Nature Heritage Fund

CANTERBURY PROTECTION STRATEGY

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CANTERBURY LAND PROTECTION STRATEGY

A REPORT TO THE NATURE HERITAGE FUND COMMITTEE

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CANTERBURY LAND PROTECTION STRATEGY
Published by the Nature Heritage Fund
PO Box 10-420
Wellington
June 2009

Hard Copy ISBN: 978-0-478-14626-4
PDF ISBN: 978-0-478-14627-1
CD-ROM ISBN: 978-0-478-14630-1

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The Nature Heritage Fund was established (as the Forest Heritage Fund) in June 1990 following the release of Government's Indigenous Forest Policy. The objective of this policy is to "*maintain or enhance, in perpetuity, the current area of indigenous forest, either by protection, sustainable management or reafforestation of native species*". The Nature Heritage Fund and a parallel fund Nga Whenua Rahui were established to help achieve this objective. Since its inception the Nature Heritage Fund has secured protection for more than 339,000 hectares of indigenous vegetation and habitat.

ACKNOWLEDGEMENTS

The preparation of this strategy was guided by Allan Mckenzie (Manager, Nature Heritage Fund), John Morton (NHF) and members of the Nature Heritage Fund Committee:

Di Lucas, Chair
Dr Gerry McSweeney
Mike Lee
Jan Riddell
Dr Les Molloy

Other people who provided information, advice and assistance during the preparation of this strategy include: Norm Thornley, Deb Zanders and Adrian Patchett (DOC) for providing data and maps; Nick Head, Kennedy Lange, Joy Comrie and Chris Woolmore (DOC) for providing information and comments on existing protected areas and opportunities for further protection; Dave Forrester (DOC); and Mark Davis for review of an earlier draft.

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1.0 INTRODUCTION

This report describes land protection priorities for nature conservation in Canterbury. The primary purpose of this report is to assist the Nature Heritage Fund and other agencies with the allocation of resources for the protection of land not already formally protected. Information about land protection priorities will help ensure that limited funds are allocated in a way that provides the greatest benefits for nature conservation.

The area covered by this report lies in the Department of Conservation's Canterbury Conservancy. The Conservancy covers the area between the Conway and upper Clarence rivers in the north; the main divide of the Southern Alps in the west; the lower Waitaki River and southern boundary of the Waitaki Basin in the south; and, the Pacific Ocean in the east. It includes the broad Canterbury Plains, the foothills and low mountains that border the plains in north and south Canterbury, the extensive intermontane basins and ranges of the eastern South Island high country, and the rugged snow-clad eastern flank of the central Southern Alps. The Conservancy lies within the rohe of Ngai Tahu.

A summary of the presumed nature and extent of the original (pre-human) vegetation of Canterbury Conservancy is presented in the first part (Section 3) of this report. The indigenous vegetation of each of the 59[1] ecological districts that lie wholly or partly within the Conservancy is then described (Section 4). The method used for these descriptions is outlined in Section 2.

In Section 5 of the report, the information presented in Section 4 is analysed to illustrate the extent to which different types of indigenous vegetation are present within existing protected natural areas. Priorities for further protection of indigenous vegetation that would help achieve a protected natural areas system that is more representative of the vegetation originally present in the Conservancy are also described.

Section 6 presents criteria to help determine the relative value of land protection proposals. The final section of the report (Section 7) presents a four-point Land Protection Strategy to assist the Nature Heritage Fund in the allocation of funds for further protection in Canterbury Conservancy.

This report covers all terrestrial ecosystems and wetlands within Canterbury Conservancy. It does not cover coastal (below mean high water spring) and marine ecosystems, or water bodies such as lakes and rivers.

Important note:
The analysis presented in this report is based on the best information available to the author at the time of writing. Information about the nature and extent of indigenous vegetation in Canterbury Conservancy, especially the original (pre-human) vegetation, is incomplete. This limitation should be taken into account when interpreting the data and recommendations presented in this report.

[1] Dillon, Manakau and Waiautoa EDs are grouped together for analysis; Whitcombe, Ella and Lindis EDs are not analyzed as only small parts of these EDs are within the Conservancy.

2.0 METHOD

Preparation of the initial draft of this Canterbury Land Protection Strategy was undertaken between July 2001 and December 2002. This draft was updated and edited for publication during May 2009. The content and format of the strategy were determined by the author in consultation with staff of the Nature Heritage Fund and the Department of Conservation's Canterbury Conservancy Office.

The descriptions of indigenous vegetation presented in this strategy are based on vegetation types, using the methodology adopted by Atkinson (1985) in which the structural class and composition (dominant species) of vegetation are used to identify and name different plant communities. The vegetation types selected for Canterbury are derived from the unpublished Habitat Protection Strategy prepared for the Department by Ken Hughey (1992). Vegetation types are listed in Table 1.

Vegetation types are further defined by altitude and, in some situations, substrate. Altitudinal zones used in this report are:

- lowland: below 300m altitude
- montane: 300m to the natural timberline (1200-1400m: see overleaf)
- subalpine and alpine: above the natural timberline (see overleaf)

Nomenclature for species follows that proposed in the volumes of New Zealand Flora (Allan, 1961; Moore and Edgar, 1976; Webb, Sykes and Garnock-Jones, 1988; Edgar and Connor, 2000) and revisions listed in Connor and Edgar (1987). Common names of species are as listed in the Landcare Research Plant Names Database. Scientific names of species cited by common name in the text are listed in Section 8.

The original (pre-human) extent of indigenous vegetation has been deduced from published results of palaeoecological research (the study of fossil plants and animals), extrapolation of existing environmental data (geology, topography, soils, climate and vegetation), and an understanding of the effects of human settlement (especially the increased frequency of fire). All published information sources are referenced in the text. Estimates of the nature and extent of original vegetation are limited by the lack of data. This limitation is acknowledged to some degree by the use of six broad cover classes to describe the original extent of indigenous vegetation types, rather than the use of precise figures. Cover classes adopted for this analysis are:

- <1%
- 1-5%
- 6-25%
- 26-50%
- 51-75%
- 76-100%

The selection of 'original' (i.e. pre-human) vegetation as the baseline for analysis (rather than, for example, 1840) arises from the general purpose of the Reserves Act 1977 to ensure "…the preservation of representative samples of all classes of natural ecosystems and landscape which in the aggregate originally gave New Zealand its own recognisable character" (s.3(1)(b)). In selecting this baseline it is acknowledged that ecosystems change through natural evolution and natural disturbance events. Presumed natural changes (such as occasional natural fires) have been taken into account during the preparation of this strategy.

The present extent of indigenous vegetation was derived from the Land Cover Database (LCDB). The extent of the relevant LCDB categories was determined by computer analysis for each ecological district. LCDB categories analysed were indigenous forest, shrubland, tussock, coastal sand, coastal wetland, inland wetland and bare ground. The version of the LCDB used comprises images dating from 2003 (LCDB2). The ecological district boundaries used for analysis were those proposed by McEwen (1987).

Additional computer analysis provided estimates of the extent of subalpine and alpine vegetation, by calculating the area above the natural timberline in each ecological district. The altitudes of the natural timberlines throughout the Conservancy were generalised as follows:

- 1400m asl for northern ecological districts (Balaclava to Motunau)
- 1350m asl for mid-north ecological districts (Minchin to Whitecliffs)
- 1300m asl for mid-south ecological districts (High Plains to Two Thumb)
- 1200m asl for southern ecological districts (Godley to Lindis)

The extent of the LCDB categories within existing protected natural areas in each ecological district was calculated by computer analysis of the Department's database of legally-protected land at May 2009. This database includes all lands protected under the Acts administered by the Department of Conservation and privately-owned areas covenanted under the Queen Elizabeth the Second National Trust Act 1977. The database is updated weekly from the Gazette and other notifications.

The method adopted for the analysis of Conservancy-wide priorities for the protection of representative areas of indigenous vegetation is outlined in Section 5.

Abbreviations used in the strategy:

asl	above sea level (altitude)
c.	circa (approximately)
CMS	Conservation Management Strategy
DOC	Department of Conservation
ED	ecological district
ER	ecological region
ha	hectares
LCDB	Land Cover Database
m	metres
PNA	protected natural area
PNAP	Protected Natural Areas Programme
QEII	Queen Elizabeth II National Trust
RAP	recommended area for protection
UCL	Unoccupied Crown Land

3.0 ORIGINAL VEGETATION OF CANTERBURY

To determine land protection priorities for Canterbury it is necessary to describe the original indigenous vegetation of the Conservancy. This is fraught with difficulty. No written records exist of the vegetation that greeted the first humans, the Polynesian migrants, when they arrived in Canterbury. Even records of Canterbury's vegetation at the time of European settlement are patchy and incomplete. In parts of the region, especially lowland areas, no remnants of the original vegetation remain. In other less modified areas, plant and animal populations have been depleted by the depredations of introduced animals and competition with introduced plants. In relatively intact areas, information about plant communities and animal populations is often lacking. Only 24 of the 59 ecological districts in Canterbury have been systematically surveyed. The results of some surveys are dated and results of others are unpublished.

What is known, however, is human settlement of Canterbury had a dramatic effect on indigenous ecosystems. Initially, extensive areas of forest and scrub were destroyed by human-induced fire. Subsequently, further areas of forest were burnt or logged for timber. Land was cleared for grazing and cultivation, wetlands drained and new plant and animal species introduced. The present-day Canterbury landscape is very different from that which prevailed prior to human discovery and settlement.

Adding to the difficulty of determining the original vegetation of Canterbury is the fact that vegetation cover also changes in response to natural influences such as climate. A gradual warming of the climate is believed to have occurred from c.14,000 years ago, prompting the recession of glaciers and a transition to the present (Holocene) interglacial period (Fleming, 1979). During this period the strength and frequency of the westerly winds that affect the South Island probably changed also, influencing the extent and severity of storms and drought (McGlone and Moar, 1998).

Along with climate change have been dramatic changes in landform, due to recession of glaciers and a corresponding rise in sea level, and continued tectonic activity. The period of landform adjustment that followed the retreat of the glaciers probably lasted 3000 to 4000 years before a state of near-equilibrium with the ice-free environment was achieved, although post-glacial landform adjustment is still occurring in the high mountains of Canterbury. Relative stability of coastal landforms was probably achieved c.6000 years ago, once sea-level rise had slowed (Soons, 1994).

Ongoing tectonic activity and rock type continues to affect landforms in Canterbury. Earthquakes displace and loosen bedrock, leading to slope failure. Storm events dislodge weakened rock, transport and deposit rock debris, and cause flooding. Spectacular examples of catastrophic slope failure are present throughout the Canterbury mountainlands and have been recorded in detail in Arthur's Pass National Park (Cave, 1987). Large-scale deposition of debris also continues in coastal areas; three such depositional events having occurred in the last 1800 years (McFadgen, 1989).

Adding to this complex interplay of climate change, tectonic activity and vegetation change is the influence of fire. Radiocarbon dating of charcoal illustrates that fires occurred at different locations in Canterbury prior to human occupation. Burrows (1996) recorded evidence of fire occurring c.8880 and c.910 years ago in the Arrowsmith Range, c.2547 years ago in the Cass Basin and c.940 years ago at Erewhon in the Rangitata Valley. Burrows and Russell (1990) recorded evidence of fire occurring at five different times between 5800 and 860 years ago at another

location in the Arrowsmith Range. McGlone and Moar (1998) recorded evidence of fire occurring c.5000 years ago in the Mackenzie Basin.

However, in an assessment of the origin of indigenous grasslands of the southeast South Island, McGlone (2001) suggests that natural fires were likely to have been patchy and small-scale. The average return-period for fire was probably c.2000 years (Ogden *et al*, 1998) and fire would not have affected all areas. The evidence, McGlone suggests, points to the evolution of an eastern South Island flora that was drought-tolerant, but intolerant of fire.

At the time humans arrived in Canterbury, the vegetation had probably achieved some sort of post-glacial stability in most parts of the region. Landform change continued to affect vegetation in localised areas, especially in the high mountains, and infrequent natural fires affected vegetation in drought-prone areas. Climate continued to be the major large-scale influence on the extent and type of vegetation present in the region.

The arrival of Polynesian people in the South Island approximately 800 years ago coincided with a sudden increase in fires (McSaveney and Whitehouse, 1989) to which the vegetation was poorly adapted. Widespread vegetation change occurred, and there was insufficient time between fires for the original plant communities to re-establish. The situation was exacerbated when European settlers arrived, further depleting the indigenous vegetation of Canterbury.

A description of the original vegetation of Canterbury

Our present understanding of the type and extent of the original vegetation of Canterbury is based largely on the study of fossil plants and animals (palaeoecology). Palaeoecology provides information on the biota previously present in an area, and enables assessments of the environmental conditions that are likely to have prevailed at that time. Most data used to determine historic vegetation patterns are derived from the analysis of buried pollen and charcoal. Recent attempts to describe the original vegetation of Canterbury are summarised below. Data relevant to particular ecological districts are discussed in Section 4.

In a recent review of the origin of indigenous grasslands, McGlone (2001) uses the analysis of pollen deposits at several sites to describe the pre-human vegetation of the southeastern South Island. McGlone maps three broad vegetation zones that were present during the mid to late Holocene (5000 to 800 years ago), two of which covered southern Canterbury. The first, an open forest-scrub zone, occupied the plains and downs of South Canterbury. The second broad vegetation zone, a low forest-scrub-grassland zone, occupied the interior of South Canterbury west of the plains and including the foothills, the intermontane basins and the eastern ranges of the Southern Alps. A third, closed forest zone, occupied areas further south and west in Southland and Otago.

The open forest-scrub zone supported a highly variable vegetation mosaic of forest with widely-spaced podocarp trees over a mixed hardwood canopy, interspersed with extensive patches of scrub and grassland. Matai and totara were the main podocarps, with lowland ribbonwood and narrow-leaved houhere the common angiosperm trees. Scrub dominants were species of *Coprosma, Myrsine, Phyllocladus, Halocarpus* and *Muehlenbeckia* (McGlone, 2001).

The interior low forest-scrub-grassland zone supported three main vegetation types. Scrub and grassland, dominated by mountain toatoa, bog pine and grasses (species of *Chionochloa, Poa, Festuca* and *Elymus*), were present in intermontane basins and on

lower slopes. Grasslands probably formed the dominant cover in intermontane basins where annual rainfall was less than 500mm. Low forest and scrub, dominated by mountain totara, mountain toatoa and bog pine, with areas of silver beech at the timberline and minor areas of mountain beech and kanuka, prevailed on the range slopes. Scrub and grassland, dominated by *Coprosma, Myrsine, Poa, Festuca,* and *Chionochloa,* were also present above the timberline (McGlone, 2001).

In summary, McGlone (2001) proposes that lowland eastern South Canterbury supported savannah-like vegetation in which stands of trees were separated by scrub and grassland, and the interior of South Canterbury supported grassland and scrub with a low-stature forest on hill slopes. Within these generalised vegetation zones were areas of taller forest along rivers, in moist gullies and on some south-facing slopes. However, tall podocarps (other than mountain totara) appear to have been largely absent from drier inland areas in South Canterbury. Tall tussock (*Chionochloa*) species were largely confined to alpine areas in the wetter western mountains. Areas of grassland in the drier intermontane basins were dominated by species of *Poa, Festuca, Elymus* and *Rytidosperma* (McGlone, 2001).

Attempts have been made to describe the pre-human vegetation of other parts of Canterbury, such as recent work by Leathwick (2001) and earlier work by McGlone (1989). These studies suggest that podocarp or podocarp-hardwood forest and scrub were present on the Canterbury Plains and Amuri Basin, podocarp-hardwood forest dominated inland basins and valleys of mid-Canterbury, and beech forest dominated the inland valleys and ranges of North Canterbury. More recent work (McGlone, 2001) suggests that grassland and scrub were more extensive on the plains and inland basins than previously thought.

Detailed analyses of pollen deposits in the Rakaia Valley of mid Canterbury (Moar, 1973; Burrows and Russell, 1990; Burrows, 1995) indicate that beech forest was relatively extensive in the northern and eastern parts of the upper Rakaia Valley. Mountain toatoa scrub and mountain totara forest were dominant in the headwater tributaries, where colder wetter conditions prevailed, and matai and other trees were present at warmer sites in the lower valley. Analysis of pollen deposits further south, in upland valleys of the Arrowsmith Range, indicates that low forest-scrub dominated by mountain toatoa was present. Mountain totara, matai and hardwood tree species were also present (Burrows *et al*, 1993).

Further north, analyses of pollen and charcoal from sites in the Waimakariri Basin (Molloy, 1964; Moar 1971) indicate that beech forest was dominant. Extensive areas of beech forest are still present north of the Waimakariri Basin, throughout the inland ranges of North Canterbury. Analysis of pollen from Lake Tennyson, at the northern boundary of the Canterbury Conservancy, indicates that mountain toatoa-bog pine shrubland was dominant, though beech forest is present in the upper Waiau Valley just west of this area (McLea, 1996). McGlone and Basher (1995) also suggest that mountain totara forest was dominant in the upper Awatere Valley (Molesworth). Areas of mountain toatoa and mountain lacebark forest, and isolated patches of beech forest were also present.

Coastal North Canterbury supported a more diverse vegetation, with mixed podocarp-hardwood forest at warm low altitude sites and beech forest on upper hill slopes in the Waikari area (Holdaway and Worthy, 1997). Mixed podocarp-hardwood forest was present on the coastal plain north of Banks Peninsula and below 500m altitude on Banks Peninsula. Mountain totara-hardwood forest and kaikawaka forest were present above 500m altitude on Banks Peninsula, and areas of beech forest were present at southeastern parts of the peninsula (Wilson, 1992).

The studies cited above provide a broad picture of the vegetation types present in Canterbury prior to the arrival of humans. More detailed descriptions of the vegetation are possible by investigating remnants of indigenous vegetation and extrapolating the local climate and landform data. This is attempted in Section 4, in the descriptions of each ecological district.

Table 1: Vegetation types of Canterbury and LCDB classes

No.	Type	Dominant Components	LCDB Class
	Forest		
1	coastal hardwood	five-finger, akeake	Indigenous forest
2	podocarp-hardwood (wet)	kahikatea, matai, totara, rimu	
3	podocarp-hardwood (dry)	matai, totara	
4	lowland hardwood	kowhai, lowland ribbonwood	
5	montane hardwood	broadleaf, putaputaweta	
6	kanuka	kanuka	
7	mixed beech	red beech, silver beech, mountain beech	
8	mountain beech	mountain beech (black beech in NE)	
9	silver beech	silver beech	
10	mountain totara	mountain totara	
11	kaikawaka-hardwood	kaikawaka	
	Treeland		
12	kowhai	kowhai, ti	Indigenous forest
13	mountain lacebark	mountain lacebark	
	Scrub/Shrubland		
14	manuka-kanuka	manuka, kanuka	scrub
15	matagouri (grey)	matagouri, Coprosma, korokio	
16	mixed Hebe (green)	Hebe, tauhinu, Olearia, Coprosma	
17	bog pine	bog pine	
18	mountain toatoa	mountain toatoa, snow totara	
19	mixed inaka	inaka, snow totara	
	Tussockland/Grassland		
20	grassland	danthonia (Rytidosperma)	tussock
21	short tussockland	fescue tussock	
22	silver tussockland	silver tussock	
23	red tussockland	red tussock	
24	tall tussockland	slim, midrib, br-leaved or narrow-leaved	
25	flaxland/fernland	mountain flax	
	Sedgeland/Rushland/Reedland/Cushionfield (wet)		
26	coastal/saline		coastal wetland
27	inland wetland	flax, raupo, Carex, Juncus, Schoenus	inland wetland
28	inland cushionfield	wire rush, comb sedge, turf	
	Cushionfield/Herbfield/Mossfield/Lichenfield (dry)		
29	coastal		
30	lowland-montane		
	Rockland/Boulderfield/Gravelfield/Sandfield		
31	coastal rockland		bare ground
32	coastal sandfield (dune)		coastal sand
33	coastal gravel/boulder		bare ground
34	lowland-montane rock		
35	gravelfield (scree, riverbed, lakeshore)		
	Alpine		alpine (above natural timberline)
36	All alpine communities		

4.0 THE INDIGENOUS VEGETATION OF EACH ECOLOGICAL DISTRICT

In this section of the strategy the nature and extent of indigenous vegetation, both original and present, is described for each of the 59 ecological districts that lie wholly or partly within Canterbury Conservancy. Estimates of the original extent of vegetation types have been compiled from published data, extrapolation of environmental data and from an understanding of the changes wrought since human settlement. The method employed for this assessment is described in Section 2. Also described are the main existing protected natural areas and the significant opportunities for further protection in each ecological district.

Ecological districts are analysed in this section of the report in the order that they are described by McEwen (1987), beginning with Balaclava Ecological District (ED) in the north and ending with Huxley ED in the south. Some EDs that lie across the Conservancy boundary are grouped together for analysis. This analysis covers only the EDs, or parts of EDs, within Canterbury Conservancy.

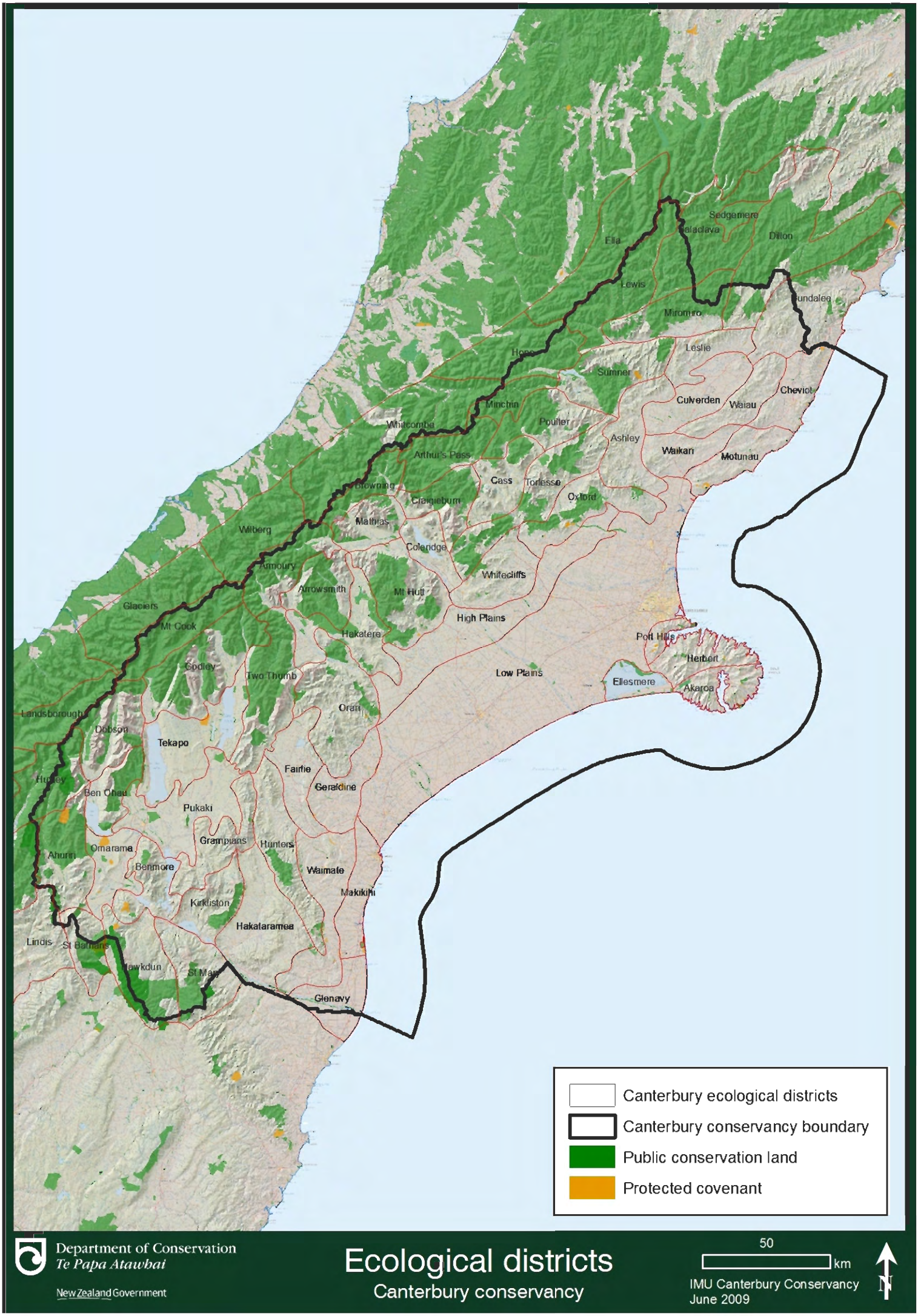
A more detailed analysis of the present extent of indigenous plant communities, and the extent to which each of these communities is protected, is presented in a table for each ecological district.

In this analysis estimates for montane and lowland vegetation types are allocated to one of six cover classes in the third column of each table. All alpine and subalpine vegetation types are grouped together. The extent of the alpine zone is presented as an actual figure derived from computer analysis of the area above the natural timberline in each ED. Vegetation types that are believed to have originally occupied only a very small proportion (<1%) of the ED are in most cases excluded from the estimates presented in the tables. Protection of these vegetation types is addressed in Section 5.

Estimates of the present extent of indigenous vegetation types are derived from computer analysis of the percentage cover of each of the Land Cover Database (LCDB) categories in each ED. The indigenous vegetation types included in each LCDB category are listed in Table 1.

The present extent of the LCDB categories for each ED is listed in the fourth column of each table. The proportion of the present extent of each LCDB category within existing protected natural areas is listed in the fifth column of each table. These figures were generated by computer analysis to two decimal places. In the tables the figures are rounded to the nearest whole percent, except figures below 1% (which are recorded as <1%) and those figures between 99.5% and 99.99% (which are recorded as <100%).

The present extent of the LCDB categories may not total 100% in a table. In most cases this is due to the presence of other LCDB categories that are not listed in the table, such as urban areas, exotic forest, pasture and open water. In other cases the reason for this discrepancy is unclear.


Sedgemere
Balaclava
Dillon
Ella
Lewis
Hundalee
Miromiro
Leslie
Hora
Sumner
Cheviot
Culverden
Waiau
Minchin
Poulter
Whitcomba
Ashley
Waikari
Motunau
Arthur's Pass
Cass
Torlesse
Oxford
Browning
Craigieburn
Wilberg
Mathias
Colendge
Armoury
Whitecliffs
Arrowsmith
Mt Hutt
Glaciers
High Plains
Mt Cook
Hakatere
Port Hills
Herbert
Codley
Two Thumb
Low Plains
Ellesmere
Akaroa
Oram
Landsborough
Dobson
Tekapo
Fairlie
Hunter
Geraldine
Ben Ohau
Pukaki
Grampians
Hunters
Ahuriri
Omarama
Benmore
Waimate
Makikihi
Kirkliston
Hakataramea
Lindis
St Bathans
Hawkdun
St Mary
Glenavy
Canterbury ecological districts
Canterbury conservancy boundary
Public conservation land
Protected covenant
Department of Conservation
Te Papa Atawbai
New Zealand Government
Ecological districts
Canterbury conservancy
50
km
IMU Canterbury Conservancy
June 2009
N

4.1 BALACLAVA ECOLOGICAL DISTRICT (43.02)

Location and physical description

The part of Balaclava ED that lies within Canterbury Conservancy covers the mountainous country of the St James Range, between the upper Clarence River in the east and the upper Waiau River in the west. It borders the main divide of the Southern Alps in the north, at Belvedere Peak (2108m), and the Edwards Valley in the south. It comprises strongly indurated greywacke and argillite of the Torlesse Group rocks (Bowen, 1964) forming extensive open summits at 1800 to 2000m above sea level (asl), with steep slopes. The main valleys lie at 700 to 1000m asl and are mostly V-shaped except for some glaciated U-shaped headwater tributaries in the north of the district (Courtney and Arand, 1994). Main tributary rivers are the Stanley, including Lake Guyon, and the headwaters of the Clarence River, including Lake Tennyson.

The ED boundary used for this analysis is that proposed by Courtney and Arand (1994). This boundary differs slightly from that proposed by McEwen (1987) by the inclusion of the headwaters of the Clarence River (above Lake Tennyson); McEwen included this area in the Lewis ED.

Original (pre-human) vegetation

Analysis of pollen from peat at Lake Tennyson indicates that pre-human vegetation of the surrounding area comprised beech forest and scrub; the latter community was dominated by mountain toatoa and bog pine, with smaller occurrences of *Coprosma* and *Dracophyllum* (McLea, 1996). Analysis of buried wood and charcoal from the Molesworth area shows that both beech and mountain toatoa were present in the Clarence Valley just east of this part of the Balaclava ED (Basher, 1990). It appears from these analyses that beech forest was present, but not as widespread as it is west of the Waiau River. Climate (mainly lower rainfall) and the frequency of natural fire are likely to have limited the post-glacial spread of beech forest in the east of the district and allowed the continued dominance of scrub and grassland communities.

In the Protected Natural Areas Programme (PNAP) survey report for the Balaclava ED, Courtney and Arand (1994) suggest that the vegetation of the lower altitude mountain slopes was probably a mosaic of low forest, mixed scrub and tussockland. Important woody species were likely to have been mountain toatoa, mountain lacebark, and shrub species. Mountain beech forest was probably present as small scattered stands, though more extensive in the west of the district (Waiau catchment). Valley floors were dominated by shrubland or scrub, recent alluvial sites by short tussockland, and alpine areas and scree dominated by tall tussockland, herbfield, turfland and rockland, much as they are today (*ibid*).

Existing (present-day) vegetation

The original vegetation of the district appears to have been substantially modified by the increased frequency of fires since the arrival of humans. Forest, treeland and most shrubland communities have been reduced in extent. Mixed *Hebe* shrubland, manuka-kanuka shrubland and montane tall tussockland communities are likely to have increased in extent, occupying areas that formerly supported forest and mountain toatoa shrubland.

Other tussockland communities have probably increased in extent, at the expense of shrubland and forest, though this is difficult to determine. Montane wetlands have been modified by grazing, but do not appear to have been drained. Alpine and rockland/gravelfield plant communities are probably still present at their approximate former extent, though are partly modified.

Extent of plant communities: Balaclava ED*				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
8	mountain beech forest	6-25	2	99
13	mountain lacebark treeland	1-5		
15	matagouri scrub	1-5	47	98
16	mixed *Hebe* scrub	6-25		
17	bog pine shrubland	1-5		
18	mountain toatoa shrubland	6-25		
21	short tussockland	1-5	10	91
23	red tussockland	1-5		
24	montane tall tussockland	1-5		
27	wetland	<1	<1	96
34	montane rockland	6-25	15	96
35	stonefield (scree, riverbed)	1-5		
36	alpine zone	25	25	

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas

The recent purchase of St James Pastoral Lease by the Crown has resulted in the almost complete protection of this ecological district. Two earlier protected natural areas in the part of Balaclava ED that lies within Canterbury Conservancy are Lake Tennyson and Lake Guyon scenic reserves. Both reserves cover the lakes and their margins, protecting lakeshore gravel plant communities. A small part of the southwest corner of the ED is protected within Lake Sumner Conservation Park.

Opportunities for further protection or restoration of original ecosystems

No further opportunities were identified during this analysis; more than 96% of the ED within Canterbury Conservancy is protected.

4.2 MIROMIRO ECOLOGICAL DISTRICT (43.03)

Location and physical description

Miromiro ED covers the Poplars Range, Hanmer Range and the adjoining Hanmer Basin in North Canterbury. It borders the mountains of Molesworth to the north, the valley formed by the Waiau and Hanmer rivers to the south, the western end of the Poplars Range at Boyle River to the west, and the southern end of the Seaward Kaikoura Range at Mt Tinline to the east. The ED boundary used for this analysis is that proposed by Courtney and Arand (1994). This boundary differs from that proposed by McEwen (1987) by the inclusion of the southern end of the Seaward Kaikoura Range, south of Mt Tinline; McEwen included this area in the Dillon ED.

The district comprises moderately to strongly indurated greywacke and argillite of the Torlesse Group rocks (Bowen, 1964) with glacial outwash gravels in the Hanmer Basin and minor areas of Cookson Volcanics near the Lottery River in the east (Gregg, 1964). Landforms are mountainous with steep dissected slopes, except for the broad Hanmer Plain on the valley-floor between Hanmer Springs and the Waiau River. Major summits on the Poplars and Hanmer ranges lie between 1600m and 1800m asl. The lowest elevation in the district is 300m at the southern edge of the Hanmer Plain. Streams and rivers in the district form tributaries of the Clarence River to the north and the Waiau River to the south.

Approximately one-fifth of the Miromiro ED, as defined by McEwen (1987), lies outside the Canterbury Conservancy. This northeastern corner of the district was covered by the Molesworth PNAP survey, and a large part of it recommended for protection (Courtney and Arand, 1994).

Original (pre-human) vegetation

There is little information on the original vegetation of the Miromiro ED. However, it appears likely that most montane slopes would have supported mountain beech forest; remnants of such forest are present in all parts of the district. Courtney and Arand (1994) suggest that mountain beech forest was dominant throughout the ED, and McEwen (1987) also describes the district as supporting mountain beech forest with pockets of red beech and silver beech.

Analysis of charcoals buried in colluvium has revealed the early presence of mountain toatoa (c.7500 years ago) near the Amuri Skifield, in the centre of the ED, and mountain totara (c.9200 years ago) near the eastern boundary of the district (Basher, 1990). Analysis of macrofossils in the Doubtful Valley just west of the ED indicates that about 11,000 years ago mountain toatoa dominated the hillside scrub, and woolly moss and matagouri were common on the valley floor (Burrows, 1997). However, the vegetation of the area would have changed between the time of these analyses and the arrival of humans: the most important change being the gradual advance of beech forest across the district, either from the west or from glacial refuges within the district.

Mountain beech would have been the dominant plant community on hill slopes beneath approximately 1400m altitude. Areas of mixed beech forest were probably present at warm valley-floor or lower-slope sites, and minor areas of hardwood (broadleaf-kowhai-putaputaweta) forest present along rivers and in gullies. Mountain totara forest is likely to have been present in the east of the district, and possibly small areas of manuka and kanuka scrub at low altitudes throughout the district. Minor areas of kahikatea-matai-beech forest were present in the east of the district along the Lottery River.

Valley floor sites, notably on the Hanmer Plain, are likely to have supported a mosaic of river gravels, short tussockland, matagouri scrub, mixed scrub, mossfield, and possibly savannah treeland. Rock bluffs, screes, and minor areas of mixed scrub and *Dracophyllum* scrub were present on montane slopes. Alpine plant communities would have present in similar proportions to those present today.

Existing (present-day) vegetation

The original vegetation of the district has been extensively modified by the increased frequency of fires since the arrival of humans. Mountain beech forest has largely disappeared from north-facing slopes, and is substantially depleted on many south-facing ridges. At drier sites, forest has been replaced by manuka-kanuka scrub/low forest; at moister sites it has been replaced by mixed *Hebe* shrubland, *Dracophyllum* scrub or tall tussockland.

At lower altitudes, especially in the Waiau Valley and Hanmer Plain, land has been developed for farming and forestry, completely displacing the original plant communities. Exotic plantations within Hanmer Forest occupy approximately 4500 ha on gentler hill slopes north and east of Hanmer Springs. Riverbed communities remain largely undeveloped, though are considerably modified by the establishment of aggressive introduced species such as broom.

Alpine and rockland plant communities are probably still present in proportion to their former extent, though are modified by introduced plants and animals, including wilding conifers near Hanmer Forest.

Extent of plant communities: Miromiro ED*				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	kahikatea-matai-beech forest	1-5	17	87
7	mixed beech forest	1-5		
8	mountain beech forest	51-75		
10	mountain totara forest	1-5		
14	manuka and kanuka scrub	1-5	34	68
16	*Hebe* matagouri shrubland	1-5		
18	mountain toatoa shrubland	1-5		
21	short tussockland	1-5	14	62
24	montane tall tussockland	1-5		
27	wetland	<1	<1	76
34	montane rockland	1-5	9	65
35	stonefield (scree, riverbed)	1-5		
36	alpine zone	8	8	

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas

Just over one-third (38%) of this part of Miromiro ED is protected as public conservation land, mainly within Hanmer Forest Park (9394 ha), Jollies Pass Scenic Reserve (2124 ha), Woodbank Run Conservation Area (1413 ha), part of Hossack Crown Land Management Area, and part of Lake Sumner Conservation Park. Smaller protected areas include marginal strips along the Waiau, Hanmer and Percival rivers, and land around the Hanmer Visitor Centre. Recent acquisition of parts of Poplars Pastoral Lease through the Nature Heritage Fund and protection of St James Pastoral Lease and Molesworth Station have increased the proportion of the ED protected to over half (58%).

