Toitu te whenua
Land Information
New Zealand

Crown Pastoral Land Tenure Review

Lease name : SIMONS PASS

Lease number : PT 019

Conservation Resources Report - Part 1

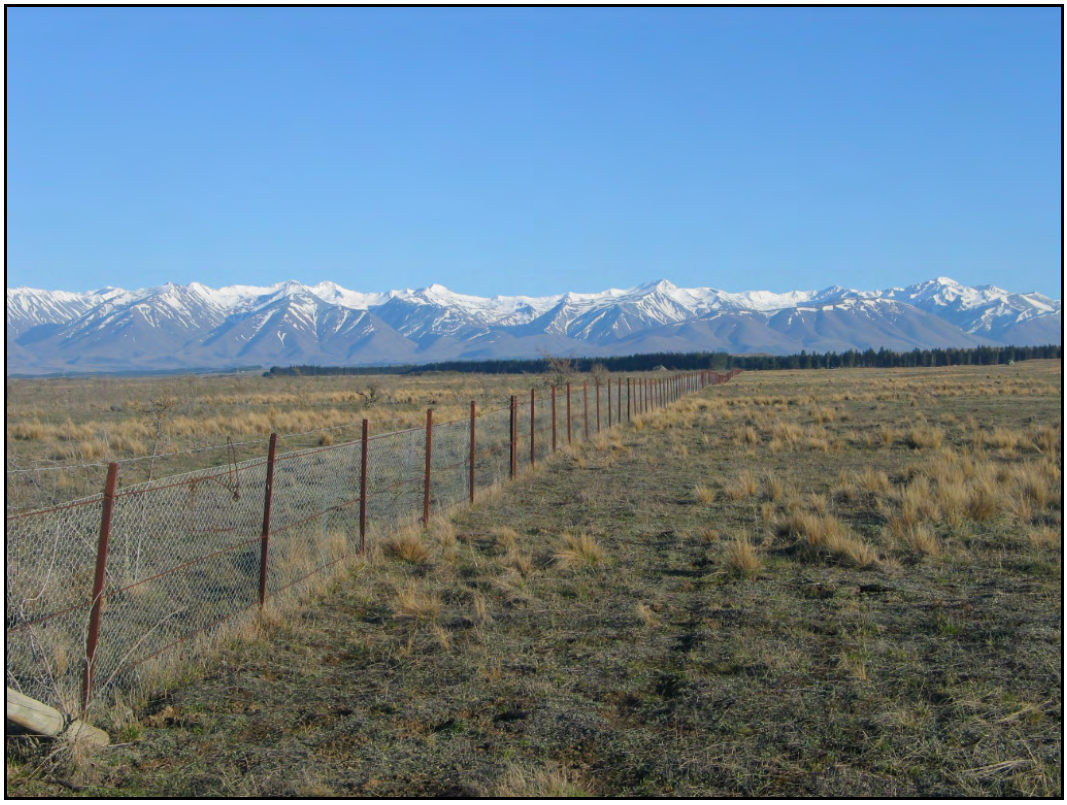
As part of the process of Tenure Review, advice on significant inherent values within the pastoral lease is provided by Department of Conservation officials in the form of a Conservation Resources Report. This report is the result of outdoor survey and inspection. It is a key piece of information for the development of a preliminary consultation document.

Note: Plans which form part of the Conservation Resources Report are published separately.

These documents are all released under the Official information Act 1982.

May 08

SIMONS PASS PASTORAL LEASE



CONSERVATION RESOURCES REPORT

DEPARTMENT OF CONSERVATION

OCTOBER 2007

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PART 1: INTRODUCTION

Simons Pass Pastoral Lease is a property of 5670 ha located in the middle of the Mackenzie Basin, at the southern end of Lake Pukaki, approximately 25 km northeast of Twizel. The property is bound by the Tekapo-Twizel Road (State Highway 8), Lake Pukaki and Maryburn pastoral lease to the north, the Pukaki River bed to the west, the Mary Range to east, and outwash plain of Simons Hill Station to the south. There are no permanent waterways on the property. Altitude ranges between 415 m beside the Pukaki River bed, and 680 m at the foothills of the Mary Range.

State Highway 8 provides road access to the northern portion of the property. The homestead is situated on freehold land adjoining the Pastoral Lease.

The majority of the Pastoral Lease is dominated by landforms of glacial origin. There are steep rocky terminal moraine slopes, hummocky and gently rolling moraine deposits with associated kettleholes and tarns; relicts of older terminal moraines and boulders; gently sloping meltwater channels and fluvio-glacial outwash plain; and low terraces associated with the Pukaki River. A small portion of hill country occupies the foot slopes of the Mary Range at the north-eastern part of the property. Agricultural development has taken place in the centre of the property (the Farm Block), where exotic conifer shelterbelts surround pasture. Cultivation and direct drilling has taken place along the south-eastern boundary, where good soils are being converted to lucerne or pasture. Much of the moraine country in the vicinity of the Farm Block has been oversown and top-dressed.

The Pastoral Lease lies within the Mackenzie Ecological Region and Tekapo and Pukaki Ecological Districts. A Protected Natural Areas Programme (PNAP) survey which included these ecological districts has been carried out (Espie *et al.* 1984). One area recommended for protection is partially located on the Pastoral Lease. RAP 6: Southern Lake Pukaki Scrub is a low montane prostrate kowhai-native broom shrubland that occupies the terminal moraine (see Botanical Values map). A soil site of significance (no. 242) has also been identified within this same area (see Landscape Values map).

The Lake Pukaki Terminal Moraine Geopreservation Site encompasses a large proportion of the northern half of the property (see Landscape Values map).

Adjoining the property to the northwest is Lake Pukaki Terminal Moraine Conservation Area, while Pukaki Flats Conservation Area is located to the west of the Pukaki River, opposite the Pastoral Lease.

The western boundary beside the Pukaki River, adjoins a Legal Road, along which a formed gravel road is roughly aligned. A second largely unformed legal road running east-west bisects the outwash plain on the Pastoral Lease to connect with other unformed Legal Roads at the property's eastern boundary (see Map 1).

The tenure review inspection of Simons Pass Pastoral Lease was undertaken on 2-6th October 2006 by a range of specialists. These specialist's reports (listed below) form the basis of this Conservation Resources Report.

- Assessment of Significant Inherent landscape Values -Simons Pass Pastoral Lease November 2006. Anne Steven. 32 pp + photos + maps.

- Simons Pass Botanical Survey. October 2006. Kate Wardle. 35pp + photos + maps
- Simons Pass Pastoral Lease Tenure Review- invertebrate survey. November 2006. Warren Chinn
- Assessment of the fauna values (bird and lizards) of Simons Pass Pastoral Lease, October 2006. Simon Elkington. 13 pp + maps.
- Simons Pass Pastoral Lease- A report on the Aquatic Fauna Surveys, November 2006. Scott Bowie. 15 pp + maps.
- Simons Pass Pastoral Lease Recreation values, October 2006. Dave Wilkins. 2 pp + map.

Map : Topo/Cadastral.

PART 2: INHERENT VALUES: DESCRIPTION OF CONSERVATION RESOURCES AND ASSESSMENT OF SIGNIFICANCE

2.1 LANDSCAPE

Landscape Context

Simons Pass Pastoral Lease is located in the heart of the Mackenzie Basin, one of the South Island's large intermontane basins containing three of the great southern lakes. The Mackenzie Basin is a landscape of national importance and has been assessed as an outstanding natural landscape on a regional scale.

Key characteristics include the lakes adding to the vastness of the landscape; the numerous geological and biological sites of importance; the clear geomorphological expression and high legibility; strong attributes of openness and naturalness; the tussock grassland character; and the coherence of land cover and landform together.

The enclosing mountains are dramatic but the floor of the Basin provides the distinctive landscape character. Landforms are expansive with subtle shadings of light and shadow, accentuated by the homogenous low grassland cover. There is a sense of remoteness and exposure to the elements, and vast panoramic views are typical of the Basin.

Key landscape elements of the basin floor are vast expanses of outwash plain with sinuous braided patterns; rolling to hummocky moraines frequently littered with angular boulders; occasional hard rock hills protruding from the floor; and dry grey gravel riverbeds with rectilinear terraces. Short tussock grassland and mat plant communities are a ubiquitous cover. Homesteads are like oases in the generally brown-grey landscape, although the presence of cultivated and planted areas is becoming more frequent.

Simons Pass Pastoral Lease is a large part of the middle of the Basin and it adjoins Lake Pukaki, one the three great southern lakes in the Basin. It comprises large classic examples of the key landform elements that contribute significantly to the Basin's character; and the characteristic low tussock grassland cover covers much of the property.

State Highway 8 traverses the Basin and passes around the south margin of Lake Pukaki and crosses the hill range at Simons Pass homestead. This highway is a major tourist route with high vehicle use. Much of the landscape of Simons Pass forms the visual corridor for the road. The experience of driving through relatively natural moraine is unique in the basin – elsewhere tree planting and built development typifies the moraine sections. The Simons Pass landscape is therefore important for enjoyment of the natural diversity of landscape.

Landscape Experiences

In a 1992 survey (Boffa Miskell Partners Ltd 1992) the Mackenzie Basin was divided into landscape compartments. Simons Pass Pastoral Lease is largely within the Twizel landscape compartment enclosed by the Mary Range, Simons Hill and the Ben Ohau Range. The road pass is the transition from the Mackenzie compartment to the Twizel compartment. It is the only pass

in the basin, crossing a low hill range that separates the east and west sides of the basin. The actual Simons Pass is 3 km to the south.

The western side of the property is part of the Pukaki River road landscape experience. The northern moraine slopes are the setting for Lake Pukaki, enjoyed at close range as the highway passes around these slopes. The new Te Araroa (The Long Pathway) trail also runs along the western side of the Pukaki River and around the lake shore.

Passing through the property is part of the first road through the Mackenzie, the Bullock trail. Another feature of significance in the Basin – a Rabbit Fence built in 1888 between Lake Pukaki and the Hakataramea Valley to try and keep rabbits in Otago coming into Canterbury – is represented on the property crossing it west to east.

Landscape Description

The landscape of the property is divided into five 'landscape units' (LU) (see Landscape Values map).

- Mary Range and Homestead Area
- Pukaki Outwash Plain
- 'Balmoral' Moraine
- Pukaki Moraine
- Pukaki Riverbed

These units reflect areas of similar landscape character, in terms of landform, vegetation types and patterns, cultural elements and patterns of land use. Each unit is described in terms of these factors.

Mary Range and Homestead Area (LU1)

Character Description

This small unit comprises the northeast part of the property including the foothills of the Mary Range, a low isolated hard rock greywacke-argillite hill range. The Mary Range ranges in altitude from 520 m to almost 680 m within the property. It forms the north side of the road pass. Along the foot of the range, small piedmont colluvial fans merge with a remnant terrace of 'Balmoral'[1] age moraine and outwash plain.

The homestead area is located on freehold land here. State Highway 8 bisects the area. The area has a lower sense of naturalness, being closely associated with the developed homestead area and having artificial boundaries fragmenting landforms.

The toe of the range splays out in four spur and valley forms, generally facing south. Steep-sided spurs are narrowly rounded and undulating with planar flanks, smoothed by glacial action and softened by colluvial deposits and loess deposition. There is little obvious rock outcrop or erosion. The range is unremarkable in appearance but has 'pass' significance.

[1] The 'Balmoral' advance is the oldest of the three glaciations of the last Otiran advance that have formed the topography of the property in late Pleistocene times. The other two are 'Mt John' and the 'Tekapo" (youngest) advances.

The fan, moraine and outwash terrace is undulating to rolling terrain with occasional hillocks formed of piles of boulders (moraine 'dumps'). The eastern extremity of the 'Balmoral' terminal moraine is strung across the terrace about 800 m south of the highway - a necklace of boulder piles. The western terrace margin is sharply defined by a short sinuous scarp, the edge of a large meltwater channel. The surface peters out at Simons Pass proper, due to removal by the subsequent fluvial action that formed the vast outwash plain adjacent (LU2).

Vegetation cover is relatively dense and robust. It is a mosaic of short tussock grassland (both silver and fescue) and matagouri-coprosma-porcupine shrub cover intermingled with exotic pasture and weed species and sweet brier. Shrub cover tends to concentrate in the gullies and fan areas. The area has been oversown and topdressed, evident by the green hue. Part of the terrace (on both pastoral lease and freehold land) has been developed into cultivated paddocks, reflecting the best soils on the property. Larch and pine trees planted around the homestead are naturally spreading up the spurs, forming a feathered edge.

There are few fencelines or tracks within the area and no obvious structures present.

Vulnerability and Threats to Values

Land uses and activities that have the potential to adversely affect this unit include:

- Inappropriate tracking and fencing of the slopes and summit of the Mary Range; the sky line should be kept 'clean'.
- The spread of conifers across the slopes should be contained to the homestead area.
- Shelterbelts and forestry will diminish the open grassland character within the viewing corridor of the highway. Need to maintain open grassland character and views to the moraine 'dumps' and views of Aoraki.
- The moraine dumps themselves are vulnerable to rock removal. They are very accessible and close to the road.
- The remnant of tussock grassland to the south of the cultivated paddocks is vulnerable to clearance, cultivation and tree planting.

<u>Pukaki Outwash Plain (LU2)</u>

Character Description

About one third of the property comprises a vast open semi-arid glacial outwash plain formed in the 'Tekapo' glacial stage. It measures about 5 km across, spanning the area between Simons Hill and the Pukaki River, and extends southwards beyond the property boundary to the Tekapo River. The scarps of the Pukaki River valley form the western edge of the plain; while the western end of the 'necklace' of 'Balmoral' terminal moraine dumps together with other moraine deposits and older higher outwash surfaces, form the north western margin. The plain emerges in the north from the large, well defined, terraced meltwater channel bordering LU 1. This channel originates well to the north in Maryburn. It has a sculptural quality, carved into the outwash and moraine. State Highway 8 crosses the channel. Strung across the transition area from channel to outwash plain (which could be described as either a narrow plain or a wide shallow channel), are more of the 'Balmoral' terminal moraine dumps.

A disused gravel pit is an obtrusive cultural element on the western margin of the channel next to the highway.

The outwash plain has a uniform gradient sloping gently southward, from 520 m altitude to just under 440 m. It has a complex micro-topography of low mounds and hollows forming a fascinating sinuously braided pattern. This is picked up visually at ground level but is best seen in elevated views. This pattern covers the entire vast surface and is thought to be a result of wind action.

The plain is composed of a great thickness of exceedingly free-draining gravels, with only a shallow infertile soil cover. With a semi-arid climate and exposure to frost heave and drying winds, the plain naturally supported a sparse but species–rich fescue tussock grassland with mat/cushion plant communities along with mosses and lichens. The sinuous braided landform pattern is echoed in the distribution of species with denser taller tussocks and grasses in the hollows and mat plants dominating the ridges, giving an overall visual effect of braided brown and ochre ribbons. On the floor of the melt-water channel, there is very little soil in places, and there are gravel and moss fields. Some surfaces have a cobbled appearance. Matagouri scrub exists along the sides of the channel in places.

The natural sparseness has been accentuated by decades of heavy rabbit browsing and sheep grazing. The tussock grassland is now generally in a degraded state and infested with hawkweed. Sweet brier is widely present on the western margin, on the 'outside' of the historic rabbit proof fence that bisects the plain north to south.

There are few vertical elements on this vast open homogenous plain. These include a line of wide-spaced willow trees marking water troughs; a few small wilding pines; a sinuous line of briar, matagouri and coprosma clinging to the only water course running through the plain (the small stream from the meltwater channel); the sweet briar over the western part; and a power pylon line marching straight across heading for Simons Pass.

Apart from the pylons and the water troughs, the rabbit fence is the only cultural element on the plain. There is also a faint track cutting 'across the grain' of the plain. This is part of the Bullock Trail, which follows a straight west-east route between Simons Pass and the Pukaki River (where a chimney in the river bed marks the spot of a past hotel and river crossing). Both these elements are of historical significance. The plains, in their natural open state, seem appropriate for these structures of pioneer times (see Historic and Recreational Values map).

Vulnerability and Threats to Values

- The extensive outwash plain landscape is extremely vulnerable to loss of its values through cultivation, pasture establishment and tree planting.
- The setting for the Bullock trail and the Rabbit Fence is extremely vulnerable to adverse change as outlined above. The retention of the natural vast open outwash plain character in its semi-arid climatically exposed state is considered essential to the authenticity of the experience of these culturally significant features.

'<u>Balmoral' Moraine (LU3)</u>

Character Description

In the centre of the property is an area about 6 km square of subdued undulating moraine and outwash from the 'Balmoral' advance. The area slopes gently southward, from around 520 m altitude to 460 m. The distinctive 'necklace' of terminal moraine 'dumps' forms a broadly curving southern margin. To the west and north, the area merges with the moraine and outwash terrain

of the younger 'Mt John' advance. A distinct minor moraine ridge topped by a shelter belt forms a tight boundary to the northwest. A shallow melt-water channel (older than the one previously described) provides the eastern margin.

The terminal moraine forms a visually interesting band some 300-500 m wide of bouldery hillocks or undulating ground littered with boulders, many of which are lichen-encrusted. These offer many viewpoints to look out over the outwash.

The subdued moraine and outwash area has been divided into large paddocks edged with long uniform coniferous shelterbelts in a chevron pattern, named the Farm Block. Underlain by better soils and sheltered by the trees, the area supports a 'clean' dense short tussock/exotic pasture cover. A more patchy tussock and exotic pasture sward with hawkweed covers the areas outside the shelterbelts, and matagouri and sweet brier is common over the terminal moraine area. Some of the hillocks have a very low tight green turf due to concentrated rabbit and sheep browsing.

The Bullock Trail is discernible in places passing through this unit.

Vulnerability and Threats to Values

- The moraine dumps are vulnerable to rock removal. Tree planting around them would isolate them and prevent the loop being seen in its entirety.

- The setting for the Bullock trail is vulnerable to adverse change through tree planting and loss of a more natural cover on the setting. The retention of the open tussock grassland/scrubland character in a semi-arid climatically exposed state is considered essential to the authenticity of the experience of these culturally significant features.

<u>Pukaki Moraine (LU4)</u>

Character Description

This large unit describes the northern half of the property. Almost all the area in this Unit is part of the Lake Pukaki Terminal Moraine Geopreservation Site.

The topography is a complex of moraine loops and ridges, meltwater channel and outwash plain topography. It comprises the high terminal moraine ridge of the youngest 'Tekapo' glacier, reaching an altitude of over 600 m at its highest point. Its steep, planar, embayed 'ice-contact' face is the northern boundary of the property, and the setting for Lake Pukaki.

Shelves have been formed in the ridge as the ice dropped, often occupied by tarns. A large example is on the adjoining Lake Pukaki Terminal Moraine Conservation Area.

The 'Tekapo' moraine is melded to older, lower 'Mt John' moraine behind. The terrain slopes away to the south from the 'Tekapo' crest for 3-4 km in a series of rolling major and minor moraine ridges, including distinctive 'washboard' moraines (small close spaced regular ridges). There are a number of ephemeral kettlehole tarns of various sizes.

A large and well defined meltwater channel bisects the area in a northeast to southwest direction, its mouth truncated by the Pukaki River. This channel, like the one described in LU1, also originates beyond the property in Maryburn. East of this channel is the principal moraine ridge

of the 'Mt John' advance. Smaller ridges are present further south. A small area of 'Mt John' outwash plain forms the southern corner of the area, blending with the moraine of LU3.

Erratic boulders are a characteristic feature of the area west of, and about, the meltwater channel. These large lichen-encrusted angular boulders, left by the retreating ice, now litter the surface. The older terrain east of the channel, beyond the moraine ridge, is relatively free of boulders due to loess mantling. It has a softer 'cleaner' appearance (also due to relative absence of shrub cover).

Towards the east the unit also includes a second smaller meltwater channel and a 'peninsula' remnant of subdued rolling 'Balmoral' age moraine. This meltwater channel is a still a large size and is equally well–defined.

