MANIOTOTO ECOLOGICAL DISTRICT

A Survey Report for the

Protected Natural Areas Programme

Department of Conservation
Te Papa Atawhai

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Contents

SUMMARY

This report is compiled as part of the Protected Natural Areas Programme. It is an inventory of existing information on the floral, faunal and landform values of the Maniototo Ecological District supplemented with some field investigation. Ten Recommended Areas for Protection and eight Areas of Interest are identified within the District. Highlights of the District include the numerous remnant saline soil areas with their unique and rare flora and fauna; the extensive wetlands of the meandering upper Taieri River; and the low-altitude fescue tussock and red tussock grassland vegetation of the Manuherikia River valley above Falls Dam. Key insect habitats are also listed for the District. In addition, several important sites in adjacent parts of the Old Man and Manorburn Ecological Districts that were not identified in their respective survey reports are described here.

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While little field work was required, my thanks to those landholders whom we approached for allowing access over their properties.

All photos have been supplied by the Department of Conservation (Brian Patrick).

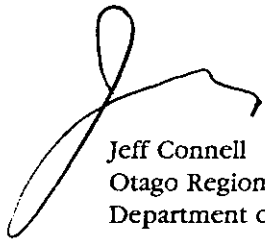
The Maniototo Ecological District covers the valley floors of Central Otago in the Manuherikia and upper Taieri catchments, and is the principal Central Otago valley floor area which has not been surveyed under the Protected Natural Areas Programme (PNAP). The district is reasonably well known, and is substantially modified from a natural state. On assessing the information available on the area, it was decided that a full scale survey was not appropriate, and that an inventory of existing information and scientific observations, along with some reconnaissance work, would provide the basis for PNAP implementation.

In 1994 the Department of Conservation contracted the author of this report, Philip Grove, to assess the conservation values of the Maniototo Ecological District.

The chief product of this report is the identification and description of a set of Recommended Areas for Protection (RAPs) or Areas of Interest (AOI). Collectively, these are intended to represent the remaining range of natural ecological diversity of the Maniototo Ecological District that is not already protected. They are the starting point for the implementation phase of the PNA programme. This will involve discussion and consultation, particularly with the landholders involved, aimed at negotiating protection of the conservation values of the areas identified, where appropriate. The Otago Conservancy of the Department of Conservation has a strong commitment to pursue the objectives of the PNA programme.

A Recommended Area for Protection or Area of Interest is as much a recommendation to the Department of Conservation as from it. Recommendations may be rejected or amended prior to their adoption as departmental proposals. Changes in recommendations may occur following the consultation process, or after consideration of other values the area and its vicinity may possess. The department will then endeavour to negotiate the proposals resulting from this process with the landholders concerned to achieve the appropriate form of protection for each area.

This report contains a great deal of information on the ecological values of the Maniototo Ecological District. It is a substantial reference work as well as a guide to conservation aspirations. It will be of wide interest to landholders, conservation managers from the department and other resource management agencies such as district and regional councils, scientists and the general public. It fills out some of the detail for the Otago Conservation Management Strategy.



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INTRODUCTION

SECTION

1

MANIOTOTO ECOLOGICAL DISTRICT SURVEY REPORT FOR PROTECTED NATURAL AREAS

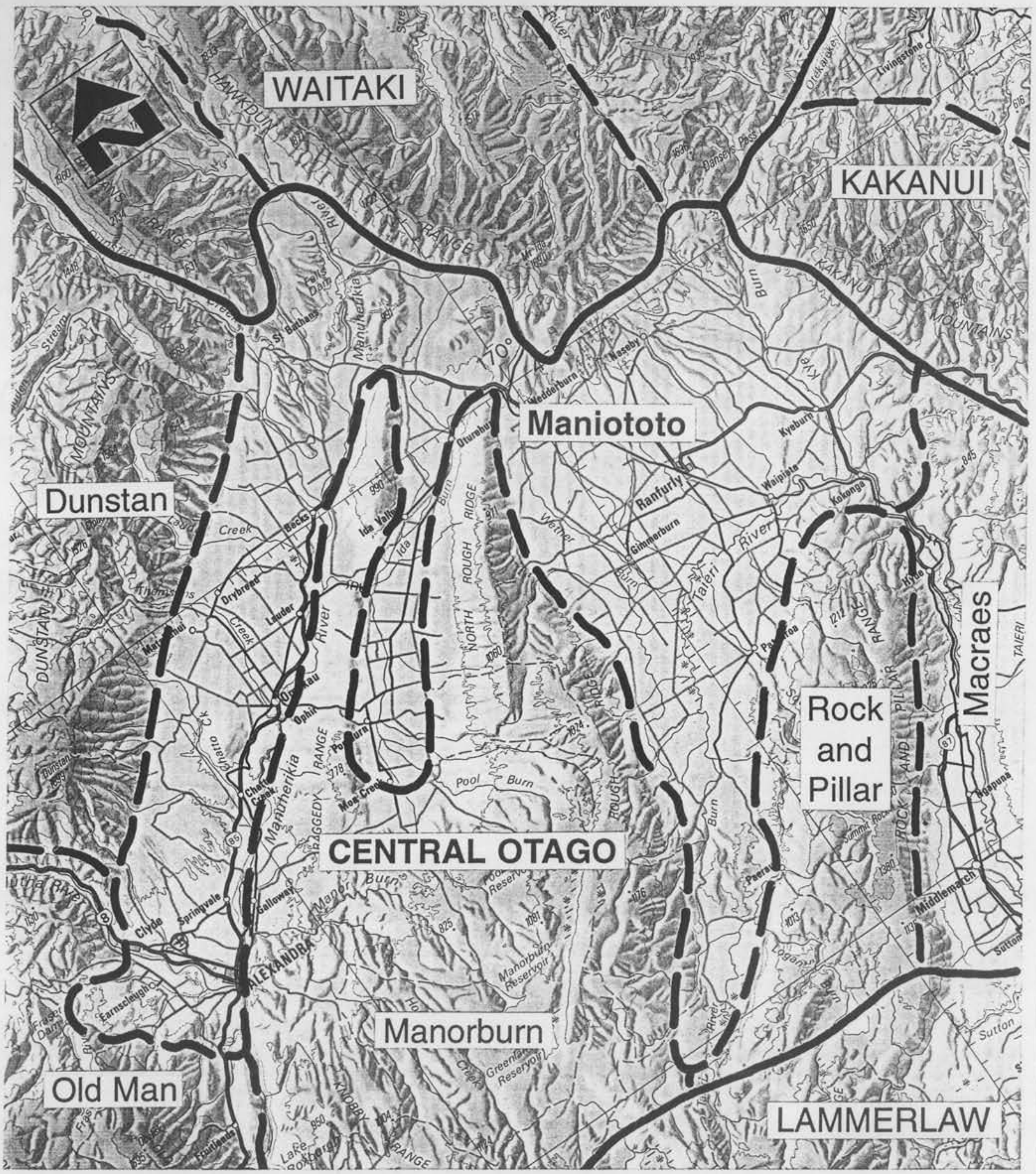
This report is part of the Protected Natural Areas (PNA) Programme which was initiated in 1983 with the object of "preservation of representative samples and classes of natural ecosystems and landscapes which in the aggregate originally gave New Zealand its own recognisable character" (Reserves Act 1977).

To assess and describe this diversity of natural ecosystems and landscapes, New Zealand has been divided into 85 ecological regions comprising 268 ecological districts (McEwen 1987). Each ecological district is a geographic area where the topographical, geological, climatic, soil and biological features produce a characteristic landscape and range of natural ecosystems. An ecological region is a group of adjacent ecological districts with closely related characteristics. It is the aim of the PNA Programme to survey each district to identify and protect the best, most representative remaining examples of its indigenous ecosystems.

Districts lacking significant protected areas and/or under threat of development were given high priority. In the South Island this has meant a focus from the start on the high country tussocklands east of the Southern Alps. Within the Central Otago Ecological Region all Districts (Rock and Pillar, Old Man, Manorburn, Dunstan, Lindis and Pisa) except the Maniototo have been surveyed. Hawkdun E.D. and Dansey E.D., adjoining the District to the north, have also been surveyed. The districts listed above all contain large areas of sparsely settled, relatively undeveloped upland and mountain country and retain a substantial proportion of their indigenous (although modified) vegetation.

Alas, the same can not be said for the Maniototo Ecological District, which probably explains why it has not yet been the subject of a full PNA survey. Yet as a lowland - montane area with many unique natural features (landforms, soils, flora and fauna) and a history of intensive and ongoing development, it is precisely the sort of district which deserves the urgent attention of the PNA programme. Fortunately many of these natural features are well-known and have been documented with some being afforded official protection. This report on the Maniototo District therefore follows a somewhat different methodology from earlier PNA survey reports. They generally started with an extensive period of field survey from which RAPs were identified and described in detail. By contrast, this is an inventory of existing information in the form of scientific reports and informed observation from sources within the Department of Conservation, Landcare Crown Research Institute, Otago Fish and Game Council and the University of Otago, supplemented with a small amount of field investigation to fill any perceived gaps in existing knowledge. By drawing this information together in one document and placing it within the context of the PNA Programme it is hoped that the best remaining examples of the Maniototo Ecological District's natural values will be clearly identified so they can be afforded the type of protection they require.

MANIOTOTO ECOLOGICAL DISTRICT - MAP 1



Maniototo — Ecological district boundary

CENTRAL OTAGO — Ecological region boundary

0 10 20 30 40
kilometres

MANIOTOTO ECOLOGICAL DISTRICT

SECTION 2

MANIOTOTO ECOLOGICAL DISTRICT SURVEY REPORT FOR PROTECTED NATURAL AREAS

2.1 AN OVERVIEW OF MANIOTOTO ECOLOGICAL DISTRICT

Maniototo Ecological District is an area of broad flat plains and low hills, surrounded by blockfaulted mountain and upland districts. The geology includes Cretaceous, Tertiary and late Quaternary deposits and the climate is subcontinental and semi-arid with severe summer droughts. Soils are also droughty and of variable thickness derived from loess over gravels and other parent materials. The soils show a leaching sequence with rainfall and there are localised saline soil patches with associated flora and fauna. Vegetation is mostly exotic pasture and weeds with small areas of depleted short tussockland, scrub and wetlands. Most of the District is grazed with exotic forest near Naseby and orchards near Alexandra.

Maniototo Ecological District (from McEwen 1987)

[Changes to the prescription are in square brackets]
Criteria: climate (severe summer droughts), topography (relatively low relief), vegetation, flora, geology.

Topography Extensive series of inland basins, mostly between 200 and 600m a.s.l., drained by Manuherikia River in the northwest and Taieri River in the east. Low convex ridges with schist outcrops, broad flat plains, meandering rivers; includes a few small inland salt patches.

Geology
Haast Schist basement, overlain (locally) by Cretaceous breccia and conglomerate, Tertiary sediments (quartz sand, clay, lignite), piedmont gravels and late Quaternary gravels and sand.

Climate
Sub-continental, semi-arid; rainfall 300-800mm p.a.; very warm, dry summers, cold winters.

Soils
In lower rainfall areas soils range from shallow to deep, stony, weakly leached, very droughty; calcium carbonate may occur in subsoils; areas of salty soils (saline soils and solonetzes). Under slightly higher rainfall soils moderately leached, shallow to deep and droughty in summer; deeper soils have pale-coloured compact subsoils. In higher rainfall areas of the north soils strongly leached with browner, more friable subsoils; droughts uncommon. Soils from basalt with cover of loess have clayey textured dark-coloured subsoils in the east; areas of alluvial soils on river flats.

Vegetation / modifications
Has been burnt frequently: mainly depleted lowland short tussockland (hard and silver tussock with scabweed; snow tussock on lower slopes of the Hawkdun Range and Taieri Ridge), often extensive scrub communities: matagouri, *Aciphylla aurea* over most unimproved lands; sweet brier and thyme abundant especially in west; other scrub species include *Coprosma propinqua, C. intertexta, Olearia odorata, O. virgata* var. *rugosa [O. bullata], O. lineata; Hymenanthera alpina [Melicytus alpinus]* is major shrub of exposed rocks; snow tussock (*Chionochloa rigida*) occurs where fires less frequent, probably more common originally; mainly exotic pasture species and weeds on lowlands; extensive rush/sedge swamps around Taieri River meanders, much modified by crack willow. No indigenous forests; some exotic forests near Naseby. Most of district grazed (mostly extensive sheep and cattle; orchards in the Manuherikia Valley.

Birds
The almost complete absence of forest remnants means there are no forest birds of note in this district. Falcon present in low numbers in the foothills of surrounding ranges; Black-fronted Dotterel and Pied Stilt breed in the Manuherikia River; the upper Taieri wetlands provide important habitat for a wide range of waterfowl.

Reptiles

Green gecko, probably jewelled gecko (*Heteropholis gemmeus*), have been found near Oturehua. Green skink (*Leiolopisma chloronoton)* occurs near Oturehua and Falls Dam.

Insects

Include very rare giant carabid beetle (*Mecodema laeviceps*), endemic to area of Ida Valley (under big stones in tussock); the grass moth *Orocrambus lindsayi* is known only from Mt Ida [Hawkdun E.D.].

2.2 BOUNDARY DEFINITION

The boundary of the Maniototo Ecological District has been defined to an extent by default, being the montane and lowland areas leftover from adjacent mountain and/or hill country districts. In its original form on the 1:500 000 topographical map (Department of Lands and Survey 1981), the District embraced the Manuherikia Valley from c.5km below the confluence of the rivers east and west branches to its junction with the Clutha River; the Ida Valley; the Maniototo Plains; and the Strath Taieri Plain, with the District's eastern boundary running along the top of Taieri Ridge. With the exception of this eastern margin, the boundary followed, for the most part, the base of the block-faulted mountain ranges and uplands which characterise inland Otago.

A PNA survey of the adjacent Manorburn Ecological District (Fagan & Pillai 1992) resulted in two boundary changes which affected the Maniototo District. Firstly, the Styx Basin, previously included in the Manorburn District, was placed in the Maniototo E.D. because the landform of meandering river and oxbows is similar to that of the Maniototo Basin. Secondly, Blackstone Hill, formerly part of Maniototo E.D. was included in Manorburn District, as a result of its similarity with north Rough Ridge and dissimilarity with the rest of Maniototo District which consists largely of broad basin floors with low hills. The new boundary is taken as the foot of the Blackstone Hill slope. The Hawkdun Ecological District survey report (Grove 1992) included Little Mt Ida within the Hawkdun District but left the nearby Home Hills in Maniototo E.D..

For the purposes of this inventory the decision was made to exclude the Strath Taieri area from Maniototo Ecological District. This area contains landforms (eg volcanic basalt, schist ridges), vegetation (eg forest remnants in gullies running off the Rock and Pillar Range) and fauna (most notably grand skinks) which are more characteristic of the adjacent Macraes Ecological District than the Maniototo District as a whole; and it has a more moderate climate than the valleys further inland. It was also decided to include the flat land and low hills of the Earnscleugh - Conroys Dam area (150m-300m) south of the Clutha River in the Maniototo District. This area was previously part of the Old Man Ecological District but its values were not documented in the survey report (Brumley *et al.* 1986).

2.3 GEOLOGY, GEOMORPHOLOGY AND PHYSIOGRAPHY

The basement rock of the Central Otago region were derived from sedimentary rocks originally deposited in the New Zealand geosyncline (Suggate *et al.* 1978) during or before the Jurassic period. In the Rangitata Orogeny (late Jurassic - early Cretaceous) these sedimentary rocks were uplifted and metamorphosed to form four textural grades within the so-called 'Haast Schist Group' and low-grade metagreywackes of the Torlesse Group (Bishop 1976), with predominantly north to northwest trending fold axes (Yeats 1987). Following the uplift of the Rangitata Orogeny there was a long period of relative tectonic stability when, in late Cretaceous and early Tertiary times, the landmass was deeply eroded and weathered to form a peneplain, that is a broad terrain of low relief, under tropical climatic conditions. Pockets of red clays found throughout Central Otago are evidence of this period (Leslie 1966).

The peneplain surface gradually subsided during the Tertiary and was deeply buried under a variety of sediments (Madin 1988).In Oligocene times, low-lying areas were subject to marine transgression and the deposition of clays, sandstone and limestone (Leslie 1966). Further west, fine-grained sediments known as the Manuherikia Group are thought to have been deposited during the Miocene in a lake basin that covered much of Central Otago (Douglas 1986). Large, thick lignite seams are present within the Manuherikia Group (Douglas 1986). The resistant quartzite boulders known as sarsen stones were formed within the Manuherikia Group, consisting of blocks of sediment strongly cemented by silica or haematite (Madin 1988). These are found over parts of the Maniototo Ecological District where erosion of the overlying sediments has exposed them, as well as in the adjacent Manorburn District (Fagan & Pillai 1992).

Severe disruption of the peneplain surface commenced during the Pliocene Kaikoura Orogeny, a period of warping and block faulting which gave rise to the elevated and depressed ranges and valleys that characterise the Central Otago Ecological Region. The newly uplifted mountain ranges were subject to active erosion which stripped the Tertiary sediments thereby exposing the underlying peneplain to erosion also (McCraw 1965). The detritus from these stripped surfaces was retained in the downfaulted depressions of the Manuherikia Valley, Ida Valley and Maniototo Basin. The older fine textured Manuherikia Group sediments and Maniototo marine sediments were overlain by late Miocene - early Pliocene Maori Bottom Gravels which are found throughout the inter-montane basins of Central Otago from the Maniototo Basin to the Cardrona Valley (Schmitt 1984).

Paleocurrent indicators and a predominance of greywacke gravels in basins flanked by schist ranges indicate that the Maori Bottom Formation was predominantly derived from the northwest trending Hawkdun and Ida and Ranges to the north of the Maniototo Ecological District (Schmitt 1984). These greywacke mountains were uplifted during the time of deposition of Maori Bottom gravels. The northeast-trending schist ranges , and the St Bathans Range (Madin 1988), appear to have been uplifted later (Yeats 1987). The uplift of the Dunstan Mountains and St Bathans and Raggedy Ranges in the late Pliocene - early Pleistocene coincided with, or precipitated, the breaching of the Manuherikia Basin by the Clutha River. Subsequently much of the Maori Bottom Formation and underlying Manuherikia Group sediments were removed from the uplifting ranges and from the basin (Madin 1988). Uplift of the Dunstan and St Bathans Ranges was accompanied by deposition of a newly recognised unit, the Vinstan Gravel, around the settlement of St Bathans and southwest along the front of the Dunstan Mountains (Madin 1988).

Around the northern and western margins of the Maniototo Basin and in the Ida and Manuherikia Valleys are hills formed from eroded remnants of the Maori bottom gravels that filled the downfaulted depressions. These include the Clare-Magdalen hills in the southern Manuherikia Valley; the Gidding Downs in the upper Manuherikia Valley; and the eroded terraces in the central Ida Valley (McCraw 1965). Near Waipiata, remnants of a covering sheet of basalt have been preserved as caps on the hills (Leslie 1966). The hills and downs of the Manuherikia Valley have a distinctive appearance resulting from the herring-bone pattern of fine-textured dissection by shallow, usually dry, gullies (Leamy 1972).

Gently rolling surfaces have developed on the fine-textured Tertiary clays and sands that have been exposed by removal of the overlying gravels. This landform occurs in the Maniototo Basin near Kyeburn and Gimmerburn with smaller areas in the middle of the Ida Valley and again in the Manuherikia Valley. The surface is dotted with small, shallow , water-filled depressions (McCraw 1965).

The glaciation of the Pleistocene ice ages did not directly affect the District with the exception of the Clyde Moraine in the southwest corner. This marks the furtherest downstream extent of the Clutha Valley glacier (Suggate *et al.* 1978). Nevertheless the effect of glacial and periglacial conditions on the surrounding mountain and hill country was to greatly increase the rate of erosion with the resulting deposition of vast quantities of Quaternary sediments in the valley floors.

Present-day landscapes of the valley floors which make up the Maniototo Ecological District are, with the exception of the hills discussed above, artifacts of Quaternary cycles of sediment deposition, degradation and lateral planation which accompanied the Pleistocene glacial and inter-glacial episodes (McCraw 1965). The alluvium deposited in the inter-montane basins during glacial episodes was cut into a series of well-defined terraces in the inter-glacial periods and these are preserved at intervals in the Manuherikia , Ida and Taieri Valleys. In places the terraces are loess covered. On the floors of the Maniototo Basin, Ida Valley and upper Manuherikia Valley the process of lateral planation is apparent where the surface of the plain has been lowered by erosion with widening and eventual merging of water courses leaving only a thin cover of alluvium overlying Tertiary sediments (McCraw 1965). Subsequent erosion has seen the streams entrench themselves in the shallow valleys they occupy at present. Some of these have been widened by lateral planation, but as most of the streams are presently underfit it is considered that the process is no longer active (Raeside *et al.* 1966).

Where a stream emerges from the surrounding mountains on to the plains or passes from a higher terrace to a lower one, a constructional fan-shaped landform is created. These are variable in size, with many larger ones coalescing to form aprons of debris at the base of the mountains. Many of the older fans in the Maniototo Basin, Ida and Upper Manuherikia Valley have been distorted or swept aside by lateral planation (McCraw 1965). Bogs are commonly formed below the toe of a fan if the surface drainage is impeded. Many of the fan-forming streams carry small amounts of dissolved salts and evaporation of this water over long periods leads to concentrations of salts at the toes of fans (McCraw 1965).

The District is drained by two river systems: the Taieri River, and the Manuherikia River which joins the Clutha River at Alexandra. The Taieri River rises on the Lammerlaw elevated plateau and flows northwards meandering across the floor of the Styx basin. It then enters a gorge cut through low hills of schist basement north of Paerau, entrenched to a depth of approximately sixty metres. This gorge is now the site of a dam which forms part of the Maniototo Irrigation Scheme. The river exits the gorge at Paerau and flows north down the gentle gradient of the Maniototo Basin where meandering bends and oxbow lakes are common on the floodplain. At Waipiata the river course turns east to round the northern foot of the Rock and Pillar Range before heading south, passing through a small gorge near Hyde and entering the Strath Taieri Plain.

The Taieri River carries water throughout the year although its tributaries the Gimmerburn, Eden Creek, Wetherburn, Hogburn, Stotburn, Pigburn and Sowburn often dry up in their lower courses over summer. These tributaries carry little water even in winter and are underfit streams, with their alluvium having been deposited during an earlier wetter climate cycle (Raeside *et al.* 1966). The largest of these tributary streams is the Kyeburn which joins the Taieri River south of east of Waipiata. The Kyeburn rises in the mountains northeast of the Maniototo Basin and flows south, receiving water from the St Marys, Ida and Kakanui Ranges. Drainage from the west side of the Rock and Pillar Range is carried by a number of small streams, the two largest being Pigburn and Sowburn. The tributaries that rise on Rough Ridge are Linnburn, Totara Creek, Stony Creek, Waitoi Creek, Stotburn and Gimmerburn. Flowing south off the Ida Range are the Wetherburn, Eden Creek, the Eweburn and the Hogburn. Swampy land in the Maniototo Basin is largely confined to the floodplain of the Taieri River and the lower reaches of the streams flowing into it (Leslie 1966).

West of Rough Ridge, the Ida Valley Basin has an unusual drainage pattern. The south end of the basin is drained by the Poolburn and tributaries such as Moa Creek which flow northwest from the Rough Ridge and Knobby Range. Most of these tributary streams in the southern part of the valley are presently underfit. The north half of the basin is drained by the Idaburn which flows south off the Hawkdun and Ida Ranges. The two streams join in the middle of the basin and pass west through a narrow gorge in the Raggedy Range to join the Manuherikia River at Ophir.

The Ida Valley shows evidence of reversal of the original drainage of the basin. The watercourses of the Ida Valley Basin once flowed into the Maniototo Basin, as shown by persisting river terraces and surface contours. After the formation of the Poolburn Gorge through the Raggedy Range, the drainage of the southern part of the basin entered the Manuherikia. When the gorge had deepened further the drainage of the northern end became reversed and flowed southwest, whereas it had previously flowed northeast (Park 1906).

The basin which contains the Manuherikia River extends From the Hawkdun Range to the base of the Old Man Range. Above Falls Dam the river is shallow and braided. Below the dam it runs for approximately five km through a gorge before emerging to flow south along the east side of the basin, close to the foot of Raggedy Range. Below Lauder the Manuherikia again passes into a gorge in which it runs as far as Chatto Creek after which it flows down the broad valley basin to Alexandra. These gorges, which periodically divert the river from its old course down the wide basin, are the result of deep fault rifts in the schist basement (Park 1906).

The Otago Conservancy Geopreservation Inventory has ten listings in the Maniototo Ecological District. Nine of these are earth deformations observable at fault line exposures. The northeast-trending Dunstan Fault is exposed at Devonshire Road (G42 364 690), Matakanui goldworkings (G42 392 723), Moutere (G42 344 668) and Waikerikeri (G42 230 564); the Blue Lake Fault is exposed near the township of St Bathans (H41 580 887) and Pennyweight Hill (H41 662 816); the northeast-trending Blackstone Fault in the Ida Valley at H41 504 611; Tunnel Hill Fault at H40 651 979; and the Vulcan Fault at H40 649 986. The only other listing for the District is the notable landform of the Taieri River meanders in the Styx Basin.

2.4 CLIMATE

The Maniototo Ecological District is characterised by low rainfall, cold winters and hot summers. This continental type of climate arises in response to two factors: the position of the District relative to the Southern Alps; and its inland location. The rain-shadow effect which is present throughout the eastern South Island is amplified in the Maniototo District by the surrounding mountain blocks that further buffer the area against moderating maritime influences. The low rainfall is reflected in other climatic elements: an abundance of clear sky and bright sunshine at all times of the year; large seasonal and diurnal temperature ranges; and numerous frosts.

Cold fronts moving across Central Otago from the west bring some rainfall to the District, however southerly cold fronts and southeasterly and easterly winds arising from depressions centred off the east coast are largely responsible for rainfall in the valleys and basins of the Maniototo E.D. (Maunder 1965).

The Maniototo Basin rainfall is highest near the northern mountains and lowest in the southern part of the plains (Raeside *et al.* 1966) near Patearoa. Rainfall figures from climate stations (NZMS 1983) in the Maniototo Basin demonstrate this trend. Naseby Forest (alt. 610m) and Kyeburn Diggings (636m) at the northern margins of the basin have annual mean rainfalls of 614mm and 636mm per annum respectively. This drops to 439mm at Ranfurly and 385mm at Patearoa. South of Patearoa rainfall again increases with 716mm at Paerau and 642mm at Totara Station in the Styx Basin.

A similar pattern of decreasing rainfall to the south is found in the Manuherikia Valley (NZMS 1983). Annual rainfall around the north end at Cambrian (746mm), Falls Dam (645mm) and St Bathans (646mm) drops to 498mm at Lauder Flat, 420mm at Ophir and 346mm at Alexandra. Only one climate station is present in the Ida Valley, at Moa Creek with a recorded yearly average of 420mm.

Throughout the District there is a distinct seasonal distribution of rainfall with average summer rainfall approximately double that for the winter months. However even with this higher summer rainfall there is a large soil moisture deficit during the growing season (Raeside *et al.* 1966). At Moa Creek and Alexandra, the annual average evaporation is more than double the average annual rainfall (Maunder 1965).

Sunshine hours are relatively high in the Maniototo E.D. They average 2034 hours p.a. at Alexandra, 1786 hours p.a. at Ranfurly and 2011 hours p.a. at Waipiata (NZMS 1983).

Mean annual temperatures from climate stations in the District (NZMS 1983) are inversely proportional to altitude and range from 8.1 degrees C at Naseby forest to 10.8 degrees C at Alexandra. Summer days are warm with mean daily maxima of 20.8 degrees at Naseby and 23.7 degrees at Alexandra. However summer diurnal temperature ranges are also high and average c. 13 degrees C. Even during the summer there are typically one or two overnight frosts each month. Frosts are common in autumn and spring and these increase in frequency and severity to the point where very few winter days are frost-free (Maunder 1965).

Mean winter temperatures range from 0.9 degrees C (Moa Creek) to 3.2 degrees C (Clyde), usually dropping below freezing point at night with a mean diurnal range of about 10 degrees C (NZMS 1983).

Strong winds are relatively rare in the low-lying Maniototo Ecological District (Maunder 1965).The prevailing wind throughout the District is the dry northwesterly of the summer months. Southerly winds are the next most frequent, and bring most of the rain and snow to the District (Raeside *et al.* 1966). Snow falls occasionally within the District but only lies for any length of time during the winter. At Alexandra snow falls on average five days each year (Maunder 1965) and although there are few records for the rest of the District, the Alexandra figure can, by virtue of its altitude, be assumed to be somewhat lower than the District as a whole. At Waipiata Sanatorium from 1922 to 1955 there was a mean 16.3 days of snowfall a year with most occurring in winter. At the same location from 1948-55 the mean annual number of days of snowlie was ten (Raeside *et al.* 1965).

2.5 SOILS

The Maniototo Ecological District lies within the zone of the brown-grey earths and yellow-grey earths (N.Z. Soil Bureau 1968). The brown-grey earths and related shallow, steepland and salty soils are found in the driest parts of the inland basins and adjacent hills where annual rainfall is below 500mm (McCraw 1965; Fagan & Pillai 1992). They are found in the Manuherikia Valley as far north as Lauder, in the southern part of the Ida Valley as far north as Oturehua and in the driest part of the Maniototo Basin from Paerau to Ranfurly (NZ Soil Bureau 1968).

Brown-grey earths can be subdivided into those containing no soluble salts within the profile, and those with a small but seasonally variable salt content. Salt-free brown-grey earths occur on well drained hilly and rolling land, and on well drained high terraces and ancient fans. Salty brown-grey earths (including some associated solonetzic soils) occur on poorly drained intermediate terraces and on rolling and hilly slopes (Raeside *et al.* 1966), at the toes of fans and along the foot of slopes and on the floor of small valleys. The salts are derived from seepage of salt from salty parent materials such as Tertiary sandstones and mudstones (some formed during marine incursions) or deeply weathered schist; from salt-rich water tables; and from long accumulations of cyclic salts (McCraw 1965).

Yellow-grey earths and related steepland soils develop under annual rainfall of 500-800mm (Fagan & Pillai 1992) in the northern parts of the Manuherikia, Ida and Maniototo Valleys and in the Styx Basin (NZ Soil Bureau 1968).

Extensive recent and gley-recent soils are confined are confined to the flood plain of the Taieri River and to some tributary streams of the Manuherikia River which run off the Dunstan Mountains (NZ Soil Bureau 1968). Most tributary streams of the District are underfit and recent soils occupy only a small area of their valley floors (Raeside *et al.* 1966)

Lowland peat soils occur on the flood plains of the Taieri River and Sowburn where they occupy a few abandoned meanders with permanently high water tables. Brown granular loams are derived from the basalt flows near Waipiata on the northern flanks of the Rock and Pillar Range (Raeside *et al.* 1966).

These main soil groups can be subdivided into classes depending on the landform on which they occur. This variation is apparent after detailed mapping as has been carried out on the Maniototo Plains by Raeside *et al.* (1966).

2.6 VEGETATION

Practically all the vegetation of the Maniototo Ecological District has been modified since the arrival of *Homo sapiens* approximately 1000 years ago. Evidence from buried wood, charcoal and pollen samples suggests that the Maniototo District and adjacent mountain slopes and uplands below climatic tree line were forested (Molloy *et al.* 1963) except on some large areas of saline soils. McGlone (1989) has described the vegetation of the very driest districts in the South Island that existed 3000 years before present as a low conifer-broadleaf forest. Toatoa (*Phyllocladus alpinus*), Hall's totara (*Podocarpus hallii*), broadleaf (*Griselinia littoralis*), kowhai (*Sophora microphylla*), kanuka (*Kunzea ericoides*) and *Myrsine australis* made up this distinctive forest type. Bog pine (*Halocarpus bidwillii*) grew at sites subject to especially harsh extremes of drought and cold.