These protected natural areas protect mountain beech forest, scrub and shrubland communities, tall tussockland, rocklands, scree and alpine plant communities. Marginal strips may include areas of gravelfield, though there is little information about these areas.

Opportunities for further protection or restoration of original ecosystems

Areas of beech forest, shrubland, tussockland and river-flat matagouri shrubland remain unprotected on parts of Poplars and Glenhope pastoral leases. Unprotected lands in the west of the ED are effectively enclaves within existing protected natural areas. Smaller areas of kanuka scrub/low-forest, wetland and gravelfield may still be present and may provide opportunities for protection or restoration in the Hanmer Basin.

4.3 DILLON, MANAKAU AND WAIAUTOA ECOLOGICAL DISTRICTS (44.02, 44.03, 44.04)

Location and physical description

These three EDs cover the Inland Kaikoura and Seaward Kaikoura ranges. Only a small part of each ED lies within Canterbury Conservancy, so they are grouped together for this analysis, forming a total area within the conservancy of approximately 17,000 ha.

This area covers the north-facing slopes on the eastern end of the Hanmer Range, and the southern end of the Seaward Kaikoura Range. It comprises moderately indurated greywacke and argillite of the Torlesse Group rocks with minor areas of glacial outwash gravel in valley bottoms (Gregg, 1964). The main summits lie between 1500 and 1750m and are characterised by extensive areas of open rocklands and scree. The area includes the catchments of the Hossack River, Tinline Creek and Winterburn Stream (all tributaries of the Clarence River), and part of the Conway and Mason river catchments on the eastern flank of the Seaward Kaikoura Range.

The ED boundaries used for this analysis are those proposed by Courtney and Arand (1994) and Moore (1999). These boundaries differ from those proposed by McEwen (1987) by the exclusion of the southern end of the Seaward Kaikoura Range (south of Mt Tinline), and exclusion of the area east of the Lottery River; McEwen included these areas in the Dillon and Manakau EDs respectively.

Original (pre-human) vegetation

Analysis of pollen in peat at a site in the upper Awatere Catchment, and of wood and charcoal from sites throughout Molesworth, indicate that the upper parts of the Awatere Catchment were almost entirely covered with forest or scrub 1000 years ago (McGlone and Basher, 1995). Matai-dominated podocarp-hardwood forest may have been present on valley floors, mountain totara forest dominated upper slopes, mountain toatoa scrub was present at the timberline, and mountain lacebark was probably also common (*ibid*).

In the PNAP survey report for the Dillon ED, Courtney and Arand (1994) suggest that the pre-human vegetation was probably a mosaic of forest, scrub and tussockland. Forest would have been predominantly mountain totara forest, with scattered mountain lacebark treeland, and pockets of mountain beech forest in the south of the district. Alpine areas were probably much the same as they are today: dominated by tall tussockland, turfland, gravelfield and rockland.

The area within Manakau ED, on the eastern flank of the Seaward Kaikoura Range, is likely to have supported mountain beech forest, with some areas of mixed beech forest and podocarp forest at lower altitudes. Early accounts of this area indicate the presence of beech forest with some podocarp trees (Johnston, 1961).

Accounts of the vegetation of the Inland Kaikoura Range by Williams (1989), and of the Seaward Kaikoura Range by Wardle (1971), do not cover the area within Canterbury Conservancy. However, it appears that area forms part of the transition between the mountain beech forests of North Canterbury and the mountain totara forests of inland Marlborough.

Existing (present-day) vegetation

Indigenous vegetation in the Clarence Catchment was substantially depleted by the increased frequency of fire after the arrival of humans (McGlone and Basher, 1995). Forest and scrub communities in many areas were probably replaced by tussockland, flaxland and scattered shrubland. Later burning and grazing associated with European settlement depleted the vegetation further, leading to an increase in grassland, *Raoulia* cushionfield and bare ground (Courtney and Arand, 1994).

On the eastern flank of the Seaward Kaikoura Range, within Manakau ED, human-induced disturbance was less extensive due primarily to higher rainfall. Forest cover is still present in the main valleys and on higher slopes.

Throughout the area, alpine communities are probably present in approximately the same proportion as they originally were, though they have been modified by burning, grazing and skifield development (at Mt Terako).

Extent of plant communities: Dillon, Manakau and Waiautoa EDs*

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	podocarp-hardwood forest	1-5	6	56
8	mountain beech forest	6-25		
10	mountain totara forest	26-50		
13	mountain lacebark forest	1-5		
16	*Hebe* matagouri shrubland	1-5	21	30
18	mountain toatoa scrub/forest	6-25		
24	montane tall tussockland	1-5	13	33
34	montane rockland	1-5	8	61
35	stonefield (scree)	1-5		
36	alpine zone	7	7	52

*This analysis covers the parts of the EDs that lie within Canterbury Conservancy.

Existing protected natural areas

The only significant protected natural area within this part of these three EDs is the Hossack Crown Land Management Area. This covers approximately 1200 ha, protecting areas of mountain beech forest, tall tussockland and alpine plant communities. The only other protected areas are marginal strips along the Clarence, Winterburn and Towy rivers.

Opportunities for further protection or restoration of original ecosystems

Just over one-third (37%) of the parts of these EDs that lie in Canterbury Conservancy is protected. The main opportunities for further protection are forest remnants and associated shrubland and tussockland along the Lottery River at the southeast edge of the ED. There are opportunities for further protection of alpine systems in the vicinity of Mt Terako.

4.4 LEWIS ECOLOGICAL DISTRICT (49.04)

Location and physical description

The Lewis ED covers the mountains and valleys lying just east of the main divide of the Southern Alps, between Waiau Pass in the north and Amuri Pass in the south. It covers the headwater catchment of the Waiau River, including the Ada, Henry, Boyle, Lewis, Nina and Doubtful river valleys.

The district comprises strongly indurated greywacke and argillite of the Torlesse Group rocks, with minor areas of volcanics, and areas of glacial outwash and river gravel on valley floors (Bowen, 1964; Gregg, 1964). Major summits along the main divide are at 1800 to 2300m asl, with the highest peaks (Gloriana, Faerie Queene, Una and Duessa) forming the Spenser Mountains in the north-west of the district. The main valley floors lie between 600 and 800m asl and are generally broad.

Original (pre-human) vegetation

The presence of beech forest throughout the Lewis ED today provides ample evidence that it was the dominant vegetation type at the time of the arrival of humans. Analyses of macrofossils at a site in the lower Doubtful Valley (Burrows, 1997) and of buried pollen at Lake Tennyson (McLea, 1996) indicate that, since the retreat of glaciers, the mountain toatoa scrub that was initially dominant was gradually replaced by beech forest. It appears that, in pre-human times, the eastern tributaries of the upper Waiau River (within the adjoining Balaclava ED) represented the eastern distribution limit of beech forest in the area (Courtney and Arand, 1994; McLea, 1996).

Mixed red beech-silver beech-mountain beech forest was present on lower slopes and terraces throughout the district. Mountain beech-silver beech forest covered most montane slopes. Mountain beech forest formed the timberline forests and was present at colder valley-floor sites (Alexander *et al*, 1979; Guest and Wilkinson, 1977). Smaller areas of hardwood forest dominated by broadleaf and/or kowhai may have been present at low-altitude sites, especially along riverbanks and on bluffs. Valley floors supported a mosaic of matagouri shrubland on recent alluvium, bog pine shrubland or mountain toatoa scrub on cold infertile terraces, mixed *Hebe* or *Olearia* shrubland, short tussockland, *Carex* wetland and cushionfield.

Alpine plant communities were probably much as they are today, including tall tussockland, herbfield, cushionfield and rockland. *Dracophyllum* scrub was present at the timberline. Riverbeds supported open gravelfield and mossfield. Rockland was present at steep montane sites.

Existing (present-day) vegetation

Indigenous vegetation in the west of the district along the main divide is probably much as it was in pre-human times, except for the modification of some plant communities on valley floors. In the east of the district, along the Waiau and Hope rivers, forest has been removed from lower slopes by fire and replaced by pasture, matagouri shrubland, or manuka and kanuka scrub.

The original valley-floor short tussockland in the east has been substantially altered, though still retains much of its natural character. There appears to have been only very limited cultivation or drainage, though infestations of broom and rowan threaten low-altitude plant communities.

Extent of plant communities: Lewis ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
7	mixed beech forest	6-25	45	99
10	mountain beech forest	26-50		
15	matagouri shrubland	1-5	9	96
16	mixed *Hebe-Olearia* shrubland	1-5		
18	mountain toatoa-inaka scrub	1-5		
21	short tussockland	1-5	16	94
24	montane tall tussockland	<1		
35	stonefield (riverbed, scree)	1-5	3	91
36	alpine zone	27	27	

Existing protected natural areas

Almost all (96%) of the Lewis ED is protected within contiguous protected natural areas: Lewis Pass Scenic Reserve, Lake Sumner Conservation Park, Nina-Doubtful River Conservation Area, Lower Doubtful and Boyle River Conservation Area and the recently-protected (through the Nature Heritage Fund) parts of Poplars and St James pastoral leases. The portion of Ella ED that lies within Canterbury Conservancy is completely protected.

Opportunities for further protection or restoration of original ecosystems

The only significant opportunities for further protection are matagouri shrubland on river flats, small areas of mixed riparian hardwood forest and manuka scrub on the remaining lower-altitude parts of Poplars Pastoral Lease.

4.5 HOPE ECOLOGICAL DISTRICT (49.05)

Location and physical description

The part of Hope ED that lies within Canterbury Conservancy covers the mountainous country east of the main divide of the Southern Alps between Amuri Pass in the north and Harper Pass in the south. It includes the upper catchment of the Hope River west of the Kiwi River confluence and the upper catchment of the Hurunui River west of Lake Sumner. The main summits along the main divide lie between 1500 and 1750m asl; valley floors mostly lie between 550 and 700m asl.

The ED comprises greywacke and argillite of the Torlesse Group rocks, with areas of glacial outwash gravel and recent alluvial deposits on valley floors (Gregg, 1964). The district has relatively gentle relief for the Southern Alps, with rounded summits, moderately steep slopes and broad valley-floors.

Original (pre-human) vegetation

The widespread presence of beech forest throughout Hope ED today indicates it was the dominant vegetation type at the time of the arrival of humans. Mixed red beech-silver beech-mountain beech forest was present on lower slopes, terraces and some valley floor sites throughout the district. Mountain beech-silver beech forest covered most montane slopes. Mountain beech forest formed the timberline forests and was present at cold valley-floor sites (Guest and Wilkinson, 1977). Kaikawaka-hardwood forest was present in isolated stands near the main divide, and smaller areas of

hardwood forest dominated by broadleaf and/or kowhai may have been present at low-altitude sites, especially along riverbanks and on bluffs.

Valley floors supported a mosaic of matagouri shrubland on recent alluvium, bog pine shrubland or mountain toatoa scrub on cold infertile terraces, mixed *Hebe* or *Olearia* shrubland, short tussockland, *Carex* wetland and cushionfield.

Alpine plant communities were probably much as they are today, with tall tussockland, herbfield, cushionfield and rockland. *Dracophyllum* and mountain toatoa scrub was present at the timberline. Riverbeds supported open gravelfield and mossfield, and rockland was present at steep montane sites.

Existing (present-day) vegetation

Indigenous vegetation in the west of the district along the main divide is probably much as it was in pre-human times. Use of the main valleys as routes over the main divide and continued grazing of the valley floors have modified low-altitude plant communities. More recently, matagouri shrubland in the Hurunui Valley has been sprayed with herbicide.

In the east of the district, nearer Lake Sumner, forest has been removed from lower slopes by fire and replaced by pasture, bracken fernland, or manuka and kanuka scrub. The original valley-floor short tussockland in the east has been substantially altered, though still retains much of its natural character. There are also infestations of gorse and hawthorn in the Hurunui Valley near Lake Sumner.

Extent of plant communities: Hope ED*

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
7	mixed beech forest	6-25	50	94
10	mountain beech forest	26-50		
11	kaikawaka-hardwood forest	1-5		
14	manuka-kanuka scrub	<1	12	99
15	matagouri-*Hebe* shrubland	1-5		
18	mountain toatoa-inaka scrub	6-25		
21	short tussockland	1-5	20	93
24	montane tall tussockland	<1		
35	stonefield (riverbed, scree)	1-5	3	55
36	alpine zone	14	14	100

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas

A significant proportion of Hope ED is protected within Lake Sumner Conservation Park and recently-protected valley floors that were formerly part of Poplars Pastoral Lease. Smaller areas are protected within Lake Sumner Conservation Area and marginal strips along the Hurunui River.

Opportunities for further protection or restoration of original ecosystems

A significant proportion (c.94%) of the ED is protected. Opportunities for further protection are areas of low-altitude beech forest, shrublands and depleted valley-floor grasslands above Lake Sumner. Property boundaries on the valley floors are generally unfenced, so forest margins on public conservation lands are largely unprotected from the effects of domestic stock.

4.6 HUNDALEE ECOLOGICAL DISTRICT (52.01)

Location and physical description

The part of Hundalee ED that lies within Canterbury Conservancy covers the hill country north-east of Waiau in North Canterbury, between Conway River in the east and the southern end of the Seaward Kaikoura Range in the north and west. Its southern boundary is along low hills between the Stanton and lower Leader rivers, adjoining Waiau ED to the south.

This part of the ED comprises greywacke and argillite of the Torlesse Group rocks in the west, and softer rocks (siltstone, sandstone, conglomerate and limestone) in the east along the Lottery and Mason valleys (Lensen, 1962; Gregg, 1964). Hills are low, steep-sided and dissected by narrow valleys. Major summits lie between 500 and 990m asl, and the main valleys between 100 and 350m asl. The eastern part of the district within Canterbury Conservancy is drained by tributaries of the Conway and Leader rivers; the western part by tributaries of the Lottery, Wandle and Mason rivers.

The ED boundary used for this analysis is that proposed by Moore (1999). This boundary differs slightly from that proposed by McEwen (1987) by the inclusion of low hill country between the Little Lottery River, Counting Brook and Dog Brook in the west of the district; McEwen included this area in Leslie ED.

Original (pre-human) vegetation

The Hundalee ED was surveyed as part of the PNAP during 1996 and 1997. In the survey report Moore (1999) proposes that the pre-human vegetation of the district, between the coastal hills and the inland ranges, comprised beech forest in steeper dry areas and podocarp forest on poorly drained terrain. Hardwood (broadleaved) forest and scrub associations were probably present on coastal hills, though these areas may have originally supported beech forest as Moore (1999) states that it is difficult to distinguish between original and induced forest and scrub.

Existing (present-day) vegetation

The original vegetation of Hundalee ED has been substantially modified since the arrival of humans. The increased frequency and extent of fires reduced most of the original plant communities and later land development for farming further depleted the indigenous vegetation.

Extensive areas are now farmed, and forest remnants tend to be confined to steep-sided valleys. At other sites manuka-kanuka scrub, mixed scrub, fernland, grassland and exotic treeland communities dominate areas previously occupied by indigenous forest. Introduced woody weeds, such as broom, have colonised large areas, especially in the southeast of the district.

In the PNAP survey report Moore (1999) identified eighteen vegetation types, fourteen of which are relevant to the analysis of indigenous vegetation in this part of the ED.

Extent of plant communities: Hundalee ED*				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	matai-kahikatea forest	6-25	4	20
4	lowland mahoe forest	1-5		

7	mixed beech forest	26-50		
8	black beech-mtn beech forest	26-50		
10	mountain totara treeland	1-5		
14	manuka-kanuka scrub/forest	1-5	31	1
16	mixed scrub	1-5		
24	tall tussockland	1-5	24	<1
32	coastal sandfield	<1	<1	0
34	rockland and stonefield	1-5	3	5

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas

There are seven protected natural areas in the part of the ED within Canterbury Conservancy. These areas support black beech-mountain beech forest, mixed beech forest, podocarp forest, manuka-kanuka scrub, mixed shrubland, rockland, kowhai treeland and *Carex* sedgeland. Four of these areas are public conservation land, covering a total area of 470 ha, and three are Open Space (QEII) Covenants, covering a total area of 62 ha.

Opportunities for further protection or restoration of original ecosystems

Approximately 2% of the ED within Canterbury Conservancy is protected. Opportunities for protection are bush remnants in the Wandle and Lottery valleys, beech forest in the upper Leader and Conway valleys, possibly remnant limestone plant communities on The Battery and Whales Back Ridge and other small forest remnants in gullies.

4.7 LESLIE ECOLOGICAL DISTRICT (52.02)

Location and physical description

Leslie ED covers the low-lying Amuri Range and adjacent Culverden Range, between the Culverden and Hanmer basins in North Canterbury. It borders the Pahau River catchment in the west and Counting Stream near Waiau in the east. It comprises moderately to strongly indurated greywacke and argillite of the Torlesse Group rocks, with minor areas of glacial outwash gravel at low altitudes, and some limestone, sandstone, conglomerate and marble near Broom Stream (Gregg, 1964; McEwen, 1987).

The ED covers moderately steep ranges with summits between 700 and 1000m asl. Flanks of the Amuri Range face southeast and northwest, and the flanks of the Culverden Range, in the west of the district, face east and west. The area is drained by tributaries of the Waiau and Hanmer rivers in the east, and by the Pahau River in the west.

The ED boundary used for this analysis is that proposed by Moore (1999). This boundary differs from that proposed by McEwen (1987) by the exclusion of an area of low hill country in the east of the district; Moore included this area in the Hundalee ED.

Original (pre-human) vegetation

Little information about the pre-human vegetation of the Leslie ED was located during the preparation of this report. However, it appears likely that the northern and western parts of the district supported mountain beech forest, and that eastern parts supported podocarp-hardwood forest or a mosaic of forest, scrub and grassland.

McEwen (1987) suggests that matai-totara-hardwood forest dominated the southeast flanks of the Amuri Range, and beech dominated the upper slopes. Molloy (1969) also indicates that matai-totara forest is likely to have been present in inland basins. Extrapolation of data from more recent studies (e.g. McGlone, 2001) indicates that while matai-totara forest may have been present at lower altitudes in the area, it is likely to have been part of a mosaic of plant communities including treeland, scrub and grassland.

Extant forest remnants, though few, suggest that mountain beech forest was the dominant plant community at montane sites. Mountain totara forest may also have been present at montane sites, though was probably less widespread than beech forest. Mountain lacebark treeland is likely to have been present at higher altitudes. Podocarp forest, including matai-totara forest, or beech-podocarp forest was likely to have been present at lower altitudes on valley-floors or lower slopes.

Drier fire-prone sites may have supported kanuka forest, scrub or grassland. A savannah-like mosaic of treeland, scrub and grassland was probably present at dry low-altitude sites.

Existing (present-day) vegetation

Today the vegetation of Leslie ED is predominantly induced pasture and scrub. The increased frequency of fire following the arrival of humans and subsequent land development for farming and forestry, have all but removed the original forest cover from the district. Introduced conifers have spread from Hanmer Forest to colonise extensive areas on the Amuri Range, and broom forms dense scrub at lower altitudes along the Waiau River in the west of the district.

Small remnants of beech forest remain in the west of the district (Pahau catchment) and there may be some small forest remnants in gullies on the Amuri Range. Areas of scrub and shrubland are present, though most are likely to have been induced by human activities. Scattered kowhai and ti tree and small wetlands are present along the Waiau River and, though much modified, they may be some of the most representative indigenous plant communities remaining in the district.

Extent of plant communities: Leslie ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
3	matai-totara forest	6-25	<1	14
6	kanuka forest	1-5		
8	mountain beech forest	26-50		
10	mountain totara forest	6-25		
12	kowhai-ti treeland	1-5		
14	manuka-kanuka scrub	6-25	24	1
15	matagouri shrubland	1-5		
21	short tussockland	1-5	36	<1
24	montane tall tussockland	1-5		
35	stonefield (riverbed)	1-5	<1	17

Existing protected natural areas

The only significant protected area within Leslie ED appears to be part of Lochiel Run Conservation Area, in the upper Pahau River catchment. This area supports induced grasslands and small mountain beech remnants. Two protected natural areas along the Waiau River, covering a total area of 2 ha, may support kowhai-ti treeland.

Opportunities for further protection or restoration of original ecosystems

Scarcely 2% of Leslie ED is protected. Opportunities for further protection appear to be limited to small areas of beech forest/kanuka in gully heads on the Amuri Range, scattered wetland/treeland on river terraces and areas of rockland vegetation on bluffs.

4.8 CULVERDEN ECOLOGICAL DISTRICT (52.03)

Location and physical description

Culverden ED covers the Culverden Basin, between Hawarden in the southwest and Waiau in the northeast. The ED comprises glacial outwash gravel and localised river gravel that together form the extensive Amuri and Emu plains. A small area of calcareous siltstone and sandstone is present at Isolated Hill in the north of the district (Gregg, 1964).

The Culverden Basin lies between 100 and 300m asl and is traversed by the Waiau, Pahau, Hurunui and Waitohi rivers. The district is mostly flat or gently sloping, except for Isolated Hill near Waiau and some gently rolling country near Hawarden. The highest point in the ED is Isolated Hill (393m). Low ranges surround the basin, including the Amuri Range in the northwest and the Lowry Peaks Range in the southeast.

Original (pre-human) vegetation

It is likely that the original vegetation of Culverden ED comprised a mosaic of treeland, shrubland and grassland, with minor areas of forest. McEwen (1987) suggests that the area formerly supported short tussockland, stands of kanuka forest, shrubland, treeland, and possibly podocarp-hardwood forest along the rivers.

In a more detailed assessment, Colin Meurk (*unpublished data*) proposes that the Amuri Plain supported a mosaic of low kanuka forest, treeland, shrubland, silver tussockland and short tussockland. Rainfall, soils, drainage and (presumably) fire would have influenced the extent and location of each of these plant communities. Seepage areas at the base of scarps and along rivers supported wetland plant communities (*ibid*).

Johnston (1961) notes that the first European accounts of the area recorded ‘raupo swamp’ along the eastern margins of the Culverden Basin. Simpson *et al* (1980) record the presence of totara logs on the northern end of the Lowry Peaks Range, just east of the Culverden Basin, and note that kahikatea forest was once present at a swampy site at Ngawiro, at the northeast edge of the ED. Leathwick (2001) suggests that lowland podocarp forest was present in the Amuri Basin, though this is not regarded as an extensive vegetation type in Meurk’s more detailed assessment.

Existing (present-day) vegetation

The original vegetation of Culverden ED has been almost completely modified by human influences. The increased frequency and intensity of fire would have initially destroyed areas of forest, scrub and shrubland. Development of land for farming and forestry has subsequently displaced or modified areas of wetland, grassland and treeland. The pine plantations of Balmoral Forest cover a large part of the flat land between the Hurunui and Pahau rivers. Other low-lying parts of the Amuri Basin now support irrigated pasture.

Extent of plant communities: Culverden ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
3	matai-totara forest	1-5	<1	<1
6	kanuka forest	26-50		
12	kowhai-ti treeland	1-5		
14	manuka-kanuka scrub	1-5	1	8
15	matagouri shrubland	6-25		
16	mixed tauhinu-*Coprosma* scrub	1-5		
21	short tussockland	6-25	0	0
22	silver tussockland	6-25		
27	wetland	1-5	0	0
35	stonefield (riverbed)	1-5	6	2

Existing protected natural areas

There are several small areas protected within Culverden ED, though together they only cover c.500 ha (less than 1% of the district). The most important of these protected areas are Culverden Scientific Reserve (15 ha) which protects a mosaic of kanuka woodland, grassland and mossfield, Waitohi Riverbed Conservation Area (141 ha), protecting gravelfield, Medbury Scientific Reserve and Waiau Recreation Reserve.

Opportunities for further protection or restoration of original ecosystems

Opportunities for further protection appear limited to small areas of kanuka and scrub adjacent to the Culverden and Medbury scientific reserves.

4.9 WAIAU ECOLOGICAL DISTRICT (52.04)

Location and physical description

Waiau ED covers the Lowry Peaks Range, between the Amuri Basin and the coastal hill country of the Cheviot and Motunau EDs. It lies between Hurunui in the southwest and Parnassus in the northeast. The district comprises moderately indurated greywacke and argillite of the Torlesse Group rocks, with areas of limestone and calcareous siltstone near Scargill Creek and minor areas of alluvium at lower altitudes (Gregg, 1964).

The Lowry Peaks Range is of relatively gentle relief with summits mostly below 600m asl; the highest point is Devils Hill (869m). The range and ED are bisected by both the Waiau and Hurunui rivers, and drained by tributaries of those rivers.

Original (pre-human) vegetation

The original vegetation of Waiau ED was probably dominated by podocarp-hardwood forest, though there is little detailed information on the early vegetation. Simpson *et al* (1980) record the presence of totara logs on the northern end of the Lowry Peaks Range and McEwen (1987) suggests that matai-totara-hardwood forest was dominant in most parts of the district. Mountain beech forest is likely to have covered areas of hill country in the north of the district (Moore, 1999; McEwen, 1987).

Also likely to have been present are silver tussockland, short tussockland, scrub, shrubland and riparian hardwood forest, though the extent of these communities in relation to forest is unclear.

Existing (present-day) vegetation

The original vegetation of Waiau ED has been substantially modified since the arrival of humans. Areas of forest have been reduced to small isolated remnants, and land development for farming has modified other areas of indigenous vegetation. Short tussockland communities and shrubland may have increased in extent in some areas, though there is little information on the present extent of these communities.

Introduced weeds, such as broom and wilding pines, threaten parts of the district; the dry open country of the district is vulnerable to further infestation by weeds.

Extent of plant communities: Waiau ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
3	matai-totara-hardwood forest	51-75	<1	<1
4	riparian kowhai-ti forest	1-5		
6	kanuka forest	1-5		
8	mountain beech forest	6-25		
14	kanuka scrub	1-5	16	<1
15	matagouri-*Coprosma* shrubland	1-5		
21	short tussockland	6-25	8	0
22	silver tussockland	1-5		
35	stonefield (riverbed)	1-5	1	2

Existing protected natural areas

The only significant protected area within Waiau ED is Balmoral Lookout (39 ha), protecting silver tussockland, grassland and shrubland (including a small population of the endangered plant *Muehlenbeckia astonii*). In total, there are 120 ha of protected land in the ED, comprising only 0.25% of the district.

Opportunities for further protection or restoration of original ecosystems

No opportunities for further protection of indigenous ecosystems were identified during the preparation of this strategy.

4.10 CHEVIOT ECOLOGICAL DISTRICT (52.05)

Location and physical description

Cheviot ED covers hill country along the North Canterbury coast, between Hurunui River in the south and Conway River in the north. Its inland (western) boundary is the base of the Lowry Peaks Range (Waiau ED). The hill country lies mostly below 600m asl and the inland plain lies mostly below 150m asl. The district is bisected by the Waiau River and drained by tributaries of the Hurunui, Waiau and Conway rivers.

The coastal hills of the ED comprise moderately indurated greywacke and argillite of the Torlesse Group rocks with areas of glacial outwash gravel forming coastal terraces in the northeast (Gregg, 1964). Low-lying country between the coastal hills and the Lowry Peaks Range comprises marine siltstone, sandstone and limestone with large areas of glacial outwash and river gravel (*ibid*).

Original (pre-human) vegetation

It appears that the original vegetation of Cheviot ED was dominated by podocarp-hardwood forest and coastal hardwood forest, with smaller areas of black beech forest in the north of the district (McEwen, 1987). In an assessment of the vegetation of a small coastal catchment in the northeast of the district, Molloy and Lintott (1979) describe the remnants of a coastal forest that was destroyed approximately 8000 years ago. Analysis of stumps remaining from this forest confirms the presence of matai, totara, kanuka and *Lophomyrtus obcordata*. Moar (2008) observed that beech forest was present in the coastal hills south of the Waiau River c.5230 years ago.

Unpublished data indicate that podocarp-hardwood forests in the ED were dominated by matai, totara, mahoe and broadleaf. Dominant species in hardwood forests were kaikomako, mahoe, putaputaweta, mapou, five-finger, kowhai, akiraho and ngaio. The extent to which the vegetation has been modified makes it difficult to determine what proportion of the district supported forest or shrubland. However, it is likely that the eastern slopes of the coastal range supported coastal forest and included coastal species such as ngaio and akeake.

Other vegetation types that may have formed part of the original vegetation of the ED are kanuka forest, mixed matagouri-*Coprosma* shrubland, rockland, sedgeland and coastal sandfield/gravelfield communities (DOC, *unpublished data*). Several species, including hinau and kiekie, are at their southern limit in the ED (Molloy and Lintott, 1979).

Existing (present-day) vegetation

Burning, logging and the development of farmland have substantially modified the vegetation of Cheviot ED: almost all the district is now farmed. The original vegetation is limited to small discrete remnants. Larger areas of induced (secondary) indigenous vegetation are present, notably hardwood forest and kanuka scrub and forest.

Coastal plant communities (dunelands and lagoons) have also been substantially modified. There are large infestations of broom in the north of the ED which threaten surrounding areas.

Extent of plant communities: Cheviot ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
1	coastal hardwood forest	6-25	1	6
2	kahikatea-hardwood forest	1-5		
3	matai-totara-hardwood forest	51-75		
4	kowhai-hardwood forest	1-5		
6	kanuka forest	1-5		
8	black beech forest	6-25		
14	kanuka scrub	1-5	17	5
15	matagouri-*Coprosma* shrubland	1-5		
22	silver tussockland	1-5	2	2
32	coastal sandfield	<1	<1	8
35	stonefield (riverbed)	1-5	3	4

Existing protected natural areas

There are a number of small protected areas within Cheviot ED. Significant areas are Waiau Rivermouth Scenic Reserve (40 ha), Shag Rock Scenic Reserve (38 ha), Gore Bay Scenic Reserve (63 ha), Manuka Bay Scenic Reserve (30 ha) and areas of

marginal strip along the major rivers. The reserves mostly protect coastal hardwood forest, and the marginal strips protect riverbed gravelfield.

Opportunities for further protection or restoration of original ecosystems

A very small proportion (c.1%) of the ED is protected. There are opportunities for protection and good opportunities for restoration of podocarp-hardwood forest on steeper coastal slopes. Otherwise, opportunities appear very limited.

4.11 MOTUNAU ECOLOGICAL DISTRICT (52.06)

Location and physical description

Motunau ED covers low hills and valleys along the North Canterbury coast between Hurunui River in the north and Waipara River in the south. Its inland (northwestern) boundary is along the Waikari and Omihi valleys, adjoining Waikari ED. The hill country lies mostly below 400m asl in the north and 500m asl in the south. Several small rivers, including the Blythe, Greta and Omihi, drain the district.

Hills in the north of the ED mostly comprise strongly indurated greywacke and argillite of the Torlesse group rocks. Hills and coastal terraces in the south and east comprise a complex mix of sandstone, siltstone, limestone and other sedimentary rocks. The prominent summits of Sail Rock in the northeast and Mt Cass in the south have areas of outcropping limestone (Gregg, 1964).

The ED includes Motunau Island: one of the most important sea-bird breeding sites on the east coast between the Bay of Plenty and Foveaux Strait (McEwen, 1987).

Original (pre-human) vegetation

The original vegetation of Motunau ED was probably dominated by podocarp-hardwood forest and coastal hardwood forest, with minor areas of black beech forest (McEwen, 1987). Also likely to have been present were short tussockland, ti treeland, kanuka forest, mixed matagouri-*Coprosma* shrubland, rockland, sedgeland and coastal sandfield/gravelfield communities (DOC, *unpublished data*). Notable in the district are plant communities on limestone outcrops, especially Mt Cass ridge, and a small area of southern rata forest (McEwen, 1987).

Unpublished data indicate that podocarp-hardwood forests in the ED were dominated by matai, totara, mahoe and broadleaf. Dominant species in hardwood forests were kaikomako, mahoe, putaputaweta, mapou, five-finger, kowhai, akiraho and ngaio. It is difficult to determine what proportion of the district supported forest, shrubland or grassland/treeland, as the district is now dominated by modified farmland.

Existing (present-day) vegetation

The original vegetation of Motunau ED has been largely eliminated by the development of farmland. Forest remnants tend to be small and confined to areas of broken or steep terrain. Low-altitude plant communities, such as short tussockland, treeland or wetland, have been almost totally eliminated.

Motunau Island is modified by the presence of introduced woody weeds, though remains an important sea-bird breeding and roosting area.

Extent of plant communities: Motunau ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
1	coastal hardwood forest	6-25	3	11
2	kahikatea-hardwood forest	1-5		
3	matai-totara-hardwood forest	26-50		
4	kowhai-hardwood forest	1-5		
6	kanuka forest	1-5		
8	black beech forest	6-25		
12	kowhai-ti treeland	1-5		
14	kanuka scrub	1-5	12	4
15	matagouri-*Coprosma* shrubland	1-5		
21	short tussockland	1-5	1	0
22	silver tussockland	1-5		
27	wetland	<1	<1	54
32	coastal sandfield	<1	<1	32
35	rockland, stonefield	<1	<1	<1

Existing protected natural areas

Several small areas are protected within Motunau ED. Significant protected areas include Napenape Scenic Reserve (47 ha), Boundary Creek Scenic Reserve (74 ha), Cranky Tom Scenic Reserve (50 ha), Tiromoana Scenic Reserve (90 ha), Motunau Island Nature Reserve (2 ha), Motunau River Marginal Strip (14 ha) and strips of conservation land along the coast south of the Hurunui River. These areas protect remnants of black beech forest, podocarp-hardwood forest, coastal hardwood forest, river and beach gravelfield and coastal rockland.

Opportunities for further protection or restoration of original ecosystems

A very small proportion (c.1%) of the ED is protected. However there are opportunities for further protection of forest and scrub on limestone (e.g. Mt Cass), forest remnants in coastal gullies and areas adjacent to Napenape Scenic Reserve.

4.12 WAIKARI ECOLOGICAL DISTRICT (52.07)

Location and physical description

Waikari ED covers the low hills and gentle valleys surrounding the small town of Waikari in North Canterbury. It lies between the Hurunui and Waipara rivers and includes a large part of the catchment of the Waikari River. Summits of the ranges lie between 500 and 700m asl in the west of the district and between 400 and 500m asl in the east.

The geology of the district is relatively complex. Major summits comprise greywacke and argillite of the Torlesse Group rocks, adjoining hill country comprises marine siltstone, sandstone and limestone, and valley floors comprise glacial outwash gravel and recent alluvium (Gregg, 1964). Limestone outcrops are prominent in the district, notably along State Highway 7 between Waipara and Waikari.

Original (pre-human) vegetation

The original vegetation of Waikari ED is likely to have been a mosaic of forest, shrubland and grassland. Low annual rainfall (<700mm) and hot summer temperatures would have made hill-slope sites vulnerable to drought and natural fires.

In a reappraisal of the fossil vertebrates of Pyramid Valley Swamp near Waikari, Holdaway and Worthy (1997) suggest that (based on the work of Burrows 1989 and Moar 1970) podocarp-hardwood forest dominated by matai was present on valley floors, and beech forest was dominant higher on valley sides. Exposed ridges and slopes probably supported open shrubland and grassland. Moar (2008) observed that beech forest was present in the area c.5460 years ago

It is also likely that wetlands were prominent on valley floors, and a specialised rock flora present on exposed limestone and sandstone bluffs. McEwen (1987) suggests that short tussockland and mixed *Coprosma* scrub were probably common, and that podocarp-hardwood forest was formerly much more extensive.

Existing (present-day) vegetation

The original vegetation of Waikari ED appears to have been almost completely eliminated by the development of farmland. Forest remnants are substantially modified and confined to steep or inaccessible sites. Grassland and shrubland communities appear to have been largely eliminated. Flora on bluffs, including limestone bluffs, may be more intact, though few areas are protected.

Extent of plant communities: Waikari ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
3	matai-totara-hardwood forest	26-50	<1	<1
4	riparian kowhai forest	1-5		
8	black beech forest	26-50		
12	kowhai-ti treeland	1-5		
15	matagouri-*Coprosma* shrubland	6-25	5	2
21	short tussockland	6-25	3	0
22	silver tussockland	1-5		
27	wetland	1-5	0	0
35	rockland, stonefield	<1	<1	0

Existing protected natural areas

The only significant protected area in Waikari ED is the Waipara Gorge Scenic Reserve (25 ha), protecting a remnant of black beech forest on unstable cliffs and incised gullies. In total only 230 ha (c.0.5%) of the ED are protected. The fossil site in Pyramid Valley is a very important and well-known archaeological site, but appears to have no formal protection.

Opportunities for further protection or restoration of original ecosystems

Less than 1% of the ED is protected. Opportunities for protection appear limited to scattered limestone bluffs and dryland forest and shrubland in the Doctors Hill area.

4.13 MINCHIN ECOLOGICAL DISTRICT (53.01)

Location and physical description

Minchin ED covers the mountainous country east of the main divide of the Southern Alps, between Worsley Pass in the southwest and Harper Pass in the northeast. It includes the Crawford Range and parts of the Dampier and Poulter ranges, between the headwaters of the South Branch Hurunui and Poulter river headwaters. Major summits in the district lie between 1600 and 1800m asl and valley floors lie between 600 and 800m asl. Major tributary rivers are Thompson and Minchin streams and the Cox River.