State Highway 8 follows the northern boundary around the ice-contact face and passes through a gap in the moraine, Dover Pass. Between here and the large melt-water channel next to LU1, the road has been re-aligned such that a sliver of Simons Pass leasehold lies to the north of the road. The terrain and cover is similar to the rest of the Unit and also continuous with the large moraine area in Maryburn to the north, which is also within the Geopreservation Site. The whole area reads as one despite being divided by the highway.

The vegetation cover is a homogenous grassland mosaic of native short tussock and exotic pasture species, interspersed with scattered matagouri and coprosma-olearia shrublands. 'Bonier' areas support mat and cushion plants including extensive hawkweed. More diverse and widespread shrublands occupy the 'Tekapo' ice-scoured moraine ridge including prostrate kowhai, porcupine shrub and native broom, springy clumps of scrubby pohuehue, and various coprosma and tree daisy species. Texture and colour in these bouldery shrub-covered hills is more diverse.

The tarns host a specific low turfy community of grasses, annuals, mosses and sedges and are visually distinct, usually as circles of brighter greens and sepia colours. Exotic conifers are present in clusters on the northwest boundary; on the more southerly moraine area; and a large maturing clump is present in the roadside strip.

Cultural structural impact is low in this landscape and, combined with the homogenous cover, means a natural appearance and high levels of visual coherence and legibility are maintained. The area is divided into large extensive grazing blocks. There are a few 4WD tracks, and three power lines cross the area. The rabbit fence continues through the southern part, to the Glentanner boundary. The old highway, when it was a narrow shingle road, winds through gullies in the northern part. It is now a briar-lined gravely surface gradually revegetating.

Vulnerability and Threats to Values

- Subdivision and development of land close to the lake for rural lifestyle and residential use. This would detract from the area's geomorphic values, fragment the landscape and weaken coherence and legibility.
- Cultivation/vegetation removal on the easier rolling terrain would result in permanent loss of tussock and shrub cover and would greatly reduce natural character. Small landforms could also be destroyed.
- Pastoral intensification would result in the greening of the land, loss of tussocks and shrubland species, making the area feel less remote and natural, and more domesticated. The meltwater channels and areas west of the main channel are most threatened.

- Subdivisional fencing, tracking and shelter planting would result in the visual fragmentation of the landscape over the whole unit.
- Oversowing and topdressing will interfere with natural vegetation patterns of some of the smaller more subtle landforms, thereby homogenising these subtle patterns.
- Grazing has an adverse effect on the tarns and wetland areas.
- Forestry is a significant threat as are the wilding trees. Exotic forest cover would displace native species, change the visual character significantly, reduce openness and obscure landforms reducing legibility.
- The development of areas within the visual corridor would significantly detract from the landscape appreciation experience. The naturalness of the area is also important for the historic Rabbit Fence setting.

Pukaki Riverbed and terraces (LU5)

Character Description

The western side of the Pastoral Lease extends to the Pukaki riverbed and includes the scarps and terraces on the true left from the Glentanner boundary to the Simons Hill boundary. These terraces are up to one kilometre wide.

The Pukaki River has carved a terraced valley into the outwash, forming impressive smoothly curving planar scarps and various discontinuous terraces. These typically have a cover of mosses and sparse grass and sweet briar. There are numerous clumps of exotic conifers throughout, some planted, some self-spread. Matagouri-coprosma shrublands are common along the base of the scarps, which also feature dark grey, coarse blocky talus.

This very dry, stony area has a very natural appearance. The pylon line is the only cultural element observed. The Pukaki River Road – a rough narrow gravel road – runs parallel to the fenced boundary.

Vulnerability and Threats to Values

The main threats to this area are:

- Visual scars on the scarps from indiscriminate tracking and fencing; tree planting and tree spread. Tree planting and spread will obscure the landform and displace native species. The appearance of trees (and structures) on the scarp crest area in views from the river road is undesirable.

Visibility

The landscape of Simons Pass contributes to the landscape seen and experienced from four different public places. The most visible parts of the property are the areas of land either side of State Highway 8 forming the immediate visual corridor, especially the more visually prominent moraine slopes, the slopes and summit of Mary Range, the Pukaki River valley and the western part of the property for 3-4 km back from the edge of the river valley scarp.

State Highway 8

The most important perspective is the visual experience from State Highway 8, which forms the northern boundary, and passes through the north-eastern part of the property. Between Dover

Pass and Simons Pass, the property forms most of the visual corridor. From some stretches of road, views are restricted to the closest moraine ridge crest, in contrast to the typically expansive views experienced in the Basin. The detail in the landscape – the micro landforms, the tussock cover and shrubs, the erratics – become important. In other places, there are oblique and often panoramic views across the rolling to flat topography of Simons Pass to the distant basin rim ranges. To the south there are views to the Benmore Range – and Lake Benmore – and the Black Forest and Grampians Ranges. More westward are views of the far away ranges around Ohau and south of Omarama. Directly west and north, the closer snowy peaks of the Ben Ohau Range and the Main Divide, including Aoraki/Mt Cook, protrude above a rolling tawny tussock-clad foreground, imparting a sense of anticipation of an expanse of alpine scenery travelling west. This is rewarded by the sudden stunning view of Lake Pukaki under the Ben Ohau Range gained at Dover Pass.

The slopes and summit ridge of the Mary Range, although not dramatic, are visually prominent. Their 'pass' location affords them greater significance as well. The range is perceived as a unique isolated low hill range, adding to the visual diversity of the Basin's landscape.

Pukaki River Road
The Pukaki River Road offers a different visual landscape experience. As the road is within the terraced river valley, views are generally restricted to the valley, with the main terrace scarp forming the skyline or a clear near horizon with the upper parts of distant mountain ranges appearing above. In a couple of places, the road climbs up on to the main terrace, from where there are expansive views across the property looking north and east.

Lake Pukaki Terminal Moraine Conservation Area
There are likely to be views across the northwest part of the property from this conservation area, which immediately adjoins the property.

Pukaki Flats Conservation Area
There will be oblique views across the property, and views down into the Pukaki River valley from the Pukaki Flats Conservation Area. Views of the valley and the nearer outwash plain and moraine areas are likely to be most important. These views will have significance for the experience of the conservation area itself, and for a sense of landscape integrity and continuity.

Scenic and Visual Values

Mary Range and Homestead Area (LU1): The flanks and summit of the Mary Range are visually prominent and their natural character has aesthetic value. The skyline is a visually sensitive area. The areas next to the road are of visual importance as the foreground to views over the Basin. The morainic 'dumps' are a striking visual feature.

Pukaki Outwash Plain (LU2): The outwash plain is not clearly visible from SH8 or the river road although it is important as the wide open mid ground to panoramic views across the basin, which are particular to its special character.

The meltwater channel is an impressive element in the visual corridor of the highway.
There are significant aesthetic values in the form of the outwash plain and melt-water channel themselves due to their distinctive features, homogeneity, legibility and coherence. The plain is the visual setting for the historic Bullock Trail and the rabbit fence, setting the features in context.

Balmoral Moraine (LU3): This area is not easily visible from any public place except the Bullock Trail. The moraine loop is important as the visual setting for the trail, setting the feature in context. There are significant aesthetic values in the necklace of the moraine 'dumps' and it's boulders, especially where it contrasts with the smooth outwash plain.

Pukaki Moraine (LU4): A large part of the Pukaki Moraine forms the visual corridor for the highway. There is a Scenic Viewing Area designation through the District Plan over a portion of moraine and melt-water channel between the highway and LU3, the purpose of which is to protect the openness for views.

The ice-contact faces are important as the visual setting for Lake Pukaki. This is recognised in the Lake Side Protection Area designation through the District Plan.

There are significant aesthetic values in the various patterns formed by the moraine loops and ridges and in the sculptural meltwater channels. The overall naturalness and intactness and high legibility over such a large area imparts high aesthetic value.

The diverse shrublands, tarns and numerous erratic boulders are visually interesting. The moraine and meltwater channel forms the visual setting for the historic Rabbit Fence.

Pukaki Riverbed (LU5): The river valley, defined by the terrace scarps and terraces, is the setting for the river, and determines the perceived character of the river in its valley as a natural feature. The entire valley is visible from the river road.

The scarps, shrubland and talus cones all have aesthetic values. The mossy gravel fields are of visual significance. The valley would probably not be generally regarded as 'pleasant' because of the obvious aridity and harsh stony environment but it is highly natural and distinctive, and contributes to the diversity of visual experiences in the Basin.

Significance of Landscape Values

Areas of Simons Pass Pastoral Lease assessed as having significant inherent landscape value are shown on the attached Landscape Values map. Small areas close to the homestead and the central core of shelter-belt enclosed paddocks are the only two areas assessed to lack significant value.

The significant inherent values are summarized under the following headings:

Natural Character of the Margins of Lakes and Rivers

The ice-contact face is a key area for the setting for Lake Pukaki. These are the most distinctive low hills enclosing the lake.

The river terraces and scarps, and a 200-300 m wide area along the top of the scarps, are significant as a natural setting for the river.

Remaining Examples of Landscapes that Characterised New Zealand before Humans Arrived

The area is relatively unmodified by activities such as tracking, fencing, tree planting and intensive pasture development. The patterns of landforms are intact and a homogenous (degraded) short tussock grassland and scattered shrublands cover the whole area.

There is considered to be sufficient natural character based on the remnant indigenous species and the unmodified and highly legible and distinctive landforms to assign significance on the basis of representative pre-European landscape. The landscape retains a character that would not be dissimilar to that existing pre-European, although there probably would have been more shrubs. The extent of natural character is significant. There are not many large areas of Basin floor that can boast such intactness.

The moraine experience around the bottom of Lake Pukaki is an important part of the total diversity of natural landscapes experienced in the Basin.

Generally Recognised Iconic High Country Landscapes or Scenery

The Mackenzie Basin as a whole is a generally recognised 'iconic' landscape. The significant areas contain key elements that contribute fundamentally to the special landscape character of the Mackenzie Basin - rolling moraine terrain, large well defined meltwater channels, classic outwash plains, dry river terraces and scarps.

The homogenous low tussock grassland cover, even though degraded and full of exotic species is characteristic, imparting the distinctive sense of large scale, openness and naturalness. Native species, including tussocks and native shrublands, are still visibly present, contributing to the overall value of these elements.

The 'pass' is a transitional area, a distinct and memorable place.

The landscape within the visual corridors of the highway and the river road have a high visual profile which, combined with the natural character and distinctive landforms, would assure that it is generally recognised as iconic high country landscape.

Opportunities to Restore or Increase the Natural Character of Recognised Iconic High Country Landscapes

There are opportunities, through removal of browsing animals, to increase the natural character of parts of the Pukaki Moraines, as it could promote shrubland and tarn recovery.

Removal of all wilding pines would be an opportunity to enhance the natural (indigenous) character as would restoration of the gravel pit.

Linking or Strategic Value

The sequence of terminal moraine - proglacial meltwater channel - outwash plain - recent river bed is present on the property at a large scale, and in an intact way. This area is an important part of the continuum of the glacial landscape around the east side of Lake Pukaki, a large part of which is a nationally important geopreservation site.

This area provides linkages between the moraines immediately enclosing Lake Pukaki, the Maryburn moraines, and the outwash plain surface of the Pukaki Flats Conservation Area to the west. The area therefore contributes to the actual and potential improved landscape continuity and integrity.

The Pukaki riverbed is a valuable link between two 'iconic' classic outwash plain surfaces. It contributes strongly to the overall pattern of landforms and natural processes and is important for landscape integrity.

Perceptual Qualities – Coherence, Intactness, Legibility, Vividness

The significant areas generally have high degrees of naturalness, coherence and legibility. These values are present over large compact areas which in itself is significant. The homogenous low short tussock-scrub cover is very important to these attributes as is the minimal presence of cultural elements and pattern.

Overall, the areas are distinctive because of the sheer extent of intact landforms and homogenous cover, but there are especially distinctive and vivid parts within it. The outwash plain, meltwater channel, and river valley leave a lasting impression of distinctive character. Intactness is compromised to some degree by the presence of exotic plant species, but landforms and patterns of landforms remain intact over areas.

Significant Landscape Elements and their Context

There are a number of landscape elements that are considered classic and visually striking, including river scarps and talus cones, mossy gravel banks, moraine 'dumps', moraine ridge patterns; tarns; meltwater channels, and the larger erratic boulders. A natural open grassland and shrubland setting is important to sustain their value as discreet landscape elements as is the clarity of their inter-relationships with other landforms.

Landscape Contexts for Historic Features

The river landscape in the vicinity of the Pukaki Inn chimney is important as its historical context, as this was also the point of river crossing for the Bullock Trail. The natural outwash plain and moraine setting is important for the integrity of the Trail, as a pioneering construction in a remote natural environment.

The vast open outwash plain and moraine under short tussock grassland is the setting that existed when the historical Rabbit Fence was erected. The extreme climatic and personal exposure and probably loneliness that would have been experienced by the men building the fence in 1888 is not difficult to imagine today.

Map : Landscape Units and Values

2.2 GEOLOGY, LANDFORMS AND SOILS

Geology and Associated Landforms

The Mackenzie Basin is surrounded by mountains composed of indurated sandstones, mudstones and conglomerates of the Torlesse Supergroup (commonly called greywacke and argillite) and to a lesser extent of low-grade chlorite schist of the Haast schist group (Gair 1967). The Basin itself is composed of Pleistocene and Holocene deposits, consisting of till, fluvio-glacial outwash, fan detritus and alluvium derived from these deposits. Surficial deposits are commonly underlain by Tertiary deposits, usually at considerable depth. Mansergh (1973) has suggested that during the Porikan and Waimangan glaciations, ice filled the Basin as coalescing piedmont glaciers, depositing a till and outwash cover approximately to its present depth.

The present-day landscape of the basin has been fashioned largely by a series of late Pleistocene ice advances and recessions with associated cycles of depositions and down cutting. Speight (1963) describes the late Pleistocene history and geomorphology of the Lake Pukaki area in terms of landform associations. Maryburn and Pukaki Landform Associations are found on the Pastoral Lease. The three main ice advances that affected the Pastoral Lease, with their associated moraines and outwash deposits, have been named from oldest to youngest as Balmoral, Mount John and Tekapo Formations (Gair 1967). These Landform Associations approximate to the Balmoral and Tekapo ice advances.

The Maryburn Landform Association or Balmoral Formations comprise moraines and outwash deposits formed at the same time during an early phase of the Otiran glaciation (approximately 223 thousand years before present, Speight 1963). On the Pastoral Lease, the extreme Maryburn Land Formation Association ice margin is marked as a band of moraine and boulders that sweep across the Pastoral Lease south of the Farm Block, including a sequence of scattered moraine deposits that occur towards the eastern property boundary. The zone of boulders and moraine mounds at the glacial margin is succeeded to the north by a mile-wide strip of very flat land. While the majority of the Maryburn Landform Association occurs to the east of the Mary Range, the western side of the Mary Range (north of State Highway 8) has been scoured by the Maryburn-aged glacier. When the glacier started to recede, and meltwater created the fluvio-glacial plains, a narrow strip of Maryburn outwash surface on the western side of the Mary Range overtopped a low point of the range (the actual Simons Pass) and flowed westwards, creating a triangle of Maryburn outwash plain at the eastern end of the Pastoral Lease. Maryburn Landform Associations/Balmoral Formation deposits are also present at the foot of the Mary Range, just west of the homestead.

The maximum mid Otiran ice limit (approximates to the Mt John Formation) is projected to have reached as far south as approximately the most northern extent of the Farm Block (ref. NZ Geological Survey 1973), although it can only just be seen on the Pastoral Lease as an east-west trending hummocky band at the western side of the Farm Block.

The final ice advance during the Otiran glaciation led to the formation of the Pukaki Landform Association. This includes a set of valley-glacier and proglacial landforms in the immediate vicinity of Lake Pukaki. The association is dominated by the terminal moraine which runs around the southern end of Lake Pukaki, beside State Highway 8. The northern face has been ice scoured, and is steep and rocky. The gentle southern slope is comprised of hummock knoll and kettle topography, outwash channels, fluted surfaces and washboard moraines. Pukaki Landform Association moraines commonly form a veneer over the older Maryburn Landform Association moraines.

Pukaki Landform Association outwashes formed when meltwater, banked up behind the massive terminal moraine ridge, created outlets e.g. those low points on either side of the Mt Cook lookout hill, forming pro-glacial outwash channels through the moraines. The extensive fluvio-glacial outwash plain at the southern end of the Pastoral Lease was formed where the pro-glacial river channels became braided in form as they left the moraines, and combined to form a great double fan sloping gently to the south.

The current day landscape is a complex relationship between Maryburn and Pukaki Landform Associations. For example, at Trig TT, the Maryburn principal morainic ridge has been modified and buried beneath a veneer of Pukaki Till, and a valley between the Trig and State Highway 8 has been rejuvenated. Further south, in the area southwest of the Farm Block, parts of the Maryburn surface have been stripped of silt cover, and thus made over to a Pukaki outwash surface by meltwater action. Much of the major Pukaki outwash surface represents a reworked Maryburn surface.

The foot slopes of the southern Mary Range lie within the Pastoral Lease. While the Mary Range is comprised of greywacke and argillite of medium induration of the Torlesse Group (Chlorite Subzone 1), the foot slopes are more typical of hill range, where mass movement processes and fluvial activity predominate.

The southern extent of the Lake Pukaki Terminal Moraine geopreservation site is present in the northern part of the Pastoral Lease. Kenny & Hayward (1993) classify it as an extremely well-defined landform of scientific/educational value, encompassing a "well-defined sequence of terminal moraine". Its main value is in the juxtaposition of all the different landforms, each intact, under a homogenous low vegetative cover. It is a record of at least three glaciations all together in one place with intact interrelationships.

Soils

The main geomorphic units present on the property over which soils have formed are: moraines, fluvio-glacial outwash plains and associated terraces, young terraces and hillslopes.

Moraine Soils

The ice-scoured Pukaki terminal moraine is a dominant feature on the property. It was formed at the snout of the glacier at its point of maximum advance, before the ice started to retreat. South of this are moraines of hummocky topography, although some parts of moraine have a subdued undulating topography. Moraines are mantled with loess of variable thickness (20-150 cm), and soils are formed from loess or a combination of loess and underlying till. At the toes of moraines, where loess can be up to 2 m thick, the whole solum is derived from loess.

Tekapo-Mary Association soils occur on rolling moraines, as well as easy rolling and hilly Pukaki Landform Association moraines. Deep phases of Tekapo soils occur on toe slopes and soil depth thins up slope to the crest, where shallow phases are predominant.

Mary soils are derived predominantly from till. They are confined to sites exposed to the north-west winds, where loess has never accumulated, or has been removed by soil erosion. They usually occur above the toe slope position, and have rough micro-topography. Most other sites have smooth topography but protruding boulders are common. Small inclusions of poorly drained Braemar soils occur in tarns.

An identified soil site of significance covers the area of shrublands on the Pukaki terminal moraine within RAP 6: Southern Lake Pukaki Scrub (Arand *et al.* 1991). The site comprises upland yellow-brown earths (Tekapo soils) over till derived from greywacke and argillite. Shrubland and short tussock grassland comprise the vegetation cover.

The Pukaki-Holbrook soil association occurs as distinct soil-landform units on old terraces, associated with Maryburn Landform Association moraines. The old terraces, correlated with Balmoral Formations, are of limited extent, and are largely confined to a few kilometers beyond the moraines from which they are derived. Being covered in loess, the microtopography of these areas is generally quite smooth, except where wind deflation has removed the loess cover to form 'dimples' and channels up to 1m deep. In areas of severe deflation, stony soils become predominant and deeper soils are confined to long sinuous ridges parallel to the north-west wind direction.

Pukaki soils are formed from deep fine sandy loess deposits, and Holbrook soils are stony soils that occupy discrete wind-deflation hollows up to one metre deep. Microtopography is even where Pukaki soils occur without Holbrook soils, but becomes increasingly rough as the proportion of Holbrook soils increases.

