobanthus strictus* plus the grass *Deyeuxia avenoidies*. Some 35 % of the outcrop had no plant cover, while another 40% was covered in lichens.

A small area of modified tussock grassland occurs on the northern side of the outcrop, the canopy dominated by *Chionochloa rigida* and *Discaria toumatou* (matagouri) with a range of exotic grasses dominating the herb layer. On the southern side there is a stock camp, with the area being dominated by exotic grasses.

Fauna

No fauna was observed, although there are likely to be lizard species present since rock outcrops, such as are present here, usually provide suitable habitat.

Discussion

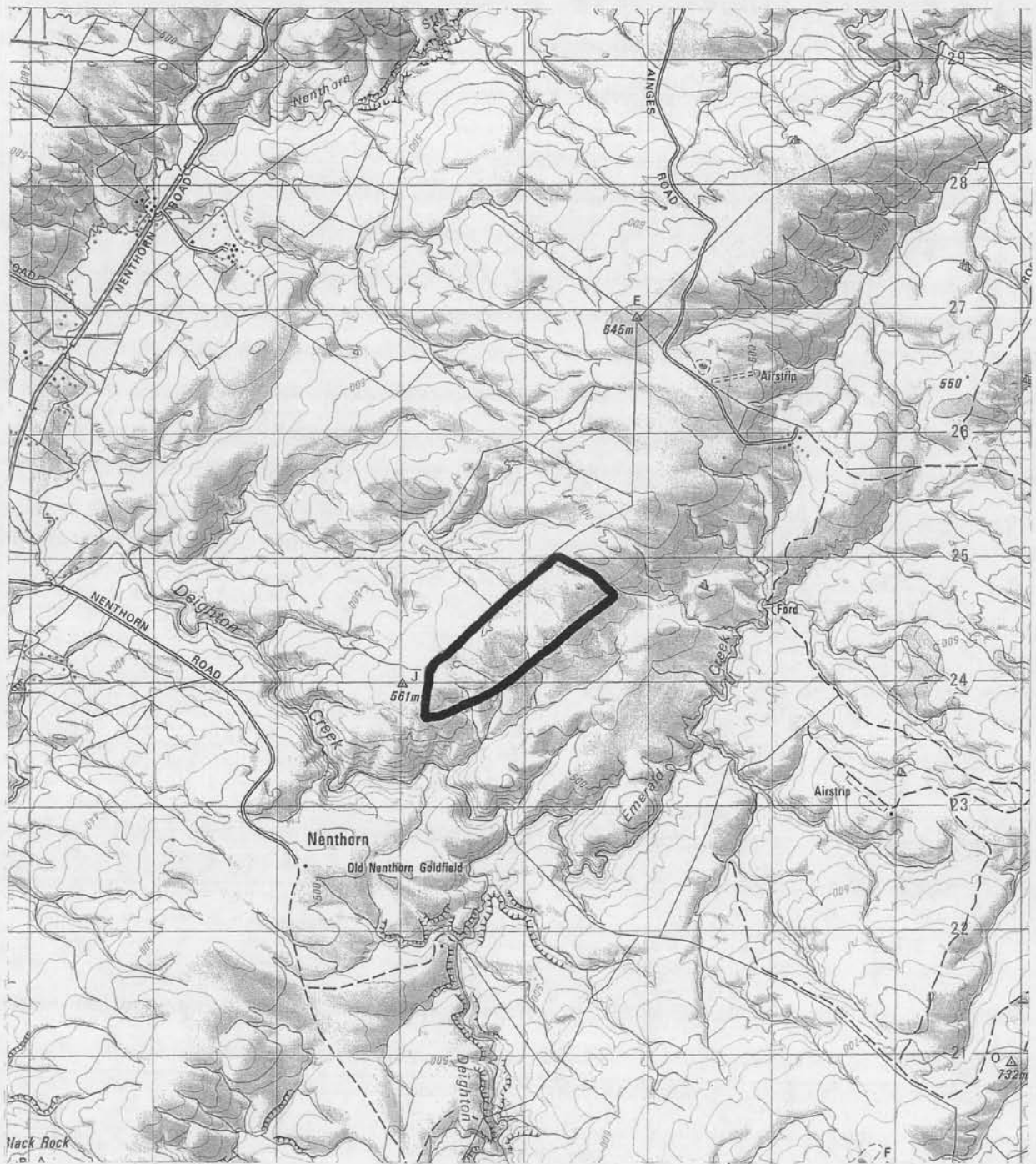
This site has the only occurrence of *Podocarpus nivalis* within the ecological district which, combined with the diversity of shrub species on the outcrop and the naturalness of the vegetation, warrant this area becoming an RAP.

Steep sides to the outcrop combined with a thick buffer of matagouri scrub render the outcrop inaccessible to stock. The steep sides are also without vegetation, providing a barrier to fire. The presence of small *Podocarpus nivalis* shrubs, along with *Melicytus alpinus*, *Coprosma cheesemanii* and *Leucopogon colensoi*, suggest that the shrubs are regenerating.

Selection criteria Macraes RAP 9 : Redbank Rock Outcrop

Representativeness	L	The vegetation is not characteristic of most rock outcrops.
Diversity	L-M	Reasonable diversity of indigenous species on the outcrop.
Naturalness	H	<i>Hieracium pilosella</i> present, however it is one of the most natural communities on a rock outcrop within the district.
Special Features	H	The only occurrence of <i>Podocarpus nivalis</i> within the district.
Buffering	L	Surrounding vegetation highly modified.
Viability	H	Inaccessible to stock and fire.
Threat	L	Steep sides of the rock provide good security
Landforms	L	Very low diversity of landform.

MAP 4.10 : MACRAES RAP 10 - NENTHORN RIDGE



0 1 2
KILOMETRES

GRID REFERENCE : I43 058246

AREA : 112 ha

ALTITUDE : 540m - 570m

TENURE : Freehold

Crown Copyright Reserved : Map Licence No. OT 1991/5

MACRAES RAP 10 : NENTHORN RIDGE

Area	112ha
Grid Reference	I43-058 246
Altitudinal Range	540-570m
Land System	Rolling Hills
Quadrat (community) Groups	A, B, C and G
Tenure	Freehold
Ecological Units	Low turf ephemeral tarn on ridge crest. (2%) Medium turf ephemeral tarn on ridge crest. (2%) Purei wetlands on ridge crest. (2%) Moist copper tussock grassland on ridge crest. (40%) Moist copper tussock grassland on upper-slopes. (2%) Narrow-leaved snow tussock grassland on ridge crests. (42%) Narrow-leaved snow tussock grassland on upper-slopes. (10%)

Landform and Soil

The Nenthorn Ridge RAP occurs within the Rolling Hills land system and encompasses upper-slope and ridge crest landforms. The broad gently sloping and undulating nature of the crest is typical of the Rolling Hills land system, and is one of three such landforms recommended for protection within the district. As with most of the RAP's the basement rock is Haast schist chlorite sub-zone IV. It contains some gold-bearing quartz veins which have been previously mined (Mutch, 1963). Two soils are found here, Pukerangi yellow-grey earth and Wehenga upland and high country yellow-brown earth (N. Z. Soil Bureau, 1968). The boundary between these two soils runs parallel to the line of the ridge.

Vegetation and Flora

Low turf ephemeral tarns (A) occur in seasonally inundated hollows up to 30m across. Vegetation above the ground layer is sparse, contributing only 1% of cover in the sample sites, with *Chionochloa rubra cuprea* (copper tussock) and *Juncus effusus* (soft rush) the only canopy species present. In the ground layer the sedge *Carex gaudichaudiana* dominates, with other common natives including the herbs *Herpolirion novae-zelandiae*, *Hypsela rivalis*, *Limosella lineata* and the rush *Isolepis aucklandica*. The exotic grass *Alopecurus geniculata* (marsh fox tail) is also prevalent in this layer.

Medium turf ephemeral tarns (B) occur in the same landform as the low turf ephemeral tarn. The exotic rush *Juncus effusus* and *Chionochloa rubra cuprea* are the only canopy species, and account for 5% of the total cover. In the herb layer, the exotic species *Juncus articulatus* (jointed rush) and *Anthoxanthum odoratum* (sweet vernal) are present at low abundances. However, it is in the ground layer that the most abundant species occur, with the native sedge *Elaeocharis acuta* and the exotic grass *Agrostis stolonifera* (creeping bent) being dominant. Other species include the native herbs *Myriophyllum propinquum*, *Lilaeopsis ruthiana* and *Hypsela rivalis*, the sedge *Carex gaudichaudiana*, and the exotic grass *Alopecurus geniculata* and rush *Juncus articulatus*.

Purei wetland (C) occurs surrounding a large pool on the ridge crest. It is dominated by the exotic rush *Juncus conglomeratus* above 30cm, with *Chionochloa rubra cuprea* being the only other species recorded within the sample site in this height class. However, beyond the sample site, there is a fringe of *Carex secta* (purei) in the canopy around the edge of the pool. In the herb layer the native sedge *Carex sinclairii* dominates along with the exotic rush *J. conglomeratus*, while the moss *Sphagnum cristatum* dominates the ground layer.

Moist copper tussock grassland (G) occurs in gently sloping hollows associated with stream heads. The canopy is dominated by the native grass *Chionochloa rubra cuprea* with the occasional plants of the rush *Schoenus pauciflorus* (bog rush), the grass *Festuca novae-zelandiae* (hard tussock) and some hybrids of *Chionochloa rigida* (narrow-leaved snow tussock) and *C. rubra cuprea*. The herb layer contains a range of species but with no obvious dominants, including the native herbs *Bulbinella angustifolia* (Maori onion), *Oreostylidium subulatum* and *Oreobolus strictus*, the woody sub-shrubs *Pentachondra pumila* (little mountain heath) and *Gaultheria macrostigma* (pink snowberry) plus the exotic grasses *Anthoxanthum odoratum*, *Agrostis capillaris* (sweet vernal) and *Holcus lanatus* (Yorkshire fog) together with the herbs *Hypochaeris radicata* (catsear) and *Hieracium pilosella* (mouse-ear hawkweed).

Narrow-leaved snow tussock grassland (F) occurs on drier areas of the ridge crest. It is characterised above 30cm by the native grass *Chionochloa rigida* with less of *Festuca novae-zelandiae*. The tussock cover varies in density, being at its lowest and generally short in stature around rock tors where stock have camped. The herb layer includes the native woody sub-shrubs *Leucopogon fraseri* (dwarf heath) and *Pimelea pseudolyallii*, and the herbs *Anisotome aromatica*, *Gonocarpus micranthus*, *Raoulia subsericea* (mat daisy) and *Helichrysum filicaule* (slender everlasting daisy). The two most dominant exotics are the grass *Agrostis capillaris* and the herb *Hieracium pilosella*.

The threatened herb *Gratiola nana* (Cameron *et al.*, 1995) is present here in the low turf ephemeral tarn, one of only 23 known locations throughout the South Island (Johnson, 1993a). Three species were identified as occurring only within this RAP - *Elatine gratioloides* and *Glossostigma* sp. in medium turf ephemeral tarns, and *Poa maniototo* in narrow-leaved snow tussock grassland.

Fauna

Grey duck (*Anas superciliosa superciliosa*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), paradise shelduck (*Tadorna variegata*), grey teal (*Anas gibberifrons gracilis*), black swan (*Cygnus atratus*), New Zealand shoveler (*Anas rhynchotis variegata*), spur-winged plover (*Vanellus miles novaehollandiae*), South Island pied oyster catcher (*Haematopus ostralegus finschi*) and New Zealand falcon (*Falco novaeseelandiae*) have all been observed in the area (Mr. G. Loh, pers. comm. 1997). The presence of such a diverse and relatively abundant water fowl fauna can be seen as a reflection of habitat availability. The large pool was the only natural pool in the district observed to have water present throughout the summer of the survey.

Rock tors also provide habitat for lizards, with small populations of both the grand (*Oligosoma grande*) and Otago (*Oligosoma ottagense*) skink being present together with more extensive populations of the Green skink (*Oligosoma chloronoton*) and McCann's skink (*Oligosoma maccanni*) (Mr. G. Loh, pers. comm. 1997).

Information on the invertebrate fauna has been provided by Mr B. Patrick (pers. comm. 1997). The insect fauna of the wetlands are distinctive and of local occurrence in Otago. The native sedge *Carex secta* supports a range of at least six moths, including the rare *Sagephora exsanguis*, plus large weevil and shield bugs such as *Rhopalimorpha lineolaris*. Other smaller *Carex* and *Juncus* species also support a wide range of insects and spiders. The native mosses *Sphagnum cristatum* and *S. falcatulum* are home to a large biennial moth *Haloxycanus patricki*, whose larvae feed on the mosses from within by means of tunnels below the water-table. Also feeding within the *Sphagnum* species is the larvae of the giant dragonfly *Uropetala chiltoni*, a long-lived and primitive species.

Discussion

Within the Nenthorn Ridge RAP, the range of different wetland types, the high diversity of insects and the presence of the threatened herb *Gratiola nana* give the RAP its high conservation value. Johnson (1993b) says in a botanical report about the wetlands that their diversity, representativeness and naturalness warrant their protection and conservation.

The main threats at present to the long-term viability of these wetlands are damage through stock trampling, particularly by cattle, plus nutrient enrichment. The exotic species in the wetlands should not pose a threat to the diversity and abundance of indigenous species at present or in the long term (Johnson, 1993a). With regard to the narrow-leaved snow tussock grassland, removal of grazing and cessation of burning would probably result in an increase in both the stature and cover of tussock in the long term.

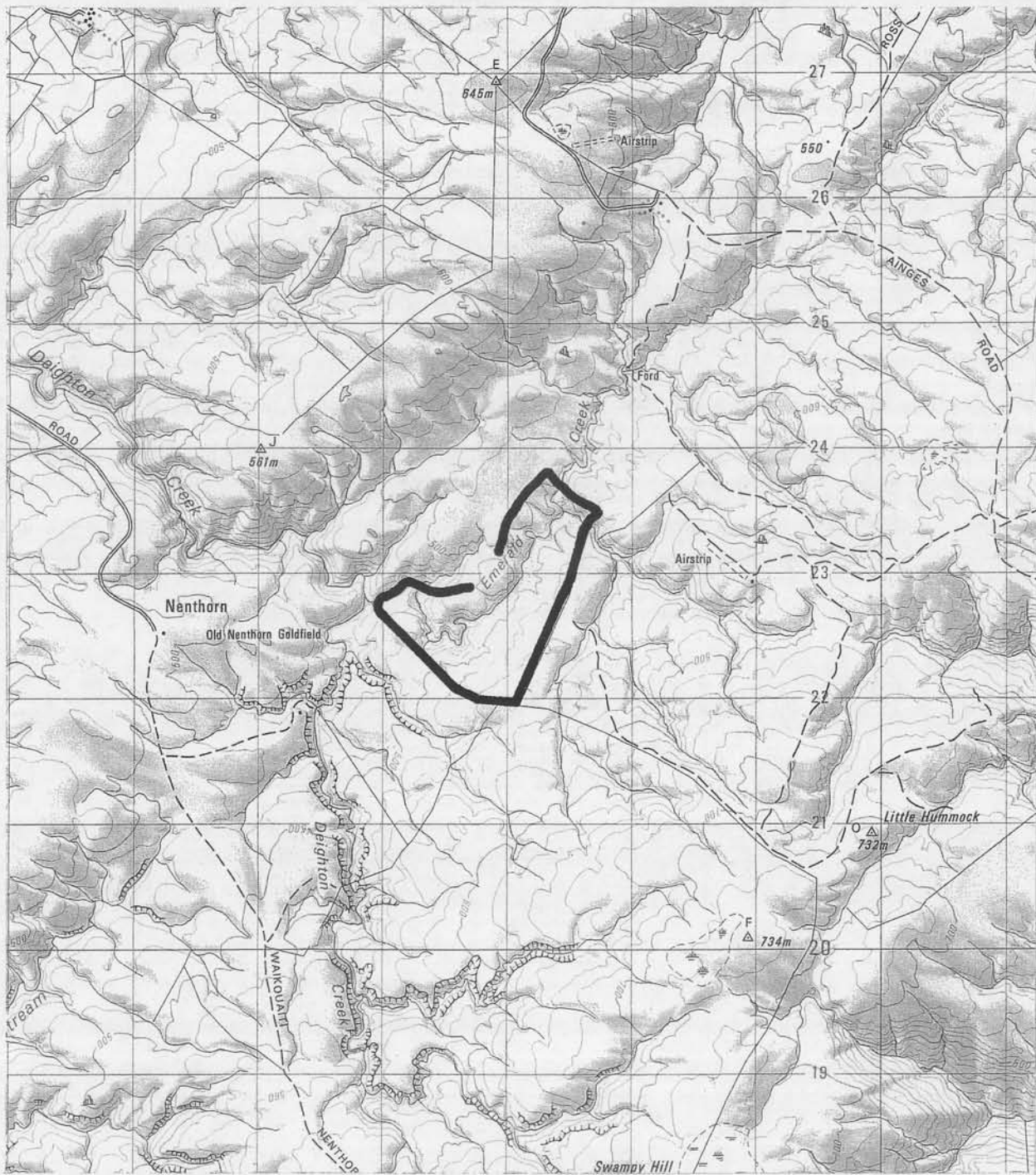
Four vegetation types were identified by Johnson (1993b) that were not recognised elsewhere within this survey. He recognised two other vegetation types associated with the purei wetland (identified from this survey), the first vegetation type 'Pools', with the native aquatic species *Myriophyllum propinquum*, *Glyceria declinata* (glaucous sweetgrass), *Alopecurus geniculatus*, *Juncus articulatus* and *Ranunculus glabrifolius*, and the second

'Sphagnum bog' with the mosses *Sphagnum cristatum* and *S. falcatulum*, together with the sedge *Carex gaudichaudiana*. The third vegetation type 'Dryland turf', occurring on sunny north-facing slopes and close to tors, is dominated by the exotic herb *Hieracium pilosella* with scattered *Chionochloa rigida* and the native herbs *Raoulia subsericea*, *Leptinella serrulata* plus the woody sub-shrub *Leucopogon fraseri*. The last vegetation type Johnson recognised is 'Tors', rocky tors scattered along the ridge crest supporting a variety of localised communities with native ferns, herbs, grasses and shrubs. There is also a high diversity of shrubs present including *Corokia cotoneaster*, *Carmichaelia virgata*, *Cyathodes juniperina*, *Gaultheria antipoda* and *Meliccytus alpinus*.

Selection criteria Macraes RAP 10 : Nentborn Ridge

Representativeness	H	Tussock grassland is representative of the land system; more wetlands than usual.
Diversity	H	The greatest range of wetland vegetation contained within one RAP in the district; high diversity of insects.
Naturalness	M-H	Trampling of wetlands by cattle; presence of exotic species in wetlands; narrow-leaved tussock grassland burnt and grazed.
Special Features	H	Presence of the threatened plant <i>Gratiola nana</i> .
Buffering	M	Ridge crest to the north has been ploughed.
Viability	H	Improved with removal of stock and cessation of burning.
Threat	L	Stock grazing and trampling; burning.
Landforms	M	Typical of the undulating schist ridge crests.