The ED comprises thick-bedded and strongly indurated greywacke and argillite of the Torlesse Group rocks, with minor areas of conglomerate and pebbly siltstone. Areas of recent alluvium are present on valley floors and at rock avalanche sites (Cave, 1987; Gregg, 1964).

Original (pre-human) vegetation

The presence of beech forest throughout Minchin ED indicates that it was the dominant vegetation type at montane sites prior to the arrival of humans. Most forests in the west of the district (Poulter Catchment) were dominated by mountain beech with some red beech at sheltered sites on lower slopes and a minor presence of silver beech (Burrows, 1986; Jane and Wearing, 1986). In the east (South Branch Hurunui Valley) mixed beech forest, dominated by red beech, was present on lower slopes and mountain beech forest on upper slopes (Jane, 1988a).

Tussockland and herbfield dominated the extensive alpine zone within the ED, with substantial areas of cushionfield and rockland. A narrow band of mixed scrub or low forest, dominated by inaka and mountain toatoa, was present at the timberline, and more extensive areas present at exposed lower-altitude sites on Worsley Pass and in the upper Cox Valley. Areas of mountain lacebark forest and *Hebe* scrub were present in upper valleys.

Valley floors are likely to have supported areas of short tussockland, matagouri shrubland, *Hebe* shrubland and minor areas of wetland. Bog pine and mountain toatoa shrubland or scrub may also have been present, though are unlikely to have been extensive. Gravelfield dominated the active riverbeds, as it does today.

Existing (present-day) vegetation

Human-induced fire does not appear to have occurred in Minchin ED and there has been no deliberate forest clearance. The present day vegetation of the district is therefore generally representative of the original vegetation.

All plant communities have been modified to some extent by introduced mammals, though alpine and valley-side plant communities still occupy their former extent. Valley floor vegetation is more modified, due to the greater dominance of introduced plants and the effects of cattle grazing.

Extent of plant communities: Minchin ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
7	mixed beech forest	6-25	44	99
8	mountain beech forest	26-50		

15	matagouri-*Hebe* shrubland	1-5	7	95
18	mountain toatoa-inaka scrub	1-5		
21	short tussockland	1-5	14	98
23	red tussockland	1-5		
34	montane rockland	1-5	7	95
35	stonefield (riverbed)	1-5		
36	alpine zone	27	27	<100

Existing protected natural areas

Minchin ED is almost completely covered by Arthur's Pass National Park and Lake Sumner Conservation Park. Together, these areas protect 26,489 ha (c.98%) of the ED. A significant part of the district in the South Branch Hurunui Valley is subject to intensive management as a mainland habitat island.

Opportunities for further protection or restoration of original ecosystems

Almost all (98%) of Minchin ED is protected. The only significant unprotected area is in the east of the district, in the South Branch Hurunui Valley within Eskhead Pastoral Lease.

4.14 ARTHUR'S PASS ECOLOGICAL DISTRICT (53.02)

Location and physical description

Arthur's Pass ED covers the mountainous country lying east of the main divide of the Southern Alps between the headwaters of the Poulter River in the northeast and the headwaters of the Wilberforce River in the southwest. It includes the headwater tributaries of the Waimakariri and Avoca rivers. Major summits in the district lie between 2000 and 2400m asl, and the main valley floors lie between 650 and 800m asl. Large rivers draining the area include the Hawdon, Edwards, Bealey, White, Crow and Anti Crow.

The ED comprises strongly indurated greywacke and argillite of the Torlesse Group rocks, with minor conglomerate and volcanics, and relatively extensive areas of recent alluvium on the main valley floors (Gregg, 1964). The mountains along the main divide are steep and broken. Recent deposits from rock avalanches, rock debris flows and rockslides are common and extensive, such as at Taruahuna Pass below Falling Mountain (Cave, 1987).

Original (pre-human) vegetation

The presence of beech forest throughout the district indicates that it was the most common vegetation type on montane slopes. Mountain beech forest was dominant on higher altitude slopes and at valley floor sites throughout the district. Forest dominated by red beech, or occasionally silver beech, was present at favourable sites on lower slopes and terraces in the Hawdon and lower Waimakariri valleys in the east of the district (Burrows, 1986; Jane and Wearing, 1986). Red beech stands at Corner Knob at the southeast edge of the ED (Burrows and Lord, 1993) represent the southwest limit of red beech in North Canterbury.

Subalpine scrub dominated by inaka and mountain toatoa was present at some locations at the beech forest timberline, and as more extensive stands on exposed mountain passes or at cold sites in valley heads (Wardle, 1985b). *Hebe* scrub and mountain lacebark forest were also likely to have been present in upper valleys, much as they are today. Tussockland, herbfield, cushionfield and rockland were dominant

vegetation types in the extensive alpine zone within the district. The district also supports areas of permanent snow, representing the northernmost glaciers in the South Island.

The relatively extensive valley floors of the Waimakariri, Hawdon and Avoca rivers are likely to have supported a mosaic of short tussockland, matagouri shrubland, *Hebe* scrub and mountain toatoa scrub. The active riverbeds supported open gravelfield, and wetlands associated with seepage from side streams, such as One Tree Swamp.

Existing (present-day) vegetation

Over a large part of Arthur's Pass ED plant communities are present to the same extent as they were prior to the arrival of humans. The extent of alpine vegetation types remains the same, though plant communities are modified by the presence of introduced animals. A small proportion of the alpine zone has been modified by skifield development.

In the montane zone minor areas of beech forest have been removed from lower-slopes by fires associated with pastoral farming or the construction of roads and railways, though forest recovery has been rapid at most sites.

Valley floor vegetation has suffered greater modification. All valley floor grasslands have been grazed by domestic stock and large areas in the main Waimakariri Valley are still grazed. Human-induced fire has affected most valley floor sites and some areas, such as Riversdale Flat, were cultivated. Riverbed gravelfields have been modified by the invasion of aggressive introduced plants, notably broom, Russell lupin and stonecrop. More intensive disturbance of valley floor sites has resulted from activities associated with the road, railway and electricity pylon line.

Extent of plant communities: Arthur's Pass ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
7	mixed beech forest	1-5	43	99
8	mountain beech forest	51-75		
14	manuka-kanuka scrub	<1	4	94
15	matagouri-*Hebe* shrubland	1-5		
18	mountain toatoa-inaka scrub	1-5		
21	short tussockland	1-5	5	94
23	red tussockland	1-5		
34	montane rockland	1-5	10	88
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	38	38	98

Existing protected natural areas

A considerable proportion of Arthur's Pass ED lies within Arthur's Pass National Park and Craigieburn Conservation Park. Parts of the lower Waimakariri Valley are protected within several smaller conservation areas.

Opportunities for further protection or restoration of original ecosystems

A large proportion (98%) of the ED is protected. Opportunities for further protection are valley-floor areas on the Riversdale Flats (presently leased for grazing) and areas matagouri shrubland and beech forest on Cora Lynn Station.

4.15 SUMNER ECOLOGICAL DISTRICT (54.01)

Location and physical description

Sumner ED covers mountainous country between the main divide of the Southern Alps and the Canterbury foothills. It is bordered to the north by the Waiau and Hope rivers, to the west by Lake Sumner, to the south by the South Branch Hurunui River and to the east by the foothills of North Canterbury (Leslie and Ashley EDs).

The relatively extensive rocky summits within the district lie between 1600 and 1900m asl: the highest summit is Mt Longfellow (1901m) in the west. Tributaries of the Waiau and Hurunui rivers, including the Glencoe, Mandamus and Glenrae rivers and Jollie and Kakapo brooks, drain the district. Several lakes, including Sumner, Sheppard, Taylor, Mason and Loch Katrine, are present in the west of the ED.

The ED comprises strongly to moderately indurated greywacke and argillite of the Torlesse Group rocks, with areas of glacial outwash gravel (including moraine deposits) and recent alluvium in the west of the district (Gregg, 1964). The Hope Fault forms the northern boundary of the district; the Esk Fault forms the southern boundary.

Original (pre-human) vegetation

Beech forest remnants indicate that mountain beech forest was dominant throughout the ED, with smaller areas of red beech forest at favourable sites in the west. Minor areas of podocarp-beech forest may have been present at low-altitude sites in the east of the district. Mixed hardwood forest, dominated by kowhai, was present along rivers and lakeshores, and mountain totara forest was present on some steep rocky slopes. Substantial areas of open rock and scree were present on steep slopes, especially in the east.

Montane valley floors, notably around the lakes in the west of the district, probably supported a range of vegetation types, including short tussockland, matagouri shrubland, mixed *Hebe* shrubland and *Olearia* shrubland. Kanuka scrub/forest may also have been present at montane sites, especially in the east. This vegetation type is presently widespread but occupies sites that are likely to have originally supported forest. Wetlands were also relatively extensive at montane sites in the west of the district.

Tussockland, herbfield, rockland and scree communities were and still are dominant in the alpine zone. Riverbed and lakeshore plant communities were common in the west of the district.

Existing (present-day) vegetation

The original vegetation of Sumner ED has been depleted by human-induced burning, the introduction of plant and animal species, and by grazing. The loss of beech forest has been greatest in the drier eastern parts of the district, where it has been replaced by rough pasture. In many places this grazing land has subsequently been colonised by kanuka scrub or a dense scrub of introduced broom. There are also infestations of gorse and wilding pines in the east.

Beech forest has been removed from the west of the district, especially on north-facing slopes and valley floors. Here it has been replaced by rough pasture, fernland or manuka/kanuka scrub. Valley floors in the west of the ED have been modified. Scrub

has been burnt or sprayed, grasslands cultivated, grazed and planted with exotic trees and wetlands grazed.

Alpine vegetation is probably still present over its original extent, although it has been modified by introduced animals. Some indigenous vegetation types have increased in extent, notably kanuka scrub, manuka scrub, bracken fernland and possibly tall tussockland.

Extent of plant communities: Sumner ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
7	red beech forest	1-5	25	69
8	mountain beech forest	51-75		
12	riparian hardwood forest	1-5		
14	manuka/kanuka scrub	1-5	26	34
15	matagouri scrub/shrubland	1-5		
16	mixed *Hebe* scrub	1-5		
19	inaka scrub	1-5		
21	short tussockland	1-5	21	17
23	red tussockland	1-5		
24	tall tussockland	1-5		
27	wetland	<1	<1	5
34	montane rockland	1-5	16	39
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	4	4	22

Existing protected natural areas

Two protected areas lie partly within Sumner ED: Lake Sumner Conservation Park and Lochiel Run Conservation Area. The first protects areas of beech forest in the west of the district in the Jollie Brook and Glenrae River catchments and around the northeast side of Lake Sumner. The second protects beech forest remnants and more extensive areas of induced scrub and grassland in the headwaters of the Pahau River in the northeast corner of the district.

Opportunities for further protection or restoration of original ecosystems

Approximately one-third (c.36%) of the ED is protected. Opportunities for further protection are areas of forest, regenerating forest, shrubland and tussockland within areas of Crown land leased for grazing, including Lake Taylor, The Lakes, Glynn Wye and Somerdale pastoral leases.

4.16 POULTER ECOLOGICAL DISTRICT (54.02)

Location and physical description

Poulter ED covers mountainous country between the main divide of the Southern Alps in the west and the Puketeraki Range of the Canterbury foothills in the east. It includes the Studleigh, Dampier and Candlesticks ranges, and the southern part of the Poulter Range. The South Branch Hurunui River forms the northern boundary of the district, and the lower Poulter and Esk rivers form the southern boundary.

Major summits in the district lie between 1600 and 2000m asl; the highest point is Mt Turnbull (2024m) on the Candlesticks Range. Summits in the east of the district are broad and rocky with extensive areas of rock pavement and scree. The main valleys

are broad, indicating the effects of earlier glaciation. Tributaries of the Poulter, Esk and South Branch Hurunui rivers drain the ED, including the North Esk River, Bull Creek, and Lucy and Ant streams.

The ED comprises strongly indurated greywacke and argillite of the Torlesse Group rocks, with minor areas of volcanics, and areas of recent alluvium on valley floors (Gregg, 1964).

Original (pre-human) vegetation

The predominant vegetation type in Poulter ED was mountain beech forest. It probably occupied all montane slopes except small areas of mixed beech forest at favourable sites in the west of the district, and areas of rockland and scree on steeper slopes in the east. Mountain lacebark treeland, mixed *Hebe* scrub and possibly areas of mountain toatoa scrub were present in valley heads.

The relatively extensive areas of valley floor, including glacial outwash terraces, in the east of the district probably supported a mosaic of short tussockland, red tussockland, matagouri shrubland, *Hebe* scrub and bog pine shrubland. Also present were small areas of wetland, cushionfield and lichenfield. Large riverbeds, notably the Poulter River, supported gravelfield. Tall tussockland, herbfield, cushionfield and rockland were present in the alpine zone, much as they are today.

Existing (present-day) vegetation

In the west of Poulter ED (within Arthur's Pass National Park) plant communities are present to the same extent as in pre-human times. Valley floor vegetation has been modified by grazing, and all vegetation is likely to have been modified to some extent by introduced animals.

In the east, human-induced burning has replaced many areas of beech forest with grassland or scrub. Valley floor vegetation, especially short tussockland, has been modified and reduced by pastoral farming. Alpine vegetation is probably still representative of the original vegetation though has also been modified by domestic stock and wild animals.

Extent of plant communities: Poulter ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
7	red beech forest	1-5	39	84
8	mountain beech forest	51-75		
15	matagouri-*Hebe* shrubland	1-5	5	10
18	mtn toatoa shrubland	1-5		
21	short tussockland	6-25	31	24
23	red tussockland	1-5		
27	wetland	<1	<1	0
34	montane rockland	1-5	14	70
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	11	11	31

Existing protected natural areas

Western parts of the ED lie within Arthur's Pass National Park, Lochinvar Forest Conservation Area and Lake Sumner Conservation Park.

Opportunities for further protection or restoration of original ecosystems

Just over half (54%) of Poulter ED is protected. Opportunities for further protection are present in the east of the ED predominantly on Crown-owned lands leased for grazing (Eskhead and Mount White pastoral leases). These are areas of regenerating beech forest, scrub, tussockland and wetland, including rare valley-floor bog pine shrublands at Flora Terraces.

4.17 CASS ECOLOGICAL DISTRICT (54.03)

Location and physical description

Cass ED covers the large intermontane basin between the mountains of the main divide and the foothill ranges of Canterbury. It lies inland and west of the Torlesse and Puketeraki ranges, and east of the Craigieburn Range and the mountains of Arthur's Pass National Park (Arthur's Pass and Poulter EDs).

The district covers the Waimakariri Basin, including the Broken River Basin and the lower Poulter River. It is dominated by glacial landforms, including the broad U-shaped Waimakariri Valley, ice-carved summits, roches moutonnées, moraines and extensive outwash terraces. Tributaries of the Waimakariri, Poulter, Esk and Broken rivers drain the district.

The ED has a relatively complex geology. Basement rock is strongly indurated greywacke and argillite of the Torlesse Group rocks. In the Waimakariri, Poulter and Esk valleys these rocks are overlain by extensive deposits of glacial outwash gravel and till, and smaller areas of recent river gravel. In the Broken River Basin and in the Brechin Burn, Tertiary deposits of siltstone, sandstone, conglomerate and limestone overlie the Torlesse rocks (Gregg, 1964). These latter deposits form the spectacular scarps and tors of the Kura Tawhiti/Castle Hill area.

The ED boundary used for this analysis is that proposed by Shanks *et al* (1990). This boundary differs slightly from that proposed by McEwen (1987) by the inclusion of the lower Esk Valley, including the lower Brechin Burn, and areas on the lower slopes of the Torlesse and Craigieburn ranges; McEwen included these areas in the adjoining Torlesse and Craigieburn EDs.

Original (pre-human) vegetation

The original vegetation of Cass ED appears to have been almost entirely beech forest. In a reconstruction of the vegetation in the Cass area 1000 years ago, Molloy (1977) proposed that all but the alpine summits, open riverbeds and small areas of valley floor, supported beech forest. Unforested valley floor sites supported 'grassland and scrub' or 'mire'. Forest was entirely mountain beech (Burrows, 1960), though minor areas of red beech forest may have been present in the northwest of the district (Burrows and Lord, 1993).

Mountain totara forest/treeland and silver tussockland were present on limestone (Shanks *et al*, 1990), and rockland and scree were common in the montane zone. Despite their appearance, the extensive screes in the area are relatively stable (Burrows, 1977a) and most would have been formed long before the arrival of humans. Outcropping Tertiary sediments, notably limestone in the Kura Tawhiti/Castle Hill area, were also present and support several rare plant species.

Relatively extensive areas of gravelfield were present in the beds of the major rivers, especially the Waimakariri River. Tall tussockland, herbfield and rockland vegetation was present in the alpine zone, probably much as it is today.

Existing (present-day) vegetation

There has been widespread loss of the original mountain beech forest in the district through human-induced fire, so that extensive areas of beech forest remain only on the slopes of Gray Hill and Mt White in the north of the district. Elsewhere beech forest is confined to small patches in sheltered gullies. Rockland, scree and riverbed gravelfield probably occupy their former extent, though are modified by introduced plant and animal species.

Vegetation of the alpine zone probably approximates its former extent, though has been modified by domestic stock and introduced wild animals. Short and tall tussocklands have increased in extent, colonising sites formerly occupied by forest. Few areas of valley-floor grassland remain uncultivated.

In the PNAP survey report for the Cass ED Shanks *et al* (1990) noted that fescue tussock grassland was the main vegetation type at the time of the survey (1988). The report lists seventeen main vegetation groups as present in the district, including a number of shrubland and grassland communities induced by the removal of the former beech forest.

Extent of plant communities: Cass ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
8	mountain beech forest	51-75	15	69
10	mountain totara forest	1-5		
14	manuka-kanuka scrub	1-5	14	10
15	matagouri-*Hebe* shrubland	1-5		
17	bog pine-inaka shrubland	1-5		
21	short tussockland	6-25	49	5
22	silver tussockland	1-5		
23	red tussockland	1-5		
24	tall tussockland	<1		
27	wetland	<1	<1	3
34	montane rockland	1-5	11	13
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	8	8	52

Existing protected natural areas

Several protected areas cover small parts of Cass ED. Areas of beech forest and alpine vegetation in the north of the district are protected within Arthur's Pass National Park and Lochinvar Forest Conservation Area. Areas of beech forest on the lower slopes of the Craigieburn and Torlesse ranges are protected within Craigieburn Conservation Park and Broken River Forest Conservation Area respectively.

Small but important protected areas in the Waimakariri Basin include Lance McCaskill Nature Reserve (6 ha), Kura Tawhiti/Castle Hill Conservation Area (54 ha), Enys Scientific Reserve (4 ha), Cave Stream Scenic Reserve (16 ha), Lake Grasmere Scenic Reserve (12 ha), and Lake Grasmere Recreation Reserve and Wildlife Refuge (70 ha). Spittle Hill and parts of Castle Hill Pastoral Lease have been protected recently through the Nature Heritage Fund.

Opportunities for further protection or restoration of original ecosystems

Less than one-fifth (19%) of Cass ED is protected. There are good opportunities for further protection of basin-floor ecosystems, mostly on University of Canterbury-owned land leased for grazing (Flock Hill, Craigieburn and Grasmere leases) and on Mt White Pastoral Lease. These include small forest remnants, strongly regenerating scrub and forest, red tussockland, short tussockland and wetland. The extensive bed of the Waimakariri River and its important braided river bird habitat are largely unprotected as UCL.

4.18 TORLESSE ECOLOGICAL DISTRICT (54.04)

Location and physical description

Torlesse ED is a long narrow district covering the Puketeraki, Torlesse and Big Ben ranges between the Waimakariri Basin and the Canterbury Plains. Its northeast boundary is at the Hurunui River and its southwest boundary is just north of the Rakaia River. The district adjoins the hill country and basins of the Ashley and Selwyn river headwaters (Oxford and Whitecliffs EDs) to the east, and the intermontane basins of the Waimakariri and Hurunui to the west.

The mountain ranges of the ED have broad flat summits with extensive areas of rock pavement and scree. Mountain slopes are steep with extensive screes and exposed rock. Major summits lie between 1600 and 2000m asl: the highest summits on each range are Chest Peak (1936m) on the Puketeraki Range, Castle Hill Peak (1998m) on the Torlesse Range, and Ben More (1655m) on the Big Ben Range. The Waimakariri River bisects the district, along a deep gorge between the Torlesse and Puketeraki ranges. Tributaries of the Acheron, Selwyn, Kowai, Broken, Esk, Ashley and Okuku rivers drain the mountain ranges of the district.

The ED comprises strongly indurated greywacke and argillite of the Torlesse Group rocks, with minor areas of recent alluvium in valleys. Several prominent fault lines traverse the ranges, including Porters Pass Fault between the Torlesse and Big Ben Ranges (Gregg, 1964).

The ED boundary used for this analysis is that proposed by Shanks *et al* (1990). This boundary differs from that proposed by McEwen (1987) by the exclusion of the Acheron River valley and the eastern side of the Esk Valley (including Brechin Burn); Shanks *et al* (1990) included these areas in the Coleridge and Cass EDs respectively.

Original (pre-human) vegetation

In a study of soil development and plant succession on the Torlesse Range, Molloy (1964) proposed that mountain beech forest was the principal plant community in the montane zone (below c.1300m) and tall tussockland the principal plant community in the low alpine zone. Forest remnants indicate that mountain beech was probably present on most montane slopes throughout the ED. This forest was likely to have been floristically simple (as it is today), with uniform canopy of mountain beech and a sparse understorey (Jane, 1986), though was more diverse on the wetter southeastern slopes (Harding, 1991).

Rockland and scree were also prominent on montane slopes. Though unstable in appearance, these landforms are a result of the rock type and weathering processes, and were present to much the same extent prior to the arrival of humans. Tall tussockland, inaka scrub and *Hebe* scrub may also have been present, though their

original extent is difficult to determine because these plant communities now cover extensive areas formerly occupied by beech forest.

Inaka scrub, mountain lacebark treeland and possibly areas of mountain toatoa scrub were probably present in valley heads and at the timberline. Mixed hardwood forest was present at riparian sites along low-altitude river gorges, such as Waimakariri Gorge. Lakeshore gravelfield was present at Lake Lyndon. A range of plant communities were present in the alpine zone, including tall tussockland, herbfield, lichenfield and sparsely-vegetated rock pavement, bluff and scree.

Existing (present-day) vegetation

Widespread human-induced fire eliminated mountain beech forest from large parts of Torlesse ED, especially on the slopes of the Torlesse and Big Ben ranges. Forest was replaced by inaka scrub at higher altitudes and manuka or kanuka scrub at lower altitudes. Most range slopes were grazed and the re-establishment of scrub and forest halted by repeated burning.

Open rockland and scree was less affected by fire, though is likely to have been modified by grazing stock and introduced wild animals. Alpine plant communities also cover their approximate former extent but have been similarly modified.

Short tussockland, tall tussockland, inaka scrub, mixed *Hebe* scrub and manuka/kanuka scrub are all common induced plant communities at montane sites, along with remnants of beech forest, rockland and scree (Harding, 1991). Plant pests, including wilding conifers, broom and gorse, affect some low-altitude parts of the district.

Extent of plant communities: Torlesse ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	1-5	26	67
8	mountain beech forest	51-75		
16	mixed *Hebe* scrub	1-5	20	18
19	inaka-mountain toatoa scrub	1-5		
21	short tussockland	<1	32	27
24	montane tall tussockland	1-5		
27	wetland	<1	<1	0
34	montane rockland	1-5	7	51
35	stonefield (scree)	1-5		
36	alpine zone	13	13	49

Existing protected natural areas

Areas of beech forest in Torlesse ED are protected within a number of conservation areas including Seaward Forest, The Den, Puketeraki Forest, Oxford, Broken River, Torlesse, Kowai and Thirteen Mile Bush conservation areas. Areas retired from adjoining pastoral leases, or recently purchased by the Crown, on the Torlesse and Big Ben ranges were recently gazetted as Korowai/Torlesse Conservation Park, included parts of Castle Hill Pastoral Lease recently funded through the Nature Heritage Fund.

Opportunities for further protection or restoration of original ecosystems

More than one-third (39%) of the ED is protected. Opportunities for further protection include areas of beech forest on the eastern flanks of the Torlesse and Puketeraki ranges, including good altitudinal sequences, dense inaka scrub, tussockland and small wetlands on the lower slopes of the Torlesse and Ben More ranges and on the Lees

Valley side of the Pukeraki Range. Substantial areas of tussockland, scrub and regenerating beech forest are present on the southern Puketeraki Range within Brooksdale and Snowdale pastoral leases. There are good opportunities to link and buffer existing protected natural areas.

4.19 CRAIGIEBURN ECOLOGICAL DISTRICT (54.05)

Location and physical description

Craigieburn ED covers the mountainous country east of the main divide between the upper Waimakariri and Rakaia rivers. It borders the Waimakariri Basin (Cass ED) to the east, and the upper Avoca River catchment to the west. The district includes the Craigieburn Range and eastern parts of the Black and Birdwood ranges.

Mountains within the district are glaciated with broad ice-carved valleys. Major summits lie between 1800 and 2100m asl and valleys between 600 and 800m asl. The natural beech forest timberline of the district is approximately 1300m (Wardle, 1985a) and a large part of the district lies above this altitude. The Harper River and tributaries of the Avoca, Cass and Broken rivers drain the district.

The district comprises strongly indurated greywacke and argillite of the Torlesse Group rocks, with areas of glacial outwash gravel and recent alluvium on valley floors (Gregg, 1964; Warren, 1967). A small area of Tertiary sandstone and siltstone is present in the Harper Valley. Extensive rock screes are present, especially on the Craigieburn Range in the east of the district. The Harper Fault traverses the district.

The ED boundary used for this analysis is that proposed by Shanks *et al* (1990). This boundary differs from that proposed by McEwen (1987) by the exclusion of the isolated hills of Gargarus and Mt Fitzwilliam at the southern end of the Birdwood Range and exclusion of the braided bed of the Rakaia River in the west of the district. Shanks *et al* (1990) included these areas in the Coleridge and Mathias EDs respectively.

Original (pre-human) vegetation

The original vegetation of Craigieburn ED comprised mountain beech forest, alpine tussockland and scree (Shanks *et al*, 1990). Mountain beech forest was dominant at montane sites, interrupted only by rockland, scree and minor areas of snow totara-mountain toatoa scrub. A small area of bog pine shrubland and red tussockland on Lagoon Saddle is presumably representative of former vegetation on exposed montane saddles.

Tussockland, rockland and scree were dominant vegetation types in the alpine zone. Small areas of sedgeland and bog were present at low altitudes in the Harper Valley (Shanks *et al*, 1990).

Existing (present-day) vegetation

The northwestern part of Craigieburn ED appears unaffected by fire and land clearance associated with human settlement, and still supports extensive mountain beech forest and relatively unmodified alpine plant communities. Human-induced fire has removed forest from lower slopes in the south and east of the district. Fire-induced shrubland and short tussockland now dominate these areas.

Screes, rockland and alpine plant communities throughout the district are largely intact, affected only by the presence of introduced browsing mammals. Skifield development affects alpine basins on the Craigieburn Range, and wilding conifer spread affects montane slopes.

Extent of plant communities: Craigieburn ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
8	mountain beech forest	26-50	18	93
15	matagouri-*Hebe* shrubland	1-5	7	30
19	inaka-mtn toatoa scrub	1-5		
21	short tussockland	1-5	18	39
24	montane tall tussockland	<1		
27	wetland	<1	<1	19
34	montane rockland	1-5	15	37
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	39	39	65

Existing protected natural areas

A large part of Craigieburn ED lies within Craigieburn Conservation Park and Porter Heights Conservation Area. Areas on the eastern flank of the Craigieburn Range were recently purchased from Castle Hill Pastoral Lease through the Nature Heritage Fund.

Opportunities for further protection or restoration of original ecosystems

Approximately half (51%) of the ED is protected. There are opportunities for further protection of tussockland, scrub and regenerating forest on Crown-owned land leased for grazing (mainly Glenthorne Pastoral Lease).

4.20 COLERIDGE ECOLOGICAL DISTRICT (54.06)

Location and physical description

Coleridge ED covers the heavily-glaciated country northeast of the Rakaia River between the Harper River in the north and Rakaia Gorge in the south. The district comprises an area of relatively low relief between the mountains of the Craigieburn and Birdwood ranges to the north, and the Mount Hutt range to the south. It is characterised by glaciated topography with broad ice-scoured valleys, extensive glacial outwash terraces and moraine and ice-smoothed ‘sugarloaf’ hills and roches moutonnées.

Lake Coleridge and a number of smaller lakes dominate the ED. These lakes and the broad valleys that connect them isolate the rounded hills and ranges from the nearby mountains. Major summits lie between 1000 and 1700m asl. Valley floors mostly lie between 500 and 700m asl, though descend to 300m on the Rakaia riverbed. The Rakaia River forms the southwest boundary of the district. Tributaries of the Rakaia, Harper and Acheron rivers drain the district.

The ED comprises strongly indurated greywacke and argillite of the Torlesse Group rocks, with extensive areas of glacial outwash gravel and moraine (Gregg, 1964, Warren, 1967). A small area of Tertiary sandstone and siltstone is present in the Harper Valley.

The ED boundary used for this analysis is that proposed by Shanks *et al* (1990). This boundary differs from that proposed by McEwen (1987) by the inclusion of the isolated hills of Gargarus and Mt Fitzwilliam at the southern end of the Birdwood Range and inclusion of the glaciated terrain above the Acheron River. McEwen (1987) included these areas in the Craigieburn and Torlesse EDs respectively.

Original (pre-human) vegetation

Analysis of pollen and macrofossil flora from deposits near Lake Coleridge indicates that mountain beech forest was the dominant vegetation on montane slopes in the area prior to the arrival of humans (Moar, 1973; Burrows, 1995). At lower altitudes in the district it appears likely that a mixed podocarp-hardwood forest, dominated by mountain totara and matai, was present. Early European settlers noted large numbers of burnt mountain totara logs, and both matai and mountain totara are present nearby at Mt Algidus and Rakaia Gorge (Burrows, 1995).

It is likely that wetland vegetation, with associated red tussockland and scrub, was reasonably extensive in the district. Areas of short tussockland (with some silver tussock) were also probably present. There were gravelfields on lakeshores and on the extensive Rakaia riverbed. The relatively small area above the natural timberline probably supported subalpine scrub and alpine tussockland and herbfield (Shanks *et al*, 1990).

It is difficult to deduce the relative extent of forest, wetland, tussockland and scrub in pre-human times. The area is likely to have been affected by occasional natural fires, and the establishment of forest on valley floors may have been inhibited by climate.

Existing (present-day) vegetation

Induced short tussockland and shrubland are the dominant vegetation types in the ED today (Shanks *et al*, 1990). These plant communities probably occupy sites that previously supported forest, as human-induced fires affected a large part of the district. Only small remnants of beech forest are present. Mixed hardwood forest, dominated by kowhai and broadleaf, is present on the banks of the Rakaia River.

There are still extensive areas of wetland vegetation, and lakeshore and riverbed gravelfields. Scrub and shrubland are also relatively common, though the extent to which these communities have been induced by forest clearance is unclear.

Extent of plant communities: Coleridge ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	1-5	<1	<1
8	mountain beech forest	51-75		
10	mountain totara-matai forest	1-5		
14	manuka-kanuka scrub	1-5	18	4
15	matagouri scrub	1-5		
16	mixed *Hebe* scrub	1-5		
19	inaka scrub	1-5		
21	short tussockland	6-25	35	3
23	red tussockland	1-5		
24	montane tall tussockland	1-5		
27	wetland	1-5	<1	7
34	montane rockland	1-5	16	2
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	2	2	0

Existing protected natural areas

Lake Ida Conservation Area (19 ha), Wilberforce Riverbed Conservation Area (205 ha) and areas of marginal strip appear to be the only protected areas within Coleridge ED. Plant pests affect parts of the ED. Wilding conifers are present east of Lake Coleridge and broom is present on the Rakaia riverbed.

Opportunities for further protection or restoration of original ecosystems

A very small part (c.2%) of Coleridge ED is protected. Opportunities for further protection include extensive wetland and moraine sequences, terrace wetlands in the east of the ED and kettlehole tarns at Mt Barker. The extensive bed of the Rakaia River and its important braided river bird habitat are largely unprotected as UCL.

4.21 ASHLEY ECOLOGICAL DISTRICT (55.01)

Location and physical description

Ashley ED covers the foothills of North Canterbury inland from the Amuri Plain at Culverden, and the northern part of the Canterbury Plains at Amberley. Inland, the ED adjoins the Organ Range (Sumner ED) and the Puketeraki Range (Torlesse ED). It stretches from the middle reaches of the Pahau River in the north to the headwaters of the Waipara River at Mt Grey/Maukatere in the south.

The ED mainly covers broken hill country, with areas of lower-altitude valley floor along the Waipara River east of Amberley and at the edge of the Amuri Plain. Major summits are between 700 and 900m asl and valley floors between 250 and 350m asl. The middle reaches of the Hurunui River bisect the ED, and tributaries of the Hurunui, Waitohi and Waipara rivers drain the district.

The inland hill country of the ED comprises moderately to strongly indurated greywacke and argillite of the Torlesse Group rocks with minor areas of Tertiary sandstone and recent alluvium on valley floors. In the east, the hills comprise Tertiary sandstone, siltstone and limestone (Gregg, 1964). These latter sediments are exposed along the Waipara River gorge and surrounding hills.

Original (pre-human) vegetation

It appears likely that mountain beech forest was the most extensive vegetation type in Ashley ED, with areas of mixed beech forest at higher rainfall sites. Mixed red beech-mountain beech forest is present at Mt Grey/Maukatere (Jane, 1985a) and was probably present at other low-altitude sites in the district. Smaller areas of mixed podocarp forest dominated by either rimu or kahikatea are present at alluvial sites (McEwen, 1987), and were probably originally more widespread. Otherwise, existing remnants indicate that mountain beech forest occupied most hill slopes.

Manuka scrub was present on poorly drained alluvial deposits (McEwen, 1987) and other scrub communities probably present on drier rocky slopes and along river gorges. Areas of fire-induced scrub and tussockland may have occupied drier sites, as occasional natural fires are likely to have affected the district. Rockland communities, including specialised flora on Tertiary sediments, was present along the Waipara River gorge.

Existing (present-day) vegetation

Human-induced fires and the development of land for farming or forestry have resulted in widespread loss of the original vegetation of the ED. Forest is now confined to relatively small remnants in gullies, except for more extensive areas on the slopes of Mt Grey/Maukatere (Ashley Forest). Rockland, tussockland and some scrub communities are still present and, in some cases, may have increased in extent following the removal of forest.

Extent of plant communities: Ashley ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	rimu-kahikatea forest	1-5	3	13
5	hardwood forest	1-5		
7	mixed beech forest	6-25		
8	mountain beech forest	51-75		
14	manuka-kanuka scrub	6-25	20	<1
15	matagouri shrubland	1-5		
16	mixed scrub	1-5		
21	short tussockland	1-5	48	<1
24	tall tussockland	1-5		
27	wetland	<1	<1	0
34	rockland	<1	<1	1

Existing protected natural areas

The only sizeable protected area in Ashley ED is the part of Ashley Forest Conservation Area on the northern slopes of Mt Grey/Maukatere.

Opportunities for further protection or restoration of original ecosystems

Less than 1% of Ashley ED is protected. Opportunities for further protection appear limited to small pockets of beech and beech-podocarp forest in gullies and an area of kanuka-beech forest at Mt Karetu. Small areas of unprotected limestone bluff flora are present.

4.22 OXFORD ECOLOGICAL DISTRICT (55.02)

Location and physical description

Oxford ED covers the foothills of North Canterbury between the Waimakariri River in the south and Mt Grey/Maukatere in the north. It lies inland of Oxford and is bordered to the northwest by the Puketeraki Range (Torlesse ED). The district includes Mt Thomas, Mt Oxford, Lees Valley and the upper plains along the north bank of the Waimakariri River (Rockford-Woodstock area).

The foothills within the district have relatively gentle rounded summits and dissected slopes. Major summits lie between 900 and 1350m asl and the highest point is Mt Oxford (1364m). The Ashley/Rakahuri River gorge bisects the district, and tributaries of the Grey, Okuku and Ashley/Rakahuri rivers drain the district.