Fluvio-glacial outwash plain soils

Mackenzie soils, of the intermediate terraces and fans of near level outwash plains, are the most extensive soil unit on the Pastoral Lease, and within the Mackenzie Basin (Webb 1992). Shallow phases predominate on the Pastoral Lease, with the degree of stoniness increasing towards the eastern property boundary. Mackenzie Soils naturally encompass a wide variation in stoniness and depth phases. All phases can occur within a distance of 10-20 metres, with deeper phases being associated with former stream channels.

Most terraces containing Mackenzie soils are relatively flat and are only weakly dissected by former stream channels. Areas where moderately deep soil phases predominate have smooth microtopography.

The Grampians-Simons-Glenrock soil association occurs on easy rolling piedmont fans, which grade into more gently sloping fans and terraces, which are associated with the older Maryburn Landform Association outwash deposits. They are of limited occurrence on the property, occurring at the base of the southern Mary Range. Grampian soils occupy the piedmont fans, while Simons soils occupy planar old fans with deep to moderately deep silty loess mantles. Depths of silt can exceed 1.3 m. Most of these soils have been cultivated.

Young Terrace Soils

Young terraces are confined to the Pukaki River valley, and occur as narrow, discontinuous strips at the base of the intermediate terrace scarp. Bendrose-Larbrek soils association occurs on the Pastoral Lease. Larbrek soils occupy young terraces, with distinct terrace scarps separating them from Mackenzie Soils on the intermediate terrace above, and Bendrose soils on the floodplain below. Soils are generally stony, with rough microtopography, with many to abundant channels.

Mary Range foothills

Meyer Hill Soils occupy the moderately steep hillslopes of the Mary Range. These yellow brown earths are stony or silty loams that have developed over greywacke with a thin cover of loess in places (Soil Bureau 1968).

Significance of Geology, Landforms and Soils

Simons Pass Pastoral Lease is the only property in the Mackenzie Basin to straddle a complete sequence of terminal moraines and outwash gravel deposits of Pleistocene age. These landforms are legible, connected together, and support a range of plant communities that retain some indigenous species. Elsewhere in the high country, many of the most accessible terminal moraines have been modified through agricultural development (e.g. Dart Valley in Otago, Kingston area in Southland); or settlement (e.g. Tekapo, Kingston, Lake Hawea and Wanaka townships). A recent development in the Mackenzie Basin has seen the conversion of semi-natural outwash plains to pasture through cultivation and irrigation (e.g. between Twizel and Omarama).

The Lake Pukaki Terminal Moraine geopreservation site is of national significance for scientific and educational purposes (Heyward & Kelly 1993). The main values of this site are in the juxtaposition of all the different elements; their intact form under a homogenous low cover of shrub and grassland; the ability to see inter-relationships and see glacial history unfold. Any kind of development could interfere with this ability.

The soil site (no. 242) located on the Pukaki terminal moraine is of regional significance because the presence of large shrublands on terminal moraine is regionally uncommon (Arand *et al.* 1991).

2.3 NEW ZEALAND'S BIODIVERSITY PROTECTION NEEDS

There are two databases that have been used to assess biodiversity protection (Walker *et al* 2005):

- The environmental distinctiveness of an area can be assessed through the Land Environments of New Zealand (LENZ). This is a classification of New Zealand lands using a comprehensive set of climate, landform and soil variables chosen for their roles in driving geographic variation in biological patterns (Leathwick *et al.* 2003). LENZ is a useful tool for measuring conservation initiatives against the New Zealand Biodiversity Strategy (see Section 3.5). It is presented at four levels of detail containing twenty, 100, 200 or 500 environments nationally. The most detailed is called LENZ Level IV.
- The area of unprotected indigenous cover in threatened land environments has been identified in the national land cover database (LCDB).

From the above databases, spatial data depicting indigenous vegetation cover and legal protection were overlaid on LENZ Level IV environments to identify biodiversity that is most vulnerable (i.e. most likely to be lost). This provides a measure for: a) percentages legally protected and b) percentages of remaining indigenous vegetation cover.

Based on these two criteria, five categories of threatened environments have been used to identify environments containing indigenous biodiversity at most risk of loss. They are classified as follows:

Threat Classification	Characteristics
Acutely threatened	<10% native vegetation cover remaining
Chronically threatened	10-20% native vegetation cover remaining
At risk	20-30% native vegetation cover remaining
Critically underprotected	>30% native vegetation cover remaining and <10% protected
Underprotected	>30% native vegetation cover remaining and 10-20% protected
No threat	>30% native vegetation cover remaining and >20% protected

At the level IV (500 environments nationally) the areas investigated on the Pastoral Lease fall predominantly within Environments N6.1b and E4.1b, with smaller contributions of N6.1a, E1.4d, N2.1a, E4.2b, E3.1a and N4.1c. Descriptions of these units are provided as an Attachment. The extent of Level IV environments as Crown land managed mainly for conservation purposes is shown in Table 1 below.

Table 1: Land Environments of New Zealand Units on Simons Pass Pastoral Lease

Threat Category	LENZ Level IV Environments on the Pastoral Lease	Area of LENZ unit on Simons Pass Pastoral Pastoral Lease (ha)	Percent protected nationally for conservation purposes	% of Indigenous vegetation cover remaining nationally	Change in Indigenous Vegetation Cover nationally between 1997 and 2002
Acutely Threatened	N2.1a	41.74 (0.73%)	0.89	0.27	Decrease
Chronically Threatened	E3.1a	1.30 (0.02%)	3.11	10.27	Decrease
At Risk	E4.1b	1988.23 (35.11%)	3.82	27	No Change
	E4.2b	16.44 (0.29%)	5	26.78	No Change
Critically Under-protected	E1.4d	155.17 (2.74%)	6.99	30.17	No Change
	N4.1c	0.99 (0.02%)	1.24	48.58	No Change
	N6.1a	363.02 (6.41%)	2.08	32.95	No Change
	N6.1b	3095.4 (54.67%)	3.78	66.44	No Change

Significance of Land Environments of New Zealand

All Level IV LENZ environments on the Pastoral Lease are significant (see LENZ threat category map) because on a national level the indigenous vegetation has largely been removed and/or little of the environment is represented in lands protected primarily for conservation purposes:

- 0.73% of the property has one "Acutely Threatened" LENZ unit (N2.1a) that has <10% of its land area still in indigenous cover.
- 0.02% of the property has one "Chronically Threatened" LENZ unit (E3.1a) that has 10-20% indigenous vegetation cover remaining.
- 35.40% of the property has two "At Risk" LENZ units (i.e. E4.1b and E4.2b) that have 20-30% indigenous vegetation cover remaining
- 63.84% of the property has four "Critically Under-protected" LENZ units (i.e. N6.1b, N6.1a, E1.4d and N4.1c) that nationally have >30% of its land area still in indigenous cover and less than 10% of the unit is protected.

The botanical survey confirmed that modified indigenous cover is present within most of the land environments. However, parts of N2.1a and E.4.1b have been cultivated or direct drilled. Exotic conifers and pasture occupy E3.1a near the homestead.

In terms of the most widespread LENZ unit on the Pastoral Lease (N6.1b), which occurs on the outwash plain, indigenous species cover is low, and the habitat is highly modified and depleted. However, the botanical survey recorded many threatened species associated with this LENZ unit. Walker *et al.* (2006) have highlighted that a high proportion of New Zealand's most threatened species survive only in depleted and highly modified ecosystems in threatened environments; therefore the protection of highly modified environments is essential to prevent the extinction of many species.

Attributing significance to LENZ units, while a useful exercise, must be treated with caution. Work is currently underway to improve the accuracy of underlying spatial data.

It is highly likely that there are small-scale areas on the Pastoral Lease that have different, and more threatened, LENZ environments than those currently mapped for that area. Examples of these include parts of the Pukaki River Low Terraces, and remnants of old Otiran terminal moraine present as islands in the Mackenzie soils that dominate the outwash plain.

Map : LENZ threat category.

2.4 CLIMATE

Simons Pass Pastoral Lease has a continental-like climate, with wide seasonal temperature variation. Predominant winds are from the northwest, and are frequently strong. Annual rainfall ranges between approximately 400 mm in the southern end of the property to 650 mm near Lake Pukaki in the north. Snow falls are common in winter, and may lie on the property for several weeks. The Pastoral Lease lies in an area that is described as having cool temperatures, moderate levels of solar radiation, high vapour pressure deficits, moderate annual water deficits, low average water deficits, but high spring vapour deficits (Leathwick *et al.* 2003).

2.5 VEGETATION

Ecological Context

The first comprehensive assessment of botanical significance arose through the Protected Natural Areas Survey Programme which surveyed the Mackenzie Ecological Region in the 1980s (Espie *et al.* 1984). The northernmost part of the property is located within the Tekapo Ecological District, while the southern part lies within the Pukaki Ecological District. Only one Recommended Area for Protection (RAP), of the thirty RAPs identified for the Tekapo Ecological District, and nineteen identified for the Pukaki Ecological District, partially occurs on the Lease. This is RAP 6: Southern Lake Pukaki Scrub, a 340 ha area of shrubland on the Pukaki terminal moraine, some of which is protected within the adjacent Lake Pukaki Terminal Moraine Conservation Area.

Walker and Lee (2000, 2002) have conducted studies, which indicate that alluvial intermontane valleys and basins of New Zealand were probably among the few non-forest ecosystems that existed below the tree line immediately before human settlement in New Zealand. These ecosystems are subject to frost and frequent disturbance by seasonal waterlogging, drought, flooding and depositional processes. In their prehuman state, alluvial valley floors in New Zealand would have supported a diversity of plant communities associated with landforms of different ages and types, which were at various stages of recovery from disturbance. The more stable alluvial surfaces would have previously supported later-successional communities in a sequence from tall tussock grassland to tussock-shrubland mixtures, shrublands and finally low forest communities on the oldest, most elevated terraces and at forest margins (Walker *et al.* 2003). Walker *et al.* (2003) postulate that in the lower, drier reaches of valleys, the elevated terraces and fans that are occupied by fescue tussocklands today, probably supported tall tussocks and woody species such as matagouri, kanuka, manuka, *Carmichaelia, Coprosma, Hebe, Melicytus, Olearia, Corokia, Aristotelia, Ozothamnus, Melicope, Myrsine, Halocarpus* and *Phyllocladus* species. The arrival of mammalian herbivores and exotic plant species with European pastoralists after c. 1850 led to further vegetation changes. The gentle terrain and moderate to high fertility of alluvial soils encouraged the early concentration of pastoral development and use in the intermontane basins, which continues to the present day (O'Connor 1982).

Some relict shrublands are known from other parts of the Tekapo and Pukaki Ecological Districts e.g. matagouri-*Coprosma* shrubland on lateral moraine at Pukaki Scientific Reserve, and on a rockland on the eastern side of Lake Pukaki; prostrate kowhai shrublands on the southern and northern Mary Range, and on the eastern Old Man Range; and bog pine scrub at Gladstone Flats.

Vegetation and Flora

The study of New Zealand's land environments (Leathwick *et al* 2003) suggests that the prehuman vegetation cover largely persists on the rocky terminal moraine slopes of the property as matagouri, small-leaved coprosmas, tree daisy, native broom, kowhai, *Rubus* and *Muehlenbeckia* lianes. The northern portion of the property (i.e. foothills of Mary Range and where moraine deposits dominate), would once have supported mountain totara, mountain toatoa and bogpine woodland, while the outwash plains in the southern portion of the property are projected to have supported fescue tussockland, with some narrow-leaved snow tussock.

The majority of the property lies on the intermontane basin floor (415 m - 600 m), with a small portion extending up the footslopes of Mary Range, to 680 m asl. Despite this narrow attitudinal range, there are variations in plant community and habitats present, depending on soil characteristics, aspect, landform, and level of modification associated with grazing and burning over the last 150 years, and the degree of pastoral development that has occurred in more recent times. All the property has been modified to some degree, but is most obvious where rabbits and hares are common (e.g. outwash plains), or where pastoral development efforts have been concentrated (e.g. direct drilling of the Farm Block; cultivation of the most eastern portion of the property; oversowing and top dressing of fescue tussockland within the blocks surrounding the Farm Block).

Vegetation Description

The Lease has been broken up into units and sub-units to assist the description of vegetation on the property:

- Lake Pukaki terminal moraine
- State Highway 8 northern corridor
- Footslopes of Mary Range and associated flats
- South-east part of property
- South-west part of property
- Farm Block

The survey was scheduled early in the season to facilitate the recording of threatened short-lived spring annuals that have been found elsewhere in the Mackenzie Basin. As a consequence, many of the turfland species and some grasses were difficult to identify as they were not yet in flower, or were emerging as tiny seedlings.

Lake Pukaki Terminal Moraine

This areas covers the ice-scoured terminal moraine near Lake Pukaki, and the hummocky moraine deposits further south, both located south of State Highway 8.

The generally north facing slopes of the ice-scoured moraine ridge along the shores of Lake Pukaki, between Mt Cook Lookout area designated on the map, but now closed and replaced with a new Mt Cook Lookout beside the Pukaki High Dam, and Lake Pukaki Terminal Moraine Conservation Area, support native shrubland of variable species composition and density. Shrubland cover is patchy, often less than 15%, but can be locally dense in places (>70%) especially on shaded aspects and at the easternmost and westernmost extent of the shrubland. Prostrate kowhai (*Sophora prostrata*) occupies the steeper rubbly slopes, growing mostly to about one metre tall, although some shrubs reach two metres behind the old Mt Cook Lookout. Here it

is the dominant species, achieving 50 % cover. Common small-leaved shrub species present include porcupine shrub (*Melicytus alpinus)*, common broom (*Carmichaelia petriei*), mingimingi (*Coprosma propinqua)*, scrub pohuehue (*Muehlenbeckia complexa)* which forms hummocks, and scattered exotic sweet briar (*Rosa rubiginosa)*. The threatened shrub *Coprosma intertexta* (ranked sparse) is scattered throughout, while *Corokia cotoneaster,* mountain wineberry (*Aristotelia fruticosa), Coprosma virescens*, matagouri (*Discaria toumatou)*, lianes clematis (*Clematis marata)* and bush lawyer (*Rubus schmidelioides)* are less common. Depleted fescue tussock grassland, rock and bare ground, typify the open areas among this shrubland. Native species present include fescue tussock (*Festuca novae-zealandiae)* (to 20% cover), *Rytidosperma* sp., *R. pumilum* and blue tussock (*Poa colensoi*), sub-shrub patotara (L*eucopogon fraseri)*, mat daisies (R*aoulia australis, R. parkii* and *R. hookeri*), white sun orchid (*Thelymitra longifolia)* and onion-leaved orchid (*Prasophyllum colensoi*). There are young fescue tussocks present. Mouse eared hawkweed (*Hieracium pilosella)* comprises locally to 40% cover in open areas, while king devil hawkweed (*H. praealtum*) is uncommon. Browntop (*Agrostis capillaris)* and sweet vernal (*Anthoxanthum odoratum)* are also present.

The presence of prostrate kowhai varies along the moraine face, being concentrated at the western property boundary, above the old Mt Cook Lookout, and midway between these two points.

The westernmost extent of the moraine shrubland was identified as an RAP (RAP 6: Southern Pukaki scrub) in 1984. Here, shrubland cover is high (>50%), with the full suite of shrub species present. Some shrubs reach 2 to 3 m in height. The shrubland values identified during the PNAP survey were confirmed.

The terminal moraine has a complicated topography, with folds and hollows providing habitats with different aspects, slope and soil depths. Common tree daisy (*Olearia odorata)* and *Coprosma rigida* tend to grow in the sites characterized by less steep slopes and deeper soils. Several ephemeral tarns occupy folds and hollows within the terminal moraine, surrounded by fescue tussockland or matagouri shrubland. The turf margins tend to be modified with up to 50% exotic cover, with meadow grass, creeping bent and white clover present. Native species include *Galium perpusillum, Carex gaudichaudiana, Epilobium angustum, Geranium sessiliflorum, Euchiton traversii* and *Schoenus concinnus*.

A tarn with standing water present has exotic sweet floating grass (*Glyceria fluitans)* present in the water, while the tarn edges are dominated by exotic plants including browntop, king devil hawkweed, Yorkshire fog (*Holcus lanatus)*, mouse-eared chickweed (*Cerastium fontanum*), and jointed rush (*Juncus articulatus)*. Native species diversity is low, with some *Epilobium angustum,* and *Crassula sinclairii* present within the tarn margin, and *Carex kaloides* tussocks locally common at the upper tarn margins.

Located immediately to the south of the main ice-scoured moraine ridge is a large area of hummocky topography, created when ice-transported material was deposited. The most extensive vegetation community present is a short tussockland, which has been oversown and top dressed in places. Fescue tussock is the dominant species (30-40% cover), with patchy occurrences of the threatened Mueller's sedge (*Carex muelleri*- ranked sparse*)*. Introduced species dominate the intertussock species, with brown top (*Agrostis capillaris)*, clovers, sheep's sorrel (*Rumex acetosella)* and mouse-eared hawkweed present. Native intertussock species diversity is greatest at the northern end of this area and where fescue tussockland rises up onto moraine outcrops. Native species include mat daisy *Raoulia subsericea, Geranium sessiliflorum,* mat coprosma *(Coprosma petriei),* occasional matagouri, danthonia grasses, *Deyeuxia avenoides* grass, orchids, scattered native shrubs including common broom, porcupine shrub and native daphne *Pimelea* "eastern South Island" shrubs, patotara, and red wood sedge (*Luzula rufa)*. The native herbs daisy

(*Celmisia gracilenta)* and *Anisotome aromatica,* while usually a common component in short tussocklands, are rare on the property.

In the vicinity of the Farm Block the fescue tussockland has been pastorally improved. Fescue tussock and Mueller's sedge are extensive and dominant, with many young tussocks evident. A dense sward of brown top is also commonly present between the tussocks. Localised within this landscape are areas of turfland, commonly located in drainage channels, old kettleholes or depressions. This community is dominated by exotic low growing species such as meadow grass, storksbill, haresfoot trefoil, parsley piert (*Aphanes arvensis)* and speedwell (*Veronica* sp.). The native bindweed *Rumex flexuosus* and threatened Buchanan's bidibid (*Aceana buchananii* - ranked gradual decline) are also a common component.

Wilding pines are scattered within this area, especially towards the western property boundary, where a shelterbelt on the adjacent property is acting as a seed source.

Native broom-porcupine shrub-mingimingi shrubland is present on isolated steep sided rocky moraine ridges, on slopes exposed to the north-westerly wind, where the removal of the loess mantle has exposed the stony to bouldery till. The threatened shrub *Coprosma intertexta* is present in most of the shrublands visited, while the low growing spreading shrub *Coprosma cheesemanii* is more local. Additional native species associated with the bouldery steep moraines include mat daisy (*Raoulia hookeri)*, *Carex breviculmis, Geranium sessiliflorum,* scabweed*,* and occasional blue tussock. Sheep camps near the summit of moraine outcrops, where the soils are better developed over loess, support low statured vegetation including exotic meadow grass, annual herbs such as speedwell and storksbill, and the native Celadon mat daisies (*Raoulia parkii)* and *R. beauverdii* (ranked sparse), creeping pohuehue (*Muehlenbeckia axillaris),* threatened button daisy (*Leptinella serrulata* – ranked gradual decline) and Buchanan's bidibid.

The threatened native dwarf broom *Carmichaelia vexillata* (ranked serious decline) grows in one locality within this area, within a degraded fescue tussockland located on a north facing moraine slope near to State Highway 8 near TT trig. Seedlings are present, and have not been browsed.

Special features of this area are the ephemeral wetlands within kettleholes, boulderfield lag tarns, and other closed depressions. These wetlands are characterized by the lack of a permanent surface outlet, and have a marked seasonal alternation between being ponded and dry (Johnson & Gerbeaux 2004), the majority of which were dry at the time of inspection. The farm manager noted that the past 3 years have been dry, resulting in many of these ephemeral wetlands not being inundated during that time.

In commenting on the conservation significance of ephemeral wetlands and their turfs, Johnson and Rogers (2003) note that "despite their scattered occurrence and small total area in New Zealand, ephemeral wetlands are diverse in their plant communities, extremely rich in their flora, and clearly important as the sole or principal habitat for a high proportion of threatened plant taxa". New Zealand wetland turf plants and their communities may be of high significance in a global context for they appear to have no analogues in the Northern Hemisphere, where ephemeral wetlands are typically vegetated with plants of much taller stature.