MAP 4.11 : MACRAES RAP 11 - EMERALD CREEK



0 1 2
KILOMETRES

GRID REFERENCE : 143 070227

AREA : 178 ha

ALTITUDE : 440m - 540m

TENURE : Freehold

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MACRAES RAP 11 : EMERALD CREEK

Area	178ha
Grid Reference	I43-070 227
Altitudinal Range	440-540m
Land System	Rolling Hills
Quadrat (community) Groups	D, F and H
Tenure	Freehold
Ecological Units	Copper tussock wetland on gully floor. (<1%) Narrow-leaved snow tussock grassland on ridge crest. (5%) Narrow-leaved snow tussock grassland on side-slopes. (80%) Narrow-leaved snow tussock grassland on toe-slope. (5%) Narrow-leaved snow tussock grassland on gully sides. (5%) Mixed shrubland on toe slope. (1%) Mixed shrubland on lower-slopes. (4%)

Landform and Soil

Emerald Creek RAP occurs within the Rolling Hills land system and follows along a section of Emerald Creek taking in the lower-slopes above the creek. There are extensive rock outcrops and rock tors present. The parent material is Haast schist, chlorite subzone IV (Mutch. 1963) over which a Wehenga upland and high country yellow brown earth lies (N. Z. Soil Bureau, 1968).

Vegetation and Flora

Mixed shrubland (H) occurs in a small area of the toe-slope, extending up in to the lower-slopes. *Leptospermum scoparium* (manuka) accounts for 75% of the canopy cover, with the native shrubs *Coprosma propinqua* (mingimingi), *C. cheesemanii* (sprawling coprosma), *Corokia cotoneaster*, *Olearia bullata* and *Carmichaelia virgata* plus the native scramblers *Muehlenbeckia complexa* and *Rubus schmidelioides* being present in low numbers. *Chionochloa rigida* (narrow-leaved snow tussock) also occurs in the canopy, however the tussocks showed signs of dieback, with many dead individuals being noted. Common sub-dominant species in the herb layer include the native grass *Poa colensoi* (blue tussock), the fern *Asplenium flabellifolium* (necklace fern), the herbs *Lagenifera strangulata*, *Cardamine corymbosa* (native bittercress) and *Oxalis exilis* (yellow oxalis). Several seedlings of the various shrub species were recorded, *L. scoparium* being the most abundant.

Narrow-leaved snow tussock grassland (F) also occurs on a similar landform to the mixed shrubland, extending up the side-slopes and on to ridge crests.

Composition of the grassland varies, and of particular note is the grassland occurring on the toe-slope. On steep (35°) rocky toe-slopes the narrow-leaved snow tussock grassland canopy is characterised by a mixture of *Chionochloa rigida*, the herbs *Phormium cookianum* (mountain flax), *Aciphylla aurea* (golden spaniard) and *Astelia nervosa*, the shrubs *Carmichaelia virgata*, *Olearia bullata* and *Dracophyllum uniflorum* (turpentine shrub), plus the ferns *Polystichum vestitum* (prickly shield fern) and *Blechnum procerum* (small kiokio). The area is very diverse, with over 60 species being recorded in one plot. Common sub-dominant species in the herb layer include the club moss *Lycopodium fastigiatum*, the ferns *Hypolepis millefolium* (thousand-leaved fern) and *Blechnum penna-marina*, plus the grass *Poa colensoi* and the woody sub-shrub *Gaultheria macrostigma* (pink snowberry) and several herbs; *Anisotome aromatica* (common anisotome), *Wahlenbergia albomarginata* (NZ bluebell), *Celmisia gracilentia* (dainty daisy) and *Helichrysum filicaule* (slender everlasting daisy).

On areas more accessible to stock, the lower-slopes, ridge crests and gently sloping toe-slopes, the canopy of narrow-leaved snow tussock grassland is dominated by *Chionochloa rigida*, with *Festuca novae-zelandiae* (hard tussock) and the shrubs *Discaria toumatou* (matagouri) and *Dracophyllum uniflorum* also present. Total canopy cover ranges from 20% to 60%, reflecting varying states of degradation. The herb layer, particularly on the gently sloping west-facing slopes, can include *Hieracium pilosella* (mouse-ear hawkweed) present with values above 50% (the lowest being <5%). Distinctive native herb layer species include the woody sub-shrubs *Pentachondra pumila* (little mountain heath), *Kelleria laxa* and *Leucopogon fraseri* (dwarf heath), the grasses *Poa colensoi* (blue tussock), *Lachnagrostis lyallii* (tumble grass) and *Deyeuxia avenoides* (mountain oat grass), the herbs *Gentiana bellidifolia* (small snow gentian), *Anisotome aromatica*, *Celmisia gracilentia* and *Bulbinella angustifolia* (Maori onion), the orchid *Thelymitra longifolia* (white sun orchid) together with the ferns *Ophioglossum coriaceum* (adder's tongue) and *Blechnum penna-marina*. Exotic species are also prominent in the herb layer, including the grasses *Anthoxanthum odoratum* (sweet vernal) and *Agrostis capillaris* (brown top) plus the herbs *Hypochoeris radicata* (catsear) and *Trifolium repens* (white clover).

On the western side of the catchment, on a gully floor cut into the ridge top, there is a copper tussock wetland (D). The canopy is dominated by the exotic rush *Juncus effusus* (soft rush) and the native sedge *Schoenus pauciflorus* (bog rush). Other common sub-dominant natives include the sedge *Carex geminata* (cutty grass) and rush *Elaeocharis acuta* (spike rush) plus the exotic *C. ovalis* (oval sedge). In the herb layer, sub-dominant species include the sedges *Carex geminata* and *C. ovalis*, which are again prominent, along with the native herbs *Celmisia graminifolia* (bog daisy), *Pratia angulata* and *Ranunculus glabrifolius* plus the sedges *Carex sinclairii* and *Uncinia rubra cuprea*. The grass *Holcus lanatus* (Yorkshire fog), the herbs *Hypochoeris radicata* and *Stellaria alsine* (bog stitchwort) together with the rush *Juncus articulatus* (jointed rush) are prominent herb layer exotics.

The shrub *Corallospartium crassicaule* and the club moss *Lycopodium varium*, found in narrow-leaved tussock grassland on the toe-slope and lower-slope, the fern *Botrychium australe* and the grass *Deyeuxia aucklandica*,

present in narrow-leaved snow tussock grassland on upper-slope, plus the herb *Crassula peduncularis* in the copper tussock wetland, are five species occurring in the Emerald Creek RAP of limited distribution within the district. The threatened grass *Simplicia laxa* (Cameron et al., 1995) is also found within this RAP, occurring under rock overhangs which are themselves surrounded by narrow-leaved snow tussock grassland. The presence of *S. laxa* has been documented by Johnson (1993), who assessed the field status, ecology and conservation of the species.

Fauna

Populations of both the threatened grand skink (*Oligosoma grande*) and Otago skink (*Oligosoma otagense*) are present within the RAP (G. Loh, pers. comm. 1995). However, the largest populations are present further up the catchment in the headwaters of Emerald Creek beyond the RAP (Towns et al., 1984). Emerald Creek RAP falls within an area encompassing 1500ha identified by Whitaker and Loh (1995) as being the most important key site for grand and Otago skink conservation. Seven species of lizard have been recorded in this area, the grand skink, Otago skink, green skink (*Oligosoma chloronoton*), McCann's skink (*Oligosoma maccanni*), cryptic skink (*Oligosoma inconspicuum*) and 'Eastern' Otago gecko (*Hoplodactylus* n.sp.aff. *maculatus*).

New Zealand falcon (*Falco novaeseelandiae*) roosts have been observed within the area (G. Loh, pers. comm. 1997)

Information on the invertebrate fauna has been provided by B. Patrick (pers. comm. 1997). Grasslands, wetland with the native rush *Schoenus pauciflorus* and the shrubland of this RAP are important habitats for a variety of native invertebrates. Grasshoppers in the genus *Siga*, particularly *S. campestris* and *S. australis*, are abundant together with the diurnal moths *Tauroscopa trapezitis* and *Pasiphila* n.sp. in the copper tussock wetland. Emerald Stream itself is important for aquatic invertebrates with two new species of diurnal black caddis, *Zelolessica cheira* and *Z. meizon*, a rare occurrence.

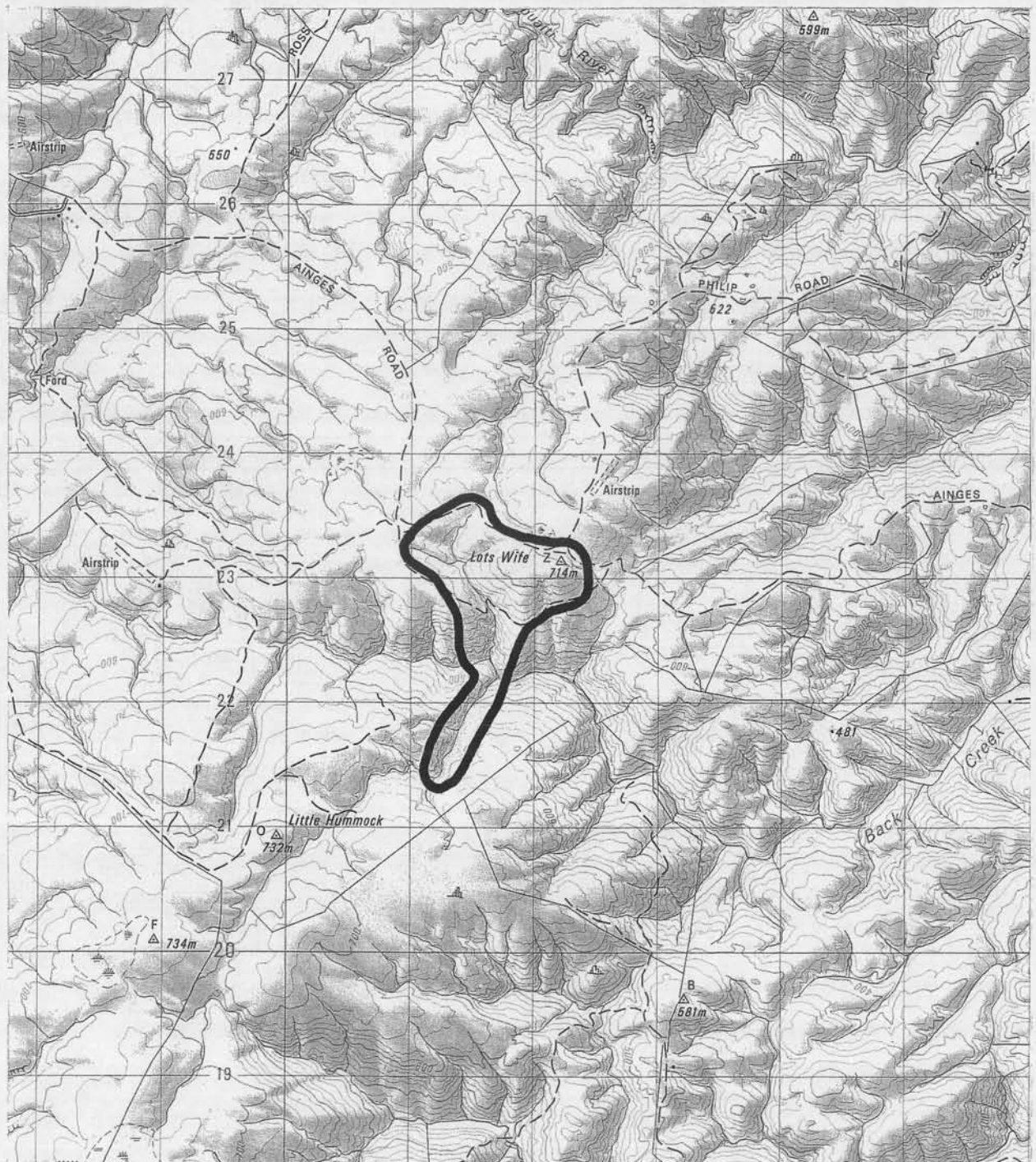
Discussion

The threatened grass *Simplicia laxa* (classified as endangered) is known only from three sites - on the Old Man Range in Central Otago, near Ngapara in North Otago, and near Nenthorn (Johnson, 1993b). Both Nenthorn populations identified in Johnson's report occur within the Emerald Creek RAP, these being at I43/065255 and I43/067225 (Johnson, 1993b). As well as endangered plants, the Emerald Creek RAP contains populations of two endangered skinks, the grand and Otago skinks. It is the combination of these endangered species that gives Emerald Creek its particularly high conservation value.

Selection criteria Macraes RAP 11 : Emerald Creek

Representativeness	M	Representative of the vegetation of the Rolling Hills land system.
Diversity	M	An average range of non-forest vegetation.
Naturalness	L	Most of the tussock grassland has been degraded.
Special Features	H	Populations of the endangered grass <i>Simplicia laxa</i> and the endangered grand and Otago skinks.
Buffering	M	Some of the vegetation to the west of the RAP has been ploughed.
Viability	M	Relatively small size.
Threat	H	Grazing by stock and burning plus oversowing.
Landforms	M	A relatively low diversity of landforms

MAP 4.12 : MACRAES RAP 12 - LOTS WIFE



0 1 2
KILOMETRES

GRID REFERENCE : I43 114228

AREA : 160 ha

ALTITUDE : 440m - 714m

TENURE : Freehold

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MACRAES RAP 12 : LOTS WIFE

Area	160ha
Grid Reference	I43-114 228
Altitudinal Range	440-714m
Land System	Dissected Steeplands
Quadrat (community) Groups	D, E, F and K
Tenure	Freehold
Ecological Units	Dry tussock-shrubland on rock outcrop. (1%) Copper tussock wetlands on gully floor. (3%) Purei wetlands on gully floor. (3%) Moist tussock-shrubland in gully on lower-slopes. (2%) Narrow-leaved snow tussock grassland on side-slopes. (70%) Narrow-leaved snow tussock grassland on ridge crests. (15%) Narrow-leaved snow tussock grassland on hilltop. (10%) Broadleaf-Pseudopanax forest on toe- slope. (2%) Broadleaf-Pseudopanax forest in gully. (4%)

Landform and Soil

Lots Wife RAP occurs within the Dissected Steeplands land system. The crest of Lots Wife consists of numerous large rock outcrops, which become infrequent as one moves down slope. The steep side-slopes (20°+) of the incised valley are characteristic of the Dissected Steeplands land system.

The distribution of forest on the foot slope and in the gully are more likely to be the result of previous management than a natural landform-vegetation association, with the landforms providing the forest with a refuge against fire. The occurrence of purei wetlands and copper tussock wetlands on gully floors is a vegetation-landform association typical of the District.

Wehenga upland and high country yellow-brown earth is the only soil present (N. Z. Soil Bureau, 1968). Geologically the RAP consists predominantly of Haast schist chlorite sub-zone IV, with a quartz reef containing gold (McKellar, 1966). The area has previously been the centre of some mining activity (the remains of the Bonanza Mine are still visible).

Vegetation and Flora

Occupying a narrow strip on the lower-slopes, toe-slopes and extending up the gully to the south of Lots wife is Broadleaf-Pseudopanax forest (K). Its canopy is of mixed age, averaging around 5m tall but being highly variable. It is dominated by *Griselinia littoralis* (broadleaf), with scattered *Cordyline australis* (cabbage tree) and *Pseudopanax colensoi* (three finger). Within the shrub layer *Coprosma parviflora*, *C. propinqua* (mingimingi), *C. rugosa* (needle-leaved coprosma), *Hebe rakaiensis* and *H. salicifolia* are present, the two Hebe species being more prominent near the stream sides. Within the herb layer ferns are most abundant, notably *Blechnum procerum* (small kiokio), *B. sp.2* (mountain kiokio), *Phymatosorus diversifolius* (hounds tongue) and *Polystichum vestitum* (prickly shield fern). Common herbs include *Astelia fragrans*, *Cardamine corymbosa* and *Libertia ixioides* (native iris). In lighter areas, the exotic grasses such as *Anthoxanthum odoratum* (sweet vernal), *Dactylis glomerata* (cocksfoot) and the herbs *Hieracium lepidulum* (tussock hawkweed), *Hypochoeris radicata* (catsear) and *Trifolium repens* (white clover) are usually present.

Further up slope into the lower gully, Moist tussock-shrubland is present. Here the native grass *Chionochloa rigida* (narrow-leaved snow tussock) and herb *Phormium cookianum* (mountain flax) are the canopy dominants, with the native shrubs *Coprosma propinqua*, *C. rugosa* and the scrambler *Fuchsia perscandens* being less abundant. Other prominent native species include the grasses *Festuca novae-zelandiae* (hard tussock) and *Poa colensoi* (blue tussock), the herbs *Aciphylla aurea* (golden spaniard), *A. subflabellata*, *Bulbinella angustifolia* (Maori onion) and *Gunnera monoica* (solitary gunnera), plus the ferns *Blechnum sp.2* and *Polystichum vestitum*.

The predominant vegetation of the Lots Wife RAP is narrow-leaved snow tussock grassland, covering approximately 85% of the RAP. It extends from the lower-slope up on to the hill top. Composition of the grassland varies greatly. In areas, such as the north-facing upper slopes, the grassland is degraded, with the cover of *Chionochloa rigida* being as low as 10% in the canopy, with the mean height around 40cm and a maximum height of 60cm. *Hieracium pilosella* (mouse-ear hawkweed) reaches 30% cover in the herb layer. However, these areas still have a high diversity of native plants, including the grass *Poa colensoi* (blue tussock), the woody sub-shrub *Pentachondra pumila* (little mountain heath), and the herbs *Celmisia gracilentia* (mountain daisy), *Luzula rufa* (red woodrush), *Stackhousia minima* and *Wahlenbergia albomarginata* (N. Z. bluebell). Areas that are in better condition, such as the steep south-facing slopes, have a canopy cover of *C. rigida* greater than 75%, being on average 50cm high and reaching a maximum of 1m. Composition of the herb layer is slightly different here, with herbs more characteristic of wetter areas. These include *Euphrasia zelandica* (small eyebright), *Forstera tenella*, *Herpolirion novae-zelandiae* (grass lily) and *Oreostylidium subulatum*. On rocky areas above the stream, shrubs become increasingly prominent, with *Coprosma cheesemanii* (sprawling coprosma), *C. cuneata*, *Olearia bullata* and *O. virgata* (twiggy tree daisy) usually present.

Copper tussock wetland (D) occurs on a gently sloping (3°) gully floor on the western side of Lots Wife. The canopy is dominated by exotic rush *Juncus effusus* and the native grass *Chionochloa rubra cuprea* (copper tussock). Other

common natives in the herb layer include the grass *Hierochloa redolens* (holy grass), the rush *Schoenus pauciflorus* (bog rush), the herb *Bulbinella angustifolia* (Maori onion), plus the sedges *Carex flagellifera* and *C. sinclairii*. The ground layer is dominated by the moss *Sphagnum cristatum*, other sub-dominant natives including the sedge *Oreobolus strictus* and the herbs *Celmisia graminifolia* (bog daisy), *Hypselia rivals* and *Oreostylidium subulatum*.