The ED comprises strongly indurated greywacke and argillite of the Torlesse Group rock, with relatively extensive areas of glacial outwash gravel and minor areas of recent alluvium in Lees Valley and on the upper plains (Gregg, 1964)

Original (pre-human) vegetation

Extensive mountain beech forest remnants on hill slopes in the district (Jane, 1985a; Jane 1987) indicate this was the most extensive original vegetation type on montane slopes. Mountain beech forest at upper montane sites contained scattered mountain totara. On lower altitude slopes black beech, red beech and rimu were present. The presence of podocarp remnants at low-altitude alluvial sites (Norton, 1986; Macmillan and Giller, 1997) indicates that mixed podocarp forest was formerly more widespread.

Occasional natural fires probably affected lower altitude slopes and the upper plains, encouraging the persistence of manuka-kanuka scrub and low forest, seral hardwood forest and tussockland. It is possible that the part of the ED bordering the Canterbury Plains supported a mosaic of podocarp-hardwood forest, ti-kowhai treeland, manuka scrub and short tussockland.

Short tussockland, red tussockland, wetland and gravelfield were probably present in Lees Valley. The very minor parts of the ED that lie above the treeline probably supported tall tussockland and shrubland.

Existing (present-day) vegetation

Mountain beech forest remains relatively widespread on upper slopes in the district, though introduced animals have modified the vegetation. At lower altitudes, including Lees Valley, most vegetation types are substantially depleted. Fire and intensive farming has eliminated most of the original vegetation of the upper plains. Remnants on lower slopes are generally small and modified. There is considerable potential for the re-establishment of forest on lower slopes, but re-establishing indigenous vegetation on the outwash gravels of the upper plains is more problematic.

Extent of plant communities: Oxford ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
3	matai-totara-black beech forest	1-5	26	72
7	mixed beech forest	1-5		
8	mountain beech forest	51-75		
12	kowhai-ti treeland	1-5		
14	manuka-kanuka scrub	6-25	16	24
15	matagouri shrubland	1-5		
21	short tussockland	6-25	15	12
23	red tussockland	1-5		
24	tall tussockland	<1		
27	wetland	<1	<1	0
34	rockland	<1	1	21
35	stonefield (riverbed)	1-5		

Existing protected natural areas

A large part of Oxford ED lies within Ashley Forest, Mt Thomas Forest and Oxford conservation areas. These areas protect beech forest, predominantly mountain beech forest on montane slopes, and small areas of podocarp forest. View Hill Scenic Reserve (31 ha) protects a remnants of beech and beech-podocarp forest on lower slopes.

Opportunities for further protection or restoration of original ecosystems

Less than one-quarter (23%) of Oxford ED is protected. There are a number of opportunities for further protection:

- remnant tussockland and wetland on alluvial sites in Lees Valley

- beech forest in the Okuku River gorge
- beech and beech-podocarp forest in the Ashley River gorge
- diverse beech and beech-podocarp forest in the Waimakariri River gorge
- podocarp swamp forest at Kareteana Bush
- forest on limestone at Onepunga

4.23 WHITECLIFFS ECOLOGICAL DISTRICT (55.03)

Location and physical description

Whitecliffs ED covers the low foothills between the Canterbury Plains and the Torlesse and Big Ben ranges, from the Waimakariri River in the north to the Rakaia River in the south. It includes several small ranges (Russell, Lady Barker and Rockwood ranges) and the outwash plain of the Kowai and Waimakariri rivers around Springfield.

The hills of the district are of relatively gentle relief, with major summits at between 700 and 950m asl. The main valleys lie between 300 and 500m asl, with the lowest at about 250m. The Kowai, Hawkins and Selwyn/Waikirikiri rivers drain the district; the Selwyn/Waikiririri catchment covers the largest area.

The hills in the north of the ED comprise strongly indurated greywacke and argillite of the Torlesse Group rocks. The Rockwood Range in the southwest of the district comprises rhyolite and andesite of the Mt Misery Volcanics and Round Top Andesite. Calcareous sandstone, siltstone and coal measures are present in the south of the district. Glacial outwash deposits are present at lower-altitude sites, including extensive moraines in the west of the district (Rakaia Valley) and loess-covered outwash gravel and till in the east (Gregg, 1964).

Original (pre-human) vegetation

It appears that the dominant vegetation of most montane parts of the district was mountain beech forest (Belton, 1981). The lack of substantial low-altitude remnants makes predictions of the original vegetation at these sites more difficult. However, it is likely that beech-podocarp forest and podocarp-hardwood forest were present at favourable sites. Mixed hardwood forest, dominated by narrow-leaved houhere and broadleaf, and occasional matai and mountain totara, are present in the Rakaia Gorge (Burrows, 1979). This community was probably once more widespread.

It is likely that occasional natural fires affected parts of the district, so scrub and tussockland communities would also have been present. Red tussockland and probably short tussockland may have occupied the extensive moraine surface in the west of the district, and a mosaic of short tussockland, matagouri shrubland and treeland is likely to have been present on glacial outwash surfaces.

Existing (present-day) vegetation

The vegetation of Whitecliffs ED has been substantially modified by human-induced fire, development of farmland and tree planting. Mining has affected some sites, and intensive land uses are present at the small towns in the district. Introduced plants, notably gorse and broom, are also present. Relatively extensive areas of induced tall tussockland and scrub are present at some hill country sites, and gradual recovery of indigenous forest is possible at these sites.

Extent of plant communities: Whitecliffs ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	kahikatea-matai forest	1-5	4	70
3	matai-totara forest	1-5		
8	mountain beech forest	51-75		
12	kowhai-ti treeland	1-5		
14	manuka-kanuka scrub	1-5	11	5
15	matagouri shrubland	6-25		
21	short tussockland	1-5	16	<1
23	red tussockland	6-25		
24	tall tussockland	<1		
27	wetland	<1	<1	11
34	montane rockland	<1	3	<1
35	stonefield (riverbed)	1-5		

Existing protected natural areas

There are three large protected areas (Torlesse Forest, Thirteen Mile Bush and Rockwood conservation areas) and several smaller reserves in Whitecliffs ED, including Lords Bush Scenic Reserve (11.7 ha).

Opportunities for further protection or restoration of original ecosystems

Only a small part (c.3%) of Whitecliffs ED is protected. Opportunities for further protection include scattered beech and beech-podocarp remnants in the Kowai Bush-Lords Bush area, podocarp-beech forest adjacent to existing reserves in the Boundary Stream area, remnants on volcanic substrates and possibly remnant terrace wetlands in the Rakaia Valley.

4.24 HIGH PLAINS ECOLOGICAL DISTRICT (56.01)

Location and physical description

The High Plains ED covers the higher-altitude gravel fans of the Canterbury Plains at the base of the foothills of the Southern Alps. It is a long narrow district stretching from the Okuku River in the north to the Rangitata River in the south. It lies mostly between 250 and 500m asl, and lacks any significant hills.

Tributaries of the Waimakariri, Rakaia and Rangitata rivers, and a number of smaller rivers, drain the district. The large rivers have cut relatively deep terraced gorges in the upper plain, depositing large quantities of gravel downstream to form wide braided riverbeds.

The district comprises glacial outwash gravels deposited by the major rivers as large fans. The fans have coalesced to form the extensive plains of the Low Plains and High Plains EDs. Older surfaces are covered with loess and younger surfaces comprise recent river gravel.

Original (pre-human) vegetation

Cool winter temperatures, frequent droughts and occasional natural fires are likely to have had an important influence on the type of vegetation that occupied the High Plains ED. The lack of substantial remnants of indigenous vegetation and the very few

macrofossil sites in the district make interpretation of the pre-human vegetation more difficult than in most other EDs.

However, even after the increased incidence of fire associated with Polynesian settlement, early European surveyors noted the presence of areas of forest, treeland, flaxland and scrub on the otherwise grassed plain (e.g. C.O. Torlesse, quoted in Andersen, 1916). Relatively extensive areas of beech or beech-podocarp forest are likely to have been present near the foothills, where higher rainfall and shelter from desiccating northwest winds protected forests from natural fires. Elsewhere, it appears likely that savannah-like vegetation prevailed, with forest present in association with treeland, shrubland, grassland and wetland communities.

In a reconnaissance survey report of the High Plains and Low Plains EDs, Stevens and Meurk (1996) describe the original vegetation of the Canterbury Plains. In the High Plains ED matai-totara forest was present at well-drained sites, kahikatea forest at poorly-drained sites and danthonia (*Rytidosperma* spp.) grassland on recently-deposited gravel. Kanuka forest, kowhai-ti treeland, matagouri shrubland, silver tussockland and wetland were also present.

Existing (present-day) vegetation

The original vegetation of High Plains ED has been substantially depleted by human-induced fire and land clearance for agriculture. Very little indigenous vegetation remains: the most extensive are small areas of beech or beech-podocarp forest at the base of the foothills on the western boundary of the district. Remnants on the plains are generally small and many are confined to roadsides or riverbanks (Stevens and Meurk, 1996).

The largest area of indigenous vegetation in the district appears to be an area of kanuka and grassland in the Eyrewell area on the boundary between the High Plains and Low Plains EDs, and recorded earlier as the 'Eyrewell scrub belt' by Johnston (1961). A small remnant is protected within Eyrewell Scientific Reserve (Molloy and Ives, 1972), though there appear to be other larger remnants in the area (Norton and Lord, 1992; Meurk *et al*, 1995).

Extent of plant communities: High Plains ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	kahikatea forest	1-5	<1	28
3	matai-totara forest	6-25		
4	riparian kowhai-ribbonwood	1-5		
6	kanuka forest	6-25		
8	mountain beech forest	1-5		
12	kowhai-ti treeland	6-25		
15	matagouri shrubland	6-25	3	17
20	danthonia grassland	6-25	<1	4
23	red tussockland	1-5		
27	wetland	<1	<1	1
35	stonefield (riverbed)	1-5	3	31

Existing protected natural areas

There are several small protected areas within High Plains ED. A number are on the inland boundary of the district and protect beech and beech-podocarp forest remnants that are probably more representative of the adjoining foothills EDs.

Important protected areas include Ashley Riverbed Conservation Area, Eyrewell Scientific Reserve (2.3 ha) and. On the boundary of the district are Awa Awa Rata Recreation Reserve (3 ha), and parts of Alford Forest and Mt Hutt Forest conservation areas.

Opportunities for further protection or restoration of original ecosystems

Only a small part (c.1.5%) of High Plains ED is protected. Opportunities for further protection are very limited. Small areas of shrubland and treeland are present on the Rakaia River scarps and small areas of matai-totara forest remain unprotected at the southern boundary of the ED in the Mt Peel area.

4.25 LOW PLAINS ECOLOGICAL DISTRICT (56.02)

Location and physical description

The Low Plains ED covers the eastern part of the Canterbury Plains, except Lake Ellesmere and Kaitorete Spit which are in Ellesmere ED. It stretches from Waipara in the north to Timaru in the south and is bordered to the west by High Plains ED and to the east by the Canterbury coastline, Lake Ellesmere and Banks Peninsula.

The ED covers a sloping plain formed by the deposition of glacial outwash and recent river gravels by the Ashley/Rakahuri, Waimakariri, Rakaia and Rangitata rivers. It extends from sea level to approximately 300m asl, and has no significant hills. Several smaller rivers drain the district. Older surfaces are covered with loess; younger surfaces comprise recent river gravel.

The long coastline of the district comprises sand and sand/gravel beaches with low dunes, dune lakes and lagoons north of Banks Peninsula, and steep gravel beaches with low cliffs of gravel and loess south of Kaitorete Spit (Johnson, 1992).

Original (pre-human) vegetation

Droughts, wind and occasional natural fires would have strongly influenced the vegetation of Low Plains ED, just as they did in High Plains ED. The presence of only a few small remnants of indigenous vegetation in the district makes interpretation of the pre-human vegetation difficult.

Early European surveyors noted the presence of areas of forest at a number of locations on the coastal plain north of Christchurch (Johnston, 1961), presumably remnants of previously more-extensive forests. Intervening areas supported raupo swamp, flax swamp, swamp forest or grassland (Moar, 2008). South of Lake Ellesmere the plain was predominantly grassland with some treeland, flaxland and scrub, except for the relatively extensive (c.200 ha) forest remnant at 'Horowenua' (Arowhenua) (Andersen, 1916). The original extent of this forest was probably significantly greater before human-induced fires (Burrows, 1984).

It is likely that the severity of the climate on the open plains, including the desiccating effect of frequent strong northwest winds and relatively low rainfall (<800mm per annum), and the frequency of natural fires, prevented the perpetuation of extensive forests. Rather, savannah-like vegetation may have prevailed over most dry areas, with some forest in association with treeland, shrubland and grassland communities. More extensive areas of podocarp forest and wetland would have been present at well-watered sites nearer the coast, such as north of Christchurch and in the vicinity of Lake Ellesmere.

In the reconnaissance survey report for the High Plains and Low Plains EDs, Stevens and Meurk (1996) describe the original vegetation of the Low Plains ED as matai-totara forest on deeper finer soils, kahikatea forest at poorly-drained sites and danthonia (*Rytidosperma* spp.) grassland on recently-deposited gravel. Stable gravels supported kanuka forest, kowhai-ti treeland, matagouri shrubland and silver tussockland. Freshwater wetlands were relatively extensive on eastern parts of the plains, and saline wetlands present along the coast.

Existing (present-day) vegetation

The original vegetation of Low Plains ED has been substantially depleted by human-induced fire and land clearance for agriculture and settlement. The city of Christchurch occupies a large area that once supported forest and wetland. Nearly all other parts of the ED are intensively farmed. Most soils have been cultivated and many areas are irrigated.

Remnants of tall forest in the ED are now confined to Riccarton Bush (Christchurch) and Arowhenua Bush near Temuka (Burrows, 1984). Remnants of kanuka are confined to the Eyrewell, Bankside and Maronan areas (McEwen, 1987). Remnants of wetland and coastal vegetation are present north of Christchurch and south of the Rangitata River. Savannah-like vegetation is present on islands with the Rakaia River and as scattered remnants alongside the lower Waimakariri River. Other remnants of indigenous vegetation are small and mostly confined to roadsides or riverbeds (Stevens and Meurk, 1996).

Extent of plant communities: Low Plains ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	kahikatea forest	1-5	<1	4
3	matai-totara forest	1-5		
4	riparian kowhai-ribbonwood	1-5		
6	kanuka forest	6-25		
12	kowhai-ti treeland	6-25		
14	manuka-kanuka scrub	1-5	2	31
15	matagouri shrubland	6-25		
20	danthonia grassland	6-25	<1	0
21	short tussockland	1-5		
26	coastal wetland	<1	<1	56
27	inland wetland	1-5	<1	22
32	coastal sandfield	1-5	<1	28
33	coastal gravelfield	1-5		
35	stonefield (riverbed)	6-25	2	37

Existing protected natural areas

Important protected areas in Low Plains ED include Riccarton Bush Scenic Reserve (11 ha), Bankside Scientific Reserve (2.7 ha), Coopers Lagoon Wildlife Management Reserve (97 ha), Milford Lagoon and Lower Orakipaoa Creek Conservation Area (85 ha), Washdyke Lagoon Wildlife Refuge (254 ha) and several conservation areas and marginal strips on the Rakaia and Rangitata river beds.

Opportunities for further protection or restoration of original ecosystems

Only a very small part (c.1%) of Low Plains ED is protected, a significant proportion of which comprises marginal strips along the major rivers. Opportunities for further protection appear limited to:

- coastal lagoons in Pegasus Bay
- kanuka remnants near Eyrewell
- treeland (kowhai-*Olearia*) on the lower floodplain of the Waimakariri River
- kowhai treeland on Rakaia Island
- kowhai-*Melicytus* shrubland/woodland on Rakaia River scarp at Barrhill
- kanuka-shrubland-grassland remnants at Rangitata Island and Arundel
- remnant sand-tussock communities along the Rakaia-Rangitata coastline
- coastal lagoons on the Rangitata-Timaru coastline
- remnant podocarp-hardwood forest and wetland at Arowhenua Bush (Temuka)
- small areas of uncultivated soil in ephemeral flood channels south of the Rangitata River
- gravelfield communities (and important braided-river bird habitats) on the open beds of the Rakaia and Rangitata rivers.

4.26 ELLESMERE ECOLOGICAL DISTRICT (56.03)

Location and physical description

Ellesmere ED covers the large (c.20,000 ha) shallow Lake Ellesmere and the sand and gravel barrier ridge of Kaitorete Spit. The district lies just south of Christchurch, between the Low Plains and Herbert EDs.

The ED is low-lying and comprised of recently-deposited beach gravels and river sediments. The Selwyn/Waikirikiri and Halswell rivers drain into the lake from the surrounding plains, and several smaller streams drain from Banks Peninsula.

Lake Ellesmere is the shallowest of the country's large lakes. The 23-km long Kaitorete Spit includes the largest unmodified dune system in Canterbury and is a geopreservation site of national significance (DOC, 1995). It is also ranked as a national priority for conservation (Johnson, 1992)

Original (pre-human) vegetation

The margins of Lake Ellesmere originally supported extensive wetland vegetation. The naturally-fluctuating level of the lake is likely to have provided habitat for a range of wetland and lake-edge plant communities, including freshwater wetland dominated by flax or raupo, *Juncus* rushland, salt marsh ribbonwood (*Plagianthus divaricatus*) shrubland and saltmarsh.

The sand and gravel barrier ridge of Kaitorete Spit supported drought-tolerant shrubland, dominated by matagouri and species of *Muehlenbeckia* and *Coprosma*, pingao sedgeland, *Raoulia* cushionfield/herbfield, sandfield and gravelfield. Short tussockland, silver tussockland and danthonia grassland were also likely to have been present.

Existing (present-day) vegetation

Vegetation of the lake margin has been substantially reduced and modified by land drainage, conversion to pasture and artificial opening of the lake outlet to maintain lower lake levels. The lake bed and margin is also likely to have been affected by increased sediment and nutrient flows into the lake following intensification of surrounding land use. Intact freshwater wetland and saltmarsh vegetation is now much

reduced in extent. However, the lake and riparian wetlands still provide very important habitat for birds.

Vegetation of Kaitorete Spit has been modified by the increased incidence of fire, grazing, sand mining, and introduced plant and animal species. However, the area still supports the largest and most continuous population of pingao in New Zealand (Johnson, 1992), the largest population of the threatened *Muehlenbeckia astonii* and populations of rare invertebrate species.

Extent of plant communities: Ellesmere ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	podocarp-hardwood forest	<1	0	0
15	matagouri-*Coprosma* shrubland	1-5	<1	12
16	*Olearia-Coprosma* shrubland	1-5		
20	danthonia grassland	1-5	<1	<1
21	short (and silver) tussockland	1-5		
26	coastal/saline wetland	6-25	8	55
27	freshwater wetland	1-5	<1	31
32	pingao sedgeland-sandfield	1-5	2	75
33	coastal gravelfield	1-5		

Note: A large proportion of Ellesmere ED is occupied by Lake Ellesmere.

Existing protected natural areas

Lake Ellesmere, which comprises a large part of the ED, is protected as a conservation area and is subject to a Water Conservation Order. Several other areas protect freshwater or saline wetland vegetation around the margin of Lake Ellesmere. The largest of these are Yarrs Flat (286 ha), Selwyn (194 ha), Wards (177 ha), Williams (87 ha), Harts Creek (234 ha) and Lakeside (101 ha) wildlife management reserves.

The coastal margin of Kaitorete Spit is protected within Kaitorete Spit Conservation Area (c.766 ha). Other parts of the barrier ridge are protected within Waihora Scientific Reserve (80 ha) and Kaitorete Spit Scientific Reserve (128 ha).

Opportunities for further protection or restoration of original ecosystems

Approximately 11% of land (terrestrial habitats) in Ellesmere ED is protected. Opportunities for further protection are wetland communities along the lake shore, coastal scrub at Birdlings Flat and the protection or restoration of shrubland and grassland linkages across Kaitorete Spit.

4.27 PORT HILLS ECOLOGICAL DISTRICT (57.01)

Location and physical description

Port Hills ED covers the hills between Lyttelton Harbour and the Canterbury Plains, forming the northeastern part of Banks Peninsula. It is a relatively small ED (c.14,000 ha) stretching from Godley Head in the northeast to Gebbies Pass in the southwest. It includes Lyttelton and parts of Christchurch City.

The ED comprises volcanic rocks (basalts and trachytes) of the Lyttelton Volcano which erupted between 10 and 12 million years ago (Wilson, 1992). It is entirely hilly, covering the eroded crater rim of the Lyttelton Volcano. The hills rise relatively steeply from Lyttelton Harbour with prominent bluffs and outcrops; slopes rising from

the Canterbury Plains are gentler and spurs more rounded. Major summits lie between 400 and 550m asl.

Several small streams drain the dissected hills though all often cease flowing during summer (Wilson, 1992). The district is the driest of the three EDs on Banks Peninsula (Banks Ecological Region).

Original (pre-human) vegetation

Port Hills ED was entirely forested prior to the arrival of humans. Lower slopes supported mixed podocarp-hardwood forest dominated by totara, matai and kahikatea, and montane slopes supported mountain totara-hardwood forest. Tall tussockland and shrubs were present on bluffs (Wilson, 1992; Wilson, 2008). Minor areas of wetland, rockland and coastal herbfield may also have been present.

It is unclear whether the ED was affected by natural fire, though it is possible that fires on the Canterbury Plains may have spread onto the lower northeastern hill slopes. If so, areas of mixed hardwood forest, scrub and tussockland may have originally been present. Even in the absence of fire, these vegetation types may have been present in areas where forest was damaged by wind or snow.

Existing (present-day) vegetation

Today the former forests of Port Hills ED are reduced to a few small and scattered remnants. Much of the forest was removed from drier slopes by fire after the arrival of Polynesian settlers, and the remainder removed by milling or deliberate burning by European settlers. Now the district is dominated by pasture, but with areas of induced silver tussockland, and regenerating kanuka scrub and mixed hardwood forest.

The residential areas of Lyttelton, Governors Bay and the southeast suburbs of Christchurch are within the district, and roads traverse the major ridgelines. Plantations of exotic trees also occupy relatively large areas.

Extent of plant communities: Port Hills ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	podocarp-hardwood forest	76-100	<1	0
10	mountain totara forest	6-25		
14	kanuka scrub/forest	<1	17	25
21	short tussockland	<1	5	36
22	silver tussockland	1-5		
34	rockland	<1	<1	?

Existing protected natural areas

The largest formally protected areas in Port Hills ED are Godley Head Farm Park Conservation Area (253 ha), Mount Vernon Park (223 ha) and Bowenvale Park (194 ha), all of which include induced scrub, silver tussockland and pasture. Several smaller reserves protect small areas of forest, tall tussockland or rockland that are representative of the original vegetation.

Opportunities for further protection or restoration of original ecosystems

A relatively small area (c.6%) of Port Hills ED is formally protected. The best opportunities for further protection are on steeper slopes and gullies on the Lyttelton Harbour side of the hills, where small forest remnants and larger areas of shrubland and scrub are present. There is considerable potential for restoration of indigenous vegetation.

4.28 HERBERT ECOLOGICAL DISTRICT (57.02)

Location and physical description

Herbert ED covers the central part of Banks Peninsula, including the highest summits. It spans the area between Lyttelton Harbour, Gebbies Pass, Lake Ellesmere, Lake Forsyth, Little Akaloa and the north coast of the peninsula. The district comprises dissected hill country, rising from sea level to 920m asl at Mount Herbert/Te Ahu Patiki (Wilson, 1992).

The geology of the district is complex. It comprises volcanic rocks of both the Lyttelton and Akaroa volcanoes (c.10 million years old), sedimentary rock (65-20 million years old), volcanic rocks (90 million years old), and sedimentary rocks dating back 240 million years. The district has sandstones, andesite, rhyolite, basalt, trachyte and small areas of recent alluvium (Wilson, 1992).

Deep bays and long valleys dissect the ED in the north, with steep coastal cliffs. In the southwest, the hills of the district slope more gently towards Lake Ellesmere and the Canterbury Plains. A significant proportion of the district lies above 500m asl, within the montane zone.

The ED boundary used for this analysis is that proposed by Wilson (1992). This boundary differs from that proposed by McEwen (1987) by the inclusion of the northern shore of Lake Forsyth and the exclusion of the area between Le Bons Bay and Little Akaloa in the west. McEwen included the first area in Akaroa ED, and the second in Herbert ED.

Original (pre-human) vegetation

Herbert ED was entirely forested prior to the arrival of humans. Lower slopes supported mixed podocarp-hardwood forest dominated by totara, matai and kahikatea, with local occurrences of rimu and miro. Montane slopes supported mountain totara-hardwood forest, with kaikawaka forest in the upper montane zone. Tall tussock, fescue tussock, inaka and mountain flax were present on high bluffs (Wilson, 1992; Wilson, 2008).

Minor areas of wetland, rockland and coastal herbfield may also have been present. It is unclear whether the ED was affected by natural fire. If so, areas of mixed hardwood forest, scrub and tussockland may have originally been present. Even in the absence of fire, these vegetation types may have been present in areas where forest was damaged by wind or snow.

Existing (present-day) vegetation

Much of the forest of Herbert ED was removed from drier slopes by fires after the arrival of Polynesian settlers. Nearly all the remaining forest was removed by milling or deliberate burning by European settlers (Wilson, 1992). Now the district is dominated by pasture, induced silver tussockland, regenerating kanuka scrub and mixed hardwood forest, and exotic plantations.

A relatively large area of the original montane forest (the largest remnant on Banks Peninsula) survives at the head of Kaituna Valley, below Mount Herbert/Te Ahu Patiki. Lowland forest remnants are limited to small fragments (Wilson, 1992).

Extent of plant communities: Herbert ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	podocarp-hardwood forest	51-75	<1	71
10	mountain totara forest	26-50		
11	kaikawaka-hardwood forest	1-5		
14	kanuka scrub/forest	1-5	14	5
19	inaka scrub	<1		
22	silver tussockland	<1	4	4
26	saline wetland	<1	<1	0
34	lowland/montane rockland	<1	<1	?

Existing protected natural areas

The largest formally protected areas in Herbert ED are Orton Bradley Farm Park (c.640 ha), Mount Herbert Scenic Reserve (240 ha), Sign of the Packhorse Scenic Reserve (104 ha) and Quail Island Recreation Reserve (81 ha). As well as some relatively extensive areas of original forest, there are large areas of induced vegetation within these reserves. Several smaller reserves protect small areas of forest, tall tussockland or rockland that are representative of the original vegetation.

Opportunities for further protection or restoration of original ecosystems

Only 1% of Herbert ED is formally protected. Data presented by Wilson (2008) suggests there are numerous opportunities for protection of small forest remnants and many more opportunities for protection of larger areas of regenerating indigenous vegetation (mostly kanuka-dominant regenerating hardwood forest). These areas are scattered throughout the ED, mostly on steeper upper slopes and in gullies.

4.29 AKAROA ECOLOGICAL DISTRICT (57.03)

Location and physical description

Akaroa ED covers the southern part of Banks Peninsula, around Akaroa Harbour. It bounds Herbert ED to the north, along a line between Lake Forsyth and Little Akaloa. The district comprises basalt and trachyte formed by the Akaroa Volcano c.9 million years ago (Wilson, 1992).

The ED is entirely hilly, covering the eroded crater of the extinct Akaroa Volcano. Summits and ridges are steep but mostly rounded; valleys are mostly long and narrow, radiating out from the sea-filled Akaroa crater. Major summits lie between 700 and 850m asl. The largest valley is in the west of the district and occupied by Lake Forsyth.

The ED boundary used for this analysis is that proposed by Wilson (1992). This boundary differs from that proposed by McEwen (1987) by the exclusion of the northern shore of Lake Forsyth and the inclusion of the area between Le Bons Bay and Little Akaloa in the west. McEwen included the first area in Akaroa ED, and the second in Herbert ED.

Original (pre-human) vegetation

Akaroa ED was almost entirely forested prior to the arrival of humans. Lower slopes supported mixed podocarp-hardwood forest dominated by totara, matai and kahikatea,

with local occurrences of rimu and miro. Montane slopes supported mountain totara-hardwood forest, with kaikawaka forest in the upper montane zone. Beech forest, dominated by red beech or black beech, was present in the southeast of the district, above c.200m altitude. Tall tussock, fescue tussock, inaka and mountain flax were present on high bluffs (Wilson, 1992; Wilson, 2008).

Minor areas of wetland, rockland and coastal herbfield may also have been present. It is unlikely that the ED was affected by natural fire, as the climate was probably wetter than other parts of Banks Peninsula and the district is isolated from the dry Canterbury Plains. However, areas of mixed hardwood forest, scrub and tussockland may have originally been present in areas where forest was damaged by wind or snow.

Existing (present-day) vegetation

Some of the forest of Akaroa ED was removed during Maori times, though not as much as in other parts of Banks Peninsula. Nearly all the remaining forest was removed by milling or deliberate burning by European settlers (Wilson, 1992). Now the district is dominated by pasture, induced kanuka scrub and mixed hardwood forest, and bracken fernland.

Extent of plant communities: Akaroa ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
1	coastal hardwood forest	1-5	<1	19
2	podocarp-hardwood forest	51-75		
7	red beech-black beech forest	6-25		
10	mountain totara forest	6-25		
11	kaikawaka-hardwood forest	1-5		
14	kanuka scrub/forest	<1	23	27
19	inaka scrub	<1		
27	wetland	<1	<1	56
32	coastal sandfield	<1	<1	15
34	lowland/montane rockland	<1	<1	?

Existing protected natural areas

There are a large number of small formally protected areas in Akaroa ED. Most of the reserves protect only small areas of forest, tall tussockland or rockland that are representative of the original vegetation. There are also a number of larger areas of regenerating forest protected within the reserves. Substantial areas of remnant and regenerating indigenous forest are present at Hinewai Reserve and on the adjacent Armstrong property in the southwest of the ED.

Opportunities for further protection or restoration of original ecosystems

Approximately 6% of Akaroa ED is formally protected. Data presented by Wilson (2008) suggests there are numerous opportunities for protection of small forest remnants and many more opportunities for protection of larger areas of regenerating indigenous vegetation (mostly kanuka-dominant regenerating hardwood forest). These areas are scattered throughout the ED, mostly on steeper slopes and in gullies.

4.30 BROWNING ECOLOGICAL DISTRICT (58.01)

Location and physical description

Browning ED covers the mountainous country just east of the main divide of the Southern Alps between Browning Pass in the north and Whitcombe Pass in the south. It includes the upper catchments of the Wilberforce and Mathias rivers; both tributaries of the Rakaia River. Major summits within the ED lie between 2000 and 2400m, with several of the highest summits on the Rolleston Range east of the main divide.

The ED comprises uniform indurated greywacke and argillite with scattered volcanics of the Torlesse Group rocks, with minor areas of recent glacial outwash gravel and recent alluvial deposits on valley-floors (Warren, 1967). It is heavily glaciated and rugged: over half of the ED lies above 1300m asl with substantial areas of year-round snow and ice.

Original (pre-human) vegetation

The original vegetation of Browning ED is likely to have been very similar to the vegetation present today. Mountain totara-mountain toatoa-broadleaf forest was present on montane slopes in the valley headwaters. Kaikawaka was an important component of this forest, especially in the Wilberforce Valley where mountain totara-kaikawaka forest still dominates (Huber and Jane, 1988). Mountain beech forest was present at lower-altitudes in eastern parts of the ED, including mountain beech-red beech hybrids near the present northern extent of beech forest in the Wilberforce valley near Moa Stream (Burrows, 1977b).

Dense scrub, dominated by inaka and mountain toatoa was present on upper valley slopes and occasionally on valley-floors. This extensive scrub graded to alpine shrubland, tussockland and fellfield (Huber and Jane, 1988). Stands of mountain holly (*Olearia ilicifolia*) were also present in upper valleys (Jane *et al*, 1989). Alpine plant communities were probably much as they are today, though obviously unaffected by browsing mammals.

Existing (present-day) vegetation

Indigenous vegetation of Browning ED is probably much as it was in pre-human times, except for the removal of some areas of forest by fire in the lower valleys. It appears that human-induced fire only affected the lower-altitude (southeast) edge of the ED (Molloy, 1983), and that the area was unaffected by natural fire. There has been some disturbance associated with gold-mining in the upper Wilberforce, wild animals (especially possums) are affecting cedar forest in the upper valleys and grazing has affected southeast parts of the ED.

Extent of plant communities: Browning ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
8	mountain beech forest	6-25	5	95
10	mtn. totara-kaikawaka forest	1-5		
16	*Hebe*-bog pine shrubland	1-5	20	92
19	inaka-mountain toatoa scrub	6-25		
21	short tussock grassland	<1	8	85
24	mid-ribbed snow tussockland	1-5		
34	rockland	1-5	15	64

35	stonefield (riverbed, scree)	6-25		
36	alpine zone	52	52	97

Existing protected natural areas
A substantial proportion of Browning ED is protected within North Mathias to Rolleston Range Conservation Area, Mathias Ecological Area and Craigieburn Conservation Park.

Opportunities for further protection or restoration of original ecosystems
Most parts (88%) of Browning ED are formally protected. Opportunities for further protection are areas of shrubland, tussockland and riverflat/riverbed vegetation in the upper Mathias and Wilberforce valleys. These areas are UCL or lie within the upper parts of Mt Algidus Pastoral Lease.

4.31 ARMOURY ECOLOGICAL DISTRICT (58.02)

Location and physical description
Armoury ED covers the very mountainous country just east of the main divide of the central Southern Alps between Whitcombe Pass in the north and Mt D'Archiac in the south. It includes the upper tributaries of the Rakaia and Rangitata rivers, including the Clyde and Havelock rivers. Major summits within the ED lie between 2000 and 2800m, with the highest summits on the Jollie Range (just west of the Arrowsmith range) and at the western end of the Two Thumb Range (Mt D'Archiac).

The ED comprises uniform indurated greywacke and argillite, with scattered volcanics, of the Torlesse Group rocks, with minor areas of recent glacial outwash gravel and recent alluvial deposits on valley-floors (Warren, 1967). It is very heavily glaciated and mountainous: over 65% of the ED lies above 1300m asl. Extensive snowfields and glaciers are present close to the main divide.

Original (pre-human) vegetation
A significant proportion of Armoury ED supported high altitude plant communities sparsely distributed among extensive rock, scree and year-round snow or ice. Below the timberline, inaka-mountain toatoa scrub and tussockland occupied stable montane slopes, between rock bluffs, scree slopes and avalanche chutes. Closer to the valley floors areas of mountain totara-broadleaf-mountain toatoa low-forest were present, with kaikawaka locally common (Jane, 1985b).

Areas of mountain beech forest were present at lower-altitudes in the southeast (Burrows, 1977b). The broad valley-floors of the main valleys are likely to have supported extensive stonefield and mossfield plant communities, with areas of short tussockland and matagouri scrub at stable sites.

Existing (present-day) vegetation
It appears that lower-altitude eastern parts of the ED have been affected by human-induced fire. There is also evidence of some minor milling of mountain totara for farm use (Newton, 1960). The effect of this burning appears to have been a reduction in the extent of mountain totara and, to a lesser extent, beech forest and its replacement with inaka scrub, tussockland and flaxland.

Valley-floor plant communities have also been modified by grazing and probably burning, though these communities retain much of their natural character. Alpine plant

communities are probably present to much the same extent as they originally were, though they have probably been modified to some extent by introduced mammals, especially chamois and tahr.

Extent of plant communities: Armoury ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
8	mountain beech forest	<1	<1	90
10	mtn totara-mtn toatoa forest	1-5		
15	matagouri shrubland	<1	13	71
19	inaka-mountain toatoa scrub	6-25		
21	short tussockland	<1	8	63
24	mid-ribbed snow tussockland	1-5		
27	wetland	<1	<1	0
34	rockland	1-5	13	53
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	66	66	81

Existing protected natural areas

A substantial proportion of Armoury ED is protected within Rangitata-Rakaia, Havelock Forest, Clyde Forest, Lawrence Forest and Rakaia Forest conservation areas. Areas in the upper Havelock Valley, protected as a result of review of Mesopotamia Pastoral Lease, are protected within the recently-established Te Kahui Kaupeka Conservation Park.

Opportunities for further protection or restoration of original ecosystems

Almost three-quarters (74%) of Armoury ED is protected. Opportunities for further protection are areas of shrubland, tussockland and riverflat/riverbed vegetation in the upper Rakaia, Havelock and Clyde valleys. These areas are UCL or lie within the upper parts of Upper Lake Heron and Erewhon pastoral leases. Property boundaries in the upper valleys are mostly unfenced, so upper valley-floors are largely unprotected from the effects of domestic stock.

4.32 MT COOK ECOLOGICAL DISTRICT (58.03)

Location and physical description

Mt Cook ED covers the mountainous country of the central Southern Alps, including New Zealand's highest peaks. It lies just east of the main divide of the Southern Alps, between the head of the Godley Valley at Mt D'Archiac in the north and the head of the Mueller Valley at Barron Saddle in the south. Included in the ED are the peaks of Aoraki/Mt Cook (3764m) and Mt Tasman (3498m). Western parts of the ED are heavily glaciated and support extensive areas of year-round snow and ice.