Buried charcoal and pollen analysis of sites in Central Otago indicate that deforestation by natural fires began at least 2500 y.b.p., with a change to a cooler and drier climate preventing regeneration. Such natural deforestation was patchy rather than extensive throughout the region, and confined to the drier valley floors ands lower slopes of areas such as the Maniototo and adjacent ecological districts (McGlone 1989). Thus the first Polynesians to reach the District found a landscape already substantially deforested and covered in low scrub and grassland. Nevertheless, the major episode of widespread anthropogenic burning from around 800 to 400 yr B.P. eliminated any remnants of this dry inland conifer-broadleaf forest that may have survived the earlier natural fires (McGlone 1989).

The vegetation that greeted the first European explorers of the District was described by Buchanan (1868) and Petrie (1912). Buchanan first visited the area in 1863 and Petrie about 1874. Both were concerned at the extent to which the indigenous vegetation had already been modified by fire and grazing (Raeside *et al.* 1966)

From their notes, the vegetation of the terraces, valley floors and low hills of the District appears to have been mostly short tussock grassland dominated by fescue tussock (*Festuca novae-zelandiae*) with associated silver tussock (*Poa cita*) and blue tussock (*Poa colensoi*). Blue wheat-grass (*Elymus solandri, E. apricus*), mountain twitch (*Triodia* spp.), plume grass (*Dichelachne crinita*) and *Rytidosperma buchananii* were conspicuous among the smaller grasses associated with the tussocks. Buchanan (1868) noted the presence of dry *Olearia virgata* shrublands at the junction of the Manuherikia River with the Clutha. Cockayne (1922) suggested that the original vegetation cover had also included shrubs of matagouri (*Discaria toumatou*), native broom (*Carmichaelia* spp.) and porcupine scrub (*Melicytus alpinus*) with *Olearia odorata, O. bullata* and *Muehlenbeckia complexa* shrubland on shady slopes and in the bottom of gullies.

Petrie noted broad correlations of vegetation with soil moisture but did not closely study the distribution of salt-tolerant or swamp plants. From his observations, Raeside *et al.* (1966) have reconstructed the pre-European indigenous vegetation of the Maniototo Plains,

supplemented by knowledge of the soil pattern and remnants of modified tussock grassland. Their reconstruction of the vegetation pattern would be applicable to the whole of the Maniototo Ecological District:

1. Matagouri/fescue tussock communities on very stony riverbeds, and stony and shallow soils of the terraces and fans. These included, among others, the following plants: fescue tussock, matagouri, desert poa (*Poa maniototo*), blue wheat grass, native broom and scabweed (*Raoulia australis*).

2. Fescue tussock/blue tussock communities on the shallow soils of the terraces and fans, including fescue tussock, blue tussock, spear grass, *Rytidosperma* spp., plume grass, mountain twitch, matagouri and native broom.

3. Silver tussock communities on deeper silt loams and moist soils, particularly of the flood plains. Associated with silver tussock were blue tussock, blue wheat grass, danthonia grasses and matagouri.

4. Salt-tolerant vegetation on sites with high concentrations of soluble salts particularly on the flood plains and low terraces. The following plants were widely distributed: *Puccinellia stricta, Sarcocornia quinqueflora, Selliera microphylla, Atriplex buchananii.*

5. Swamp vegetation on the waterlogged soils particularly of the Taieri River flood plain. Little is known of this, but it was probably dominated by *Juncus* spp. and *Carex* spp.

Little remains of this indigenous vegetation after 140 years of European settlement in the District. Extensive use of fire in the early years, plus continued grazing by sheep and rabbits have wrought major changes. Most of the tussock grassland communities have been completely replaced with introduced grasses, weeds and agricultural crops. Relicts of the original tussock vegetation survive in isolated patches where farming development has been less intensive but all have been invaded by exotic grasses and weeds. Swamp vegetation has also been reduced in extent and the remainder invaded by exotic plant species, most obviously crack willow (*Salix fragilis*). Saline vegetation was once much more extensive in the District. Historical records of Petrie (1890) confirmed the presence of saline areas last century and even as late as 1949 their earlier abundance was demonstrated by Raeside who counted 90 salt pans in a 100 ha area near Gimmerburn (Fagan & Pillai 1992). The saline areas that remain today are small and fragmented. Cultivation and irrigation have replaced most saline areas with exotic pasture. Most remaining salt pans have managed to retain some of their native flora, although the exotic flora is generally dominant (Patrick 1989). The flora and fauna of saline areas is discussed in more detail in the following section.

Present day vegetation of the Maniototo Ecological District, with its mixture of native and exotic species, has received little attention from botanists. Small areas of manuka (*Leptospermum scoparium*) shrubland occur on terraces around the upper reaches of the Kyeburn and its tributaries (Burrell 1965). Matagouri shrubland occupies some stony sites especially along water courses. A 'semidesert' scabweed vegetation occupies some of the driest parts of the region that have not been agriculturally improved. The scabweed (*Raoulia australis*) has replaced fescue tussock grassland depleted by the heavy grazing of rabbits and stock from the 1870s onwards. The low, dense *Raoulia* cushions may cover less than half of the ground, while the areas between them are occupied by erosion pavement. Small native and exotic grasses and weeds are scattered throughout, especially on the cushions themselves. In such areas silver and fescue tussock and matagouri shrubs usually retain dominance in gullies and damp hollows (Mark 1965).

Perhaps the most recent study is Hubbard & Wilson's (1988) survey of the lowland vegetation of the Upper Clutha District of Otago. Their study area followed the Clutha valley from Luggate down to Roxburgh, with the Clyde to Alexandra stretch falling within the Maniototo E.D. The vegetation was summarised by Cluster Analysis into eight major communities of

which all are present in the Maniototo District. Ordination of the communities showed moisture to be the major factor in determining their distribution. The following paragraphs describe the communities identified by Hubbard and Wilson as they apply to the Maniototo District.

The wettest sites are occupied by a community dominated by willow trees (*Salix fragilis*) with occasional Lombardy poplars (*Populus alba*), and open marshy areas with *Eleocharis acuta, Juncus effusus, Alisma plantago-aquatica* and *Lilaeopsis novae-zelandiae*. A second community comprises species-poor wetland sites with little else in common, an artifact of the classification method.

On more mesic sites with deeper soils, pasture dominated by *Dactylis glomeratus* and californian thistle (*Cirsium arvense*) is widespread. Other characteristic species include the grasses *Holcus lanatus, Anthoxanthum odoratum, Lolium perenne;* the legume *Medicago lupulina*, sweet brier (*Rosa rubiginosa*); the herbs *Trifolium pratense, Prunella vulgaris, Rumex crispus* and *Plantago lanceolata*. The community occurs on loamy soils with relatively good water availability which have been used for agriculture. The species are mostly exotic, with occasional native species which are generally considered as troublesome weeds, such as matagouri, *Coriaria sarmentosa* and the unpalatable grass *Elymus apricus*. In areas near water, often under a broken willow canopy, there may grow a dense shrub thicket combining the exotic species European broom (*Cytisus scoparius*), gorse (*Ulex europeus*) and sweet brier with occasional natives such as matagouri, *Coprosma propinqua* and *Muehlenbeckia complexa*.

Three plant communities of drier sites are characterised by an abundance of the adventive herb *Rumex acetosella* and grass *Vulpia megalura*: The first, a *Verbascum thapsus -Thymus vulgaris / Rumex acetosella* community is widespread in the Upper Clutha Valley. *V. thapsus* (woolly mullein) is present where the vegetation cover is more open, and on stony ground the low succulent herb stonecrop (*Sedum acre*) is usually present also. This community is found in dry derelict pasture, on dredge tailings and other rocky areas, usually at a lower altitude than other dryland communities and on sites with an easterly aspect.

Within the Maniototo E.D., dense thyme cover is very obvious on the hills around Clyde and Alexandra, and on the terraces of the Clutha River between the two towns. Another extensive thyme-dominated area is present on the slopes of the Raggedy Range near Ophir. Hubbard and Wilson's survey did not identify thyme dominated, north-facing slopes as one of the main community types for the region, but that probably reflects the scale of their survey and the fact that thyme is still expanding into the area covered by their study (Morgan 1990).

The second is a dry *Rosa rubiginosa / Leucopogon fraseri* shrub/heathland community is widespread on steeper slopes protected from agricultural disturbance. While *R. rubiginosa* is common in many other plant associations, it is most constantly present in this community. The native heath *L. fraseri* is largely restricted to this community type within the Maniototo District. Native species that are found in this community, but are relatively rare outside of it, include the shrub *Melicytus alpinus;* the low creeper *Muehlenbeckia axillaris;* the low herbs and grasses *Poa maniototo, Raoulia australis, Carex breviculmis* and *Raoulia subsericea*; taller herbs of *Hypericum gramineum* and *Microtis unifolia*; with scattered *Poa cita* tussocks.

The third community, at higher altitudes on west-facing slopes, is *Echium vulgare / Verbascum virgatum* with associated *Bromus diandrus, Aira caryophyllea* and *Trifolium arvense*.

On even drier sites, flat and with deeper soils that have been cultivated in the past but are now usually left unmanaged, a community dominated by the exotic grass *Bromus tectorum* is present. Associated species are few in number but may include *B. mollis, Trifolium arvense, Rumex acetosella* and *Thymus vulgaris*.

A dry community characterised by *Trifolium arvense* and *Echium vulgare* occurs on sites with moderately deep soils and little slope. Often these sites are derelict pasture, and their summer water deficiency is reflected in a spring flush of annual grasses of *Vulpia megalura* and *Aira caryophyllea*. Moister depressions support the annual grass *Bromus tectorum* while scattered *Poa cita* tussocks may be present.

The most water-deficient sites, on stony soils and north-facing slopes, have mats of *Raoulia australis*, with bare soil between and scattered plants of *Erodium circutarium* and ephemeral *Aira caryophyllea*. In places, the shelter of rock outcrops on stony slopes have allowed the persistence of the native species such as *Poa cita* and the ferns *Pteridium esculentum* and *Asplenium flabellifolium*.

In most parts of the Maniototo E.D. native plant communities have been lost or are restricted to relatively inaccessible areas of gorge and rock bluffs. The native species have been replaced by a variety of exotic grasses, herbs, shrubs and trees to give a vegetation cover that is probably yet to reach equilibrium in the local environment (Hubbard & Wilson 1988). Many exotic species are still expanding their range in a region where considerable pressure from herbivorous mammals add to the stresses for plant life of a semi-arid environment (Morgan 1990).

2.7 VERTEBRATE FAUNA

Birds

Moa were present in the Maniototo District occupying the shrubland, forest and grassland habitats that existed in the past. Excavation of swamp sites in the Manuherikia Valley have revealed tonnes of naturally deposited moa bones indicating the birds must have been very common throughout the District (Anderson 1989). Extinction of the moas, and localised extinction of flightless kiwi, kakapo and takahe in the eastern South Island was caused by a combination of habitat-destroying anthropogenic fires and predation by dogs, rats and humans (McGlone 1989).

The extant Avifauna of Maniototo E.D is listed below (from Atlas of N.Z. Birds, Bull *et al.* 1985). * denotes introduced species.

Black shag	*Phalacrocornax carbo*
Little shag	*P. melanoleucos*
White-faced heron	*Ardea novaehollandiae*
Canada goose*	*Branta canadensis*
Black swan*	*Cygnus atratus*
Paradise shelduck	*Tadorna variegata*
Australasian bittern	*Botaurus stellaris poiciloptilus*
Mallard*	*Anas platyrhynchos*
Grey duck	*A. superciliosa*
Grey teal	*A. gibberifrons*
New Zealand shoveler	*A. rhynchotis*
Australasian harrier	*Circus approximans gouldi*
New Zealand falcon	*Falco novaeseelandiae*
California quail*	*Lophortyx californica*
Australian coot	*Fulica atra australis*
Pukeko	*Porphyrio porphyrio melanotus*
South Island pied oystercatcher	*Haematopus ostralegus finschi*
Spur-winged plover	*Vanellus miles novaehollandiae*
Banded dotterel	*Charadrius bicinctus*
Pied stilt	*Himantopus himantopus leucocephalus*
Southern black-backed gull	*Larus dominicanus*
Black-billed gull	*L. bulleri*

Black-fronted tern	*Sterna albostriata*
Feral pigeon*	*Columbia livia*
Little owl	*Athene noctua*
New Zealand kingfisher	*Halcyon sancta vagans*
Skylark	*Alauda arvensis*
N.Z. pipit	*Anthus novaeseelandiae*
Hedgesparrow*	*Prunella modularis*
Grey warbler	*Gerygone igata*
Song thrush*	*Turdus philomelos*
Blackbird*	*T. merula*
Silvereye	*Zosterops lateralis*
Chaffinch*	*Fringilla coelabs*
Greenfinch*	*Carduelis chloris*
Goldfinch*	*C. carduelis*
Redpoll*	*C. flammea*
House sparrow*	*Passer domesticus*
Starling*	*Sturnus vulgaris*
Australian magpie*	*Gymnorhina tibicen*

The complete absence of forest from the District, and the modification of the indigenous tussockland and shrubland vegetation has meant that there exists no suitable habitat for many native bird species. However the wetlands of the Maniototo and Styx basins that are formed by the meandering Taieri River are heavily utilised by native and introduced waterfowl for breeding, feeding and moulting, and constitute a habitat of national importance. Braided sections of the Manuherikia River are important as habitat for a variety of wading birds such as the black fronted dotterel and pied stilt.

Reptiles

Recent surveys (Whitaker 1986) have identified only three species of lizard within the Maniototo Ecological District (excluding the Strath Taieri area). Common geckos (*Hoplodactylus maculatus*) and common skinks (*Leiolopisma nigriplantare maccanni*) both live up to their name. They are widespread, and abundant wherever suitable habitat of rock outcrops, loose stones, tussock or shrubby vegetation are present. Green skinks (*Leiolopisma chloronoton*) are known from the Manuherikia River gorge just below Falls Dam.

An accurate report of a green gecko (*Heteropholis* sp.) was provided from a small gully site near Oturehua (H42 642 703) at the boundary of the Maniototo and Manorburn Districts. The gully contains approximately 1ha of indigenous shrubland growing around schist outcrops and bluffs (Whitaker 1986).

Neither species of giant skink, the Otago skink and grand skink (*Leiolopisma otagense* and *L. grande*), were found in the Maniototo District or the adjacent Manorburn District, although they have been known to be present in the Alexandra area as recently as twenty-five years ago. Both would have undoubtedly occurred throughout the Central Otago Ecological Region in earlier times. They are well known from the Macraes Flat-Nenthorn-Middlemarch-Sutton area in east Otago and from the Queenstown, Lake Hawea and Lindis Pass areas to the west. It is suggested that drastic habitat alteration in this, the driest part of Otago, and the extensive use of poisons for rabbit control are reasons for the disappearance of giant skinks from the District (Whitaker 1986).

Fish

Information on fish distribution in the Maniototo District comes mostly from the freshwater fish data base and McDowall (1990). Work on the non-migratory galaxiids within the Taieri River system is being carried out by researchers at the Zoology Department, University of Otago (Townsend, Allibone and Crowl 1992).

Amongst native fish, the following species are widespread through the District's rivers, streams and dams: Longfinned eel (*Anguilla dieffenbachii*), common bully (*Gobiomorphus cotiadanus*), common river galaxiid (*Galaxias vulgaris*).

Lamprey (*Geotria australis*) are present in the Taieri River as far upstream as Waipiata (M Wright pers. comm.) The upland bully (*Gobiomorphus breviceps*) is found in the Manuherikia River and its tributaries, and in small tributary streams of the Taieri.

Galaxias anomalus is present in the Eweburn and Kyeburn, unusually this species has been found to co-exist with introduced trout. Other non-migratory Taieri River system galaxiids have suffered from trout competition and predation, and persist only in small fragmented populations in the headwaters of small streams (Townsend *et al.* 1992) which mostly lie outside of the District. Within the Maniototo District, Linnburn has a population of *Galaxias* sp (name yet to be decided) and Totara Creek has a population of *Galaxias* 'upper Taieri type' (Townsend *et al.* 1992).

Amongst introduced fish species, brown trout (*Salmo trutta*) are abundant and widespread through the District's rivers, streams and dams. Brook char (*Salvelinus fontinalis*) are present in a few small streams and creeks where trout are uncommon or absent eg Spec Gully, a tributary of the Kyeburn; Idaburn; Upper Manuherikia River (above Falls Dam) and tributaries. Rainbow trout (*Onchorhyncus mykiss*) are stocked in a few farm dams. Perch (*Perca fluviatilis*) are present through the Taieri River and in ponds and dams around Alexandra (McDowall 1990; Townsend *et al.* 1992).

2.8 INSECTS OF THE MANIOTOTO ECOLOGICAL DISTRICT *(from B H Patrick 1994)*

Introduction

This short review of the native insects of the Maniototo Ecological District will concentrate on the lepidoptera (moths) although other insect groups will be covered where known. Specimens were either hand collected by day or night, or light trapped. Specimens are stored in the B H Patrick private collection.

The ecological district is generally very much modified to farmland (often with irrigation), urban areas or intensive horticulture, but the following semi-natural communities persist together with a characteristic insect fauna. Despite the increasing modification the insect fauna is almost completely native, often switching its hostplant/s to cope with the changing flora. Undoubtedly some species do not survive the changes, thus the more modified an area is, the less the diversity of native insects.

Despite the widespread modification of the ecological district, species diversity is high by New Zealand standards, perhaps reflecting the long geological history of dry land in Otago. For example, a survey of the moth species of a block of land at Conroys Road near Alexandra recorded 214 species over a twelve month period with an additional 28 species recorded nearby. Wetlands, shrublands and semi-natural grasslands contained the majority of the species while rock faces and saltpans, although supporting less species, had a highly distinctive moth fauna. Listed below are the insect species that have their type locality in this ecological district:

Coleoptera	*Prodontria bicolorata* Given 1952	Alexandra CO
Coleoptera	*Mecodema laeviceps* Broun 1904	Ida Valley CO
Plecoptera	*Zelandobius auratus* McLellan 1993	Conroys Rd CO
Lepidoptera	*Cladoxycanus minos* (Hudson 1905a)	Ophir CO
Lepidoptera	*Paranotoreas fulva* (Hudson 1905a)	Wedderburn CO
Lepidoptera	*Atomotricha lewisi* Philpott 1927	Central Otago CO
Lepidoptera	*Phylacodes cauta* Meyrick 1905	Ida Valley CO

Lepidoptera	*Tingena melanamma* (Meyrick 1905)	Ida Valley CO
Lepidoptera	*Eurythecta zelaea* Meyrick 1905	Ida Valley CO
Lepidoptera	*Asaphodes recta* (Philpott 1905)	Ida Valley CO
Lepidoptera	*Dichromodes simulans* Hudson 1905a	Ida Valley CO
Lepidoptera	*Orocrambus sophistes* (Meyrick 1905)	Ida Valley CO

Saltpans

Saltpans were an extensive landscape and ecological feature of the Maniototo Ecological District prior to farm modifications covering many square kilometres around Ranfurly and Alexandra (Kirk 1890). Today their distribution is very patchy and the individual sites very small, usually measured in tens of square metres. Patrick (1989a) documented the characteristic fauna associated with the typical halophyte flora and later mapped the distributions of some of the species (Patrick 1990). Moths are the most conspicuous insect group on the saltpans with the diurnal geometrid *Paranotoreas fulva* and the pyralid *Loxostege* n.sp. representative. Both have larvae feeding on the halophyte *Atriplex buchananii*. The rare moth *Kiwaia lenis* is known only from one Central Otago site, the Patearoa Saline Area, where it is found associated with *Selliera microphylla*. Elsewhere it is known only from near Kurow and the type locality near Lake Pukaki.

Tiger beetles are also conspicuous on the bare salty areas together with pompilids (spider hunting wasps). Many other moth species are found on salt pans (Patrick 1989a) but they are also found on short sward grassland areas where their hosts exist.

Key sites for the saltpan fauna are:

- Patearoa Saline Area
- Belmont Saline Area
- Rockdale Saline Area
- Blackmans Saline Area
- Conroys Dam
- Chapmans Road Saline Areas
- Patricks Place - Conroys Road Saline Areas
- Chatto Creek Saline Area
- Springvale Saline Area.

Grasslands

The native grasslands of the district are degraded with the least degraded being situated in the higher (up to 700 m) altitudes of the district north of Falls Dam. These are *Festuca* dominated short tussocklands. Elsewhere silver tussock (*Poa cita*) dominates as on the Waikerikeri Terrace, *Elymus apricus* as at Belmont or more commonly *Rytidosperma maculatum, R. clavatum* and *Poa maniototo* on severely degraded areas. the cushion plant species *Raoulia australis, R. beauverdii* and *R. parkii* are commonly present together with *Scleranthus uniflorus* and *Colobanthus brevisepalus*. All these species are important for the native insect fauna, providing both food and shelter. The various grasses support many moth species in the genera *Aletia, Orocrambus* and *Tmetolophota* of which *A. sistens, O. corruptus* and *T. unica* are typical. Some species are effectively immobile in having short winged, large bodied females such as *Eurythecta zelaea* (larvae polyphagous), *Tawhitia pentadactyla* and *Sporophylla oenospora*. Other moth species typical of the dry depleted grasslands are *Euxoa admirationis, Arctesthes catapyrrha, Scoparia exilis, Eudonia sabulosella, Capua semiferana, Kiwaia thyraula, K. schematica, Tingena maranta* and the butterfly *Zizina oxleyi*. The diurnal oecophorid *Oxythecta austrina*, whose larvae feed on *Leucopogon fraseri* is locally common in the ecological district. The small plume moth *Stenoptilia celidota* has larvae feeding on the flowers of *Vittadinia australis*. It is uncommon in Otago, but is present on slopes around the Patearoa saltpans. The flightless chafer beetle *Prodontria bicolorata* is locally common north and west of

Alexandra, on the terrace flats between the Dunstan Mountains and the Manuherikia river, south of Brassknocker Creek. The closely related *P. modesta* occupies the low hills to the south and east of Alexandra. There is an area of sympatry where a terrace meets the foothills of the Old Man Range in the vicinity of Conroys Gully and the Fraser Dam road. Four grasshopper species *Phaulacridium otagoensis, P. marginale, Sigaus australis* and *S. minutus* occur on grasslands in the ecological district. The first named on bare, depleted areas and the last named on adjacent to salty areas east of Alexandra only. Elsewhere *S. minutus* is found only in the Mackenzie Country (Patrick 1992). An undescribed ground weta (*Hemiandrus* n.sp.) is present on the airport terrace immediately north of Alexandra. Elsewhere it is also found around Cromwell. Native flies, wasps, bugs and silverfish are also conspicuous components of the grassland fauna.

Key sites for the grassland fauna are:

- Waikerikeri Terrace
- Upper Manuherikia Flats
- Gibson Road - Maniototo
- Conroys Road site
- Patearoa Saline Area
- Belmont Saline Area.

Tors

Exhumed rock stacks (tors) are a distinctive feature of the Otago montane and alpine landscape. They support a characteristic moth fauna (Patrick 1989b) in the families Psychidae, Oecophoridae and Geometridae. The casemoths (Psychidae) are represented by a winter emerging, undescribed *Reductoderces* species, the larger *Scoriodyta suttonensis* and the largest of all *Liothula omnivora*. Among the oeophorids are *Tingena lassa*, an undescribed *Tingena* species confined to the Alexandra south area and *Phaeosaces* new species, the last two named having short winged females. The geometrids are in the subfamily Oenochromidae of the genus *Dichromodes*. The diurnal, gaily coloured adults have cryptic larvae feeding on the various tor dwelling lichen species. Up to three species of *Dichromodes* adults may be found on any tor with *D. ida* orange and green, *D. gypsotis* black and green and *D. simulans* orange and grey. An undescribed smaller species occurs south and west of Alexandra. An undescribed cave weta is common on tors south of Alexandra.

Key sites for tor insects are:

- Falls Dam Bluffs
- Conroys Road Tors
- Lower Maniototo Tors.

Shrublands

The shrublands of the Maniototo Ecological District are as diverse in character as the insect fauna they support. Diminutive native broom shrublands (*Carmichaelia monroi*) at Patearoa have larvae of the tiny moth *Scythris epistrota* feeding on them while taller shrublands dominated by *Aristotelia fruticosa* and *Olearia odorata* south of Alexandra and around Falls Dam have a diverse moth fauna associated with them. The deciduous *O. odorata* has over twelve native moths dependent on it, feeding on flowers, leaves and mining the leaves. Species included are the striking *Meterana grandiosa, M. exquisita, Pseudocoremia rudisata, Pasiphila cotinaea, Pasiphila* n.sp., *Maoritenes* n.sp., *Stigmella ilsea, Stathmopoda* n.sp. and *Thiotricha oleariae*. The shrubs of *Coprosma* are rich in moths also, especially *C. propinqua*, although the local *C. intertexta* shrublands around the north of Falls Dam have not been sampled. The moths *Meterana tartarea, Pasiphila sandycias* and *Austrocidaria gobiata* have larvae only on *Coprosma* species. Lianes are a feature of many shrublands particularly *Muehlenbeckia complexa*. The species of copper butterfly

Lycaena salustius and *L. feredayi* are locally common throughout the district together with a large variety of other moth species which include the tiny leaf miner *Zapyrasta stellata, Pseudocoremia indistincta, Homadotis megaspilata*, the stem gall former *Morova subfasciata, Meterana ochthistis, Bityla defigurata* and various polyphagous leaf rollers such as *Harmologa oblongana* and *Ctenopseutis obliquana*.

Key sites for protection of shrubland fauna are:

- Falls Dam Gorge and Bluffs
- Western Maniototo
- Conroys Road Gullies
- Omnibus Creek
- Puketoi Runs Road.

Wetlands

The vegetation of the wetlands in the Maniototo Ecological District are dominated by up to ten species each of *Carex* and *Juncus* including the tall, and important for invertebrates, *Carex secta*. Seasonal ponds contain in addition *Myosurus, Schoenoplectrus* and *Myriophyllum* species. The yponomeutid *Phylacodes cauta* is endemic at both generic and specific level to such sites in Central Otago where the larvae feed on *Carex* species. The related *Rhigognostis sera* is local in Otago and has larvae feeding on *Rorripa. Carex secta* supports many moth species, among them *Tmetolophota semivittata, Diplopseutis pieresalis* and *Orocrambus ephorus* while smaller *Carex* species have *Glyphipterix aulogramma* and *Protosynaema quaestuosa. Juncus* species support *G. iochaerea, Batrachedra arenosella* and probably *Schrankia costaestrigalis*. The genus *Elaeocharis* is common in permanent wetlands and had larval damage probably from the torticid *Bactra xystrota*. The geometrids *Asaphodes recta, A. abrogata, A. clarata, A. aegrota, Epyaxa rosearia, Hydriomena rixata* and the rare *Xanthorhoe lophogramma* breed on herbs such as *Ranunculus* in the wetland rich herbfields. The hepialid moth *Cladoxycanus minos* has larvae feeding on various moth species in wetlands. Its type locality is Ophir within the ecological district but it is not commonly recorded in the district. Higher montane, tall red tussocklands (*Chionochloa rubra* var. *cuprea*) north of Falls Dam support a rich insect fauna commensurate with the greater diversity of moss, sedge and herb species. The late autumn moth *Eurythecta leucothrinca* and a related undescribed species are typical. Wetlands of Conroys Road dominated by *Juncus*, support a stonefly species *Zelandobius auratus* endemic to this small area. The species only emerges as adults in mid-August - October.

Key sites for the protection of the wetland fauna are:

- Upper Manuherikia River Flats
- Lower Maniototo - Upper Taieri River
- Conroys Road wetlands.

Summary

The key features of the Maniototo Ecological District insect fauna are the following:

1. Several endemic species including the beetle *Prodontria bicolorata*, stonefly *Zelandobius auratus*, moth *Phaeosaces* n.sp.
2. Despite the severe winter climate, several moth species only emerge in winter (*Atomotricha lewisi, Reductoderces* n.sp.) or late autumn (*Eurythecta leucothrinca, Meterana grandiosa, Pasiphila cotinaea*).
3. Diverse non-forest insect communities, particularly the dry grasslands, wetlands and shrublands (moths *Eurythecta zelaea, Sporophylla oenospora* and *Arctesthes catapyrrha*).

4. A distinctive insect fauna to match the flora of the saltpans - an ecosystem almost totally confined to Otago (eg the moth *Paranotoreas fulva*).
5. An insect fauna reliant on and feeding on the flora on tors eg the undescribed cave weta, the moth genus *Dichromodes*.

Biogeographic relationships are strongly with the upper Clutha and Mackenzie Country (Patrick 1992) insect fauna epitomised by the torticid *Eurythecta zelaea*, geometrid *Paranotoreas fulva* and grasshopper *Sigaus minutus*, all shared exclusively. Conservation of this characteristic fauna is very important because of increasing and continued change due to urban sprawl, subdivision to smaller blocks and new horticultural opportunities, irrigation and new agricultural methods. Saltpans and tussock grasslands appear to be the most affected by recent changes and require immediate attention.

The insect fauna of the Maniototo Ecological District is very distinctive reflecting the age of the schist basement rock, its long and varied terrestrial history and varying degrees of aridity.

2.9 CULTURAL INFLUENCES

Cultural influences on the ecology of the Maniototo Ecological District commenced with the arrival of Polynesian moa-hunters. Moa-hunting and deforestation through anthropogenic burning commenced in the area about 900 years ago and from 800 to about 450 years before the present there was a period of intensive exploitation. Archaeological investigations have shown the lowlands of Central Otago are rich in moa kill sites (McGlone 1989). Moa hunting and forest burning had largely ended by 400 years B.P. and it is likely that moas were extinct by this time or shortly afterwards (Anderson 1989).

In the period following moa extinction, Maori presence in the District was temporary and seasonal. They visited the area in the summer months on bird snaring and eeling expeditions building small huts roofed with tussock (Aitken 1947). The Maniototo District was also a travel route to the greenstone-bearing rivers of the Southern Alps (Cowan 1978).

European settlement in the District began with the arrival of pastoralists in 1855 and by 1858 the whole of the area was occupied (Cowan 1978). The early runholdings were very large and the occupiers immediately began grazing flocks of sheep on the native vegetation. Livestock numbers increased rapidly through the 1860s and 1870s, almost entirely dependent on grazing of native grasslands. At the same time introduced rabbits, hares, pigs and goats were released and their numbers also rapidly increased. Even before the arrival of rabbits in pest proportions, Petrie (1912) had noted the deterioration of native vegetation due to overgrazing by sheep and frequent burning. Burning was used by the farmers to suppress tall tussock and shrub vegetation and promote growth both of nutritious fresh tussock shoots and the palatable inter-tussock herbs and grasses. However repeated burning soon destroyed not only the tussock and scrub but also the valuable native grasses (Aitken 1947). By the 1880s the native pasturage had been largely depleted. This factor, plus an explosion in the rabbit population forced stock numbers into decline (O'Connor 1982). Rabbits, assisted by fire damage and overgrazing by sheep, reduced wide areas of native vegetation to a 'desert' of scabweed and bare soil.

The discovery of gold in the 1860s brought a fresh influx of settlers to the District and the establishment of a number of towns with populations reaching several thousand: Alexandra and Clyde on the banks of the Clutha River; and towns such as Matakanui, St Bathans and Naseby at gold-bearing sites on the margins of the District as well as a host of smaller gold mining settlements and staging posts (Forrest 1965). Evidence of the gold mining era remains in the numerous stone and sod cottages, the earthworks and sluicings and the miles of water races. The large mining population provided a market for meat, fruit and vegetables from small farm holdings around the towns, as opposed to the large wool-producing sheep

stations (Raeside *et al.* 1966). Construction of the Central Otago railway transformed the District allowing, for example, the large-scale transport of previously rare timber for building and fencing materials. A regrouping of population in the Maniototo Basin also followed the arrival of the railway with the decline of Naseby and the rise of Ranfurly as a business and administration centre (Aitken 1947).