Across the road, a purei wetland (C) drains into the North Branch of the Waikouaiti River, at the head of a gully. The native sedge *Carex secta* (purei), the rush *Juncus gregiflorus* and the shrub *Hebe odora* are the most prominent native canopy species. The herb layer is dominated by the native moss *Sphagnum cristatum*; other indigenous species include the fern *Blechnum penna-marina*, the sedge *Carex coriacea*, the rush *Elaeocharis gracilis* and the herbs *Gunnera prorepens*, *Nertera balfouriana* (dense nertera), *Pratia angulata* and *Ranunculus glabrifolius*.

The summit of Lots Wife consists of extensive rock outcrops. *Dracophyllum uniflorum* (turpentine shrub) is the most common shrub. Other shrub species here include, *Cassinia leptophylla* (cottonwood), *Coprosma pseudocuneata*, *C. cheesemanii* (sprawling coprosma), *Gaultheria antipoda* (fool's beech), *Halocarpus bidwillii* (bog pine) and *Phyllocladus alpinus* (mountain celery pine). The club moss *Lycopodium varium* and the daisy *Celmisia hookeri* are also present.

Eight species of limited distribution within the district occur here: *Halocarpus bidwillii* is present both here and in the Redbank RAP while *Phyllocladus alpinus* and *Coprosma pseudocuneata* occur only in the rock outcrops on the summit of Lots Wife. Both *C. cuneata* and *Olearia virgata* occur in the narrow-leaved snow tussock grassland, while in the Broadleaf-Pseudopanax forest there is *Uncinia uncinata*, *Pseudopanax colensoi* and *Acaena fissistipula*. *Mazus radicans* occurs in the moist tussock-shrubland. In addition to these eight species the local plant *Celmisia hookeri* (Cameron et al., 1995) is also present.

Fauna

The common skink (*Oligosoma nigriplantare polychroma*) was sighted in narrow-leaved snow tussock grassland. South Island fantail (*Rhipidura fuliginosa penitus*), tomtit (*Petroica macrocephala*) and bellbird (*Anthornis melanura*) were seen in the forest.

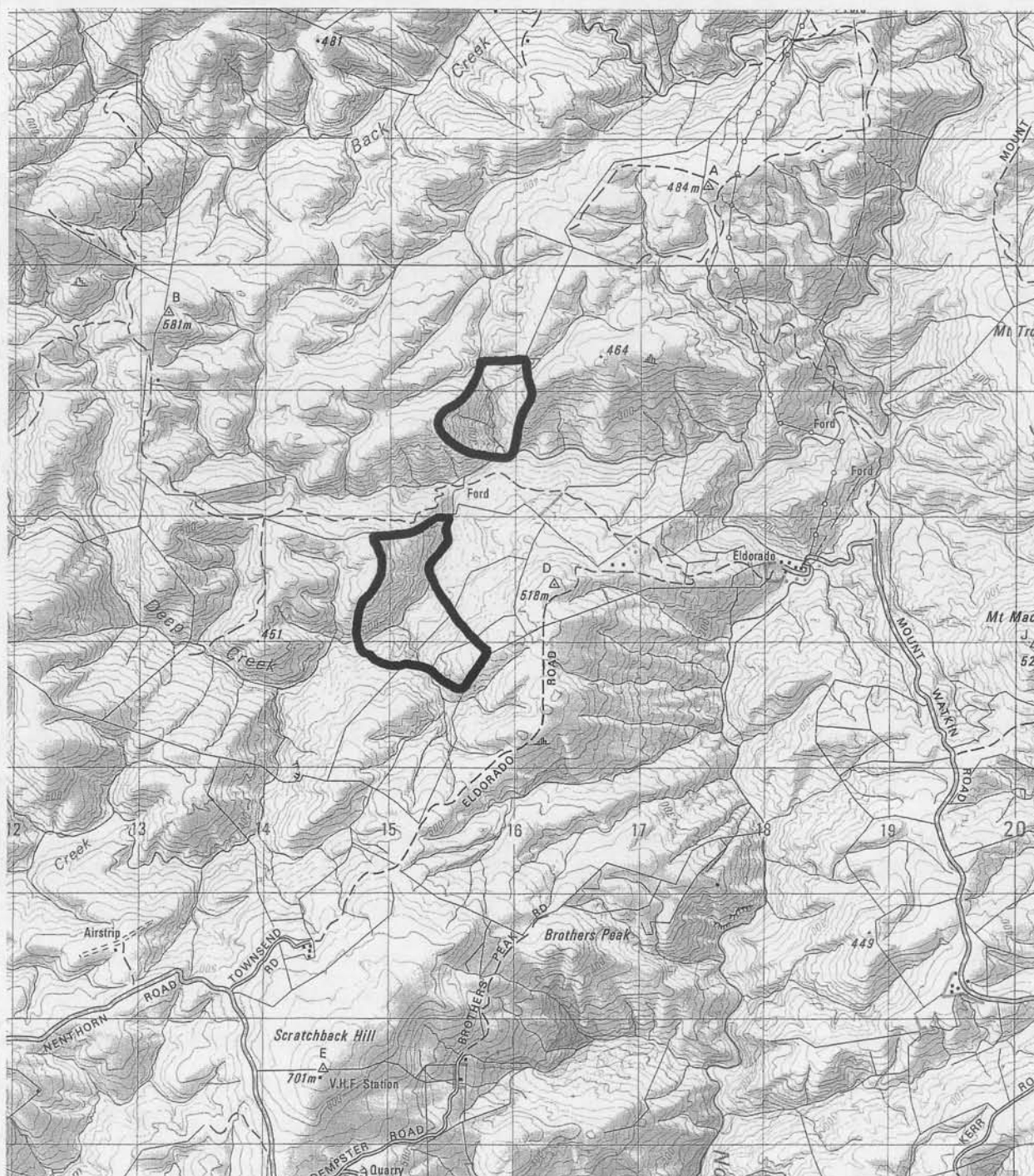
Discussion

Although the total area of forest is small, this RAP contains the most extensive example of broadleaf-pseudopanax forest in the ecological district. Vegetation on the rocky outcrops of the summit of Lots Wife is among the most extensive and natural in the district. These features, combined with the only occurrence of several species within the district, give the RAP its high conservation value. A large proportion of the narrow-leaved tussock grassland is in poor condition, although the low tussock cover is more a reflection of reduced stature and not low abundance. It is likely that over time the density of tussock cover would increase, providing conditions more suitable for native herb layer species which are presently of low abundance.

Selection criteria Macraes RAP 12 : Lots Wife

Representativeness	H	The most extensive example of broadleaf-pseudopanax forest; a representative example of narrow-leaved snow tussock grassland in the Dissected Steeplands land system.
Diversity	H	A good diversity of both species and vegetation.
Naturalness	M	The tussock grassland has been modified; a high occurrence of <i>Hieracium pilosella</i> on north-facing slopes. A stock watering hole has been created in the head of the main gully. Bulldozed roads are a prominent feature.
Special Features	H	The occurrence of several species of limited distribution within the district. The local species <i>Celmisia bookeri</i> , is present.
Buffering	M	Area relatively small; surrounding vegetation is relatively natural.
Viability	M-H	Forest strip is small.
Threat	M	Continued grazing and burning; introduction of exotic species through aerial oversowing.
Landforms	M	Extensive rock outcrops on Lots Wife summit.

MAP 4.13 : MACRAES RAP 13 - DEEP CREEK



0 1 2
KILOMETRES

GRID REFERENCE : I43 155180

AREA : 156 ha

ALTITUDE : 180m - 460m

TENURE : Freehold

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MACRAES RAP 13 : DEEP CREEK

Area	156ha
Grid Reference	I43-155 180
Altitudinal Range	180-460
Land System	Dissected Steeplands
Quadrat (community) Groups	E, H, I, J and L
Tenure	Freehold
Ecological Units	Moist tussock-shrubland on upper-slope with scattered rock outcrops. (3%) Mixed shrubland on upper-slope. (2%) Dry tussock-shrubland on rock bluff. (5%) Mixed broadleaved forest on lower-slopes. (20%) Mixed broadleaved forest on toe-slope. (10%) Kanuka woodland on lower-slopes. (8%). Kanuka woodland on toe-slope. (2%) Modified narrow-leaved snow tussock grassland on upper-slopes. (50%).

Landform and Soil

The steep rocky hill slopes of the Deep Creek RAP are characteristic of the Dissected Steeplands land system. Extensive rocky outcrops occur on the hill slopes, with a large rock bluff in the northern part of the RAP. Geologically the RAP consists solely of Haast schist, chlorite sub-zone IV (McKellar, 1966) with the soil being Wehenga upland and high country yellow-brown earth (N. Z. Soil Bureau, 1968).

The association between vegetation and landform is most likely the result of previous management, with forest on the lower-slopes and toe-slope being a result of clearing the upper slopes for pastoral farming.

Vegetation and Flora

Mixed broadleaved forest (L) occurs on the toe-slopes and lower-slopes of both the northern and southern sections of the RAP. The native trees *Carpodetus serratus* (marbleleaf), *Griselinia littoralis* (broadleaf) and *Pittosporum tenuifolium* (kohuhu) dominate the canopy, with average height being around 7m and reaching 9m. The canopy itself is composed of mixed aged trees with many areas of windthrow. Other native canopy species of lower abundance include *Aristotelia serrata* (Wineberry), *Pseudopanax crassifolium* (lancewood) and *Pseudopanax simplex*. In the shrub layer *Coprosma ciliata*, *C. propinqua* (mingimingi), *Helicbrysum lanceolatum* and *Myrsine divaricata* (weeping mapou) are the most abundant native species, however overall the

shrub layer is relatively sparse. The native ferns *Asplenium terrestre*, *Blechnum procerum* (small kiokio), *Phymatosorus diversifolius* (hounds tongue) and *Polystichum richardii* (common shield fern) and the native herbaceous species *Arthropodium candidum* (star lily), *Lagenifera strangulata*, *Scandia geniculata* and *Schizeilema trifoliolatum* are characteristic of the herb layer which covers around 30% of the ground. About 50% of the ground is bare.

Kanuka woodland (J) also occurs on a similar landform in the southern section of Deep Creek RAP. This stand is even-aged, with a closed canopy about 6m high on average, but locally attaining 7m. *Kunzea ericoides* (kanuka) dominates the canopy, with a few individuals of *Cordyline australis* (cabbage tree) and *Pittosporum tenuifolium* also occurring. Diversity within the shrub layer is low with *Coprosma ciliata*, *C. propinqua* and *Helicbrysum lanceolatum* being the only species present. Prominent species within the herb layer include the native ferns *Polystichum vestitum* (prickly shield fern) and *Asplenium flabellifolium* (necklace fern), along with the native herbs *Acaena novae-zelandiae* (red bidibid), *Hydrocotyle novae-zeelandiae*, *Lagenifera strangulata* and *Oxalis exilis* (yellow oxalis). Many of these native herbs are more characteristic of open vegetation and this, together with the absence of regenerating *Kunzea ericoides*, indicate the kanuka woodland is successional. Seedlings of the native trees *Griselinia*, *Pittosporum tenuifolium*, *Pseudopanax crassifolium* and *Sophora microphylla* (kowhai) suggest eventual replacement of the *Kunzea ericoides* canopy with broadleaved tree species.

Mixed shrubland vegetation (H) occurs upstream of the kanuka woodland. The shrubs present here are *Carmichaelia virgata*, *Coprosma propinqua*, *C. rugosa* (needle-leaved coprosma) and *Leptospermum scoparium* (manuka). These species mainly occur within the canopy with an average height of 1.6m. However, the most common species in this layer is the native fern *Polystichum vestitum* which accounts for half of the total cover of 70%. The herbs *Acaena anserinifolia*, *Hydrocotyle moschata* and *Oreomyrrhis ramosa* are the most abundant natives in the herb layer, although it is the exotic grasses *Agrostis capillaris* (brown top), *Anthoxanthum odoratum* (sweet vernal), *Dactylis glomerata* (cocksfoot) and *Holcus lanatus* (Yorkshire fog) which dominate this layer.

In the northern section of the RAP, the final two vegetation types occur on the west facing upper-slopes above the Mixed broadleaved forest. Dry tussock-shrubland (I) occurs here on a rocky bluff system. *Chionochloa rigida* (narrow-leaved snow tussock) dominates the canopy, with notable sub-dominant species being *Aciphylla aurea* (golden spaniard) and *Pteridium esculentum* (bracken). The native shrubs *Carmichaelia virgata*, *Coprosma crassifolia*, *C. propinqua*, *C. cf. parviflora*, *Gaultheria antipoda* (fool's beech), *Helicbrysum lanceolatum* and *Olearia bullata* are of minor importance. The herb layer contains the native ferns *Asplenium richardii*, *Blechnum vulcanicum*, *B. procerum* and *Phymatosorus diversifolius*, the grasses *Poa colensoi* (blue tussock) and *Rytidosperma gracilis* as well as several herbaceous species: *Brachyglottis bellidioides*, *Gingidia montana* (mountain anise), *Helicbrysum filicaule* (slender everlasting daisy) and *Luzula banksii*, and some scramblers: *Fuchsia perscandens* and *Clematis marata*. Exotic species are common in the herb layer including the grasses *Anthoxanthum odoratum* and *Dactylis*

glomerata, and the herbs *Hieracium pilosella* (mouse-ear hawkweed), *Hypochoeris radicata* (catsear) and *Trifolium repens* (white clover).

The moist tussock-shrubland (E) occurs in the same general area as the previous type, but on slopes of a more moderate angle (8-10° as compared to 20°+) and with only scattered rock outcrops. The canopy is dominated by a mix of the native grasses *Chionochloa rigida*, *Festuca novae-zelandiae* (hard tussock) and *Poa cita* (silver tussock), the ferns *Polystichum vestitum* and *Pteridium esculentum*, and the shrubs *Carmichaelia virescens*, *Coprosma cheesemanii* (sprawling coprosma), *C. rigida*, *C. rugosa*, *C. propinqua*, *Discaria toumatou* (matagouri) and *Melicactus alpinus* (porcupine shrub). Exotic species are a prominent feature of the herb layer, with the grasses *Agrostis capillaris*, *Anthoxanthum odoratum*, *Dactylis glomerata* and the herbs *Cerastium fontanum* (mouse-ear chickweed) and *Trifolium repens* contributing up to half the cover. Native species in the herb layer include the grasses *Elymus solandri* (blue wheat grass) and *Rytidosperma gracilis* plus the herbs *Bulbinella angustifolia* (maori onion), *Helicbrysum bellidioides* (everlasting daisy), *H. filicaule*, and *Oreomyrrhis ramosa*.

Modified narrow-leaved snow tussock grassland occurs on the upper-slopes in both sections of the RAP. It is dominated by exotic grasses and herbs in the herb layer, with scattered individuals of the native grasses *Chionochloa rigida* and *Festuca novae-zelandiae* plus the shrub *Discaria toumatou*. In some areas there are extensive patches of the native fern *Pteridium esculentum* dominating the canopy layer.

Eleven species of limited distribution are found within the Deep Creek RAP. The Broadleaf forest contains the shrubs *Aristotelia serrata*, *Coprosma areolata* (thin-leaved coprosma) and *Myrsine divaricata*, the climber *Calystegia tuguriorum* (New Zealand convolvulus), the grass *Microlaena avenacea* (bush rice grass) and the sedge *Carex forsteri*. In the dry tussock-shrubland the herbs include *Gingidia montana* (mountain anise) and *Senecio dunedinensis* (fireweed). *Sophora microphylla* (kowhai) was found in both kanuka and broadleaf forests. Finally the sedge *Oreobolus impar* is a component of the Moist tussock-shrubland.

Fauna

Many bird calls were heard within forest vegetation, but only bellbird (*Anthornis melanura*) were seen.

Discussion

The Deep Creek RAP contains the only example of mixed broadleaved forest identified within the district along with a diverse range of shrubland types. This factor, combined with the numerous plant species identified as being of limited distribution within the ecological district, gives the RAP its high conservation value.

Of particular concern is damage to the forest stands through browsing, particularly by goats. As has been noted in the vegetation description, the understorey of both types of forest is sparse. While this may in part be associated with succession in the kanuka woodland, the obvious signs of browsing suggest otherwise in the mixed broadleaved forest where the scarcity

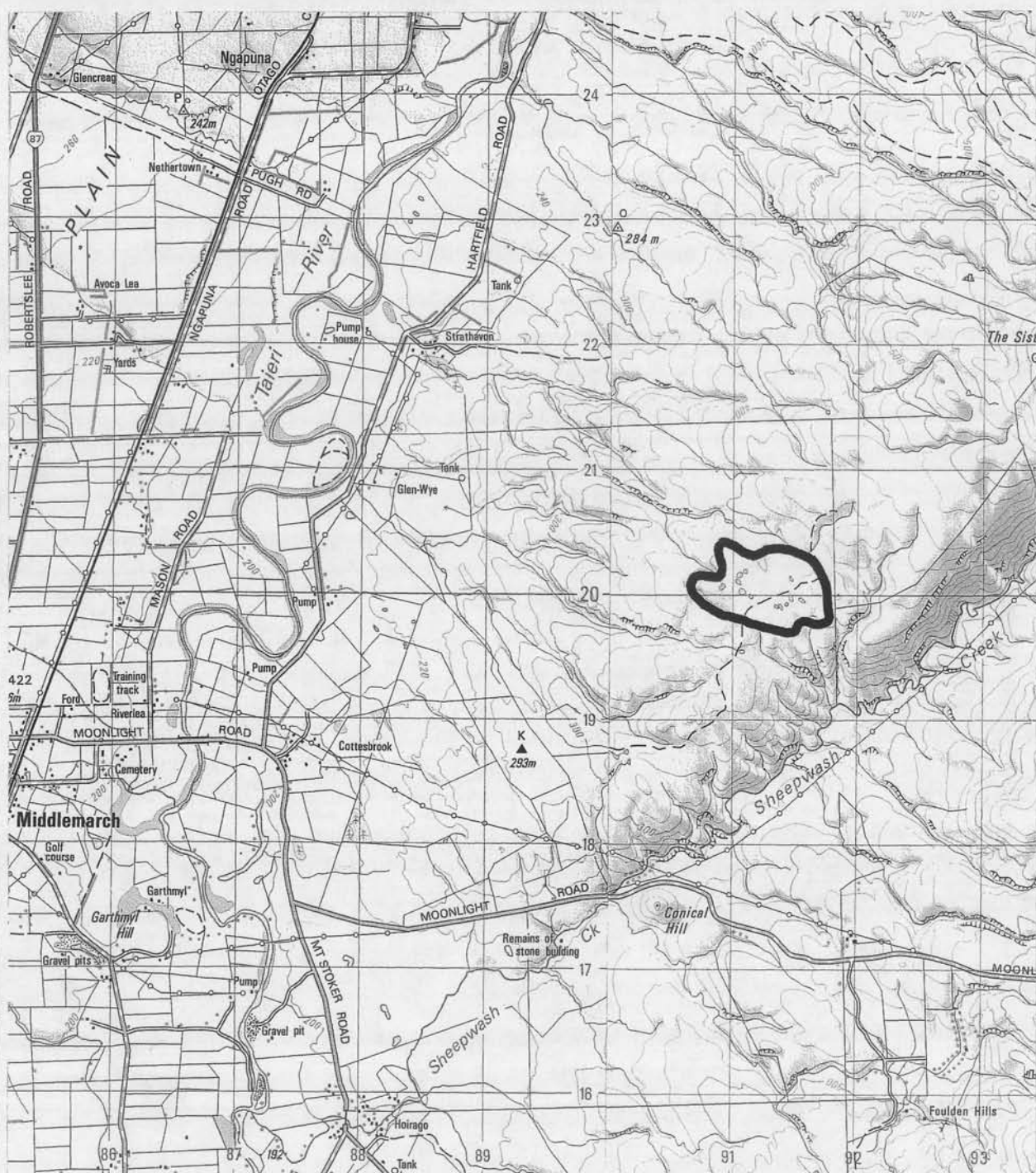
of seedlings brings into question the long-term viability of this forest. In the long term, the composition of the kanuka woodland and the various shrubland communities may change with the invasion of broadleaved species, as is suggested by the range of broadleaved seedlings present in these vegetation types.