Ephemeral wetlands are vulnerable to a number of impacts including hydrological alteration, alteration to soil aeration, sedimentation, mechanical disturbance, nutrient enrichment, pollutants, trampling impacts of mammals, and weeds (Johnson and Rogers 2003). A series of dry years has led to most of the ephemeral wetlands not being seasonally inundated in recent years, leaving them vulnerable to stock trampling, nutrient enrichment via their faeces and top dressing, and the introduction of competitive weed seed through animal droppings and aerial

oversowing. While native avifauna, including now-extinct birds would have congregated on turf vegetation adjacent to water bodies, their physical impacts would have been much less than those of introduced livestock. Large-hoofed animals have undesirable soil disturbance impacts. A flow-on effect of this disturbance is that it provides microsites suitable for germination and establishment of weeds. Most of the ephemeral wetlands are moderately to highly modified, with obvious signs of stock and rabbit or hare use, fertilizer inputs resulting from recent over sowing and top dressing activities, and dominance by exotic grass species.

At one of the more indigenous tarns, a damp turfland is present amongst scattered boulders at its margins, with standing water in its centre. *Crassula sinclairii* forms large patches at its damp margins, with occurrences of the small grasses *Deschampsia chapmanii* and *Agrostis muscosa*, the threatened dwarf wood-sedge (*Luzula celata* – ranked serous decline), willowherb (*Epilobium angustum*), stiff pin cushion (*Colobanthus strictus), Pratia purpusilla,* mudwort (*Limosella lineata*), *Abrotanella caespitosa* and *Euchiton traversii*. A fine sedge (possibly *Carex gaudichaudiana*) is present, with meadow grass and browntop encroaching in places. Other native species present at ephemeral tarns include small rush *Schoenus concinnus,* herbs *Dichondra repens, Galium perspusillum, Neopaxia lineariifolia* and *Epilobium komarovianum,* and adder's tongue fern *Ophiglossum petiolata.* Scattered Mueller's sedge may be present nearby. Wetlands which, have, or recently have had, standing water often support the exotic semi-aquatic floating sweet grass.

A fluvio-glacial channel has been carved through the moraine, forming a flat bottomed valley which trends north east to south west. The outwash gravel soils are light, and have not been prioritized for pastoral development. Native species diversity is patchy, with native species tending to be concentrated within depleted fescue tussockland, mat coprosma- dwarf patotara dominated matfield in depressions, and a series of ephemeral depressions and bouldery bottomed lag tarns. Mueller's sedge and native plantain are scattered through the fescue tussockland. Where erratic boulders are present, necklace fern (*Asplenium flabellifolium)* and prickly shield fern (*Polysticchum vestitum)* hug the base of the boulder, together with bidibid (*Aceana caesii-glauca*). Localised depressions support 80% cover of native species dominated by dwarf patotara, with hooded orchid (*Hymenochilus tristus* – ranked sparse), plantain, mat coprosma and exotic mouse-eared hawkweed (to 15%) also present. On terraces within the channel, fescue tussock are scattered in an exotic mouse-eared hawkweed herbfield, where hawkweed contributes 20-25% cover, browntop is patchy, and bare ground patches are evident. Native species include mat coprosma, dwarf patotara, *Poa maniototo*, Celadon mat daisy and tussocks of *Rytidosperma sp.* Two populations of the threatened pink herb *Neopaxia erythrophylla* (ranked sparse) occur growing in bare ground beside stock tracks.

The ephemeral wetland depressions located within the meltwater channel have obviously been disturbed by stock, and are highly modified, with exotic species including creeping bent and meadow grass dominating the margins. Persisting native species include tussocks of *Carex kaloides* at the margins, with the small grass *Deschampsia chapmanii*, gnapweed (*Euchiton audax*) and *Polytricchum* sp. moss located in the periodically inundated zone. Naturalness is low.

State Highway 8 Northern Corridor

This area encompasses a triangle of land at the State Highway 8-Hayman Road junction, and a narrow strip of land which lies between the old Mackenzie Basin gravel legal road, and the existing alignment of State Highway 8, extending some three kilometres east along State Highway 8 from Dover Pass.

The triangle of land is dominated by exotic pine trees. However, amongst the trees is a small wetland with permanent water, characterized by numerous dead pedestals, presumably of pukio

(*Carex secta)*. The exotic oval sedge (*Carex ovalis)* dominates, growing up through the pedestals, with occurrences of soft rush (*Juncus effusus), Carex flaviformis* and *C. kaloides* present. Meadow grass is the dominant grass species at the edge of the wetland, forming a dense rank sward in places. It is unclear as to why the pukio have died, but may be the result of herbicide spraying, as a patch of European broom (*Cytisus scoparius)* has been sprayed nearby.

Located to the north of the wetland is a matagouri shrubland, which has scattered sweet briar, and scrub pohuehue present. A patch of the threatened shrub *Coprosma intertexta,* including many young plants, is growing amongst the matagouri. A single large narrow-leaved snow tussock is also present. Ground cover is dominated by browntop and Chewings fescue.

The strip of land between the two road formations supports a fescue tussockland. The western extent of the strip is readily accessible to vehicles from State Highway 8. As a consequence, some dumping has occurred, and vegetation cover is more open than elsewhere along the strip. There are scattered fescue tussock and blue tussock, with patches of briar and scattered wilding pines. Chewings fescue (*Festuca rubra)* is common. A large pine plantation is located at the widest point along the strip, from where wilding pines are spreading. From the pine plantation to the most easterly extent of the road strip, the fescue tussock is in good condition, with 30-40% cover. Native species diversity is good, with native daphne (*Pimelea* "eastern South Island"), dwarf patotara, mat coprosma, scattered threatened coral broom *(Carmichaelia crassicaule* – ranked gradual decline*)* and matagouri present. Blue tussock, native plantain, white sun orchid, and threatened Mueller's sedge occupy the intertussock spaces. Mouse eared hawkweed and king devil hawkweed are a small component. The shadier south-east faces support more browntop, while bony sites have more *Rytidosperma pumilum, Gnaphalium audax,* chewed coral broom and exotic annuals such as whitelow grass (*Erophila verna)*. Traveling eastwards, the fescue tussockland grades into a healthy tussockland-shrubland, where matagouri becomes increasingly common. Occasional mingimingi, common broom, cottonwood (*Ozothamnus leptophylla)* and sweet briar are present. Some young wilding pines have recently died from spraying.

Footslopes of Mary Range and associated flats

This area comprises all parts of the property located on the northern side of State Highway 8, in the vicinity of the Simons Pass homestead.

At the toe slope immediately behind the shearer's quarters and associated freehold paddocks, a south facing slope supports a mix of exotic conifers, sweet briar, native shrub species and a brown top dominated sward. Native shrub species are scattered along the narrow watercourse, and include matagouri, mingimingi, scattered tree daisy and scrub pohuehue. Flowering currant, crack willow, pine trees and briar are a common component of this small catchment. One large narrow-leaved snow tussock is present.

Further west, a healthy relictual native shrubland occupies the south-east facing footslopes at the southern end of Mary Range. Matagouri, mingimingi (to 2 m tall), common broom (to 1.5 m tall) and scattered *Coprosma intertexta* (ranked sparse) are present. Patches of tree daisy extend up from the watercourse onto the south east facing hillslope. Porcupine shrub occurs at the edge of the shrubland. Clematis scrambles over shrub species. Tussocks of bog-rush (*Schoenus pauciflorus)* occupy the creek bed. Yorkshire fog and white clover are common ground cover species. Little hardfern (*Blechnum penna-marina)* can be found under some shrubs. The often browsed threatened swamp speargrass *Aciphylla subflabellata* (ranked sparse) is scattered along the margins of the shrubland. A large crack willow tree occupies the creek bed mid slope, at the property fenceline. An occasional gorse bush is present, the majority of which have been sprayed.

Healthy fescue tussockland occupies the adjacent hillslopes, with cover to 40%. Occasional silver tussocks (*Poa cita*) are present. Native intertussock species diversity is relatively high, with mat daisy *Raoulia subsericea, Helichrysum filecaule*, buttercup (*Ranunculus multiscapus*), patotara, occasional speargrass (golden and swamp), and scattered matagouri present. Mouse-eared hawkweed is present at low levels, and king devil hawkweed is uncommon. Horehound (*Marrubium vulgare)* dominates sheep camps located on the ridge crest to the west of the shrubland described above. Mueller's sedge is a common component of fescue tussockland at the foot of the most western hillslopes.

The north-south trending valley bottoms, at the southern end of the hill county, support a healthy fescue tussockland, with up to 50% tussock cover. Browntop dominates the intertussock spaces. However, native woody species (e.g. matagouri, common broom, daphne, patotara) are scattered within the community. Porcupine shrub is confined to boulder surfaces. Scattered gorse (majority has been sprayed) occurs towards State Highway 8.

On the valley floor, meltwater inundation channels and modified kettlehole depressions have formed over Maryburn Landform Association moraine deposits (c.f. Speight 1963). These provide habitat for the threatened spring annual species New Zealand mousetail (*Myosurus minimus* subsp. *minimus* – ranked nationally endangered*)* and small flowered forget-me-not (*Myosotis pygmaea var. minutiflora* - ranked nationally vulnerable*)*. The turfland present is dominated by meadow grass (60% cover), with white clover, dandelion, storksbill, parsley piert and sheep's sorrel present. The native herb *Crassula sinclairii*, an indicator species of damp habitats, is present. *Carex colensoi* and *Rumex flexuosus* are locally common. The turfland has been cropped short by rabbits and sheep, and bare patches created by the scratchings of rabbits. Five populations of New Zealand mousetail were found, ranging from five plants to over 200 plants. These small herbs tend to occupy the bare patches near rabbit diggings within the depressions, although some plants extend up the sides to drier sites. Only two plants of forget-me-not were found in an ephemeral stream channel. There were many other depressions present in the block, which were not surveyed, but are likely habitat for the spring annuals.

Further west a meltwater channel has cut through the surrounding moraine, which persists as a ridge on either side of the outwash channel. The bouldery steep moraine slopes support native shrubland of similar species composition as the Lake Pukaki terminal moraine area, without the prostrate kowhai. Shrubland density is greater on the western moraine ridge than that on the eastern ridge. Bracken fern (*Pteridium esculentum*) and threatened creeping blue-wheat grass (*Elymus falcis*- ranked range restricted*)*, both uncommon on the property, were found within the shrubland on the western moraine ridge.

The meltwater channel is about 500 m wide, and has variable microtopography, ranging from bouldery rises to depressions where soil has been deposited. The bouldery outwash riser supports scattered native species that are adapted to droughty conditions e.g. the low growing and small grasses *Poa maniototo* and *Rytidosperma pumilum,* sedge *Carex resectans,* woolly wood sedge *Luzula ulophila*, Celadon mat daisy and *R. beauverdii,* and cushion daphne *Pimelea pulvinaris*. The only record of the threatened dwarf broom (*Carmichaelia vexillata* – ranked serious decline*)* on outwash material, was found here. Exotic species are also scattered with mouse eared hawkweed (to 20% cover), sweet vernal, white clover, and annuals such as speedwell (*Veronica verna)*. On south east facing micro-aspects, fescue tussocks persist, with tumbling lichen *Chondropsis semiviridis*, onion-leaved orchids and mat daisies. Dwarf patotara is locally dominant in depressions on the outwash material where mat coprosma, *Geranium sessiliflorum*, porcupine shrub and browntop are also found.

An ephemeral stream channel has been cut into the outwash surface at its western side. A dense, healthy native shrubland is present, with lots of the threatened *Coprosma intertexta* (ranked sparse) present, together with mingimingi, matagouri (to 3 m tall) and tree daisy. At its northern extent, this shrubland joins up with that associated with the adjacent moraine ridge. Shrub density and width of shrubland declines as State Highway 8 is approached.

South-east part of property

This area encompasses the area south of State Highway 8 and east of the rabbit proof fence and the Farm Block. The area is characterized by a fluvio-glacial outwash plain or middle terrace, and localized areas of terminal moraine deposits associated with an older glacial event (i.e. Maryburn Landform Association; cf. Speight 1963 or 'Balmoral' Moraine- Gair 1967), some of which are visible from State Highway 8. The loess has been eroded off the north face to expose the rocks. The tallest moraine ridge, in the eastern part of the area, is rubbly (50% cover) with 10% bare ground. It supports a patchy shrubland community with the usual species present. There is much sign of browsing and stock damage, probably resulting from stock and rabbits camping here during the heavy snow fall in Winter 2006. *Coprosma intertexta* and *C. cheesemanii* are present.

A series of elevated summit depressions associated with the 'Balmoral' terminal moraine deposits, have accumulated silty soils, and provide important habitat for a threatened spring annual species *Ceratocephala pungens* (ranked nationally critical) and Buchanan's bidibid (ranked gradual decline). The plants grow in a browsed turfland, dominated by exotic low growing species – meadow grass, parsley piert, sheep's sorrel, harefoots trefoil and storksbill. These habitats are sheep and rabbit/hare camps, with plentiful dung and scratchings evident. *Ceratocephala pungens* tends to occupy those areas which have been disturbed by rabbits, and is dependent on high nutrient inputs and a period of winter wetness. Four populations were found with between 5 and 50 plants in each.

At its northern extent, the fluvio-glacial outwash plain feature is present as two meltwater channels. These coalesce to form an extensive fluvio-glacial outwash plain south of the moraine features just described. The outwash plain has patterned micro topography, which relates to the braiding pattern of the meltwater during the time of its creation. This has influenced both soil pattern and distribution of native flora.

The outwash plain is dominated by exotic herbfield (mainly mouse-eared hawkweed). It would previously have supported a degraded fescue tussockland, which has deteriorated over time to its current state.

Exotic species present are fairly cosmopolitan across the outwash plain, but may vary in cover. They include mouse-eared hawkweed (30-80%), numerous annual herbs including harefoots trefoil, forget-me–not (*Myosotis discolor),* whitlow grass, speedwell, and sheep's sorrel. Sweet vernal is very local. Patches of browntop are associated with the deeper soil phases, while meadow grass and parsley piert occur in isolated lenses of deep unbouldery soils of depressions near to the main ephemeral stream channel. The cover of bare ground and rock varies across the outwash plain.

Overall, native species cover does not exceed 3%. However, the patterning in soil phases has resulted in some parts of the outwash plain having greater concentrations of native species than others. A severely degraded fescue tussockland is present, where fescue tussocks are now confined to the deeper, moister soil phases associated with the south-east facing sides of fluves. Other native species present on these shady slopes and fluves include tumbling lichen, Celadon mat daisy, mat daisy (R*aoulia subsericea)*, small tufts of *Poa maniototo*, fine tufts of sedge *Carex*

colensoi and *C. resectans*, low growing native daphne (*Pimelea* "eastern South Island"), mat coprosma (*Coprosma petriei*), patotara, dwarf patotara and patches of creeping pohuehue. The native cress *Lepidium sysimbrioides* subsp. s*ysimbrioides* (gradual decline) is present on a rocky alluvial fluve.

Bouldery convex risers occur between the fluves and at the edge of outwash terraces, particularly to the east, and in the vicinity of, the ephemeral stream channel. These habitats also support a greater diversity of native plants than the flat parts of the outwash plain. Native species include mat coprosmas (mainly *Coprosma petriei,* but occasionally *C. perpusilla* subsp. *perpusilla),* woolly wood sedge *Luzula ulophila, Poa maniototo,* creeping pohuehue*,* Hooker's mat daisy, Celadon mat daisy, clumps of *Carex resectans* and *Carex colensoi* sedges, cushion daphne, *Geranium sessiliflorum, Scleranthus uniflorus,* threatened orchid *Hymenochilus tristus* (ranked sparse) and tumbling lichen. One plant of mat broom *Carmichaelia nana* was recorded. The threatened species mat daisy (*Raoulia beauverdii* – ranked sparse), trailing bindweed (*Convolvulus verecundus* – ranked sparse*),* dryland button daisy *(Leptinella serrulata), Raoulia monroi* (ranked gradual decline) and native cress *Lepidium sysimbrioides* subsp. *sysimbrioides* occur in this habitat, and were found together near the pylon track.

The ephemeral stream channel that has been previously described in the "Footslopes of Mary Range" section, continues southwards through the outwash plain. Little shrubland persists in the channel through the northern part of this area, where stock appear to have been overwintered. Within the channel is a highly modified relic wetland with a boulder bottom, which supports the native species indicative of seasonally inundated depressions: willowherb (*Epilobium angustum*), mudwort, *Dichondra brevifolia* and *Crassula sinclairii.* Exotic species present include pearlwort (*Sagina procumbens*), creeping bent, white clover and meadow grass. Floating sweet grass occurs where standing water occurs from time to time.

Further south the ephemeral stream channel is dominated by matagouri (to 25% cover), some of which exceed two metres in height. Briar is also common, with occasional porcupine shrub present. The common exotic species found elsewhere in the outwash plain dominate the understorey, with more browntop, Chewings fescue and exotic forget-me-not present.

A small triangle of healthy fescue tussockland occupies a localized remnant of old terrace soils associated with the Maryburn Landform Association at the eastern property boundary. The rest of this land unit has been cultivated. Tussock health is good, with seedling tussocks present. Tussock cover is variable, but reaches 40%. Native species diversity is relatively good, with greater concentrations of scabweed, *Raoulia beauverdii, Geranium sessiliflorum, Poa maniototo,* sedges, dwarf patotara and native daphne present here than elsewhere within the area.

At the south-eastern end of the triangle, a seasonally inundated depression has been created as a result of earth removal for the creation of a small dam wall nearby. The resultant depression supports thousands of New Zealand mousetail (ranked nationally endangered), the largest and most dense population of this threatened plant found on the property, where it coexists with dryland button daisy and *Crassula sinclairii.* Exotic species include brown top, sheep's sorrel, white clover, dandelion, and small patches of mouse eared hawkweed (2% cover). New Zealand mousetail extends up the gentle margins of the depression, with Buchanan's bidibid (ranked gradual decline) present on the steeper margins.

No New Zealand mousetail was found on the floor of the nearby dam, although the threatened Buchanan's bidibid was present.

South-western part of property

This area includes the outwash plain (mid terraces), and low terraces associated with the Pukaki River.

The meltwater channel which cuts its way through the moraines in the northern part of the property spreads out to form an extensive outwash plain by the Pukaki River. The dominant community, as far south as the band of old terminal moraine and boulders, is a fescue tussockland, which has developed over the older 'Mt John' outwash plain that has been reworked with the 'Balmoral' moraine deposits. Fescue tussocks are healthy, with seedlings present, and achieve 30% cover. Unlike elsewhere on the outwash plain, the tussocks occupy not only the shady south-east facing fluve risers, but extend out onto the interfluves as well. The cover of other native species is also greater here, with 20% cover being blue tussock. Sub shrub species present include patotara, mat coprosma, native daphne (*Pimelea* "eastern South Island"), and occasional cushion daphne. The native dwarf grasses *Rytidosperma pumilum* and mountain twitch (*Pyrrhanthera exigua)* and tumbling lichen are also present. Mountain twitch is locally dominant. Mouse eared hawkweed comprises 20-30% cover. Open areas have more bare ground, with increased tumbling lichen, and patches of native sub shrub species. Sweet briar is scattered throughout.

Old Terminal Moraine and Boulders

A band of old terminal moraine associated with the Maryburn Landform Association/'Balmoral' moraine dumps, together with numerous large boulders, occupies a 3 km wide band at the lower edge of the gently sloping moraines, south of the Farm Block.

The shady end slope which demarcates the junction between the old glacial moraine deposits and the glacial outwash plain to the south, has fescue tussock and seedlings, with mat coprosma, clumps of sedge *Carex resectans* and daphne *Pimelea* "eastern South Island" common. Mouse-eared hawkweed is present with ~ 10% cover. This community continues on the hummocky surface, where relatively good fescue tussockland (up to 40% cover) occurs in places. Here, patotara, porcupine shrub and herbs such as *Geranium sessiliflorum* are more common. Elsewhere, exotic grasses and herbs dominate the intertussock species, especially meadow grass, sheep's sorrel, mouse-eared hawkweed, speedwell, forget-me-not, storksbill and parsley piert.