In the last fifty or sixty years, the earlier decline in stock numbers has been offset by conversion of the degraded tussockland into exotic pasture with oversown grass and clover species, the application of artificial fertiliser, programmes of rabbit control and irrigation (O'Connor 1982). The earliest irrigation projects in central Otago (eg the Ida Valley irrigation scheme) were developed by using and extending a network of old water races built originally to supply goldmining operations (Park 1965). At present, irrigation schemes utilise water from the Manuherikia River and tributaries, the Idaburn and other streams running off the Ida and Hawkdun Ranges and, most recently, the Taieri River and tributaries to irrigate farmland on suitable soils of the valley floors. Nearly all of the District is farmland. Agriculture consists of sheep and beef cattle grazing on dryland and irrigated pasture, with some cropping for supplementary stock feed. The farm units are relatively large with some worked in conjunction with runs on the adjoining mountains (Raeside & Cutler 1966). The rectangular pattern of pasture and crops is interrupted by lines of planted shelter belts, and by farm houses linked with the widely spaced towns by a network of roads. Orchards and market gardens are present in the lowest part of the District, around Alexandra and Clyde. A new dairy farm has been established on the Maniototo Plains south of Patearoa and an exotic
forest plantation at Naseby supplies the needs of the surrounding district.

SALINE SOIL HABITATS

SECTION

3

MANIOTOTO ECOLOGICAL DISTRICT SURVEY REPORT FOR PROTECTED NATURAL AREAS

The information in this section is mostly drawn from *The Lepidoptera of Central Otago Salt-pans* (Patrick 1989) as it applies to the Maniototo Ecological District.

3.1 INTRODUCTION

The occurrence of saline soils, and that of accompanying plant communities, in the Central Otago region have been noted since the late nineteenth century. Past reports indicate that the saline soils were much more extensively distributed than they are today, eg Kirk (1890). The presence and extent of the salty soils was a problem to farmers in the region. Investigators (eg Collins 1929, McIndoe 1932, Leamy & Saunders 1967) found various salts present in the soils and proposed remedies.

The first insects described from presumably saline habitats of the Maniototo Ecological District were collected by J.H. Lewis and sent to G.V. Hudson for describing or recording. In the *Flora of New Zealand* series (Allan 1961, Webb *et al.* 1988) many plant species are specifically recorded from inland saline or salty areas of Central Otago, and Burrows (1964) mapped some of the salt-pan flora. A recognition of the unique nature of the flora, plus a realisation that the habitat was fast disappearing led to series of studies by botanists including Johnson (1976) and Partridge (1981) who documented the best areas they found and in some cases proposed reserves. Williams and Given (1981) drew attention to the status of some plant species restricted to the saline areas. To date a Conservation Covenant has been placed on a saline areas at Belmont (section 4) on the Maniototo Plains and a 125 ha reserve gazetted (1991) to encompass Sutton Salt Lake in the Strath Taieri. Work continues to identify and protect the best remaining examples of saline soil ecosystems.

Saline areas with any natural characteristics that remain today are mostly small and fragmented. Cultivation and irrigation have replaced most such areas with exotic pasture. The remaining saltpans have managed to retain some of their native flora and fauna, although exotic flora is generally dominant. A critical factor for the native moth fauna is that the salty soils tend to have a predominantly short vegetation of herbs and grasses surrounding the barest, most salty areas. This mixture of low vegetation, native or exotic, and bare areas is conducive to the survival of the moth fauna of the Central Otago salt-pans.

Other native plant communities often exist adjacent to the salt-pan communities, perhaps relying to an extent on slightly salty soils. Few orders of insects apart from Lepidoptera were apparent in the saline areas, the majority of species could be observed during the daytime. In surveying the moth fauna it is sometimes difficult to be sure which plant community they inhabit, or if they utilise both. A list of plant and insects species found on or around the saltpans of the Maniototo District is provided in the appendices.

3.2 CONSERVATION AND MANAGEMENT

The saline soil sites are of immense historical and biological importance, therefore it is imperative that the best remaining examples must be actively conserved. That they have survived at all indicates their resilience but to remain much longer they must be managed in a way that takes account of their dynamic nature and, in most cases, their predominantly exotic flora.

Current threats to the survival of the remaining saline areas are irrigation, planting of salt-bush, weed invasion, cultivation, mining and other earthworks, feral animals and increased stock pressure.

Extensive sheep grazing appears to do little damage but irrigation border-dyking is catastrophic for the flora and fauna. Saline soils themselves may remain, and even increase, but observations show that floral and faunal diversity is severely reduced. Planting of salt-bush on several sites near Chatto Creek, Springvale and Galloway is equally disastrous as

they grow to three metres and shade out the native plants and insects. Introduced alkali bees (*Normia melanderi*) nest in the alkali soils of the salt-pans but do not appear to be a threat to native species.

It would be helpful to undertake some monitoring to determine the maximum stocking level of sheep that the sites can withstand to maintain the native plant cover. There may be some sites where stock could be excluded without the exotic plants shading-out the native flora and fauna. The effect of rabbits is difficult to gauge but the areas have survived past plagues. The main threat is direct soil disturbance and unsympathetic grazing regimes.

3.3 KEY SALINE SITES IN THE MANIOTOTO ECOLOGICAL DISTRICT

This list of key saline sites is drawn from the inventories of McIntosh *et al.* (1990 & 1992) and D Bruce (unpublished report).

Site Number	Name
SS5CO	Chapman Rd
SS6CO	Manorburn type site, Chapman Rd
SS8CO	Chatto Creek
SS11CO	Patearoa saline area
SS12CO	Belmont salt pans
SS13CO	Wilsons Rd
SS19CO (b)	Blackstone No. 2 (Manorburn E.D.)
SS21CO	Rockdale
SS22CO	Dunard
SS23CO	Blackmans
SS24CO	Conroys
SS25CO	Patrick's Place
SS26CO	Butchers Dam (Old Man E.D.)
D Bruce (unpub.)	Totara Creek
D Bruce (unpub.)	Olrig 1 & 2 (Manorburn E.D.)

The Dunard site is extremely alkaline (but not saline) and contains the rare spring annuals *Ceratocephalus pungens* and *Myosurus minimus* ssp. *novae-zelandiae*; The Rockdale site contains an extensive area of *Myosurus* and *Atriplex buchananii* and is truly saline.

Bearing in mind the small size and scattered nature of the saline soil areas, the rarity of some of their plant species and their susceptibility to damage or loss through disturbance, several key saline areas of the adjacent Manorburn and Old Man Ecological Districts which were not described in their respective survey reports (Brumley *et al.* 1986; Fagan & Pillai 1992) have also been listed here and are briefly described in Section 6. All the Maniototo District key sites are further described in Section 5.

3.4 *LEPIDIUM KIRKII* AND *L. MATAU* SITES IN THE MANIOTOTO, MANORBURN AND OLD MAN ECOLOGICAL DISTRICTS (R ALLEN 1992)

Lepidium kirkii and *L. matau* are both rare native plants, characteristic of saline soil areas. Because of their rarity it was thought prudent to list the sites of known populations (sometimes only two or three plants). Some of these *Lepidium* sites are within the key saline areas listed above, but others are outside the key areas.

Species	Grid Ref	Alt.	E.D.	Site Name
L. kirkii	H42 716 382	380m	Maniototo	Patearoa Saline Area
L. kirkii	H42 734 487	370m	Maniototo	Wilsons Road
L. kirkii	H42 521 526	440m	Maniototo	Dovedale
L. kirkii	G42 212 407	280m	Maniototo	Conroys Dam
L. kirkii	G42 228 427	210m	Maniototo	Manorburn Soil Type Site (Chapman Road)
L. kirkii	G42 316 466	200m	Manorburn	Manorburn Race, Galloway
L. kirkii	G42 320 464	200m	Manorburn	Galloway district
L. kirkii	G42 321 470	190m	Manorburn	Poplar Creek, Galloway
L. kirkii	G42 324 482	200m	Manorburn	Shennan Downs, Galloway
L. kirkii	G42 330 491	200m	Manorburn	Galloway district
L. kirkii	G42 338 497	210m	Manorburn	Galloway No.1 RAP (Fagan & Pillai 1992)
L. kirkii	G42 350 500	220m	Manorburn	Galloway No.2 RAP (Fagan & Pillai 1992)
L. kirkii	G42 340 515	220m	Manorburn	Olrig 1
L. kirkii	G42 359 517	260m	Manorburn	Olrig 2
L. kirkii	G42 300 503	180m	Maniototo	Springvale Junction
L. kirkii	G42 360 576	240m	Maniototo	Chatto Creek
L. matau	G42 326 482	200m	Manorburn	Shennan Downs, Galloway
L. matau	G42 334 494	200m	Manorburn	Galloway No.1 RAP
L. matau	G42 338 497	220m	Manorburn	Galloway No.1 RAP

Early records indicate *Lepidium matau* was previously more widespread in the Maniototo District with Alexandra its type locality (Allen 1961).

EXISTING PROTECTED NATURAL AREAS

SECTION

4

MANIOTOTO ECOLOGICAL DISTRICT SURVEY REPORT FOR PROTECTED NATURAL AREAS

The Maniototo Ecological District contains many (more than 250) areas of reserved land. Most are vested in the Department of Conservation either directly or as stewardship land with the remainder controlled by a variety of organisations such as the Central Otago District Council and the New Zealand Historic Places Trust. Apart from marginal strips, most existing reserves are small (less than 5 ha) sites of historical interest, recreation reserves or for a variety of special purposes. There are but few reserves which are specifically for the protection and/or management of indigenous flora and fauna, although some may incidentally serve this function, and no scientific reserves. Existing reserves in the Maniototo District which are considered important for their biological values are listed with area and grid reference (NZMS 260 map series):

• Taieri Lake Reserve	265 ha	G.R. H42 900 550
• Taieri Basin Wetlands Wildlife Management Reserve	37.5 ha	G.R. H42 780 532
• Halls Road Wildlife Management Reserve	44 ha	G.R. H42 763 498
• Belmont Saline Area	21 ha	G.R. H40 682 425
• Serpentine Wildlife Management Reserve	136 ha	G.R. H43 615 214
• Conroys Dam	17 ha	G.R. G42 213 416
• West Eweburn Dam	40 ha	G.R. H41 795 845
• Eweburn Reserve	12 ha	G.R. H41 805 613

Existing reports on the values of Belmont, Conroys Dam and Taieri Lake are summarised below:

BELMONT SALT PANS

Reference	Register of Saline Soil Sites (McIntosh, Beecroft and Patrick 1990)
Site no	SS12CO (McIntosh *et al.* 1990)
Grid reference	H40 682 425
Site status	Private Land. Queen Elizabeth II Trust Conservation Covenant.
Altitude	395m
Rainfall	400mm
Slopes	Undulating
Landform	Floodplain or low terrace
Site modification	Lucerne drilling
Special features	Largest inland site of *Sarcocornia quinqueflora*
Soil series (tentative)	Linnburn fine sandy loam, very salty phase
N.Z. classification	Sodic Immature Semiarid Soil (Hewitt 1989, version 2)
Vegetation	Halophytic *Sarcocornia quinqueflora* is well represented here, one of only two sites at which it is recorded in Central Otago. The population is substantial and healthy. Other saline-soil plants are present: *Selliera radicans* and exotic *Plantago coronopus*. A healthy population of the native grass *Elymus rectisetus* adjacent to the saline area adds considerably to the conservation value of this site.
Fauna	Moths include *Paranotoreas fulva, Eurythecta zelaea, Orocrambus corruptus.*

CONROYS DAM

Reference	McIntosh *et al.* 1992; D Bruce (unpub.)
Site No	SS24CO
Grid reference	NZMS 260 G42 213 406
Site status	DOC estate, some leased for grazing.
Altitude	280 m
Rainfall	400 mm
Slopes	Rolling; 8 degrees at site.
Landform	Planar footslope in valley.
Modification	Roadworks, grazing.
Geology	Strongly weathered schist, schist outcrops on hill slope.
Soil Series (tentative)	Chapman
N.Z. Classification	Saline Argillic Semiarid Soil (Hewitt 1992, version 3)
Vegetation	Abundance of *Atriplex buchananii*; also *Puccinellia* sp. and *Crassula tetramera*; *Lepidium kirkii* (G. Loh pers. comm.). Exotic grasses and *Erodium circutarium*.
Fauna	Moths - *Loxostege* n.sp. (larvae on *Atriplex*), *Paranotoreas fulva, Orocrambus corruptus, Eurythecta zelaea* all common at this site. All diurnal and sunbathing on barest areas.
Special features	1. One of few truly saline soil sites (very high conductivity), and alkaline; 2. common halophytes present; 3. has potential for revegetation and protection; moderate conservation value at present.
Action required	Increase protection by limiting grazing and access, possibly re-introduce rare species.

TAIERI LAKE RESERVE

Reference	*Report on future status and management of Taieri Lake Recreation Reserve and adjoining Crown Land.* Department of Lands and Survey, Dunedin. 1985.
Introduction	The reserve is an area confined on one side by the north (true left) bank of the Taieri River and on the other by low cliffs. These cliffs are the eroded edge of an outwash terrace of the Holocene period. The former Taieri Lake occupied the lower end until about 1915. The present surface is the result of river outwash and mining sludge falling in the basin. Subsequent lowering of the river (in the 1940s) and drainage have left an area which is dry for most of the summer but can be flooded during high river levels. The area has a relatively long history as a reserve of one sort or another being set aside for recreation purposes in 1892 but has also been grazed since 1902.

Altitude: 340m

Grid reference H42 900 550

Climate Hot, dry summers and cold winters. Rainfall is in the range of 400-420mm per annum. Frosts may occur at any time of the year and are severe in winter.

Geology The lake is surrounded by low hills of quartz conglomerate, sandstone, siltstone and mudstone to the north, and of basalt of the Waipiata Volcanics to the south and west, with remnants of successive tills and associated outwash fans, piedmont and river terrace gravels of schist and greywacke to the east.

Soils Paerau recent gley soils (silt loams and sandy loams) with a high nutrient status occupy the lake bed, over Holocene stream, peat and swamp deposits.

Vegetation (from Allen 1985) Taieri Lake is an extensive low-lying area of drained and occasionally inundated sedge and rushland, a minor proportion being permanently wet marsh and ponds. Five vegetation types were recognised:

1. Plantation and rough scrub
2. Rough pasture (Approx. 70% of reserve area)
3. Swamp (10%)
4. Rushland (5%)
5. Sedgeland (15%)

The vegetation is highly modified and dominated by exotic species and thus has little value as a representative example of the original vegetation of the area. The more extensive wetlands of the Taieri River further upstream probably contain better examples of indigenous vegetation. Apart from rautahi (*Carex coriacea*), native plants commonly associated with inland wetlands are rare or absent. Present vegetation patterns are primarily determined by soil moisture, which is affected by variations in ground level reflecting past river meanders as well as by more recent artificial drainage. Surviving swamps owe their existence to the proximity of the Taieri River and continue to be affected by variations in its flow.

Fauna The reserve area and the low-lying farmland on the south (true right) side of the Taieri River supports a diverse and varying population of birdlife. The reserve attracts numbers of pukeko and mallard and it is likely that marsh crake and Australasian bittern are present. However the freehold property on the opposite side of the river is richer in birdlife with a greater number of species and larger populations.

Discussion At present Taieri Lake is designated a recreation reserve (c. 215 ha) and managed by the Central Otago District Council with an adjoining 51 ha of DOC stewardship land. From the viewpoint of protecting and managing the wildlife which utilise the Taieri Lake area, the addition of the wetlands on the opposite side of the river to the reserve would be very desirable. In spite of its highly modified vegetation, Taieri Lake Reserve has great value as habitat for a large number of native bird species.

RECOMMENDED AREAS FOR PROTECTION AND AREAS OF INTEREST

SECTION

5

MANIOTOTO ECOLOGICAL DISTRICT SURVEY REPORT FOR PROTECTED NATURAL AREAS

INTRODUCTION

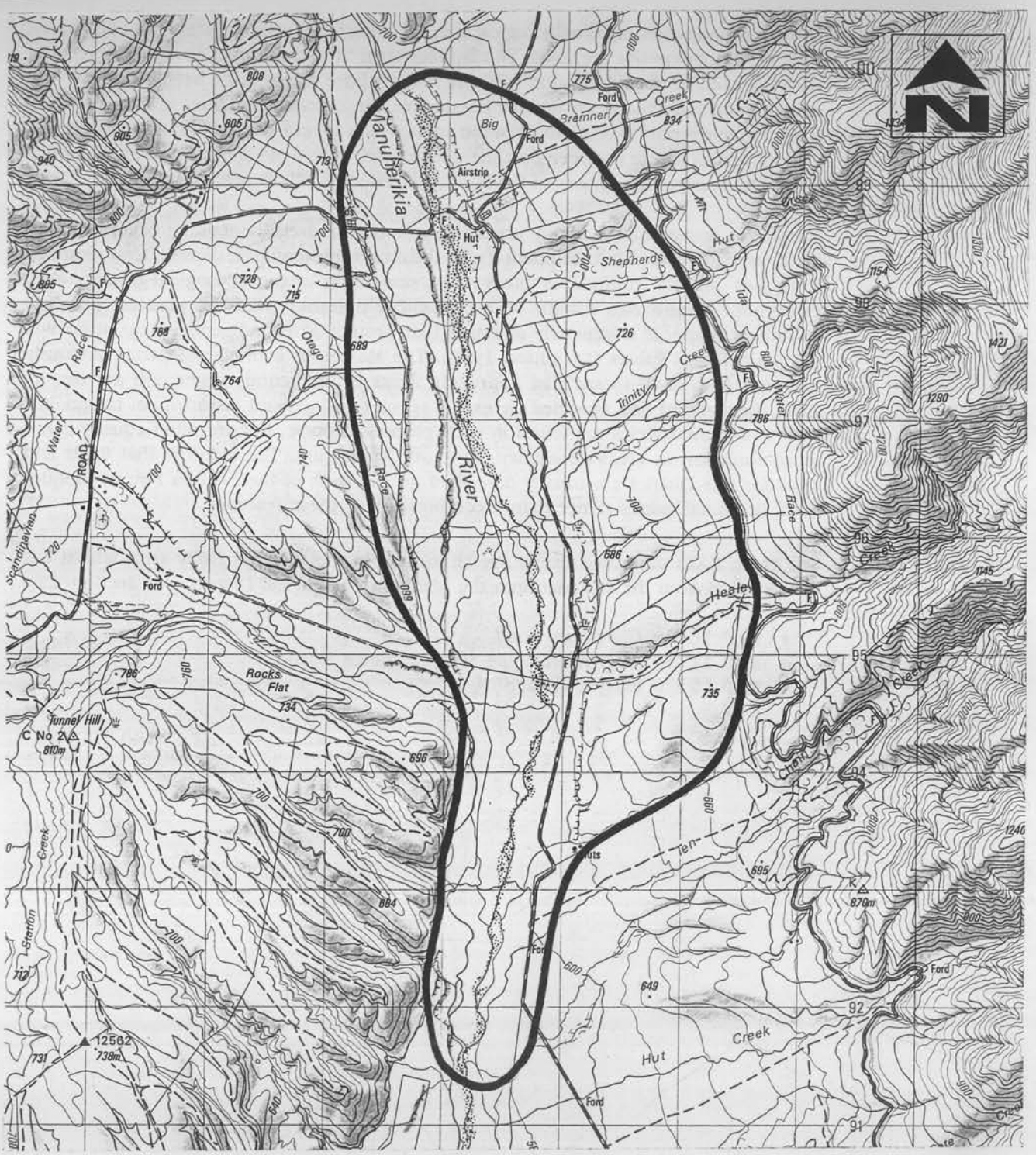
In describing specific areas of biological and/or landform values in the Maniototo Ecological District two categories are used. The familiar term 'Recommended Area for Protection' (RAP) is used in the description of those areas whose values have been relatively well documented and which have definite boundaries. The broader term 'Area of Interest' (AOI) is used in this report to bring to attention areas which are considered to hold conservation values but have either not been documented in detail or have no definite boundaries at this stage. Obviously, more intensive fieldwork is needed to fully describe these areas.

Usual PNA survey methodology urges the selection of areas containing vegetation and landform types which in combination give the most representative, diverse, least modified examples of the indigenous ecosystems remaining in the ecological district with catchment boundaries sought where possible together with the greatest possible altitudinal range. It is generally assumed that protection of indigenous vegetation will safeguard faunal values (Dickinson 1988). The Maniototo Ecological District obviously does not lend itself to such an approach. Areas of indigenous vegetation are usually small, fragmented and modified by exotic species and general disturbance. Indigenous flora and fauna species are found in such places of course, but are often equally if not more abundant in areas dominated by exotic vegetation. The result is that RAPs and AOIs for this District are usually described on the basis of their (often rare or unique) floral or faunal values rather than a combination of these features.

The three RAPs described below are all located in the Conroys Gully area, which has been moved from the Old Man into the Maniototo Ecological District (see Section 2.2):

- RAP 10 Chapman Road
- RAP 11 Manorburn Type Site, Chapman Road
- RAP 12 Patrick's Place

AOI 1
UPPER MANUHERIKIA



GRID REFERENCE : INFO MAP 260 H40 670 960

AREA : 2040 hectares

ALTITUDE : 508m - 700m

0 1 2 3 4
kilometres

AOI 1 UPPER MANUHERIKIA VALLEY

Reference Chapman (1985)

Introduction The vegetation of this area has been documented in some detail by Chapman (1985) as the botanical component of the investigations by the Liquid Fuels Trust Board into the lignite deposits of the upper Manuherikia Valley. Chapman concluded that the vegetation of this area was of high botanical value because it represents one of the best remaining examples of low-altitude red tussock grassland and associated mosaic of vegetation types on river terrace landforms. These valley-floor grasslands, shrublands and wetlands are of further significance as part of an altitudinal sequence of indigenous vegetation from the Manuherika Valley floor to the summits of the Hawkdun and St Bathans Ranges. Chapman also predicted that under present management practices, red tussock grassland plus associated fescue tussock and silver tussock grasslands would be depleted in extent and eventually replaced by exotic pasture. This would indeed appear to be the case, nearly ten years after that botanical survey. Nevertheless, examples of most of the vegetation types identified in the 1985 report can still be found, albeit with a greater exotic component in the flora, and are included in the AOI.

Landform The area lies at approximately 600 - 750 m bounded to the west by the foothills of the St Bathans Range and to the east by the fault scarp of the Hawkdun Range. The valley floor is a down-faulted basin filled with Manuherikia Group sediments, which are a mixture of fine grain muds and gravels. The sediments erode to produce the hummocky topography found on the western edge of the basin. Maori Bottom gravels in places overlie the sediments forming low hills. The semi-permeable properties of these gravels lead to runoff from hill slopes into flushes. The fans and terraces are composed of coarse greywacke gravels and are highly permeable. The fans, as a relatively young landform still in the process of formation contrast with the older terraces whose different levels represent different periods of deposition.

Climate The average yearly rainfall is 600 mm over most of the upper Manuherikia basin. Winds are predominantly northwesterly and southerly. Snow can lie for up to two weeks over most of the area during winter and frosts are severe from May until late August.

Soils Cass soils predominate on the greywacke hillslopes and fans. These are of moderate to low fertility and are vulnerable to wind and sheet erosion. Tasman soils are associated with river terraces, braided river channels and swampy ground, and are of medium to low fertility.

Flora A full list of plant species recorded in the upper Manuherikia basin is included in Chapman (1985).

In summary, the following numbers of plant species were recorded:

	Native	Naturalised	Total
Trees, shrubs and lianes	28	5	33
Herbaceous dicotyledons	80	45	125
Monocotyledonous plants	36	22	58
Ferns and fern allies	6		6
	150	72	222

Despite some extensive modification of the indigenous vegetation the number of native species far exceeds the number of exotic ones, although many of the exotic grasses and herbs do occur with a very high frequency. Two noteworthy native species which occur here are: the low shrub *Pimelea traversii* which is found in narrow leaved snow tussock (*Chionochloa rigida*) and red tussock (*Chionochloa rubra*) grassland and is near the southern limit of its distribution; *Coprosma intertexta* is a species of limited range in Otago and Canterbury and is present in shrublands within the AOI.

Vegetation Types

The distribution of vegetation types is largely due to soil moisture conditions which are in turn determined by aspect and underlying geology. When the environment is controlled by a strong, localised influence, such as in a cushion bog or flush, certain species will constantly occur together and there will be well defined vegetation boundaries. However, more extensive vegetation types such as grasslands and shrublands do not have distinct boundaries but tend to merge into each other. The actual species composition at any one point will reflect the habitat conditions along a shallow gradient in controlling environmental factors and the way in which different combinations of plant species have adjusted to land use.

1. Matagouri shrubland

Matagouri (*Discaria toumatou*) 1.5-2.5 metres tall makes up approximately 60% of the vegetation cover of the shrub layer. Associated shrubby species include sweet brier (*Rosa rubiginosa*), porcupine scrub (*Melicytus alpinus*) and *Coprosma intertexta*. The lianes *Muehlenbeckia complexa* and *Rubus* sp. scramble over and among the shrubs. The shrubs overtop a sparse understorey (5-30cm) of mainly pasture grass, plume grass (*Dichelachne crinita*) and exotic herbs especially white clover, sorrel and woolly mullein.

Matagouri shrubland is most extensive on stream sides where it can form a fringe up to 10m wide. It also occurs in gully bottoms and around the base of hill slopes where there is ample water supply, and on steep hill slopes where matagouri is able to tap soil moisture below the reach of grass roots. The gully-bottom stands are distinct from the more widespread stream-side shrublands in having taller matagouri and associated shrubs over a species-rich understorey.

2. *Chionochloa rubra* tussockland

a) Red tussock on terraces and hill slopes
Red tussock 1m - 1.3m high forms an open canopy through which matagouri and fescue tussock (c. 70-90cm) are scattered with occasional shrubs of *Carmichaelia petriei* and *Coprosma intertexta*. A sward layer (c.40cm) includes species such as *Poa cita* and the exotic grasses *Holcus lanatus* and *Poa pratensis*. Dwarf shrubs and both naturalised and weedy herbs (c.15cm tall) form a species-rich ground layer. *Leucopogon fraseri* and *Coprosma petriei, Bulbinella angustifolia* and *Ranunculus foliosus,* and *Hieracium pilosella* are all characteristic species. Patches of *Pernettya nana* are scattered within red tussock grassland on these sites, associated with local rises in the water table. Smaller patches of *Euphrasia zelandica* and the clubmoss *Lycopodium scariosum* occur on terraces.

b) Red tussock fringing water seeps
Red tussock up to 2m tall forms a dense canopy with up to 90% cover. Exotic species such as *Holcus lanatus* and *Juncus effusus* occupy the inter-tussock spaces with a scattering of low herbs eg white clover (*Trifolium repens*) and *Ranunculus foliosus*.

c) Red tussock on periodically waterlogged sites
Red tussock (c. 90cm tall) forms an open canopy interspersed with shrubs such as *Olearia bullata* up to 2m high. An intermediate vegetation tier (20cm-60cm) of varying density is formed by *Juncus effusus, Schoenus pauciflorus* and *Carex coriacea*. Low moisture-loving herbs such as *Montia fontana* and *Hydrocotyle heteromeria* are also present.

Within the whole valley basin, red tussock occurs on the deep soils of higher terraces and gentle south or southeast facing hill slopes of the Maori Bottom hills, and on the lower slopes of the St Bathans and Hawkdun Ranges. It is (or was) the dominant vegetation cover of the poorly draining hummocky ground of the valley floor and in places still forms a dense fringe to water seeps flowing down hill slopes and through the hummocky ground. Red tussock merges into narrow-leaved snow tussock (*Chionochloa rigida*) grassland above about 900m, where some hybridisation is evident, and into pasture on lower altitude, freely draining soils.

3. Fescue tussock grassland

Fescue tussock (*Festuca novae-zelandiae*) 50 - 60cm high forms an open canopy in which silver tussock (*Poa cita*) may be co-dominant. Matagouri is scattered among the short tussocks with occasional native broom (*Carmichaelia* sp.), red tussock and snow tussock. Browntop (*Agrostis capillaris*) is the most abundant species in a sward layer 20-30cm tall, with sweet vernal (*Anthoxanthum odoratum*), *Lachnagrostis* sp. and blue tussock (*Poa colensoi*) sometimes present. *Carex breviculmis* and *Luzula rufa* are present at low frequency. There is a sparse ground cover with up to 30% bare soil or small stones. Exotic herbs especially *Cerastium fontanum, Hypochoeris radicata* and white clover dominate the ground cover with a sparser distribution of native species such as *Raoulia subsericea* and *Scleranthus uniflorus*.

Fescue tussock grassland is characteristic of low terraces and low to mid-altitude hill slopes, especially lower altitude sites which have been burnt or heavily grazed. Fescue tussock gradually gives way to red tussock on less disturbed terraces and moister sites and to snow tussock at higher altitudes. Much of the original cover has been converted to pasture but a substantial amount of fescue tussock remains on the terraces within the AOI. *Hieracium pilosella* is abundant on burnt or heavily grazed ground and *Bulbinella angustifolia* on damper sites.

4. Silver tussock grassland

Silver tussock (c. 50cm tall) forms a canopy of variable cover with several low or grazed shrubs including matagouri and native broom, and fescue tussock. Narrow leaved snow tussock, red tussock, sweet brier and *Olearia bullata* are scattered emergents. Blue tussock (c. 30-40cm tall) is a major component of the sward layer. Pasture grasses including browntop, sweet vernal and Yorkshire fog also make significant contributions. A dense, species rich ground cover is dominated by exotic species including white clover, Californian thistle (*Cirsium arvense*) and *Hieracium pilosella*.
Silver tussock grassland occurs on low- to mid-altitude sites between 750 and 900m. It predominates on gentle, free draining hill slopes and some areas of low lying flat ground. Fire and grazing have led to the exclusion of silver tussock from some sites to be replaced by fescue tussock. Much of this vegetation type has been converted to pasture by oversowing and topdressing.

5. Riverbed vegetation

Riverbed vegetation occurs on periodically-flooded sections of river channel made up of stones and gravel with various proportions of sand and silt. This unstable substrate can only be colonised by a limited number of native species; characteristically prostrate creeping herbs and cushion plants, plus a variety of adventive herbs and grasses. Vegetation height ranges from 1-2m of brier and matagouri down to prostrate herbs and cushion plants. The vegetation type is best developed on the gravel braids of the Manuherikia River. It also occurs on gravel sites associated with tributaries flowing from the Hawkdun and St Bathans Ranges.

Native mat-forming herbs and cushion plants such as *Raoulia hookeri, R. tenuicaulis, Muehlenbeckia axillaris, Epilobium microphyllum* and *E. brunnescens* predominate on the most unstable and flood-prone sections of riverbed, commonly lining the waters edge. The mats and cushions are in turn colonised by small herbs such as *Anisotome aromatica* and *Wahlenbergia albomarginata. Scleranthus* spp. and *Colobanthus* spp. are scattered among the mats and cushions. Naturalised annual or biennial weedy species with a wide ecological tolerance are scattered across riverbed sites, their particular distribution being determined by chance. Drier sites which usually escape flooding are colonised by species associated with tussock grasslands such as *Geranium sessiliflorum, Bulbinella angustifolia* and brier.

6. Cushion bog vegetation

This term describes patches of vegetation in which comb sedge (*Oreobolus pectinatus*), dwarf rushes, grasses and creeping herbs combine to form more than 80% of the cover. The structure of a cushion bog varies according to its particular species composition but the low, single-tiered structure contrasts sharply with the surrounding grassland or shrubland. Grasses, rushes and sedges (30cm - 1m) are scattered across the bog surface and become dense towards the edge. The most abundant species within the comb sedge matrix are *Rytidosperma pumilum, Gnaphalium* spp., and *Isolepis aucklandica*. Some cushion bogs at the southern end of the area are dominated by a new species of *Galium* ('tarn').
Cushion bogs are restricted to areas in which there is surface water seep. These are most common on hillsides in gully heads, on the edge of high terraces where streams flow down from adjoining steep hill slopes, on gravel fans adjoining drainage channels and in the hollows on hummocky terrain underlain by Maori Bottom gravels. Comb sedge tends to predominate on bogs where the surface water is slow-moving and poorly aerated. Dwarf rushes and herbs predominate where there is a more rapid water flow and consequently more available air and nutrients.