Although there is little natural value at present in the modified snow-tussock grassland on the upper slopes of the RAP, the presence of extensive patches of bracken fern indicate a potential for regeneration. The long-term view to provide for the extension of the forest and shrublands is the justification for including these areas in the RAP.

Selection criteria Macraes RAP 13 : Deep Creek

Representativeness	H	The only example of Mixed broadleaved forest within the ecological district. It is probably representative of the vegetation in the Dissected Hills land system in pre-European times.
Diversity	H	A range of shrubland types, along with forest vegetation.
Naturalness	M	Many exotics in the herb layer of the shrubland vegetation.
Special Features	M	The presence of many indigenous species of limited distribution within the district.
Buffering	L	The forest and shrublands are small, surrounding vegetation is highly modified.
Viability	M	Relatively small forest stand; low catchment integrity.
Threat	H	Browsing animals. particularly goats
Landforms	M	Representative of the incised valleys of the Dissected Steeplands land system.

MAP 4.14 : MACRAES RAP 14 - GLENWYE



0 1 2
KILOMETRES

GRID REFERENCE : I43 913201

AREA : 70 ha

ALTITUDE : 300m - 320m

TENURE : Freehold

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MACRAES RAP 14 : GLYNWYE

Area	70ha
Grid Reference	I43-913 201
Altitudinal Range	300-320m
Land System	Fault block ridges
Quadrat (community) Groups	B
Tenure	Freehold
Ecological Units	Medium turf ephemeral tarn on broad ridge crest. (10%). Modified narrow-leaved snow tussock grassland on broad ridge crest. (90%)

Landforms and Soil:

The Glynwye RAP contains only one notable landform - a broad ridge crest. It occurs within the Fault Block Ridges land system and is geologically characterised by Haast schist chlorite sub-zone IV (McKellar, 1966) which is associated with a Matarae yellow-grey earth (N. Z. Soil Bureau, 1968).

Vegetation and Flora

The prominent species within the medium turf ephemeral tarns (B) are the exotic grasses *Alopecurus geniculatus* (marsh fox tail) and *Glyceria fluitans* (floating sweet grass), and the rush *Juncus effusus* (soft rush), indicating this ecological unit has been considerably modified. Although there is a high diversity of indigenous species they tend to be at lower abundances. Examples are the rushes *Elaeocharis gracilis* and *Juncus gregiflorus*, and the herbs *Lilaeopsis ruthiana*, *Limosella lineata* and *Myriophyllum propinquum*. Generally the centres of the tarns are the most modified. Most of the indigenous species are found closer to the tarn edge. The very edge of the tarns tend to be invaded by exotic grassland species such as the herbs *Hypochoeris radicata* (catsear) and *Trifolium repens*, plus the grass *Holcus lanatus* (Yorkshire fog). These tarns contain three threatened herbaceous species (Cameron et al., 1995): *Cardamine* "tarn", which is listed as endangered, and *Gratiola nana* and *Myosurus novae-zelandiae*, which are listed as rare. *Pratia perpusilla* was found only at this site. It is considered locally rare within Macraes Ecological District.

The surrounding area is best described as highly modified. Remnant individuals of *Chionochloa rigida* (narrow-leaved snow tussock) suggest that the vegetation was once Narrow-leaved snow tussock grassland. However, it is now characterised by the native grass *Festuca novae-zelandiae* (hard tussock) and the shrub *Discaria toumatou* (matagouri), accompanied by a suite of exotic species including the grasses *Agrostis capillaris* (brown top) and *Anthoxanthum odoratum* (sweet vernal) plus the herb *Hypochoeris radicata* (catsear).

Fauna

Only two species were observed. Paradise shelduck (*Tadorna variegata*) was seen nearby and a common skink (*Oligosoma nigriplantare polychroma*) was seen within the RAP. Many insects were seen but could not be identified.

Discussion

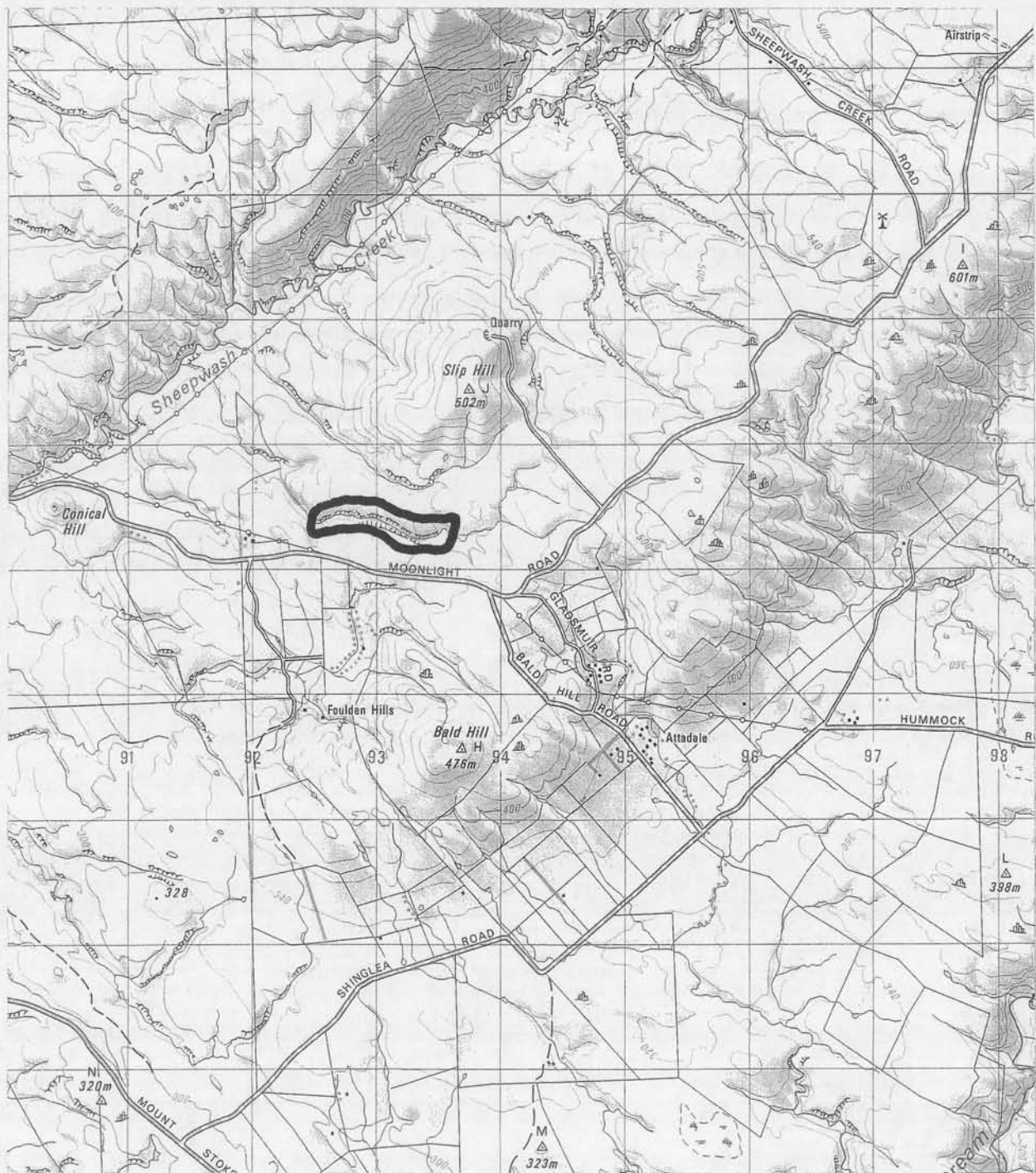
This RAP contains the most extensive system of ephemeral tarns on the Fault Block Ridges land system. Although modified, they are among the most natural examples of this vegetation type within Macraes Ecological District. Four of the six sample sites identified as 'medium turf ephemeral tarns' (group B) are represented here. The presence of a suite of threatened plants adds considerably to the conservation value of this RAP.

A considerable amount of visible damage to the tarns comes from animal trampling. Their use as watering holes dramatically increases the trampling effects. The main effect of animal trampling is mechanical damage to plants, which leads to some mortality and the development of extensive bare patches of bare ground. The presence of stock can also lead to nutrient enrichment.

Selection criteria Macraes RAP 14 : Glenwye

Representativeness	L	The high number of ephemeral tarns present is not representative of the Fault Block Ridges land system.
Diversity	M	While there is a low diversity of ecological units, the diversity of indigenous species within the ephemeral tarns is relatively high.
Naturalness	M	Trampling and probably eutrophication by stock, modification of surrounding vegetation and the presence of exotic species within the tarns.
Special Features	H	Three threatened species and one species of local distribution are present within the ecological district.
Buffering	L	Surrounding vegetation is modified, the total RAP area is relatively small
Viability	M	Relatively small area; has survived human modification so far.
Threat	H	Animal trampling and eutrophication; oversowing.
Landforms	L	Only one landform type represented.

MAP 4.15 : MACRAES RAP 15 - SHEEPWASH CREEK



0 1 2
KILOMETRES

GRID REFERENCE : I43 931174

AREA : 37 ha

ALTITUDE : 320m - 400m

TENURE : Freehold

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MACRAES RAP 15 : SHEEPWASH CREEK

Area	37ha
Grid Reference	I43-931 174
Altitudinal Range	320-400m
Land System	Fault Block Ridges
Quadrat (community) Groups	H
Tenure	Freehold
Ecological Units	Mixed shrubland on side-slope. (70%) Mixed shrubland on gully floor. (30%)

Landform and Soil

The RAP is entirely contained within a deeply incised gully on the lower dip slope of Billys Ridge, a landform more prominent on the dip slope of the Taieri Ridge. Haast schist chlorite sub-zone IV is the parent material for this RAP (McKellar, 1966) with the soil being classified as a Pukerangi yellow-grey earth (N. Z. Soil Bureau, 1968).

Vegetation and Flora

Mixed shrubland (H) occupies most of the gully floor and side-slopes, the canopy being dominated by the native shrubs *Carmichaelia virgata*, *Coprosma propinqua* (mingimingi), *Discaria toumatou* (matagouri) and the climber *Muehlenbeckia complexa*. Other shrub species present include *Carmichaelia kirkii*, *Coprosma virescens*, *Corokia cotoneaster*, *Hebe salicifolia*, *Melicytus alpinus* (porcupine shrub) and *Olearia bullata*. The herb layer is modified, containing many weedy exotic species such as *Hypochoeris radicata* (catsear), *Galium aparine* (cleavers) and the grass *Dactylis glomerata* (cocksfoot). Among the natives present in this layer are the herbs *Arthropodium candidum* (star lily), *Dichondra repens* and *Scandia geniculata* (climbing aniseed). Distribution of the shrub community on side-slopes is at times patchy, the open areas being dominated by exotic grasses.

Vegetation surrounding the gully, on the gently sloping areas, has been highly modified and consists of extensive areas of *Discaria toumatou*, *Festuca novae-zelandiae* (hard tussock), pasture grasses and other exotic species.

The shrub *Coprosma virescens* woody sub-shrub *Coprosma perpusilla* and the herb *Plantago uniflora* were identified only from this area and are therefore considered to be local within the district. The threatened shrub *Carmichaelia kirkii* is also present (Cameron et al., 1995).

Fauna

Information on the invertebrate fauna has been provided by B. Patrick (pers. comm. 1997). Shrubland insects are strongly represented here, with each native shrub species having a different suite of dependent insect species. Richer shrubs include *Olearia bullata*, with many beetles, mirid bugs and moths feeding on it, *Carmichaelia virgata*, *C. kirkii*, *Coprosma* spp., *Melicytus*

alpinus and *Corokia cotoneaster*. The climber *Muehlenbeckia complexa* is one of the richest hosts for native insects, including copper butterflies, longhorn beetles, stick insects and over twenty moth species.

The common skink (*Oligosoma nigriplantare polychroma*) was found within this RAP.

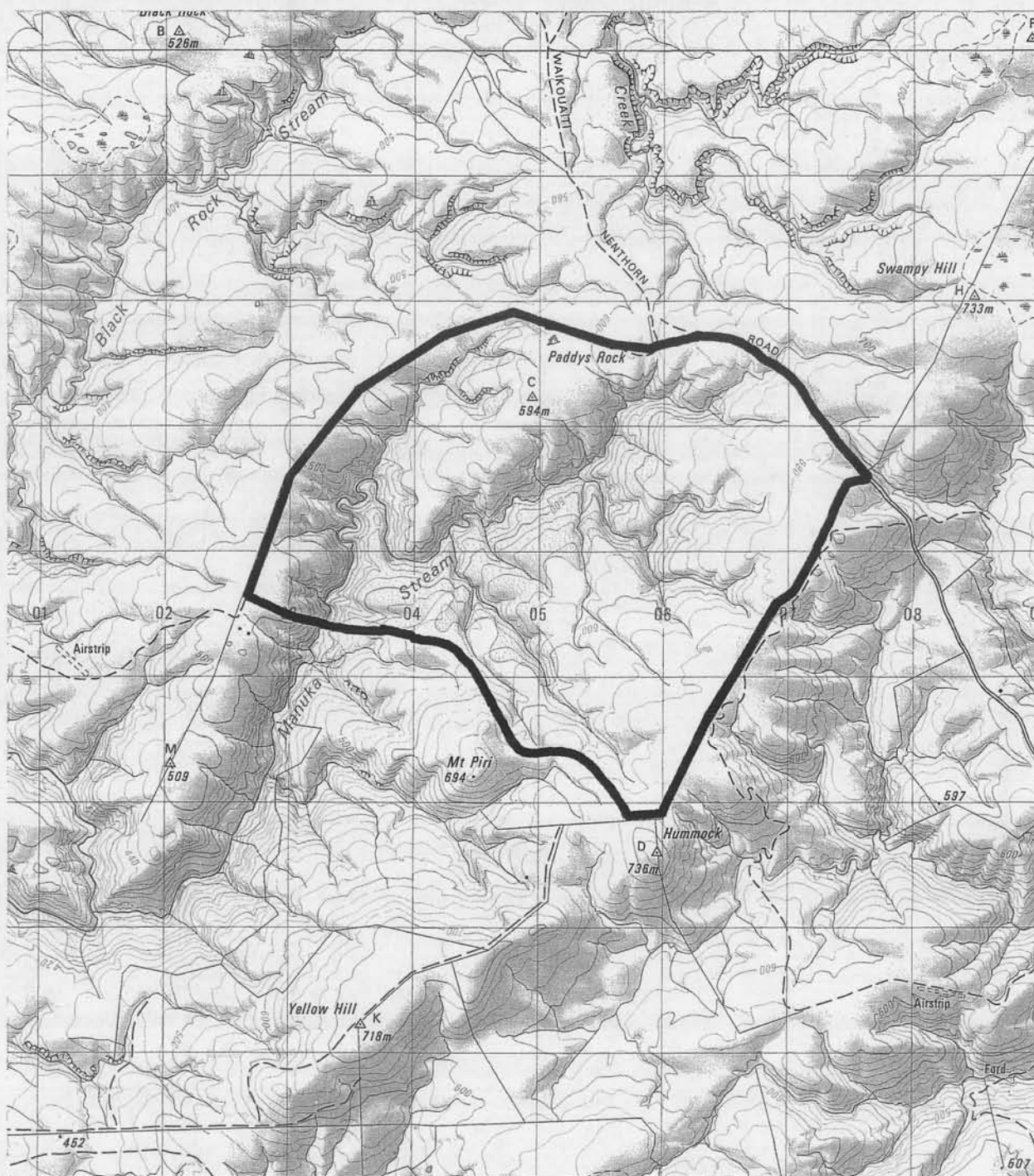
Discussion

The most extensive population of the native threatened shrub *Carmichaelia kirkii* within the district, along with the only population of *Coprosma virescens* recorded in the District, are important features of this RAP. The shrub community is species diverse and extensive throughout the gully. The herb layer seems to have been modified through grazing and oversowing, and the exotic shrub *Cytisus scoparius* (broom) and trees *Sambucus nigra* (elderberry) and *Pinus radiata* (radiata pine) are present. While these species may threaten conservation values in the future, the present plant cover is dominated by indigenous species and the natural values are high.

Selection criteria Macraes RAP 15 : Sheepwash Creek

Representativeness	H	Mixed shrubland in gullies is representative of the Block faulted ridge land system.
Diversity	L-M	Many shrub species present, but only one vegetation type.
Naturalness	M	Modified herb layer.
Special Features	H	Presence of the threatened species <i>Carmichaelia kirkii</i> ; <i>Coprosma virescens</i> is of local distribution within the ecological district.
Buffering	M	Surrounding area is highly modified and the RAP small, however steep sides to the gully provide protection from stock and fire..
Viability	M	Small area; shrubland is extensive; well protected from stock.
Threat	M	Oversowing, animal browsing such as rabbits and presence of invasive woody species.
Landforms	M	Deeply incised gullies characteristic of Block-faulted ridge dip slope.

MAP 4.16 : MACRAES RAP 16 - MANUKA STREAM



0 1 2
KILOMETRES

GRID REFERENCE : I43 050160

AREA : 1306 ha

ALTITUDE : 480m - 680m

TENURE : Freehold

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MACRAES RAP 16 : MANUKA STREAM

Area	1306ha
Grid Reference	I43-050 160
Altitudinal Range	480-680m
Land Systems:	Rolling Hills
Quadrat (community) Groups	A, E, F, G and J
Tenure	Freehold
Ecological Units	Low turf ephemeral tarn on broad ridge crest. (<1%) Moist tussock-shrubland on side-slopes. (5%) Narrow-leaved snow tussock grassland on broad ridge crest. (20%) Narrow-leaved snow tussock grassland on side-slope. (10%) Narrow-leaved snow tussock grassland on gully side-slope. (5%) Moist copper tussock grassland broad ridge crest. (20%) Kanuka woodland on side-slope. (25%) Kanuka woodland on toe-slope. (5%) Kanuka woodland on gully side-slope. (10%)

Landform and Soil

Manuka Stream contains landforms typical of the Rolling Hills land system within which it lies. Covering the whole of the upper Manuka Stream, with boundaries on the watersheds, it is an area with high catchment integrity. The drainage pattern of the stream is predominantly determined by the north-east and north-west trending structures of the underlying schist (Brown, 1962), the schist being the ubiquitous Haast schist chlorite sub-zone IV (McKellar, 1966).