Scattered briar is present. Large boulders support a distinct flora of blue tussock, scrub pohuehue, *Viola filicaulis* and the ferns *Asplenium flabellifolium* and *Cheilanthes humilis*. Native shrub cover often increases in the vicinity of the boulders, growing at the base, on top, and within cracks of the boulders. Species present include large common broom, mingimingi, porcupine shrub, scrambling shrub pohuehue and briar.

The rolling topography has gentle depressions that are similar in topography and species composition to those sites further east where the threatened *Ceratocephala pungens* (ranked nationally critical) was located. However, no *Ceratocephala* was found. The rare bidibid (*Aceana buchananii* – ranked gradual decline) occurs at sheep camp sites. The rare Mueller's sedge is scattered in the fescue tussockland. Other native species present include sedge *Carex breviculmis, Geranium sessiliflorum* var. *novae-zelandiae, Rytidosperma pumila,* and mat coprosma.

Between the Farm Block and the band of old terminal moraine and associated boulders, the fescue tussockland has been pastorally developed. The fescue tussocks have responded well to fertilizer inputs, and are large and strong, but with exotic grasses and herbs between.

South of the band of old moraine and boulders, a depleted fescue tussockland is present, with wilding pines and briar present. Willow trees have been planted near water troughs. At the southern end of the area the depleted glacial outwash surface is dominated by mouse-eared

hawkweed and bare ground (with 20 – 40 % cover for each). Patches of fescue tussock occur sporadically. Sweet briar (to 20% cover) is scattered throughout. A reasonable diversity of native species is present, including scabweed, Celadon mat daisy, mat daisy *Raoulia monroi,* mat Coprosma, sedge *Carex resectans,* common broom, *Pimelea* "eastern S. Island", blue tussock, patorara, *Poa maniototo, Geranium sessiliflorum var. novae-zelandiae,* creeping pohuehue and *Rytiosperma sp.* Lichen species are colonizing areas of bare ground. However the abundance of native species is generally sparse and predominantly confined to the old outwash channels. Commonly occurring exotic species include parsley piert, speedwell, forget-me-not, sheep's sorrel, browntop, sweet vernal and St John's wort (*Hypericum perforatum*). Exotic species are generally more abundant than native species.

Pukaki River terraces

A series of very dry, stony and sandy alluvial low terraces occur as long strips of land adjoining the Pukaki River bed. The southernmost terrace is dominated by sweet briar, which has a patchy cover, being more prevalent on deeper soils. The driest, most stony parts support a relatively intact native moss and herbfield, including an interesting association of cushion daphne, *Carex resectans, Luzula rufa var albicomans*, *L. ulophila* and woolly moss (*Racomitrium pruinosum*). Lichen is common on this surface, as is mouse-eared hawkweed. Other native species present include *Colobanthus strictus, Poa maniototo*, patotara, scabweed, Celadon mat daisy, *Scleranthus uniflorus, Carex breviculmis, Epilobium uniflorum,* creeping pohuehue, mat coprosma and the occasional porcupine shrub.

On bouldery phases closer to the river, matagouri becomes common, with briar comprising 35% of cover. Ubiquitous exotic species include sheep's sorrel, woolly mullein, mouse-eared hawkweed, speedwell and scattered king devil hawkweed.

Species composition is similar for all the terraces, although the cover of briar and matagouri is greater midway along the river, near the old Bullock Track. The most northerly low terrace is notable for its native mossfield dominated by woolly moss (60% cover), scattered mouse-eared hawkweed, dwarf patotara, and scattered porcupine shrub. Some interfluves on this terrace support more woody species including porcupine shrub, cushion daphne and *Pimelea "*eastern South Island", and sedges.

The terrace riser comprises depleted fescue tussock grasslands of sparse tussock cover (<10%), native small leaved shrublands, scattered sweet briar, and patches of wilding conifers. Associated with the fescue tussock grasslands are the usual component of native and exotic herbs and grasses, but also includes *Aceana caesii-glauca*, blue tussock, little hard fern and *Carmichaelia nana,* which were not commonly seen elsewhere on the property.

Native shrublands occur more or less consistently along the bottom of the terrace riser on boulderfield, and also within an outwash channel gully in the vicinity of the historic Bullock Track and chimney. These shrublands typically comprise matagouri, native broom, mingimingi, porcupine shrub, and occasional *Coprosma rigida*, tree daisy and mountain wineberry present. The lianes scrub pohuehue, native jasmine (*Parsonsia capsularis var. tenuis)* and clematis scramble over shrubs in places. Sweet briar and the occasional patches of wilding pine and larch are present. *Coprosma intertexta* is also present in patches as part of these shrublands.

Farm Block

The Farm Block is located at the centre of the property, occupying the gently sloping loess covered moraines. Exotic conifer shelterbelts surround several of the paddocks. Pasture species dominate, although fescue tussocks persist. The Farm Block has either been direct drilled or over

sown and top dressed. This development has extended to the east, where fescue tussock and Mueller's sedge are common, and large areas of matagouri shrubland has been induced in response to the fertilizer inputs. Ephemeral channels support the close-cropped meadow grass-parsley piert turfland that provides habitat for Buchanan's bidibid, and is associated with *Ceratocephala pungens* elsewhere on the property.

Significance of Vegetation Values

Areas of Simons Pass Pastoral Lease that have been identified as having significant vegetation values are shown on the attached Botanical Values map.

At least 110 native vascular species and 39 exotic species are present. Of these, at least 18 species are listed as threatened in the most recent threat classification system (Hitchmough et al 2007). A list of these species with their threat of extinction status and distribution within the Lease is provided in Table 2.

Of highest significance is the presence of three threatened spring annual herbs. The Nationally Critical spring annual *Ceratocephala pungens* occupies winter wet gentle depressions on old glacial landforms associated with the Maryburn Landform Association/"Balmoral' moraine dumps. This is the 8th record for the Mackenzie Basin and adds to the list of six modern South Island populations (Rogers *et al.* 2002, Rogers *et al.* in prep). The four populations on the Lease have between 5 and 50 individuals present, while most of the Central Otago populations have 1 – 10 individuals (Rogers *et al.* 2002), and recently found populations in the Mackenzie Basin have 3000-4000 plants (Rogers *et al.* in prep).

Six populations of the Nationally Endangered New Zealand mousetail (*Myosurus minimus* subsp. *minimus*) were found on the Lease. Additional suitable habitat was present at the foot of the Mary Range, but was not surveyed. One population, located in a man-made depression on an old terrace dominated by fescue tussock grassland, has thousands of New Zealand mousetail plants present. The dominance of native plants at this site suggests that it may provide secure habitat for the species. This is the 4th record for the Mackenzie Basin and adds to the list of 33 still existing populations (Rogers *et al.* 2002; Rogers *et al.* in prep), the majority of which occur in Otago.

A single population of the Nationally Vulnerable forget-me-not M*yosotis pygmaea* var. *minutiflora* was found in an ephemeral channel at the foot of the Mary Range. This is one of four known records of this plant currently existing in the Mackenzie Basin. There are three modern North Island sites, and 26 modern South Island sites, of which six occur in Canterbury as tarn and lake margin populations. (Rogers *et al* 2002; Rogers *et al.* in prep).

Species listed in the category Serious Decline and Gradual Decline fall within the division 'Chronically Threatened'. Species in this division face extinction but are buffered slightly by either a large total population size, or a slow decline rate. Species listed as Sparse and Range Restricted fall under the division "At Risk". Although they are not currently in decline, their population characteristics mean a new threat could rapidly deplete their populations. Sparse taxa have very small, widely scattered populations.

The threatened grass *Elymus falcis*, which grows at the base of boulders on the glacial moraines, is at its northern distributional limit. The tiny herb *Neopaxia erythrophylla* is at its western distributional limit.

Several other species, although not ranked as nationally threatened, are notable in a regional and local context. Species which are regionally uncommon include prostrate kowhai (*Sophora prostrata), Coprosma virescens* and *Corokia cotoneaster*. Species such as *Pimelea pulvinaris* and *Raoulia parkii* that are associated with the alluvial outwash plain face a real threat of habitat destruction, resulting from a recent trend in cultivation, irrigation and settlement of these degraded lowland habitats, both in the Mackenzie Basin and Central Otago.

Alluvial fluvio-glacial outwash plains, till-covered glacial hummocks, stony terraces, kettleholes and ephemeral tarns, and lowland hillcountry shrubland are all significant as distinctive ecosystems, habitats and communities. These habitats occur as a sequence from the Pukaki terminal moraine, to the hummocky moraine deposits with associated kettleholes and ephemeral tarns, a band of old terminal moraine and associated boulders, to the fluvio-glacial channels and outwash plain, with stony terraces present, the lowest ones being associated with the Pukaki riverbed. The lowland hillcountry shrublands occur at the foot of the Mary Range, in the north-eastern part of the Lease. This sequence of important and diverse habitats supports a range of vegetation communities, and provides the opportunity for natural ecosystem processes and linkages to take place.

Of high significance is the shrubland (dominated by small-leaved coprosmas, tree daisy, matagouri, native broom, kowhai, *Rubus* and *Muehlenbeckia* lianes) of the Pukaki terminal moraine face, as it constitutes a remnant of the original pre-human vegetation cover (Leathwick *et al.* 2003). Part of this shrubland was identified as RAP 6: Southern Lake Pukaki Scrub during the PNA Survey of the Mackenzie Ecological Region (Espie *et al.* 1984). This small RAP (340 ha) was noted for having prostrate kowhai present with common broom, in a fescue sward. The tenure review survey confirmed the presence of these species, as well as the threatened *Coprosma intertexta* within the RAP area, and has highlighted that these values persist elsewhere on the terminal moraine.

Remnants of lowland shrubland on the footslopes of Mary Range, on moraine ridges, boulderfields on low terrace risers by Pukaki River, and within the fluvial channel at the eastern side of the property, are also significant. Although this community lacks the structural dominants of the earlier predicted woodland (Leathwick *et al.* 2003) it retains species thought to reflect the understorey composition of such a forest. Restoration of a greater woody component of the native vegetation of intermontane basins, including shrubland communities that were determined by cold-air inversion, edaphic factors, and flooding disturbance during pre-human times, are desirable biodiversity conservation outcomes (Walker *et al.* 2003).

The matagouri shrubland-fescue tussockland community located within the road strip along State Highway 8 is significant, as pollen samples and soil charcoal, suggest mixed grassland and shrubland, dominated by non-*Chionochloa* grasses and small-leaved shrubs would have been present in prehuman times, in parts of the Mackenzie Basin which had not been disturbed recently (McGlone 2001).

The small ephemeral wetlands and kettleholes that occupy the hummocky moraines occur within a modified setting. While even the least modified ephemeral wetland lacks the species richness present at other kettleholes in the region e.g. Glenmore tarns, some of them do retain moderate native species diversity. Wetlands nationally have undergone a 90% reduction, and remaining examples are a priority for protection. One threatened species (*Luzula celata* - ranked serious decline) on this property is restricted to the ephemeral tarns.

The fescue tussocklands on the property are variable in their species composition and health. Those located along the State Highway 8 road strip are the most natural, with healthy tussocks and a reasonable range of native herbs, sedges, orchids and shrub species present.

A very localised area of healthy fescue tussock, associated with the largest population of threatened New Zealand mousetail (ranked nationally endangered), occurs along the eastern property boundary. It is located on a chronically threatened LENZ unit, the remainder of which, on the property, has been cultivated.

The fescue tussocklands on the hummocky moraines within the northern part of the property retain some native intertussock species diversity. Sheep camps provide habitat for the threatened species *Acaena buchananii* and *Leptinella serrulata,* while *Carmichaelia vexillata, Hymenochilus tristus, Raoulia beauverdii, Elymus falcis* and *Neopaxia erythrophylla* have scattered distributions.

The fescue tussocklands on the moraine country further south have been heavily oversown and top dressed, resulting in strong healthy tussocks, with exotic pastoral species, including browntop and white clover, dominating. These tussocklands provide habitat for the threatened sedge *Carex muelleri*, which is scattered throughout, and the threatened bidibid *Aceana buchananii,* often present at sheep camps.

The fescue tussockland present in the northern area near the Pukaki River, as far south as approximately the band of old moraine and boulders, is notable as having the most extensive fescue tussock cover and native species cover of the outwash plain environment on the property.

The vegetation cover of the majority of the fluvio-glacial outwash plain is severely depleted. Despite being highly modified, native plant species persist, although their distribution and cover are patchy. Approximately 70% of vascular species present are native, and of these, ten species (32% of native species) are threatened and two species are notable. This significant environment provides habitat for over half of the threatened species found on the property as a whole. It is acknowledged that there was insufficient time to survey all the fluvio-glacial outwash plain. However, sufficient variation in microhabitats across the outwash plain was observed, to be able to expect these threatened plant species to be present elsewhere on the outwash plain. Native species cover and species richness is higher in the eastern outwash plain than nearer the Pukaki River, where sweet briar is more common. Walker *et al.* (2006) have highlighted the need to protect highly modified and depleted ecosystems to prevent the extinction of many threatened species which survive only in such ecosystems.

The low terraces associated with the Pukaki River are relatively intact and support representative plant communities of very dry and recent alluvial surfaces. Of particular note are the *Raccomitrium* mossfields, which are particularly dominant on the most northern low terrace, and a relatively intact native moss and herbfield, including an interesting association of cushion daphne*, Carex resectans, Luzula rufa var albicomans*, *L. ulophila* and woolly moss (*Racomitrium pruinosum*), more common on the southernmost terrace. Both these communities are likely to be prehuman plant communities. These values are patchy, and large areas are much more modified by briar infestation. These dry landforms and associated dryland plant communities are some of the least protected in New Zealand. Shrublands persist along the terrace riser toe slope. These shrublands add significance to the low terrace environment.

While fescue tussocks persist in the Farm Block where direct drilling has taken place, this part of the property is not considered to have high significance.

Table 2: Threatened plants found on Simons Pass Pastoral Lease

Threat Division	Threat Category	Species	Location on lease
Acutely threatened	Nationally Critical	*Ceratocephala pungens*	Gentle depressions on old terminal moraine surfaces of eastern outwash plain utilised as sheep/rabbit camps.
	Nationally Endangered	*Myosurus minimus subsp. minimus*	Ephemeral wetland depressions at foot of Mary Range; in manmade depression in corner of eastern outwash plain beside lucerne paddocks
	Nationally Vulnerable	*Myosotis pygmaea* var. *minutiflora*	Ephemeral wetland meltwater channel at foot of Mary Range
Chronically Threatened	Serious Decline	*Carmichaelia vexillata*	Outwash channel, north of SH8; moraine ridge near Trig TT.
		Luzula celata	Damp turfland margin of kettlehole ephemeral wetland in hummocky moraines.
	Gradual Decline	*Acaena buchananii*	Short tussockland of hummocky and gently sloping moraines, and associated with *Ceratocephala pungens* sheep camp habitat on old glacial surfaces
		Carmichaelia crassicaule	Short tussockland and tussockland/shrubland within SH8 road strip.
		Lepidium sysimbrioides subsp sysimbrioides	On bouldery phases of outwash plain including terrace risers.
		Leptinella serrulata	Sheep/rabbit camps in short tussockland on moraine surfaces; bouldery interfluves of eastern outwash plain.
		Raoulia monroi	Bouldery interfluves – eastern and western outwash plain.
At Risk	Sparse	*Aciphylla subflabellata*	Foothills of Mary Range, in short tussockland and at shrubland margins
		Carex muelleri	Short tussocklands throughout property
		Convolvulus verecundus	Bouldery interfluve south of pylon track, eastern outwash plain.
		Coprosma intertexta	Shrublands throughout property including on Mary Range footslopes, terminal moraine, moraine ridges further south, and shrublands on terrace risers near Pukaki River
		Hymenochilus tristus	Depleted short tussockland of hummocky moraines, and eastern outwash plain
		Neopaxia erythrophylla	Two populations in bare ground associated with outwash channel cutting through hummocky moraine south of SH8.
		Raoulia beauverdii	Scattered throughout outwash plain, and bony areas of terminal moraine, hummocky moraines, low river terraces, and terrace risers.
	Range Restricted	*Elymus falcis*	On bouldery moraines; old glacial surfaces present on eastern outwash plain.

Map : Significant Botanical Values

2.5.1 Problem Plants

At least 39 exotic species of plants are present on the lease but relatively few are of conservation concern. Many are plants of agricultural importance or are common pastoral weeds.

Gorse
Small gorse plants are present scattered mainly within the area north of State Highway 8 near the homestead. Most of these have been recently sprayed, although a few remain to be controlled at the margins of the shrubland located on the footslopes of the Mary Range.

Rowan
A few rowan seedlings are present amongst boulders lining an ephemeral lag tarn. These were removed by hand, but more may be present.

Wilding conifers
Wilding conifers (e.g. lodgepole pine, ponderosa pine, Douglas fir and larch) are locally scattered along the western boundary. Parent trees are present as a shelterbelt along the property boundary with freehold land adjoining the Lake Pukaki Terminal Moraine Conservation Area; a shelterbelt on Simons Hill; patches of trees along the Pukaki River low terrace risers; a planting on the State Highway 8 road strip; and the shelterbelts associated with the Farm Block. Many of the young wilding trees have been sprayed, but control will be on-going. Wilding conifers threaten the conservation and landscape values of Simons Pass Pastoral Lease.

Sweet briar
Sweet briar is scattered throughout the property, but is most prevalent across the southern half of the property. Briar is most common along the low terraces beside the Pukaki River bed, and on the outwash plain located above the river.

Broom
Broom is not common on the property. A few shrubs are present in the State Highway 8 road strip part of the property, and should be controlled.

Crack Willow
Crack willow trees are located in the streambed within the Mary Range shrubland, and beside a spring just south of the Farm Block. Crack willow can encroach on waterways and rapidly modify the aquatic habitat by providing greater amounts of shade and leaf drop into the stream. This has implications for native aquatic invertebrate fauna values; the trees should be removed. The crack willow trees planted along the stock water line pose little threat to ecological values.

Flowering Currant
A number of flowering currant shrubs are present in the riparian shrubland located behind the shearer's quarters. Flowering currant is an invasive weed of forest and shrubland margins in wetter climates of New Zealand, and would be an issue only within the shrublands of the Mary Range.

Exotic pasture species
Where exotic pasture species pose a threat to acutely and chronically threatened flora or uncommon habitats, consideration may have to be given to their control or management. Recent studies of acutely threatened spring annual species, all of which are found on the Lease, indicate that herbivore disturbance aids perpetuation of *Ceratocephala pungens* in its 'desert' pavement habitat, by suppressing taller herbaceous plants (Rogers *et al.* in prep). Grazing animals may also benefit threatened species within prostrate turf communities of ephemeral wetlands *e.g. Myosotis*

pygmaea var. minutiflora and *Luzula celata* by suppressing compositional transitions to taller vegetation and retarding competition of invasive exotic plants (Rogers *et al.* in prep; Johnson & Rogers 2003).

Hawkweeds
Mouse-eared hawkweed is present throughout the property, but is most common on the outwash channels and plains, where it can be present to 80% cover. King devil hawkweed is localized, with patches being found in fescue tussockland on the Mary Range, and amongst shrublands.

2.6 FAUNA

2.6.1 Avifauna

Ecological Context

The avifauna of this area is typical of eastern South Island high country leases that border braided rivers and large glacial lakes. The Pukaki River, which is on the southern boundary of Simons Pass, drains Lake Pukaki. It is a braided river that has been largely dewatered for the storage of water in Lake Pukaki for hydro electric generation. However, a section of the lower Pukaki River still retains a spring–fed braided river section that provides habitat to a range of wetland birds. Braided rivers of the type found in Canterbury are internationally rare habitat types (O'Donnell and Moore 1983).