7. Flush vegetation

The term flush vegetation is used to describe an assemblage of plants in which a combination of *Carex coriacea,* jointed rush (*Juncus articulatus*), *Ranunculus glabrifolius, Mimulus moschatus* and *Myosotis laxa* ssp. *caespitosa* are characteristic. No single species occurs in every example of flush vegetation; the species composition is variable and determined by particular site conditions. Flush vegetation occurs where there is moving surface water and a silty substrate. Gully heads on hillsides, natural seepage channels and the edge of ponds are characteristic habitats and are scattered throughout the AOI.

The species composition of a flush varies according to the rate of water flow, depth of substrate and nutrient availability. Jointed rush and *Mimulus moschatus* tend to predominate on the wettest sites where there is relatively fast flowing water. Associated aquatic plants confined to the main water channel include *Myriophyllum propinquum* and *Potamogeton cheesemanii*. Toward the outside edge of a flush red tussock in association with rushes and sedges such as *Carex gaudichaudiana, C. sinclairii* and *Elaeocharis acuta* dominate.

8. Ponds and water races

Shallow (<30cm) and deep (>30cm) ponds are associated with seepage channels which meander along the base of hill slopes or low river terraces. They usually occur within a few metres of a stream or main river channel. Shallow ponds usually have a muddy substrate which is colonised by stands of spiked rush (*Eleocharis acuta*). This gives way to jointed rush where there is some water flow and to cutty grass on the drier margins. *Mimulus moschatus, Ranunculus glabrifolius, Eplilobium ciliatum, Mentha spicata, Nasturtium offficinale, Hydrocotyle* sp and *Glyceria fluitans* are all associated with the edge of stands of rushes and are usually scattered amongst or beneath them. Pasture grasses and sort rush (*Juncus effusus*) reach to the pond edge.

Deep ponds have a stony substrate and clear water. They are colonised by exotic plants such as pondweed (*Potamegeton cheesemanii*), *Myriophyllum propinquum* and *Myosotis laxa* ssp. *caespitosa*. Chickweed and *Montia fontana* float on the pond surface. The aquatic vegetation of water races comprises *Ranunculus fluitans*, water milfoil and pondweed.

Fauna

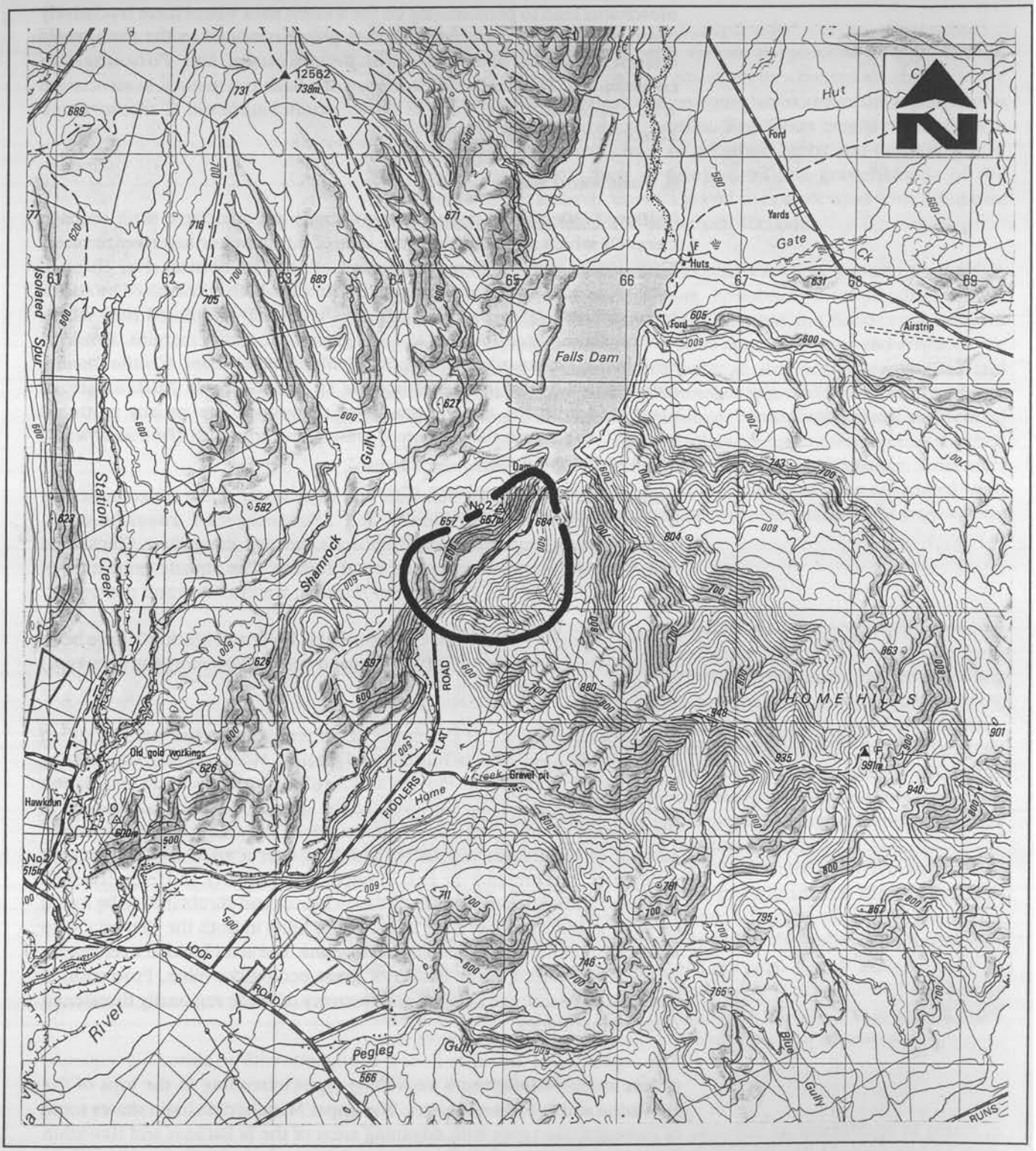
Wrybill regularly visit the upper Manuherikia River and black stilt have been reported there also (McEwen 1987). Upland bully (*Gobiomorphus breviceps*) live in the river and tributary streams.

Discussion

The tussock grassland of the upper Manuherikia basin has been modified by over a hundred years of burning and grazing. More recently, oversowing with pasture grasses and clovers and fertiliser topdressing in association with burning and grazing has favoured the spread of exotic plant species at the expense of native vegetation. Nevertheless, the area retains a substantial amount of indigenous vegetation and flora over a wide area of montane valley floor. It represents the best example of red tussock and fescue tussock grassland and associated wetlands, tussocklands and shrublands to be found on such a landform (low river terraces and hills) in both the Central Otago and neighbouring Waitaki Ecological Regions. The semi-braided river system of the Manuherikia River is also of great ecological value. Protection is essential to ensure the survival and recovery of these regionally threatened plant communities.

The vegetation of the valley floor is contiguous with an altitudinal sequence of less modified indigenous vegetation types extending to the tops of the Hawkdun and St Bathans Ranges. The upper Manuherikia basin shares some of its vegetation types with adjoining areas of the St Bathans and Hawkdun Ecological Districts (Waitaki Ecological Region). A detailed ecological re-assessment of the whole area is essential to fully document existing values in anticipation of future tenure changes and ongoing pastoral modifications. Ideally, a protected area should be established that is continuous with and complementary to recently acquired conservation land on the Hawkdun Range thereby securing a sequence from high-alpine mountain tops to montane valley floor. A reserve here, containing examples of what are now regionally rare red tussock and fescue tussock grasslands, wetlands and shrublands would be of immense conservation, scientific and scenic value.

AOI 2
FALLS DAM



GRID REFERENCE : INFO MAP 260 H41 650 875

AREA : 150 hectares

ALTITUDE : 600m - 820M

0 1 2 3 4
kilometres

AOI 2 FALLS DAM GORGE

Reference Chapman (1985)

Landform Stable boulder slopes, coarse talus, loose scree and rock bluffs on gully sides of between 30 and 50 degrees slope. Gorge carved by Manuherikia River immediately below Falls Dam. Elevated alluvial terraces on the east side of the river are remnants of an earlier phase of river deposition. Three stream gully tributaries (including Johnston Creek) flow from Home Hills into Falls Dam within the AOI.

Vegetation and Flora The dry river terraces support a matagouri-brier / *Festuca novae-zelandiae* shrub-tussockland over a mainly exotic understorey of pasture grasses and clovers. Various scabweeds and other native species grow amongst the exotics: *Carmichaelia enysii, C. monroi, Pimelea oreophila, P. prostrata, P. sericeo-villosa, Stackhousia minima.* In seasonally damp places a short species of summergreen *Carex muelleri* forms dense stands on the river terraces.

The river gorge and tributary stream gulleys, plus parts of the dam shoreline hold a diverse mixed shrubland. A mixture of matagouri, brier and *Coprosma propinqua* (1.5 to 3m high) forms most of the shrub cover but other shrub species are also common including: *Carmichaelia petriei, Olearia odorata, Aristotelia fruticosa, Melicytus alpinus, Coprosma parviflora* and *Coprosma intertexta.* The latter is a regionally rare, but locally quite common shrub species. Lianes of *Muehlenbeckia complexa* and *Rubus* sp. trail over the shrubs. Understorey vegetation varies in composition and density according to the substrate. Bracken (*Pteridium esculentum*) is dominant on boulder piles while *Blechnum penna-marina* is scattered amongst coarse talus. Tussock grasses (*Festuca novae-zelandiae, Poa cita* and occasional *Chionochloa rigida*) are present on the rocky outcrops of steep slopes while pasture grasses form cover on more gentle ground. Shorter grasses and herbs present are *Elymus solandri, Deyeuxia avenoides, Poa colensoi, Raoulia australis, R. parkii, Acaena buchananii, A. caesiiglauca, Leucopogon fraseri, Crassula tetramera, Vittadinia australis, Brachyglottis bellidioides, Epilobium alsinoides, E. melanocaulon* and *E. nummularifolia.*

The west side of the river gorge has a population of the threatened plant *Lepidium kawarau.* A single plant of the rare native nettle *Urtica aspera* was found at the base of a scee slope.

Senecio quadridentata grows on screes and exposed rock outcrops. Other rock outcrop species present are *Helichrysum selago, Luzula rahdina, Anisotome brevistylus* and *Rytidosperma coronim.*

Streambeds at the base of tributary gulleys hold *Juncus gregiflorus, Carex sinclairii* and *C. buchananii.*

More gently sloping sites near the lake edge hold a mosaic of fescue tussock grassland and native heath, the latter including *Coprosma perpusilla, Pernettya nana, Leucopogon fraseri, Galium aparine, Carex breviculmis, Deyeuxia avenoides, Raoulia subsericea, Geranium sessiliflorum, Scleranthus uniflorus, Helichrysum filicaule* and *Colobanthus* sp.

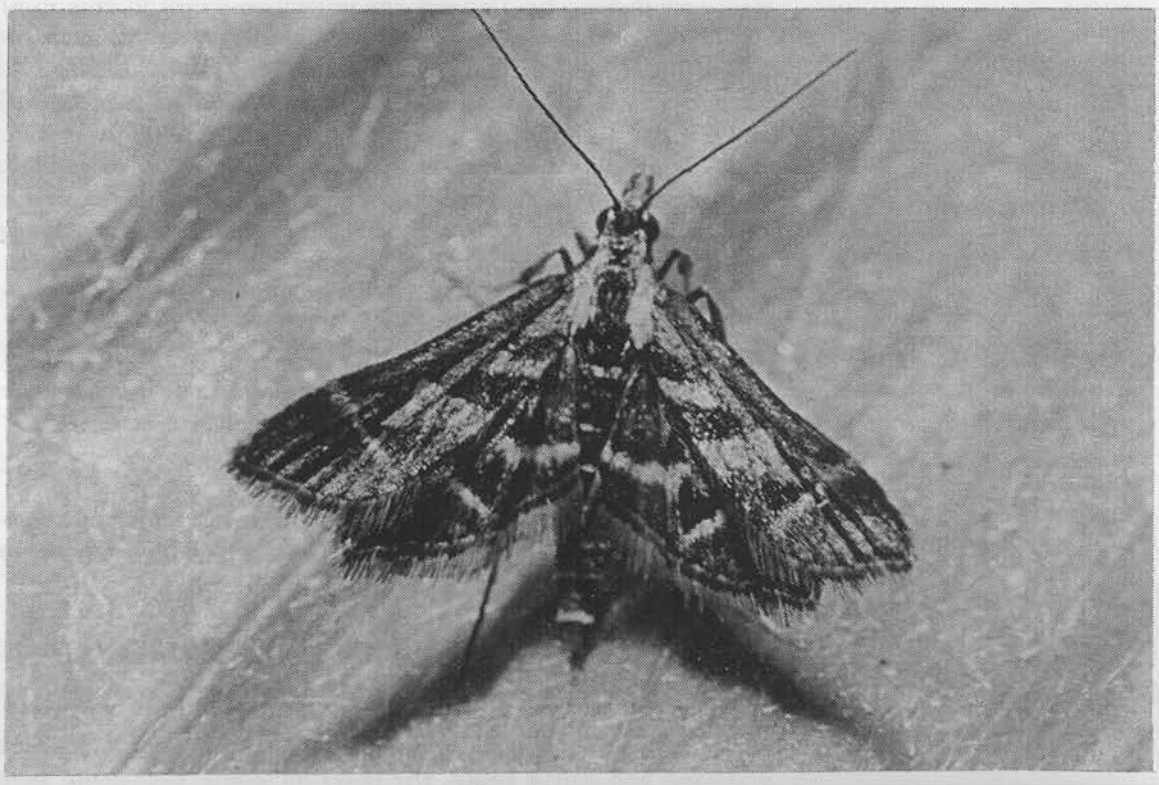
Falls Dam itself holds an impressive aquatic flora which is revealed during low lake levels.

Fauna

Green skinks (*Leiolopisma chloronoton*) are present in the gorge below Falls Dam. Common skinks and common geckos are present throughout the area (Whitaker 1986).

Discussion

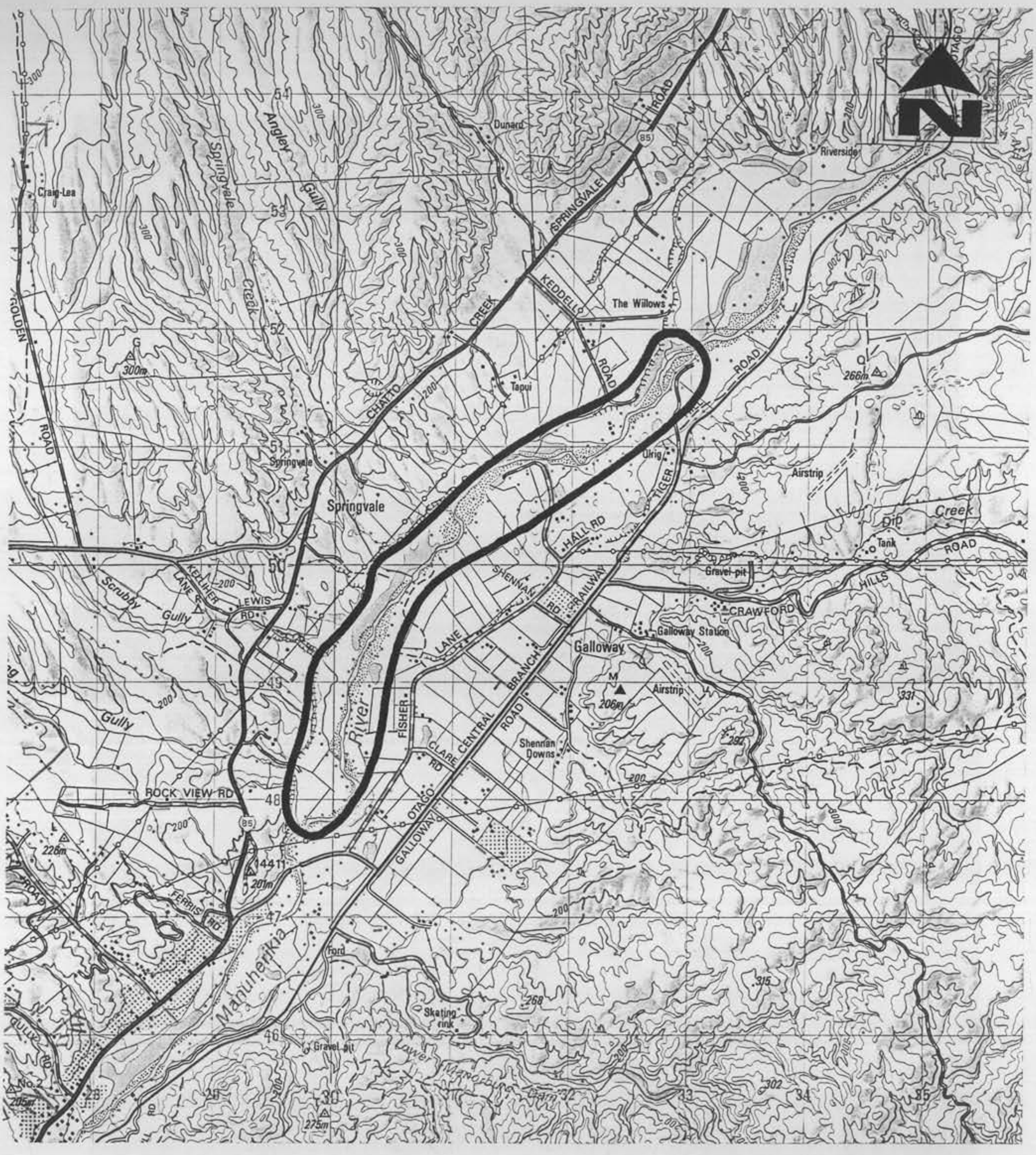
This AOI contains some of the most diverse and extensive shrublands in the Maniototo Ecological District. Within it are populations of the threatened plant *Lepidium kawarau*. The relatively rare shrub *Coprosma intertexta* is common in the AOI. Tussockland, heath, scree, rock outcrop, wetland and aquatic vegetation add to the botanical diversity. The shrublands, river and lake are habitat for a range of native and introduced birds.



Typical of open short tusock areas is the diurnal moth Diasemia grammalis

Seasonally wet cushionfield at the base of the Hawkdun Range

AOI 3
LOWER MANUHERIKIA RIVER



GRID REFERENCE : INFO MAP 260 G42 305 495

AREA : 330 hectares

ALTITUDE : 160m

0 1 2 3 4
kilometres

AOI 3 LOWER MANUHERIKIA RIVER

Introduction

A recommendation to recognise and protect as bird habitat the section of the Manuherikia River from below the Ophir gorge to the confluence with the Clutha River is made. It arises from internal reports on surveys conducted in 1982, 1986 and 1989 by the Wildlife Service and Department of Conservation. The 1986 survey was in response to an application for a prospecting licence over the lower twelve kilometres of the river.

Description

The Manuherikia River has its source on the slopes of the Hawkdun and St Bathans Ranges. Downstream of the Ophir gorge the river alternates between a single-thread or braided channel river spread out over a moderate size shingle bed. Below the Galloway Bridge it tends to be mostly a single channel river until it finally joins the Clutha River at Alexandra.

Bird Species

Wetland bird species present on the river have changed over the years that the surveys were undertaken. Most significant are the disappearance of banded dotterel and breeding black-billed gulls and the appearance of breeding black-fronted dotterels between the 1982 and 1986 surveys. The black-fronted dotterel has steadily increased in numbers since it was first recorded in 1981. Between the 1986 and 1989 surveys black fronted terns also disappeared from the river. However M. Child has reported seeing black billed gulls and black fronted terns on the river since the 1989 survey so their absence was only temporary.

The commonest bird recorded on the river was the pied stilt with mallard being second most common. The wading species are concentrated in the wide braided shingle parts of the river.

A list of bird species recorded in the various surveys follows:

AVIFAUNA RECORDED ON THE LOWER MANUHERIKIA RIVER

Bird Species	1982 Survey	1982 P Child	1986 Survey	1989. Survey
Black Shag	*	*	*	*
White-Faced Heron		*	*	*
Paradise Shelduck	*		*	*
Mallard	*	*	*	*
Grey Duck		*	*	
Grey Teal	*	*	*	*
NZ Shoveler	*	*	*	
Australasian Harrier	*	*	*	*
Californian Quail	*	*	*	
Pukeko	*	*	*	*
SI Pied Oystercatcher	*	*	*	*
Spur-Winged Plover	*	*	*	*
Banded dotterel		*		
Black-Fronted dotterel		*	*	*
Pied Stilt	*	*	*	*
S. Black-Backed Gull		*	*	*
Black-Billed Gull		*	*	
Black-Fronted Tern		*	*	
Rock Pigeon	*	*	*	*
Shining Cuckoo	*	*	*	*

Discussion

The Manuherikia River is of value to wildlife as the only moderate sized river in the Maniototo District (and Central Otago Region) that maintains a partially braided nature and provides habitat for a range of wetland bird species. The value of this river is accentuated by the presence of black fronted dotterel, an uncommon species in the southern South Island.

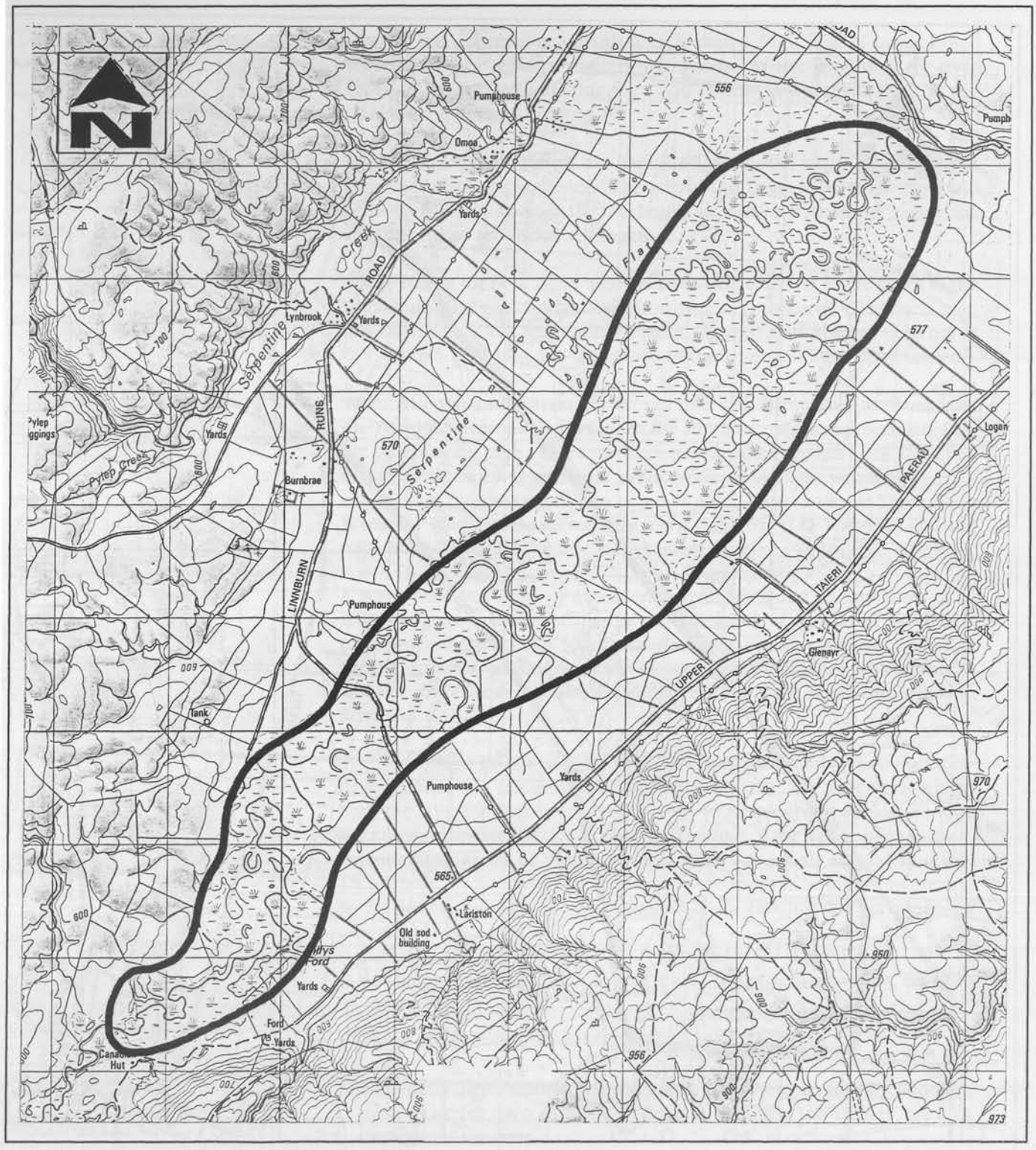
The disappearance of banded dotterel from the river is a source of regret and follows a gradual decline in population. The species used to breed on scabweed flats adjacent to the river as well as on the shingle braids. It is thought that the encroachment of lupins, willow and broom on to the river bed was a major factor in the disappearance of the banded dotterel.

For most of its length the river is unfenced from adjacent pastures. Free access of stock, particularly cattle, to the river is detrimental resulting in trampled banks, muddy water and nutrient enrichment.

Retention of a large proportion of the river's flow in Falls Dam, and subsequent diversion through irrigation races has had serious environmental impacts. The amount of space available for birds to find food, and the number of braids creating islands and safe breeding sites is reduced. Moreover the reduced water flow is insufficient to keep the river clear of adventive willow, lupin and broom vegetation. A definite programme of weed control for the river needs to be developed with the object of improving wetland bird habitat by removing adventive vegetation from the central part of the water course.

MANIOTOTO ECOLOGICAL DISTRICT
MAP 3/4A : AOI 4A

AOI 4A
UPPER TAIERI WETLANDS (Part)



GRID REFERENCE : INFO MAP 260 H43 605 205

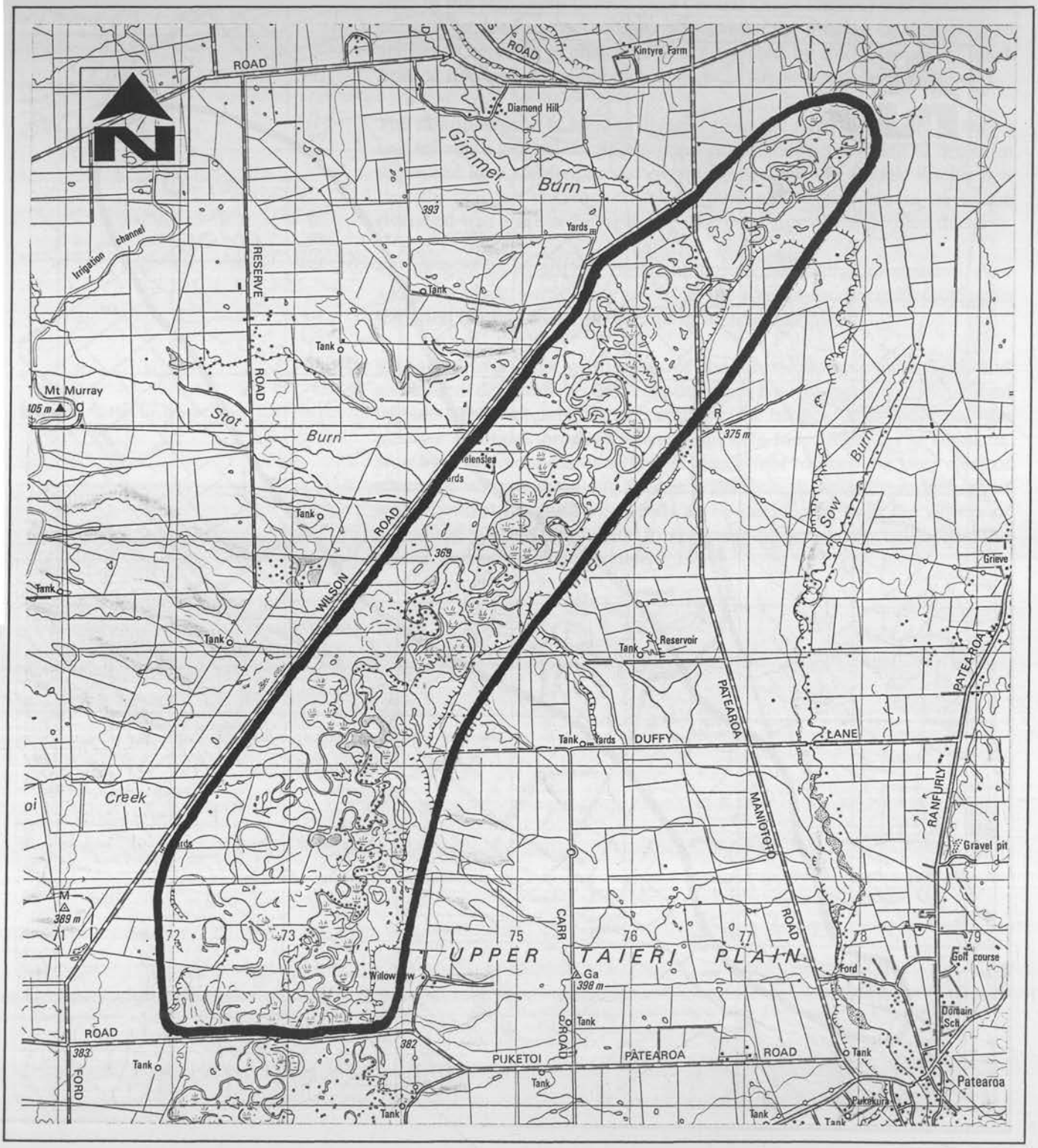
AREA : 1500 hectares

ALTITUDE : 550m

0 1 2 3 4
kilometres

MANIOTOTO ECOLOGICAL DISTRICT
MAP 3/4B : AOI 4B

AOI 4B
UPPER TAIERI WETLANDS (Part)



GRID REFERENCE : INFO MAP 260 H42 750 490

AREA : 1450 hectares

ALTITUDE : 370m

0 1 2 3 4
kilometres

AOI 4 UPPER TAIERI WETLANDS

Reference

Most of the information on this area is drawn from files of unpublished Wildlife Service reports written in response to the proposals for river channelling and straightening for flood control purposes as well as the Maniototo Irrigation Scheme.

Introduction

Two large areas of interest are identified within the expanse of wetlands associated with the meandering course of the Taieri River in the Styx and Maniototo Basins. Because the two basins are similar in landform, vegetation and fauna they are described together.

The whole of the Styx Basin wetland from Canadian Hut in the south to the Loganburn Ford road bridge at the north end is considered valuable. Within this large area is the Serpentine Wildlife Management Reserve (136 ha) at G.R. (NZMS 260) H43 615 214 north of the Linnburn Runs Road bridge.

Within the Maniototo Basin, the area of river and surrounding wetland from the Puketoi-Patearoa Road bridge in the south to a point approximately 2.5 km downstream of the Patearoa-Maniototo Road bridge has been identified as the best remaining example in the wake of changes wrought by river channelling and the irrigation scheme. Within this area are the Taieri Basin Wetlands Wildlife Management Reserve (37.5 ha; H42 780 532) and the Halls Road Wetlands Wildlife Management Reserve (44 ha; H42 763 498).

Landform

A scroll-plain landform of meandering river beds and oxbow lakes at all stages of development occurs on the floodplain of the Taieri River as it traverses both the Styx (c. 550m) and Maniototo Basins (c.370m). Separating the two is an entrenched gorge cut through low schist hills between Paerau and Patearoa. The gorge is now dammed as part of the Maniototo Irrigation Scheme.

The flood-plains lie in readily erodible alluvium patterned by past meander-development of a relatively unstable river channel. The valley gradient in both the Styx and Maniototo Basins is flat so frequent and prolonged high river flows inundate the flood-plain, and because of the nature of its surface, considerable areas of water are left lying for up to several months. Throughout the floodplain are numerous permanent oxbow lagoons created by the natural shifting of the river channel. There are three distinct categories of wetland:

a) Permanent River and Lagoons (oxbows, old braids, backwaters, cut-offs etc).