The broad ridge crests on the eastern edge of the RAP, associated with poorly drained areas of copper tussock, form predominant landform-vegetation associations in the RAP. The side-slopes of the valley itself are associated with narrow-leaved snow tussock grassland and kanuka woodland with their distributions probably reflecting management history. Rocky outcrops and tors are common features of this RAP and provide habitats for the skink populations.

McIntosh (1995) found Typic Acid Brown Soils in this RAP, all formed on schist, and all extremely acid. In assessing the RAP, McIntosh concluded that the combination of typical landforms and soils with a range of different vegetation types made the area a valuable soil reference site for the district.

Vegetation and Flora

There is one example of a low turf ephemeral tarn (A) within this RAP occurring on a broad ridge crest near 'Paddy's Rock'. The exotic rush *Juncus effusus* (soft rush), with a low cover, is the only species in the canopy and is most common around the margin of the tarn. The native herb *Hypochaeris glabra*, the sedge *Carex gaudichaudiana* and the rush *Elaeochloa acuta* are the most abundant species and are present in the ground layer. The tarn is relatively unmodified in terms of exotic species, the grass *Alopecurus geniculatus* (marsh fox tail) occurring in the sample site with less than 1% cover. However, disturbance through trampling by stock is evident, with about 35% of the tarn being churned up bare ground. The nationally local plant *Tetrachondra hamiltonii* is present (Cameron et al., 1995).

Moist tussock-shrubland (E) occurs on the steep (40°) east-facing side slope of the Manuka Stream catchment, below the ridge with 'Paddy's Rock'. The canopy is dominated by the native grass *Chionochloa rigida* (narrow-leaved snow tussock) with the shrubs *Coprosma ciliata*, *Dracophyllum longifolium*, *Gaultheria antipoda* (fool's beech), *Leptospermum scoparium* (manuka) and *Olearia bullata* being present at low abundances. The herb layer consists of the native ferns *Asplenium flabellifolium* (necklace fern), *A. richardii*, *Blechnum vulcanicum* and *Polystichum vestitum* (prickly shield fern), together with the native grasses *Hierochloa redolens* (holy grass), *Poa colensoi* (blue tussock) and *Trisetum antarcticum*, plus the native herbaceous species *Anisotome aromatica* (common anisotome), *Bulbinella angustifolia* (Maori onion), *Celmisia gracilentia* (dainty daisy) and *Oreomyrrhis ramosa*.

Low Kanuka woodland (J) is the most extensive vegetation type present, covering about 40% of the RAP. It tends to occur on both east- and west-facing side-slopes of the main catchment. *Kunzea ericoides* (kanuka) is the dominant canopy species with heights ranging mainly from 2.5 to 3.5m, the tallest individuals reaching 5m. The canopy is both dense and even aged with very little light penetrating to the herb layer. The presence of dead and dying plants of *Chionochloa rigida* and *Festuca novae-zelandiae* (hard tussock), along with the native inter-tussock herbs *Luzula rufa* (red woodrush), *Wahlenbergia albomarginata* (N. Z. bluebell) and the grass *Deyeuxia avenoides* suggests that the area was once narrow-leaved snow tussock grassland. Some indigenous species more characteristic of forest understorey, such as the ferns *Asplenium terrestre* and *Phymatosorus diversifolius* (hound's tongue), and the herbaceous species *Cardamine corymbosa* and *Lagenifera strangulata* are present. Generally much of the ground is bare soil and loose litter, accounting for about 60% of the cover.

The next major vegetation type present is narrow-leaved snow tussock grassland (F) which covers about 30% of the RAP. It occurs on hill slopes not occupied by kanuka woodland and extends to the ridge crests. The grassland is in varying states of degradation, with some of the worst patches being on the broad ridge crest near 'Paddy's Rock'. This area tends to contain scattered plants of the native grasses *Chionochloa rigida* and *Festuca novae-zelandiae*, and a herb layer dominated by exotic grasses. Grassland in better condition generally occurs on the west-facing slopes in the eastern part of the catchment, and on the side-slopes below 'Paddy's Rock'. The grassland canopy, in good condition, is dominated by *C. rigida*, often with an element of *Leptospermum scoparium*

(manuka). On the side-slopes of the upper half of the catchment within the RAP, *L. scoparium* becomes a more significant feature of the grassland. Natives in the herb layer include the herb *Brachyglottis bellidioides*, the woody sub-shrubs *Gaultheria depressa* (snowberry), *Leucopogon fraseri* (dwarf heath) and *Pentachondra pumula* (little mountain heath), together with the orchids *Aporostylis bifolia* (odd-leaved orchid), *Microtis unifolia* (onion orchid) and *Thelymitra longifolia* (white sun orchid). On the broad ridge sloping down from 'Hummock', a hill to the east, the presence of the native herbs *Herpolirion novae-zelandiae* (grass lily) and *Oreostylidium subulatum*, plus the sedge *Oreobolus strictus*, indicate a high soil moisture in these areas of grassland. It is on this broad ridge that the last vegetation type occurs, moist copper tussock grassland.

Moist copper tussock grassland (G) is dominated by *Chionochloa rubra cuprea* (copper tussock) in the canopy, with a low abundance of the exotic rush *Juncus effusus*. The herb layer contains the native moss *Sphagnum cristatum*, indicative of poor drainage. Other indigenous species in this layer include the herbs *Herpolirion novae-zelandiae* and *Bulbinella angustifolia*, the sedges *Carex dissita* and *Oreobolus strictus*, and the fern *Blechnum penna-marina*.

The valley floor is highly modified and consists of a few scattered plants of the native sedge *Carex secta* (purei) together with the tussocks *Chionochloa rubra cuprea* and *C. rigida*. The herb layer is dominated by exotic grasses and herbs. Trampling damage by stock is particularly evident at the stream side.

Four species were identified as occurring only within this RAP - the grass *Hierochloa equisetata*, the sedge *Uncinia filiformis* and the herb *Nertera scapanioides* in the moist copper tussock grassland; *Poa pusilla* in the moist tussock-shrubland.

Fauna

Whitaker (1995), in a study of the herpetofaunal values of the upper Manuka Stream catchment identified six species of lizard: green skink (*Oligosoma chloronoton*), the threatened grand skink (*O. grande*), McCann's skink (*O. maccanni*), common skink (*O. nigriplantare polychroma*), the threatened Otago skink (*O. otagense*) and Eastern Otago gecko (*Hoplodactylus* aff. *maculatus* 'Eastern Otago'). The high diversity of lizard species combined with the relative abundance and wide distribution of the threatened Otago skink make the Manuka Stream RAP highly important for lizard conservation.

Discussion

This RAP contains a range of significant conservation values. With reference to the vegetation, both the extensive kanuka woodland and areas of moist copper tussock grassland are of particular note as they are uncommon within the ecological district. The low abundance of exotic species in the moist copper tussock grassland makes it one of the least modified examples within the district. Given the presence of two endangered species of skink, the Otago and grand skinks, and the high diversity of lizards, this area has high faunal conservation value. Combined with the value of the RAP as a soil reference area, these factors justify a very high conservation value being placed on the Manuka Stream RAP.

McIntosh (1995) argues that, given the extreme acidity of the soil, large quantities of both lime and fertiliser, along with regular maintenance applications of both, would be required to maintain and increase pasturage through oversowing and/or cultivation. Thus the opportunity for more intensive agricultural use seems limited.

With a view to the long-term dynamics of this RAP, it is likely that the area will undergo significant changes. The kanuka woodland is apparently seral and, without disturbance, may eventually be replaced by broadleaved forest. While there is no immediate seed source within the catchment, the proximity of the RAP to the broadleaved forests of the Waikouaiti River and Lots Wife RAP provide opportunity for seed carriage by birds. It is also likely that, with the removal of burning and grazing, the abundance of shrub species within the narrow-leaved snow tussock grassland will increase.

A vegetation survey of the upper Manuka Stream was undertaken by Bruce (1986), who reached similar conclusions in respect to the high conservation value of the area. Bruce delineated an area very similar to that of this report, with the exception of his inclusion of an area extending across Ramrock Road towards Swampy Hill. However, Swampy Hill was found to be of little conservation value due to a high degree of modification.

Selection criteria Macraes RAP 16 : Manuka Stream

Representativeness	H	Representative of moist copper tussock grassland and kanuka woodland vegetation types.
Diversity	H	High diversity of contiguous vegetation types; also of skink species.
Naturalness	M	Areas of modified Narrow-leaved tussock grassland; evidence of burning in the upper catchment.
Special Features	H	The presence of the endangered Otago and grand skinks
Buffering	H	Excellent catchment integrity.
Viability	H	Probable successional change of communities in the long term.
Threat	M	Burning, stock grazing, oversowing and topdressing.
Landforms	H	Representative of the Rolling Hills land system.

MAP 4.17 : MACRAES RAP 17 - MURRAYS ROAD



0 1 2
KILOMETRES

GRID REFERENCE : H43 873132

AREA : 1 ha

ALTITUDE : 190m

TENURE : Freehold

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MACRAES RAP 17 : MURRAY'S ROAD

Area	1ha
Grid Reference	I43-873 132
Altitudinal Range	190m
Land System	Tor Plateau
Quadrat (community) Groups	N/A
Tenure	Freehold
Ecological Units	Salt pan on gently sloping planar surface. (85%) Pasture grassland on gently sloping planar surface. (15%)

Landform and Soil

The RAP occurs on a gently sloping planar surface of the Tor Plateau land system - a land system geologically dominated by Haast schist chlorite sub-zone IV (McKellar, 1966). The soil is saline and not shown on the N. Z. Soil Bureau Soil Map (1968).

Vegetation and Flora

The salt pan is a mosaic of bare exposed saline soil and the native halophytes *Apium* sp., *Selleria microphylla* and the exotic *Spergularia rubra*. A definite zonal pattern exists around the edges, with the exotic grass *Puccinellia distans* on the inside edge, next to a band of the exotic grass *Agrostis stolonifera* (creeping bent) which is replaced on the outer edge by pasture grasses. The pan grades into a small wetland at one end containing the native sedge *Carex buechananii* and the rushes *Elaeocharis acuta* and *Juncus gregiflorus*, with the exotic rushes *Juncus effusus* (soft rush) and *J. articulatus* (jointed rush) also present. The surrounding pasture grassland is almost totally dominated by exotic grasses notably *Anthoxanthum odoratum* (sweet vernal), *Cynosurus cristatus* (Crested dogs tail) and *Dactylis glomerata* (cocksfoot). There are a few scattered plants of the native shrub *Discaria toumatou* (matagouri) and grass *Festuca nova-zelandiae* (hard tussock).

The native halophytes *Apium* sp. and *Selleria microphylla* occur only here. They are considered to be rare within the district.

Fauna

Pied stilt (*Himantopus himantopus leucocephalus*) were observed in the area. The native lygaeid bug *Nysius battoni* and a range of tiny black beetles were observed, active by day on the bare saline soils.

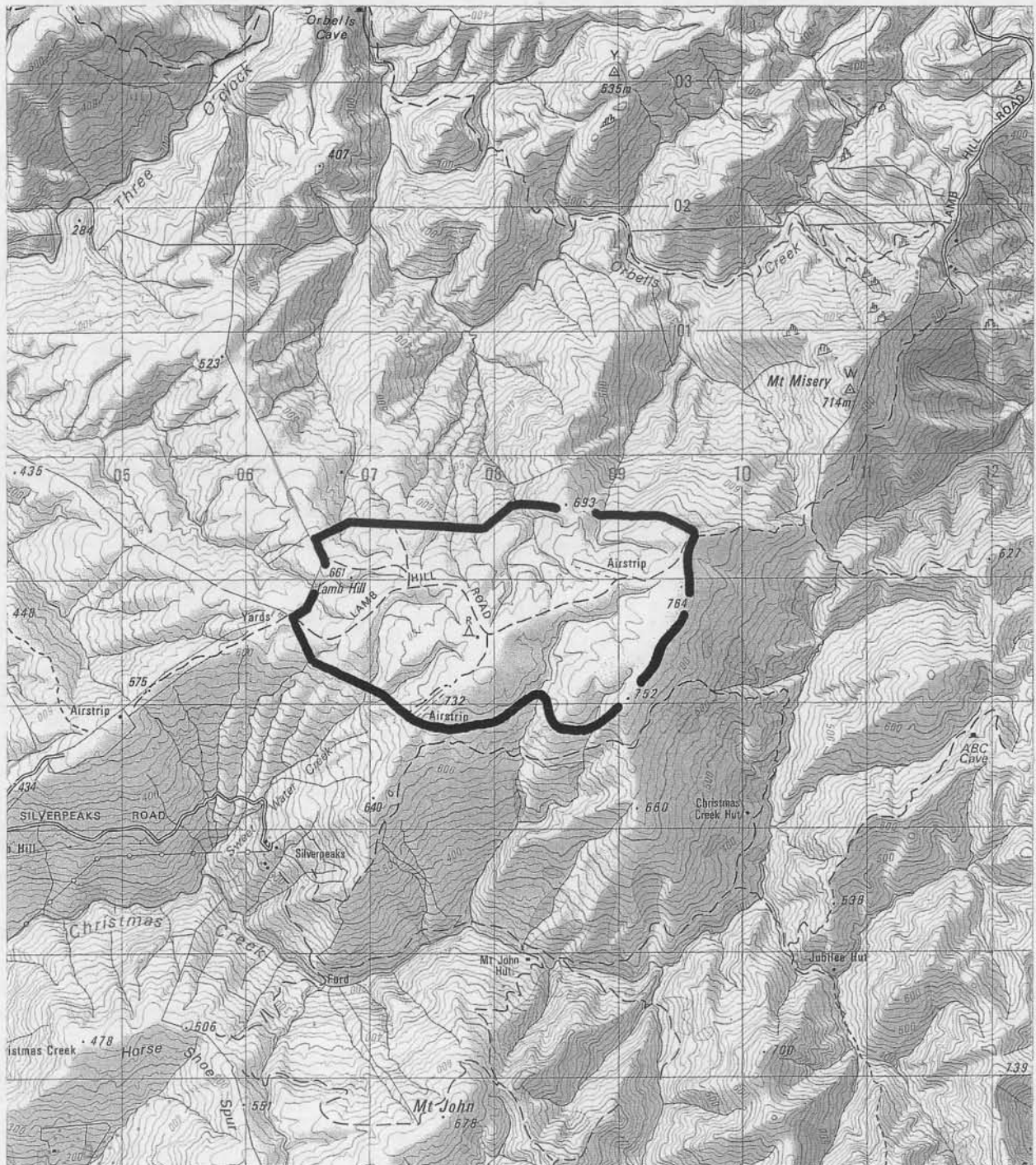
Discussion

This RAP is the only known salt pan within the district and is isolated within an area of highly modified vegetation. According to the landowner the entire area, including the salt pan, was previously ploughed (H. Keast, pers. comm. 1996). Modification continues, particularly disturbance through stock grazing and trampling.

Selection criteria Macraes RAP 17 : Murrays Road

Representativeness	L	This is a unique feature within the ecological district.
Diversity	L	Only one indigenous ecological unit.
Naturalness	L	The area has been disturbed apparently by ploughing, oversowing and presence of grazing stock.
Special Features	H	Only occurrence of a salt pan and associated native halophytes within the ecological district.
Buffering	L	A very small area surrounded by modified vegetation.
Viability	M	Small area, although has apparently survived being ploughed.
Threat	M	Introduction of exotic species through oversowing and disturbance by stock. Yet the community seems robust.
Landforms	L	Typical of the Tor Plateau land system, but not very diverse.

MAP 4.18 : MACRAES RAP 18 - LAMB HILL



0 1 2
KILOMETRES

GRID REFERENCE : I44 084987

AREA : 500 ha

ALTITUDE : 600m - 764m

TENURE : Freehold

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MACRAES RAP 18 : LAMB HILL

Area	500ha
Grid Reference	I44-084 987
Altitudinal Range	600-764m
Land System	Dissected Steeplands
Quadrat (community) Groups	D, E, F and G
Tenure	Freehold
Ecological Units	Copper tussock wetland on gully floor of rolling mountain top. (1%) Copper tussock grassland in asymmetric gully floor on rolling mountain top. (4%) Moist tussock-shrubland on extensive rock outcrops of the upper-slopes. (5%) Narrow-leaved snow tussock grassland on rolling mountain top. (60%) Narrow-leaved snow tussock grassland on upper-slopes. (20%) Narrow-leaved snow tussock grassland on asymmetric gully side-slopes on rolling mountain top. (10%)

Landform and Soil

The Lamb Hill RAP is unique as it is the only extensive rolling mountain top above 700m within the Dissected Steeplands land system. Geologically it is dominated by Haast schist chlorite sub-zone IV (McKellar, 1966). A clear relationship between landform and vegetation type can be seen: the broader floors of the asymmetric gullies support moist copper tussock grassland, with copper tussock wetland present on narrower gully floors. Rock outcrops on the upper-slopes contain a moist tussock-shrub community, while the rolling tops and upper-slopes support narrow-leaved snow tussock grassland.

Lamb Hill presents landscape features not typical of Macraes Ecological District, and as such is unique. Geomorphological features, such as asymmetrical valleys and slumps, are more typical of a schist landscape formed in a periglacial environment (McIntosh, 1995).

McIntosh (1995) found that the soils of Lamb Hill are mostly extremely acid (all less than pH 4.5). As with the landforms the soils are not typical of the district, but present a unique feature. The Lamb Hill RAP was found to contain the only soil within the surveyed areas showing signs of podzolisation.

Vegetation and Flora

Four different vegetation groups occurred here, D) copper tussock wetlands, E) moist tussock-shrubland, F) Narrow-leaved snow tussock grassland and G) moist copper tussock grassland.

Narrow-leaved snow tussock grassland is the dominant vegetation type accounting for approximately 90% of the RAP. The native grass *Chionochloa rigida* (narrow-leaved snow tussock) dominates the canopy, with a range of sub-dominant native species in the herb layer which including native orchids *Aporostylis bifolia* (odd-leaved orchid), *Prasophyllum colensoi* (leek orchid), *Pterostylis montana* and *Thelymitra pulchella* (blue sun orchid). Other common natives in this layer include the grasses *Poa colensoi* (blue tussock) and *Rytidosperma gracilis*, the woody sub-shrub *Gaultheria depressa* (snowberry), and the herbs *Brachyglottis bellidioides* and *Helichrysum filicaule* (slender everlasting daisy). The presence of the native herbs *Bulbinella angustifolia* (Maori onion) and *Herpolirion novae-zelandiae* (grass lily) plus the sedge *Oreobolus strictus* in the tussock grassland on the rolling tops suggests that soil moisture is high. Where the tussock canopy is denser there is a tendency for fewer species to be present in the herb layer. In comparison to other areas within the District exotics are relatively uncommon. *Hieracium pilosella* (mouse-ear hawkweed) was not observed in the areas surveyed, a rare situation within the district. *Gunnera prorepens* (creeping gunnera) and *Plantago novae-zelandiae* (dwarf plantain) were noted only from this site within the District.