The braided seepages in lower Pukaki River, where it adjoins the Pastoral Lease along its southern boundary, provides nesting and feeding habitat for the following species: black stilt (nationally critical), black fronted tern (nationally endangered), wrybill and grey duck (nationally vulnerable), black billed gull (serious decline) and banded dotterel (gradual decline), and unthreatened species such as Australasian pied stilt, South Island pied oystercatcher, paradise shelduck, and spur winged plover.

This area also provides feeding habitat for Caspian tern: (nationally vulnerable), New Zealand falcon (gradual decline), black shag (sparse), and the non-threatened species little shag, New Zealand pipit, white faced heron, New Zealand shoveler, grey teal, Australasian harrier, black backed gull, and welcome swallow (Simon Elkington unpublished data).

Common bush birds such as grey warbler and silvereye occur both here and on neighbouring properties. South Island fantail has been recorded from surrounding properties and freehold portions of Simons Pass.

Birds observed on the Pastoral Lease are described below for the main areas surveyed.

Terminal moraine and tarns

This area comprises hummocky and rolling terminal moraine south of Lake Pukaki. There are a number of ephemeral wetlands or tarns present in kettleholes and depressions. Most of these tarns were dry with only the three larger ones having standing water present. The surrounding vegetation is dominated by short fescue tussock and mouse-eared hawkweed. There are some scattered scrub patches dominated by matagouri and sweet brier and within the scrub there are scattered rocks.

Species observed using the tarns that had some water left were black stilt (nationally critical), grey duck (nationally endangered) were seen feeding at several tarns and black fronted terns (nationally endangered) were seen flying through the area towards Lake Pukaki and would probably feed on insects in the grasslands and the tarn areas. Other indigenous bird species recorded from here include Australasian harrier, spur winged plover, Australasian pied stilt and paradise shelduck. The grey warbler and silvereye were noted in some of the scrub areas. Five species of introduced birds were recorded from this area.

Mid flats

This extensive area includes the lower rolling moraine country, which supports modified fescue tussockland, the band of old moraine and scattered rock tors with associated scrub of matagouri, porcupine shrub, mingimingi and sweet briar, and dry outwash channels with hawkweed present. An occasional crack willow is present.

Threatened bird species recorded here were black fronted terns (nationally endangered) that were seen flying through the area, feeding on insects and lizards in the grasslands as they went. Other indigenous bird species recorded from here include Australasian harrier, spur winged plover and southern black backed gull. Grey warbler and silvereyes were seen in the scattered willows and from scrub. Eleven species of introduced birds were recorded from here.

Shelter belts surrounding rough pasture (Farm Block)

This area is rough pasture dominated by introduced grasses and some short fescue tussock surrounded by lines of pine tree shelterbelts. It is surrounded by fescue tussocklands associated with the "Mid Flats" area.

No threatened species of birds were recorded from here. Indigenous birds recorded from here include Australasian harrier and spur winged plover. Grey warbler and silvereye were recorded from the pine tree shelter belts. Twelve species of introduced birds were recorded here.

Fluvio-glacial outwash plain

This area is very dry. The vegetation is dominated by hawkweed and bare ground covered with lichen and dry land moss. Fescue tussock are confined to deeper south-east facing fluve sides, and mat daisies, native sub-shrubs and diminutive tufts of *Poa maniototo* occur on bouldery interfluves and terrace risers. Scattered sweet briar is present, with matagouri concentrated in an ephemeral stream channel. Crack willow trees have been planted along a stock water line.

Threatened bird species that were present include nesting banded dotterel (gradual decline), and black fronted terns (nationally endangered) that were seen flying through the area catching insects and lizards as they went. Other indigenous bird species found in this area include nesting South Island pied oystercatcher, spur winged plover, Australasian harrier and southern black backed gull. Silvereyes and grey warblers were seen in the willows and scattered scrub. Seven species of introduced passerine birds were located in this area.

Pukaki River Low Terraces, Gully and Terrace Faces

This area includes the low terraces located between the property boundary fence beside Pukaki River, and the main terrace risers that mark the edge of the fluvio-glacial outwash plain.

These terraces are dominated by lichen and dryland mosses, with scattered sweet briar and matagouri. Short fescue tussocks occupy the terrace faces. Boulderfields present at the base of the terrace risers support shrubland dominated by matagouri, sweet briar, porcupine shrub and mingimingi.

A small gully has been cut into the edge of the terrace riser by an ephemeral stream, which occupies a meltwater channel that dissects the moraine country in a NE-SW direction, and drains into the Pukaki River near the historic chimney. Talus occupies the gully sides, which supports native shrubland species, and occasional wilding conifers.

No threatened bird species were recorded from this area but indigenous birds recorded include Australasian harrier, New Zealand pipit, welcome swallow and spur winged plover in the open areas; and grey warblers and silvereyes in the shrubland.

Six species of introduced birds were recorded.

Southern end of Mary Range

This area is a small parcel of land at the northern boundary of the Pastoral Lease, and includes the foothills of the Mary Range, an outwash channel, and moraine deposits.

On the flats, scattered fescue tussocks are present with pasture grasses. A native shrubland, dominated by mingimingi, matagouri, native broom, tree daisy and an occasional crack willow and sweet briar, occupies a gully on the footslopes.

Threatened bird species recorded here were banded dotterel (gradual decline) found in the meltwater channel. Other indigenous species of birds recorded from here include Australasian harrier, spur winged plover, silvereye and grey warbler. Ten species of introduced birds were recorded from this area.

Summary of Avifauna

Twenty eight Bird species were recorded from Simons Pass Pastoral Lease during the field inspection (See Table 3). This comprises of 8 endemic, 6 native and 14 introduced species.

Table 3: List of endemic and native bird species recorded from Simons Pass Pastoral Lease.

Status	Common name	Locations
Endemic[2]	Banded dotterel	Outwash plain, southern end of Mary Range
	Black fronted tern	Outwash plain, mid flats, terminal moraine & tarns
	Black stilt	Terminal moraines & tarns
	Grey duck	Terminal moraines & tarns
	Grey warbler	Throughout
	New Zealand pipit	Pukaki River low terraces
	Paradise shelduck	Terminal moraines & tarns
	South Island pied oystercatcher	Outwash plain
Native[3]	Australasian harrier	Throughout property
	Australasian pied stilt	Terminal moraine & tarns
	Silvereye	Throughout

	Southern black backed gull	Outwash plain & mid flats
	Spur wing plover	Throughout
	Welcome swallow	Pukaki River low terraces

[2] Endemic = endemic species or sub-species, found only in the New Zealand region.
[3] Native = naturally occurring in New Zealand and in other countries.

Introduced bird species recorded include Australian magpie, blackbird, Canada goose, chaffinch, dunnock, goldfinch, greenfinch, hedge sparrow, mallard duck, redpoll, skylark, songthrush, starling, and yellowhammer.

Significance of Avifauna

Four bird species recorded on the Pastoral Lease are listed as being under threat (Hitchmough et al 2007) (see Table 4 below). Significant avifauna values are shown on the attached Bird Values map.

The ephemeral wetlands and tussocklands, located in the hummocky terminal moraines, provide important feeding habitat for black stilt, black fronted terns and grey duck. They probably fly across the Pastoral Lease en route to nesting habitat throughout the upper Waitaki, but also spend some time catching insects and small lizards within the grasslands of the Pastoral Lease.

Other threatened bird species that are likely to use this wetland habitat include wrybill (Nationally Vulnerable), black billed gull (Serious Decline), banded dotterel (Gradual Decline) and New Zealand falcon (Gradual Decline).

The fescue tussockland/hawkweed herbfield of the outwash plain provides significant breeding and feeding habitat for banded dotterel and feeding habitat for black fronted tern. This area is adjacent to the lower Pukaki River braided seepages that provide outstanding breeding and feeding habitat for threatened bird species: black stilt, black fronted tern, grey duck, wrybill, black billed gull and banded dotterel.

Table 4: Threatened bird species at Simons Pass Pastoral Lease

Threat Division	Threat Category	Species	Location on lease
Acutely Threatened	Nationally critical	Black stilt	Terminal moraines & tarns
	Nationally endangered	Black fronted tern	Outwash plain, mid flats, terminal moraine
	Nationally endangered	Grey duck	Terminal moraines & tarns
Chronically threatened	Gradual decline	Banded dotterel	Outwash plain & southern end of Mary Range

Map : Significant Bird Values

2.6.2 Herpetofauna

Introduction

A search of the Herpetofauna database found no records of lizards on the property. However there are numerous lizard records from the Upper Waitaki valley. Three species of common lizards have been found immediately surrounding this Pastoral Lease: Southern Alps gecko, common skink and McCann's skink. The threatened scree skink (Gradual Decline) and spotted skink (Gradual Decline) have been recorded to the south, in a gully on the shores of Lake Benmore. The jewelled gecko (Gradual Decline) and green skink (Gradual Decline) have been recorded to the east in the upper Tekapo River, while the long toed skink (Gradual Decline) has been found at Mt Edwards to the north east of Simons Pass.

Habitats

Lizards observed on the Pastoral Lease are described below for the main areas surveyed.

Terminal moraine and ephemeral wetlands

This area comprises hummocky and rolling terminal moraine south of Lake Pukaki. There are a number of ephemeral wetlands or tarns present in kettleholes and depressions. Most of these tarns were dry with only the three larger ones that had a little water left. The surrounding vegetation is dominated by short fescue tussock and mouse eared hawkweed. There are some scattered scrub patches dominated by matagouri and sweet brier and within the scrub there are scattered rocks.

Lizards in this area were searched for within the grass and under stones. The common skink was located within this area.

Mid flats

This area is extensive. It includes the lower rolling moraine country, which supports modified fescue tussockland, the band of old moraine and scattered boulders with associated scrub of matagouri, porcupine shrub, mingimingi and sweet briar, and dry outwash channels with hawkweed present. An occasional crack willow is present.

Stones were looked under throughout the area, especially around and on the rock tors. Southern Alps gecko, the common skink and McCann's skink were found in this area.

Shelter belts surrounding rough pasture (Farm Block)

This area is rough pasture dominated by introduced grasses and some short fescue tussock surrounded by lines of pine tree shelterbelts. It is surrounded by fescue tussocklands associated with the "Mid Flats" area. The few stones that were located in this area where rolled over and searched for inactive lizards beneath. No lizards were located in this area.

Outwash Plain

This area is very dry. The vegetation is dominated by hawkweed and bare ground covered with lichen and dry land moss. Fescue tussock are confined to deeper south-east facing fluve sides,

and mat daisies, native sub-shrubs and diminutive tufts of *Poa maniototo* occur on bouldery interfluves and terrace risers. Scattered sweet briar is present, with matagouri concentrated in an ephemeral stream channel.

Stones were turned over to search for inactive lizards within this area, but none were found.

Pukaki River Low Terraces, Gully and Terrace Faces

This area includes the low terraces located between the property boundary fence beside Pukaki River, and the main terrace risers that mark the edge of the fluvio-glacial outwash plain.

These terraces are dominated by lichen and dryland mosses, with scattered sweet briar and matagouri. Short fescue tussock occupy the terrace faces. Boulderfields at the base of the terrace risers support shrubland dominated by matagouri, sweet briar, porcupine shrub and mingimingi.

A small gully has been cut into the edge of the terrace riser by an ephemeral stream, which occupies a meltwater channel that dissects the moraine country in a NE-SW direction, and drains into the Pukaki River near here. Talus occupies the gully sides, which supports native shrubland species, and occasional wilding conifers.

The grasslands and talus slopes throughout this area were searched for basking and foraging lizards, many rocks were rolled over to locate inactive lizards. The common skink, McCann's skink and Southern Alps gecko were all found. In a small gully where the Bullock Track drops down to the Pukaki River and the historic chimney, time was spent searching the talus for basking lizards around mid day. Five spotted skink (Gradual Decline) were found in addition to the three lizards mentioned above.

Southern end of Mary Range

This area is a small parcel of land at the northern boundary of the Pastoral Lease, and includes the foothills of the Mary Range, an outwash channel, and moraine deposits.

On the flats, scattered fescue tussocks are present with pasture grasses. A native shrubland, dominated by mingimingi, matagouri, native broom, tree daisy and an occasional crack willow and sweet briar, occupies a gully on the footslopes. Lizards were searched for under stones and in the grasslands. The Southern Alps gecko was found here.

Summary of Lizard Fauna

Four lizard species, all endemic, were recorded from Simons Pass Pastoral Lease during the field inspection. These included three species of skink (spotted, common and McCann's) and one species of gecko (Southern Alps gecko).

One species of threatened lizard, the spotted skink (Gradual Decline) was found on the Pastoral Lease and this was from talus in a small gully near the western boundary with the Pukaki River Table 5 summarises the lizard fauna on the Pastoral Lease.

Table 5 : Lizard species recorded from Simons Pass Pastoral Lease

Common name	Threat status	Locations
Spotted skink	Gradual decline	Gully cutting into outwash plain near Pukaki River low terrace
Common skink	Not threatened	Mid flats, terminal moraines and Pukaki River low terraces
McCann's skink	Not threatened	Mid Flats and Pukaki River low terraces
Southern Alps gecko	Not threatened	Mid Flats, Pukaki River low terraces and southern Mary Range

Significance of Herpetofauna Values

Rocky areas associated with the toe slopes of terrace faces near Pukaki River, the gully that cuts down from the outwash plain to the Low Terrace, and the boulders associated with the old terminal moraines provide habitat for lizards on the Pastoral Lease. Of particular significance is the talus habitat within the gully, which provides breeding and feeding habitat for four species of lizard including the threatened spotted skink (Gradual Decline). Lizard species richness and abundance is much higher at this site than any other site on the Pastoral Lease. Significant lizard values are shown on the attached Lizard Values map.

Map : Significant Lizard Values

2.6.3 Aquatic Fauna

Introduction

Simons Pass Pastoral Lease lies in the upper Waitaki River catchment, at the southern end of Lake Pukaki, wedged between the Pukaki River and the southern end of the Mary Range. The property is drained by unnamed tributaries of the Pukaki River.

One of the distinguishing features of the Waitaki River is the presence of hydro-electric dams. This has two major effects on the fish communities. The first is that fish communities upstream from the dams are generally composed of only non-diadromous species (those species without a marine phase in their lifecycle), although some exceptions do occur (e.g. longfin eels (*Anguilla dieffenbachii*) may still be present and common bully (*Gobiomorphus cotidianus*) and koaro (*Galaxias brevipinnis*) have become non-diadromous, substituting lakes for the sea). The second effect is that the fish communities are separated into discrete populations, preventing recolonisation of previously dewatered streams.

The New Zealand Freshwater Fish Database (NZFFD) has 1074 records (at 1st November 2006) from the Waitaki River catchment (McDowall & Richardson 1983). Species recorded from Lake Pukaki and Pukaki River near Simons Pass Pastoral Lease include longfin eel, Canterbury galaxias (*Galaxias vulgaris*), upland bully (*Gobiomorphus breviceps*), common bully, rainbow trout (*Oncorhynchus mykiss*), and brown trout (*Salmo trutta*). Longfin eel has a threat ranking of gradual decline (Hitchmough et al 2007).

Aquatic Fauna Description

Two main aquatic habitats are present on the property; ephemeral tarns and ephemeral streams and their gullies.

Ephemeral tarns

This habitat type is represented by numerous small tarns in kettleholes on the moraines. They are classified as "Palustrine – Ephemeral Wetlands", which Johnson & Gerbeaux (2004) define as being "fed by rain, ground or surface water, but are not directly associated with lakes or rivers; and that seasonal variations in rainfall lead to ponding of water during wet periods and evaporation of water during dry periods".

The lag tarns present have large areas of boulder clusters with little vegetation present. The majority of tarns were dry at the time of survey, and supported a turfland community at their margins, dominated by exotic grasses, with some native plants usually present. Tarns that carry water for longer, but were still dry at the time of the survey; have larger areas of turfland communities present, generally with a higher cover of native plant species present. A number of tarns had standing water present, with exotic floating sweet grass present.

Periodically inundated tarns occupying kettlehole depressions are a feature of the terminal moraine. These tarns were between 0.03 ha and $80m^{2.}$ in size, and most commonly had the capacity to hold 100 mm depth of water. Some of the tarns were partially filled with water. at the time of inspection. Aquatic habitats of this nature are uncommon in the Mackenzie Basin. Aquatic invertebrates were common, and include two Crustacea; the threatened tadpole shrimp

Lepidurus apus viridis (Sparse) and Copepods (*Boeckella hamata*), as well as larvae of the diving beetle *Rhantus pulverosus*.

Stock access is generally unrestricted to the tarns, with the exception of two tarns in the vicinity of the Mt Cook Lookout. Rabbits and hares appear to frequent all tarns, with plenty of faeces evident, and some scuffing disturbance. Vehicle tracks bisect several tarns.

Ephemeral Streams

Within the moraine country, the large stream gullies have headwaters beyond the pastoral lease boundary, while the smaller streams are sourced from within the moraines. The dry nature of most stream channels gives the vegetation a similar quality to the surrounding hill slopes, characterised by exotic and native grass species, and occasional shrubs. The exception to this is the stream community on the northern side of State Highway 8, in the gully behind the Simons Pass homestead. The base of this almost-running stream supported a turfland community, while a dense riparian shrub community occupied its margins.

Most streams of the outwash flats are sourced from outside the pastoral lease boundary. These streams tend to be drier than those in the moraine country, and are found in shallow depressions on the outwash plain. Native shrub species and sweet briar occupy the stream depressions. Most streams were dry at time of survey.

Most stream beds on the property are up to 2 m wide, and have an average depth of 100 mm.

Just south of the Farm Block, near the band of old terminal moraine is a small isolated spring, comprised of two small stagnant pools. The spring was 100 mm deep at the time of inspection, probably a reflection of the prolonged snow fall which would have recharged the water table. Willow trees are growing near this spring.

A gravel quarry is present in one stream channel, beside State Highway 8. There are two shallow water-filled depressions separated by a gravel bar. The water depth at the time of inspection was 150 mm, but is unlikely to persist.

Sheep access to stream gullies is generally unrestricted, although where shrublands are dense e.g. at the foot of the Mary Range, stock access is impeded. Vehicle tracks cross some streams.

Description of Species

No fish species were recorded on the property. Water quality is poor, with few macro-invertebrates being recorded: waterfleas (*Daphnia* sp.), worms (Oligochaete sp.), and copepods (*Copepoda* sp.) were found in water bodies of both the moraine and outwash plain country, while water boatmen (*Sigara* sp), back swimmers (*Anisops* sp), larvae of diving beetle (*Rhantus pulerosus*) and tadpole shrimp (*Lepidurus viridus*) were only recorded in water bodies of the moraines.

Tadpole shrimp populations are able to survive in ephemeral ponds of still, fresh water in which the eggs may remain viable for years due to their resistance to desiccation and freezing. Shrimp survival is also enhanced by rapid maturation and all populations in New Zealand appear to be hermaphroditic. In general these crustacea are omnivorous and they have a number of natural predators including fish and insects (Chapman 1976).

Significance of Aquatic Fauna

No fish were found during the freshwater fauna survey of Simons Pass Pastoral Lease. The macro-invertebrate fauna communities were also sparse, reflecting the highly ephemeral character of the naturally occurring water-bodies on this pastoral lease.

One threatened invertebrate species was recorded: tadpole shrimp (L*epidurus apus viridus* – ranked Sparse). Hitchmough et al 2007 suggest "habitat modification, predation, and habitat fragmentation" as possible reasons for their very small, widely scattered populations. The ephemeral tarn habitats on the Pastoral Lease provide significant habitat for this threatened species, and while they were only found in two tarns, they may be able to colonise new waterways by wind dispersal of their eggs (Herriott 1917). Herriot (1917) notes that tadpole shrimp eggs may lay dormant in the ground until the next time water pools in the waterway; though no timeframe for this dormancy was defined. While *Lepidurus* is a worldwide genus, this New Zealand species is only known from few locations in New Zealand.

The Pukaki River, including all the catchments below Lake Pukaki and Lake Pukaki itself, are recognised as part of the 'Tekapo River' unit in the Waters of National Importance (WONI) documentation (DOC 2004). This waterway has been identified as containing special features of national importance in terms of threatened bird and fish communities.