These experience seasonal variations in flow / levels.

b) Semi-permanent shallow marshy areas, ponds etc created by flooding. they exist for two months or longer and are sometimes present throughout the year.

c) Temporary, existing for two months or less in an average year.

River flows often exceed channel capacity resulting in frequent inundation of the flood-plains from April/May through to November in most years.

Vegetation and Flora

Vegetation of both wetlands has been considerably modified by farming activities and the introduction or naturalisation of exotic plant species. Present day vegetation is a mixture of indigenous and exotic species and ranges from fully aquatic flora of the river channel and newly-formed oxbow lagoons; the swamp, marsh and sedgeland vegetation of the open water margins and partially infilled lagoons; through to the periodically inundated grasslands of the floodplain.

The river flats are a mosaic of vegetation types surrounded by exotic pasture. These include:

1. Crack willow (*Salix fragilis*) forest. Mostly scattered in narrow bands on the main river banks in the Maniototo Basin but in places occupies broader areas often growing in shallow oxbow lagoons. Crack willows are present as scattered trees or shrubs in the higher Styx Basin but not nearly as abundant as in the Maniototo.

2. (Crack willow)/ *Eleaochoris acuta - Holcus lanatus / Myosotis caespitosa* swamp.

3. *Carex secta* sedgelands in association with rushes of *Juncus gregiflorus* and *J. effusus*.

4. Raupo (*Typha orientalis*) / *Carex secta* swamp.

5. *Carex diandra* swamp.

6. *Chionochloa rubra* grassland. Red tussock is more common in the less-modified Styx Basin than the Maniototo.

7. *Poa cita - Festuca novae-zelandiae* grassland. These species are also more common in the Styx Basin.

8. *Carex secta - C. maorica / Glyceria declinata* swamp.

9. *Glyceria declinata - Alopecurus geniculatus - Ranunculus flammula* swamp is common in shallow water.

10. *Juncus articulatus - Poa trivialis* swamp.

11. *Juncus gregiflorus - J. effusus / Agrostis capillaris - Rumex crispus* swamp or swampy pasture.

12. *Festuca rubra* grassland.

D. Bruce (unpub. report) noted the presence of the halophyte *Selliera microphylla* at G.R. H42 755 506 (Maniototo Basin) growing in turfy patches along and near the banks of the Taieri River. This is in part of an area mapped as "very salty" soils on the DSIR soil map. *Apium filliforme* and *Puccinellia* sp are also found in this area. Bruce adds that *Selliera* may be common elsewhere near the banks of the Taieri particularly south of this site.

Fauna

The Upper Taieri wetlands were regarded by the former New Zealand Wildlife Service as an internationally important waterfowl habitat, one of the three most valuable fresh water wildlife habitats in Otago and one of the ten most valuable in New Zealand (National Water and Soil Conservation Organisation 1983). This ranking took productivity in terms of birds produced, diversity in terms of species present, abundance in terms of

numbers present and distribution or internal migration as the basic criteria. Other factors taken into account were the presence of shallow water areas for feeding, vegetation and cover and moulting bird use.

The areas of greatest wildlife value are situated on the flood-plains of the river where annual flooding maintains and recharges the permanent and semi-permanent water areas. Observations have shown that the Upper Taieri wetland makes significant contributions to the regional waterfowl population, with mallard, grey duck, New Zealand shoveler, paradise shelduck, black swan and grey teal all breeding here. Other waterbirds including white faced heron, marsh crake, Australian bittern and pukeko breed in the wetlands, while some species such as oystercatchers and pied stilt nest adjacent to the wetlands taking their broods to the wet areas after hatching.

Seasonal inundation creates large sheets of shallow fertile water. Light penetration and warmth results in these areas producing large amounts of food, both animal and vegetable, which is available for waterbirds and is especially important during pre-nesting and nesting periods. The plentiful cover provided by the willow lined permanent water channels, oxbows and dense willow clumps, and the abundant areas of sedges, rushes etc in close proximity to the inundated areas produce conditions which make the wetlands an outstanding wildlife habitat. Waterfowl also depend on open water areas during moulting. At this time moulting birds are completely flightless and rely on open water and dense cover for security.

The Maniototo and Styx Basins are the centre for paradise shelduck population found in the Otago region. The wetlands provide one of the major moulting areas for this species, with flocks exceeding 1000 birds common throughout the area during January/February. After moulting these birds disperse. Other waterfowl including mallard, grey duck, grey teal and black swan have ben recorded moulting in high numbers.

The wetland must also be considered for the role it has in relation to the distribution of those young birds produced there into outside populations and also the seasonal or other use made of the wetland by migratory species. Some species are particularly sedentary, remaining in the area throughout the year. Bittern, marsh crake and pukeko are examples. Other species breeding here are known to disperse through Otago, to adjoining regions, and for some species, throughout New Zealand. Those dispersing through Otago are mallard, grey duck, paradise shelduck, black swan. To adjoining regions fly pied stilt, banded dotterel and spur-winged plover; while New Zealand shoveler, grey teal and South Island pied oystercatcher are known to disperse throughout New Zealand. Others such as the glossy ibis migrate overseas. A total of fifty-two bird species have been recorded in the area. Of these, twenty-seven species are dependent on the wetland to meet their specialised needs. These species are listed below:

Species	B	G	P	C	U	R	M	Mou
Black Shag	x			x				
Little Shag			x			x		
White Heron			x			x	x	
White faced Heron	x		x		x			
Australian bittern	x		x			x		
Glossy Ibis			x			x	x	

Species	B	G	P	C	U	R	M	Mou
Australian White Ibis			x			x	x	
Black Swan	x	x		x			x	x
Paradise Shelduck	x	x		x			x	x
Mallard	x	x		x				x
Grey Duck	x	x			x			x
Grey Teal	x		x	x			x	x
New Zealand Shoveler	x	x		x			x	x
New Zealand Scaup			x			x		
Marsh Crake	x		x			x		
Pukeko	x	x			x			
Australian Coot			x			x		
S.I. Pied Oystercatcher	x		x	x			x	
Spurwinged Plover	x		x		x			
Banded Dotterel	x		x	x			x	
Japanese Snipe			x			x	x	
Pied Stilt			x		x	x		
Southern Black Backed Gull	x		x		x			
Black Billed Gull			x	x			x	
Black Fronted Tern	x		x		x		x	
Kingfisher	x		x		x			
Canada Goose	x	x		x				

B = breeding G = Game P = Protected C = Common
U = Uncommon M = Migratory R = Rare Mou = Moulting

Discussion

The Upper Taieri wetlands are (like all wetlands) important buffer zones, intercepting the nutrient discharges from adjoining farm land. Protection of the wetlands helps maintain the river's water quality further downstream.

The Taieri River and its associated floodplain wetlands are important wildlife habitats providing for the needs of a variety of waterfowl, wading birds and other aquatic bird species. In addition to the abundance of widespread and relatively common birds there are several species present which may be classified as uncommon, of a limited distribution pattern, or as having specific habitat requirements. These include the grey teal, shoveler, scaup, coot, bittern and crake. The difference between the abundance of birdlife in the wetland area and the rest of the District is an indicator of its regional importance. This is especially so in a dry year when many of the small ponds and areas of swampy ground away from the Taieri lose their water and birds which would use them must rely on the river wetlands.

The size and complexity of the meander pattern in the Upper Taieri is exceptional in a national context. The meander pattern has developed to a stage where natural cut offs are occurring and oxbow lakes are plentiful but not yet all filled in with swamp material and vegetation. Meander patterns have been a natural target for drainage schemes because of the ease with which a channel length can be shortened by cut-offs. Examples of such modification are seen in the Makarewa River Scheme which has dried many miles meandering water courses in Southland's Otapiri, Makarewa and Hedgehope Streams. Because of flat valley gradients and conveniently placed

valley restrictions downstream, meandering river systems have been drowned under lakes behind irrigation and power dams for example Lake Onslow and Loganburn Dam. Channel shortening of the Taieri River as a flood control measure has been carried out in the Maniototo Basin with consequent change in river behaviour and some loss of the effectiveness of the meander system as a ponding area.

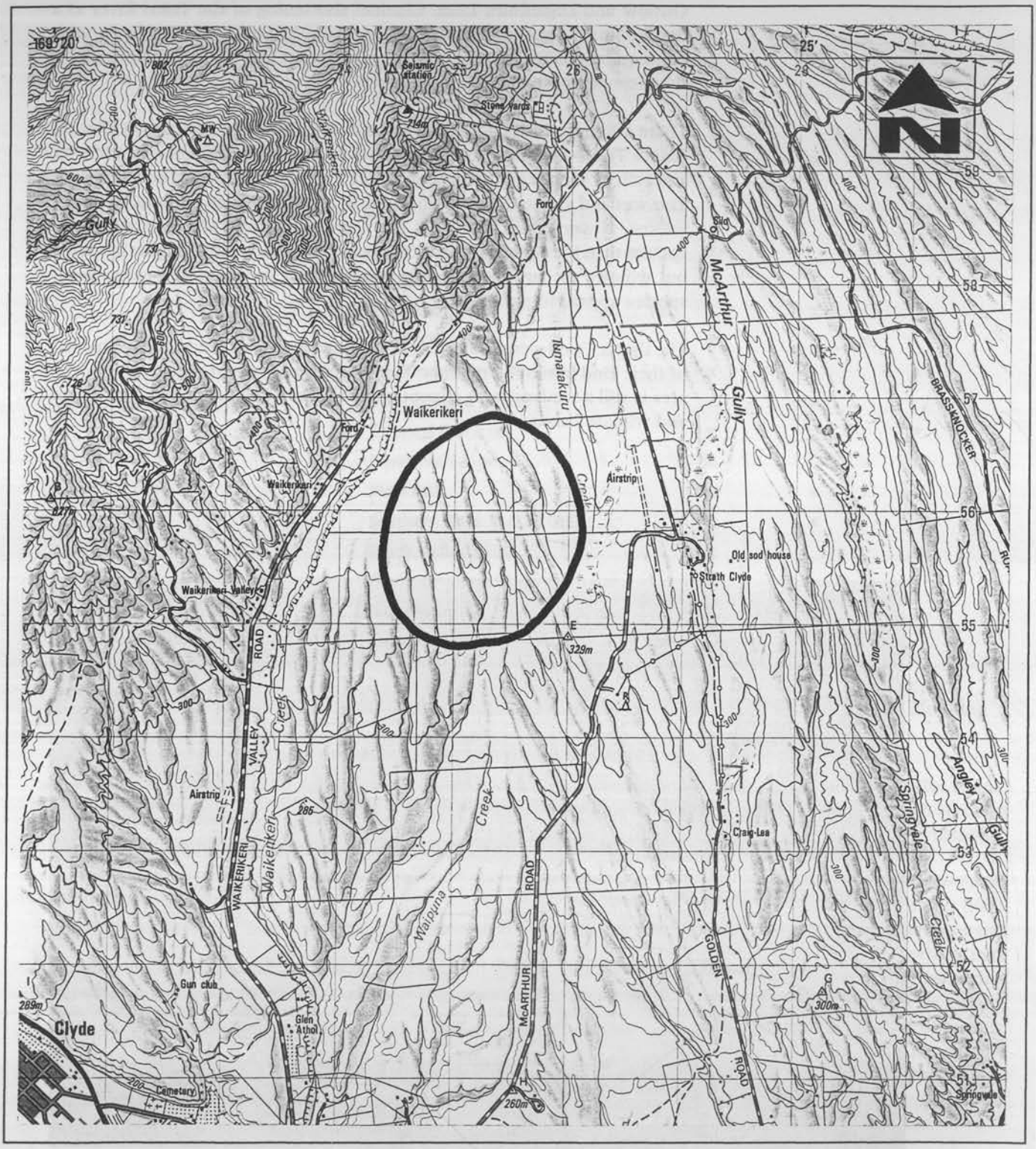
There are some differences between the wetlands of the Styx and Maniototo Basins. The lower Maniototo Basin has been more affected human settlement and activity such as goldmining and more intensive agricultural development. The wetland vegetation is dominated by exotic species particularly crack willow. Nevertheless, this area has a greater variety of habitats for bird species than the Styx Basin. The Styx Basin vegetation is also highly modified but willows are far less abundant and a greater proportion of native plant species appear to persist here.

The Upper Taieri wetlands comprise the only significant inland, upland habitat of their kind left in the country. Despite past and recent modifications, the area is still a wetland with exceptional value as a splendid natural landform and wildlife habitat.

Meanders in the Upper Taieri enclose large wetland areas important for many native waterfowl.

MANIOTOTO ECOLOGICAL DISTRICT
MAP 3/5 : RAP 5

RAP 5
WAIKERIKERI FLATS



GRID REFERENCE : INFO MAP 260 G42 250 560

AREA : 280 hectares

ALTITUDE : 330m

0 1 2 3 4
kilometres

RAP 5 WAIKERIKERI TERRACE FLATS

Grid Reference Infomap 260 G42 250 560

Reference Allen (1988); Emerson (unpubl.)

Altitude 330m

Rainfall 580mm

Geology, Landforms, and Soil Outwash gravels of the penultimate glaciation form broad, very gently south-sloping terraces with regular wide, shallow, southward-draining channels. The soil is mapped as Waikerikeri stony sand, a moderately developed, shallow profile, Drybread group brown-grey earth.

Vegetation The grassland is extensively grazed but otherwise agriculturally undeveloped. There are marked seasonal changes in the vegetation, and spatial variation that results in a mosaic of large patches dominated by different groups of three or four species. These patches are distinguished as the following vegetation types:

1. Tussock grassland.
Silver tussock provides 10-30% cover over areas varying in size from small patches of less than 100 sq.m to entire interfluves of several hundred square metres. Fescue tussock and blue tussock are usually associated, with a cover generally less than a third that of silver tussock, but are rare where silver tussock is sparse. Sweet vernal is the main intertussock species, particularly prominent in summer, a time when haresfoot trefoil is also important. Small *Pimelea aridula* shrubs occur at low density, and are mainly confined to this vegetation type, and sweet brier is commonest here with plants 0.5 - 1m tall at densities of 1-3 plants per 100 sq.m. Matagouri is present but is an insignificant component of the vegetation.

2. Haresfoot trefoil herbfield.
In summer, haresfoot trefoil provides about 30% cover over areas of up to a few hundred square metres of silty soil that lack large perennial grasses or shrubs. Patches of scabweed are prominent but do not provide much ground cover. About 20% of the soil surface is bare, and a mixture of the lichen *Chondropsis semiviridis*, small annual grasses, and herbs, provides the balance of cover. In winter *Chondropsis* covers up to 80% of the ground otherwise left bare by the departed annuals.

3. Danthonia - sweet vernal grassland.
An almost continuous turf, in winter dominated by danthonia, and in summer by danthonia and sweet vernal, covers the floor of most drainage channels. Clumps of several other grasses are also prominent, and the common herbs of the terrace reach their greatest stature here.

4. Thyme shrubland.
Thyme shrubs, mostly less than 0.4m tall, form a few dense stands up to 100 sq.m in extent, mainly on the eastern rims of drainage channels. In winter the ground between the shrubs is largely bare, in summer haresfoot trefoil and a few other herbs provide a sparse cover.

Many species occur throughout all these vegetation types, varying in prominence with the season. Grasses include the native danthonia and blue wheat grass; and the introduced annual silvery hair grass, downy brome and soft brome. The great majority of herbs are exotic: most prominent in winter are catsear, sheep's sorrel, hawksbeard, suckling clover, and whiter

fuzzweed, joined in spring and summer by St Johns wort, sheep's burr and viper's bugloss. *Geranium sessiliflorum* and the sedge *Carex breviculmis* are the most common native herbs. Small clumps of moss are scattered about.

Flora

Vascular plants

*Acaena agnipila**	Australian sheep's bur
*Aira caryophyllea**	silvery hair grass
*Anthoxanthum odoratum**	sweet vernal
*Bromus hordeaceus**	soft brome
*B. tectorum**	downy brome
*Capsella bursa-pastoris**	shepherd's purse
Carex breviculmis	
*Crepis capillaris**	hawksbeard
Dichelachne crinita	plume grass
Discaria toumatou	matagouri
*Echium vulgare**	viper's bugloss
Elymus solandri	blue wheat grass
*Erodium cicutarium**	storksbill
Festuca novae-zelandiae	fescue/hard tussock
F. rubra	
Geranium sessiliflorum	
*Hieracium pilosella**	mouse-ear hawkweed
Melicytus alpinus	porcupine scrub
*Hypericum perforatum**	St John's wort
*Hypochoeris radicata**	catsear
Leucopogon fraseri	patotara
Pimelea aridula	
Poa cita	silver tussock
Poa colensoi	blue tussock
*Potentilla argentea**	hoary cinquefoil
Raoulia australis	scabweed
R. parkii	
*Rosa rubiginosa**	sweet brier
*Rumex acetosella**	sheep's sorrel
Rytidosperma buchananii	danthonia
*Thymus vulgaris**	thyme
*Trifolium arvense**	haresfoot trefoil
*T. dubium**	suckling clover
*Verbascum thapsus**	woolly mullein
*Veronica arvensis**	field speedwell
Vittadinia australis	white fuzzweed
*Vulpia megalura**	

*denotes exotic species

Fauna

The terraces west of the lower Manuherikia River are habitat for the Alexandra chafer beetle *Prodontria biclorata* as well as an undescribed species of weta. Both species have been recorded in or around the Waikerikeri terrace grasslands (B Emerson unpub.). The diurnal moths *Notoreas* n.sp. and *Eurythecta zelaea* have been found here too.

Discussion

The vegetation of the part of the Waikerikeri terraces here described is closer to a natural state than that described for similar glacial outwash terrace landforms in any other part of the Central Otago Ecological Region. Elsewhere on the terraces of the lower Manuherikia Valley, tussock densities are negligible, and the vegetation is dominated by exotic grasses and weeds,

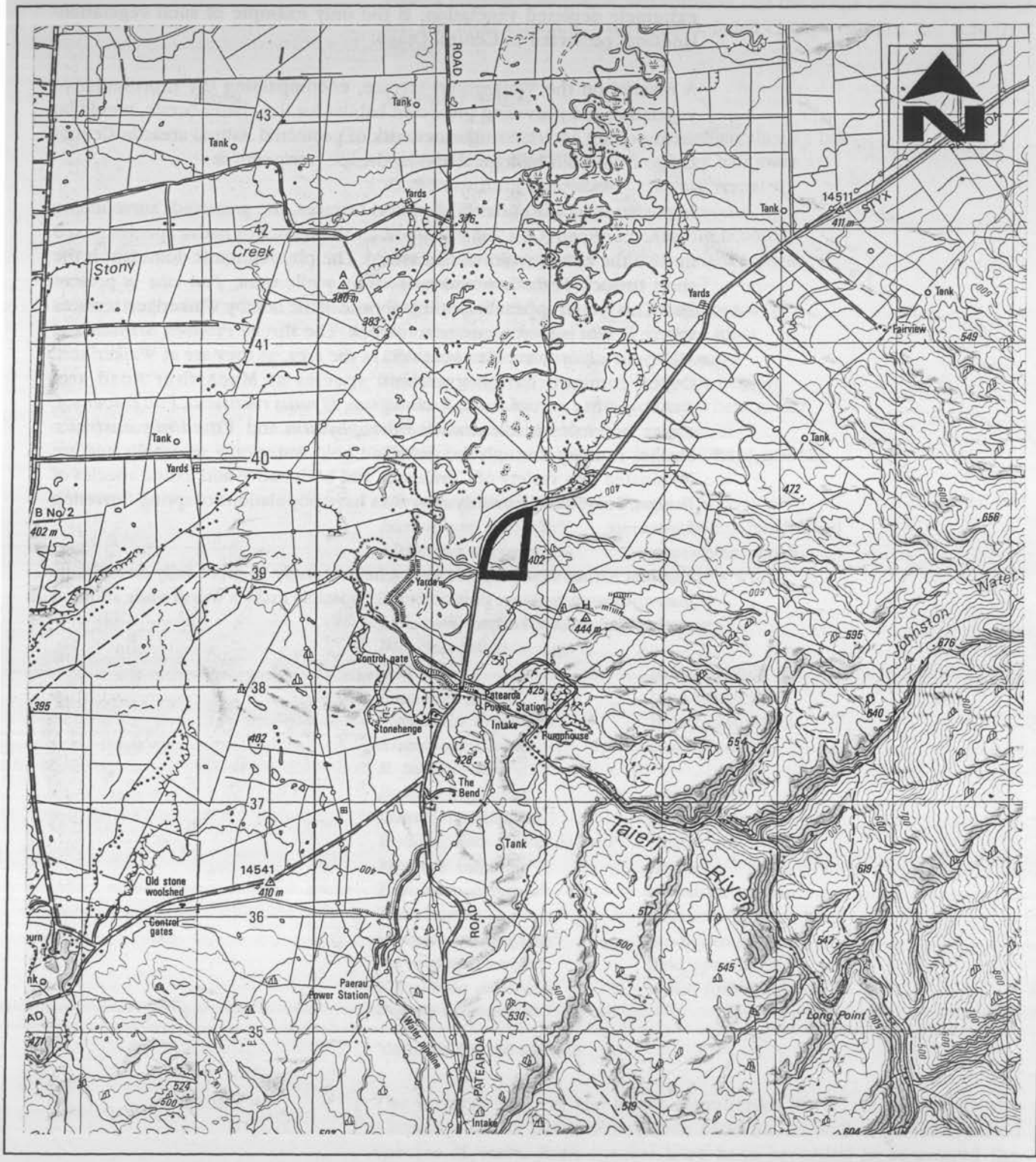
or by fodder crops. No similar vegetation is protected in the remainder of the Maniototo ecological District. The Cromwell chafer beetle reserve, with extremely depleted vegetation, is the only example of such vegetation-landform protected in Central Otago.

A reserve on the Waikerikeri terrace, encompassing the representative vegetation and providing protected habitat for the chafer beetle, would be an important addition to the network of protected natural areas in Central Otago from both biological and landscape perspectives.

Immediately north of the Waikerikeri terraces, the grasslands surrounding MacArthur Road (G42 265 565) have an abundance of native species mixed in with the exotic sweet vernal sward. The physiognomic dominant is the short tussock *Festuca novae-zelandiae*, while some *Poa cita* is present also. This would appear to be the opposite of the nearby Waikerikeri terraces where *P. cita* is the commonest tussock. The shrubs *Pimelea aridula* and *Melicytus alpinus* are also common in the area, as they are at Waikerikeri. Other common native grassland species at MacArthur Road are: *Rytidosperma maculatum, R. clavatum, Elymus rectisetus, Poa coloensoi, Carex breviculmis, Geranium microphyllum* and *Vittadinia australis.* Flushes running through the grassland hold water only seasonally and are dominated by a variety of *Carex* spp. and both native and exotic species of *Juncus*. Some bare, possibly salty sites have populations of spring-flowering *Myosurus*.

The MacArthur Road area deserves further study to more fully describe its flora and fauna, as some part of it could possibly make a worthwhile addition to the Waikerikeri Terrace Flats RAP.

RAP 6
PATEAROA SALINE AREA



GRID REFERENCE : INFO MAP 260 H42 717 392

AREA : 30 hectares

ALTITUDE : 395m

0 1 2 3 4
kilometres

RAP 6 PATEAROA SALINE AREA

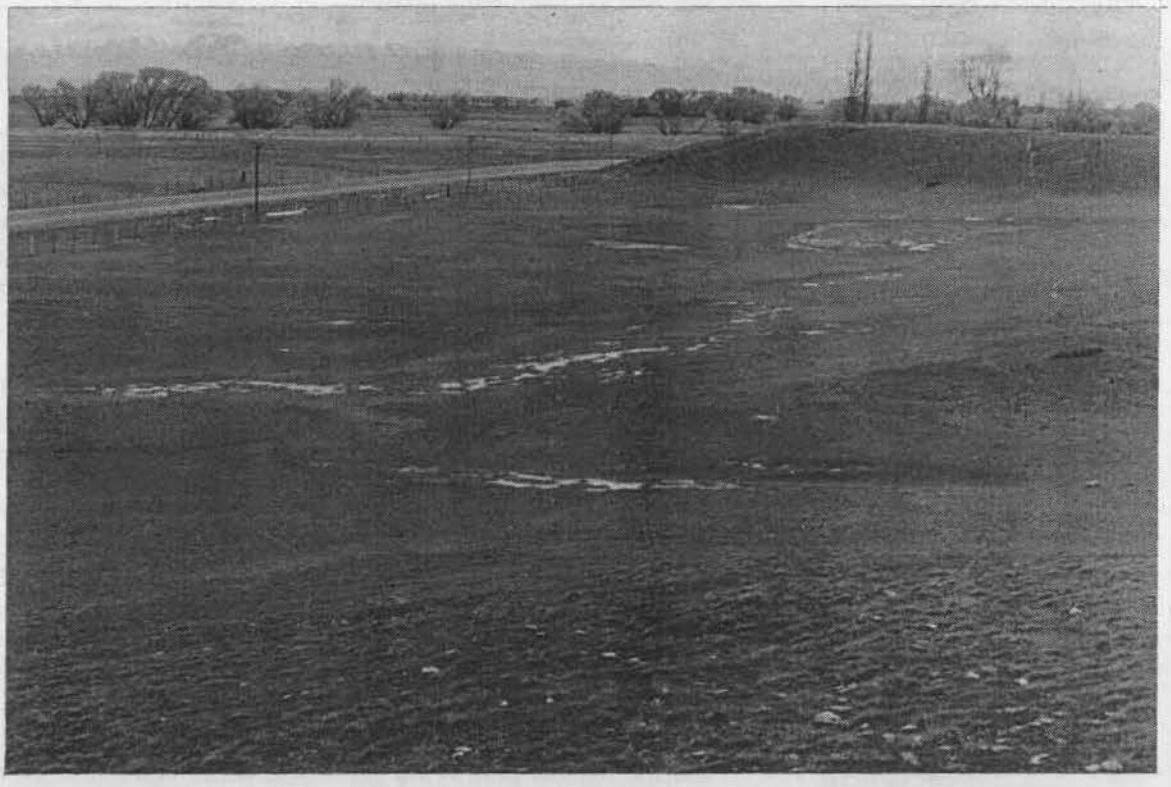
Reference	McIntosh, Beecroft & Patrick 1990; Patrick 1989; Johnson 1976.
Site No	SS11CO
Grid reference	Infomap 260 H42 717 392
Status	Private land (farmed by J. Beattie)
Altitude	395m
Rainfall	500mm
Slopes	Flat near road, rolling terrace edge, undulating on top of terrace
Landform	Floodplain and low terrace (salty area restricted to floodplain)
Site modification	Grazed
Special features	Roadside frontage for interpretation. Scenic - terrace forms backdrop.
Soil series (tentative)	Patearoa silt loam, salty phase
N.Z. Classification	Sodic Immature Semiarid Soil (Hewitt 1989, version 2)
Geology Notes	The terrace gravels are derived from weakly weathered schist deposited in the Drybread Formation of penultimate and older glaciation (Mutch 1963). Underlying strata is not visible at the site but both schists and Miocene sediments have been mapped nearby. It is unclear whether salts have their origin in the terrace deposits, or due to closed basin topography , or underlying rock.
Vegetation and Flora	Very diverse with *Lepidium sisymbrioides, L. kirkii, Leptinella maniototo, Selliera microphylla, Puccinellia* spp., *Plantago coronopus* (exotic), *Atriplex buchananii, Apium filiforme, Vitttadinia australis, Carmichaelia monroi, Raoulia australis.*
Fauna	Very diverse with moths *Paranotoreas fulva, P. brephosata, Zizina oxleyi, Scopula rubraria, Scythris triatma, Stenoptilia celidota, Sporophylla oenospora, Crocydopora cinigerella, Eurythecta zelaea, Lycaena boldenarum, Orocrambus corruptus, Capua semiferana, Scoriodyta suttonensis, Phaeosaces* n.sp. and grasshopper *Sigaus campestris.*
Discussion and Assessment	The Patearoa saline area is considered to have very high conservation value and the highest priority for protection. A moderately large site, it is the best example of a saline area in the Maniototo District, with its combined botanical and entomological values making it the most important example of such habitat in Central Otago and New Zealand. It has the typical saline soils plants including a small colony of *Lepidium kirkii* and *Apium filiforme* as well as a rich array of plant species adjacent to the saline area that may depend to a greater or lesser extent on the presence of the saline soils. Included in this group is a healthy colony of *Lepidium sisymbroides, Leptinella maniototo* and *Carmichaelia monroi*. The site consists of old meanders that are seasonally wet and small bare salty areas at the bases of surrounding hillsides. A large tarn has a rich water beetle fauna and only drys up in mid-summer.

The Lepidoptera fauna is excellent and contains all the species that are characteristic of Maniototo saline areas as well as additional species of high interest that are associated with plant communities adjacent to the saline soils. The site has also been proposed for reservation by Wardle (1975), Johnson (1976) and Partridge (1981).

Action Required

1. Protection by reserve status or conservation covenant.
2. Investigate setting up roadside interpretation.
3. Vegetation monitoring set up.

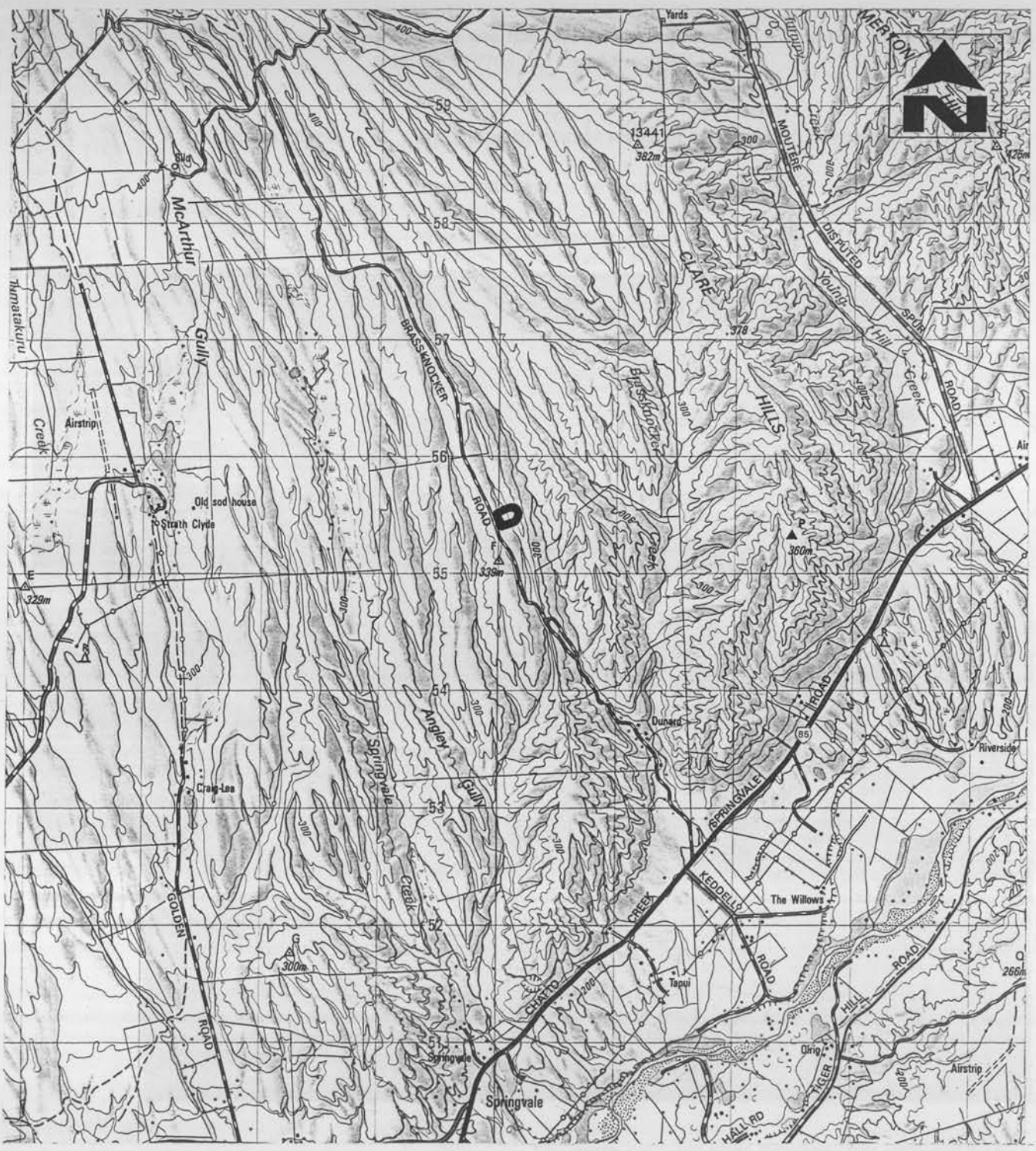
Landcare Research scientists R.B. Allen and P.D. McIntosh have recently (1993) published a management plan for the area.