The ED comprises greywacke and argillite of the Torlesse group rocks, with minor areas of glacial outwash gravel and alluvial deposits in the major valleys. At the western edge of the ED, along the main divide of the Southern Alps, the greywacke and argillite give way to chlorite schist (Warren, 1967; Gair, 1967). Two major river systems have their headwaters within the ED: the Tasman River and its tributaries the Mueller, Hooker and Murchison; and the Godley River.

Original (pre-human) vegetation

The original vegetation of Mt Cook ED was probably much as it is today: extensive areas of rock, snow and ice above the timberline, with sparsely-distributed herbfield and fellfield plant communities; inaka scrub, tussockland and herbfield on stable montane slopes; smaller areas of low mountain totara-mountain toatoa-broadleaf forest; and, localised silver beech forest (McEwen, 1987). Minor areas of stonefield, tussockland and matagouri shrubland may have been present on eastern valley-floors. Approximately three-quarters (c.76%) of the ED is above the timberline.

Existing (present-day) vegetation

Indigenous vegetation of Mt Cook ED has been modified at lower altitudes by human-induced fire and, to a lesser extent, by grazing of domestic animals. Forest communities were formerly more extensive in the Tasman Valley (Wilson, 1978). Silver beech forest is confined to 'Governors Bush' on the slopes of the Sealy Range behind Aoraki/Mt Cook village and mountain totara-broadleaf forest is restricted to lower slopes that escaped fires.

Valley-floor vegetation has also been modified by fire and grazing, though only very small areas of vegetated valley floor are present within the ED. Otherwise, plant communities are present to much the same extent as they originally were, though all have been modified to some degree by introduced wild animals, notably chamois and tahr.

Extent of plant communities: Mt Cook ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
9	silver beech forest	<1	<1	100
10	mtn totara-mtn toatoa forest	1-5		
16	mixed *Hebe* scrub	1-5	3	100
19	inaka scrub	1-5		
24	mid-ribbed snow tussockland	1-5	4	100
34	rockland	6-25	15	100
35	stonefield (scree, riverbed)	1-5		
36	alpine zone	76	76	100

Existing protected natural areas

Almost all of Mt Cook ED is protected within Aoraki/Mt Cook National Park. Only a few hectares of pastoral lease land in the northeast of the ED remain unprotected.

4.33 MATHIAS ECOLOGICAL DISTRICT (59.01)

Location and physical description

Mathias ED covers the open braided river beds of the lower Wilberforce and Mathias rivers, the upper Rakaia River, and the intervening high mountains of the Ragged and Rolleston ranges. It lies east of the main divide of the Southern Alps between Browning ED in the northwest and Mt Hutt and Coleridge EDs in the south and east.

The ED comprises greywacke and argillite of the Torlesse Group rocks, with extensive areas of recently-deposited river gravel, sand and silt on the valley-floors (Warren, 1967). Approximately half the ED is mountainous, with broad ridges and summits rising to c.2100m and extensive rock and scree throughout the alpine and montane

zones. The remainder of the ED comprises the broad valleys of the Rakaia River and its major tributaries, the Wilberforce and Mathias rivers.

Original (pre-human) vegetation

Mountain beech forest was present on montane slopes in eastern lower-altitude parts of the ED prior to human settlement. This forest graded up-valley to mountain totara-broadleaf forest, with areas of mixed hardwood forest at stream or river margins (Arand and Glenny, 1990). The presence of miro in beech forest near Mt Algidus (Huber and Jane, 1988) and matai near Manuka Point (*personal observation*) indicates that other podocarps are likely to have been present in forest communities.

Dense mountain toatoa-inaka scrub would have been present above the forest communities in the upper valleys within the ED, probably with localised areas of mountain lacebark and mountain holly. Tussockland, herbfield and fellfield plant communities, interspersed with snow, rock and scree, would have occupied alpine areas (c.30% of the ED) much as they do today. The broad valley-floors supported stonefield, short tussockland, sedgeland and wetland plant communities.

Existing (present-day) vegetation

Frequent fires associated with human settlement, especially pastoral farming, have removed forest from large areas in the east of the ED. These areas now support tussockland, mountain kiokio fernland, inaka scrub and, at some low-altitude sites, kanuka scrub (Arand and Glenny, 1990). On valley-floors, short tussockland and mossfield are now prominent at stable sites, with sedgeland, reedland and red tussockland at poorly-drained sites. The extensive open gravel of the main rivers supports sparse stonefield vegetation, probably much as it originally did, though with the addition of introduced plant species and modification by introduced animals.

Extent of plant communities: Mathias ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	<1	12	77
8	mountain beech forest	6-25		
10	mountain totara-broadleaf forest	6-25		
15	matagouri shrubland	1-5	19	20
18	mountain toatoa-inaka scrub	6-25		
24	montane tall tussockland	1-5	15	6
25	mountain kiokio fernland	1-5		
27	wetland	<1	<1	0
34	rockland	1-5	21	9
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	31	31	34

Existing protected natural areas

Significant mountain beech forest remnants within Mathias ED are protected in Craigieburn Conservation Park, Rakaia Forest Conservation Area and Mt Algidus Ecological Area. Hydra Waters (246 ha), on the valley-floor near Mt Algidus is protected by a conservation covenant (Arand and Glenny, 1990).

Opportunities for further protection or restoration of original ecosystems

Just under one-fifth (19%) of Mathias ED is protected. Opportunities for further protection include forest remnants, extensive areas of montane shrubland and tussockland and riverflat plant communities (including matagouri shrubland and wetland) on pastoral lease land (Manuka Point and Mt Algidus pastoral leases). Other

opportunities are protection of additional wetlands in the Hydra Waters-Titan Stream area and protection of gravelfield communities (and important bird habitats) on the beds of the Wilberforce, Mathias and Rakaia rivers.

4.34 MT HUTT ECOLOGICAL DISTRICT (59.02)

Location and physical description

Mt Hutt ED covers the block of mountainous country between the Rakaia River, Ashburton Lakes (Lake Heron area) and the Canterbury Plains. It includes the Palmer, Taylor, Black Hill, Winterslow and Mt Hutt ranges, and the outlying summit of Mt Somers. Major peaks on the ranges in the ED lie between 2000 and 2300m asl. The area is drained through the centre by the Ashburton River (North Branch) and other parts of the ED are drained by tributaries of the Ashburton and Rakaia rivers.

The ED is mostly comprised of greywacke and argillite of the Torlesse Group rocks, with minor areas of glacial outwash gravel and alluvium on the main valley floors (Warren, 1967). In the south of the ED rhyolite and andesite of the Mt Somers Volcanics are present in the Mt Somers area (Gair, 1967), and Tertiary sediments outcrop at several locations near Mt Somers (Arand and Glenny, 1990).

Original (pre-human) vegetation

Mountain beech forest appears likely to have been the main plant community at montane sites throughout the ED. Mountain totara-broadleaf forest and a mixed hardwood forest dominated by akiraho, kowhai and broadleaf were also present at wet and dry sites respectively. Other montane sites are likely to have supported areas of matagouri and *Coprosma* scrub, tall tussockland, rock and scree. Alpine areas supported tussockland, fellfield and subalpine mountain toatoa-inaka scrub much as they do today (Arand and Glenny, 1990). Minor areas of podocarp forest and silver beech forest are present within mountain beech forest at the lower-altitude southeast edge of the ED (Kelly, 1972).

Existing (present-day) vegetation

Mt Hutt ED appears to have been affected by occasional natural fires that presumably restricted the extent of forest and scrub communities. However, more frequent fires since human settlement have reduced forest cover substantially and encouraged a dramatic increase in the extent of slim snow tussockland, short tussockland, inaka scrub, manuka scrub and possibly mixed hardwood forest (Arand and Glenny, 1990). Sunny faces, such as those on the south side of the Rakaia Valley, now support extensive grasslands with forest and scrub confined to small remnants in gullies. Alpine plant communities are probably present to much the same extent as they originally were.

Extent of plant communities: Mt Hutt ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	1-5	5	86
8	mountain beech forest	26-50		
10	mountain totara-broadleaf forest	1-5		
14	manuka-kanuka scrub	<1	5	40
15	matagouri-*Coprosma* scrub	1-5		
18	mountain toatoa-inaka scrub	1-5		

24	montane tall tussockland	1-5	38	35
27	wetland	<1	<1	4
34	rockland	1-5	6	16
35	stonefield (scree)	1-5		
36	alpine zone	36	36	?

Existing protected natural areas

Mountain beech forest remnants in the southeast part of Mt Hutt ED are protected within Mt Hutt Forest and Alford Forest (Mt Somers) conservation areas. Smaller areas are protected within Pudding Hill, Alford and Sharplin Falls scenic reserves, and within Awa Awa Rata Recreation Reserve. Inland and high-altitude areas are protected within the recently-established Hakatere Conservation Park.

Opportunities for further protection or restoration of original ecosystems

Less than half (42%) of Mt Hutt ED is protected. Opportunities for further protection include remnant and regenerating beech forest in the south of the ED (Mt Hutt, Alford Forest, Staveley and Mt Somers), riparian forest (including kowhai) along the Rakaia Gorge, small wetlands on the Rakaia River terraces and flats, shrublands (including prostrate kowhai) on the lower sunny faces in the Rakaia Valley, and relatively extensive areas of montane shrubland and tussockland in inland valleys (such as on Winterslow Pastoral Lease).

4.35 ARROWSMITH ECOLOGICAL DISTRICT (59.03)

Location and physical description

Arrowsmith ED covers the mountainous country between the Lawrence Valley (Armoury ED) and the low-lying Ashburton Lakes area (Hakatere ED). It lies between the Rakaia and Rangitata river valleys and includes most of the Arrowsmith Range and the associated ranges to the southeast. The highest summit within the ED is Mt Arrowsmith (2795m) and there are a number of other peaks over 2600m asl.

The ED comprises uniform greywacke and argillite of the Torlesse Group rocks, with areas of recent alluvium in the major valleys and at the lower-altitude edges of the district. It is drained by tributaries of the Rakaia, Rangitata and Ashburton rivers, notably the Potts, Cameron and Ashburton (South Branch) rivers. Almost half (c.48%) of the ED is above the timberline.

Original (pre-human) vegetation

The vegetation history of the main upland valleys in the Arrowsmith Range was deduced by Burrows *et al* (1993) from the analysis of pollen and macrofossils. It appears that until just prior to human settlement a low-stature mountain toatoa forest and associated scrub flora was widespread and dominant at montane sites. Areas of mountain totara, mountain lacebark and mixed hardwood forest may also have been present. Mountain beech forest and minor localised stands of silver beech forest were present at lower-altitude eastern sites (Burrows and Russell, 1990).

Existing (present-day) vegetation

Montane parts of Arrowsmith ED now support extensive areas of tussockland and matagouri scrub, plant communities that were induced by widespread fires sometime in the last 4000 years (Burrows *et al*, 1993). Subalpine and upper montane scrub is also relatively extensive. Forest communities are confined to just a few small sites in the ED (Burrows, 1996b).

Upper montane and alpine plant communities are less likely to have been affected by fires, and are probably relatively intact and therefore representative of the original vegetation. Likewise, the relatively extensive montane screes are also probably representative of their original state.

Extent of plant communities: Arrowsmith ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	<1	<1	34
8	mountain beech forest	1-5		
15	matagouri-*Coprosma* scrub	1-5	2	21
18	mountain toatoa-inaka scrub	26-50		
23	red tussockland	<1	40	49
24	tall tussockland	1-5		
27	wetland	<1	<1	100
34	rockland	1-5	8	69
35	stonefield (scree, riverbed)	1-5		
36	alpine zone	48	48	

Existing protected natural areas

A substantial part of the ED on Hakatere Pastoral Lease was recently purchased for protection through the Nature Heritage Fund and substantial parts of Mt Potts Pastoral Lease protected through tenure review. These areas, along with the Rangitata-Rakaia Conservation Area, are now protected within the recently-established Hakatere Conservation Park

Opportunities for further protection or restoration of original ecosystems

More than half of Arrowsmith ED (57%) is formally protected. Opportunities for further protection include beech forest remnants in gullies, extensive montane tussockland, high-elevation wetlands, and gravelfield and mossfield on the extensive bed of the Clyde River. Most unprotected areas lie within Upper Lake Heron and Mt Arrowsmith pastoral leases.

4.36 HAKATERE ECOLOGICAL DISTRICT (59.04)

Location and physical description

Hakatere ED covers the low-lying country between the mountains of the Arrowsmith, Mt Hutt, Two Thumb and Orari EDs. It lies between Lake Heron in the north and the Rangitata River in the south. The highest point in the ED is Mt Barossa (1367m) on the Clent Hills; almost all other parts of the district lie below the natural timberline (c.1300m).

The ED has been heavily glaciated. Landforms affected by at least five main Pleistocene glacial advances are present (Mabin, 1984). Extensive glacial and fluvioglacial landforms dominate the ED, with less extensive areas of greywacke, argillite and volcanics in the Clent Hills and Moorhouse Range area (Warren 1967; Gair, 1967). The area is generally of low and gentle relief, with numerous lakes and tarns including Lake Heron, Lake Clearwater and Maori Lakes. It is drained by tributaries of the Rakaia, Ashburton and Rangitata rivers.

Original (pre-human) vegetation

The extent of recent glaciation, the cool climate and infrequent natural fires are likely to have severely restricted the extent of forest cover in the Hakatere ED. It appears likely that low-stature mountain toatoa forest and scrub were present over parts of the ED (Burrows *et al*, 1993) and that mountain beech and silver beech forest were present in some other parts of the district (Burrows and Russell, 1990). Otherwise it appears that the ED was dominated by short tussock, narrow-leaved snow tussock, red tussock, and sedgeland or reedland in the relatively extensive wetlands (Harrington *et al*, 1986).

Matagouri-*Coprosma* shrubland, and perhaps minor areas of mountain totara and mountain lacebark forest, may also have been present. Relatively extensive open stonefield plant communities were present on the beds of the Rangitata, Potts and Ashburton (South Branch) rivers.

Existing (present-day) vegetation

Today, the most extensive indigenous plant community in Hakatere ED is induced short tussockland. Depleted tall tussockland is present on some lower slopes, and relatively extensive areas of modified red tussockland present at wetlands. Forest is confined to remnants of mountain beech in the south of the ED on Butler Downs (Mesopotamia Pastoral Lease), on low hills in the east of the ED and at Lake Stream in the north. Areas of mixed shrubland and scrub are also present.

Wetland plant communities, including cushionfield (turf) vegetation at kettleholes, are present, albeit mostly modified, throughout low-lying parts of the ED. Stonefield is also present, and in relatively natural condition except for localised infestations of weeds (Harding, 2002), on the beds of the main rivers.

Extent of plant communities: Hakatere ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	<1	<1	5
8	mountain beech forest	1-5		
15	matagouri-*Coprosma* shrubland	1-5	4	22
18	mountain toatoa scrub	6-25		
21	short tussockland	6-25	65	27
23	red tussockland	6-25		
24	tall tussockland	6-25		
27	wetland and cushionfield	6-25	1	30
35	stonefield/gravelfield (riverbed)	6-25	8	10
36	alpine zone	<1	<1	

Existing protected natural areas

Important protected natural areas in Hakatere ED are Lake Heron Nature Reserve and Wildlife Refuge, Lake Heron Conservation Area, Maori Lakes Nature Reserve, Lake Camp Recreation Reserve and Upper Rangitata Riverbed Conservation Area. Protection of Hakatere and Clent Hills pastoral leases through the Nature Heritage Fund have increased the proportion of the ED protected. These areas are protected within the recently-established Hakatere Conservation Park.

Opportunities for further protection or restoration of original ecosystems

One-fifth (20%) of Hakatere ED is formally protected. Although substantial parts of the ED are now quite modified, there are some significant opportunities for further protection:

- Lake Stream wetlands and Cameron River fan
- red tussockland on the basin floor
- lake margins, kettlehole lakes and moraine plant communities
- uncultivated basin-floor sites
- gravelfield and mossfield on the beds of the Rangitata River and Forest Creek
- large wetlands alongside the Rangitata River, upstream from Forest Creek
- tall tussocklands on lower hill slopes
- limestone plant communities in the Ashburton River (South Branch)
- wetlands in the upper Hinds River valley

4.37 TWO THUMB ECOLOGICAL DISTRICT (59.05)

Location and physical description

Two Thumb ED covers the moderately-glaciated Two Thumb Range between the Rangitata Valley and the Godley-Lake Tekapo Valley, in South Canterbury. The ED is entirely mountainous with the major summits lying between 2500m asl in the north and 2000m asl in the south. It adjoins Orari and Fairlie EDs to the east, and Godley and Tekapo EDs to the west.

The ED comprises greywacke and argillite of the Torlesse Group rocks in the north, and older weakly-schistose greywacke and argillite in the south (Gair, 1967). Minor areas of moraine or recent alluvium are present in the major valleys, such as in the upper Bush Stream basin. The ED is drained by tributaries of the Rangitata River to the north, the Opihi River to the east, and Lake Tekapo catchment (Godley and Macaulay rivers) to the west.

Original (pre-human) vegetation

Montane parts of Two Thumb ED appear to have supported mountain totara-hardwood forest in the west and more localised mountain beech forest in the east (Harrington *et al*, 1986). Inaka-mountain toatoa scrub, narrow-leaved snow tussock, and scattered areas of mountain lacebark forest are likely to have been present at upper montane sites including high basins such as the upper Bush Stream basin. Forest on the intermontane range slopes of the Mackenzie Basin is likely to have been a low-stature plant community interspersed with areas of scrub and grassland (McGlone, 2001). Alpine areas, comprising over half the ED, supported extensive snow, rock and fellfield.

Existing (present-day) vegetation

Today, montane slopes in Two Thumb ED are dominated by induced tall tussock and scrub. Forest remnants and associated induced shrubland and scrub are present but localised in damp gullies and valleys. Plant communities below the timberline have been largely induced by grazing and the increased frequency of fire following human settlement, though they are dominated by indigenous species and are moderately-natural over large areas. Alpine plant communities are present to the same extent as they originally were.

Extent of plant communities: Two Thumb ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	1-5	<1	67
8	mountain beech forest	6-25		

10	mtn totara-hardwood forest	6-25		
19	inaka-mountain toatoa scrub	1-5	4	49
24	montane tall tussockland	1-5	31	50
34	rockland	<1	3	71
35	gravelfield/stonefield (scree)	1-5		
36	alpine zone	58	58	

Existing protected natural areas

Large protected natural areas in Two Thumb ED are Mesopotamia, Mount Gerald/Two Thumb, Run 77 Retirement Area, Two Thumb Range, and Mount Dobson conservation areas. Substantial parts of this ED have been protected in recent years through the tenure review of Richmond and Mesopotamia pastoral leases. All these areas are now protected within the recently-established Te Kahui Kaupeka Conservation Park.

Opportunities for further protection or restoration of original ecosystems

Over half (55%) of Two Thumb ED is formally protected. Opportunities for further protection are:

- areas of mid-altitude tussockland on pastoral leases
- small remnants of mountain totara forest in incised western gullies
- low-altitude tussockland at the southern end of the Two Thumb Range
- important freshwater habitats in Edwards Stream
- small areas of beech-broadleaf forest in southern valleys

4.38 GODLEY ECOLOGICAL DISTRICT (60.01)

Location and physical description

Godley ED covers the mountainous country between the Murchison and Tasman valleys (Mount Cook ED) and the Mackenzie Basin (Tekapo ED). It is dominated by the Gammack, Hall, Liebig and Sibbald ranges, with the main summits at between 2200m and 2800m asl, and supporting extensive areas of snow, rock and scree.

The ED comprises greywacke and argillite of the Torlesse Group rocks, with areas of outwash gravel and other alluvium in the Tasman and Godley valleys (Gair, 1967). The area is drained by tributaries of the Godley, Tekapo and Tasman rivers.

Original (pre-human) vegetation

A significant proportion (c.66%) of Godley ED is above the natural timberline, and supports extensive areas of year-round snow and ice, rock, scree and fellfield. In the montane zone, scattered low-stature forest dominated by mountain toatoa and mountain totara is likely to have been present at stable sites (Wilson, 1978). Small areas of silver beech forest were present in the southeast of the ED (McEwen, 1987). Elsewhere, dense mountain toatoa-inaka scrub and scattered tall tussockland and herbfield are likely to have been dominant. At lower-altitudes, on the relatively extensive beds of the Tasman and Godley rivers, stonefield and areas of short tussockland were probably present.

Existing (present-day) vegetation

The extensive alpine zone within Godley ED is likely to support sparse plant communities that are representative of the original vegetation. At montane sites, plant communities in the east of the ED have been affected by fire and grazing and, in places, replaced by tall tussockland. Riverbed vegetation is likely to be present to

much the same extent as it originally was, though modified by introduced plants and animals.

Extent of plant communities: Godley ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
9	silver beech forest	<1	0	0
10	mtn totara-mtn toatoa forest	1-5		
15	matagouri-*Coprosma* scrub	1-5	3	41
18	mountain toatoa-inaka scrub	6-25		
21	short tussockland	<1	18	42
24	montane tall tussockland	1-5		
27	wetland	<1	<1	33
34	rockland	1-5	13	18
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	66	66	71

Existing protected natural areas

Large protected natural areas in Godley ED include the Liebig Range and Godley-Macaulay conservation areas and parts of Aoraki/Mt Cook National Park. An area in the west of the ED has recently been protected through tenure review of Mt Cook Pastoral Lease.

Opportunities for further protection or restoration of original ecosystems

Just over half (57%) of Godley ED is formally protected. Opportunities for further protection are:

- extensive and nationally-important gravelfield/stonefield/mossfield/grassland communities and fauna habitat on the braided beds of the Tasman, Cass, Godley and Macaulay rivers
- wetlands on river deltas and margins (e.g. Glentanner wetland)
- low forest and scrub on steep low- to mid-altitude faces
- freshwater habitats in Fork Stream and Cass River
- tall tussockland on montane faces

4.39 DOBSON ECOLOGICAL DISTRICT (60.02)

Location and physical description

Dobson ED covers the mountainous country just east of the main divide of the Southern Alps south of Aoraki/Mt Cook National Park. It is dominated by the Ben Ohau and Neumann ranges, lying between Lake Pukaki/Tasman River and the Dobson and Hopkins rivers. Major summits on the ranges lie between 2200m and 2600m asl, and are covered year-round by snow and ice.

The ED comprises greywacke and argillite of the Torlesse Group rocks and weakly schistose greywacke and argillite, with glacial and fluvioglacial deposits in the main valleys (Gair, 1967). The area is bisected and drained by the tributaries of the Hopkins, Dobson and Tasman rivers.

Original (pre-human) vegetation

Montane slopes in the ED supported relatively extensive stands of mountain beech forest in the lower valleys and silver beech forest in the upper (higher-rainfall) valley

heads (Wardle and Guest, 1977). Areas of mountain toatoa-inaka scrub, tall tussock and mountain lacebark forest are also likely to have been present on valley sides, interspersed with rock and scree.

Valley-floors are likely to have supported areas of matagouri shrubland, short tussockland, stonefield (riverbed) and wetland vegetation. The extensive alpine zone (c.58% of the ED) supported snow, ice, rock, fellfield and tall tussock.

Existing (present-day) vegetation

Fire associated with human settlement (especially pastoralism) has removed forest cover from many slopes especially those in the east of the ED. Tall tussockland and scrub now occupy many sites formerly occupied by forest. Valley-floor plant communities have also been depleted and modified though retain some of their natural character. Alpine plant communities are present to much the same extent as they originally were, though are modified by introduced animals.

Extent of plant communities: Dobson ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	1-5	10	89
8	mountain beech forest	6-25		
9	silver beech forest	1-5		
15	matagouri-*Coprosma* scrub	1-5	7	32
18	mountain toatoa-inaka scrub	1-5		
21	short tussockland	1-5	16	27
24	montane tall tussockland	1-5		
34	rockland	1-5	9	18
35	stonefield (riverbed, scree)	6-25		
36	alpine zone	58	58	30

Existing protected natural areas

Large protected natural areas in Dobson ED include Hopkins Forest, Dobson Forest, Round Hill Forest, Ferintosh Retirement Area, Dusky Run and Ruataniwha (Ben Ohau) conservation areas.

Opportunities for further protection or restoration of original ecosystems

One-third (35%) of Dobson ED is formally protected. Opportunities for further protection are:

- extensive gravelfield/stonefield/mossfield/grassland communities and fauna habitat on the braided beds of the Dobson and Hopkins rivers
- riverflat tussocklands (red and short) in the upper valleys
- scrub and regenerating forest on mid-altitude faces
- extensive areas of alpine vegetation

4.40 ORARI ECOLOGICAL DISTRICT (61.01)

Location and physical description

Orari ED covers the hill country between the Canterbury Plains and Two Thumb Range in South Canterbury. It includes the Harper, Mount Peel and Four Peaks ranges, and part of the Ben McLeod Range. The ED is mostly mountainous, though with rounded summits at 2000m asl on the Ben McLeod Range and between 1500 and 1700m asl on the eastern ranges.

The ED comprises greywacke and argillite of the Torlesse Group rocks with areas of Mt Somers volcanics (rhyolite and andesite) in the north, and areas of glacial outwash gravel and river alluvium in the main valleys (Gair, 1967). The ED is drained by tributaries of the Rangitata River in the north, Orari River in the centre, and Opihi River in the south. It borders High Plains and Geraldine EDs to the east, Hakatere ED to the north, Two Thumb ED to the west and Fairlie ED to the south.

Original (pre-human) vegetation

Montane parts of Orari ED appear to have been almost entirely forested, with podocarp and podocarp-hardwood forest at low-altitude sites in the east, and mountain beech forest in the west (McEwen, 1987). It is likely that most montane parts of the ED supported mountain beech forest, and that forests of the area represent a transition between the podocarp-hardwood forest of the upper plains and eastern foothills and the mountain beech forest of the foothills ranges.

Mixed hardwood forest and matagouri-*Coprosma* shrublands were likely to have been present on valley-floors, probably with areas of short tussockland. Inaka scrub and tall tussock were probably present at upper-montane sites, and the relatively small alpine zone (c.9% of the ED) probably supported tall tussock, cushionfield and stonefield.

Existing (present-day) vegetation

Today, forest is almost completely confined to podocarp-hardwood remnants on eastern and southern slopes of the Mt Peel Range, small podocarp remnants at low altitudes in the east (Peel Forest), and small isolated mountain beech remnants at inland sites. Elsewhere, narrow-leaved snow-tussock, modified grassland or manuka scrub dominates on sunny slopes, and inaka scrub or fernland dominates at damper sites.

Most valley-floors are highly modified, except for the open stonefield on the main bed of the Rangitata River. The original alpine plant communities are still present but are substantially modified by domestic and wild animals.

Extent of plant communities: Orari ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
3	podocarp-hardwood forest	1-5	2	55
8	mountain beech forest	51-75		
10	mountain totara forest	6-25		
15	matagouri-*Coprosma* scrub	1-5	6	11
19	inaka scrub	1-5		
24	montane tall tussockland	1-5	66	11
25	fernland	1-5		
27	wetland	<1	<1	63
34	rockland	<1	3	21

35	stonefield/stonefield (scree)	1-5		
36	alpine zone	9	9	

Existing protected natural areas

Large protected natural areas in Orari ED include Peel Forest Park, Orari Gorge, Waihi Gorge and Hae Hae Te Moana scenic reserves, and Four Peaks Range Tops Conservation Area. Protection of Mt Peel, Waikari Hills and The Gorge pastoral leases through tenure review and parts of Mt Possession through the Nature Heritage Fund have increased the proportion of the ED protected.

Opportunities for further protection or restoration of original ecosystems

Only (11%) of Orari ED is formally protected. Opportunities for further protection are:

- extensive scrub, regenerating forest and beech forest remnants on the south side of the Mt Peel Range
- unlogged low-altitude forest in eastern valleys
- substantial areas of regenerating forest in southern and eastern valleys
- small river-terrace wetlands
- dry rock-face plant communities in the Rangitata Valley
- Coal Hill limestone shrublands
- extensive areas of mid-altitude tall tussockland
- tributary streams with remnant populations of blue duck

4.41 FAIRLIE ECOLOGICAL DISTRICT (61.02)

Location and physical description

Fairlie ED covers the low-lying country east of the Two Thumb Range, Hunters Hills and Albury Range in South Canterbury. It is mostly a broad gentle basin bisected by the upper tributaries of the Opihi River, including the North Opuha, South Opuha and Tengawai rivers. The ED lies mostly between 150 and 600m asl. It comprises outwash gravel and till, with smaller areas of marine deposits including siltstone and limestone (Gair, 1967).

Original (pre-human) vegetation

It is likely that the predominant vegetative cover of the main Fairlie Basin was forest with areas of short tussockland, matagouri-*Coprosma* scrub and wetland vegetation. Podocarp and mixed podocarp-hardwood forest were present at lower altitudes and along streams, and a low-stature podocarp hardwood forest is likely to have occupied some lower slopes (McGlone, 2002; McEwen, 1987).

Existing (present-day) vegetation

Today, forest in the Fairlie ED is confined to small remnants in gullies. Otherwise, vegetation of the ED has been substantially modified by farm development, and few areas of intact indigenous vegetation remain.

Extent of plant communities: Fairlie ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
3	podocarp-hardwood forest	6-25	<1	13
10	mountain totara forest	6-25		
15	matagouri-*Coprosma* scrub	6-25	7	1
21	short tussockland/grassland	6-25	8	<1

24	tall tussockland	6-25		
27	wetland	1-5	0	0
34	rockland	<1	1	4
35	gravelfield/stonefield (riverbed)	<1		

Existing protected natural areas
Only small scattered sites, mostly gravel reserves, are protected in Fairlie ED.

Opportunities for further protection or restoration of original ecosystems
Less than 1% of Fairlie ED is formally protected. Known opportunities for further protection are restricted to scrub and forest remnants, with threatened species, in the Opihi River gorge (UCL), shrubland and scrub in the Opuha River gorge, and scrub and regenerating forest on steep south-facing slopes above the Tengawai River.

4.42 GERALDINE ECOLOGICAL DISTRICT (61.03)

Location and physical description
Geraldine ED covers the downlands and upper plains between the Orari and Tengawai rivers in South Canterbury. It borders Orari and Fairlie EDs to the north and west, Low Plains ED to the east and Waimate ED to the south. The ED is low-lying, covering gentle rolling hills between 100 and 300m asl.

The ED comprises extensive areas of till and loess-covered gravel, with areas of Tertiary greensand, siltstone, coal-measures and limestone (Gair, 1967). Outcropping basalt near Geraldine is mostly overlain by deep loess deposits. The ED is drained by parts of Orari, Waihi, Hae Hae Te Moana, Kakahu, Opihi and Tengawai rivers.

Original (pre-human) vegetation
Large parts of Geraldine ED are likely to have supported podocarp or podocarp-hardwood forest, with matai-totara forest on the free-draining gravels of the plains and matai-totara-kahikatea-hardwood forest on the rolling hill country. Limestone scarps are numerous and would have supported podocarp-hardwood forest and limestone rock flora. It is also likely that at least parts of the ED were affected by natural fires and therefore probably supported a mosaic of short tussockland, scrub, treeland and forest.

Many areas of forest were probably removed by the increased frequency of fire following human settlement. At the time of European exploration, significant remnants of podocarp and podocarp-hardwood forest were recorded at ‘Gurdon Forest’ (Peel Forest), ‘Waihi Forest’ (Woodbury), and Talbot Forest (Geraldine) by Charles Torlesse in 1849 (Andersen, 1916).

Existing (present-day) vegetation
Today, the original podocarp forest is confined to modified, but significant, remnants at Peel Forest, Waihi Bush, Talbot Forest, Kakahu, Waitohi and Pioneer Park. Scattered regenerating matai-totara forest is present on the plains near Woodbury (including Conways Bush) and regenerating podocarp-hardwood forest present in small gullies on the hill country. Areas of scattered ti (cabbage tree) are probably representative of the treeland that covered parts of the area. Limestone flora and small forest remnants are present on limestone scarps. Otherwise, the vegetation of the ED is substantially modified, its fertile soils supporting intensive agriculture.

Extent of plant communities: Geraldine ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	matai-totara-kahikatea forest	6-25	1	37
3	matai-totara forest	51-75		
6	kanuka forest and scrub	1-5		
12	kowhai-ti-*Hoheria* treeland	6-25		
14	kanuka shrubland	1-5	6	7
15	matagouri shrubland	<1		
21	short tussockland	1-5	<1	0
27	wetland	<1	0	0
35	gravelfield/stonefield (riverbed)	1-5	2	6

Existing protected natural areas

Significant protected natural areas in Geraldine ED include Talbot Forest Scenic Reserve (26 ha), Pioneer Park Conservation Area (120 ha), and two covenanted areas: Waihi Bush and Kakahu Bush.

Opportunities for further protection or restoration of original ecosystems

Only approximately 1% of Geraldine ED is formally protected. Opportunities for further protection are:

- scattered patches of strongly regenerating matai-totara forest in the Woodbury-Waihi area
- podocarp-hardwood forest at Pioneer Park
- remnant and regenerating podocarp-hardwood forest on the Geraldine Downs
- limestone scarps with good populations of limestone plants and remnant or regenerating forest (including bat-roost sites)
- large trees (mostly crack willow) along rivers (bat-roost sites)

4.43 HUNTERS ECOLOGICAL DISTRICT (61.04)

Location and physical description

Hunters ED covers the low hills of the Albury Range and The Hunters Hills in South Canterbury. The ranges lie in a northwest-southeast direction inland from the coastal plain and downs west of Timaru. The rounded summits of the ranges lie between 1000 and 1500m asl and are dissected by a number of small streams and river tributaries. The ED borders Fairlie and Waimate EDs to the east, and Grampians and Hakataramea EDs to the west.

The ED comprises greywacke and argillite of the Torlesse Group rocks, with areas of schist, loess-covered gravels and Tertiary sediments (siltstone, sandstone and limestone) (Gair, 1967). The ranges are drained to the east by tributaries of the Pareora River, and the west by tributaries of the Hakataramea and Waihao rivers.

Original (pre-human) vegetation

It is likely that podocarp and podocarp-hardwood forest dominated at lower altitudes throughout Hunters ED, with scrub and tall tussock at higher altitudes (McEwen, 1987; Andersen, 1916). The extent to which the area was affected by natural fires is unclear, but it is likely that such fires had an influence, particularly on drier slopes.

Existing (present-day) vegetation

Today, remnants of podocarp-hardwood forest are present on the lower slopes of The Hunters Hills, mostly in incised gullies where they have escaped the burning associated with human settlement. Relatively extensive areas of scrub and regenerating forest are also present on the range slopes. At other montane sites tall tussock occupies slopes formerly covered with forest and, at higher altitudes, smaller areas of subalpine-alpine vegetation are present.

Extent of plant communities: Hunters ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	podocarp forest	6-25	4	38
3	podocarp-hardwood forest	26-50		
5	montane hardwood forest	1-5		
10	mountain totara forest	6-25		
12	kowhai-ti treeland	1-5		
14	kanuka scrub	1-5	6	4
15	matagouri-*Coprosma* scrub	1-5		
19	inaka scrub	1-5		
21	short tussockland	1-5	45	18
24	tall tussockland	6-25		
34	rockland	<1	<1	<1
36	alpine zone	6	6	61

Existing protected natural areas

Significant protected natural areas in Hunters ED include Otaio Gorge, Matata and Mt Nimrod scenic reserves, and Hunters Hills, Hook Bush, Gunns Bush, Kelceys Bush, North Waihao Bush and Studholme conservation areas.

Opportunities for further protection or restoration of original ecosystems

Approximately 11% of Hunters ED is formally protected. Opportunities for further protection are:

- areas of limestone flora at Manahune and Albury Park
- forest remnants and regenerating forest in the main lower eastern valleys of the Albury Range
- forest remnants and regenerating forest in the lower eastern valleys of The Hunters Hills, often providing links or buffers to existing protected remnants
- areas of montane tall tussock on the flanks of the range

4.44 WAIMATE ECOLOGICAL DISTRICT (61.05)

Location and physical description

Waimate ED covers the low-lying hill country and downs east and south of The Hunters Hills, from the Opihi River in the north to the Waitaki River in the south. It borders Makikihi and Glenavy EDs to the east and Hunters and Hakataramea EDs to the west. The downs and slopes of the ED lie between 150 and 600m asl and are drained by numerous small tributaries of the Pareora, Otaio and Waihao rivers. The ED comprises a complex geology including basalt, schist, till, loess-covered gravels and limestone (Gair, 1967).

Original (pre-human) vegetation

It appears likely that Waimate ED originally supported relatively extensive areas of podocarp and podocarp-hardwood forest, with minor areas of silver beech forest. Shrubland, treeland and short tussockland may have occupied areas that were prone to infrequent natural fires. Limestone bluffs supported a specialised flora, and riparian areas probably supported mixed hardwood forest dominated by kowhai.