Significant aquatic fauna are shown on the attached Aquatic Values map.

Map : Aquatic Fauna Values

2.6.4 Terrestrial Invertebrates

Introduction

Several invertebrate species of conservation interest have been found on, or near, Simons Pass Pastoral Lease. During the PNA survey, three moth species endemic to the Mackenzie Basin – *Gelechia lenis* (Gelechiidae), *Cremnogenes hoesta* (Oecophoridae) and *Ericotenes pukakiense* (Tortricidae) were recorded in the Southern Lake Pukaki Scrub RAP 6 (Ward 1986). During the mid 1990's the late lepidopterist Graeme White carried out extensive light trapping in the Mackenzie Basin and collected a Gelechiid moth (*Kiwaia lenis*) from the central paddocks of Simons Pass Pastoral Lease. Gelechiid moths include the flightless *Kiwaia* 'plains jumper' (ranked Serious Decline). *Kiwaia* 'plains jumper' has in fact been found on the neighbouring Mary Burn Pastoral Lease during a tenure review survey of that property (Alison Evans pers. comm.).

The threatened grasshopper *Sigaus minutus* (Data Deficient) has been noted near the Pukaki River (Simon Elkington pers. comm.), and has been seen in the Tekapo river, but not found on the south neighbouring property, Simons Hill Station (Morris 2001).

Invertebrate Fauna and Habitat Description

A total of 50 species of invertebrate were collected from Simons Pass Pastoral Lease, and of these nearly all were endemic or native. The invertebrates collected included: copepod, tadpole shrimp, centipede, pseudoscorpion, spiders, beetle, flies, bees, wasps, moth, butterfly and grasshoppers.

Invertebrate species observed on the Pastoral Lease are described below for the following collection sites:

- Lake Pukaki terminal moraine
- State Highway 8 northern corridor
- Footslopes of Mary Range and associated flats
- South-east part of property
- South-west part of property

Lake Pukaki terminal moraine

(i) Ice-scoured Terminal Moraine Face

The ice-scoured terminal moraine feature, directly above State Highway 8 overlooking Lake Pukaki, supports a community of native dryland shrubs. Here, a population of the threatened 'stealthy spider' *Taieria erebus* (Data Deficient) was found beneath stones. *Taieria erebus* is nationally widespread although little is known about its biology or systematics. Several specimens of the large vagrant hunting spider *Uliodon ?frenatus* (Zoropsidae; formerly Miturgidae), were also found beneath rocks and stones. The relative density of this spider here was the highest on the pastoral lease, and presumably the local habitat offers some greater ecological benefit than elsewhere on the property. *Uliodon* spiders are nocturnally active hunters and feed on small ground dwelling arthropods, such as slaters and beetles.

Three noteworthy beetle species were found at the western end of the terminal moraine face. These include the two carabids *Holcaspis bidentella* and *Metaglymma tersatum* and the darkling beetle *Mimopeus impressifrons.*

One species of grasshopper *Sigaus,* was found active on the sunny moraine slopes above the highway. These individuals were probably *Sigaus* species A (the 'notched grasshopper' which are members of the *Sigaus australis* complex (Morris 2002)) and are known only from the Mackenzie Basin. There was a distinct bi-modal age structure to the population, with numerous first and second moult nymphs and few adults, the latter were possibly over-wintered individuals.

Of the few moths and butterflies active this early in the season, tussock ringlet butterflies and tussock moths (*Orocrambus flexuosellus*) were common. Both are widespread in the high country, reflecting a presence of host plants (e.g. *Poa* and *Festuca*).

(ii) Hummocky moraines of Lake Block
This area comprises of hummocky moraines, with rocky outcrops common on north-west facing hummocks, and kettlehole depressions. Fescue tussockland is the dominant vegetation cover, with shrub species present on rocky knolls, and wetland turfland vegetation at the margins of the ephemeral tarns.

The majority of invertebrates collected from this area are associated with kettlehole and rock outcrop habitats.

Three endemic spider species were collected. These included a Linyphiid (*Latesia* sp.), the common native wolf spider *Anoteropsis hilaris* and a native Agelenid (*Neoramia* sp.). The wolf spider and Agelenid are both typical of this open grassland habitat. A surprising find was the sheet-web spider *Cambridgea antipodiana* (Stiphidiidae). This species is typically a forest dwelling spider (although it may occupy houses and buildings). A fifth spider of note was a species of jumping spider in the genus *Holoplatys*. This spider species has been found in a range of habitats from lowland flax-bush communities to semi-arid rocky outcrops in the sub-alpine zone. These characteristically flattened spiders occupy crevices and fissures within rocky outcrops (Forster and Forster 1999).

Nearly all rock outcrops surveyed supported dozens of native Pseudoscorpions (*Philomaoria novazealandica*) and the darkling beetle (*Mimopeus impressifrons*), which is endemic to the Mackenzie basin and North Otago (Watt 1992).

Two carabid beetles of conservation interest were found in the moraine area. A single specimen of *Holcaspis bidentella* was collected beneath stones near to a tarn. This beetle species is a local endemic and is of conservation interest due to its restricted distribution, limited biological data and negative susceptibility to habitat disturbance (Johns 2003). Similarly, the larger ground beetle *Metaglymma tersatum*, a Mackenzie Basin endemic, shares many ecological vulnerabilities with *H. bidentella.*

Muscid flies and root gnats (Sciriidae) were the only insect taxa recorded by yellow pan trapping beside a tarn. Such low catches probably reflect the early-season visit to this property. By contrast, numerous tussock ringlet butterflies (*Argyrophenga antipodum*) were seen in flight near the western boundary of the Pastoral Lease. This species was seen only here and at the triangle of land beside the Hayman Road turnoff.

The majority of the gently sloping moraine surface closer to the Farm Block has been over-sown, and is now a modified fescue tussockland with pasture species dominating the intertussock

spaces. Scattered porcupine and matagouri are present. The area was being grazed at the time of inspection, and invertebrates recorded were representative of typical grassland species. Examples include the common native grass grub beetle *Costelytra zealandica*, tussock moths (*Orocrambus* spp.) and blowflies.

South of Trig TT, a large porcupine shrub was flowering with dense clusters of dance flies (Empididae) active on the florets. Dance flies are typically associated with water or damp habitats where males display leking behaviour, appearing to dance up and down while offering females silk-wrapped food packages as a mating 'offering' (Le Bas *et. al.* 2004). The larvae are largely predatory (although some are scavengers) and they occupy a wide range of habitats, both aquatic and terrestrial. Female Empidid flies commonly feed on flower nectar and pollen (Cumming 1994; Elberling and Olesen 1999) and New Zealand Empidids are known to visit matagouri, *Hebe* and manuka wherein they may play a pollination role (Primack 1983). The flies found on the porcupine shrubs throughout the property, belong to the genus *Hilara,* which is common in the northern hemisphere. However New Zealand Empididae are in need of further study as the original work was conducted in 1928 (Collin 1928).

A rock outcrop near the western point of the Farm Block supports two specimens of the distinctively flattened jumping spider *Holoplatys* sp. These native spiders are relatively common in the eastern South Island high country where they inhabit crevices and slots within rocky outcrops. Similarly, numerous individuals of the xerophilic darkling beetle *Mimopeus impressifrons* were also found beneath loose rock at this location. Both taxa are representative of the few invertebrate guilds able to tolerate the dry freeze/thaw environment at this location.

Footslopes of Mary Range

This eastern protrusion of the Pastoral Lease onto the footslopes of the Mary Range covers the highest spot elevation (680m). A native shrubland, dominated by matagouri, mingimingi, common broom, and scattered *Coprosma intertexta* and tree daisy, occupies the main gully, extending up from the watercourse onto the south east facing hillslope. Porcupine shrub and sweet briar occur at the edge of the shrubland. A number of tussock ringlet butterflies (*Argyrophenga antipodum*), two species of tussock moth (*Orocrambus flexuosellus* and a species of *Eudonia:*Pyralidae) were active here. The presence of tree daisy in the gully was significant because by far the majority of tree daisy species are obligate hosts to numerous native moth taxa (Patrick 1994; 2000; Derraik *et. al.* 2003). Determining the full suite of moths associated with the *Olearia* within this area would necessitate repeated visits throughout the summer.

On a spur above the shrubland, small rocky outcrops and grazed short tussockland are present. In general, this type of habitat usually supports invertebrate taxa that form specific trophic guilds including primary consumers, scavengers and predators. Of the few invertebrate species collected, beetles were the most conspicuous, particularly the predatory Carabid *Metaglymma tersatum* and the scavenger *Mimopeus impressifrons*. The beetles were found beneath stones occasionally sharing the same cavity as the native soil centipede *Zelanophilus provocator*.

South-east part of Property

The fluvio-glacial outwash plain at the southern-eastern end of the property is arid, with relatively poor vegetation cover. In general few invertebrate species were found. Three common native invertebrates were recorded under rocks: the soil centipede *Zelanophilus provocator*, the southern

ant *Monomorium antarcticum* and the ubiquitous wolf spider *Anoteropsis hilaris*. Numerous Muscid flies and Pyralid moths (*Diasema grammalis*) were present.

The ephemeral tarn depression habitat that supports a large population of the threatened spring annual herb M*yosurus minimus* subsp. *minimus* (New Zealand mousetail), was notable for the abundance of *Hilaris* dance flies found on the flower heads. The flies were presumably acquiring pollen and/or nectar. A relationship, which may well have some important ecological function, exists between the flies, the herb and the periodic submerging of the hollow.

A single red admiral butterfly (*Vanessa gonerilla* ex. *Bassaris*), was seen flying near a large porcupine shrub on a terrace riser on the outwash plain. This individual was probably an over-wintered adult, and was possibly in search of the larval host plant *Urtica aspera* (southern nettle), which is found growing on the nearby Mary Range. *Vanessa gonerilla* is native to New Zealand and the species is found in a wide variety of habitats.

Dense clusters of *Hilaris* dance flies were recorded on the florets of porcupine shrub. Although it is unlikely the flies are traveling sufficiently far to effect widespread cross-pollination, indeed, they may well be promoting self pollination.

South-west part of property

This part of the property has some of the more arid and least vegetated habitats of the property. However, they also included some of the most productive places for threatened invertebrate species and others of conservation interest.

(i) Old terminal moraine and boulders
A band of old terminal moraine with large boulders, is present to the south of the Farm Block. A modified fescue tussockland is the dominant vegetation cover, with native shrub species associated with the boulders. The forest green grasshopper *Sigaus* species A (Morris 2002) was collected here. This undescribed species falls within the *Sigaus australis* complex and was first highlighted by Collen Jamieson, who found the grasshopper on old gold tailings near Alexandra and Muttontown, Central Otago (Jamieson 1999). Genetic information (using DNA sequencing) and morphological analysis should, in the future, confirm the status of this taxon.

Additional species of conservation interest found here include the spider *Taieria erebus*, the Carabid *Metaglymma tersatum* and the darkling beetle *Mimopeus impressifrons*.

(ii) Pukaki Low Terraces
The threatened grasshopper, *Sigaus minutus* (Gradual Decline) was frequently seen on the Pukaki low terraces, within 500 m of the Pukaki riverbed. *Sigaus minutus* is endemic to the eastern South Island high country and collection records suggest their distribution is confined to central Canterbury and Central Otago.

Despite the local relative abundance of *S. minutus,* this grasshopper is susceptible to habitat modification including over sowing, irrigation and forestry plantation (Jamieson 1996). The Otago population also appears to be restricted to locations that support the cushion plant *Raoulia australis*, which the grasshoppers use for oviposition and as an alternative food source (Jamieson 1996).

Additional species of conservation interest found on the Pukaki low terraces include the Carabid *Metaglymma tersatum* and the darkling beetle *Mimopeus impressifrons*.

(iii) Southern outwash plain
The threatened grasshopper *Sigaus minutus* is present on the fluvio-glacial outwash plain at the south-western end of the property. The Carabid *Metaglymma tersatum* of conservation interest was found on the south western outwash plain.

Significance of Invertebrate Values

50 species of invertebrate were collected from Simons Pass Pastoral Lease, and of these nearly all were endemic or native. The property supports some extreme habitats including ephemeral tarns, arid river beds and shrublands. Within these habitats, two threatened species are listed on the most recent classification system (Hitchmough et al 2007) and two species are regionally significant (see Table 6 below), each contributing to a diverse and regionally significant invertebrate fauna. Significant invertebrate fauna are shown on the attached Invertebrate Values map.

Although locally common in the Mackenzie Basin and parts of Otago, *Sigaus minutus* is ranked Gradual Decline because it has isolated populations and is restricted to remnant areas of habitat. This species is present in low numbers.(McGuinness 2001).

Although *Taieria erebus* is widespread throughout New Zealand, little is known of its basic biology, taxonomic provenance and relationships to Australasian Gnaphosids. The species is more common in forest (Forster & Blest 1979).

The beetle *Holcaspis bidentella* is a local endemic and is of conservation interest due to its restricted distribution, limited biological data and negative susceptibility to habitat disturbance (Johns 2003). Similarly, the larger ground beetle *Metaglymma tersatum,* also a Mackenzie Basin endemic, shares many ecological vulnerabilities with *H. bidentella.*

Darkling beetle *Mimopeus impressifrons* is of interest as it is endemic to Mackenzie Basin and North Otago, and is at the northern extent of its distribution. It favours dry stony habitat, and, being flightless, will become scarce as this habitat is lost through land conversion to irrigated pastures.

The sheet-web spider *Cambridgea antipodiana* (Stiphidiidae), recorded in fescue tussockland, is typically a forest dwelling spider. Finding a specimen in the arid grasslands of Simons Pass Pastoral Lease has intrinsic value**.**

Table 6: Notable invertebrate species found on Simons Pass Pastoral Lease

Threat Division	Threat Category	Species	Location on Lease/ Comments
Chronically Threatened	Gradual Decline	*Sigaus minutus* Bigelow. Grasshopper	South-west part of property: band of old terminal moraine and boulders Pukaki low terraces; and fluvio-glacial outwash plain
At Risk	Data deficient	*Taieria erebus* Koch L. Spider	Terminal moraine face near State Highway 8; old band of terminal moraine south of Farm Block

Regionally significant: endemic to Mackenzie Basin	*Holcaspis bidentella* Johns. Beetle	Under rocks near tarn in Lake Block; hummocky moraines; terminal moraine beside State Highway 8; band of old terminal moraine south of Farm Block. Previously collected from neighbouring Simons Hill pastoral lease.
	Metaglymma tersatum Broun. Beetle	Under rocks near tarn on terminal moraine faces beside State Highway 8; foothills of Mary Range; rocky outcrop west of Farm Block; Pukaki River low terraces, band of old terminal moraine south of Farm Block, and south-western fluvio-glacial outwash plain.

Map : Significant Invertebrate Values

2.6.5 Problem Animals

Introduced animals that may have a significant effect on indigenous animal (see Sanders, M. D., and Maloney, R. F. (2002); Norbury, G. 2001) or plant communities on the property are listed below. Some of these can be more readily controlled or contained than others.

Rabbits and hares
All parts of the property, particularly the stony outwash terraces, are prone to rabbit and hare infestations. Both appeared common at the time of the field survey, and with increasing rabbit populations following the recovery from the rabbit calicivirus disease, rabbits in particular could quickly become a significant problem. Browsing of shrubland species may be attributed to rabbits and hares, as well as stock, during the long period of snow lie in Winter 2006. Rabbits and hares, however, may make a positive contribution to the maintenance of exotic turfland habitats occupied by threatened spring annual plant species. Elsewhere, control of rabbits and hares is likely to be required to protect conservation values

Hedgehog
Hedgehogs appear to be common on the property, based on the number of scats observed. Hedgehogs predate on invertebrates, lizards and eggs of ground-nesting birds.

Feral cats, stoats, weasels and rats
Feral cats, stoats, weasels and rats all predate on invertebrates, lizards and eggs of ground-nesting birds. The impact of feral cats on native fauna is most marked when rabbit numbers have recently fallen.

Possum
Possum sign (droppings) was observed at rock outcrops, boulderfields and talus. Possum browse on native shrubland species, and likely predate on native invertebrate and lizard species.

Wallaby
Wallaby have been sighted in the adjacent Pukaki River bed, and may, from time to time, cross the property. Their likely impact in unknown.

2.7 HISTORIC

2.7.1 Maori Cultural Values

The first settlers in the region were the Maori as they travelled through the Mackenzie Basin in search of seasonal food resources. They were able to give early pakeha visitors information about the local geography in terms of good eeling and weka hunting spots, river crossings, and even where coal deposits existed (Whelan 1989). There are numerous records of Maori archaeological sites in the Mackenzie Basin, but not necessarily from the pastoral lease. Simons Pass however, was named after Simon, a Banks Peninsula Maori or half-caste, who was part of a group who crossed the pass in 1856 to occupy Marys Range, the first Mackenzie Country Station.

2.7.2 Pakeha Heritage Values

Simons Pass was first settled in 1856. At this time, the Station included Simons Hill, which was balloted off in about 1911. There are three areas of historic interest on the property: the rabbit fence, Bullock Track and remnants of the Pukaki River Inn.

The rabbit fence was built in 1888 and extended from Lake Pukaki to the Hakataramea Valley. It was built following concerns by the then Commissioner of Crown Lands that rabbits had eaten out a lot of country around Omarama and would soon move north and over-run all Crown lands in the Rangitata and northern Waitaki. Men and huts were placed at 10 mile intervals along the length of the fence to keep it in good condition. The fence is constructed using materials considerably thicker than materials used today, resulting in a very solid fence.

The Bullock Track is the original road through the Mackenzie Basin, and goes from Burkes Pass, via at least four properties in a south-west direction, before crossing Simons Pass. It is visible from the air crossing an ephemeral channel on the outwash plain at the eastern side of the pastoral lease. The track is visible from the ground further west, where its formation can be seen cutting down from the side of a gully from the outwash plain to the low terraces of the Pukaki River, in the vicinity of the old Pukaki Inn chimney.

An old chimney is located beside the Pukaki River, where the Bullock Track drops down to the river. This chimney probably originates form the second inn at this site, and comes from the building that was constructed in the 1920s. The earlier building, the first inn, was constructed in the early 1860s, and was removed with the creation of the hydro-electric scheme. The chimney is constructed of concrete, having been cast on site in five or six layers over a wooden framework, and subsequently smoothed off where it must have been visible within the inn.

Significance of Historic Values

Significant historic values are shown on the attached Historic and Recreation Values map. The rabbit fence is a unique example of the Government taking an active and financial interest in the nineteenth century's rabbit problem. No subsequent rabbit fence has been built on this scale. The fence is notable for using materials considerably different from those used today. It is an interesting example of historical fencing at a scale not otherwise known. The rabbit fence is significant because of its rarity and strong association with the first explosion in rabbit numbers in the Waitaki Basin.

The Bullock Track is of significance, being the original route across the Mackenzie Basin.

These two locations on the property have significance as archaeological sites under the Historic Places Act (1993) for human activity that occurred before 1900.

The old chimney is all that is left of the second Pukaki Inn, which provided shelter for travellers stopping at the Pukaki River ferry crossing. The chimney therefore has significance in that it has an association with historical travel through the Mackenzie Basin.

2.8 PUBLIC RECREATION

2.8.1 Physical Characteristics

The property can be divided into two main recreation units:

Terminal Moraine Unit

This unit covers the terminal moraines that are situated on the northern part of the property. The moraine landform is distinct with kettleholes and alluvial outwash channels. The vegetation cover includes shrublands on steep bouldery moraine faces, with fescue tussockland being the most widespread cover. Turf vegetation occupies the margins of kettleholes, which are scattered through this unit. Low growing herbfields occupy the outwash channels. The elevation of the moraine provides good views of the Mackenzie Basin and surrounding ranges including the Main Divide on a clear day.

The setting for this unit is predominantly cultural due to power and telephone utilities, the farming influence and the presence of the Tekapo – Twizel Road (State Highway 8) close by.