The main saltpans near Patearoa are enclosed by low terraces and adjoin the main road to Styx.

The diurnal moth Paranotoreas fulva *is characteristic of saltpan areas where its larval host* Atriplex buchananii *thrives.*

RAP 7
DUNARD



GRID REFERENCE : INFO MAP 260 G42 301 555

AREA : 1 hectare

ALTITUDE : 330m

0 1 2 3 4
kilometres

RAP 7 DUNARD

Reference McIntosh *et al.* 1992

Site No: SS22CO

Grid Reference Infomap 260 G42 301 555

Site Status Freehold

Owner Robert Jopp, Moutere Station

Published Information McCraw (1964)

Environmental Information

Altitude 330m

Rainfall 400mm

Slopes Flat

Landform Terrace in minor valley

Modification Grazing and vehicular traffic

Site Assessment

Special Features:

1. Rare plant, rare community and unusual soil parent material (loess) - vegetation association in a reasonably large area.
2. Extremely alkaline site (but not saline); pH of 9.0 in A horizon is very unusual.
3. Very high conservation value.

Action Required Negotiate legal protection urgently.

Geology Site is a narrow loess covered terrace presumably on Tertiary sediments (no outcrop). Behind terrace is hills composed of Clare gravels.

Vegetation Site well vegetated with mainly native species. Halophytes include *Puccinellia, Atriplex buchananii, Myosurus minimus* ssp. *novae-zelandiae* and *Ceratocephalus pungens* (eight plants, two of them large, amongst *Atriplex* and *Myosurus*). *Acaena buchananii* present also.

Fauna:

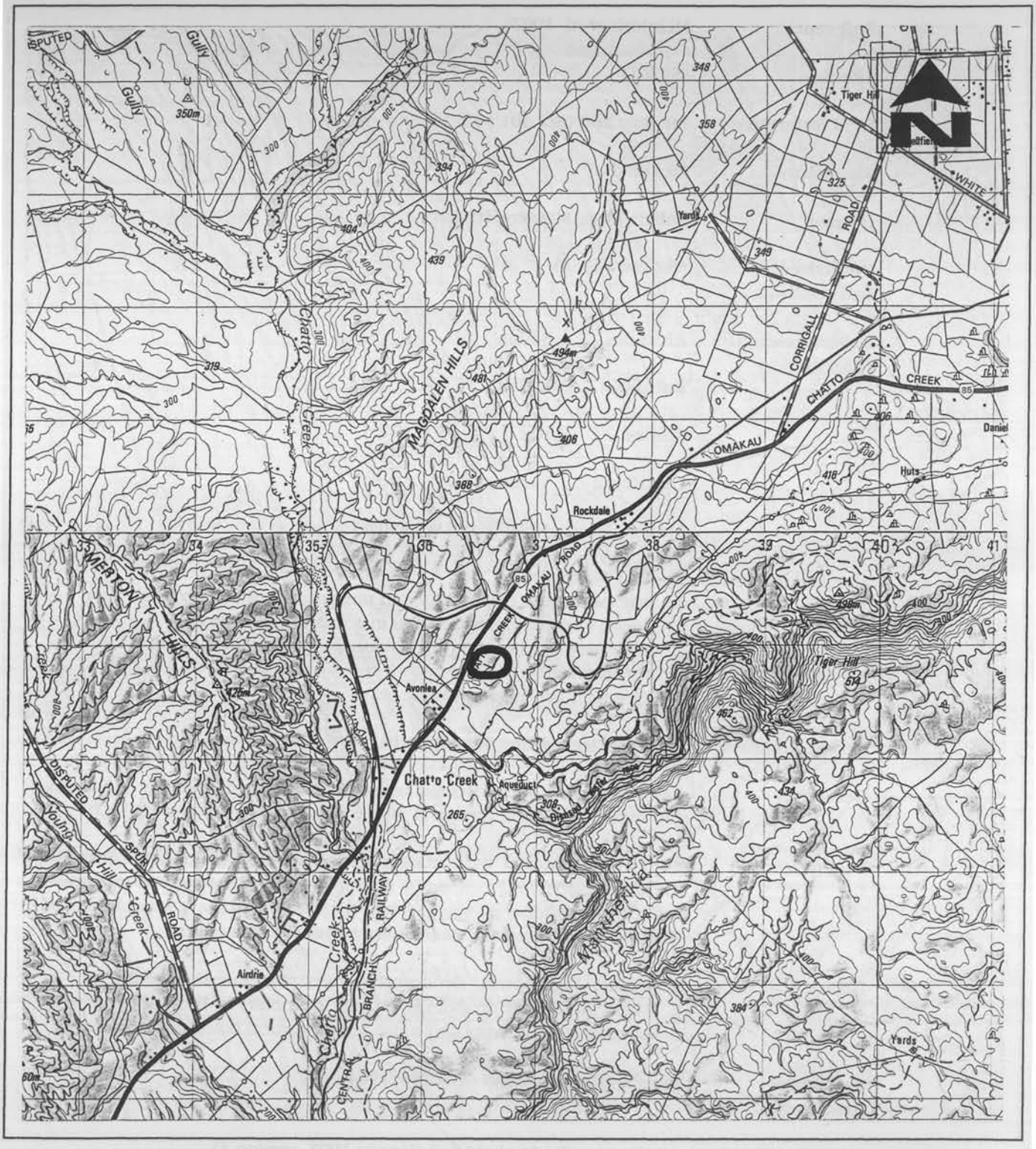
1. Insecta: Lepidoptera: *Orocrambus corruptus, Eurythecta zelaea*
2. Many fine insect droppings (1-2mm diameter) in little piles all over *Myosurus* community and some 2-3mm vertical holes, origin unknown.

Soil Series (tentative) Ripponvale loamy sand (McCraw 1964)

N.Z. Classification Alkaline Argillic Semiarid Soil (Hewitt 1992, version 3)

MANIOTOTO ECOLOGICAL DISTRICT
MAP 3/8 : RAP 8

RAP 8
ROCKDALE



GRID REFERENCE : INFO MAP 260 G42 366 589

AREA : 2 hectares

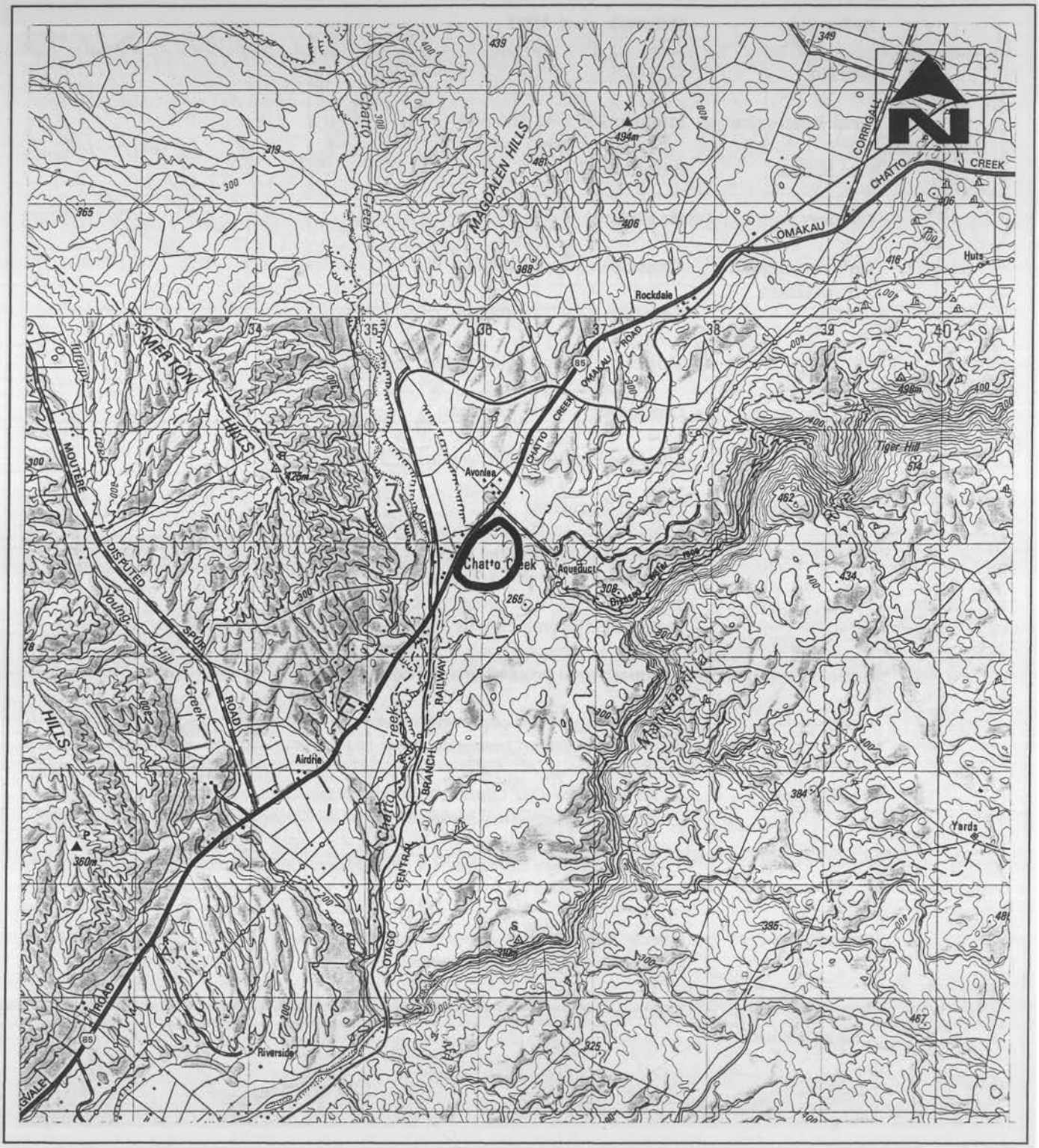
ALTITUDE : 270m

0 1 2 3 4
kilometres

RAP 8 ROCKDALE

Reference	McIntosh *et al.* 1992	
Site No	SS21CO	
Grid Reference	Infomap 260 G42 366 589	
Site Status	Private Land	
Owner	Mr Kinney	
Environmental Information	**Altitude**	270m
	Rainfall	400mm
	Slopes	Undulating; 5 degrees at site
	Landform	Terrace
	Site Modification	Sheep grazing, fencing
Site Assessment	**Special Features:** 1. Many rare and local halophytes and rare insects 2. One of the few saline sites 3. Cushion-plant area adjacent 4. Overall very high conservation value. 5. Roadside prominent site for soil-plant-insect interpretation	
Action Required	Negotiate legal protection and realign fences	
Geology	Low hills of greywacke gravels on basement of weathered schist; flat terrace plain on weathered basement rock.	
Vegetation	1. Halophytes (all common here): *Myosurus minimus* ssp. *novae-zelandiae, Lepidium kirkii, Atriplex buchananii, Puccinellia* and exotic *Plantago coronopus.* 2. Cushion area adjacent (*R. australis, Colobanthus brevisepalus, Rytidosperma* sp.)	
Fauna	Insecta: Lepidoptera *Paranotoreas fulva, Orocrambus corruptus, Eurythecta zelaea*	
N.Z. Soil Classification	Alkaline Argillic Semiarid Soil (Hewitt 1992, version 3).	

RAP 9
CHATTO CREEK



GRID REFERENCE : INFO MAP 260 G42 380 575

AREA : 30 hectares

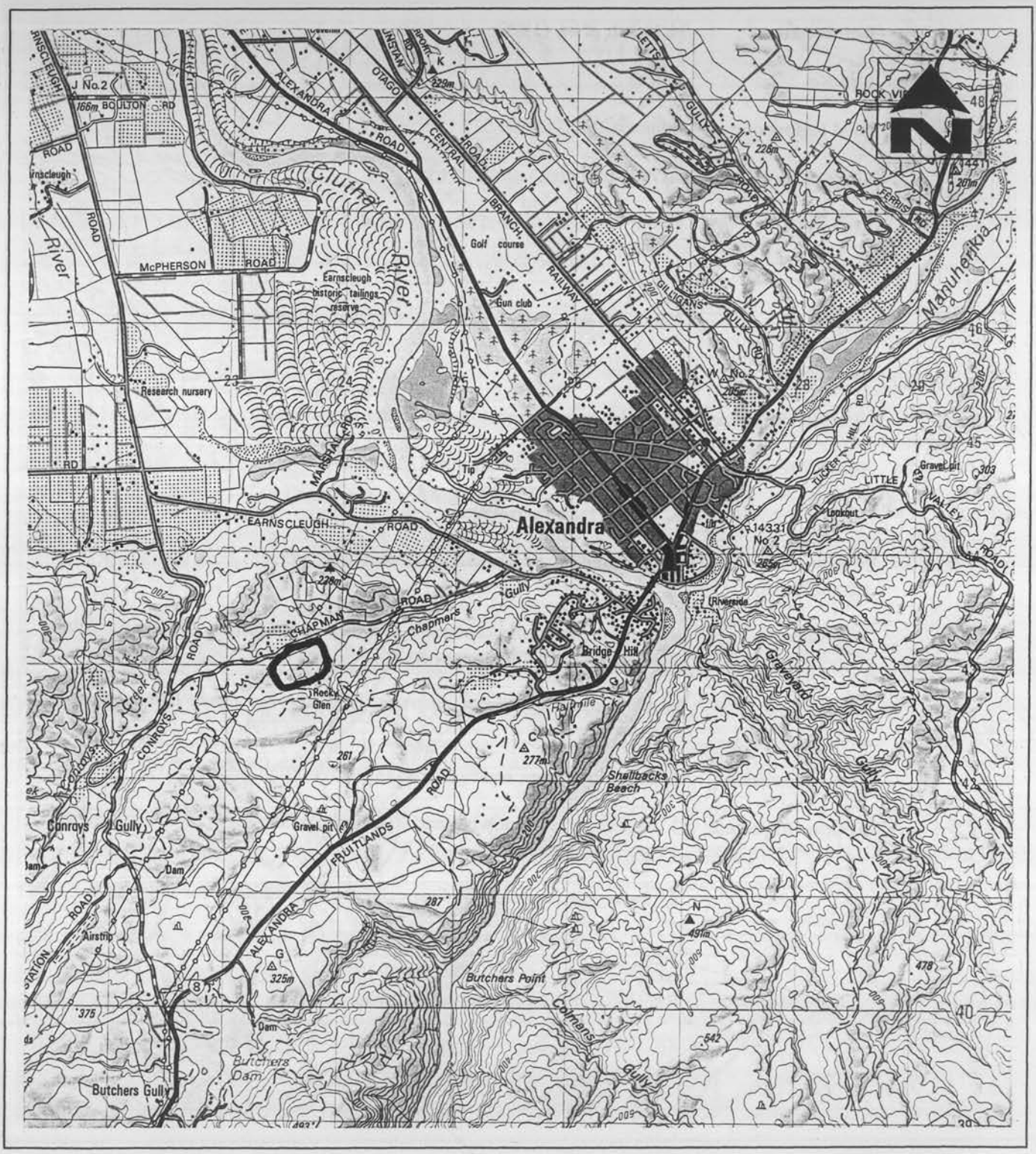
ALTITUDE : 245m

0 1 2 3 4
kilometres

RAP 9 CHATTO CREEK

Reference	McIntosh *et al.* (1990)
Site No	SS8CO
Grid Reference	Infomap 260 G42 380 575
Site Status	MOWD trial area - saltbush trial
Altitude	245m
Rainfall	400mm
Slopes	Hilly with some steep gully sides. Rolling ridge crest.
Landform	Dissected terrace
Site Modification	25% bare ground; erosion (wind and tunnel gully)
Special features	1. Large weathered schist area (1-2 ha) 2. Tunnel gully erosion 3. fenced rabbit-proof site
N.Z. Soil Classification	Typic Paralithic Semiarid Soil (Hewitt 1989, version 2)
Vegetation	*Atriplex buchananii, Lepidium sisymbrioides, L. kirkii, Elymus rectisetus, Poa colensoi, Rytidosperma* sp.
Fauna	Moths include *Oxythecta austrina, Paranotoreas fulva, Loxostege* n.sp., *Kiwaia thyraula.*
Site Assessment	Second ridge from west suitable as reserve. High priority.
Action Required	1. Discuss with landowner and MOWD the possibility of reserving a suitable portion of this area. 2. Survey surrounding land especially to the southeast for saline soils.

RAP 10
CHAPMAN ROAD



GRID REFERENCE : INFO MAP 260 G42 253 435

AREA : 2 hectares

ALTITUDE : 150m

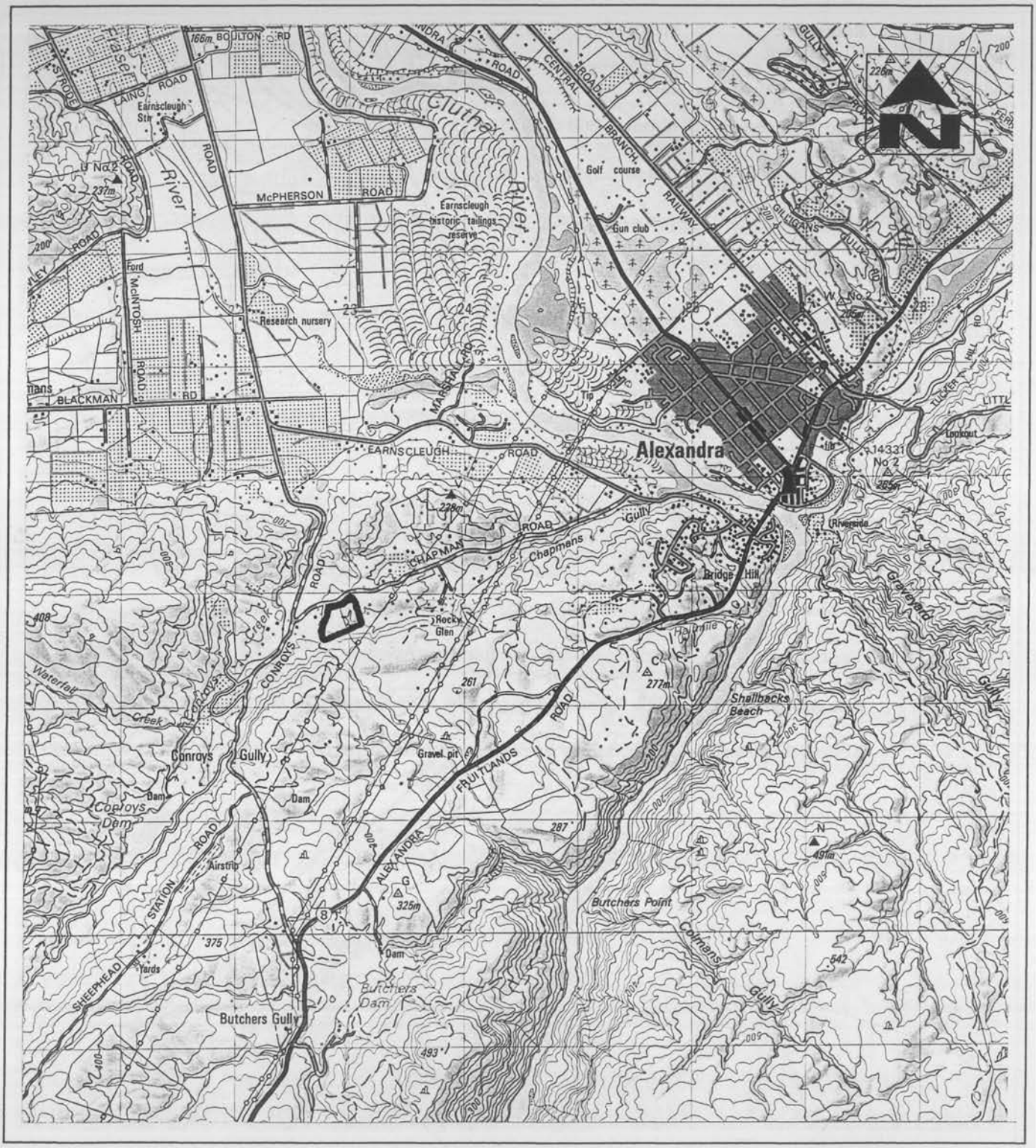
0 1 2 3 4
kilometres

RAP 10 CHAPMAN ROAD

Reference	McIntosh *et al.* 1990
Site No	SS5CO
Grid Reference	Infomap 260 G42 253 435
Site Status	Private land (Mr L McGregor)
Altitude	150 m
Rainfall	350 mm
Slopes	3 degrees northwest
Landform	Rolling to undulating basin
Modification	Holding paddock next to homestead.
Soil Series (tentative)	Chapman series
N.Z. Soil Classification	Saline immature semiarid soil (Hewitt 1989, version 2)
Geology	Moderate to strongly weathered schist.
Vegetation	*Puccinellia* spp., *Atriplex buchananii.*
Site Assessment	High value: One of the few sites classified as saline rather than alkaline.
Action Required	Protection by agreement with landowner.

MANIOTOTO ECOLOGICAL DISTRICT
MAP 3/11 : RAP 11

RAP 11
MANORBURN SOIL TYPE
CHAPMAN ROAD



GRID REFERENCE : INFO MAP 260 G42 240 432

AREA : 2 hectares

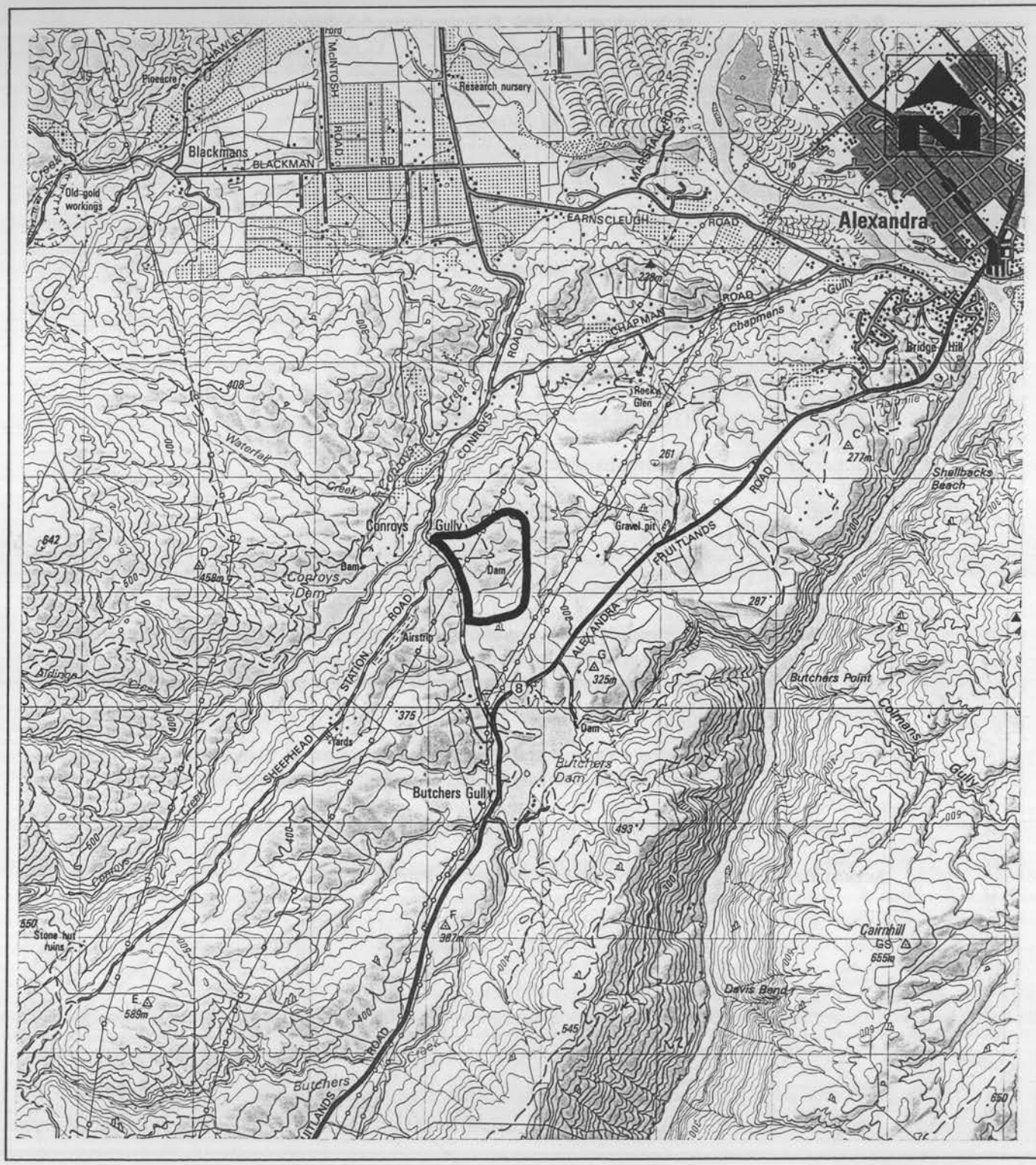
ALTITUDE : 170m

0 1 2 3 4
kilometres

RAP 11 MANORBURN TYPE SITE, CHAPMAN ROAD

Reference	McIntosh *et al.* 1990; D Bruce (unpub.); Patrick 1989.
Site No	SS6CO
Grid Reference	Infomap 260 G42 240 432
Site Status	Reserve
Altitude	170 m
Slopes	Undulating to rolling
Landform	Valley floor
Site Modification	Considerable disturbance by gold and clay mining and recreational use.
Special Features	Type site for Manorburn soil
Soil Series	Manorburn series
N.Z. Soil Classification	Sodic Argillic Semiarid Soil
Geology	Strongly weathered schist
Vegetation	*Apium filiforme, Samolus repens* (one of only two inland sites) in shallow small grassy gully along with *Juncus gerardii, Atriplex buchananii, Puccinellia* spp. *Lepidium kirkii* grows on a salty hillslope at the southeast corner.
Fauna	Moths - representative saline soils fauna of *Paranotoreas fulva, P. brephosata, Loxostege* n.sp., *Eurythecta zelaea, Scopula rubraria*.
Site Asessment	High value
Action Required	Recommended for reserve by Patrick (1989).

RAP 12
PATRICKS PLACE



GRID REFERENCE : INFO MAP 260 G42 227 410

AREA : 50 hectares

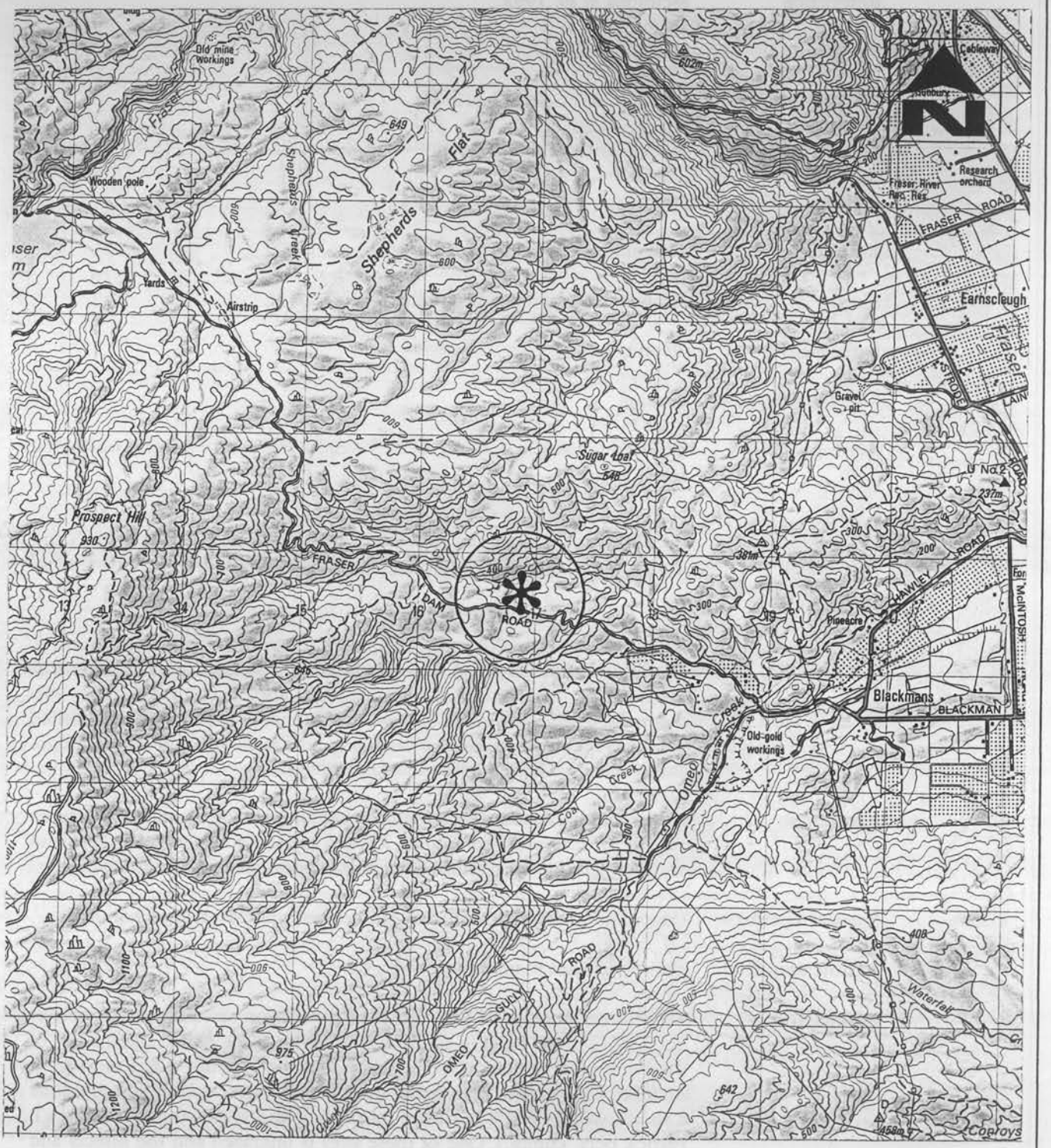
ALTITUDE : 300m

0 1 2 3 4
kilometres

RAP 12 PATRICK'S PLACE

Reference	McIntosh *et al.* 1992
Site No	SS25CO
Grid Reference	Infomap 260 G42 227 410
Site Status	Private land (various owners)
Altitude	300 m
Rainfall	400 mm
Slopes	Strongly rolling; 6 degrees at site
Landform	Medium altitude tor landscape
Site Modification	Grazing
Geology	Exposed schist tors in south, weakly weatherd gravels overlying weathered schist to north.
Soil Series	Chapman (tentative)
N.Z. Soil Classification	Saline argillic Semiarid Soil (Hewitt 1992, version 3).
Vegetation	Halophytes *Puccinellia* spp., *Atriplex buchananii, Crassula tetramera, Myosurus minimus* subsp. *novae-zelandiae, Poa lindsayi, Lachnogrostis filiformis*, lichens and mosses fringing area also. Exotic grasses, *Raoulia australis, Vittadinia gracilis, Erodium* on margins. Patrick (unpublished data) has recorded 140 native vascular plants from adjacent gullies, ridges and wetlands. These are listed in Appendix 3.
Fauna	Moths: Diurnal *Loxostege* n.sp. and *Paranotoreas fulva* a feature. *Eurythecta zelaea, Orocrambus corruptus, Kiwaia thyraula* also present. Rare and undescribed diurnal noctuid (Heliothinae) present on *Vittadinia* nearby.
Special Features	Uncommon halophytes present but not rare species; uncommon moths.
Action Required	Ask owners not to modify area.
Discussion	There are a number of bare salt pans present on six different properties north of Conroys Road in addition to Patrick's Place which share many of the same plant species. One of these areas has *Apium* n.sp.; most have *Atriplex, Puccinellia, Myosurus*; some have *Ceratocephalis* and *Myosotis* n.sp. *Lepidium kirkii* has been introduced and is thriving at one site (B Patrick pers. comm.). One of these sites is ungrazed and the insects and halophytes are thriving.