Existing (present-day) vegetation

Today the original forest cover of Waimate ED is confined to small remnants in gullies along the lower slopes of The Hunters Hills. These remnants are typically surrounded and buffered by more extensive areas of scrub and regenerating forest. Some limestone bluffs still support a relatively intact flora, though such sites are frequently threatened by introduced plants. Otherwise, the indigenous vegetation of the ED is substantially depleted or modified.

Extent of plant communities: Waimate ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	podocarp forest	26-50	2	30
3	podocarp-hardwood forest	26-50		
5	montane hardwood forest	1-5		
6	kanuka forest	1-5		
12	kowhai-ti treeland	1-5		
14	kanuka scrub	1-5	7	8
15	matagouri-*Coprosma* scrub	1-5		
21	short tussockland	1-5	4	1
22	silver tussockland	1-5		
34	rockland	<1	<1	27

Existing protected natural areas

Significant protected natural areas in Waimate ED include Tasman Smith, Pareora, Pareora River and Claremont scenic reserves.

Opportunities for further protection or restoration of original ecosystems

Only approximately 1% of Waimate ED is formally protected. Opportunities for further protection are:

- areas of limestone flora, including forest remnants, in the Taiko and Craigmoor areas
- scrub and regenerating forest on basalt in the Claremont to Mt Horrible area
- scrub on steep faces south of Cave
- forest remnants in the Waihao Gorge
- limestone areas in the McCullochs Bridge area

4.45 HAKATARAMEA ECOLOGICAL DISTRICT (61.06)

Location and physical description

Hakataramea ED covers the broad low-lying Hakataramea River basin between the Kirkliston Range and The Hunters Hills in South Canterbury. It lies between 300 and 900m asl and includes the gently-sloping floor of the Hakataramea Valley and the rounded hill country between the Hakataramea and Waihao valleys. The ED borders

Hunters ED to the north, Waimate ED to the east, Kirkliston ED to the west, and St Mary and Duntroon EDs across the Waitaki River to the south.

The ED comprises greywacke and argillite of the Torlesse Group rocks, schist, till, loess-covered gravels, and areas of Tertiary sediments (siltstone, sandstone and limestone (Gair, 1967, NZGS, 1972). It is drained by the Hakataramea and Waihao rivers, and adjoins the lower Waitaki River on its southern boundary.

Original (pre-human) vegetation

Little information about the original vegetation of Hakataramea ED was located during the preparation of this report. It is likely that the broad Hakataramea Valley supported areas of scrub and short tussockland, and that hill slopes supported low-stature mountain totara-hardwood forest (McGlone, 2001). It is also likely that sheltered low-altitude sites supported tall podocarp-hardwood forest (McEwen, 1987). Treeland, dominated by ti, kowhai and lowland ribbonwood, may also have been present, and relatively extensive areas of stonefield present on the open bed of the Waitaki River.

Existing (present-day) vegetation

Today, Hakataramea ED supports developed farmland or modified short tussockland at lower altitudes with scrub and forest remnants in gullies, and narrow-leaved snow-tussock at higher altitudes. The original vegetation has been substantially modified by the increased frequency of fire and land development that accompanied human settlement.

Extent of plant communities: Hakataramea ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
3	matai-totara-hardwood forest	1-5	<1	0
10	mtn totara-hardwood forest	26-50		
12	kowhai-ti treeland	1-5		
15	matagouri-*Coprosma* scrub	6-25	6	7
21	short tussockland	6-25	46	<1
24	narrow-leaved snow-tussockland	6-25		
34	rockland	<1	1	11
35	gravelfield/stonefield (riverbed)	1-5		
36	alpine zone	<1	<1	2

Existing protected natural areas

The only protected natural areas in Hakataramea ED are a series of conservation areas on the open bed of the Waitaki River in the south of the ED. However, parts of Waihao Bush Conservation Area in Hunters ED, and Kirkliston Range Conservation Area in Kirkliston ED, lie on the boundaries.

Opportunities for further protection or restoration of original ecosystems

Only approximately 1% of Hakataramea ED is formally protected. Opportunities for further protection are:

- gravelfield, herbfield/mossfield on uncultivated riverflats in the upper valley
- shrubland/wetland complexes in the upper valley
- shrubland on faces along the lower Waitaki valley
- forest remnants and shrubland in the Elephant Hill Stream area
- freshwater habitats (though modified) in the Hakataramea River

4.46 MAKIKIHI ECOLOGICAL DISTRICT (62.01)

Location and physical description

Makikihi ED covers the downs and narrow coastal plain between Timaru and Waimate in South Canterbury. It lies between Waimate ED and the Canterbury Bight, and borders Low Plains ED to the north and Glenavy ED to the south. The ED is mostly below 150m asl.

The ED comprises relatively extensive recent alluvial deposits and areas of loess-covered gravel and basalt (Gair, 1967; NZGS, 1972). It is drained by the lower tributaries of a number of smaller rivers including the Pareora, Otaio and Makikihi. The coastline of the ED comprises narrow gravel beaches.

Original (pre-human) vegetation

Downlands in the north of the ED supported tall podocarp forest c.6730 years ago (Moar, 2008). Southern parts of the ED are likely to have supported vegetation similar to that in the southern part of Low Plains ED. Early maps of the area indicate relatively extensive areas of swamp in the Washdyke, Pareora and Wainono areas, supporting flax, grass, raupo or wet tussock (Johnston, 1961). No forest is indicated on the early maps described by Johnston or those of Charles Torlesse (Andersen, 1916).

The ED probably supported areas of lowland podocarp forest, kowhai-ti treeland, scrub, short tussockland and wetland vegetation. The extent to which the area was affected by natural fires is unclear, though the low annual rainfall (600-700mm) suggests that it is likely that such fires affected a substantial part of the ED.

Existing (present-day) vegetation

Today little remains of the original vegetation of the ED. Some very small modified areas of forest remain (McEwen, 1987) and wetlands are present, though modified, notably south of the Otaio River and at Wainono Lagoon. Shrubland and low coastal vegetation are present at some beaches. Otherwise, Makikihi ED has been substantially modified by farm development and the urban sprawl of Timaru.

Washdyke Lagoon, Caroline Bay, Pareora River mouth and Wainono Lagoon are ranked as having relatively high natural values in the Sand Dune and Beach Inventory of New Zealand (Johnson, 1992). Of these, Wainono Lagoon ranks highest.

Extent of plant communities: Makikihi ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	lowland podocarp forest	6-25	<1	2
3	podocarp-hardwood forest	26-50		
6	kanuka forest	1-5		
12	kowhai-ti treeland	1-5		
14	kanuka scrub	1-5	1	8
15	matagouri-*Coprosma* scrub	6-25		
21	short tussockland	6-25	0	0
26	coastal wetland	<1	<1	39
27	inland wetland	1-5	<1	98
35	gravelfield/stonefield	<1	<1	19

Existing protected natural areas

Significant protected natural areas in Makikihi ED include Pareora River Mouth, Otaio River and Wainono Lagoon conservation areas. A relatively long stretch of foreshore north of Wainono Lagoon is also protected as a conservation area.

Opportunities for further protection or restoration of original ecosystems

Less than 1% of Makikihi ED is formally protected. Opportunities for further protection appear to be limited to small coastal sites just south of Timaru, areas adjacent to Wainono Lagoon and very small areas of modified vegetation in gullies and on scarps on the downlands behind Timaru.

4.47 GLENAVY ECOLOGICAL DISTRICT (62.02)

Location and physical description

Glenavy ED covers the coastal floodplain of the Waitaki River and an area of coastal plain north of the river mouth. Only the area north of the Waitaki River lies within Canterbury Conservancy. Glenavy ED is low-lying (mostly below 150m asl) and of gentle relief. It borders Makikihi ED to the north and Waimate ED to the west.

The ED comprises glacial outwash gravels with areas of recent alluvium and steep gravel beaches (NZGS, 1972, McEwen, 1987). It is drained by the lower tributaries of the Waitaki and Waihao rivers.

Original (pre-human) vegetation

Little information about the original vegetation of Glenavy ED was located during the preparation of this report. However, it is likely that it supported vegetation similar to that in the Makikihi and Low Plains EDs. Early maps of the area indicate relatively extensive areas of swamp along the coast in the northern part of the district (south of Wainono Lagoon) (Johnston, 1961). No forest is indicated on the early maps described by Johnston or those of Charles Torlesse (Andersen, 1916).

The ED probably supported areas of lowland podocarp forest, kowhai-ti treeland, scrub, short tussockland and wetland vegetation. The extent to which the area was affected by natural fires is unclear, though the low annual rainfall (600mm) suggests that natural fires would have affected most parts of the ED.

Existing (present-day) vegetation

Today little remains of the original vegetation of the ED. Some modified areas of short tussockland and scrub remain (McEwen, 1987) and parts of the foreshore may also support remnants of indigenous vegetation. Otherwise, Glenavy ED has been substantially modified by farm development.

Extent of plant communities: Glenavy ED*

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
2	lowland podocarp forest	6-25	<1	0
3	podocarp-hardwood forest	26-50		
6	kanuka forest	1-5		
12	kowhai-ti treeland	1-5		
14	kanuka scrub	1-5	3	12
15	matagouri-*Coprosma* scrub	6-25		

21	short tussockland	6-25	0	0
27	wetland	1-5	0	0
32	coastal sandfield	<1	<1	0
35	gravelfield/stonefield (riverbed)	1-5	2	11

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas

Significant protected natural areas in the part of Glenavy ED within Canterbury Conservancy include Waihao Box and Cruikshanks Pond wildlife management reserves, and a number of areas along the Waitaki River (Waitaki Riverbed Conservation Area).

Opportunities for further protection or restoration of original ecosystems

Only approximately 3% of Glenavy ED is formally protected. Opportunities for further protection appear limited to small uncultivated sites in coastal gullies and areas of gravelfield (albeit affected by weeds) in the bed of the Waitaki River.

4.48 TEKAPO ECOLOGICAL DISTRICT (63.01)

Location and physical description

Tekapo ED covers the formerly-glaciated northern part of the Mackenzie Basin in inland South Canterbury. It lies between the Ben Ohau Range in the west, Two Thumb Range in the east and the Gammack and Hall ranges in the north. The topography of the ED is relatively gentle though elevated, lying between 500 and 1000m asl. The ED borders Godley ED to the north, Two Thumb ED to the east, Pukaki ED to the south, and Dobson and Ben Ohau EDs to the west.

The ED comprises extensive areas of moraine (till) with minor areas of glacial outwash gravel and an ice-smoothed hill of greywacke and argillite at Mt John (Gair, 1967). It is drained by tributaries of the Tekapo and Pukaki rivers, and includes the large lakes Tekapo and Pukaki, and the smaller Lake Alexandrina.

Original (pre-human) vegetation

The original vegetation of Tekapo ED was strongly influenced by recent glaciation, a harsh intermontane basin climate and infrequent natural fires. It appears unlikely that forest was present except perhaps for areas of low-stature mountain toatoa-bog pine forest on the moraines of the Mackenzie Basin, and mountain totara forest on lower range slopes (McGlone, 2001). The ED was probably dominated by short tussockland, red tussockland, tall tussockland, mountain toatoa-bog pine scrub and matagouri-*Coprosma* scrub (Espie *et al*, 1984). Areas of wetland vegetation were probably relatively common along the numerous small rivers and around Lake Alexandrina.

Existing (present-day) vegetation

An increased frequency of fire following human settlement, particularly European pastoralism, reduced the extent of scrub/low forest and tall tussock communities, and increased the extent of short tussockland. Now, after years of pastoralism, those short tussocklands are degraded by grazing (sheep and rabbits) and introduced plants (especially grasses and mouse-ear hawkweed). Relatively extensive areas of red tussockland are still present, though frequently modified.

Wetlands, especially those on lake-margins, have been destroyed by the raising of lakes Tekapo and Pukaki for hydro-electricity generation, or substantially modified by

pastoralism. Sparse cushionfield-herbfield-shirt tussockland vegetation is present on the shallow soils of the outwash surfaces, and turf vegetation at the numerous kettleholes that occupy the moraine hollows.

Extent of plant communities: Tekapo ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
10	mountain totara forest	1-5	<1	0
15	matagouri-*Coprosma* scrub	1-5	3	3
17	bog pine scrub	1-5		
18	mtn toatoa scrub/low forest	6-25		
21	short tussockland	6-25	62	5
23	red tussockland	26-50		
24	tall tussockland	6-25		
27	wetland	1-5	<1	0
35	gravelfield/stonefield	1-5	2	1
36	alpine zone	<1	<1	17

Existing protected natural areas

Important protected natural areas in Tekapo ED include Lake Alexandrina Scenic Reserve, Micks Lagoon Wildlife Reserve, and Cass River Delta and Lake Pukaki Terminal Moraine conservation areas.

Opportunities for further protection or restoration of original ecosystems

Approximately 3% of Tekapo ED is formally protected. Opportunities for further protection are:

- moraine/kettlehole/wetland systems, notably Glenmore Tarns
- moraine and tarn systems on the eastern shore of Lake Tekapo
- shrubland and rockland vegetation on small hills (e.g. Mt Hay and Mt John)
- lakeshore turflands, though modified and limited in extent
- freshwater habitats in Fork Stream and Edwards Stream
- wetland and tussockland ecosystems (Braemar and army lands)
- Maryburn wetlands

4.49 PUKAKI ECOLOGICAL DISTRICT (63.02)

Location and physical description

Pukaki ED covers the outwash plains of the Tekapo and Pukaki rivers, in the central part of the Mackenzie Basin. It lies between the outlets of lakes Tekapo, Pukaki and Ohau, and the upper reaches of Lake Benmore. The topography of the ED is relatively gentle though elevated, lying mostly between 400m and 600m asl, except for the isolated summits of the Mary Range and Simons Hill. It borders Tekapo ED to the north, Grampians ED to the east, Benmore and Omarama EDs to the south, and Ben Ohau ED to the west.

The ED comprises extensive areas of glacial outwash gravel and till over subdued moraine topography, with isolated outcrops of greywacke and argillite at the Mary Range and Simons Hill. It is drained by tributaries of the Ohau, Twizel, Pukaki and Tekapo rivers.

Original (pre-human) vegetation

The original vegetation of Pukaki ED was strongly influenced by recent glaciation, a harsh intermontane basin climate and infrequent natural fires. It appears unlikely that forest was present except perhaps for areas of low-stature mountain toatoa-bog pine forest on the extensive moraines of the Mackenzie Basin, and mountain totara forest on lower range slopes (McGlone, 2001). The ED was probably dominated by short tussockland, tall tussockland, mountain toatoa-bog pine scrub and matagouri-*Coprosma* scrub (Espie *et al*, 1984). Areas of wetland vegetation were probably relatively extensive along the numerous small rivers and around the lake margins.

Existing (present-day) vegetation

An increased frequency of fire following human settlement, particularly European pastoralism, reduced the extent of scrub/low forest and tall tussock communities, and increased the extent of short tussockland. Now, after years of pastoralism, those short tussocklands are mostly degraded by grazing (sheep and rabbits) and introduced plants (especially grasses and mouse-ear hawkweed). Wetland vegetation, especially lake-margin wetlands, has also been substantially modified.

There are wetland and shrubland remnants in parts of the district, notably along the lower slopes of the Ben Ohau Range, and areas of shrubland and low forest along the rivers.

Extent of plant communities: Pukaki ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
10	mountain totara forest	1-5	<1	0
15	matagouri-*Coprosma* scrub	6-25	3	10
17	bog pine scrub	1-5		
18	mtn toatoa scrub/low forest	6-25		
21	short tussockland	26-50	79	6
23	red tussockland	26-50		
24	tall tussockland	6-25		
27	wetland	1-5	<1	0
35	gravelfield/stonefield (riverbed)	1-5	2	1

Existing protected natural areas

Important protected natural areas in Pukaki ED include Lake Tekapo Scientific Reserve and marginal strips along the Twizel River and Fraser Stream.

Opportunities for further protection or restoration of original ecosystems

Only approximately 3% of Pukaki ED is formally protected. Opportunities for further protection are:

- extensive depleted short tussockland on uncultivated outwash terraces of the Tekapo and Pukaki rivers
- wetlands along Grays River
- wetlands and red tussocklands at Rhoboro Downs
- manuka shrubland on toe slopes and terraces below the Ben Ohau Range
- scattered shrubland and tussockland on moraines

4.50 BEN OHAU ECOLOGICAL DISTRICT (63.03)

Location and physical description

Ben Ohau ED covers the southern end of the Ben Ohau Range, the lower Dobson Valley and Lake Ohau on the western side of the Mackenzie Basin. It is mostly mountainous, with major summits on the Ben Ohau Range between 1900 and 2200m asl. The ED borders Tekapo and Pukaki EDs to the east, Dobson ED to the north, Huxley and Ahuriri EDs to the west and Omarama ED to the south.

The ED comprises greywacke and argillite of the Torlesse Group rocks, with areas of schist of the Haast Schist Group on the eastern side of the Ben Ohau Range, and areas of till and river alluvium in the Dobson Valley (Gair, 1967). It is drained in the west by tributaries of the Dobson River, and in the east by tributaries of Fraser Stream and Twizel River.

Original (pre-human) vegetation

Analysis of fossil pollen at the southern (Duncan Stream) end of the Ben Ohau Range indicates that the pre-human vegetation of that area was dominated by *Halocarpus* (bog pine) scrub and tall tussock (McGlone and Moar, 1998). Natural fires had removed the earlier dense stands of mountain toatoa scrub and encouraged both tall and short tussock to dominate for a time (*ibid*). Mountain beech forest and perhaps areas of silver beech forest, at higher (wetter) altitudes, was probably present on western slopes of the Ben Ohau Range (Wardle and Guest, 1977; Jane, 1988b). Mountain totara forest is likely to have been present in some locations (Harding, 1992; McEwen, 1987).

The substantial part (c.42%) of the ED above the natural timberline is likely to have supported vegetation similar to that present today: cushionfield, herbfield, fellfield, tussockland and rockland. Matagouri-*Coprosma* shrubland, short tussockland and stonefield (riverbed) were probably present in the Dobson Valley.

Existing (present-day) vegetation

Today, tall narrow-leaved snow-tussock dominates higher altitude slopes in Ben Ohau ED (Espie *et al*, 1984). Mountain beech forest is confined to narrow gullies in the west, and mountain totara forest to steep rocky slopes. Scrub is present at scattered locations, but appears to be substantially reduced compared to its original extent. Alpine plant communities appear to be relatively intact, though valley-floor shrubland and tussockland are substantially modified.

Extent of plant communities: Ben Ohau ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
8	mountain beech forest	6-25	<1	15
9	silver beech forest	1-5		
10	mountain totara forest	1-5		
15	matagouri-*Coprosma* scrub	1-5	5	28
17	bog pine-mtn toatoa scrub	6-25		
21	short tussockland	1-5	34	49
24	tall tussockland	6-25		
34	rockland	<1	2	7
35	stonefield (scree, riverbed)	1-5		
36	alpine zone	42	42	54

Existing protected natural areas

Important protected natural areas in Ben Ohau ED include Dusky Run, Ruataniwha (Ben Ohau) and part Ferintosh conservation areas, and Ohau Terminal Moraine Scenic Reserve.

Opportunities for further protection or restoration of original ecosystems

Almost half (42%) of Ben Ohau ED is formally protected. Opportunities for further protection are:

- lakeshore shrublands, turfs and groves of trees (especially kowhai and beech)
- red tussockland, wetland and grassland on the delta and lower reaches of Hopkins River
- forest remnants, tussockland and shrubland on lower and montane slopes

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4.51 GRAMPIANS ECOLOGICAL DISTRICT (63.04)

Location and physical description

Grampians ED covers the Grampian Mountains and Dalgety and Rollesby ranges on the east and southeast sides of the Mackenzie Basin. It includes the low mountain ranges that separate the Mackenzie Basin from the Fairlie and Hakataramea basins. Range summits within the ED lie between 1200 and 1700m asl. It adjoins Hunters ED to the east, Pukaki ED to the north, Benmore ED to the west, and Kirkliston and Hakataramea EDs to the south.

The ED comprises greywacke and argillite of the Torlesse Group rocks, with areas of loess-covered gravel and minor areas of siltstone and sandstone at lower altitudes (Gair, 1967). The mountain ranges are transitional between the greywacke mountains of Canterbury and the rounded summits of the Otago mountains. It is drained in the east by tributaries of the Tengawai and Hakataramea rivers, and in the west by tributaries of the Tekapo River.

Original (pre-human) vegetation

Little information about the original vegetation of Grampians ED was located during the preparation of this report. However, the ED was covered by the Mackenzie PNAP survey and its authors suggest short and tall tussockland was the dominant vegetation (Espie *et al*, 1984). McGlone (2001) proposes that lower montane slopes of the intermontane basins supported mountain toatoa-bog pine scrub, and upper slopes supported low forest and scrub dominated by mountain totara, mountain toatoa and bog pine. Alpine areas (c.15% of the ED) supported tussockland, cushionfield and fellfield vegetation.

Existing (present-day) vegetation

Today, Grampians ED supports extensive tall tussockland at higher altitudes and modified tussockland and scrub at lower altitudes. Alpine vegetation is still present, though likely to be modified by years of grazing.

Extent of plant communities: Grampians ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
10	mtn totara-hardwood forest	6-25	0	0
15	matagouri-*Coprosma* scrub	1-5	3	0
18	mtn toatoa-bog pine scrub	26-50		

21	short tussockland	1-5	76	<1
24	tall tussockland	6-25		
34	rockland	<1	<1	0
36	alpine zone	16	16	2

Existing protected natural areas

There are no protected natural areas of significant size in Grampians ED, though pastoral leases in this area have been surveyed for tenure review.

Opportunities for further protection or restoration of original ecosystems

Less than 1% of Grampians ED is formally protected. Opportunities for further protection are extensive montane and high-altitude tall tussockland, sparse shrubland (including prostrate kowhai) on north-facing rocky slopes, denser subalpine shrubland on shadier slopes, sparsely-vegetated rock pavement communities on alpine summits and habitats for spring-annuals on some lower slopes.

4.52 AHURIRI ECOLOGICAL DISTRICT (63.05)

Location and physical description

Ahuriri ED covers the glaciated mountain ranges at the southwest edge of the Waitaki Basin. It includes the mountains of the Barrier and Diadem ranges and most of the upper Ahuriri Valley. The ED is generally mountainous (c.40% lies above the timberline) with summits of main ranges lying between 2000m and 2300m asl. It borders Ben Ohau and Omarama EDs to the east, Huxley ED to the north, Wanaka and Lindis EDs to the west and St Bathans ED to the south.

The ED comprises greywacke and argillite of the Torlesse Group rocks, Haast schist, and relatively extensive areas of valley-floor alluvium in the Ahuriri Valley (Gair, 1967). It is drained principally by the Ahuriri River in the south and Maitland Stream in the north.

Original (pre-human) vegetation

Western (wetter) parts of Ahuriri ED appear to have supported extensive mountain beech forest, with silver beech forest at the valley heads, prior to human settlement (Wardle and Guest, 1977). Further east, mountain totara forest and mountain toatoa scrub communities are likely to have been dominant (McGlone, 2001; Wardle, 2001a). Alpine areas supported extensive tall tussock, fellfield and rock, with some areas of year-round snow on the Barrier Range. Valley-floors probably supported matagouri-*Coprosma* scrub, short tussockland and wetland vegetation (Espie *et al*, 1984).

Existing (present-day) vegetation

The increased frequency of burning that accompanied human settlement is likely to have removed much of the mountain totara forest that occupied the east of the district, as occurred in the adjoining upper Clutha Valley (Wardle, 2001b). Mountain beech forest and scrub were also reduced in extent and generally replaced with tall tussock. Today, relatively extensive areas of forest are still present in the upper catchment, including in Maitland Stream, and scattered forest remnants at eastern sites. Tall tussock and scrub prevail at other montane sites. Alpine plant communities probably occupy their former extent, but valley-floor communities are substantially modified (Espie *et al*, 1984).

Extent of plant communities: Ahuriri ED				
Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
8	mountain beech forest	6-25	3	85
9	silver beech forest	1-5		
10	mtn totara-mtn toatoa forest	6-25		
15	matagouri-Coprosma scrub	1-5	5	32
18	mtn toatoa-bog pine scrub	6-25		
19	inaka scrub	1-5		
21	short tussockland	<1	42	48
24	tall tussockland	1-5		
27	wetland	<1	<1	83
34	rockland	<1	3	20
35	stonefield (riverbed, scree)	1-5		
36	alpine zone	40	40	80

Existing protected natural areas

Important protected natural areas in Ahuriri ED include Ahuriri Forest, Ahuriri River Flats and Ohau (Upper Maitland, Ohau Range and Freehold Creek) conservation areas. Marginal strips are present along the Ahuriri River, and the river is protected by a Water Conservation Order. A substantial part of the ED has been protected by the recent purchase of Birchwood Pastoral Lease through the Nature Heritage Fund. This and other conservation lands in the ED are now protected within the recently-established Ahuriri Conservation Park.

Opportunities for further protection or restoration of original ecosystems

Just over half (53%) of Ahuriri ED is formally protected. Opportunities for further protection are:

- successional shrubland in the Maitland valley
- shrubland and small areas of forest on steep montane slopes, including mountain totara on scree
- short tussockland, wetland and bog pine shrubland on Ben Avon
- lakeshore forest, shrubland and turfs

4.53 OMARAMA ECOLOGICAL DISTRICT (63.06)

Location and physical description

Omarama ED covers the broad outwash plain between the Diadem and Benmore ranges in the southern part of the Waitaki Basin. It is of generally low and gentle relief though still elevated, lying mostly between 400 and 900m asl. The ED borders Ben Ohau and Pukaki EDs to the north, Ahuriri ED to the west, St Bathans and Hawkdun EDs to the south and Benmore ED to the east.

The ED comprises extensive till with subdued moraine topography, and areas of fluvioglacial outwash gravel (Gair, 1967). It is drained by tributaries of the Ohau and lower Ahuriri rivers. It is one of the driest EDs in Canterbury.

Original (pre-human) vegetation

Analysis of fossil pollen at Ben Dhu Scientific Reserve within Omarama ED indicates that the pre-human vegetation in this part of the Mackenzie Basin was dominated by

bog pine scrub, with mountain toatoa and species of *Coprosma* (McGlone and Moar, 1998). Areas of short tussock, red tussock and tall tussockland were probably also present (Espie *et al*, 1984), and possibly isolated areas of mountain totara forest.

Existing (present-day) vegetation

Increased frequency of fires associated with human settlement led to the replacement of bog pine scrub with short tussockland dominated by speargrass (*Aciphylla*) species (McGlone and Moar, 1998). Nowadays depleted short tussockland dominates, with some areas of scrub and minor areas of wetland and cushionfield.

Extent of plant communities: Omarama ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
10	mountain totara forest	1-5	<1	39
15	matagouri-*Coprosma* shrubland	1-5	3	26
17	bog pine-mtn toatoa scrub	51-75		
21	short tussockland	6-25	40	5
23	red tussockland	6-25		
24	tall tussockland	1-5		
27	wetland	6-25	4	41
35	stonefield (riverbed)	1-5	2	31

Existing protected natural areas

Important protected natural areas in Omarama ED include Ben Omar Swamp Government Purpose Reserve, Ben Dhu Scientific Reserve and Clay Cliffs Open Space Covenant. Marginal strips are present along the Ahuriri River, and the river is protected by a Water Conservation Order.

Opportunities for further protection or restoration of original ecosystems

Only 5% of Omarama ED is formally protected. Opportunities for further protection are:

- short tussockland on moraine
- bog pine shrubland on Quailburn
- wetlands on the Ahuriri River delta
- small areas of shrubland (now very rare in ED)

4.54 BENMORE ECOLOGICAL DISTRICT (63.07)

Location and physical description

Benmore ED covers the Benmore and Cuthbert ranges, and Lake Benmore, at the southern edge of the Waitaki Basin. It is mostly mountainous, with summits on the Benmore Range lying between 1400 and 1850m asl and c.14% of the ED above the timberline. It adjoins Pukaki ED to the north, Omarama ED to the west, Hawkdun and St Mary EDs to the south, and Kirkliston and Grampians EDs to the east.

The ED comprises greywacke and argillite of the Torlesse Group rocks with minor areas of sandstone, and areas of alluvium at lower altitudes. Lake Benmore occupies a significant proportion (c.12%) of the ED; it is otherwise drained by tributaries of the Waitaki River.

Original (pre-human) vegetation

Little information about the original vegetation of Benmore ED was located during the preparation of this report. However, the ED was covered by the Mackenzie PNAP survey, and its authors suggest that short and tall tussockland were the dominant vegetation (Espie *et al*, 1984). McGlone (2001) proposes that lower montane slopes of the intermontane basins supported mountain toatoa-bog pine scrub, and upper slopes supported low forest and scrub dominated by mountain totara, mountain toatoa and bog pine. Alpine areas supported tussockland, cushionfield and fellfield vegetation.

Existing (present-day) vegetation

Today, Benmore ED supports extensive tall tussockland at higher altitudes and modified short tussockland and scrub at lower altitudes. Alpine vegetation, notably fellfield, is still present though likely to be modified by years of grazing. A significant proportion of the lower-altitude plant communities of the ED were inundated by the creation of Lake Benmore for hydro-electricity generation.

Extent of plant communities: Benmore ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
10	mountain totara forest	1-5	0	0
15	matagouri-*Coprosma* scrub	1-5	7	7
18	mtn toatoa-bog pine scrub	51-75		
21	short tussockland	1-5	62	6
24	tall tussockland	6-25		
27	wetland	1-5	<1	1
34	rockland	<1	<1	0
35	stonefield (riverbed, scree)	1-5		
36	alpine zone	14	14	15

Existing protected natural areas

There are no large protected natural areas in Benmore ED.

Opportunities for further protection or restoration of original ecosystems

Only 5% of Benmore ED is formally protected. Opportunities for further protection are:

- shrublands on the lake shore and lower lake-side slopes
- higher-altitude tussockland
- remnant mountain totara forest
- short tussockland on dry valley floor sites (with habitat for rare spring-annual plants)

4.55 KIRKLISTON ECOLOGICAL DISTRICT (64.01)

Location and physical description

Kirkliston ED covers the Kirkliston Range and adjoining mountains between the Waitaki Basin and Hakataramea Valley. It is mostly mountainous, with the major summits between 1800m and 1900m asl. The ED adjoins Hakataramea ED to the east, Grampians ED to the north, Benmore ED to the west and St Mary ED across the Waitaki River to the south.

The ED comprises greywacke and argillite of the Torlesse Group rocks, with minor areas of alluvium at lower altitudes. It is drained by tributaries of the Hakataramea and Waitaki rivers, and includes two large hydro lakes on the Waitaki River: Aviemore and Waitaki.

Original (pre-human) vegetation

Little information about the original vegetation of Kirkliston ED was located during the preparation of this report. However, adjoining EDs were covered by the Mackenzie PNAP survey, and its authors suggest that short and tall tussocklands were the dominant vegetation in the area (Espie *et al*, 1984). McGlone (2001) proposes that lower montane slopes of the intermontane basins supported mountain toatoa-bog pine scrub, and upper slopes supported low forest and scrub dominated by mountain totara, mountain toatoa and bog pine. Alpine areas supported tussockland, cushionfield and fellfield vegetation.

Existing (present-day) vegetation

Today, Kirkliston ED is dominated by tall tussockland at higher altitudes and modified short tussockland at lower altitudes, with areas of scrub and mixed hardwood forest in southern valleys (McEwen, 1987). Valley-floor sites in the Waitaki Valley were inundated during the creation of lakes Aviemore and Waitaki. Alpine plant communities (comprising c.24% of the ED), including fellfield and cushionfield, are still present though modified by years of pastoral activity.

Extent of plant communities: Kirkliston ED

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	mixed hardwood forest	1-5	<1	0
10	mountain totara forest	6-25		
15	matagouri-*Coprosma* scrub	1-5	11	14
18	mtn toatoa-bog pine scrub	26-50		
21	short tussockland	<1	54	16
24	tall tussockland	6-25		
27	wetland	<1	<1	0
34	rockland	<1	<1	0
35	stonefield (riverbed, scree)	<1		
36	alpine zone	24	24	41

Existing protected natural areas

The only large protected natural area in Kirkliston ED is Kirkliston Range Conservation Area on the summit of the Kirkliston Range.

Opportunities for further protection or restoration of original ecosystems

Approximately 14% of Kirkliston ED is formally protected. Opportunities for further protection are extensive areas of shrubland in the Deep Stream catchment and high-altitude tussockland and rockland communities on the Kirkliston Range.

4.56 ST MARY ECOLOGICAL DISTRICT (64.02)

Location and physical description

The part of St Mary ED that lies within Canterbury Conservancy covers the St Marys Range and adjoining hill country south of the Waitaki River, on the boundary of Canterbury and Otago conservancies. It is mostly hilly or mountainous, with major summits lying between 1300m and 2000m asl. It adjoins Hakataramea and Kirkliston EDs across the Waitaki Valley to the east and north, Hawkdun ED to the west, and Dansey and Duntroon EDs to the south.

The ED comprises greywacke and argillite of the Torlesse Group rocks, with minor areas of alluvium at lower altitudes. It is drained by tributaries of the Otematata and Waitaki rivers, and adjoins the Waitaki River along its northeast boundary.

Original (pre-human) vegetation

The adjoining Hawkdun ED was covered by a PNAP survey, and its author suggests that a mosaic of tussockland, shrubland and podocarp-hardwood forest formed the dominant vegetation in the area (Grove, 1994). McGlone (2001) proposes that lower montane slopes of the inland mountain ranges supported mountain toatoa-bog pine scrub, and upper slopes supported low forest and scrub dominated by mountain totara, mountain toatoa and bog pine. Alpine areas supported tussockland, cushionfield and fellfield vegetation.

Existing (present-day) vegetation

Today, St Mary ED supports extensive areas of tall tussockland at higher altitudes, modified short tussockland, pasture and matagouri scrub at lower altitudes, scrub and occasional mountain totara remnants in gullies and on rubble slopes, and fellfield, cushionfield and boulderfield in alpine areas (Grove, 1994; McEwen, 1987). Indigenous vegetation over much of the ED has been modified by grazing and the increased frequency of fire, although has high naturalness values in places.

Extent of plant communities: St Mary ED*

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	1-5	<1	0
10	mountain totara forest	6-25		
15	matagouri-*Coprosma* scrub	1-5	4	5
18	mtn toatoa-bog pine scrub	26-50		
21	short tussockland	1-5	57	24
24	tall tussockland	6-25		
27	wetland	<1	<1	38
34	rockland	<1	<1	32
35	stonefield (scree)	<1		
36	alpine zone	26	26	71

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas

The main large protected natural area in the part of St Mary ED that lies within Canterbury Conservancy is St Marys Range Conservation Area.

Opportunities for further protection or restoration of original ecosystems

Approximately one-quarter (26%) of St Mary ED within Canterbury Conservancy is formally protected. Opportunities for further protection are:

- extensive shrubland above Lake Aviemore
- low-altitude limestone outcrops
- tussocklands at higher altitudes

4.57 HAWKDUN ECOLOGICAL DISTRICT (64.03)

Location and physical description

The part of Hawkdun ED that lies within Canterbury Conservancy covers the Hawkdun Range south of the Mackenzie Basin on the boundary between Canterbury and Otago conservancies. It is mostly mountainous, with c.45% above the timberline, and major summits lying between 1600m and 1800m asl. It adjoins St Mary ED to the east, Benmore ED to the north, St Bathans ED to the west and Maniototo ED to the south.

The ED mostly comprises greywacke and argillite of the Torlesse Group rocks, with areas of semi-schistose Haast Schist and minor areas of alluvium at lower altitudes (McEwen, 1987; Grove, 1994). It is drained by tributaries of the Otematata and Manuherikia rivers. Periglacial landforms are an important feature of the ED.

Original (pre-human) vegetation

Hawkdun ED has been surveyed as part of the PNA Programme, and its author suggests that a mosaic of tussockland, shrubland and podocarp-hardwood forest formed the dominant vegetation in the area (Grove, 1994). McGlone (2001) proposes that lower montane slopes of the inland mountain ranges supported mountain toatoa-bog pine scrub, and upper slopes supported low forest and scrub dominated by mountain totara, mountain toatoa and bog pine. Alpine areas supported tussockland, cushionfield and fellfield vegetation.

Existing (present-day) vegetation

Today, Hawkdun ED supports extensive areas of tall tussockland at higher altitudes, modified short tussockland, pasture and matagouri scrub at lower altitudes, scrub and occasional mountain totara remnants in gullies and on rubble slopes, and fellfield, cushionfield and boulderfield in alpine areas (Grove, 1994; McEwen, 1987). Indigenous vegetation over much of the ED has been modified by grazing and the increased frequency of fire, although has high naturalness values in places. The ED contains plant communities transitional between those on Canterbury greywacke and those on Otago schist substrates.