The copper tussock wetlands are characterised by the native grass *Chionochloa rubra cuprea* (copper tussock) and *Cortaderia richardii* (toetoe), the sedge *Carex secta* (purei) and the exotic rush *Juncus effusus* (soft rush) in the canopy, with *C. secta* being the dominant. The mosses *Sphagnum cristatum* and *Echinodium umbrosum* along with the liverwort *Marchantia berteroana* dominate the ground layer, with *Colobanthus strictus* and *Nertera depressa* (common nertera) plus the rush *Juncus pusillus* being less common. The presence of the exotic grass *Holcus lanatus* (Yorkshire fog) and the herbs *Mimulus moschatatus* (musk) and *Stellaria graminea* (stitchwort) indicates modification within this ecological unit.

Chionochloa rubra cuprea dominates the canopy in the moist copper tussock grassland and is present with the shrubs *Dracophyllum longifolium* (inaka) and *Cassinia leptophylla* (cottonwood), plus the sedge *Carex coriacea*. The native moss *Sphagnum cristatum* shares dominance in the ground layer with the native cushion plant *Oreobolus strictus* and the woody sub-shrub *Pentachondra pumila* (little mountain heath). Other indigenous species common in the ground layer include the sedge *Isolepis habra* and the herb *Forstera tenella*, with the woody sub-shrub *Gaultheria macrostigma* (pink snowberry) present in the herb layer. Exotics are less abundant than in the previous vegetation type, with the herb *Hypochoeris radicata* (catsear) and the grass *Anthoxanthum odoratum* (sweet vernal) being the most common species. The only occurrence of *Nertera balfouriana* (dense nertera) within the district was noted here.

The canopy of the moist tussock-shrubland is characterised by a mixture of the native grass *Chionochloa rigida*, the tree *Fuchsia excorticata*, the fern *Polystichum vestitum* (prickly shield fern), the herbs *Aciphylla glaucescens* and *Phormium cookianum* (mountain flax), together with the scrambler *Muehlenbeckia australis* (bush pohuehue). The herb layer, by contrast is quite modified, with a large suite of exotic species being present, including the herbs *Cerastium fontanum* (mouse-ear chickweed), *Cirsium vulgare* (scotch thistle)

and *Digitalis purpurea* (foxglove), plus the grasses *Anthoxanthum odoratum* and *Holcus lanatus*. There a greater range of natives present within the herb layer, but generally at lower abundances than the exotics; native species include the herbs *Anisotome aromatica* (common anisotome), *Celmisia gracilenta* (dainty daisy), *Ranunculus reflexus*, *Sagina procumbens* and the fern *Asplenium flabellifolium* (necklace fern). A high diversity of native grasses were recorded within this ecological unit, these being *Elymus solandri* (blue wheat grass), *Poa colensoi* (blue tussock), *Trisetum antarcticum*, and *Rytidosperma unarede* (only occurrence of the last-mentioned species) in the district.

Fauna

Numerous insect species were observed during the survey. The common skink (*Oligosoma nigriplantare polychroma*) was also seen.

Discussion

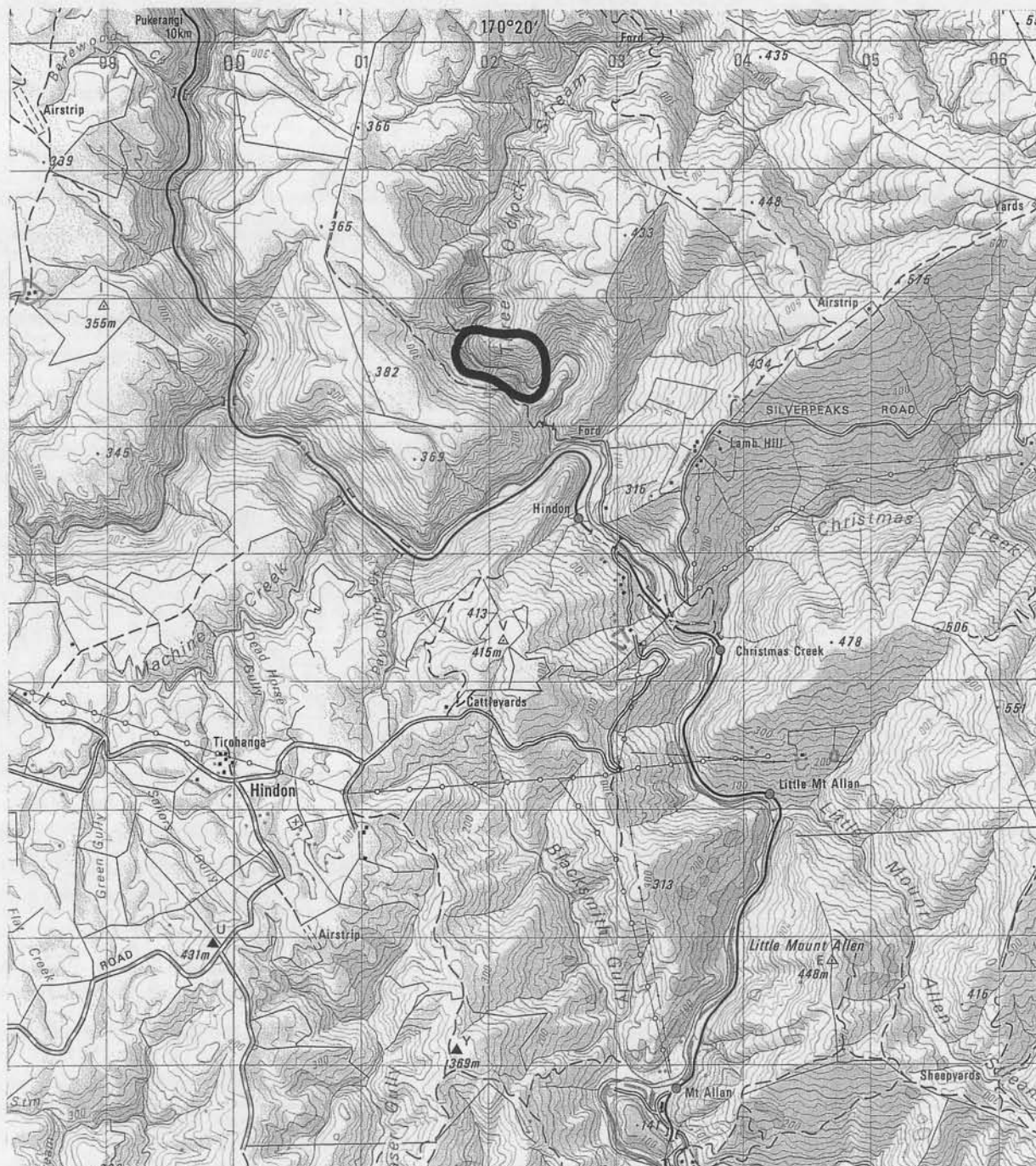
This is the southern-most RAP containing non-forest vegetation within the ecological district. It contains extensive areas of relatively unmodified vegetation that are among the most extensive and natural examples of their types within the district. The short stature of the tussock on the summit of Lamb Hill suggest that it has been burnt relatively recently, but there are few exotics and the density and cover of the tussocks is high. The naturalness of the vegetation, the presence of species with limited distributions within the ecological district and the unique soil and landscape features, combine to give the Lamb Hill RAP a high conservation value.

McIntosh (1995) comments that the acidity of the soils, low temperatures and climatic exposure make the area unsuitable for developing into legume-based pastures. Therefore, the farming potential for this land is limited.

Selection criteria Macraes RAP 18 : Lamb Hill

Representativeness	M	Representative of non-forest vegetation on high altitude rolling mountain tops. Some landscape features are not typical for the district.
Diversity	H	A good range of contiguous ecological units.
Naturalness	H	Generally few exotic plant species.
Special Features	H	Unique landscape and soil features.
Buffering	H	Large area with surrounding modified tussock grassland.
Viability	H	Large area; good condition.
Threat	M	Grazing, burning and oversowing.
Landforms	H	Unique landscape features.

MAP 4.19 : MACRAES RAP 19 - HINDON



0 1 2
KILOMETRES

GRID REFERENCE : I44 021975

AREA : 40 ha

ALTITUDE : 200m - 380m

TENURE : Freehold

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MACRAES RAP 19 : HINDON

Area	40ha
Grid Reference	144-021975
Altitudinal Range	200-380m
Land System	Dissected Steeplands
Quadrat (community) Groups	I and M
Tenure	Freehold
Ecological Units	Dry tussock-shrubland on upper-slope of truncated spur. (40%) Broadleaf forest on lower-slope of truncated spur. (60%)

Landform and Soil

This RAP covers the face of a fluvially eroded truncated spur, occurring within the Dissected Steeplands land system. Haast schist chlorite subzone IV forms the basement rock (McKellar, 1966) with very little soil present. The substrate surface consists of large boulders. The entire area could be described as an extensive rock outcrop.

Vegetation and Flora

The dry tussock-shrublands (I) occur up-slope of the broadleaf forest vegetation, with a canopy dominated by the native shrubs *Cassinia leptophylla* (cottonwood), *Coprosma propinqua* (mingimingi), the herb *Phormium cookianum* (mountain flax) and the grass *Chionochloa rigida* (narrow-leaved snow tussock). Other shrub species of lower abundance include *Carmichaelia virgata*, *Coprosma cheesemanii* (sprawling coprosma), *C. rubra*, *C. crassifolia*, *Corokia cotoneaster*, *Fuchsia perscandens* and *Hebe salicifolia*, making this one of the most diverse sites for shrub species. Abundant natives in the herb layer include the grass *Rytidosperma gracilis*, the ferns *Blechnum vulcanicum*, *Blechnum penna-marina* and *Polystichum vestitum* (prickly shield fern), the herb *Helichrysum filicaule* (slender everlasting daisy), plus seedlings of *Griselinia littoralis* (broadleaf). Many exotic grass species are also present, notably the grasses *Agrostis capillaris* (brown top) and *Anthoxanthum odoratum* (sweet vernal). They account for up to 40% of the cover.

Griselinia littoralis (broadleaf) and *Pittosporum tenuifolium* (kohuhu) above 5m tall dominate the canopy accounting for 50% cover in the broadleaf forest vegetation type. Average canopy height here is 6m. Some large *Sophora microphylla* (kowhai) are present in the canopy further down slope. In the sub-canopy *Griselinia littoralis* and *Pittosporum tenuifolium* are again abundant, along with the shrubs *Corokia cotoneaster* and *Coprosma propinqua* and the exotic species *Sambucus nigra* (elderberry). Species in the shrub layer here are shared with the dry tussock-shrubland, these being *Coprosma crassifolia*, *Corokia cotoneaster*, *Fuchsia perscandens* and *Hebe salicifolia*. The herb layer is sparse, with 60% of the cover being bare rock with a further 25% litter. Among this layer are the native climbers *Scandia geniculata* (climbing aniseed) and

Parsonsia heterophylla (Maori jasmine), plus the ferns *Asplenium bulbiferum* (hen and chickens fern), *Asplenium flabellifolium* (necklace fern), *Asplenium terrestre* and *Phymatosorus diversifolius* (hound's tongue). Seedlings of *Griselinia littoralis* and *Sambucus nigra* occur in very low numbers.

Fauna

Bellbird (*Anthornis melanura*) and South Island fantail (*Rhipidura fuliginosa penitus*) were identified within the broadleaf forest, and the common skink (*Oligosoma nigriplantare polychroma*) was seen on exposed rocks in the dry tussock-shrubland.

Discussion

This dry tussock-shrubland is one of the most diverse and apparently natural stands seen within the district. The *Cassinia leptophylla* forms the largest and most mature population occurring in the district. However, the herb layer appears to be largely modified with many exotic grasses present. The occurrence of *Sambucus nigra* in the canopy of the broadleaf forest reduces its naturalness in comparison to other sites such as Deep Creek and McCormicks Creek, but the landform adds considerably to the conservation value. The relative bareness of the understorey relates not only to extensive outcrops of bedrock but also to the presence of goats. The presence of *Griselinia littoralis* seedlings in the shrubland may indicate its seral status, and thus call into question its long term viability.

Selection criteria Macraes RAP 19 : Hindon

Representativeness	M	A good example of a dry tussock-shrubland.
Diversity	M	A very species-rich shrubland; few ecological units.
Naturalness	M	Modification of herb layers; <i>Sambucus nigra</i> in forest canopy.
Special Features	M	Best stand of <i>Cassinia leptophylla</i> in district
Buffering	M	Rockiness makes it relatively inaccessible to stock and provides a fire barrier.
Viability	M	Probable long-term replacement of shrublands by forest.
Threat	M	Goat (and stock) browsing; oversowing, and <i>Sambucus nigra</i> in canopy.
Landforms	M	Truncated spur with extensive rock outcrops; low diversity.

MACRAES RAP 20 :TAIERI GORGE

Area	50ha
Grid Reference	I44-997 986
Altitudinal Range	100-300m
Land System	Tor Plateau
Quadrat (community) Groups	N/A
Tenure	Freehold
Ecological Units	Olearia shrubland on rocky mid- slope. (100%)

Landform and Soil

The Taieri Gorge is a prominent feature of the Tor Plateau land system. It is a deeply incised river gorge, the largest such landform within the district, cut into a bedrock of Haast schist chlorite sub-zone IV (McKellar, 1966). The soil of this area of the Taieri Gorge is a Silver peaks lowland yellow-brown earth (N. Z. Soil Bureau Vegetation and Flora, 1968).

The vegetation of this area is highly modified and consists of a community of trees and shrubs featuring an undescribed species of native *Olearia*. *Olearia* 'new species' is only known elsewhere from the mid-Pomahaka Valley (Umbrella Ecological District), the Hokonui Hills, and one individual on Otago Peninsula (Peat and Patrick, 1995). There are at least 42 individuals of this species present within the RAP. The herb layer is highly modified, consisting of exotic grasses and herbs.

Fauna

New Zealand falcon (*Falco novaeseelandiae*) has been observed roosting in the vicinity (B. Patrick, pers. comm. 1997).

Information on the invertebrate fauna has been provided by B. Patrick (pers. comm. 1997). The only record of the clapping cicada *Amphipsalta strepitans* within the ecological district is from this area. Several species of moth in the genera *Hierodoris*, *Dichromodes* and *Reductoderces* feed, as larvae, on lichens and algae on the many rock faces present in the Taieri Gorge. The native shrub *Olearia* n.sp. is an important host for insects, particularly moth larvae.

Discussion

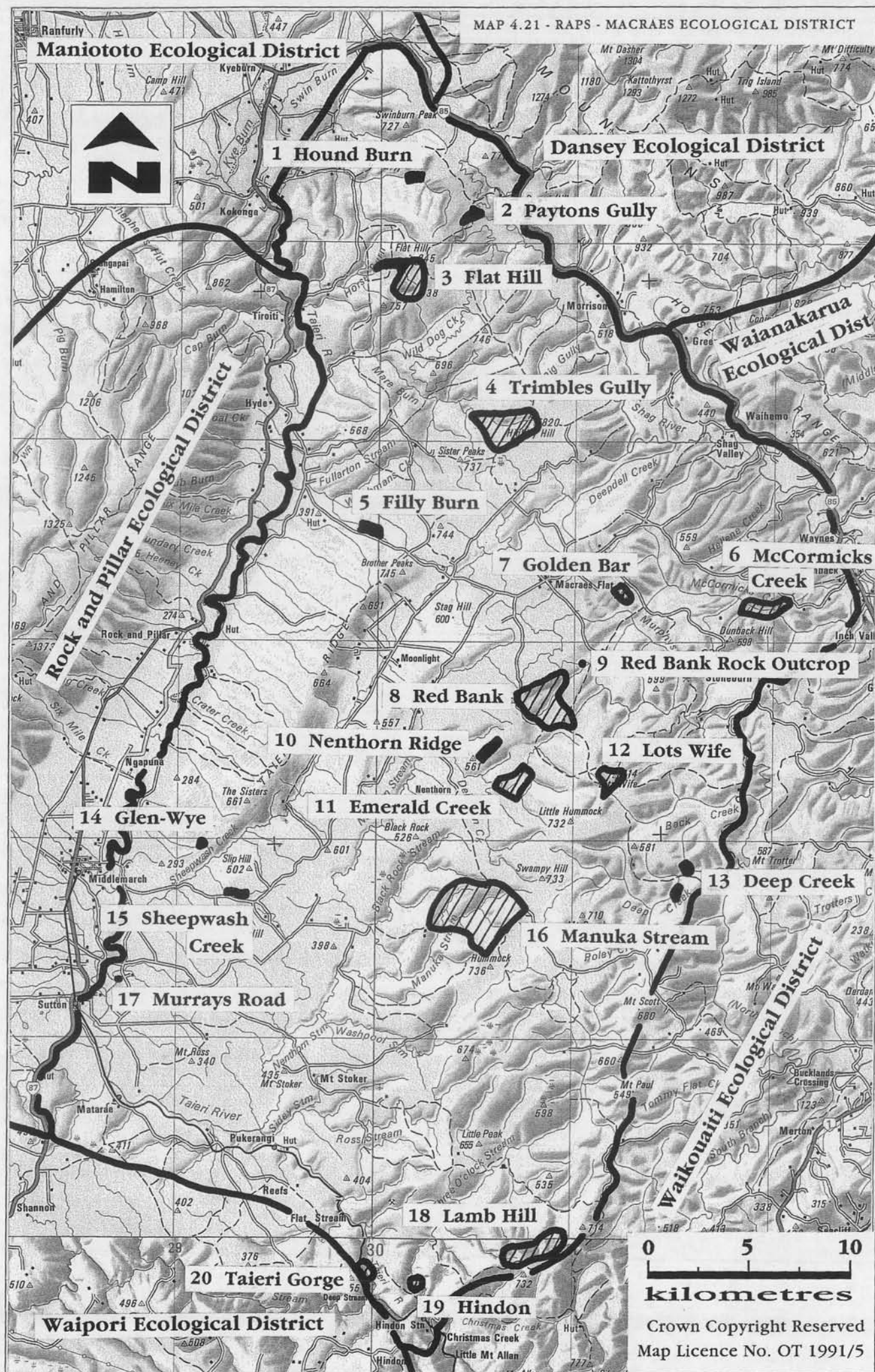
The Taieri Gorge RAP is an area of special interest due to the occurrence of *Olearia* 'new species', an as yet undescribed shrub species. The botanical values, however, are essentially limited to the presence of this species, although there are additional faunal values with the only known occurrence of the clapping cicada *Amphipsalta strepitans*.

Of concern is the long-term management of the area for the continued survival of the *Olearia* population. The Taieri Gorge contains many weedy trees (crack willow and wilding pines) and shrubs (in particular broom and gorse) that may threaten the *Olearia* population.

The population has the advantage of being situated beside the Taieri Gorge Railway and so has high public visibility and accessibility.