RAP 13
BLACKMANS



GRID REFERENCE : INFO MAP 260 G42 170 457

AREA : 2 m²

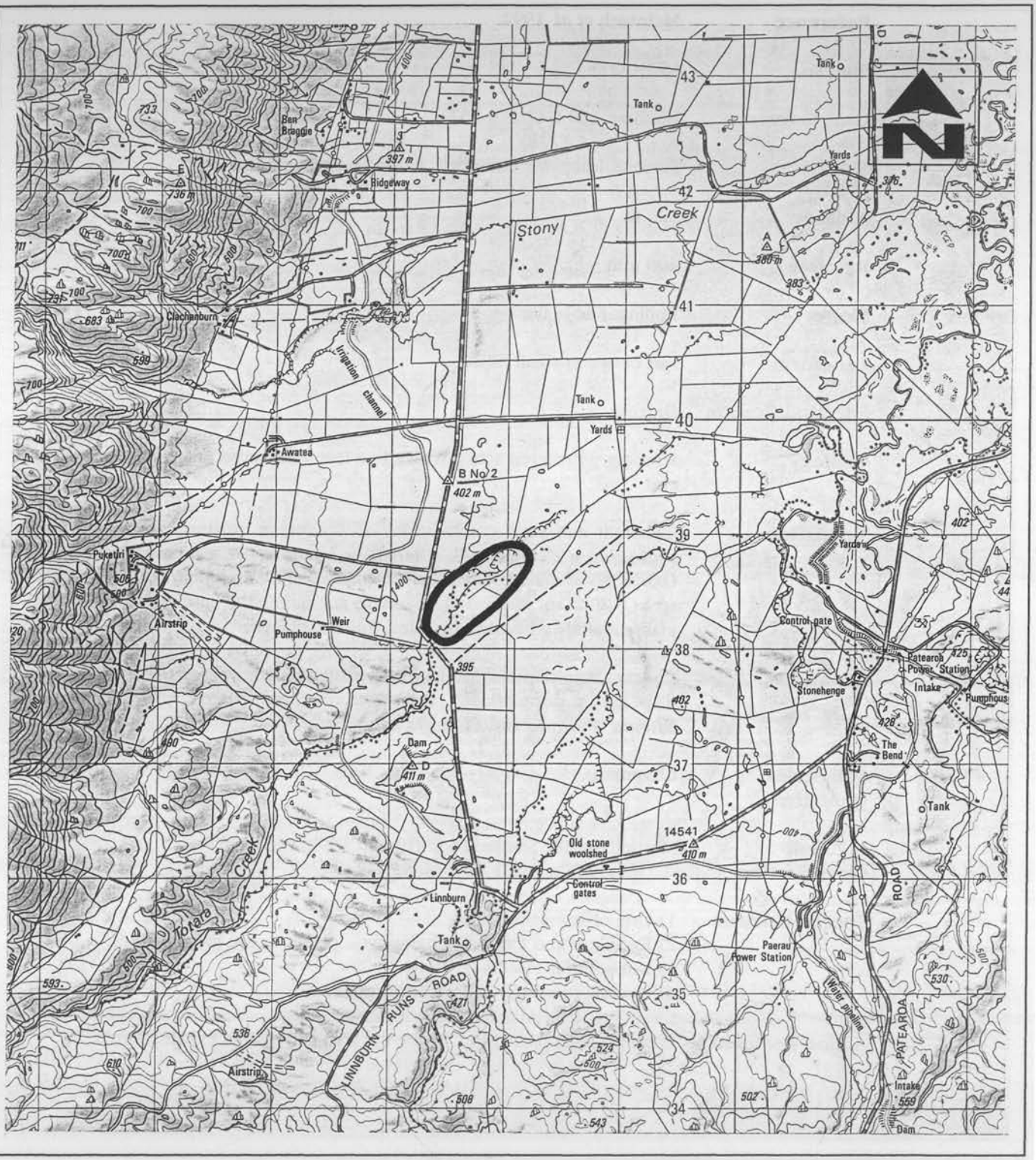
ALTITUDE : 320m

0 1 2 3 4
kilometres

RAP 13 BLACKMANS

Reference	McIntosh *et al.* 1992.
Site No	SS23CO
Grid Reference	Infomap 260 G42 170 457
Site Status	Pastoral lease: Mr Campbell, Earnscleugh Station.
Altitude	320 m
Rainfall	400 mm
Slopes	Rolling. Site is flat
Landform	Fan between small hills
Site Modification	Grazing
Geology	Strongly weathered schist with some less weathered outcrops at southern end.
Vegetation	Excellent and large communities of *Myosurus minimus* subsp. *novae-zelandiae* with *Puccinellia, Atriplex buchananii, Crassula tetramera, Oxalis, Myosotis pygmaea* var. *minutiflora* and *Chenopodium.* A very large area (> 2000 sq. metres) of *Myosurus* surrounds the bare salty area. Exotic plants include *Aphanes, Galium*, thistles, grasses.
Fauna	Insecta - Lepidoptera. Moths of salty soils: *Paranotoreas fulva, Loxostege* n.sp. (good populations), *Orocrambus corruptus, Eurythecta zelaea, Kiwaia thyraula* and *Eudonia sabulosella.*
Soil Series (tentative)	Chapman
N.Z. Soil Classification	Mottled Argillic Semiarid Soil (Hewitt 1992, version 3)
Special Features	1) One of few saline sites 2) Excellent and extensive halophytic plants, some local species. 3) Uncommon insects. 4) Overall very high conservation value.
Action Required	Establish legal protection. Fence the area and realign existing fence.

RAP 14
TOTARA CREEK



GRID REFERENCE : INFO MAP 260 H42 678 387

AREA : 40 hectares

ALTITUDE : 400m

0 1 2 3 4
kilometres

RAP 14 TOTARA CREEK

Reference D. Bruce (unpub.)

Grid Reference Infomap 260 H42 678 346

Site Status Private land?

Altitude 400m

Landform Scattered saline areas lying along an old river terrace on the true left of Totara Creek. The area is adjacent to the boundary between Awatea and Linnburn Stations, on Awatea Station.

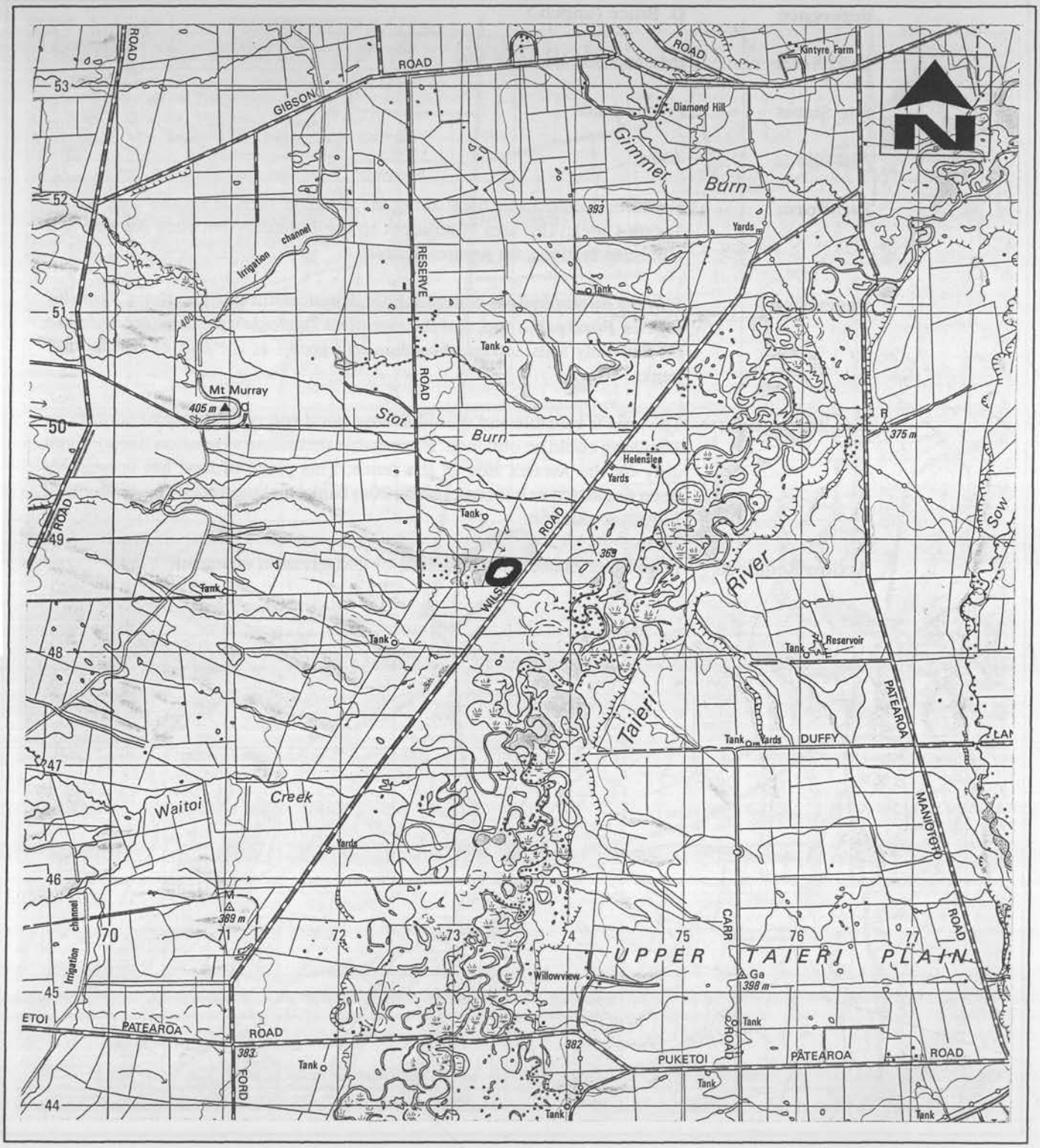
Vegetation *Selliera microphylla* is common here. *Sarcocornia quinqueflora, Samolus repens, Puccinellia* spp. and the rare plant *Triglochin palustre* are all found on flat, salty soils. *Atriplex buchananii* grows at the foot of nearby clay banks.

Site Assessment The area is valuable and would make a good reserve if a strip of land about 1km long could be obtained. It is notable that saline vegetation has survived only on the Awatea side of the fence. This piece of land has apparently been neglected as it is buffered by 20m banks making access for agricultural purposes difficult.

Action Required Investigate establishing a reserve or conservation covenant.

MANIOTOTO ECOLOGICAL DISTRICT
MAP 3/15 : RAP 15

RAP 15
WILSONS ROAD



GRID REFERENCE : INFO MAP 260 H42 734 488

AREA : 7 hectares

ALTITUDE : 395m

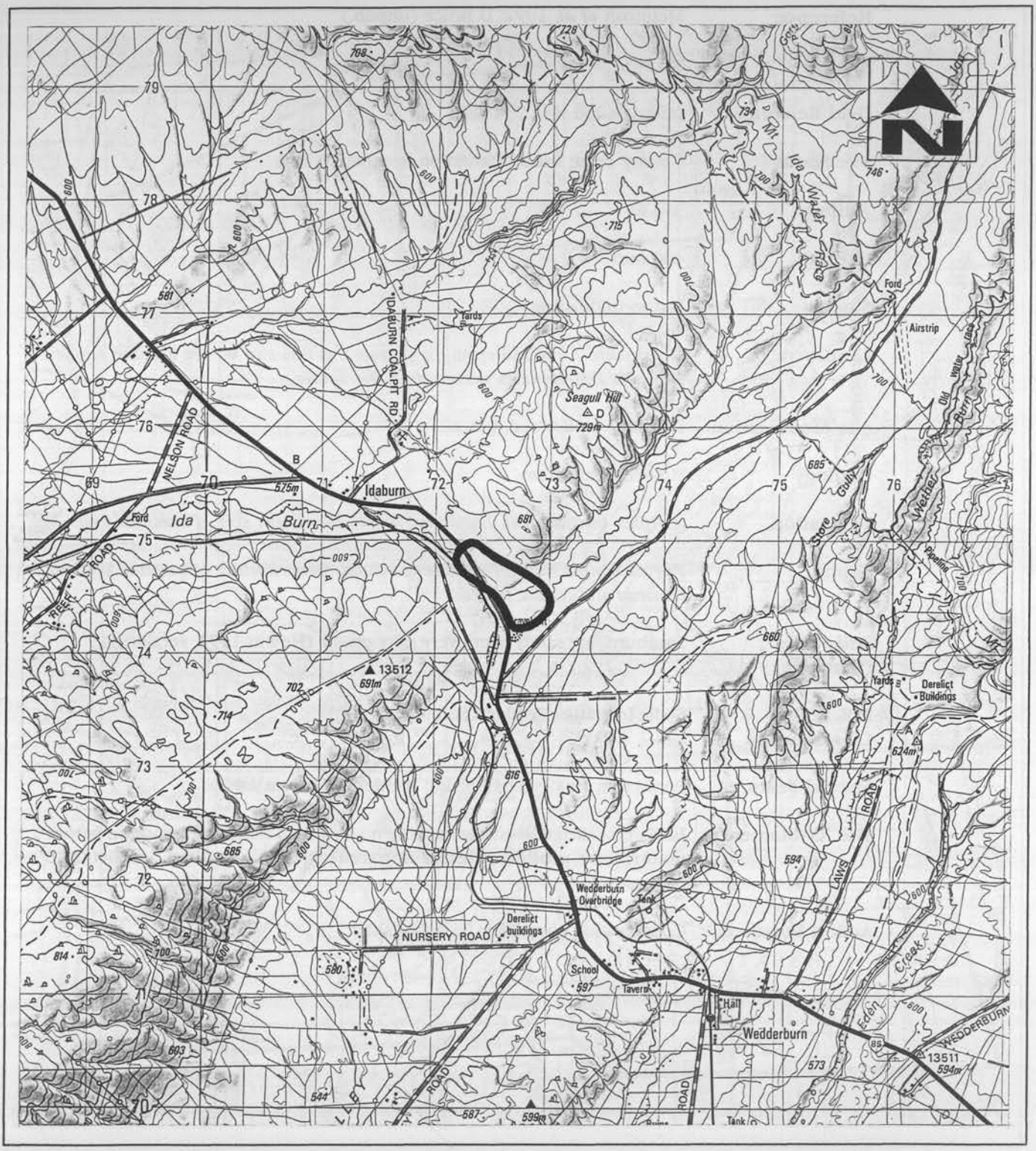
0 1 2 3 4
kilometres

RAP 15 WILSONS ROAD

Reference	McIntosh *et al.* 1992; D Bruce (unpub.)
Site No	SS13CO
Grid Reference	Infomap 260 H42 734 488
Site Status	County Lease Land - Plantation Reserve.
Altitude	395 m
Rainfall	400 mm
Slopes	Flat to undulating
Landform	Floodplain. A mound spring is prersent at this site where a saline aquifer emerges and deposits salts around the spring.
Site Modification	Drained, topdressed, grazed.
Geology	Holocene alluvium
Vegetation	*Atriplex buchananii, Lepidium kirkii, Hordeum* spp., *Puccinellia* sp.
Fauna	*Paranotoreas fulva, Eurythecta zelaea, Orocrambus corruptus, Scythris triatma* among the moths.
Soil Series (tentative)	Linnburn fine sandy loam, very salty phase. (Hewitt 1992, version 3)
N.Z. Soil Classification	Sodic Immature Semiarid Soil
Special Features	Formed in Holocene alluvium; site for *Lepidium kirkii*.
Site Assessment	Important site geologically because no obvious Tertiary influence on parent material or groundwater is apparent locally. Medium importance biologically.
Action Required	Conservation covenat to be established.

MANIOTOTO ECOLOGICAL DISTRICT
MAP 3/16 : AOI 16

AOI 16
IDABURN WETLAND



GRID REFERENCE : INFO MAP 260 H41 727 745

AREA : 20 hectares

ALTITUDE : 620m

0 1 2 3 4
kilometres

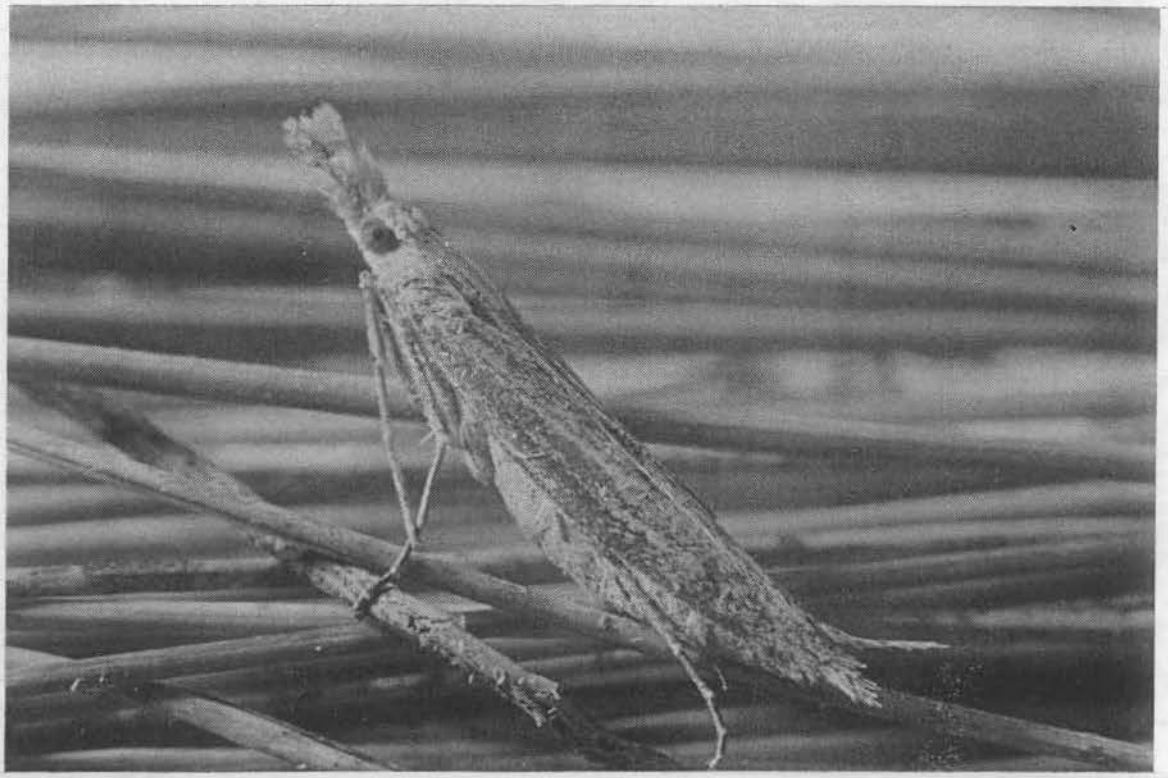
AOI 16 IDABURN WETLAND

Grid Reference Infomap 260 H41 727 745

Altitude 620 m

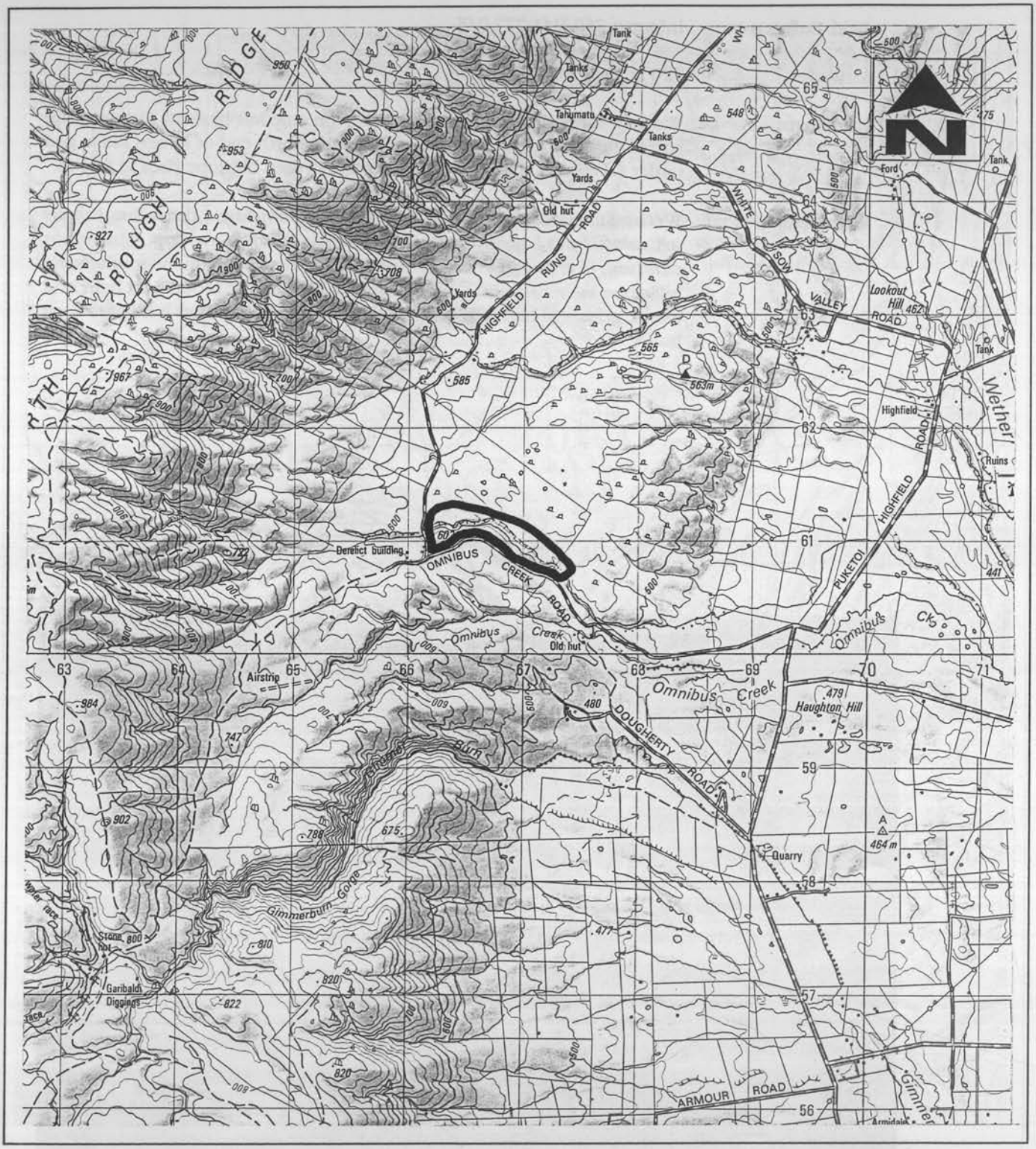
Landform Wetland formed on low stream terrace on true left bank of Idaburn. The stream flowing south then doglegs past the north end of Rough Ridge and under SH 85. On the right bank a shrub-covered hillslope rises to 684 m.

Vegetation Wetland includes *Carex secta, C. coriacea, C. sinclairii;* the rushes *Juncus articulatus* and *J. gregiflorus*; *Schoenus* sp., *Ranunculus* spp., *Epilobium ciliatum, E. brunescens* and *Apium* sp. The shrublands on the south-facing hill slope are mostly *Discaria toumatou* with exotic broom and brier and exotic grass and herb understorey. North-facing hill slopes hold bare rock bluffs.



The crambid moth Orocrambus sophistes *has a flightless female (pictured) and was first described from the Ida Valley. The species breeds in* Festuca *grassland and is now uncommon.*

AOI 17
OMNIBUS CREEK



GRID REFERENCE : INFO MAP 260 H41 668 612

AREA : 30 hectares

ALTITUDE : 580m

0 1 2 3 4
kilometres

AOI 17 OMNIBUS CREEK ROAD SHRUBLANDS

Grid Reference Infomap 260 H41 668 612

Landform Stream gully entrenched 10-20m below plain.

Vegetation Dense shrublands cover gully sideslopes for c. 1.5km downstream of Highfield Runs Road Bridge. Shrub species include *Discaria toumatou, Carmichaelia petriei, Coprosma* spp. and the liane *Muehlenbeckia complexa.*

AOI 18
GIBSONS ROAD

GRID REFERENCE : INFO MAP 260 H42 722 533

AREA : 2 hectares

ALTITUDE : 400m

0 1 2 3 4
kilometres

AOI 18 GIBSON ROAD

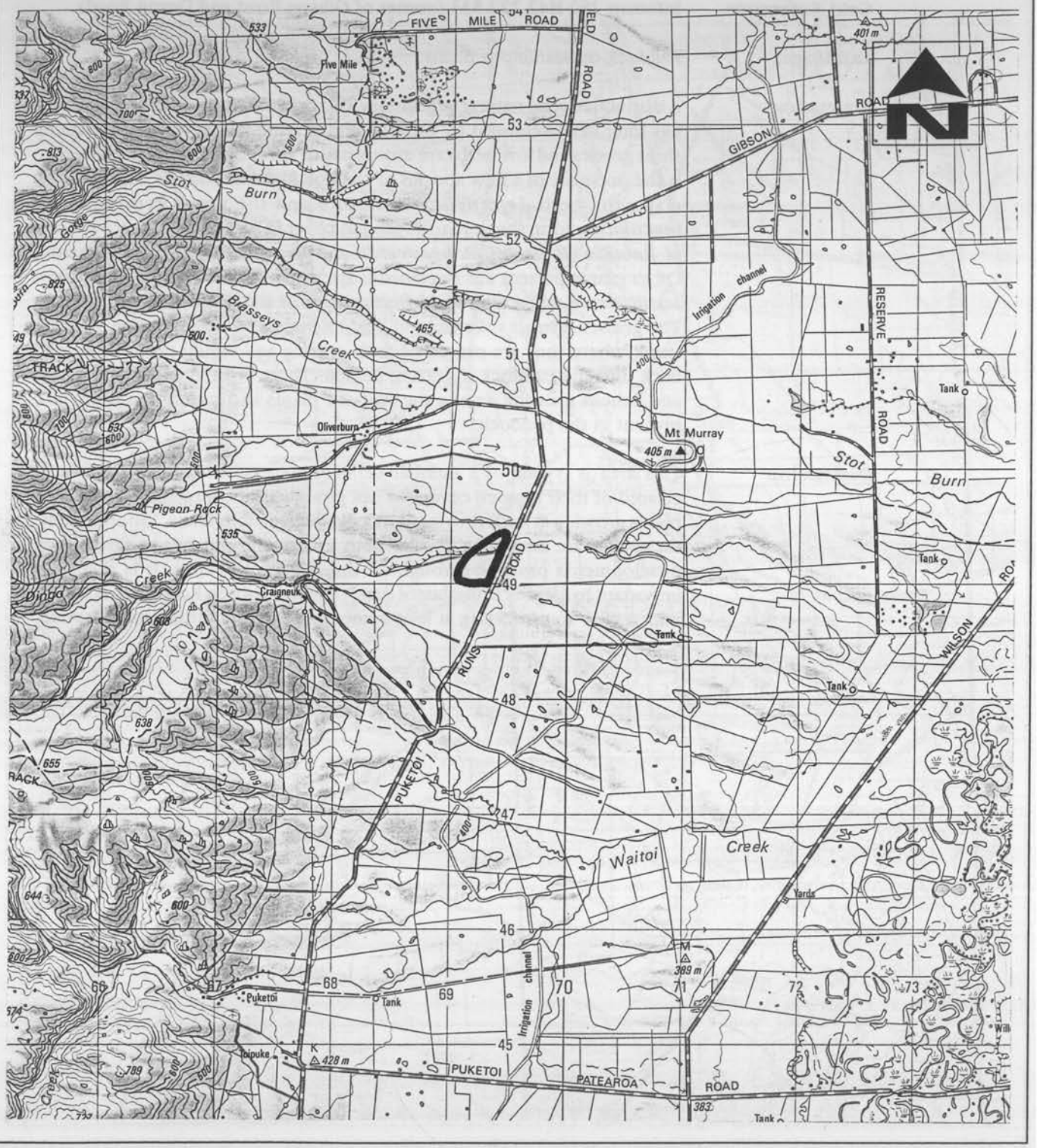
Grid Reference Infomap 260 H42 722 533 (corner of Gibson Road and Devon Road)

Landform Paddock on Maniototo plains.

Vegetation A distinctive semi-natural vegetation. The original shrub and tussock cover has long been removed by burning and grazing. However the remaining short grasses and low herbs are mostly native species. Of special significance is the presence of a new species of cushion-forming *Galium*. This *Galium* n.sp., the herb *Leptinella maniototo* and the grass *Rytidosperma maculatum* form the dominant ground cover in places while three species of *Raoulia* (*R. parkii*, *R. beauverdii* and *R. australis*) are also common. Other plants present are *Puccinellia* sp., *Dichelachne crinita, Geranium sessiliflorum* and scattered *Melicytus alpinus* and *Carmichaelia monroi*. The grasses *Elymus solandri* and *Poa colensoi* are present on the roadside verge where they are protected from grazing and would probably spread back into the paddock if grazing ceased. There is an abundance of moss and lichens growing among the vascular plants and sarsen stones are also present in the paddock.

Discussion This area is typical of a number of Maniototo paddocks that have been cleared of their tussock cover but not ploughed or overgrazed. The native plants growing at such sites support a distinctive moth fauna. Unfortunately, these sites are becoming smaller both in size and number as agricultural developments proceed throughout the Maniototo Plains. It is therefore important to identify a number of sites, of which Gibson Road is an example, with a view to protecting at least some of them from further modification.

AOI 19
PUKETOI RUNS ROAD



GRID REFERENCE : INFO MAP 260 H42 694 492

AREA : 10 hectares

ALTITUDE : 400m

0 1 2 3 4
kilometres

AOI 19 PUKETOI RUNS ROAD SHRUBLANDS

Grid Reference Infomap 260 H42 694 492

Landform Alluvial plain.

Vegetation Excellent shrublands at this site, a small area (several hectares) bordering the roadside and surrounded by exotic pasture and pine shelter belts. *Olearia odorata* is the dominant shrub, reaching about two metres in height. Other shrubs present are *Carmichaelia petriei* and *Melicytus alpinus*. Native grasses are present also: *Elymus apricus* (often growing through the *Melicytus*), *Dichelachne crinita, Poa cita, Festuca novae-zelandiae* and *Rytidosperma maculatum*. *Raoulia beauverdii* is common here.

The carabid beetle Metaglymma tibiale *is widespread in the Maniototo Ecological District*

KEY SALINE SITES OF THE OLD MAN AND MANORBURN ECOLOGICAL DISTRICTS

SECTION 6

MANIOTOTO ECOLOGICAL DISTRICT SURVEY REPORT FOR PROTECTED NATURAL AREAS

BUTCHERS DAM

Reference McIntosh *et al.* 1992

Site No SS26CO

Grid Reference Infomap 260 G42 234 397

Site Status Crown Land (DOC Reserve)

Altitude 300 m

Rainfall 400 mm

Slopes 3 degrees

Landform Mid-section of low-angled fan

Site Modification Grazed

Geology Down-faulted block of strongly weathered schist preserved under younger fan sediments. The salty soils are developed in the younger sediments.

Soil Classification Alkaline Immature Semiarid Soil (Hewitt 1992, version 3)

Vegetation The vegetation of the soil description site contains *Atriplex buchananii, Myosurus minimus* ssp *novae-zelandiae, Myosotis pygmaea* var. *minutiflora* and *Crassula tetramera*. Some exotic grassesand herbs present also. Nearby *Poa cita, Raoulia australis, Stelleria gracilenta* and the lichen *Chondropsis* dominate with the halophyte *Apium* common in turf beside Butchers Dam. A vegetation list for adjacent Flat Top Hill is given by Johnson and Hewitt (1991). It includes the halophytes *Myosurus minimus* ssp. *novae-zelandiae* and also the rare *Ceratocephalus pungens* .