Extent of plant communities: Hawkdun ED*

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
5	montane hardwood forest	1-5	0	0
10	mountain totara forest	6-25		
15	matagouri-*Coprosma* scrub	1-5	3	9
18	mtn toatoa-bog pine scrub	6-25		
21	short tussockland	1-5	46	36
24	tall tussockland	6-25		
27	wetland	<1	<1	35

34	rockland, boulderfield	<1	<1	70
36	alpine zone	47	47	

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas

Important protected natural areas in Hawkdun ED include Mt Ida Conservation Area on the Conservancy boundary at the southern end of the Hawkdun Range. Other areas, retired from pastoral lease land, are presently being transferred to DOC administration.

Opportunities for further protection or restoration of original ecosystems

Approximately one-third (35%) of Hawkdun ED is formally protected. Opportunities for further protection are areas of high-altitude tussockland and rock pavement.

4.58 ST BATHANS ECOLOGICAL DISTRICT (64.04)

Location and physical description

Only a small part of St Bathans ED lies within Canterbury Conservancy. This area covers the upper catchment of Omarama Stream on the northeast flank of St Bathans Range. It comprises greywacke and argillite of the Torlesse Group rocks, with areas of alluvium at lower altitudes (McEwen, 1987).

Original (pre-human) vegetation

Little information about the original vegetation of St Bathans ED was located during the preparation of this report. However, the adjoining Hawkdun, Ahuriri and Omarama EDs have been described as part of the PNA Programme (Grove, 1994; Espie *et al*, 1984). The reports' authors suggest that a mosaic of tussockland, shrubland and podocarp-hardwood forest formed the dominant vegetation in the area. McGlone (2001) proposes that lower montane slopes of the inland mountain ranges supported mountain toatoa-bog pine scrub, and upper slopes supported low forest and scrub dominated by mountain totara, mountain toatoa and bog pine. Alpine areas supported tussockland, cushionfield and fellfield vegetation.

Existing (present-day) vegetation

Today, this part of St Bathans ED supports tall tussockland on upper slopes and induced and highly-modified short tussockland on lower slopes. A significant proportion of the ED (c.38%) lies above the natural timberline. The ED contains plant communities transitional between those on Canterbury greywacke and those on Otago schist substrates.

Extent of plant communities: St Bathans ED*

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
10	mountain totara forest	6-25	<1	0
15	matagouri-*Coprosma* scrub	1-5	5	20
18	mtn toatoa-bog pine scrub	6-25		
21	short tussockland	1-5	56	15
24	tall tussockland	6-25		
27	wetland	<1	0	0
34	rockland, boulderfield	<1	<1	17
36	alpine zone	38	38	

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas
There are no significant protected natural areas in the part of St Bathans ED that lies within Canterbury Conservancy.

Opportunities for further protection or restoration of original ecosystems
Approximately 16% of St Bathans ED is formally protected. Opportunities for further protection are montane and high-altitude tussockland communities on pastoral lease land.

4.59 HUXLEY ECOLOGICAL DISTRICT (66.01)

Location and physical description
Only a small part of Huxley ED lies within Canterbury Conservancy. This part of the ED covers the mountainous country just east of the main divide at the southwest corner of the conservancy. It includes the northern part of the Barrier Range, and the headwaters of the Ahuriri and Huxley rivers. This part of the ED adjoins Ahuriri ED to the south, Dobson ED to the east, and Landsborough ED across the main divide of the Southern Alps to the north.

This part of the ED mostly comprises Haast Schist with areas of alluvium on valley-floors. It is drained by Temple Stream and the upper tributaries of the Ahuriri and Huxley rivers.

Original (pre-human) vegetation
Most of Huxley ED within Canterbury Conservancy (c.72%) lies above the natural timberline and supports alpine fellfield, cushionfield, rock and year-round snow and ice. Montane slopes supported mountain beech forest, with silver beech forest at the heads of the valleys (Wardle and Guest, 1977), and minor areas of shrubland and grassland on valley-floors.

Existing (present-day) vegetation
This part of Huxley ED still supports extensive indigenous plant communities representative of the original vegetation. Alpine plant communities remain relatively intact, and forests are still present in the upper valleys. The increased frequency of fire associated with human settlement has led to the replacement of forest in eastern, lower-altitude parts of the ED with scrub and tussockland.

Extent of plant communities: Huxley ED*

Plant Community		Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected
No	Name			
8	mountain beech forest	6-25	14	93
9	silver beech forest	1-5		
15	matagouri-Coprosma shrubland	<1	5	74
19	inaka scrub	1-5		
21	short tussockland	<1	6	75
24	tall tussockland	<1		
34	rockland	1-5	3	86
35	stonefield (riverbed, scree)	<1		
36	alpine zone	72	72	

*This analysis covers the part of the ED that lies within Canterbury Conservancy.

Existing protected natural areas

Important protected natural areas within the Canterbury Conservancy part of Huxley ED include parts of Ahuriri Forest and Ohau conservation areas. These lands are now protected within the recently-established Ahuriri Conservation Park.

Opportunities for further protection or restoration of original ecosystems

Almost all (83%) of Huxley ED is formally protected. Opportunities for further protection appear limited to shrublands and regenerating forest on Huxley Gorge.

5.0 ANALYSIS OF REPRESENTATIVENESS

In this section of the report, data presented for each ecological district in Section 4 are collated and analyzed for each class of indigenous vegetation. This analysis summarises the extent to which vegetation classes are depleted relative to their assumed original extent. The primary purpose of these data summaries is to assist with assessments of representativeness (Criterion 1, Section 6.3) when considering proposals for the protection of indigenous ecosystems in Canterbury Conservancy.

Seven broad vegetation classes derived from the Land Cover Database (LCDB) were selected for the presentation of data for each ecological district in Section 4. These seven classes represent the 36 vegetation types identified in Section 3 and listed in Table 1.

The analysis in this section is based on the seven broad vegetation classes, rather than the 36 vegetation types, so that the digital (GIS-based) data can be used for analysis. This method of analysis will obscure some of the differences within each vegetation-class. This limitation is addressed by discussion of the separate vegetation types in Sections 5.1 to 5.7 and by listing of priority rankings for each vegetation type in Section 5.8. These analyses are included to help ensure that less-common vegetation types are not overlooked when assessing the merit of protection proposals.

In the analysis of each vegetation class, ecological districts are placed in one of five priority groups according to the extent to which the original vegetation is formally protected. The five priority groups are:

1. less than 1% protected
2. 1% to 5% protected
3. 6% to 25% protected
4. 26% to 50% protected
5. more that 50% protected

Detailed figures for each vegetation class are listed in the tables in Appendix 1.

5.1 INDIGENOUS FOREST

Indigenous forest was originally the dominant vegetation type at lowland and montane sites in North Canterbury, western mid and south Canterbury and on Banks Peninsula. It is now substantially depleted in all but the western mountains.

Less than 1% of the original extent of indigenous forest is formally protected in 31 (52%) of the ecological districts (EDs) in Canterbury Conservancy. Predictably, these districts are located in coastal, lowland and eastern-high country parts of the Conservancy. More than 25% of the original extent of indigenous forest is formally protected in only 12 EDs (20%). These EDs are located in the wetter western mountains of the Conservancy.

In some EDs (Grampians, Hawkdun, Godley, Benmore and Ellesmere) there is (apparently) no indigenous forest remaining (i.e. no opportunities for protection). Conversely, in one ED (Mt Cook) all existing forest is protected, though forest cover is assumed to be slightly reduced from its original extent.

Indigenous Forest: priority for protection by ecological district	
<1%	Port Hills, Waiau, Glenavy, Hakataramea, Culverden, Grampians, Kirkliston, Hawkdun, St Mary, St Bathans, Godley, Tekapo, Pukaki, Benmore, Ellesmere, Herbert, Akaroa, Geraldine, Cheviot, Motunau, Ashley, Waimate, Hundalee, Leslie, Waikari, Makikihi, High Plains, Coleridge, Low Plains, Fairlie, Ben Ohau
1-5%	Orari, Hunters, Two Thumb, Hakatere, Whitecliffs
6-25%	Dillon-Manakau-Waiautoa, Ahuriri, Mt Hutt, Arrowsmith, Balaclava, Cass, Miromiro, Omarama, Oxford, Sumner, Torlesse
26-50%	Armoury, Mathias, Browning, Dobson, Craigieburn, Mt Cook
>50%	Poulter, Huxley, Hope, Lewis, Minchin, Arthur's Pass

The accuracy of data for indigenous forest is limited by the difficulty determining the extent to which this vegetation type has been depleted. It has been assumed, in this analysis, that most lowland and montane sites that were not affected by relatively frequent natural fires originally supported forest cover. This assumption may over-estimate the original extent of indigenous forest and therefore the extent to which it has been depleted.

Another limitation of the analysis is that different forest types are not differentiated by the LCDB data. This limitation is not so significant for the extensive forest types such as mountain beech forest. However, it is significant for the forest types that were originally less common or more scattered in their distribution. To help address this limitation, each forest type is discussed briefly below.

Coastal hardwood forest (vegetation type 1)

Coastal hardwood forest appears to be present in only two EDs: Cheviot and Motunau. However, it is assumed that this vegetation type would have originally been present to some extent in all coastal EDs. There are presumably no opportunities for protection of coastal hardwood forest in these EDs. Regenerating (or restored) forest in all coastal EDs may not be particularly representative of the original vegetation. However, for the purposes of this strategy, any coastal forest is likely to be a high priority for protection at least for habitat values if not representativeness values.

Podocarp-hardwood forest (vegetation types 2 & 3)

Podocarp-hardwood forest is substantially depleted throughout the Conservancy. It formerly occupied lowland sites and was targeted for clearance for timber and conversion to agricultural land. In this analysis it is presumed to have originally been

present in all lowland EDs and at favourable locations in some higher-altitude EDs. It is a high priority for protection throughout the Conservancy though there are few unprotected remnants.

Hardwood forest (vegetation types 4 & 5)

Hardwood forest is presumed to have been present at specific sites (bluffs, bouldery slopes, old slips, gullies, stream sides and riverbanks) at montane and lowland sites in most EDs. This vegetation type includes stable forest associations such as riparian forest, and seral vegetation such as forest on recent slip-faces. The extent to which it is depleted is difficult to estimate, though it is a relatively high priority for protection at most sites.

Kanuka forest (vegetation type 6)

Kanuka forest is presumed in this analysis to have originally been present at lowland or low-montane sites in the Conservancy. It appears to have been a significant component of the savannah-like vegetation mosaic that was present on parts the Canterbury Plains and at lower-altitude inland basins. It also seems likely to have been present as a seral, but relatively long-lived, plant community on riverbanks and terraces in northern parts of the Conservancy. Elsewhere, kanuka is assumed to have been a scrub community, often association with regenerating beech forest. Tall kanuka forest is a relatively high priority for protection throughout the Conservancy, even where it is a seral community.

Mixed beech and silver beech forests (vegetation types 7 & 9)

Mixed beech forest occupied valley floors and warmer lower slopes throughout northern parts of the Conservancy. It is a high priority for protection at all sites. Silver beech forest was present in southwest parts of the Conservancy but is now confined to the upper valleys. The precise extent of these two vegetation types relative to the extent of mountain beech forest is difficult to determine. However, both forest types have been substantially depleted and all remnants are a high priority for protection.

Mountain beech forest (vegetation type 8)

Mountain beech forest (including black beech forest) was the most widespread forest type in the Canterbury. It occupied most montane sites in North Canterbury and the western Waitaki Basin, and had a scattered presence in inland Mid Canterbury. Extensive tracts of mountain beech forest are present within protected areas in the wetter western mountains. Further east this forest type has been substantially depleted. Mountain beech forest remains an important priority for protection, despite the extensive protected forests, because it has been substantially depleted compared with its former extent.

Mountain totara forest (vegetation type 10)

Mountain totara forest is presumed to have been a relatively common vegetation type on the drier inland ranges, second in extent to mountain beech forest. It appears to have suffered much greater depletion than mountain beech forest because of the greater frequency of human-induced fire at these drier sites. Remnants of this forest type are important priorities for protection.

Kaikawaka-hardwood forest (vegetation type 11)

Kaikawaka-hardwood forest is presumed to have been a relatively uncommon forest type, confined to higher-altitude sites in the upper western valleys. It is still present at most sites, especially in the central Southern Alps valleys, though has probably been slightly reduced in extent through burning and is threatened by wild animals. Remnants of this vegetation type mostly lie within protected areas.

Kowhai treeland (vegetation type 12)

Kowhai treeland is presumed to have been a relatively important vegetation type in the savannah-like vegetation mosaic that occupied parts of the Canterbury Plains and lower-altitude inland basins. It may also have been common on inland valley-floors, perhaps in association with hardwood forest. It is a relatively uncommon vegetation type now, and a high priority for protection.

Mountain lacebark treeland (vegetation type 13)

Mountain lacebark treeland is likely to have been present throughout inland parts of the Conservancy, occupying gullies, rubble-slopes and upper-montane sites. It is still relatively common, though probably depleted relative to its former extent. This vegetation type is well-protected at western sites, though largely unprotected on the eastern high country ranges.

5.2 SCRUB/SHRUBLAND

Scrub and shrubland vegetation types were relatively widespread throughout eastern and southern parts of the Conservancy where altitude or climate precluded the establishment of forest, or where relatively frequent natural fires favoured seral plant communities. Original scrub and shrubland vegetation types are substantially depleted. However, scrub and shrubland (albeit in a modified form) now exceed their former extent in many parts of the Conservancy.

Less than 6% of the original extent of scrub/shrubland is formally protected in 26 (44%) of EDs in Canterbury Conservancy. These EDs are located in lowland and southern parts of the Conservancy where the original relatively-extensive shrublands have been displaced by pastoralism and agricultural development. Conversely, more than 25% of the original extent of scrub/shrubland is protected in 33 EDs (56%). These EDs are located in the wetter western mountains of the Conservancy.

In 25 EDs (42%) the extent of scrub/shrubland exceeds that presumed to have originally been present. In seven EDs (Mt Cook, Sumner, Browning, Balaclava, Miromiro, Port Hills and Akaroa) there is a greater extent of scrub/shrubland protected than is presumed to have originally been present.

Scrub/Shrubland: priority for protection by ecological district	
<1%	Grampians, Benmore, St Mary, Pukaki, Culverden, Fairlie, Makikihi, Tekapo
1-5%	Omarama, Arrowsmith, Hawkdun, Leslie, Waikari, Ellesmere, Hakataramea, Glenavy, Ashley, Low Plains, High Plains, Hunters, Waiau, Kirkliston, St Bathans, Hundalee, Hakatere, Whitecliffs
6-25%	Waimate, Ben Ohau, Coleridge, Ahuriri, Godley, Motunau, Poulter, Herbert, Cheviot, Orari, Geraldine
26-50%	Cass, Mathias, Dillon-Manakau-Waiautoa, Mt Hutt, Oxford, Craigieburn, Torlesse, Dobson
51-100%	Armoury, Two Thumb, Hope, Huxley, Arthur's Pass, Lewis, Minchin
>100%	Mt Cook, Sumner, Browning, Balaclava, Miromiro, Port Hills, Akaroa

Interpretation of the LCDB data for scrub and shrubland is problematic as the LCDB does not differentiate between scrub/shrubland types. Many areas of scrub/shrubland in the Conservancy are seral communities occupying sites that formerly supported forest. So, while the LCDB data suggests that the extent of scrub/shrubland communities has increased in some EDs, it provides no reassurance that the scrub/shrubland communities that were originally present are well protected. In fact, original scrub/shrubland communities are probably very uncommon and in some cases

critically depleted. Nearly all stands of this vegetation type that are representative of the original vegetation are a high priority for protection.

Estimates of the former extent of different types of scrub/shrubland are difficult. They are most difficult for the high country basins and ranges in the southwest of the Conservancy where the increased frequency of fire since human settlement has had such a widespread impact. Actual priority rankings are therefore affected greatly by the assumptions made during the analysis about the original extent of forest, scrub, shrubland and grassland communities. However, scrub and shrubland associations at these sites are generally a high priority for protection as representative vegetation types or as communities that are successional to the former forest cover, aside from their value as habitat.

Manuka-kanuka scrub (vegetation type 14)

Manuka or kanuka scrub is presumed to have originally been present in most eastern EDs. It is likely to have been a seral community at most sites, and is presumed to have increased in extent following the increased frequency of burning that followed human settlement. It is a relatively low priority for representative protection in most EDs.

Matagouri (grey) scrub (vegetation type 15)

Matagouri scrub/shrubland is presumed to have originally been present in all EDs, though largely confined to valley-floors or plains. Its ability to colonise new surfaces would have favoured its presence on recently-deposited gravels of alluvial fans and riverbeds. Matagouri shrubland has probably increased in extent in most EDs, colonising areas formerly occupied by forest. The ability of matagouri to withstand grazing, and its response to fertilising (top-dressing), have allowed it to become the most successful and widespread shrubland community on high country grazing lands. Despite this, there is little matagouri scrub/shrubland on alluvial surfaces (especially river flats) within existing protected areas, and it remains a relatively high priority for protection at such sites.

Mixed (*Hebe-Olearia-Coprosma*) scrub and bog pine scrub (vegetation types 16 & 17)

This diverse mix of scrub and shrubland types includes a range of different species that are present in varying combinations in low woody vegetation throughout the Conservancy. They are grouped together, along with bog pine (*Halocarpus*) scrub, for analysis here because they are difficult to adequately differentiate and they share similar rates of depletion. These communities are dominated by small-leaved divaricating species and include a disproportionate number of Canterbury's threatened plants.

These scrub/shrubland associations would have occupied a range of lowland and montane sites but would have been most prominent on rock bluffs, the margins of scree slopes, river and stream terraces, lake shores and river and stream banks. Some scrub/shrubland types, especially those dominated by *Hebe* and *Coprosma* species, have successfully colonised some areas formerly occupied by forest. They now occupy relatively extensive areas of montane hill-slope in the high country. Other types, such as those dominated by *Olearia* or *Carmichaelia* species and bog pine, appear substantially depleted.

Some lowland scrub associations are presumed to have formed a significant component of the vegetation mosaic that occupied the Canterbury Plains and some inland basins. All lowland, and many montane, scrub/shrubland communities are substantially depleted and a high priority for protection.

Mountain toatoa scrub and mixed inaka scrub (vegetation types 18 & 19)

Mountain toatoa (*Phyllocladus*) scrub and inaka (*Dracophyllum*) scrub are presumed to originally been present at higher altitudes in all western EDs and as relatively extensive low-stature communities in inland South Canterbury. The actual extent of these vegetation types in South Canterbury is difficult to estimate as it would have been strongly influenced by the frequency and extent of natural fires. These scrub associations are relatively well protected in northern and western (higher-altitude) parts of the Conservancy, and are a relatively low priority for representative protection. However, they appear to be substantially depleted in inland South Canterbury and are a high priority for protection in EDs in that area.

5.3 TUSSOCKLAND/GRASSLAND

Grassland or tussockland was originally present in parts of the Conservancy where climate and/or the frequency of natural burning precluded the establishment of woody vegetation. Original grassland or tussockland communities are substantially depleted, except tussocklands in alpine areas. Tall tussockland has colonised extensive areas, especially in the eastern high country, that were formerly occupied by forest or scrub.

In 43 EDs (73%) tussockland occupies a greater extent than it is presumed to have originally occupied. In 23 EDs (39%) there is a greater extent of tussockland protected than is presumed to have originally been present. Conversely, in four EDs (Culverden, Makikihi, Glenavy and Akaroa) there is no tussockland remaining, though there was originally very little tussockland in Akaroa ED. In nine EDs there is no tussockland within existing protected areas.

Tussockland/Grassland: priority for protection by ecological district	
<1%	Culverden, Low Plains, Waiau, Waikari, Makikihi, Glenavy, Motunau, Geraldine, Akaroa, Fairlie, High Plains, Waimate
1-5%	Ellesmere, Cheviot, Hakataramea, Whitecliffs, Tekapo, Grampians, Hundalee
6-25%	Omarama, Pukaki, Coleridge, Ashley, Leslie, Herbert, Oxford, Mathias, Benmore, Cass
26-50%	Port Hills, Hakatere, St Bathans
51-100%	Hunters, Kirkliston, Poulter, Mt Cook
>100%	St Mary, Dillon-Manakau-Waiautoa, Hawkdun, Ben Ohau, Sumner, Dobson, Miromiro, Godley, Balaclava, Armoury, Orari, Mt Hutt, Browning, Minchin, Craigieburn, Arthur's Pass, Torlesse, Hope, Lewis, Two Thumb, Arrowsmith, Huxley, Ahuriri

Interpretation of the LCDB data for grassland and tussockland is problematic as the LCDB does not differentiate between tussockland types. Many areas of tussockland in the Conservancy are seral communities occupying sites that formerly supported forest or scrub. So, while the LCDB data suggests that the extent of tussockland communities has increased in some EDs, original tussockland associations are not well protected. All areas of lowland or montane grassland or tussockland that are representative of the original vegetation are a high priority for protection.

Grassland and short tussockland (vegetation types 20 & 21)

Grassland and short tussockland communities dominated by species of *Rytidosperma*, *Poa*, *Elymus* and *Festuca* are presumed to have occupied relatively extensive areas on the Canterbury Plains, and in inland basins and valley floors. These communities appear to have been an important component of the vegetation mosaic that occupied sites where climate and/or the frequency of natural fires precluded the establishment of permanent woody vegetation. They probably represent the most depleted vegetation

types in Canterbury. Most sites that formerly supported grassland or short tussockland are now cultivated or intensively farmed.

An exception to this generalisation is fescue tussockland which still occupies valley floor and river terrace sites in the eastern high country. However, these fescue tussockland communities are substantially modified at most sites. Very few areas of short tussockland are present within existing protected areas.

Silver tussockland (vegetation type 22)

Silver tussockland is presumed to have originally occupied relatively fertile lowland and montane sites throughout the Conservancy, especially on limestone or volcanic soils and on recent alluvium. Silver tussock is unlikely to have covered extensive areas, except perhaps on the Canterbury Plains and on the wider gravel riverbeds. Estimates of its former extent, and therefore the extent of depletion, are difficult. In some locations the extent of silver tussock has increased substantially, such as on Banks Peninsula and on the South Canterbury foothills where it occupies sites that formerly supported forest.

Red tussockland (vegetation type 23)

Red tussockland is presumed to have originally occupied poorly-drained and low-fertility sites throughout montane parts of the Conservancy, especially in the eastern high country. It is a common wetland vegetation type and was probably relatively extensive in high country basins. There are few substantial areas of red tussockland within existing protected areas. This vegetation type is a relatively high priority for protection.

Tall tussockland and flaxland (vegetation types 24 & 25)

Tall tussockland dominated by species of *Chionochloa* is presumed to have been largely confined to high-altitude (subalpine and alpine) sites prior to human settlement. The removal of forest and shrubland communities from montane sites allowed tall tussock to spread down-slope. Continued burning and grazing prevented the re-establishment of woody vegetation, and allowed tall tussock to dominate extensive areas, especially in the eastern high country. Originally tall tussockland in montane areas was probably confined to bluffs, slip-faces, scree margins and some valley-floor sites.

The original tall tussockland communities remain at many alpine sites, though this vegetation type is well-protected only in the western mountains (*see* 5.7 Alpine, below). Tall tussockland at montane sites remains largely unprotected, though interpretation of the data is complicated by the extensive areas of tall tussockland that are less representative of the original vegetation (i.e. that which has colonised areas that formerly supported forest).

5.4 FRESHWATER WETLAND, CUSHIONFIELD, TURF

Freshwater wetland, cushionfield and turf communities are presumed to have been originally present in all parts of the Conservancy. These vegetation types have been substantially depleted or modified.

The LCDB data suggests that in 27 EDs (46%) there is no or very little wetland vegetation remaining and that in 37 EDs (63%) no or very little wetland vegetation is presently protected. In seven EDs (Motunau, Akaroa, Orari, Miromiro, Ahuriri, Balaclava and Arrowsmith) more than 50% of the estimated original extent of wetland vegetation is protected.

Freshwater wetland: priority for protection by ecological district	
<1%	Tekapo, Fairlie, Glenavy, Pukaki, Culverden, Waikari, Dillon-Manakau-Waiautoa, Lewis, Hope, Hundalee, Leslie, Waiau, Cheviot, Minchin, Arthur's Pass, Port Hills, Herbert, Browning, Mt Cook, Two Thumb, Dobson, Geraldine, Hunters, Waimate, Hakataramea, Ben Ohau, Grampians, St Bathans, Huxley, Poulter, Torlesse, Ashley, Oxford, Armoury, Mathias, Kirkliston, Benmore (37=63%)
1-5%	Hakatere, High Plains, Coleridge, Cass, Mt Hutt, Low Plains, Sumner (7=12%)
6-25%	Ellesmere, Whitecliffs, Omarama, Craigieburn (4=7%)
26-50%	Makikihi, Godley, Hawkdun, St Mary (4=7%)
>50%	Motunau, Akaroa, Orari, Miromiro, Ahuriri, Balaclava, Arrowsmith (7=12%)

The LCDB data for wetland vegetation is of limited value for this analysis because the former extent of wetland vegetation is difficult to estimate and existing areas of wetland difficult to identify. However, it is reasonable to assume that wetland vegetation is substantially depleted. Protection of intact wetland vegetation is a high priority in all EDs in Canterbury.

Freshwater wetland (vegetation type 27)

Freshwater wetland originally occupied many low-lying or poorly-drained sites in the Conservancy, though probably covered extensive areas in only a few EDs. There were a wide range of wetland types. All are assumed to be considerably reduced from their former extent or substantially modified. Wetlands are a high priority for protection in all EDs.

Inland cushionfield and turf (vegetation types 28 & 30)

Inland cushionfield and turf vegetation is presumed to have been present in scattered locations throughout the Conservancy. It was probably only extensive on valley floors, especially on moraines (e.g. kettlehole lake margins) and fluvioglacial outwash surfaces in the eastern high country. Very few areas of montane or lowland cushionfield are formally protected. This vegetation type is a high priority for protection.

5.5 COASTAL

All coastal vegetation types are grouped together for this analysis. The LCDB data does not enable useful analysis of protection priorities. It is probably reasonable to assume that all areas of indigenous vegetation at coastal sites are a high priority for protection.

5.6 BARE GROUND

Bare ground was originally present in all EDs, in the form of rockland, scree, gravelfield or boulderfield (vegetation types 33, 34 and 35). The largest areas of bare ground below the natural timberline are likely to have been the recently-deposited gravels on riverbeds, especially the beds of the major braided rivers, and the extensive screes of the high country ranges.

Less than 6% of the original extent of bare ground is formally protected in 21 EDs (36%). These EDs are located in eastern (low altitude) and southern parts of the Conservancy. More than 50% of the original extent of bare ground is protected in 21 EDs (36%). These EDs are mostly located in western (higher-altitude) parts of the Conservancy.

Bare Ground: priority for protection by ecological district	
<1%	Benmore, Waikari, Grampians, Kirkliston, Port Hills, Herbert, Akaroa, Motunau, Whitecliffs, Hunters (10=17%)
1-5%	Waiau, Tekapo, Pukaki, Ashley, Coleridge, Culverden, Cheviot, Fairlie, Low Plains, Hundalee, Hakataramea (11=19%)
6-25%	Balaclava, Leslie, Geraldine, Ben Ohau, Mathias, Hakatere, Glenavy, Cass, Mt Hutt, St Bathans, Godley, Dobson, High Plains, Makikihi, Ahuriri, Orari, Oxford (17=29%)
26-50%	Waimate, Omarama, St Mary, Craigieburn, Sumner (5=8%)
>50%	Torlesse, Armoury, Hope, Dillon-Manakau-Waiautoa, Browning, Arrowsmith, Poulter, Hawkdun, Two Thumb, Ellesmere, Huxley, Arthur's Pass, Lewis, Minchin, Miromiro, Mt Cook (16=27%)

The LCDB data has some limitations for this analysis, as it includes areas of exposed soil. It is also likely to under-estimate the extent of rock bluffs. This appears to have occurred in the Banks Peninsula EDs where the data indicate that no bare ground is presently protected.

Coastal gravel or boulderfield (vegetation type 33), riverbeds and lakeshores (vegetation type 35) are in many EDs substantially modified by the presence of introduced plants. They also frequently lack formal protection as UCL. All coastal, riverbed and lakeshore sites are a high priority for protection.

Rock bluffs (vegetation type 34) and scree (vegetation type 35) are less modified and are, to a greater extent, formally protected. In most parts of the Conservancy they are a lower priority for protection.

5.7 ALPINE

Alpine ecosystems are present in 36 of the 59 EDs in the Conservancy. This vegetation class includes all plant associations and ecosystems above the natural timberline, including subalpine scrub. Alpine ecosystems are presumed in this analysis to occupy their original extent although are frequently modified, especially on the eastern mountain ranges.

Less than 6% of alpine areas are protected in only three (8%) of the EDs that support alpine ecosystems. These EDs are located in the eastern high country. More than 50% of alpine areas are formally protected in 21 (58%) of the EDs that support alpine ecosystems. These EDs include those located in the western (Southern Alps) mountains and a number of EDs in the eastern high country.

Alpine: priority for protection by ecological district*	
<1%	Coleridge (1=3%)
1-5%	Grampians, Hakataramea (2=5%)
6-25%	Hakatere, Benmore, St Bathans, Tekapo, Orari, Sumner (6=17%)
26-50%	Dobson, Poulter, Mathias, Kirkliston, Mt Hutt, Torlesse 6=17%)
>50%	Cass, Dillon-Manakau-Waiautoa, Ben Ohau, Hunters, Craigieburn, Miromiro, Arrowsmith, Hawkdun, Godley, Two Thumb, St Mary, Ahuriri, Armoury, Huxley, Lewis, Balaclava, Browning, Arthur's Pass, Minchin, Mt Cook, Hope (21=58%)

*** Note: alpine plant communities are present in only 36 EDs**

This analysis of alpine ecosystems is limited by the accuracy of the altitudes selected to represent the natural timberline in different parts of the Conservancy. These generalised timberlines may have obscured some of the local and regional differences in the extent of alpine vegetation. Also, the extent of the alpine zone in each ED is

disguised by the percentages cited above. For example, there is only a very small area above the natural timberline in Coleridge and Hakatere EDs. Despite these limitations, the data provides an indication of the relative priorities for protection of alpine ecosystems.

5.8 SUMMARY OF PROTECTION PRIORITIES FOR REPRESENTATIVENESS

The highest priority vegetation types that need to be protected for the creation of a protected areas system that is representative of the original vegetation of Canterbury are listed below (in the order that they are presented in Section 5).

- Lowland and coastal forest (all types)
- Montane forest (all types) in the eastern high country and on Banks Peninsula
- Montane podocarp forest (including mountain totara forest)
- Lowland and montane treeland
- Matagouri scrub/shrubland on valley floors
- Scrub/shrubland (all types) that is representative of original vegetation at the site
- Lowland grassland/tussockland (all types)
- Montane silver tussockland and red tussockland that is representative of the original vegetation at the site
- Montane tall tussockland that is representative of the original vegetation at the site
- Lowland and montane wetland, cushionfield and turf (all types)
- Coastal plant communities that are representative of the original vegetation at the site
- Gravel riverbeds
- Alpine vegetation in the southeast Waitaki Basin

6.0 CRITERIA FOR ASSESSING PROTECTION PROPOSALS

Ideally, unprotected remnants of indigenous ecosystems in Canterbury should be protected and depleted indigenous ecosystems should be restored. However, all funding agencies, including the Department of Conservation and Nature Heritage Fund, are constrained financially in their ability to purchase, or assist with the protection of, indigenous ecosystems. The consideration of protection proposals is nearly always an exercise in determining relative priorities.

In this section of the report, criteria are developed to assist with the assessment of land protection priorities. These criteria are derived from two existing strategies: the Department of Conservation's Conservation Management Strategy for Canterbury (Department of Conservation, 2000) and the Nature Heritage Fund's national strategy (Harding, 1994). The objectives of these strategies are summarized and discussed as part of the development of criteria for this Land Protection Strategy for Canterbury Conservancy.

6.1 CANTERBURY CONSERVATION MANAGEMENT STRATEGY

The Department of Conservation's goals for ecosystem protection in Canterbury are outlined in the Department's Conservation Management Strategy (CMS) for Canterbury. The CMS sets out Conservancy-wide goals and priorities for heritage protection, and lists key goals for each of the nine geographic parts (places) of the Conservancy. The Conservancy-wide goals are summarised below.

Kaupapa/Philosophy for Canterbury

The CMS Goals for Heritage are to identify, protect and enhance Canterbury's:
- indigenous ecosystems, processes and species
- natural landscapes, natural landscape values, geological features and landforms
- historic and cultural heritage

The CMS vision for Heritage Conservation in the year 2005 is:
"The prime examples of the full range of representative ecosystems in Canterbury have been accorded some form of formal protection and active management, with special emphasis on the protection of:
- podocarp forest
- coastal, hardwood and seral bush
- savannah, manuka and kanuka woodland
- snow, red, silver and fescue tussock and blue wheat grass
- grassland
- dunelands
- freshwater and saline wetlands, including lakes
- mudflats
- estuaries
- marine fish nursery areas
- freshwater fish spawning areas
- natural riparian margins for all water bodies

so that a comprehensive regional system of protected natural areas is in place."

CMS Goals and Priorities

The relevant Conservancy Management Goals for Heritage in Canterbury are:
- To identify and work towards adequate representation of the indigenous biodiversity of Canterbury in the protected natural area system.
- To identify, protect and enhance a representative range of Canterbury's cultural and historic heritage with a focus on land managed by the Department.
- To identify, prioritise and contribute to the protection of a representative range of Canterbury's geological features and landforms.
- To identify, prioritise and contribute to the protection of Canterbury's distinctive landscapes and heritage landscape values.

6.2 THE STRATEGY OF THE NATURE HERITAGE FUND

The national strategy of the Nature Heritage Fund was prepared in 1994 to help determine the relative merits of individual protection proposals (Harding, 1994). The strategy criteria for the assessment of funding applications are listed below.

Representativeness

The extent to which the area proposed for protection is representative of the full range of community variation that was originally present in the natural landscape, including:
- both commonplace and rare indigenous species, habitats, and communities
- the ecological processes that link them
- the extent to which the ecosystems are already protected in the proportion they were originally present in the ecological district

Sustainability

The extent to which the area proposed for protection is likely to continue to be viable and evolve in a natural way in the long term, including the extent to which area is:
- protected by its size and shape
- buffered from the effects of adjoining land uses or activities
- linked to or dependent on other protected areas (either physically or by ecological processes) for its continued viability
- expected to maintain its ecological integrity through major natural disturbance events
- resilient to the depredations of introduced species
- able to be managed to protect its ecological values
- expected to contribute to sustaining existing protected areas, through additional scale, buffering, linkages or restoration

Landscape integrity

The extent to which the area proposed for protection contributes to and maintains the original integrity of the landscape, including the extent to which it:
- protects the original character
- protects the original context
- protects the range of processes that link the ecosystems present
- maintains the natural nutrient cycles, energy flows, and hydrological regimes
- maintains the functional coherence of the original and remaining natural landscape values
- protects an uninterrupted ecological sequence
- eliminates unprotected enclaves in an otherwise protected landscape

Amenity/Utility

The extent to which the area proposed for protection would contribute to the physical and spiritual welfare of the local people, including its contribution to:

- protecting aesthetic coherence and pleasantness
- conserving soil
- maintaining water quality and yield
- providing for recreation or tourism
- providing for physical, social, and spiritual renewal

6.3 CRITERIA FOR ASSESSING PROTECTION PROPOSALS

Four criteria, adapted from the NHF criteria and guided by the objectives of the CMS, are proposed to guide the strategic assessment of protection proposals in Canterbury:

- Representativeness
- Distinctiveness
- Sustainability/Condition
- Landscape Integrity/Amenity

Depending upon the level of assessment required, the criteria could be used as a checklist of the information required for the assessment of a site, or used to systematically score sites. The four criteria are described below.