Selection criteria Macraes RAP 20 : Taieri Gorge

Representativeness	L	Area notable only for a single species.
Diversity	L	As above.
Naturalness	L	Generally greatly modified.
Special Features	H	The only known population of <i>Olearia</i> 'new species' in the District and the clapping cicada <i>Amphipsalta strepitans</i> .
Buffering	L	Surrounding vegetation highly modified.
Viability	M	With weed control.
Threat	H	Many weedy trees and shrubs present.
Landforms	M	Taieri Gorge is a prominent feature of the Tor Plateau land system.



4.3 SUMMARY TABLE OF THE SELECTION CRITERIA RANKINGS FOR ALL RAPS

SELECTION CRITERIA	REPRESENTATIVENESS	DIVERSITY	NATURALNESS	SPECIAL FEATURES	BUFFERING	VIABILITY	THREAT	LANDFORM
RAP 1 : Hound Burn	M	L-M	M	M	M	M	M	H
RAP 2 : Paton's Gully	H	M-H	M	M-H	M	M	M	M
RAP 3 : Flat Hill	H	M	M	H	H	M-H	M	H
RAP 4 : Trimbells Gully	H	M	L-M	M	H	M-H	M-H	H
RAP 5 : Filly Burn	H	L-M	M	L	L-M	M	L-M	M
RAP 6 : McCormicks Creek	H	M-H	M	M	M	H	M	M
RAP 7 : Golden Bar	M	L	L	H	L	M	H	L
RAP 8 : Redbank	H	H	M	H	M-H	H	M	H
RAP 9 : Redbank rock outcrop	L	L-M	H	H	L	H	L	L
RAP 10 : Nenthorn Ridge	H	H	M-H	H	M	H	L	M
RAP 11 : Emerald Creek	M	M	L	H	M	M	H	M
RAP 12 : Lots Wife	H	H	M	H	M	H	M	M
RAP 13 : Deep Creek	H	H	M	M	L	M	H	M
RAP 14 : Glenwye	H	M	L	H	L	M	H	L
RAP 15 : Sheepwash Creek	H	L-M	M	H	M	M	M	M
RAP 16 : Manuka Stream	H	H	M	H	H	H	M	H
RAP 17 : Murrays Road	L	L	L	H	L	M	M	L
RAP 18 : Lamb Hill	M	H	H	H	H	H	M	H
RAP 19 : Hindon	M	M	M	M	M	M	M	M
RAP 20 : Taieri Gorge	L	L	L	H	L	M	H	M

4.4 OTHER AREAS OF POTENTIAL CONSERVATION VALUE

Several properties where access was denied (Map 2.1) may contain areas of conservation value. Some areas noted during the reconnaissance survey as possibly having conservation values are described below.

'The Crater' (Grid reference I43: 945 250) on the Taieri Ridge is the only volcanic cone that exists in the Macraes Ecological District and, as such, is a unique geological feature. This is surrounded by apparently modified narrow-leaved snow tussock grassland which is typical of the mid- to upper-slopes of Taieri Ridge. Through a combination of vegetation, geological and landscape features, The Crater may have conservation value.

Extensive ridge crest swamp areas are mapped on the Infomap 260 series map I43 at Peatmoss Hills (Grid reference I43: 060 100) and Black Rock (I43: 010 180). No information could be collected on these areas, although an apparently similar site at Swampy Hill contained Copper tussock wetland (D). The 'copper tussock wetland on ridge crests' ecological unit is only present in the Redbank RAP. As these two areas may contain a similar ecological unit they have been identified as sites of potential conservation value.

5 Discussion and Conclusions

Prior to this study, only a few reports provided information on the indigenous vegetation of some specific areas in Macraes Ecological District (Bruce, 1986; Johnson, 1993a, 1993b; Whitaker, 1987b). This survey represents the first comprehensive report documenting the vegetation and associated conservation values of Macraes Ecological District.

A total of 20 RAPs were identified in the survey, covering 4733ha and representing 5% of the total area of Macraes Ecological District. While this may seem a small proportion, it should be noted that approximately 50% of the district has been developed into pasture grassland. There are presently 31 areas of land within the district administered by the Department of Conservation, although none of these are gazetted and formally protected. Two of the RAPs occur on DOC stewardship land, while the remainder occur on privately owned freehold land.

A land systems approach (Christian & Stewart, 1953) was used to allow for an overall assessment of RAPs by integrating information on vegetation, soils and landform. The Valley Incision, Colluvial Infill, Fault Block Ridges and Tor Plateau land systems are all heavily modified with extensive areas of developed pasture land. This high degree of modification is reflected in the low number of RAPs identified in these land systems. There are none in the Valley Incision and Colluvial Infill land systems, two small RAPs in the Tor Plateau land system (both sites of special interest) and two RAPs in the Fault Block Ridges land system. The low number of RAPs in the Fault Block Ridges land system is due to access being denied to an area of land which apparently contains among the highest conservation values of the district. Representation in the remaining land systems, however, is relatively good.

The full range of indigenous plant communities identified during the survey are represented within the RAPs, along with a representative range of soils and geological features. Of particular note is the presence of the endangered Otago and grand skinks, several threatened plant species including the critically endangered shrub *Carmichaelia kirkii* and the tree *Sophora prostrata*, which is at its southern limit of distribution.

A total of 427 vascular species, 22 lichens and 49 bryophytes were identified during the survey. Of the vascular species 356 were native and 71 exotic. The abundance of species is higher than the Maniototo Ecological District where 246 vascular species were identified, 106 of them being exotic (Grove, 1994), but values are similar to the Wapori Ecological District where 448 vascular plants were found (Carter, 1994). The relatively high diversity of native plant species is somewhat surprising given the generally highly modified nature of Macraes Ecological District.

While there are several reports on aspects of the fauna occurring within the district (Patrick, 1997; Towns et al., 1984; Bull et al., 1985; Whitaker, 1985; 1987a; 1995), no comprehensive report on the faunal values within the district exists. A detailed survey of fauna was not carried out during this survey. It is possible that there are faunal values other than those mentioned in this report.

It is generally assumed that the fauna will be adequately represented in the RAPs as long as the natural diversity of habitat is captured (Dickinson, 1989; Fagan & Pillai, 1992).

Implementation of the recommendations in this report should be undertaken as soon as possible to protect the RAPs from further degradation. However, it is recognised that the occurrence of most of the RAPs on freehold private land severely limits the ability of the Department of Conservation to protect them. As the Department of Conservation already holds in stewardship a large tract of land including the Redbank RAP, it is suggested that the retention of this entire area could provide protection for some of the values represented in the Paton's Gully and Trimbells Gully RAPs if these two RAPs cannot be protected. It should be noted that the Redbank area is not as high in conservation value as the Paton's Gully and Trimbells Gully RAPs.

In conclusion, this report provides the first detailed account of the vegetation and conservation values of Macraes Ecological District. While much of the district has been extensively modified, there are still substantial natural areas worthy of protection. Macraes Ecological District provides a unique opportunity to preserve a range of natural montane vegetation in an area relatively close to a large urban population. This survey has employed a rapid inventory and should not be viewed as a definitive statement of all the important natural values that exist within the district. It is possible there are areas of high conservation value beyond the scope of the RAPs identified here.

6 References

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Appendix I :Plant Taxa of Macraes Ecological District.

Records are based on the current survey, with species classes given for those species in the TWINSpan classification. Vascular species whose only occurrence was outside of the plots are marked N/A. Lichens and bryophytes are also marked N/A, as they were not included in the TWINSpan analysis. Within the list of bryophytes, liverworts are marked with an (L) while mosses have no marking. Nomenclature for the vascular plants follow Allan (1961), Moore & Edgar (1970), Healy & Edgar (1970), Connor & Edgar (1987) and Webb *et al.* (1988); pteridiophytes and lycophytes follow Brownsey & Smith-Dodsworth (1989); bryophytes Beever *et al.* (1992); lichens Galloway (1985). The bryophytes and lichens have been deposited at the Otago University Herbarium (OTA). Common and Maori names follow Johnson & Brooke (1989), Salmon (1963) and Wilson (1982) with additional Maori names provided by Mr G. Kerr (pers. comm., 1997).

Species	Common and Maori names	Spp. Class
Lichens		
<i>Aspicilia</i> cf. <i>cinerea</i>		N/A
<i>Caloplaca citrina</i>		N/A
<i>Cladia aggregata</i>		N/A
<i>Cladina arbuscula</i> ssp. <i>stricta</i>		N/A
<i>Cladina confusa</i>		N/A
<i>Cladonia capitellata</i>		N/A
<i>Cladonia crispata</i>		N/A
<i>Cladonia gracilis</i>		N/A
<i>Flavoparmelia haysomii</i>		N/A
<i>Neofuscelia adpicta</i>		N/A
<i>Neofuscelia petriseda</i>		N/A
<i>Pertusaria perrimosa</i>		N/A
<i>Poridia crustulata</i>		N/A
<i>Ramboldia petraeoides</i>		N/A
<i>Rhizocarpon geographicum</i>		N/A
<i>Stereocaulon ramulosum</i>		N/A
<i>Umbilicaria</i> sp.		N/A
<i>Usnea</i> cf. <i>capillacea</i>		N/A
<i>Usnea torulosa</i>		N/A
<i>Xanthoparmelia australiasica</i>		N/A
<i>Xanthoparmelia mongeotina</i>		N/A
<i>Xanthoparmelia scabrosa</i>		N/A
Bryophytes		
<i>Amblystegium riparium</i>		N/A
<i>Brachythecium salebrosum</i>		N/A
<i>Breutelia pendula</i>		N/A
<i>Bryum</i> sp.		N/A

<i>Campylopus clavatus</i>		N/A
<i>Campylopus introflexus</i>		N/A
<i>Catagonium nitens</i>		N/A
<i>Ceratodon pupureus</i>		N/A
<i>Chandonanthus squarrosus</i> (L)		N/A
<i>Chiloscyphus bidentatus</i> (L)		N/A
<i>Chiloscyphus compactus</i> (L)		N/A
<i>Chiloscyphus lentus</i> (L)		N/A
<i>Cyathophorum bulbosum</i>		N/A
<i>Dicranoloma robustum</i>		N/A
<i>Dicranum aucklandicum</i>		N/A
<i>Depanocladus fluitans</i>		N/A
<i>Ditrichum difficile</i>		N/A
<i>Drepanocladus aduncus</i>		N/A
<i>Echinodium umbrosum</i>		N/A
<i>Fabronia australis</i>		N/A
<i>Grimmia pulvinata</i>		N/A
<i>Hedwigia ciliata</i>		N/A
<i>Hedwigia integrifolia</i>		N/A
<i>Hypnum cupressiforme</i>		N/A
<i>Lembophyllum clandestinum</i>		N/A
<i>Lepidozia concinna</i> (L)		N/A
<i>Marchantia berteroana</i> (L)		N/A
<i>Metzgeria decipens</i> (L)		N/A
<i>Metzgeria decipiens</i>		N/A
<i>Pohlia camptotrachela</i>		N/A
<i>Pohlia nutans</i>		N/A
<i>Polytrichadelphus magellanicus</i>		N/A
<i>Polytrichum commune</i>		N/A
<i>Polytrichum juniperinum</i>		N/A
<i>Porella elegantula</i> (L)		N/A
<i>Ptilidium ciliare</i> (L)		N/A
<i>Ptychomnion aciculare</i>		N/A
<i>Pyrrhobryum mnioides</i>		N/A
<i>Racomitrium crispulum</i>		N/A
<i>Racomitrium lanuginosum</i>		N/A
<i>Riccardia</i> sp. (L)		N/A
<i>Stokesiella praelonga</i>		N/A
<i>Sphagnum cristatum</i>		N/A
<i>Sphagnum falciculatum</i>		N/A
<i>Symphyogyna</i> sp.		N/A
<i>Telaranea praenitens</i> (L)		N/A
<i>Thuidium furfurosum</i>		N/A
<i>Trichocolea rigida</i> (L)		N/A
<i>Triquetrella papillata</i>		N/A
<i>Tylimanthus</i> sp. (L)		N/A
Pteridophytes		
<i>Asplenium bulbiferum</i>	hen and chickens fern, piupiu, mouku	16
<i>Asplenium flabellifolium</i>	necklace fern, walking fern, butterfly fern	16

<i>Asplenium flaccidum</i>	hanging spleenwort, makawe o raukatauri	N/A
<i>Asplenium hookerianum</i> var. <i>hookerianum</i>		16
<i>Asplenium richardii</i>		14
<i>Asplenium terrestre</i> subsp. <i>terrestre</i>		16
<i>Blechnum chambersii</i>	nini, rereti	16
<i>Blechnum discolor</i>	crown fern, piupiu	N/A
<i>Blechnum fluviatile</i>	kiwakiwa	16
<i>Blechnum minus</i>	swamp kiokio, kiokio	16
<i>Blechnum penna-marina</i>		4
<i>Blechnum procerum</i>	small kiokio	14
<i>Blechnum</i> sp. 2	mountain kiokio	9
<i>Blechnum vulcanicum</i>		16
<i>Botrychium australe</i>	parsley fern, patotara	N/A
<i>Cyathea colensoi</i>		3
<i>Hymenophyllum multifidum</i>	mauku	6
<i>Hypolepis millefolium</i>	thousand-leaved fern, huarau	2
<i>Ophioglossum coriaceum</i>	adder's tongue	1
<i>Phymatosorus diversifolius</i>	hound's tongue, kowaowao, maratata	16
<i>Polystichum richardii</i>	common shield fern, pikopiko, tutoke	16
<i>Polystichum vestitum</i>	puniu, prickly shield fern	14
<i>Pteridium esculentum</i>	bracken, rahurahu, aruhe, rarauhe, raurauhe, papaka	14
Lycophytes		
<i>Lycopodium australianum</i>		N/A
<i>Lycopodium fastigiatum</i>		3
<i>Lycopodium scariosum</i>		3
<i>Lycopodium varium</i>	iwituna	3
Gymnosperms		
<i>Halocarpus bidwilli</i>	bog pine, noi	3
* <i>Pinus con torta</i>	lodgepole pine	3
* <i>Pinus radiata</i>	radiata pine	N/A
<i>Phyllocladus alpinus</i>	mountain celery pine	N/A
<i>Podocarpus hallii</i>	hall's totara	N/A
<i>Podocarpus nivalis</i>	snow totara, tauhinu	3
Monocotyledons		
* <i>Agrostis capillaris</i>	brown top	7
<i>Agrostis muscosa</i>	pincushion grass	3
<i>Agrostis pallescens</i>		3
* <i>Agrostis stolonifera</i>	creeping bent	1
* <i>Aira caryophyllea</i>	silvery hair grass	3
* <i>Alopecurus geniculatus</i>	marsh fox tail	1
* <i>Anthoxanthum odoratum</i>	sweet vernal	4
<i>Aporostylis bifolia</i>	odd-leaved orchid	3
* <i>Arrenatherum elatuis</i>		2
<i>Arthropodium candidum</i>	star lily, repehinapapa	16
<i>Astelia fragrans</i>	bush flax, kakaha	16

<i>Astelia nervosa</i>	kakaha	3
* <i>Bromus mollis</i>	soft brome	2
<i>Bulbinella angustifolia</i>	Maori onion, purau	4
<i>Carex breviculmis</i>		4
<i>Carex buchananii</i>		2
<i>Carex colensoi</i>		3
<i>Carex coriacea</i>	rautahi	1
<i>Carex decurtata</i>		N/A
<i>Carex dissita</i>		1
<i>Carex echinata</i>	star sedge	3
<i>Carex flagellifera</i>		2
<i>Carex forsteri</i>		16
<i>Carex gaudichaudiana</i>		1
<i>Carex geminata</i>	cutty grass, rautahi	1
<i>Carex inversa</i>		2
<i>Carex kirkii</i>		1
<i>Carex lachenalii</i>		3
* <i>Carex ovalis</i>	oval sedge	1
<i>Carex pumila</i>		16
<i>Carex raoulii</i>		16
<i>Carex secta</i>	ballerina sedge purei, makura, pukio	8
<i>Carex secta</i> var. <i>tenuiculmis</i>		2
<i>Carex sinclairii</i>		1
<i>Carex wakatipu</i>		3
<i>Chionochloa rigida rigida</i>	narrow-leaved snow tussock	4
<i>Chionochloa rigida x rubra</i>		3
<i>Chionochloa rubra cuprea</i>	copper tussock, haumata	2
<i>Cordyline australis</i>	cabbage tree, ti, kauru	16
<i>Cortaderia richardii</i>	toetoe	5
<i>Corybas macranthus</i>	spider orchid	5
<i>Corybas orbiculatus</i>	spider orchid	14
* <i>Cynosurus cristatus</i>	crested dogs-tail	8
* <i>Dactylis glomerata</i>	cocksfoot	15
<i>Deyeuxia aucklandica</i>		3
<i>Deyeuxia avenoidies</i>	mountain oat grass	3
<i>Deyeuxia quadriseta</i>		3
<i>Dichelachne crinita</i>	plume grass	12
<i>Elaeocharis acuta</i>	spike rush	1
<i>Elaeocharis gracilis</i>		1
<i>Elymus solandri</i>	blue wheat grass	5
<i>Festuca novae-zelandiae</i>	fescue, hard tussock	3
* <i>Festuca rubra</i>	chewing's fescue	6
* <i>Glyceria declinata</i>	blue sweet grass	2
* <i>Glyceria fluitans</i>	floating sweet grass	1
<i>Herpolirion novae-zelandiae</i>	grass lily, sky lily, ground lily	1
<i>Hierochloa equisetia</i>		3
<i>Hierochloa redolens</i>	holy grass, k...retu	2
* <i>Holcus lanatus</i>	Yorkshire fog	6
<i>Isolepis aucklandica</i>	wiwi	1
<i>Isolepis habra</i>		3