Outwash Plains Unit

This unit covers the flat outwash plains south of the moraines. The flatness of the outwash plain is distinct and contrasts with the adjacent moraine landform. Depleted fescue tussockland is localised, with exotic herbfield (with a native plant component) being the most common vegetation cover. Moss and lichenfields occupy the Low Terraces beside the Pukaki River. Shrublands are common at the base of terrace risers. Good views of the Mackenzie Basin can be obtained from this unit.

The setting for this unit is predominantly cultural due to the presence of power utilities and the influence of farming.

2.8.2 Legal Access

Roads

The Tekapo – Twizel Road (State Highway 8) runs alongside the northern boundary of the Pastoral Lease providing access. A portion of the old graveled highway adjoins the northern property boundary east of Dover Pass, for approximately 3 km, where the modern State Highway 8 has taken a new alignment. A formed legal gravel road runs alongside the true left hand bank of the Pukaki River and provides access to the western boundary of the Pastoral Lease.

Several unformed legal roads are present in the southern and eastern parts of the property (see Map 1). One dissects the property from west to east across the outwash plains west of Simons Pass. This road continues eastwards towards Simons Pass. A second unformed legal road crosses this legal road, running in a north-south direction along the south-eastern property boundary, before crossing freehold cultivated land to reach State Highway 8, opposite the Simons Pass homestead. Another unformed legal road branches off the main west-east road in the south-eastern corner of the property, before crossing the southern property boundary.

Adjoining Crown and Public Conservation Land

Simons Pass Pastoral Lease adjoins Lake Pukaki Terminal Moraine Conservation Area at the north-western end of the property. Opposite the south western corner of the property, on the true right hand side of the Pukaki River is the Pukaki Flats Conservation Area.

Marginal Strips

Pukaki River, located at the property's western boundary, has a marginal strip. No marginal strips appear to be present along streams within the property boundaries.

2.8.3 Activities

There are no current recreation permits issued for the pastoral lease. Hunting (for rabbits and hares) has been undertaken in the past. The pylon track is occasionally used by bikers and walkers to cross the outwash plain between Simons Pass and the Pukaki River, en route for Twizel.

The formed legal road, located on the true left of the Pukaki River, is utilised by four wheel drivers and mountain bikers for access down the river bed.

The farm track that follows a meltwater channel through the hummocky moraines from State Highway 8, to the outwash plain and low terraces of the Pukaki River provides an interesting setting for family mountain biking, walking or horse riding.

The Te Araroa (The Long Pathway) Trail traverses the Pukaki Flats Conservation Area, then continues along the road that follows the true right bank of the Pukaki River to the Tekapo – Twizel Road (State Highway 8). The trail then continues alongside the Pukaki lakeshore through to the Pukaki Power Station northeast of the property. There are opportunities on the property (e.g. by following the farm track described above) to provide a more interesting linkage for the Te Araroa Trail between the Pukaki River and Lake Pukaki.

The old Bullock Track is visible in places, cutting across the outwash plain and terraces. This track would provide an interesting route for recreationists to follow in the footsteps of early travellers crossing this vast landscape.

Significance of Recreation Values

Significant recreational routes are shown on the attached Historic and Recreation Values map.

The terminal moraines at the northern end of the property provide a unique setting and opportunity for recreation because of their close proximity to the tourist route Tekapo – Twizel Road (State Highway 8) and the connection they have with the Lake Pukaki Terminal Moraine Conservation Area.

The Pastoral Lease, by virtue of location, is strategic in providing an interesting alternative linkage between the Pukaki River and Lake Pukaki for the Te Araroa (The Long Pathway) Trail.

The old Bullock Track provides an interesting route for recreationists to follow in the footsteps of early travellers crossing this vast outwash plain landscape.

Parts of the formed Pukaki River gravel road located on the property does not coincide with the alignment of the legal road. This gravel road provides significant recreational access to the Pukaki River bed from Lake Pukaki to the Tekapo River junction.

Map : Historic and Recreation Values

PART 3: OTHER RELEVANT MATTERS & PLANS

3.1 CONSULTATION

The property was discussed at NGO early warning meetings held in Christchurch on 4th September, and Geraldine on 5th September 2006.The main points raised during these meetings were:

- The presence of an historic bullock track on the property, which had a ferry crossing over the Pukaki River, was noted.
- No tramping occurs on the property. The nearest use occurs as a traverse to Mt Mary.
- Good road access along the Pukaki River boundary is important. This road provides good opportunities for mountain biking.
- The Te Aroroa national walkway is nearby, passing the northern property boundary by Lake Pukaki's edge.
- The Pastoral Lease offers accessible recreation for mainstream New Zealanders.
- Terminal moraine deposits are present by the lake.
- Protection of lake foreshore is required.
- Short tussock grasslands need protection.
- Connections need to be made with the Pukaki Flats Conservation Area across the Pukaki River and the short tussocklands on the property.
- Prostrate kowhai is present on the property (survey done by Brian Molloy).
- Wetland areas need consideration for protection.
- A strong invertebrate focus is required.
- The riverlands are under an Environment Canterbury Management Plan. The degraded area (about one third of the property), is under a significant management plan. (This is for a term of twenty years which expires in April 2010).
- Other Acts cannot be relied on to protect values in the area.
- Landscape values identified as requiring protection include: towards the lake, along State Highway 8; and lowland areas.
- Scenic values need protection to prevent residential development along the Highway.

3.2 DISTRICT PLANS

Simons Pass Pastoral Lease lies within the Rural Zone of the Mackenzie District Plan 2004.

Sites of Natural Significance listed in the Mackenzie District Plan that lie on or adjacent to the property are:

- SV16 – Simons Pass. Scenic Viewing area providing views to the south to Lake Benmore.
- H44 – Pukaki Inn Chimney. Mackenzie District Plan classification 'Z'.

3.3 CONSERVATION MANAGEMENT STRATEGIES & PLANS

The Canterbury Conservancy of DOC has prepared a Conservation Management Strategy (CMS) which was approved by the Minister of Conservation in 2000.

Simons Pass Pastoral Lease lies within the Waitaki Unit of the CMS. Key priorities for this unit are listed as:

- To identify, maintain and seek to enhance the natural landscape values of the unit through appropriate methods such as tenure review and district plans.
- To identify the significant native vegetation and threatened species of the unit and to use a range of effective methods to protect a representative range of indigenous biodiversity of the unit, as well as protecting and enhancing the viability of priority threatened species populations and their habitats in the Unit.
- To provide new recreational facilities and opportunities by the Department and other organizations and concessionaires where natural and historic resources and cultural values are not compromised, and to liaise with adjacent landholders to resolve conflicts over access for recreation to land managed by the Department.
- To reduce and maintain rabbit and tahr densities to levels that ensure their adverse effects on natural values are minimized.

3.4 NEW ZEALAND BIODIVERSITY STRATEGY

The New Zealand Government is a signatory to the Convention on Biological Diversity. In February 2000, Government released the New Zealand Biodiversity Strategy which is a blueprint for managing the country's diversity of species and habitats and sets a number of goals to achieve this aim. Of particular relevance to tenure review, is goal three which states:

-Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments, and do what is necessary to:-

-Maintain and restore viable populations of all indigenous species across their natural range and maintain their genetic diversity.

The strategy outlines action plans to achieve this goal covering terrestrial and freshwater habitat and ecosystem protection, sympathetic management, pest management, terrestrial and freshwater habitat restoration, threatened terrestrial and freshwater species management.

PART 4: ATTACHMENTS

4.1 ADDITIONAL INFORMATION

4.1.1 Summary of Land Environments of New Zealand Units present on Simons Pass Pastoral Lease.

From Leathwick, J., F. Morgan, G. Wilson, D. Rutledge, M. McLeod and K. Johnston. 2002: Land Environments of New Zealand. Technical Guide. Ministry for the Environment.

Level IV Environment	Description
E1.4d	Steep inland foothills from Marlborough south to mid-Canterbury. Mild temps, high solar radiation, high annual water deficits. Well-drained soils of moderate fertility; from greywacke.
E3.1a	Easy rolling foothills of northern and mid-Canterbury. Cool temps, moderate solar radiation, moderate vapour pressure deficits, slight annual water deficits. Imperfectly drained soils of moderate fertility from loess from greywacke and schist.
E4.1b	Gently undulating foothills of central South Island, east of Southern Alps. Cool temps, high solar radiation, high vapour pressure deficits, very low monthly water balance ratios, moderate annual water deficits. Well drained high fertility soils from greywacke alluvium with some loess, colluvium and till.
E4.2b	Easy rolling hills of central South Island, east of Southern Alps, closer to the coast. Mild temps, high solar radiation, moderate vapour pressure deficits, lower monthly water balance ratios, moderate annual water deficits. Well drained high fertility soils from greywacke alluvium with some loess, colluvium and till.
N2.1a	Flat plains of north of Timaru to Christchurch. Mild temps, moderate solar radiation, high vapour pressure deficits, moderate annual water deficits. Well drained soils of high fertility from greywacke gravels with some loess.
N4.1c	Steep lower hillslopes of Central Otago, Alexandra, Lake Waitaki. Cool temps, moderate solar radiation, moderate vapour pressure deficits, very low monthly water balance ratios, low annual water deficits.
N6.1a	Recent soils on gently undulating plains between Twizel and Lake Tekapo. Cool temps, moderate levels of solar radiation, high vapour pressure deficits, moderate annual water deficits. Well-drained soils of high fertility, from greywacke gravels, loess and colluvium.
N6.1b	Older soils on gently undulating plains between Twizel and Lake Tekapo. Cool temps, moderate levels of solar radiation, high vapour pressure deficits, moderate annual water deficits. Well-drained soils of high fertility, from greywacke gravels, loess and colluvium.

4.1.2 Plant Species referred to in text.

Species names follow those in the published volumes of New Zealand Flora and the name changes listed in A Checklist of Indigenous Vascular Plants of New Zealand, 10th Revision (*Unpublished Document*, S. Courtney, Department of Conservation, Nelson). Maori names are included for taonga species listed in Schedule 97 of the Ngai Tahu Claims Settlement Act 1998. Naturalised species are indicated by an asterisk (*).

Species name	Common name
Woody Sub-shrubs, Shrubs and Trees	
Aristotelia fruticosa	Mountain wineberry
Carmichaelia crassicaule	Coral broom
Carmichaelia nana	Mat broom
Carmichaelia petriei	Common broom
Carmichaelia vexillata	Dwarf broom
Coprosma cheesemanii	
Coprosma intertexta	
Coprosma perpusilla subsp. perspusilla	Mat Coprosma
Coprosma petriei	Mat Coprosma
Coprosma propinqua	
Coprosma rigida	
Coprosma virescens	
Corokia cotoneaster	Corokia
*Cytisus scoparius**	European broom
Discaria toumatou	Matagouri
*Larix deciduas**	Larch
Leucopogon fraseri	Patotara
Leucopogon nanum	Dwarf patotara
Melicytus alpinus	Porcupine shrub
Olearia odorata	Common tree daisy
Ozothamnus leptophylla	Cottonwood; tauhinu
Pimelea "eastern South Island"	Native daphne
Pimelea prostrata	Native daphne
Pimelea pulvinaris	Cushion daphne
*Pinus contorta**	Contorta pine
*Pinus nigra**	
*Pinus ponderosa**	Ponderosa pine
*Pseudotsuga menziesii**	Douglas fir
*Rosa rubiginosa**	Sweet briar
*Salix fragilis**	Crack willow
Sophora prostrata	Prostrate kowhai
*Sorbus aucuparia**	Rowan
*Ulex europeaus**	Gorse
Lianes	
Clematis marata	Clematis
Muehlenbeckia axillaris	Creeping pohuehue
Muehlenbeckia complexa	Scrub pohuehue

Rubus schmidelioides	Bush lawyer
Herbaceous Plants	
Abrotanella caespitosa	
*Aceana agnipila**	Sheep's burnett
Aceana buchananii	Buchanan's bidibid
Aceana caesiiglauca	Bidibid
Aciphylla aurea	Golden speargrass
Aciphylla subflabellata	Swamp speargrass
Anisotome aromatica	Kopoti
*Aphanes arvensis**	Parsley piert
Cardamine debilis	
Celmisia gracilenta	Dainty daisy
*Cerastium fontanum**	Mouse–ear chickweed
Ceratocephala pungens	
*Cirsium vulgare**	Scotch thistle
Colobanthus buchananii	
Colobanthus strictus	
Convolvulus verecundus	
Crassula sinclairii	
Dichondra brevifolia	
Dichondra repens	
Epilobium angustum,	
Epilobium uniflora	
*Erodium cicutarium**	Storksbill
*Erophila verna**	Whitlow's grass
Euchiton traversii	Gnapweed
Galium perpusillum	
Geranium sessiliflorum	
Gnaphalium audax	Gnapweed
Helichrysum filicaule	
*Hieracium pilosella**	Mouse–ear hawkweed
*Hieracium praealtum**	King devil hawkweed
Hydrocotyle hetermira	
Lepidium sysimbrioides subsp. sysimbrioides	Native cress
Leptinella serrulata	Dryland button daisy
Limosella lineata	Mudwort
*Marrubium vulgare**	Horehound
*Myosotis discolour**	Forget-me-not
*Myosotis laxa subsp caespitose**	Forget-me-not
Myosotis pygmea var minutiflora	Native forget-me-not
Myosurus minimus var. minimus	New Zealand mousetail
Neopaxia erythrophylla	
Neopaxia lineariifolia	
Plantago novae zealandiae	Plantain
Prasophyllum colensoi	Onion leaved orchid

Pratia perpusilla	
Ranunculus multiscapus	Grassland buttercup
Raoulia australis	Scab weed
Raoulia beauverdii	Mat daisy
Raoulia hookeri	Mat daisy
Raoulia monroi	Mat daisy
Raoulia parkii	Mat daisy
Raoulia subsericea	Mat daisy
*Rumex acetosella**	Sheep sorrel
Rumex flexuosus	Native bindweed
*Sagina procumbens**	Peartwort
Scleranthus uniflorus	
Stackhousia minima	
Stellaria gracilenta	
*Taraxacum officinale**	Dandelion
*Trifolium arvense**	Haresfoot trefoil
*Trifolium dubium**	Suckling clover
*Trifolium repens**	White clover
Thelymitra longifolia	White sun orchid
*Verbascum thapsus**	Woolly mullein
*Veronica arvensis**	Speedwell
*Veronica verna**	Speedwell
Viola filicaulis	Viola
*Vittadinia gracilis**	Fuzz weed
Wahlenbergia albomarginata	Hare bell

Grasses

*Agrostis capillaries**	Browntop
Agrostis muscosa	
*Agrostis tenuis**	Creeping bent
*Anthoxanthum odoratum**	Sweet vernal
Chionochloa rigida	Narrow leaved snow tussock
*Dactylis glomerata**	Cocksfoot
Deschampsia chapmanii	
Deyeuxia avenoides	
Elymus falcis	
Elymus solandri	Bluegrass
Festuca novae-zelandiae	Fescue tussock
*Festuca rubra**	Chewings fescue
*Glyceria fluitans**	Floating sweet grass
*Holcus lanatus**	Yorkshire fog
Poa cita	Silver tussock
Poa colensoi	Blue tussock
Poa maniototo	
*Poa pratensis**	Meadow grass
Pyrrhanthera exigua	Mountain twitch

Rytidosperma pumilum	
Rytidosperma sp. (unarede?)	Danthonia tussock
Sedges and Rushes	
Carex breviculmis	
Carex colensoi	
Carex flaviformis	
Carex gaudichaudiana	
Carex kaloides	
Carex muelleri	Mueller's sedge
*Carex ovalis**	Oval sedge
Carex resectans	
Carex secta	Pukio
Carex solandri	
*Juncus articulatus**	Jointed rush
*Juncus buffonius**	Toad rush
*Junus effuses**	Soft rush
Luzula celata	
Luzula rufa var albicomans	
Luzula ulophylla	
Schoenus concinnus	
Schoenus pauciflorus	Bog rush
Ferns	
Asplenium flabellifolium	Necklace fern
Blechnum penna-marina	Little hard fern
Cheilanthes humilis	Rock fern
Ophioglossum petiolata	Adder's tongue
Polystichum vestitum	Prickly shield fern
Pteridium esculentum	Bracken
Mosses and Lichens	
Polytrichum juniperinum	Wire moss
Racomitrium langinosum	
Chondropsis semi-viridis	Tumbling lichen

4.1.3. Animal Species referred to in text

Species names follow King (1990) for mammals, the June 2003 version of the New Zealand Recognized Bird Names list (compiled by C.J.R. Robertson and D.G. Medway for the Ornithological Society of New Zealand Inc.) for birds, Whitaker (1998) for lizards and McDowall (2000) for fish. Maori names are included for taonga species listed in Schedule 97 of the Ngai Tahu Claims Settlement Act 1998.

(@ not recorded from the property; * naturalized introduced species)

Australasian harrier	*Circus approximans*
Australasian pied stilt	*Himantopus himantopus leucocephalus*
Australian magpie*	*Gymnorhina tibicen*
Banded dotterel	*Charadirus bicinctus bicinctus*
Black billed gull @	*Larus bulleri*
Black fronted tern	*Sterna albostriata*
Black shag @	*Phalacrocorax carbo novaehollandiae*
Black stilt	*Himantopus novaezelandiae*
Blackbird*	*Turdus merula*
Brown trout*	*Salmo trutta*
Canada goose*	*Branta Canadensis maxima*
Canterbury galaxias@	*Galaxias vulgaris*
Caspian tern @	*Sterna caspia*
Cat*	*Felis catus*
Chaffinch*	*Fringilla coelebs*
Common bully @	*Gobiomorphus cotidianus*
Common skink	*Oligosoma nigriplantare polychroma*
Diving beetle	*Rhantus pulverosus*
Dunnock*	*Prunella modularis*
Goldfinch*	*Carduelis carduelis*
Green skink @	*Oligosoma chloronoton*
Greenfinch*	*Carduelis chloris*
Grey duck	*Anas superciliosa superciliosa*
Grey teal @	*Anas gracilis*
Grey warbler	*Gerygone igata*
Hare*	*Lepus europaeus*
Hedgehog*	*Erinaceus europaeus occidentalis*
House sparrow*	*Passer domesticus*
Jewelled gecko @	*Naultinus gemmeus*
Koaro	*Galaxias brevipinnis*
Little shag @	*Phalacrocorax melanoleucos brevirostris*
Longfin eel/tuna @	*Anguilla dieffenbachii*
Long-toed skink @	*Oligosoma longipes*
Mallard duck*	*Anas platyrhynchos platyrhynchos*
McCann's skink	*Oligosoma maccanni*
New Zealand falcon @	*Falco novaeseelandiae*
New Zealand pipit	*Anthus novaeseelandiae novaeseelandiae*
New Zealand shoveler @	*Anas rhynchotis variegata*
Paradise shelduck	*Tadorna variegata*
Possum*	*Trichosurus vulpercula*
Rabbit*	*Oryctolagus cuniculus cuniculus*
Rainbow trout @*	*Oncorhynchus mykiss*

Rat*	*Rattus norvegicus*
Redpoll*	*Carduelis flammea*
Scree skink [@]	*Oligosoma waimatense*
Silvereye	*Zosterops lateralis lateralis*
Skylark*	*Alauda arvensis*
Songthrush*	*Turdus philomelos*
South Island fantail [@]	*Rhipidura fuliginosa fuliginosa*
South Island pied oystercatcher	*Haematopus ostralegus finschi*
Southern Alps gecko	*Hoplodactylus "Southern Alps"*
Southern black backed gull	*Larus dominicanus dominicanus*
Spotted skink	*Oligosoma lineoocellatum*
Spur winged plover	*Vanellus miles novaehollandiae*
Starling*	*Sturnus vulgaris*
Stoat*	*Mustela eminea*
Tadpole shrimp	*Lepidurus apus viridis*
Upland bully[@]	*Gobiomorphus breviceps*
Wallaby[@]*	*Macropus sp.*
Weasel*	*Mustela nivalis*
Welcome swallow	*Hirundo tahitica neoxena*
White faced heron [@]	*Ardea novaehollandiae novaehollandiae*
Wrybill [@]	*Anarhynchus frontalis*
Yellow hammer*	*Emberiza citrinella*

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