1. Representativeness

Representativeness is measured by how much of the original extent of the vegetation type is formally protected proportion in the ecological district in which the protection proposal is located. Suggested levels of depletion for ranking purposes are:

- <1% of the original extent protected
- 1% to 5% of the original extent protected
- 6% to 25% of the original extent protected
- 26% to 50% of the original extent protected
- >50% of the original extent protected

2. Rarity/Threatened Species

Rarity is the importance of the habitat for which protection is proposed, based on the threat categories for plants and animals. Suggested levels of importance for habitat protection, derived from Townsend *et al* (2008), are:

- important habitat for a *threatened* (nationally critical, nationally endangered or nationally vulnerable) species
- important habitat for an *at risk* (declining, recovering, relict or naturally uncommon) species; ***or***, moderate habitat for a *threatened* species
- moderate habitat for an *at-risk* species; ***or***, potential habitat for a *threatened* species
- important habitat for species representative of the ecological district
- unimportant habitat values

3. Sustainability/Condition

Sustainability is the extent to which the area proposed for protection or restoration is sustainable (viable) based on its condition, size and shape, and the extent to which it links or buffers existing protected areas. Suggested levels of sustainability for ranking purposes are:

- The area is an enclave of unprotected land surrounded by protected land; ***or***, a large unmodified area *(>100 ha for intact forest or alpine ecosystems, and >20 ha for intact lowland or montane non-forest ecosystems)*
- The area adjoins protected land along >50% of its terrestrial boundary; ***or***, links two or more protected areas, or a protected area with the sea, river or lake (and the linkage is wide enough to be viable); ***or*** is large (as above) but modified
- The area adjoins protected land along <50% of its terrestrial boundary; ***or***, does not adjoin a protected area but is large and unmodified enough to sustain the ecosystem with certainty (including resilience to natural disturbance)
- The area does not adjoin a protected area but is large enough, of suitable shape and sufficiently buffered to sustain the ecosystem; ***or***, is not large enough, of suitable shape or sufficiently buffered to sustain the ecosystem, but budgeted management action will sustain key ecosystem processes and components;
- The area does not adjoin a protected area and is not large enough, of suitable shape or sufficiently buffered to sustain the ecosystem, and management action to sustain key ecosystem processes and components is unlikely to be sustainable.

4. Landscape Integrity/Amenity

Landscape Integrity is the position and place of the area proposed for protection in the wider landscape. Amenity is the significance of sites within the area for geo-preservation, archaeology, history, culture, science or recreation. Suggested levels of landscape integrity and amenity for ranking purposes are:

- The area forms a significant part of a nationally-important landscape or uninterrupted ecological sequence (altitudinal, soil, vegetation); ***or***, contains a nationally important site
- The area forms a significant part of a regionally-important landscape or uninterrupted ecological sequence; ***or***, a minor part of a nationally important landscape or sequence; ***or***, contains a regionally important site
- The area forms a significant part of a locally-important landscape or uninterrupted ecological sequence; ***or***, a minor part of a regionally important landscape or sequence; ***or***, contains a locally important site
- The area forms a minor part of a locally-important landscape or uninterrupted ecological sequence; ***or***, contains part of a locally important site
- The area forms an insignificant part of a locally-important landscape or uninterrupted ecological sequence.

7.0 LAND PROTECTION STRATEGY

A four-point strategy for the protection and restoration of indigenous ecosystems in Canterbury

1. ***Assess proposals for the protection of indigenous ecosystems against the criteria in Section 6.3 of this report, utilizing:***

    - ***the data presented in Section 5 of this report to determine the relative importance of the area for representativeness (criterion 1)***
    - ***the presence of habitat for threatened species to determine the relative importance of the area for threatened species (criterion 2)***
    - ***the condition, location, size and shape of the area to determine the sustainability of the area (criterion 3)***
    - ***the ecological and landscape context of the area, and the presence of important sites, to determine the relative importance of the area for landscape integrity and amenity (criterion 4)***

2. ***Actively seek the protection of vegetation types that are poorly represented in existing protected areas, guided by the analysis in Section 5, and using the criteria in Section 6.3 to determine relative protection priorities.***

3. ***Seek to restore depleted vegetation types where ecosystem processes are still intact and ecosystem components are still present nearby (or able to be reintroduced from other sites).***

4. ***Determine final priorities for protection by assessing current opportunities for protection of the vegetation type and the immediate threats to the area proposed for protection.***

8.0 SPECIES CITED BY COMMON NAME IN TEXT

* = naturalised species

Common Name	Botanical Name
akeake	*Dodonaea viscosa*
akiraho	*Olearia paniculata*
beech	*Nothofagus spp.*
black beech	*Nothofagus solandri var. solandri*
bog pine	*Halocarpus bidwillii*
bracken	*Pteridium esculentum*
bristle tussock	*Rytidosperma setifolium*
broadleaf	*Griselinia littoralis*
broad-leaved snow tussock	*Chionochloa flavescens*
broom*	*Cytisus scoparius*
comb sedge	*Oreobolus pectinatus*
crack willow*	*Salix fragilis*
danthonia	*Rytidosperma sp.*
fescue tussock	*Festuca sp.*
five-finger	*Pseudopanax arboreus*
flax	*Phormium tenax*
hawthorn*	*Crataegus monogyna*
hinau	*Elaeocarpus dentatus*
inaka	*Dracophyllum spp.*
kahikatea	*Dacrycarpus dacrydioides*
kaikawaka	*Libocedrus bidwillii*
kaikomako	*Pennantia corymbosa*
kamahi	*Weinmannia racemosa*
kanuka	*Kunzea ericoides*
kiekie	*Freycinetia baueriana*
korokio	*Corokia cotoneaster*
kowhai	*Sophora microphylla*
lowland ribbonwood	*Plagianthus regius*
mahoe	*Melicytus ramiflorus*
manuka	*Leptospermum scoparium*
mapou	*Myrsine australis*
matagouri	*Discaria toumatou*
matai	*Prumnopitys taxifolia*
mid-ribbed snow tussock	*Chionochloa pallens*
miro	*Prumnopitys ferruginea*
mountain beech	*Nothofagus solandri var. cliffortioides*
mountain flax	*Phormium cookianum*
mountain holly	*Olearia ilicifolia*
mountain kiokio	*Blechnum montanum*
mountain lacebark	*Hoheria lyallii*
mountain toatoa	*Phyllocladus alpinus*
mountain totara	*Podocarpus hallii*
mouse-ear hawkweed*	*Hieracium pilosella*
narrow-leaved houhere	*Hoheria angustifolia*
narrow-leaved snow-tussock	*Chionochloa rigida*
ngaio	*Myoporum laetum*
pingao	*Desmoschoenus spiralis*
putaputaweta	*Carpodetus serratus*

Common Name	Botanical Name
rata	*Metrosideros umbellata*
raupo	*Typha orientalis*
red beech	*Nothofagus fusca*
red tussock	*Chionochloa rubra*
rimu	*Dacrydium cupressinum*
rowan*	*Sorbus aucuparia*
Russell lupin*	*Lupinus polyphyllus*
salt marsh ribbonwood	*Plagianthus divaricatus*
silver beech	*Nothofagus menziesii*
silver tussock	*Poa cita*
slim snow-tussock	*Chionochloa macra*
snow totara	*Podocarpus nivalis*
stonecrop*	*Sedum acre*
tauhinu	*Ozothamnus leptophyllus*
ti	*Cordyline australis*
totara	*Podocarpus totara*
wire rush	*Empodisma minus*
woolly moss	*Racomitrium lanuginosum*

9.0 REFERENCES CITED IN TEXT

Alexander, D.J.; Neeson, M.P.; Simpson, N.C. 1979. *The Lewis Pass Region: An Investigation for the National Parks Authority*. Department of Lands and Survey. 116p + appendices.

Allan, H.H. 1961. *Flora of New Zealand Volume I*. Government Printer, Wellington. 1085p.

Andersen, J.C. 1916. *Jubilee History of South Canterbury*. Whitcombe and Tombs Ltd. 775p.

Arand, J.; Glenny, D. 1990. Mathias and Mt Hutt ecological districts, survey report for the Protected Natural Areas Programme. *Protected Natural Areas Programme Survey Report 12*, Department of Conservation, Wellington. 248p.

Atkinson, I.A.E. 1985. Derivation of mapping units for an ecological survey of Tongariro National Park, North Island, New Zealand. *NZ Journal of Botany 23*: 361-378.

Basher, L.R. 1990. Vegetation history of Molesworth Station – evidence from identification and dating of subfossil wood and charcoal. *Unpublished Department of Conservation research report S1025/312*. DSIR Land Resources, Christchurch.

Belton, M.C. 1981. *Alford, Mt Hutt, Rockwood Forests: An Ecological Survey*. NZ Forest Service. 52p.

Bowen, F.E. 1964. *Sheet 15 Buller (1st Ed.) Geological Map of New Zealand 1:250,000*. Department of Scientific and Industrial Research, Wellington.

Burrows, C.J. 1960. Recent changes in vegetation of the Cass area of Canterbury. *NZ Geographer 16*: 57-70.

Burrows, C.J. (Ed.) 1977a. *Cass: History and Science in the Cass District, Canterbury, New Zealand*. University of Canterbury, Christchurch. 418p.

Burrows, C.J. 1977a. Vegetation in the Cass district and its ecology. In: *Burrows (Ed.) 1977*: 173-184.

Burrows, C.J. 1977b. Forest and scrub flora of the upper Rangitata, Rakaia and Wilberforce valleys. *Canterbury Botanical Society Journal No.10*: 1-9.

Burrows, C.J. 1979. A preliminary floristic list of native plants from the Rakaia Gorge. *Canterbury Botanical Society Journal 13*: 51-52.

Burrows, C.J. 1984. Arowhenua Bush: a remnant of the forest of the South Canterbury plains. *Canterbury Botanical Society Journal 18*: 72-78.

Burrows, C.J. 1986. Botany of Arthur's Pass National Park, South Island, New Zealand. *NZ Journal of Botany 24*: 9-68.

Burrows, C.J. 1989. Moa browsing: evidence from the Pyramid Valley mire. *NZ Journal of Ecology 12 (supplement)*: 51-56.

Burrows, C.J. 1995. A macrofossil flora from sediments in a lagoon marginal to Lake Coleridge, Canterbury, New Zealand. *NZ Journal of Botany 33*: 519-522.

Burrows, C.J. 1996a. Radiocarbon dates for Holocene fires and associated events, Canterbury, New Zealand. *NZ Journal of Botany 34*: 111-121.

Burrows, C.J. 1996b. Records of the forest and scrub flora of eastern-southern Arrowsmith Range valleys. *Canterbury Botanical Society Journal 31*: 71-76.

Burrows, C.J. 1997. A macrofossil flora from early Aranuian lake-bed deposits, Doubtful River, Waiau-uha catchment, North Canterbury, New Zealand. *NZ Journal of Botany 35*: 545-553.

Burrows, C.J.; Russell, J.B. 1990. Aranuian vegetation history of the Arrowsmith Range, Canterbury. *NZ Journal of Botany 28*: 323-345.

Burrows, C.J.; Lord, J.M. 1993. Recent colonisation by *Nothofagus fusca* at Cass, Canterbury. *NZ Journal of Botany 31*: 139-146.

Burrows, C.J.; Randall, P.; Moar, N.T.; Butterfield, B.G. 1993. Aranuian vegetation history of the Arrowsmith Range, Canterbury, New Zealand. *NZ Journal of Botany 31*: 147-174.

Canterbury Botanical Society, 1993. Vegetation changes on the Hawdon River floodplain, Waimakariri Basin, Canterbury. *Canterbury Botanical Society Journal 27*: 33-38.

Cave, M.P. 1987. Geology of Arthur's Pass National Park. 1:80,000. *National Parks Scientific Series No. 7*. Department of Conservation, Wellington.

Connor, H.E.; Edgar, E. 1987. Name changes in the indigenous New Zealand flora, 1960-1986 and Nomina Nova IV, 1983-1986. *NZ Journal of Botany 25*: 115-170.

Courtney, S.; Arand, J. 1994. Balaclava, Sedgemere and Dillon ecological districts: survey report for the Protected Natural Areas Programme. *NZ Protected Natural Areas Programme No. 20*. Department of Conservation, Nelson. 294p.

Department of Conservation, 1995. Canterbury Conservation Management Strategy Volume I. *Canterbury Conservancy Management Planning Series No.8.* Department of Conservation, Christchurch. 284p. and maps.

Department of Conservation, 2000. Canterbury Conservation Management Strategy Volume II. *Canterbury Conservancy Management Planning Series No.10.* Department of Conservation, Christchurch. 320p.

Edgar, E.; Connor, H.E. 2000. *Flora of New Zealand Volume V*. Manaaki Whenua Press, Lincoln. 650p.

Espie, P.R.; Hunt, J.E.; Butts, C.A.; Cooper, P.J.; Harrington, W.M.A. 1984. *Mackenzie Ecological Region, New Zealand Protected Natural Areas Programme.* Department of Lands and Survey, Wellington. 60p.

Fleming, C.A. 1979. *The Geological History of New Zealand and its Life.* Auckland University Press. 141p.

Gair, H.S. 1967. *Sheet 20 Mt Cook (1st Ed.) Geological Map of New Zealand 1:250,000*. Department of Scientific and Industrial Research, Wellington.

Gregg, D.R. 1964. Sheet 18 Hurunui (1st Ed.) *Geological Map of New Zealand 1:250,000*. Department of Scientific and Industrial Research, Wellington.

Grove, P. 1994. *Hawkdun Ecological District-A Survey Report for the Protected Natural Areas Programme.* Department of Conservation, Dunedin.

Guest, R.; Wilkinson, G.B. 1977. Forests and animals of the Hope Catchment. *NZ Journal of Forestry Science 7*: 123-136.

Harding, M.A. 1991. *Torlesse Range: Proposal for a Conservation Park*. Royal Forest and Bird Protection Society, Wellington. 40p.

Harding, M.A. 1992. Ruataniwha: protecting a natural remnant of the Mackenzie Basin. *Forest & Bird 263*: 29-31.

Harding, M.A. 1994. *Implementing Biodiversity Conservation, an Assessment of the Strategic Direction of the Forest Heritage Fund*. Forest Heritage Fund, Wellington. 56p.

Harding, M.A. 2002. Upper Rangitata Valley: Weed Infestations on UCL and AMF Land in the Upper Catchment of the Rangitata River, Canterbury. *Unpublished Report.* Department of Conservation, Raukapuka. 17p + maps.

Harrington, W.M.A.; Cooper, P.J.; Davis, C.M.; Higham, T.D.; Mason, C.M. 1986. Arrowsmith, Hakatere and Two Thumb ecological districts. *Protected Natural Areas Survey Report 4.* Department of Conservation, Wellington. 214p.

Holcroft, A. 1998. Flora of Tawhai Bush, Oxford. *Canterbury Botanical Society Journal 32*: 29-32.

Holdaway, R.N.; Worthy, T.H. 1997. A reappraisal of the late Quarternary fossil vertebrates of Pyramid Valley Swamp, North Canterbury, New Zealand. *NZ Journal of Zoology 24*: 69-121.

Huber, A.; Jane, G.T. 1988. Wilberforce Ecological Area vegetation survey 1984-85. *Department of Conservation Survey Report No.13.* Department of Conservation, Christchurch. 274p.

Jane, G.T. 1985a. Ashley River catchment survey. *New Zealand Forest Service Technical Report, Canterbury Conservancy Survey Report No.4.* 25p.

Jane, G.T. 1985b. Forests and animals of the Rakaia River headwaters, 1978-80 surveys. *NZ Forest Service Survey Report No.1.* NZ Forest Service, Christchurch. 18p.

Jane, G.T. 1986. Puketeraki Survey 1984-85. *New Zealand Forest Service Technical Report, Canterbury Conservancy Survey Report No.6.* 37p.

Jane, G.T. 1987. Oxford Forest Survey. *Canterbury Regional Office Survey Report No.11*. Department of Conservation, Christchurch. 59p.

Jane, G.T. 1988a. Wild animal and vegetation survey, South Hurunui forests 1986/87. *Canterbury Region Survey Report No.15.* Department of Conservation, Christchurch. 63p.

Jane, G.T. 1988b. Waitaki Grasslands and Forest Survey 1985/86. *Canterbury Region Survey Report No.16.* Department of Conservation, Christchurch. 190p.

Jane, G.T.; Wearing, A. 1986. Forests and animals, Waimakariri and Harper-Avoca catchments. *NZ Forest Service Technical Report, Canterbury Conservancy Survey Report No.7.* NZ Forest Service, Christchurch. 53p.

Jane, G.T.; Wardle, R.; Newton, I.A. 1989. Mathias Ecological Area: Animal-vegetation survey 1986/87. *Canterbury Region Survey Report No.17.* Department of Conservation, Christchurch. 102p.

Johnson, P.N. 1992. The sand dune and beach vegetation inventory of New Zealand: II. South Island and Stewart Island. *DSIR Land Resources Scientific Report No.16*. DSIR Land Resources, Christchurch.

Johnston, W.B. 1961. Locating the vegetation of early Canterbury: a map and the sources. *Transactions of the Royal Society of New Zealand – Botany 1*: 5-15.

Kelly, G.C. 1972. Scenic Reserves of Canterbury. *Botany Division, Biological Survey of Reserves Report No.2.* DSIR. 390p.

Leathwick, J.R. 2001. New Zealand's potential forest pattern as predicted from current species-environment relationships. *NZ Journal of Botany 39*: 447-464.

Lensen, G.J. 1962. *Sheet 16 Kaikoura (1st Ed.) Geological Map of New Zealand 1:250,000*. Department of Scientific and Industrial Research, Wellington.

Mabin, M.C.G. 1984. Late Pleistocene glacial sequence in the Lake Heron basin, mid Canterbury. *NZ Journal of Geology and Geophysics 27*: 191-202.

McEwen, W.M. 1987. Ecological regions and districts of New Zealand (3rd revised edition), Sheets 3 and 4. *NZ Biological Resources Centre Publication No. 5*. Department of Conservation, Wellington.

McFadgen, B.G. 1989. Late Holocene depositional episodes in coastal New Zealand. *NZ Journal of Ecology 12 (supplement)*: 145-149.

McGlone, M.S. 1989. The Polynesian settlement of New Zealand in relation to environmental and biotic changes. *NZ Journal of Ecology 12 (supplement)*: 115-129.

McGlone, M.S. 2001. The origin of the indigenous grasslands of southeastern South Island in relation to pre-human woody ecosystems. *NZ Journal of Ecology 25*: 1-15.

McGlone, M.S.; Basher, L.R. 1995. The deforestation of the upper Awatere catchment, Inland Kaikoura Range, Marlborough, South Island, New Zealand. *NZ Journal of Ecology 19*: 53-66.

McGlone, M.S.; Moar, N.T. 1998. Dryland Holocene vegetation history, Central Otago and the Mackenzie Basin, South Island, New Zealand. *NZ Journal of Botany 36*: 91-111.

McLea, W.L. 1996. The late-Quaternary pollen record of south-east Nelson, South Island, New Zealand. *NZ Journal of Botany 34*: 523-538.

Macmillan, B.; Giller, M. 1997. Woodstock Station, Waimakariri River. *NZ Botanical Society Journal 50*: 6.

McSaveney, M.J.; Whitehouse, I.E. 1989. Anthropic erosion of mountain land in Canterbury. *NZ Journal of Ecology 12 (supplement)*: 151-163.

Moar, N.T. 1970. A new pollen diagram from Pyramid Valley swamp. *Records of the Canterbury Museum 8 (5)*: 455-461.

Moar, N.T. 1971. Contributions to the Quaternary history of the New Zealand flora. *NZ Journal of Botany 9*: 80-145.

Moar, N.T. 1973. Contributions to the Quaternary history of the New Zealand flora. *NZ Journal of Botany 11*: 291-304.

Moar, N.T. 2008. Late Quaternary Vegetation: Chapter 7 in Winterbourn *et al*, 2008.

Meurk, C.D.; Bellingham, P.; Macmillan, B. 1995. The last kanuka landscape on the Canterbury Plains? *Canterbury Botanical Society Journal 29*: 11-24.

Molloy, B.P.J. 1964. Soil genesis and plant succession in the subalpine and alpine zones of Torlesse Range, Canterbury, New Zealand. *NZ Journal of Botany 2*: 143-176.

Molloy, B.P.J. 1969. Recent history of the vegetation. In: *The Natural History of Canterbury* 340-360. Knox, G.A. (Ed.), AH and AW Reed, Wellington.

Molloy, B.P.J. 1977. The fire history. In: *Burrows (Ed.) 1977*: 157-171.

Molloy, B.P.J. 1983. *An Assessment of Botanical Values: Rakaia River Catchment.* Botany Division, DSIR, Lincoln. 16p.

Molloy, B.P.J.; Ives, D.W. 1972. Biological reserves of New Zealand 1. Eyrewell Scientific Reserve, Canterbury. *NZ Journal of Botany 10*: 673-700.

Molloy, B.P.J.; Lintott, H. 1979. The vegetation and flora of Sawpit Creek, Wadi Nimrin, Conway Flat. *Canterbury Botanical Society Journal 13*: 26-30.

Moore, S. 1999. Hundalee Ecological District: survey report for the Protected Natural Areas Programme. *Occasional Publication No. 43.* Department of Conservation, Nelson. 257p.

Moore, L.B.; Edgar, E. 1976. *Flora of New Zealand Volume II*. Botany Division, DSIR. Government Printer, Wellington. 354p.

Newton, P. 1960. *Mesopotamia Station: A survey of the first hundred years*. The Timaru Herald Co. Ltd., Timaru. 55p.

Norton, D.A. 1986. The botany of a small kahikatea-matai stand, Grey River, Ashley State Forest. *Canterbury Botanical Society Journal 20*: 20-24.

NZGS (New Zealand Geological Survey), 1972. *South Island (1st Ed.) Geological Map of New Zealand 1:1,000,000.* Department of Scientific and Industrial Research, Wellington.

O'Donnell, C.F.J.; Moore, S.M. 1983. The wildlife and conservation of braided river systems in Canterbury. *Fauna Survey Unit Report No.33*. NZ Wildlife Service, Department of Internal Affairs, Christchurch. 73p.

Ogden, J.; Basher, L.; McGlone, M.S. 1998. Fire, forest regeneration and links with early human habitation: evidence from New Zealand. *Annals of Botany 81*: 687-696.

Shanks, A.; Glenny, D.; Gibson R.; Rosser, K.; Roozen, D.; Phillipson, S.; Steven, J.; Arand, J. 1990. Coleridge, Craigieburn and Cass ecological districts, survey report for the Protected Natural Areas Programme. *New Zealand Protected Natural Areas Programme No.10.* Department of Conservation, Wellington. 306p.

Simpson, M.J.A.; Macfarlane, J.M.; Macmillan, B.H.; Matthews, B.A.; Elix, J. 1980. "Ngawiro", Waiau, North Canterbury. *Canterbury Botanical Society Journal 14*: 28-31.

Soons, J.M. 1994. Changes is geomorphic environments in Canterbury during the Aranuian. *NZ Journal of Botany 32*: 365-372.

Stevens, J.C.; Meurk, C.D. 1996. Low and High Plains ecological districts, Plains Ecological Region, Canterbury. *Protected Natural Areas Programme Survey Report (unpublished draft).* 114p.

Townsend, A.J.; de Lange, P.J.; Duffy, C.A.J.; Miskelly, C.M.; Molloy, J.; Norton, D. 2008. *New Zealand Threat Classification System manual*. Department of Conservation, Wellington. 35p.

Wardle, J. 1971. The forests and shrublands of the Seaward Kaikoura Range. *NZ Journal of Botany 9*: 269-292.

Wardle, J.; Guest, R. 1977. Forests of the Waitaki and Lake Hawea catchments. *NZ Journal of Forestry Science 7*: 44-67.

Wardle, P. 1985a. New Zealand timberlines. 1. Growth and survival of native and introduced tree species in the Craigieburn Range, Canterbury. *NZ Journal of Botany 23*: 219-234.

Wardle, P. 1985b. New Zealand timberlines. 2. A study of forest limits in the Crow Valley near Arthur's Pass, Canterbury. *NZ Journal of Botany 23*: 235-261.

Wardle, P. 2001a. Distribution of native forest in the upper Clutha district, Otago, New Zealand. *NZ Journal of Botany 39*: 435-446.

Wardle, P. 2001b. Holocene forest fires in the upper Clutha district, Otago, New Zealand. *NZ Journal of Botany 39*: 523-542.

Warren, G. 1967. Sheet 17 Hokitika (1st Ed.) *Geological Map of New Zealand 1:250,000*. Department of Scientific and Industrial Research, Wellington.

Webb, C.J.; Sykes, W.R.; Garnock-Jones, P.J. 1988. *Flora of New Zealand Volume IV*. Botany Division, DSIR, Christchurch. 1365p.

Williams, P.A. 1989. Vegetation of the Inland Kaikoura Range. *NZ Journal of Botany 27*: 201-220.

Wilson, H.D. 1978. *Wild Plants of Mount Cook National Park. Field* Guide Publications, Christchurch. 294p.

Wilson, H.D. 1992. Banks Ecological Region. Port Hills, Herbert and Akaroa Ecological Districts. *Protected Natural Areas Programme Survey Report No.21*. Department of Conservation, Christchurch. 342p.

Wilson, H. D. 2008. Vegetation of Banks Peninsula: Chapter 9 in Winterbourn *et al*, 2008.

Winterbourn, M.; Knox, G.; Burrows, C.; Marsden, I. (editors). 2008. *The Natural History of Canterbury*, Third Edition. Canterbury University Press.

APPENDIX 1

Indigenous Forest (sorted in order of priority for protection)				
Ecological District	Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected	% of original extent protected
Port Hills	95	<1	0	0
Waiau	78	<1	<1	0
Glenavy	60	<1	0	0
Hakataramea	48	<1	0	0
Culverden	45	<1	<1	0
Grampians	19	0	0	0
Kirkliston	18	<1	0	0
Hawkdun	18	0	0	0
St Mary	15	<1	0	0
St Bathans	15	<1	0	0
Godley	3	0	0	0
Tekapo	3	<1	0	0
Pukaki	3	<1	0	0
Benmore	3	0	0	0
Ellesmere	<1	0	0	0
Herbert	95	<1	71	<1
Akaroa	95	<1	19	<1
Geraldine	94	1	37	<1
Cheviot	90	1	6	<1
Motunau	89	3	11	<1
Ashley	85	3	13	<1
Waimate	85	2	30	<1
Hundalee	84	4	20	<1
Leslie	75	<1	14	<1
Waikari	73	<1	<1	<1
Makikihi	62	<1	2	<1
High Plains	60	<1	28	<1
Coleridge	59	<1	<1	<1
Low Plains	40	<1	4	<1
Fairlie	40	<1	13	<1
Ben Ohau	21	<1	15	<1
Orari	80	2	55	1
Hunters	70	4	38	2
Two Thumb	32	<1	67	2
Hakatere	3	<1	5	2
Whitecliffs	77	4	70	4
Dillon, Manakau, Waiautoa	60	6	56	6
Ahuriri	34	3	85	8
Mt Hutt	45	5	86	10
Arrowsmith	3	<1	34	11
Balaclava	17	2	99	12
Cass	66	15	69	16
Miromiro	72	17	87	20
Omarama	2	<1	39	20
Oxford	78	26	72	24

Sumner	70	25	69	25
Torlesse	69	26	67	25
Armoury	3	<1	90	30
Mathias	30	12	77	31
Browning	15	5	95	32
Dobson	25	10	89	36
Craigieburn	38	18	93	44
Mt Cook	2	<1	100	50
Poulter	60	39	84	55
Huxley	20	14	93	65
Hope	60	50	94	78
Lewis	56	45	99	79
Minchin	53	44	99	82
Arthur's Pass	46	43	69	93

Scrub (sorted in order of priority for protection)				
Ecological District	Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected	% of original extent protected
Grampians	45	3	0	0
Benmore	62	7	7	<1
St Mary	45	4	5	<1
Pukaki	32	3	10	<1
Culverden	20	1	8	<1
Fairlie	20	7	1	<1
Makikihi	20	1	8	<1
Tekapo	20	3	3	<1
Omarama	56	3	26	1
Arrowsmith	36	2	21	1
Hawkdun	20	3	9	1
Leslie	19	24	1	1
Waikari	10	5	2	1
Ellesmere	10	<1	12	1
Hakataramea	20	6	7	2
Glenavy	20	3	12	2
Ashley	10	20	<1	2
Low Plains	20	2	31	3
High Plains	15	3	17	3
Hunters	9	6	4	3
Waiau	5	16	<1	3
Kirkliston	43	11	14	4
St Bathans	25	5	20	4
Hundalee	8	31	1	4
Hakatere	19	4	22	5
Whitecliffs	10	11	5	5
Waimate	10	7	8	6
Ben Ohau	20	5	28	7
Coleridge	10	18	4	7
Ahuriri	20	5	32	8
Godley	13	3	41	10
Motunau	5	12	4	10

Poulter	5	5	10	10
Herbert	5	14	5	14
Cheviot	5	17	5	17
Orari	4	6	11	17
Geraldine	2	6	7	21
Cass	5	14	10	28
Mathias	13	19	20	29
Dillon, Manakau, Waiautoa	21	21	30	30
Mt Hutt	6	5	40	33
Oxford	10	16	24	38
Craigieburn	5	7	30	42
Torlesse	8	20	18	45
Dobson	5	7	32	45
Armoury	15	13	71	61
Two Thumb	3	4	49	65
Hope	18	12	99	66
Huxley	5	5	74	74
Arthur's Pass	5	4	94	75
Lewis	10	9	96	86
Minchin	7	7	95	95
Mt Cook	Ecological Districts in which more than 100% of the original extent of scrub is protected.			
Sumner				
Browning				
Balaclava				
Miromiro				
Port Hills				
Akaroa				

Tussock (sorted in order of priority for protection)				
Ecological District	Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected	% of original extent protected
Culverden	28	0	0	0
Low Plains	18	<1	0	0
Waiau	15	8	0	0
Waikari	15	3	0	0
Makikihi	15	0	0	0
Glenavy	15	0	0	0
Motunau	5	1	0	0
Geraldine	2	<1	0	0
Akaroa	<1	0	?	?
Fairlie	37	8	<1	<1
High Plains	20	<1	4	<1
Waimate	5	4	1	<1
Ellesmere	5	<1	<1	1
Cheviot	2	2	2	2
Hakataramea	30	46	<1	2
Whitecliffs	10	16	<1	2
Tekapo	70	62	5	4
Grampians	20	76	<1	4

Hundalee	5	24	<1	5
Omarama	30	40	5	7
Pukaki	60	79	6	8
Coleridge	10	35	3	10
Ashley	5	48	<1	10
Leslie	3	36	<1	12
Herbert	<1	4	4	16
Oxford	10	15	12	18
Mathias	5	15	6	18
Benmore	15	62	6	25
Cass	10	49	5	25
Port Hills	5	5	36	36
Hakatere	47	65	27	37
St Bathans	22	56	15	38
Hunters	15	45	18	54
Kirkliston	15	54	16	58
Poulter	10	31	24	74
Mt Cook	4	4	100	100
St Mary	Ecological Districts in which more than 100% of the original extent of tussock is protected.			
Dillon, Manakau, Waiautoa				
Hawkdun				
Ben Ohau				
Sumner				
Dobson				
Miromiro				
Godley				
Balaclava				
Armoury				
Orari				
Mt Hutt				
Browning				
Minchin				
Craigieburn				
Arthur’s Pass				
Torlesse				
Hope				
Lewis				
Two Thumb				
Arrowsmith				
Huxley				
Ahuriri				

Freshwater wetland (sorted in order of priority for protection)				
Ecological District	Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected	% of original extent protected
Tekapo	5	<1	0	0
Fairlie	3	0	0	0
Glenavy	3	0	0	0
Pukaki	3	<1	0	0
Culverden	2	0	0	0
Waikari	2	0	0	0
Dillon, Manakau, Waiautoa	<1	?	?	?
Lewis	<1	?	?	?
Hope	<1	?	?	?
Hundalee	<1	?	?	?
Leslie	<1	?	?	?
Waiau	<1	?	?	?
Cheviot	<1	?	?	?
Minchin	<1	?	?	?
Arthur's Pass	<1	?	?	?
Port Hills	<1	?	?	?
Herbert	<1	?	?	?
Browning	<1	?	?	?
Mt Cook	<1	?	?	?
Two Thumb	<1	?	?	?
Dobson	<1	?	?	?
Geraldine	<1	?	?	?
Hunters	<1	?	?	?
Waimate	<1	?	?	?
Hakataramea	<1	?	?	?
Ben Ohau	<1	?	?	?
Grampians	<1	?	?	?
St Bathans	<1	?	?	?
Huxley	<1	?	?	?
Poulter	<1	<1	?	?
Torlesse	<1	<1	?	?
Ashley	<1	<1	?	?
Oxford	<1	<1	?	?
Armoury	<1	<1	?	?
Mathias	<1	<1	?	?
Kirkliston	<1	<1	?	?
Benmore	3	<1	1	<1
Hakatere	23	1	30	1
High Plains	<1	<1	1	1
Coleridge	3	<1	7	2
Cass	<1	<1	3	3
Mt Hutt	<1	<1	4	4
Low Plains	4	<1	22	5
Sumner	<1	<1	5	5
Ellesmere	3	<1	31	10
Whitecliffs	<1	<1	11	11
Omarama	10	4	41	16

Craigieburn	<1	<1	19	19
Makikihi	3	<1	98	33
Godley	<1	<1	33	33
Hawkdun	<1	<1	35	35
St Mary	<1	<1	38	38
Motunau	<1	<1	54	54
Akaroa	<1	<1	56	56
Orari	<1	<1	63	63
Miromiro	<1	<1	76	76
Ahuriri	<1	<1	83	83
Balaclava	<1	<1	96	96
Arrowsmith	<1	<1	100	100

Bare Ground (sorted in order of priority for protection)				
Ecological District	Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected	% of original extent protected
Benmore	3	<1	?	?
Waikari	<1	<1	?	?
Grampians	<1	<1	?	?
Kirkliston	<1	<1	?	?
Port Hills	<1	<1	?	?
Herbert	<1	<1	?	?
Akaroa	<1	<1	?	?
Motunau	<1	<1	?	?
Whitecliffs	3	3	<1	<1
Hunters	<1	<1	<1	<1
Waiau	2	1	2	1
Tekapo	2	2	1	1
Pukaki	2	2	1	1
Ashley	<1	<1	1	1
Coleridge	16	16	2	2
Culverden	5	6	2	2
Cheviot	3	3	4	4
Fairlie	<1	1	4	4
Low Plains	15	2	37	5
Hundalee	3	3	5	5
Hakataramea	2	1	11	5
Balaclava	17	15	96	6
Leslie	3	<1	17	6
Geraldine	2	2	6	6
Ben Ohau	2	2	7	7
Mathias	21	21	9	9
Hakatere	8	8	10	10
Glenavy	2	2	11	11
Cass	11	11	14	14
Mt Hutt	6	6	16	16
St Bathans	<1	<1	17	17
High Plains	5	3	31	19
Ahuriri	3	3	20	20

Orari	3	3	21	21
Oxford	2	1	21	21
Godley	13	13	18	18
Dobson	9	9	18	18
Makikihi	<1	<1	19	19
Waimate	<1	<1	27	27
Omarama	2	2	31	31
St Mary	1	<1	32	32
Craigieburn	15	15	37	37
Sumner	16	16	39	39
Torlesse	7	7	51	51
Armoury	13	13	53	53
Hope	3	3	55	55
Dillon, Manakau, Waiautoa	8	8	61	61
Browning	15	15	64	64
Arrowsmith	8	8	69	69
Poulter	14	14	70	70
Hawkdun	<1	<1	70	70
Two Thumb	3	3	71	71
Ellesmere	2	2	75	75
Huxley	3	3	86	86
Arthur's Pass	10	10	88	88
Lewis	3	3	91	91
Minchin	7	7	95	95
Miromiro	6	9	65	97
Mt Cook	15	15	100	100

Alpine (sorted in order of priority for protection)				
Ecological District	Estimated original extent (% of ED)	Present extent (% of ED)	% of present extent protected	% of original extent protected
Coleridge	2	2	0	0
Grampians	16	16	2	2
Hakataramea	<1	<1	2	2
Hakatere	<1	<1	10	10
Benmore	14	14	15	15
St Bathans	38	38	17	17
Tekapo	<1	<1	17	17
Orari	9	9	21	21
Sumner	4	4	22	22
Dobson	58	58	30	30
Poulter	11	11	31	31
Mathias	31	31	34	34
Kirkliston	24	24	41	41
Mt Hutt	36	36	47	47
Torlesse	13	13	49	49
Cass	8	8	52	52
Dillon, Manakau, Waiautoa	7	7	52	52
Ben Ohau	42	42	54	54
Hunters	6	6	61	61

Craigieburn	39	39	65	65
Miromiro	8	8	65	65
Arrowsmith	48	48	69	69
Hawkdun	47	47	70	70
Godley	66	66	71	71
Two Thumb	58	58	71	71
St Mary	26	26	71	71
Ahuriri	40	40	80	80
Armoury	66	66	81	81
Huxley	72	72	86	86
Lewis	27	27	91	91
Balaclava	25	25	96	96
Browning	52	52	97	97
Arthur's Pass	38	38	98	98
Minchin	27	27	<100	<100
Mt Cook	76	76	100	100
Hope	14	14	100	100