<i>Juncus antarcticus</i>	dwarf rush	1
* <i>Juncus articulatus</i>	jointed rush	1
* <i>Juncus bufonius</i>	toad rush	1
* <i>Juncus conglomeratus</i>		2
* <i>Juncus effusus</i>	soft rush	1
<i>Juncus gregiflorus</i>	native rush, wiwi	1
<i>Juncus pusillus</i>	dwarf rush	1
<i>Koleria novo-zelandica</i>		2
<i>Lachnagrostis filiformis</i>	tumble grass	2
<i>Lachnagrostis glabra</i>		1
<i>Lachnagrostis lyallii</i>	tumble grass	1
<i>Lachnagrostis semiglabra</i>		16
<i>Libertia ixioides</i>	native iris, mikoikoi, t—k...uki	16
<i>Luzula banksiana</i> var. <i>rahdina</i>		3
* <i>Luzula congesta</i>		N/A
<i>Luzula picta</i> var. <i>limosa</i>	woodrush	3
<i>Luzula rufa</i> var. <i>rufa</i>	red Woodrush	3
<i>Microlaena avenaceas</i>	bush rice grass	16
<i>Microtis oligantha</i>	small onion orchid	3
<i>Microtis unifolia</i>	onion orchid, grassland orchid	3
<i>Oreobolus impar</i>		2
<i>Oreobolus strictus</i>		3
<i>Oreostylidium subulatum</i>		3
* <i>Pbleum pratense</i>	timothy grass	1
<i>Phormium cookianum</i>	mountain flax, wharariki	10
<i>Poa cita</i>	silver tussock, patiti, mauku	10
<i>Poa colensoi</i>	blue tussock, patiti, mauku	4
<i>Poa imbecilla</i>	weak poa, patiti, mauku	14
<i>Poa kirkii</i>	kirk's poa, patiti, mauku	14
<i>Poa maniototo</i>	patiti, mauku	1
<i>Poa pusilla</i>	patiti, mauku	2
<i>Prasophyllum colensoi</i>	leek orchid	3
<i>Pterostylis banksii</i>	greenhood orchid, tutukiwi	16
<i>Pterostylis montana</i>	greenhood orchid	14
* <i>Puccinella distans</i>		N/A
<i>Rytidosperma gracile</i>		14
<i>Rytidosperma maculatum</i>		N/A
<i>Rytidosperma pilosum</i>		3
<i>Rytidosperma pumilum</i>		3
<i>Rytidosperma racemosum</i>		3
<i>Rytidosperma setifolium</i>	bristle tussock	3
<i>Rytidosperma thomsonii</i>		2
<i>Rytidosperma unarede</i>		2
<i>Schoenus pauciflorus</i>	bog rush	2
<i>Simplicia laxa</i>		N/A
<i>Thelymitra longifolia</i>	white sun orchid, maikuku	3
<i>Thelymitra pulchella</i>	blue sun orchid, maikaika	3
<i>Thelymitra venosa</i>	veined sun orchid	3
<i>Trisetum antarcticum</i>		3
<i>Trisetum youngii</i>		3

<i>Uncinia egmontiana</i>	hooked sedge	3
<i>Uncinia elegans</i>		13
<i>Uncinia filiformis</i>	hooked sedge	3
<i>Uncinia fuscovaginata</i>	hooked sedge	3
<i>Uncinia nervosa</i>	hooked sedge	3
<i>Uncinia rubra</i>	hooked sedge	3
<i>Uncinia sinclairii</i>	hooked sedge	3
<i>Uncinia</i> sp. "fine nervosa"	hooked sedge	3
<i>Uncinia uncinata</i>	dense forest sedge, kamu, matau-a-maui	16

Dicotyledons

<i>Abrotanella caespitosa</i>		2
<i>Abrotanella linearis</i>		3
* <i>Acaena agnipila</i>		15
<i>Acaena anserinifolia</i>	native bidibid, piripiri	10
<i>Acaena buechananii</i>	native bidibid, piripiri	3
<i>Acaena caesiiglauca</i>	native bidibid, piripiri	4
<i>Acaena fissistipula</i>	native bidibid, piripiri	16
<i>Acaena novae-zelandiae</i>	red bidibid, piripiri	12
* <i>Achillea millefolium</i>	yarrow	2
<i>Aciphylla aurea</i>	golden spaniard	4
<i>Aciphylla glaucescens</i>		2
<i>Aciphylla scott-thomsonii</i>	giant spaniard	3
<i>Aciphylla subflabellata</i>		10
<i>Anisotome aromatica</i>	common anisotome, kopoti	2
<i>Anisotome brevistylis</i>		15
<i>Anisotome caudicola</i>		3
<i>Apium</i> sp. aff. <i>filiformis</i>		N/A
* <i>Arctium lappa</i>	burdock	2
<i>Aristotelia fruticosa</i>	mountain wineberry	14
<i>Aristotelia serrata</i>	wineberry, makomako	16
<i>Brachyglottis bellidioides</i>		3
<i>Brachyglottis haastii</i>	Haast's groundsel	3
<i>Brachyscome longiscapa</i>		3
<i>Brachyscome sinclairii</i>	grassland daisy	3
<i>Callitriche petriei</i>		1
<i>Calystegia tuguriorum</i>	New Zealand convolvulus, powhiwhi	16
<i>Cardamine corymbosa</i>	native bittercress, panapana	16
<i>Cardamine debilis</i>		2
<i>Cardamine</i> "tarn"		1
<i>Carmichaelia kirkii</i>		15
<i>Carmichaelia virgata</i>		15
<i>Carpodetus serratus</i>	marbleleaf, putaputaweta	16
<i>Cassinia leptophylla</i>	cottonwood, tauhinu	13
<i>Celmisia densiflora</i>	mountain daisy, tikumu	3
<i>Celmisia gracilentia</i>	dainty daisy, tikumu	3
<i>Celmisia graminifolia</i>	bog daisy, tikumu	3
<i>Celmisia hookeri</i>	tikumu	3
* <i>Centaurium erythraea</i>	centaury	13
<i>Centella uniflora</i>		11

<i>*Cerastium fontanum</i>	mouse-ear chickweed	5
<i>*Cirsium arvense</i>	californian thistle	2
<i>*Cirsium vulgare</i>	scotch thistle, kotimana	15
<i>Clematis marata</i>		14
<i>Clematis quadribacteolata</i>		2
<i>Colobanthus affinis</i>		
<i>Colobanthus strictus</i>		1
<i>Coprosma areolata</i>	thin-leaved coprosma	16
<i>Coprosma</i> cf. <i>parviflora</i>		N/A
<i>Coprosma cheesemanii</i>	sprawling coprosma	9
<i>Coprosma ciliata</i>		16
<i>Coprosma crassifolia</i>		16
<i>Coprosma cuneata</i>		3
<i>Coprosma linariifolia</i>	yellow-wood	16
<i>Coprosma parviflora</i>	leafy coprosma	16
<i>Coprosma propinqua</i>	mingimingi	15
<i>Coprosma pseudocuneata</i>	variable coprosma	N/A
<i>Coprosma rigida</i>		3
<i>Coprosma rotundifolia</i>	round-leaved coprosma	16
<i>Coprosma rubra</i>		15
<i>Coprosma rugosa</i>	needle leaved coprosma	14
<i>Coprosma virescens</i>		15
<i>Corallospartium crassicaule</i>	coral broom	N/A
<i>Coriaria lurida</i>		3
<i>Coriaria plumosa</i>	small leaved tutu	3
<i>Coriaria sarmentosa</i>	tutu, tupakihi	2
<i>Corokia cotoneaster</i>	korokio	15
<i>Craspedia uniflora</i> var. <i>uniflora</i>	woollyhead	3
<i>Crassula peduncularis</i>		2
<i>Crassula tetramera</i>		2
<i>*Crepis capilaris</i>	hawksbeard	14
<i>Cyathodes empetrifolia</i>	dwarf heath, miki	3
<i>Cyathodes juniperina</i>	prickly mingimingi	3
<i>Dichondra repens</i>		15
<i>*Digitalis purpurea</i>	foxglove	14
<i>Discaria toumatou</i>	wild irishman, matagouri	5
<i>Dracophyllum longifolium</i>	inaka, grass tree	3
<i>Dracophyllum uniflorum</i>	turpentine scrub	3
<i>Drosera arcturi</i>	sundew	3
<i>Elatine gratioloides</i>		1
<i>Einadia allanii</i>		15
<i>Epilobium alsinoides</i>	willowherb	4
<i>Epilobium alsinoides</i> subsp. <i>atriplicifolium</i>	willowherb	3
<i>Epilobium alsinoides</i> subsp. <i>tenuipes</i>	willowherb	4
<i>Epilobium billardierianum</i>	willowherb	3
<i>Epilobium brunnescens</i>	creeping willowherb	2
<i>Epilobium brunnescens</i> subsp. <i>brunnescens</i>	creeping willowherb	2
<i>Epilobium brunnescens</i> subsp. <i>minutiflorum</i>	creeping willowherb	2

<i>Epilobium chionanthum</i>	marsh willowherb	5
<i>Epilobium insulare</i>		2
<i>Epilobium komarovianum</i>	creeping willowherb	1
<i>Epilobium macropus</i>		2
<i>Epilobium nerterioides</i>	creeping willowherb	5
<i>Epilobium pubens</i>	willowherb	10
<i>Epilobium rotundifolium</i>	round-leaved willowherb	16
* <i>Erophila verna</i>		15
<i>Euphrasia zelandica</i>	small eyebright	3
<i>Forstera tenella</i>		3
<i>Fuchsia excorticata</i>	tree fuchsia, kotukutuku	16
<i>Fuchsia perscandens</i>		14
* <i>Galium aparine</i>	cleavers, goosegrass, bedstraw	15
<i>Galium perpusillum</i>		1
<i>Galium propinquum</i>		10
<i>Galium</i> sp. aff. <i>perpusillum</i>		1
<i>Gaultheria antipoda</i>	fool's beech, t...winiwini, takapo	6
<i>Gaultheria crassa</i>	lily of the valley shrub	2
<i>Gaultheria depressa</i> var. <i>depressa</i>	snowberry	3
<i>Gaultheria depressa</i> var. <i>novae-zelandiae</i>	snowberry	3
<i>Gaultheria macrostigma</i>	pink snowberry, prostrate snowberry	3
<i>Gaultheria macrostigma</i> x <i>depressa</i>		
var. <i>novae-zelandiae</i>		3
<i>Gentiana amabilis</i>		3
<i>Gentiana bellidifolia</i>	small snow gentian	3
<i>Gentiana grisebachii</i>	marsh gentian	3
<i>Geranium microphyllum</i>	cranesbill, namunamu	4
<i>Geranium sessiliflorum</i>		
var. <i>novae-zelandiae</i>	cranesbill, namunamu	5
<i>Geum leiospermum</i>	dwarf avens	3
<i>Gingidia montana</i>	mountain anise	15
<i>Glossostigma</i> sp		1
<i>Gnaphalium audax</i>	cudweed	5
<i>Gnaphalium delicatum</i>	cudweed	16
<i>Gnaphalium laterale</i>	cudweed	1
<i>Gnaphalium limosum</i>	cudweed	12
<i>Gnaphalium ruabinicum</i>	cudweed	12
<i>Gnaphalium traversii</i>	cudweed	1
<i>Gonocarpus aggregatus</i>		3
<i>Gonocarpus micranthus</i>		3
<i>Gratiola nana</i>		1
<i>Griselinia littoralis</i>	broadleaf, k...puka, p...p...uma	13
<i>Gunnera densiflora</i>		3
<i>Gunnera monoica</i>	solitary gunnera	4
<i>Gunnera prorepens</i>	creeping gunnera	3
<i>Hebe odora</i>		N/A
<i>Hebe rakaiensis</i>		14
<i>Hebe salicifolia</i>	kokomuka, koromiko	16
<i>Helicbrysum bellidioides</i>	everlasting daisy	4
<i>Helicbrysum filicaule</i>	slender everlasting daisy	4

<i>Helichrysum lanceolatum</i>	niniaio	16
* <i>Hieracium lepidulum</i>	tussock hawkweed	6
* <i>Hieracium pilosella</i>	mouser-ear hawkweed	4
<i>Hoeberia angustifolia</i>	narrow-leaved lacebark	N/A
<i>Hydrocotyle heteromeria</i>	waxweed	15
<i>Hydrocotyle hydrophila</i>		1
<i>Hydrocotyle microphylla</i>	pennywort	12
<i>Hydrocotyle moschata</i>	pennywort	14
<i>Hydrocotyle novae-zeelandiae</i>	pennywort	2
<i>Hypericum japonicum</i>	matted St. John's wort	1
* <i>Hypericum perforatum</i>	St. John's wort	15
* <i>Hypochoeris radicata</i>	catsear	6
<i>Hypsela rivalis</i>		1
<i>Kelleria dieffenbachii</i>		3
<i>Kelleria laxus</i>		3
<i>Kunzea ericoides</i>	white tea tree, kanuka, kaikatoa	16
<i>Lagenifera barkeri</i>		2
<i>Lagenifera cuneata</i>		3
<i>Lagenifera petiolata</i>	papat...niwhaniwha	5
<i>Lagenifera pumila</i>	papat...niwhaniwha	3
<i>Lagenifera strangulata</i>	paranui	16
<i>Leptinella pectinata</i>		2
<i>Leptinella serrulata</i>		10
<i>Leptinella squalida</i>		1
<i>Leptinella squalida mediana</i>		1
<i>Leptospermum scoparium</i>	tea tree, manuka	13
<i>Leucopogon colensoi</i>		13
<i>Leucopogon fraseri</i>	dwarf heath, patotara	3
<i>Lilaeopsis novae-zelandiae</i>		1
<i>Lilaeopsis ruthiana</i>		1
<i>Limosella lineata</i>		1
* <i>Linum catharticum</i>	purging flax	3
* <i>Lotus pedunculatus</i>	birdsfoot treefoil	1
<i>Mazus radicans</i>	swamp musk	2
<i>Melicytus alpinus</i>	porcupine shrub	14
<i>Melicytus ramiflorus</i>	whitey wood, m...hoe, hinahina	16
<i>Mentha cunninghamii</i>	native mint, hūoi	1
* <i>Mimulus moschatus</i>	musk	1
<i>Montia fontana</i>	blinks	1
<i>Muehlenbeckia australis</i>	bush p•huehue, p•huehue	14
<i>Muehlenbeckia complexa</i>	p•huehue	5
* <i>Myosotis arvensis</i>	field forget-me-not	2
* <i>Myosotis discolor</i>	grassland forget-me-not	2
* <i>Myosotis laxa caespitosa</i>	water forget-me-not	14
<i>Myosurus minimus novae-zelandiae</i>	mouse tail	1
<i>Myriophyllum pedunculatum</i>		
<i>novae-zelandiae</i>		2
<i>Myriophyllum propinquum</i>		1
<i>Myriophyllum triphyllum</i>		2
<i>Myrsine australis</i>	red m...pou, matipo, m...pou	16

<i>Myrsine divaricata</i>	weeping m...pou	16
<i>Neopaxia australasica</i>		2
<i>Nertera balfouriana</i>	dense nertera	N/A
<i>Nertera ciliata</i>		3
<i>Nertera depressa</i>	common nertera	2
<i>Nertera scapanioides</i>		3
<i>Nertera setulosa</i>		3
<i>Olearia bullata</i>		5
<i>Olearia</i> n.sp.		
<i>Olearia odorata</i>		2
<i>Olearia virgata</i> var. <i>lineata</i>	twiggy tree daisy	3
<i>Oreomyrrhis colensoi</i>	mountain myrrh	3
<i>Oreomyrrhis ramosa</i>		10
<i>Oxalis exilis</i>	yellow oxalis	12
<i>Oxalis magellanica</i>	white oxalis, tutae-kahu	N/A
<i>Parsonsia heterophylla</i>	Maori jasmine, kaihua, kaiku, kaiwhiria, tawhiwhi	16
<i>Pentachondra pumila</i>	little mountain heath	3
<i>Pimelea oreophila</i>		6
<i>Pimelea pseudolyallii</i>		3
<i>Pittosporum eugenioides</i>	lemonwood, tarata	16
<i>Pittosporum tenuifolium</i>	kohuhu, rau-tawhiri	16
<i>Plantago novae-zelandiae</i>	dwarf plantain	3
<i>Plantago spathulata picta</i>	kopakopa	2
<i>Plantago triandra triandra</i>	starweed	1
<i>Plantago uniflora</i>	dwarf plantain	15
<i>Potamogeton cheesemanii</i>	red pondweed, manihi	2
<i>Potentilla anserinoides</i>	silver weed	2
<i>Pratia angulata</i>	creeping pratia, panakenake	2
<i>Pratia perpusilla</i>		1
* <i>Prunella vulgaris</i>	self heal	12
<i>Pseudopanax colensoi</i> var. <i>ternatus</i>	three-finger, oriou, ouhou	16
<i>Pseudopanax crassifolium</i>	lancewood, horoeaka, kokoeka	16
<i>Pseudopanax simplex</i>	haumakaroa	16
<i>Pseudognaphalium luteoalbum</i>		14
<i>Ranunculus foliosus</i>	buttercup	5
<i>Ranunculus glabrifolius</i>	buttercup	1
<i>Ranunculus multiscapus</i>	grassland buttercup	4
<i>Ranunculus reflexus</i>	hairy buttercup, maruru	16
<i>Raoulia subsericea</i>	mat daisy	3
* <i>Ribes uva-crispa</i>	gooseberry	3
* <i>Rorippa microphylla</i>	watercress	1
* <i>Rosa rubiginosa</i>	sweet briar	15
<i>Rubus cissoides</i>	bush lawyer, t...tar...moa, tatarahika	16
<i>Rubus schmidelioides</i>	t...tar...moa	15
* <i>Rumex acetosa</i>	sorrel	3
* <i>Rumex acetosella</i>	sheep's sorrel	7
* <i>Rumex crispus</i>	curled dock	2
<i>Rumex flexuosus</i>	native dock, runa	1
* <i>Rumex obtusifolius</i>	broad dock	3

<i>*Sagina procumbens</i>	pearlwort	2
<i>*Sambucus nigra</i>	elderberry	16
<i>Scandia geniculata</i>	climbing aniseed	16
<i>Schizeilema trifoliolatum</i>		16
<i>Scleranthus biflorus</i>		1
<i>Scleranthus uniflorus</i>	scabweed	3
<i>Selleria</i> sp. aff. <i>microphylla</i>		N/A
<i>Senecio dunedinensis</i>	firweed	15
<i>*Senecio jacobaea</i>	ragwort	15
<i>Senecio minimus</i>	fireweed	15
<i>*Senecio vulgaris</i>	common groundsel	16
<i>Senecio wairauensis</i>	fireweed	14
<i>*Sonchus asper</i>	prickly sow thistle, puwha, rauriki	14
<i>Sophora microphylla</i>	kowhai, kohai	16
<i>Sophora prostrata</i>	prostrate kowhai	N/A
<i>*Spergularia rubra</i>	sand spurrey	1
<i>Stackhousia minima</i>		3
<i>*Stellaria alsine</i>	bog stitchwort	8
<i>Stellaria gracilentia</i>		14
<i>*Stellaria graminea</i>	stitchwort	2
<i>*Stellaria media</i>	chickweed	12
<i>Stellaria parviflora</i>	native chickweed	14
<i>Taraxacum magellanicum</i>	native dandelion, tohetake	N/A
<i>*Taraxacum officinale</i>	dandelion, tohetake	2
<i>Tetrachondra hamiltonii</i>		1
<i>*Trifolium arvense</i>	haresfoot trefoil	15
<i>*Trifolium dubium</i>	suckling clover	2
<i>*Trifolium fragiferum</i>	strawberry clover	N/A
<i>*Trifolium pratense</i>	red clover	3
<i>*Trifolium repens</i>	white clover	6
<i>*Verbascum thapsus</i>	wolley mullein	12
<i>*Veronica arvensis</i>	field speedwell	2
<i>*Veronica serpyllifolia</i>	turf speedwell	1
<i>*Vicia sativa</i>	vetch	15
<i>*Vinca minor</i>	lesser periwinkle	12
<i>Viola cunninghamii</i>	N. Z. violet, haka	6
<i>Viola filicaulis</i>	forest violet	9
<i>Wahlenbergia albomarginata</i>	N. Z. bluebell	3
<i>Wahlenbergia gracilis</i>		3
<i>Wahlenbergia rupestris</i>		16