Fauna Lepidoptera - Both *Loxostege* n.sp. and *Paranotoreas fulva* have larvae feeding on *A. buchananii. Orocrambus corruptus* and *Eurythecta zelaea* are also present. All are diurnal and characteristic of bare salty areas.

Special Features
1. Unusual soils with typical Central Otago landscape in adjacent area; soil is only slightly saline.
2. *Myosurus* and *Ceratocephalus pungens* noted in adjacent areas.
3. Rare insects feeding on halophytes.

Action Required Protect site from sheep grazing. Install interpretation panels describing soil/ vegetation history.

OLRIG 1

Reference	D Bruce (unpub.)
Grid Reference	Infomap 260 G42 341 515
Landform	A gully containing several bare, salty patches.
Vegetation	*Lepidium kirkii* - several small populations . Plants are healthy probably due to the relative lack of grazing in the area. *Atriplex buchananii* is common throughout. *Puccinellia* spp. present.
Modification	Salt bushes planted in trial plot. Some seedling spread.
Site Assessment	High value.

OLRIG 2

Reference	D Bruce (unpub.)
Grid Reference	Infomap 260 G42 359 517
Landform	Two separate salty areas. The larger are contains small salty patches on hillsides. The smaller area contains salt pans on gently sloping ground.
Vegetation	The larger area is poor in native halophytes. Three *Lepidium kirkii* plants were found in one patch. *Atriplex buchananii* is another natve halophyte present. Some patches are sheep camps and have very depleted vegetation of sparsely scattered *Malvus neglecta* and *Spergularia rubra* on bare soil. The smaller area's salt pans have *Atriplex* and *Puccinellia* spp. with *Selliera microphylla* in grassy turf nearby.
Site Assessment	Moderate value.

BLACKSTONE NO. 2

Reference	McIntosh *et al.* 1992
Site No	SS19CO (b)
Grid Reference	Infomap 260 H41 595 770
Site Status	Private Land
Altitude	450 m
Rainfall	500 mm

Slopes	Steep; 25 degrees at site
Landform	Footslope of Balckstone Hill
Modification	Heavily grazed and erosion
Geology	Strongly weathered schist hillslope
Soil Classification	Alkaline Immature Semiarid Soil (Hewitt 1992, version 3)
Vegetation	The locally distributed crucifer herb *Lepidium sisymbrioides* was found in high numbers (> 200 plants) over a limited area. Lower half of northern sude slope with *Erodium*, thistles, grasses, shepherds purse, clover.
Fauna	Moths *Eurythecta zelaea* and *Orocrambus corruptus*.
Special Features	Extremely alkaline subsoils but not saline; high numbers of *Lepidium sisymbrioides*.
Action Required	Conservation covenant or other form of legal protection.

Finally, two non-saline sites holding rare species of fern and grasshopper respectively are briefly described. Both lie at the south-western edge of the Manorburn Ecological District near the town of Alexandra:

CLOCKTOWER

The rare fern *Pleurosurus rutifolius* is found in dry sunny rock crevices of the Manorburn Ecological District (Given 1981). It is present in the rocky gullys near the Alexandra clocktower (Fagan & Pillai 1992) near the Maniototo - Manorburn District boundary. B Patrick suggests a formalised reserve would be appropriate to protect this population of *P. rutifolius* and associated flora and fauna on these dry rock faces.

LOWER MANORBURN DAM

A five hectare site at the end of Tuckers Hill Road where it meets the dam edge is home to the rare grasshopper *Sigaus minutus*. The area is an old mining site on a dry rocky hill with sparse cushion vegetation. A small reserve here would help protect this insect species.

REFERENCES

SECTION 7

MANIOTOTO ECOLOGICAL DISTRICT SURVEY REPORT FOR PROTECTED NATURAL AREAS

Aitken, M. 1947. The Maniototo Basin, Central Otago: from natural to cultural landscape. *The New Zealand Geographer. Volume III, Number 1:* 59-74.

Allan, H.H. 1961. *Flora of New Zealand. Volume 1.* Government Printer, Wellington.

Allen, R.B. 1988. Vegetation of Waikerikeri Terraces. DSIR unpublished report.

Allen, R.B. 1992. Recovery Plan for saline soil *Lepidium* species. DSIR Land Resources Contract Report 92/18, Dunedin.

Allen, R.B.; McIntosh, P.D. 1993. *Saline Soils and Plant Communities and Their Management, Patearoa, Central Otago.* Landcare Research Contract Report LC92/93/48, Dunedin.

Anderson, A. 1989. *Prodigious Birds - Moas and Moa-hunting in Prehistoric New Zealand.* Cambridge University Press, Cambridge, England.

Bathgate, A. 1922. Some changes in the flora and fauna of Otago in the last sixty years. *New Zealand Journal of Science and Technology 4(6):* 273-283.

Beanland, S.; Berryman, K.R.; Hull, A.G.; Wood, P.R. 1986: Late Quaternary deformation at the Dunstan Fault Central Otago, New Zealand. *Royal Society of New Zealand Bulletin 24:* 293-306.

Bishop, I. 1976: Mt Ida. Geological Map of New Zealand, 1:63 360, sheet S126 with accompanying report. *New Zealand Geological Survey.* DSIR, Lower Hutt.

Bruce, D. Saline-Soil Areas of Central Otago. Unpublished report.

Brumley, C.F., Stirling, M.W., Manning, M.S., 1986. *Old Man Ecological District. Survey Report for the Protected Natural Areas Programme.* Lands and Survey Department, Wellington.

Buchanan, J. 1868. Sketch of the botany of Otago. *Transactions and Proceedings of the New Zealand Institute 1:* 181-212.

Burrell, J. 1965. Ecology of *Leptospermum* in Otago. *New Zealand Journal of Botany 3*:3-16.

Bull, P.C., Gaze, P.D., Robertson, C.J.R., 1985. *The Atlas of Bird Distribution in New Zealand.* The Ornothological Society of New Zealand, Wellington.

Cowan, J. 1978. *Down the Years in the Maniototo.* Capper Press, Christchurch.

Department of Conservation, Dunedin, 1992. Otago Conservancy Geopreservation Inventories. Unpubl. report.

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

Department of Lands and Survey 1985. *Report on the future status and management of the Taieri Lake Recreation Reserve and adjoining Drown Land.* Department of Lands and Survey, Dunedin.

Dickinson, K.J.M. 1988. *Umbrella Ecological District. Survey Report for the Protected Natural Areas Programme.* Department of Conservation, Wellington.

Douglas, B.J., 1986. *Lignite Resources of Central Otago.* New Zealand Energy Research and Development Committe Publication. p.104.

Emerson, B. 1993. Conservation status of chafer beetles *Prodontria bicolorata* and *P. modesta*: distribution and ecological observations. Unpublished report.

Fagan, B., Pillai, D. 1992. *Manorburn Ecological District. Survey Report for the Protected Natural Areas Programme.* Department of Conservation, Wellington.

Forrest, J. 1965: Settlement and Communications in *Central Otago* edited by R.G. Lister and R.P. Hargreaves, New Zealand Geographical Society. pp174-188.

Grove, P. 1992. Hawkdun Ecological District. Survey Report for the Protected Natural Areas Programme. Unpublished MSc thesis, University of Otago.

Hubbard, J.C.E., Wilson, J.B. 1988. A survey of the lowland vegetation of the Upper Clutha District of Otago, New Zealand. *New Zealand Journal of Botany 26:* 21-35.

Johnson, P.N. 1976. Central Otago salt pan vegetation - a proposal for two reserves in the Maniototo. Unpublished DSIR Botany report.

Kirk, T. 1890. Description of a new species of *Cheroppdium - C. buchananii. Transactions and proceedings of the New Zealand Institute. Vol. 22:* p.446.

Kearsley, G. & Fitzharris, B. (eds) 1990. *Southern Landscapes. Essays in Honour of Bill Brockie and Ray Hargreaves.* Department of Geography, University of Otago.

Leamy, M.L. 1972: Fine-textured dissection in semi-arid Central Otago. *N.Z. Journal of Geology and Geophysics 15 (3):* 394-405.

Leslie, D. M. 1966. The Maniototo Basin. An evaluation of physical, social and economic aspects of its agriculture with special reference to the proposed irrigation scheme. Unpublished MSc thesis, University of Otago.

McCraw, J.D. 1964. Soils of the Alexandra District, Otago, New Zealand. *New Zealand Soil Bureau Bulletin 24.*

McCraw, J.D. 1965. 'Landscapes of Central Otago' and 'Soils and Conservation'in *Central Otago* edited by R.G. Lister and R.P. Hargreaves. New Zealand Geographical Society. pp 30-45 & 92-102.

McDowall, R.M. 1990. *New Zealand Freshwater Fishes. A Natural History and Guide.* Heinemann Reed, Auckland.

McEwen, W.M. (ed) 1987. *Ecological Regions and Districts of New Zealand.* Department of Conservation, Wellington.

McGlone, M.S., 1989. The Polynesian settlement of New Zealand in relation environmental and biotic changes. Supplement to *New Zealand Journal of Ecology 12*: 115-219.

McIntosh, P.D., Beecroft, F.G., Patrick, B. 1990. *Register of Saline Soil Sites in North and Central Otago, Volume 1.* DSIR.

McIntosh, P.D., Beecroft, F.G., Patrick, B.H. 1992. *Register of Saline Soil Sites in North and Central Otago, Volume 2.* DSIR.

Madin, I. 1988. *Geology and neotectonics of the Upper Manuherikia Basin, Central Otago, New Zealand.* DSIR, Lower Hutt.

Maunder, W.J. 1965. Climatic Character in *Central Otago* edited by R.G. Lister and R.P. Hargreaves. New Zealand Geographical Society. pp 46-68.

Mark, A.F. 1965. Vegetation and mountain climate, in *Central Otago* edited by R.G. Lister and R.P. Hargreaves. NZ Geographical Society. pp 69-91.

Molloy, B.P.J., Burrows, C.J., Cox, J.E., Johnston, J.A., Wardle, P., 1963. Distribution of subfossil forest remains, eastern South Island, New Zealand. *New Zealand Journal of Botany 1*: 68-77.

Morgan R.K. 1990. Thyme in the Central Otago Landscape. in *Southern Landscapes* edited by G.Kearsley and B. Fitzharris.University of Otago 1990. pp 213-232.

National Water and Soil Conservation Organisation 1983. *Wetlands: A Diminshing Resource. A Report for the Environmental Council.* Water and Soil Miscellaneous Publication No. 58, Wellington.

New Zealand Meteorological Service, 1983. *Temperature Normals 1951-1980.* New Zealand Meteorological Service Miscellaneous Publication 183.

New Zealand Meteorological Service, 1983. *Rainfall Normals for New Zealand 1951-1980.* NZMS misc. pub. 185.

New Zealand Meteorological Service, 1983. *Sunshine Normals 1951-1980.* NZMS misc. pub. 186.

New Zealand Soil Bureau 1968: *Soils of New Zealand. Part 1.* N.Z. Soil Bur. Bull. 26(1).

New Zealand Soil Bureau, 1968. *Soils of South Island, New Zealand.* NZ Soil Bureau Bulletin 27.

O'Connor, K.F., 1982. The implications of past exploitation and current development to the conservation of South Island tussock grasslands. *NZ Journal of Ecology 5:* 97-107.

Park, J.M., 1906. *The geology of the area covered by the Alexandra Sheet, Central otago Division.* New Zealand Geological Survey Bulletin 2.

Park, A.G. 1965: Irrigation Schemes in *Central Otago* edited by R.G. Lister and R.P. Hargreaves, New Zealand Geographical Society. pp 156-165.

Partridge, T.R., 1975. Salt pan vegetation of Central Otago. Unpub. report. Botany Division, DSIR, Dunedin.

Partridge, T.R., 1981. Rare and endangered habitats of New Zealand: inland saline habitats. Unpub. report. Botany Division, DSIR, Lincoln.

Patrick, B.H. 1989a. *The Lepidoptera of Central Otago Salt-pans.* Department of Conservation, Dunedin.

Patrick, B.H. 1989b. *The Lepidoptera, Cicadidae and Acrididae of the Manorburn Ecological District.* Department of Conservation, Science Directorate, Wellington. No. 60, 16 pp.

Patrick, B.H. 1990. Panbiogeography and the General Naturalist with Special Refernce to Conservation Implications. *New Zealand Journal of Zoology. Vol. 16(4):* 749-756.

Patrick, B.H. 1992. Supplement to the Lepidoptera of the Mackenzie Country with Recomendations on their Conservation. *New Zealand Entomologist Vol. 15:* 48-58.

Patrick, B.H. 1994. Valley Floor Lepidoptera of Central Otago. Department of Conservation, Dunedin. 54pp

Petrie, D. 1912: Report on the grass-denuded lands of Central Otago. *New Zealand Department of Agriculture, Industries and Commerce bulletin no. 23* (new series).

Raeside, J.D., 1949. The origin of salt pans in Central Otago. *New Zealand Journal of Science and Technology 30:* 96-101.

Raeside, J.D., Cutler, E.J.B., Miller, R.B. 1966. *Soils and Related Irrigation Problems of Part of Maniototo Plains, Otago.* Soil Bureau Bulletin 23. New Zealand Department of Scientific and Industrial Research.

Schmitt, K., 1984. The statigraphy and depositional environment of the Maori Bottom Formation in the Maniototo Basin, Central Otago. Unpub. thesis, University of Otago, Dunedin.

Suggate, R.P., Stevens G.R., Te Punga, M.T. (eds) 1978. *The Geology of New Zealand.* Government Printer, Wellington.

Townsend, C., Allibone, R., Crowl, T. 1992. Detailing Habitat Requirements and Necessary Conservation Measures for some South Island *Galaxias* Species. Unpublished report, University of Otago.

Whitaker A.H. 1986. A Survey of the Lizards of the Alexandra Area, Otago. Unpulished report, N.Z. Wildlife Service, Wellington.

Williams, G.R.; Given, D.R. 1981: *The red data book of New Zealand - rare and endangered species of endemic terrestrial vertebrates and vascular plants.* Nature Conservation Council, Wellington. 24 p.

Yeats, R.S. 1987. Tectonic map of Central Otago based on Landsat imagery. *New Zealand Journal of Geology and Geophysics, Vol. 30*: 261-271.

APPENDICES

SECTION 8

APPENDIX 1 Insect Fauna of Maniototo Ecological District

APPENDIX 2 Flora of the Maniototo Ecological District Salt Panst

APPENDIX 3 Plant Species List for Conroys Road area, Maniototo Ecological District

INSECT FAUNA OF THE MANIOTOTO ECOLOGICAL DISTRICT SALINE AREAS

(from Patrick 1989a)

The saline areas have a distinctive diurnal moth fauna plus a group of larger species that are typical of short vegetation generally in Central Otago. In the following species list are species typical of, and probably breeding within, the salt-pan ecosystem. Other species often found in saline areas but not likely to be breeding in them are listed. Some are clearly characteristic of adjacent areas.

LEPIDOPTERA

Scythridae

Scythris triatma (Meyrick 1935)

Gelechiidae

Kiwaia thyraula (Meyrick 1885)
Athrips zophochalca (Meyrick 1918) — Larvae on *Carmichaelia* spp.

Lycaenidae

Zizina oxleyi (Felder and Rogenhofer 1875) — Larvae on *Trifolium* spp, *Carmichaelia* spp
Other Species:
Lycaena boldenarum (White) Larvae on *Muehlenbeckia axillaris*

Tortricidae

Eurythecta zelaea (Meyrick 1905) — Larvae polyphagous; female brachypterous
Capua semiferana (Walker 1863)
Crocidosema plebejana (Zeller 1847)
Other Species: *Merophyas leucaniana* (Walker)

Pyralidae

Sporophylla oenospora (Meyrick 1897)
Crocydopora cinigerella (Walker 1865)
Loxostege (new species) — Larvae on *Atriplex buchananii*
Other Species: *Homoeosoma anaspila* (Meyrick) — Larvae on *Vittadinia* seed heads

Crambidae

Eudonia leptalea (Meyrick 1885)
Orocrambus corruptus (Butler 1877)
Other Species:
Eudonia sabulosella (Walker)
Eudonia critica (Meyrick)
Eudonia octophora (Meyrick)
Scoparia atmogramma (Meyrick) — These *Orocrambus* larvae all feed
Scoparia chalicodes (Meyrick) — on various grasses.
Scoparia exilis (Knaggs)
Scoparia submarginalis (Walker)
Orocrambus cyclopicus (Meyrick)
Orocrambus flexuosellus (Doubleday)
Orocrambus lewisi (Gaskin)
Orocrambus vittellus (Doubleday)
Orocrambus vulgaris (Butler)
Mnesictena flavidalis (Doubleday) — Larvae on *Acaena, Malva.*
Tawhitia pentadactyla (Zeller)

Geometridae

Arctesthes catapyrrha (Butler 1877)	Larvae on *Colobanthus* spp.
Paranotoreas brephosta (Walker 1862)	Larvae on *Epilobium* spp.
Paranotoreas fulva (Hudson 1905)	Larvae on *Atriplex buchananii*
Scopula rubraria (Doubleday 1843)	Larvae on *Plantago* spp.
Other Species:	
Helastia christinae (Craw)	
Helastia corcularia (Guenee)	
Notoreas perornata (Walker)	Larvae on *Pimelea* spp.
Dichromodes simulans (Hudson)	Larvae of these *Dichromodes* spp.
Dichromodes ida (Hudson)	found on lichens growing on tors
Dichromodes gypsotis (Meyrick)	
Epyaxa rosearia (Doubleday)	
Epyaxa lucidata (Walker)	
Asaphodes recta (Philpott)	
Asaphodes aegrota (Butler)	
Asaphodes clarata (Walker)	
Pseudocoremia melinata (Felder & Rogenhofer)	Larvae on *Carmichaelia* spp.

The following families do not have characteristic salt-pan species but these species have been recorded:

Noctuidae

Euxoa admirationis (Guenee)	Larvae on *Raoulia australis*
Aletia moderata (Walker)	Larvae on *Elymus, Rytidosperma* spp.
Aletia sistens (Guenee)	
Graphania disjungens (Walker)	
Graphania phricias (Howes)	
Graphania lithias (Meyrick)	Larvae on *Melicytus alpinus*

Heliothinae new genus and species — Larvae on *Vittadinia* spp.

Yponomeutidae

Phylacodes cauta (Meyrick) — Larvae on *Carex* spp.

Oecophoridae

Oxythecta austrina (Meyrick)	Larvae on *Leucopogon fraseri*
Hierodoris frigida (Philpott)	
Tingena maranta (Meyrick)	Larvae on *Poa cita*
Phaeosaces n.sp.	

Glyphipterigidae

Glyphipterix achlyoessa (Meyrick)

Choreutidae

Tebenna micalis (Mann)

Pterophoridae

Pterophorus innotatalis (Walker) — Larvae on *Dichondra* spp.

Satyridae

Agyrophenga antipodum (Doubleday) — Larvae on *Poa cita* etc.

List of Other Orders of Insects:

Orthoptera

Acrididae (grasshoppers)
Sigaus campestris (Hutton)
Sigaus australis (Hutton)
Sigaus minutus (Bigelow)
Phaulacridium marginale (Walker)
Phaulacridium otagoensis

Coleoptera

Neocicindela parryi (White)

FLORA OF THE MANIOTOTO ECOLOGICAL DISTRICT SALTPANS
(from Patrick 1989a)

A list of species growing on the saline areas (* denotes adventive species)

Crucerifae
Lepidium kirkii Petrie
Lepidium matau Petrie
Lepidium sisymbrioides Hook

Chenopodiaceae
**Chenopodium album* L (fathen)
**Chenopodium erosum* R Br
Atriplex buchananii (Kirk) Cheeseman
**Atriplex rosea* L (salt-bush)
Sarcocornia quinqueflora (Ung-Sternb.) A J Scott

Crassulaceae
Crassula multicaulis (Petrie)

Umbelliferae
Apium filiforme (A Rich) Hook f

Ranunculaceae
Myosurus minimus subsp. *novae-zelandiae* (W Oliver) Garnock-Jones

Geraniacea
Geranium sessiliflorum Cav

Caryophyllaceae
Colbanthus brevisepalus Kirk
Scleranthus uniflorus Williamson

Fabaceae
Carmichaelia compacta Petrie
Carmichaelia monroi Hook f
Carmichaelia petriei Kirk

Asteraceae
Vittadinia australis A Rich
**Vittadinia gracilis* (Hook f) N Burb
Raoulia australis Hook f
Raoulia parkii Buchanan
Raoulia beauverdii Allan
Cotula maniototo Petrie

Plantaginaceae
Plantago spathulata Hook f
**Plantago coronopus* L

Goodeniaceae
Selliera radicans Cav

Primulaceae
Samolus repens (J R et G Forster)

Scrophulariaceae
Limosella curdieana F Muell

Violaceae
Melicytus alpinus

Graminacaea
Puccinellia distans (L) Parl.
Puccinellia stricta (Hook f)
Puccinellia fasiculata (Torr) Bicknell
Elymus rectisetus (Nees) Love and Connor
Poa maniototo Petrie
**Hordeum jubatum* L
**Hordeum hystrix* Roth

Juncaginaceae
Triglochin palustre L

PLANT SPECIES LIST FOR THE CONROYS ROAD AREA (300M), MANIOTOTO ECOLOGICAL DISTRICT

Compiled by B Patrick, January 1993.

* exotic
** introduced from within 5 km
*** introduced from within 10 km

PLANT SPECIES	STATUS	No. OF POPULATIONS
Aspleniaceae		
Asplenium flabellifolium	common	
Blechnaceae		
Blechnum penna-marina	common	
Blechnum vulcanicum		
Pteridaceae		
Cheilanthes humilis	common	
Pellaea calidirupium	common	
Dryopteridaceae		
Polystichum richardii	common	
Polystichum vestitum	local	
Dennstaedtiaceae		
Pteridium esculentum	common	
Histiopteris incisa	rare	1
Hypolepis millefolium	local	2
Azollaceae		
Azolla filiculoides	common	
Hydrocharitaceae		
**Elodea canadensis*	common	
Juncaginaceae		
Triglochin striata	local	3
Juncaceae		
**Juncus tenuis*	local	1
**Juncus articulatus*	common	
**Juncus arcuminatus*	common	
**Juncus bufonius*	local	1
Juncus gregiflorus	common	
Juncus distegus	common	
Juncus amabilis	common	
**Juncus effusus*	local	
Juncus sarophorus	common	
Juncus gerardii		1
"Luzula tenuis"	local	3
"Luzula rhadina"	common	
"Luzula limosa"	local	3

PLANT SPECIES	STATUS	No. OF POPULATIONS
Agavaceae		
Phormium tenax	local	1
Typhaceae		
Typha orientalis	common	
Orchidaceae		
Prasophyllum colensoi	local	1
Microtis uniflora	local	2
Cyperaceae		
Isolepis caligenis	local	
Isolepis setacea	common	
Isolepis aucklandica	local	
Eleocharis acuta	common	
Eleocharis pusilla	common	
Shoenus concinnus	common	
Uncinia elegans	common	
Uncinia sinclairii	common	
Uncinia purpurata	local	
Carex breviculmis	common	
Carex coriacea	common	
Carex buchananii	common	
**Carex ovalis*	common	
Carex secta	common	
Carex gaudichaudiana	common	
Carex resectans	common	
Carex colensoi	local	
Poaceae		
**Alopecurus geniculatus*	local	
**Holcus lanatus*	common	
Poa cita	common	
Poa imbecilla	local	
Poa lindsayi	local	1
Poa colensoi	common	
Poa maniototo	common	
Dichelachne crinita	common	
Festuca novae-zelandiae	local	
**Festuca ovina*	common	
**Festuca arundinacea*	common	
**Festuca rubra var. commutata*	local	1
Puccinellia stricta	local	2
**Puccinellia fasciculata*	local	1
Puccinellia n.sp. 1	local	
**Puccinellia* distans	local	1
Rytidosperma clavatum	common	
Rytidosperma maculatum	common	
Rytidosperma unarede	local	1
**Rytidosperma racemosum*	common	
**Dactylis glomerata*	local	
Elymus apricus	common	
Elymus solandri		
Rytidosperma pumilum		

PLANT SPECIES	STATUS	No. OF POPULATIONS
**Bromus tectorum*	common	
**Bromus diandrus*	local	
**Vulpia myuros*	common	
**Vulpia bromoides*	common	
**Aira caryophyllea*	common	
**Anthoxanthum odoratum*	common	
Agrostis petriei	common	
**Agrostis capillaris*	common	
**Agrostis stolonifera*	common	
**Cortaderia selloana*	rare	1
**Cynosurus cristatus*	common	
Deyeuxia avenoides	common	
**Lolium perenne*	common	
**Lolium* sp.	local	1
**Hordeum hystrix*	common	
**Hordeum murinum*	local	
**Hordeum jubatum*	local	1
Lachnagrostis filiformis	local	1
Liliaceae		
Anthropodum candidum	local	4
Bulbinella angustifolia	local	1
Ranunculaceae		
Ceratocephalus pungens	common	>4
Ranunculus amphitricus	common	
Ranunculus multiscapus	common	
Clematus marata	rare	1
Myosurus minimus ssp. *novae-zelandiae*	common	>5
Brassicaceae		
**Erophila verna*	common	
**Rorippa microphylla*	common	
**Sisymbrium altissimum*	local	
****Lepidium kirkii*		
Violaceae		
Viola cunninghamii	common	
Melicytus alpinus	common	
Crassulaceae		
Crassula tetramera	common	
**Sedum acre*	local	
Caryophyllaceae		
**Cerastium fontanum*	common	
Colobanthus brevisepalus	common	
Gypsophila australis	local	1
Stellaria gracilenta	common	
**Stellaria graminea*	common	
**Stelleria alsine*	common	
**Stelleria media*	common	
Scleranthus uniflorus	rare	1
**Sagina procumbens*	local	

PLANT SPECIES	STATUS	No. OF POPULATIONS
**Silene latifolia alba*	local, roadside	1
**Spergularia rubra*	local	1
Polygonaceae		
**Polygonum hydropiper*	common	
**Rumex acetosella*	common	
**Rumex crispus*	common	
Chenopodiaceae		
Atriplex buchananii	local	1
**Atriplex prostrata*	local	3
**Chenopodium murale*	local, roadside	
Chenopodium ambiguum		
Linaceae		
**Linum catharticum*	local	
Oxalidaceae		
Oxalis exilis	common	
Onagraceae		
Epilobium hectorii	rare	2
Epilobium insulare	common	
Epilobium komarovianum	common	
Epilobium alsinoides	common	
Epilobium pubens	common	
Epilobium rotundifolium	common	
Epilobium microphyllum	rare	1
Epilobium cinereum	local	3
**Epilobium ciliatum*	local	
Clusiacea		
Hypericum japonicum	local	
**Hypericum perforatum*	common	
Urticaceae		
**Urtica urens*	common	
Myrtaceae		
Kunzea ericoides	rare	1
Rosaceae		
**Rosa rubiginosa*	common	
Potentilla anserinoides	local	
Acaena buchananii	common	
Acaena caesiiglauca	local	1
Acaena novae-zelandiae	common	
Acaena inermis	local	2
Acaena juvenca	local	
**Acaena agnipila* var. *aequispina*	common	
**Aphanes australiana*	common	

PLANT SPECIES LIST FOR CONROYS ROAD AREA, MANIOTOTO ECOLOGICAL DISTRICT

PLANT SPECIES	STATUS	No. OF POPULATIONS
Fabaceae		
Sophora microphylla	rare	
Carmichaelia petriei	rare	
***Carmichaelia compacta*		
**Meliotus alba*	local	
**Lotus pendunculatus*	local	
**Lupinus arboreus*	local	
**Trifolium repens*	common	
**Trifolium dubium*	common	
**Cytisus scoparius*	local	
**Ulex europeus*	local	
**Vicia sativa*	common	
Epacridaceae		
Leucopogon fraseri	common	
Salicaceae		
**Salix fragilis*	local	
Rubiaceae		
Coprosma propinqua	common	
Galium aff. *perpusillum*	rare	1
**Galium aparine*	common	
Plantaginaceae		
Plantago uniflora	local	1
**Plantago coronopus*	local	1
**Plantago australis*	common	
**Plantago lanceolata*	common	
Boraginaceae		
Myosotis n.sp. *"minutiflora"*	common	1
**Myosotis discolor*	common	
**Myosotis laxa* ssp. *caespitosa*	common	
Echium vulgare	common	
Convolvulaceae		
Dichondra repens	local	4
Scrophulariaceae		
***Hebe salicifolia*		
***Hebe rupestris*		
**Mimulus moschatus*	common	
**Veronica verna*	common	
**Verbascum thapsus*	common	
**Verbascum virgatum*	local	
Lamiaceae		
**Prunella vulgaris*	common	
**Marrubium vulgare*	local	
**Thymus vulgaris*	common	

PLANT SPECIES	STATUS	No. OF POPULATIONS
Campanulaceae		
Wahlenbergia albomarginata	common	
Thymelaceae		
Pimelea aridula	common	
Primulaceae		
**Anagellis arvensis*	local	
Dipsacaceae		
**Dipsacus fullonum*	local	
Papaveraceae		
**Eschscholzia californica*	common	
Euphorbiaceae		
**Euphorbia peplus*	common	
Geraniaceae		
**Geranium molle*	local	
Geranium sessiliflorum glabrum	common	
Geranium sp. aff. *microphyllum*	common	
**Erodium circutarium*	common	
Polemoniaceae		
**Navarettia squarrosa*	common	
Malvaceae		
**Malva neglecta*	local	1
**Malva sylvestris*	roadside, local	1
Solanaceae		
**Solanum dulcamara*	common	
Elaeocarpaceae		
Aristotelia fruticosa var. *rigidula*	common	
Rhamnaceae		
Discaria toumatou	rare	
Grossulariaceae		
**Ribes uva-crispa*	local	1
Caprifoliaceae		
**Sambucus nigra*	common	
Polygonaceae		
Muehlenbeckia complexa	common	

PLANT SPECIES	STATUS	No. OF POPULATIONS
Apiaceae		
Apium n.sp.(aff. *prostratum* var. *filiforme*)	local	1
Aciphylla aurea	local	1
Anisotome aromatica	rare	
****Anisotome cauticola*		
Oreomyrrhis ramosa	common	
Oreomyrrhis rigida	local	3
Hydrocotyle microphylla	common	
Hydrocotyle heteromeria	common	
**Conium maculatum*	common	
Asteraceae		
**Achillea millefolium*	local	
Brachyglottis haastii	rare	1
***Cassinia fulvida*		
Celmisia gracilenta	common	
**Carduus tenuiflorus*	local	
**Cirsium arvense*	common	
**Cirsium vulgare*	common	
**Hypochoeris radicata*	common	
Helichrysum bellidioides	rare	1
Helichrysum filicaule	common	
**Crepis capillaris*	common	
Gnaphalium audax	rare	1
Gnaphalium ruahinicum	common	
Gnaphalium delicatum	local	1
Gnaphalium limosum	local	
**Hieracium lepidulum*	local	
**Hieracium pilosella*	common	
**Leontodon taraxacoides*	common	
**Leucantheum vulgare*	rare	
Olearia lineata	rare	1
Olearia odorata	common	
Lagenifera petiolata	common	
Raoulia australis	common	
Raoulia beauverdii	common	
Raoulia parkii	local	
Raoulia subsericea	common	
Senecio quadridentatus	local	1
**Senecio sylvaticus*	local	3
**Sonchus asper*	local	1
**Taraxacum officinale*	common	
Vittadinia australis	rare	4
**Vittadinia gracilis*	common	
**Onopordum acanthium*	local	
Pinaceae		
**Pinus radiata*	local	
Resedaceae		
**Reseda luteola*	local	

SUMMARY OF SPECIES

	Total	Exotic	Native
Ferns and allies	10	0	10
Conifers	1	1	0
Monocotyledons	79	29	50
Dicotyledons	156	76	*80
Total	**246**	**106**	**140**

* Note that four of these are introduced from within 5 km of site.