Before the MACKENZIE DISTRICT COUNCIL

IN THE MATTER OF	of Schedule 1 of the Resource Management Act 1991
AND	
IN THE MATTER	of proposed Plan Change 18 to the Mackenzie District Plan

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STATEMENT OF EVIDENCE OF NICHOLAS JOHN HEAD
On behalf of
The Royal Forest and Bird Protection Society

DATED 12 February 2021

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1. INTRODUCTION

1.1 My name is Nicholas John Head. I have been engaged by the Royal Forest and Bird Protection Society Inc. to provide ecological evidence on Plan Change 18 - Indigenous biodiversity - for the Mackenzie District Plan.

1.2 Since 2017 I have been employed as the Senior Ecologist for the Christchurch City Council. For the previous 23 years I worked as plant ecologist for Department of Conservation (DOC). Prior to that I worked for Landcare Research New Zealand Ltd as a botanist for the Rabbit and Land Management Programme and Semi-Arid Lands Programme, based in Alexandra.

1.3 I have a Master of Science (Hons) degree in plant ecology from Lincoln University and a BSc with a double major in plant ecology and physical geography from the University of Canterbury.

1.4 I have almost 3 decades experience working in Canterbury and throughout New Zealand undertaking ecological and botanical work.

1.5 From a practical perspective, I have extensive field experience assessing, recording and reporting on botanical matters throughout New Zealand, in particular with a focus on threatened and rare plants and ecosystems in the eastern South Island.

1.6 I have undertaken many botanical assessments ranging in size from greater than 40,000 hectares to less than one hectare. I was involved in 3 Protected Natural Area Programme (PNAP) surveys in Canterbury that used a standard scientific approach to assess significant ecological values across large areas. I have surveyed many sites that form the basis of Significant Natural Areas (SNAs) in district plans and in my current role I oversee Christchurch City Council significant ecological site identification for the district plan. I have also prepared many successful proposals for land protection in Canterbury.

1.7 I was part of Environment Canterbury's ecologists' working party to develop ecological criteria for the Canterbury Regional Policy Statement (CRPS). I was also responsible for the preparation of DOC's best practice guidelines for assessing

significant ecological values[1] which I co-authored. I have presented evidence on ecological matters in numerous hearings at the district and regional level, including in the Environment Court.

1.8 I am very familiar with the ecological values of the Mackenzie Basin and the wider Mackenzie District. As part of the Tenure Review process under the Crown Pastoral Land Act, I have undertaken numerous botanical assessments throughout the South Island high country. This includes assessing 23 pastoral leases in the Mackenzie Basin, which collectively occupy more than 200 thousand hectares and covers a considerable portion of the Mackenzie Basin floor.

1.9 The properties I have surveyed in the Mackenzie Basin include Sawdon Station, Mt Hay Station, Balmoral Station, Holbrook Station, Irishmans Creek Station, Glenmore Station, Braemar Station, The Wolds Station, Maryburn Station, Simons Pass Station, Mt Dalgety Station, Mt Gerald Station, Grampians Station, Black Forest Station, Gurragmore Station, Streamlands Station, Stony Creek Station, Kirkliston Station, Omahau Hill Station, Ferintosh Station, Quailburn Station, and Twin Peaks Station.

1.10 I have a long involvement with research on the management of threatened plant species and rare dryland ecosystems, such as that undertaken in the Tekapo Scientific Reserve[2], and I am currently running a dryland restoration project at McLeans Island on the Canterbury Plains. Such research involves in-depth studies on threatened species populations and ecosystem health over time, and assessing responses to various management actions.

1.11 I provide a wide range of botanical and ecological advice to colleagues and the public generally. I have published numerous articles on threatened plant species and ecosystems, some of which are included in the references section of this evidence.

[1] Davis, M.; Head, N. J.; Myers, S. C.; Moore, S. H. 2016. Department of Conservation guidelines for assessing significant ecological values. Department of Conservation, Wellington, 71p.

[2] Walker, S.; Comrie, J.; Head, N.; Ladley, K. J.; Clarke, D. 2016. Hawkweed invasion does not prevent indigenous non-forest vegetation recovery following grazing removal. *New Zealand Journal of Ecology,* 40(1) 137 - 149.
Walker, S.; Comrie, J.; Head, N.; Ladley, K. J.; Clarke, D.; Monks, A, 2016b. Sampling method and sample size affect diversity and indigenous dominance estimates in a mixed grassland community. New Zealand Journal of Ecology, 40(1) 150-159.

1.12 The evidence I have prepared for this hearing draws on evidence I prepared for the Environment Court hearing on Plan Change 13 (PC13) to the Mackenzie District Plan.

2. CODE OF CONDUCT

2.1 I confirm this evidence is within my area of expertise. Although this is a council hearing, I have read and agree to comply with the Environment Court's Code of Conduct for Expert Witnesses. My qualifications and experience are set out above. Other than any matters identified within my evidence as being from other experts, I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

3. SCOPE OF EVIDENCE

3.1 My evidence focusses on the Mackenzie Basin sub zone (here within referred to as the Mackenzie Basin), in particular the glacial derived (depositional) outwash and moraine ecosystems of that comprise the basin floor. Specifically I will:

(a) I provide an ecological overview of the Mackenzie Basin;

(b) discuss ecological values and the national significance of the Mackenzie Basin, including naturally rare ecosystems, threatened ecosystems, flora and fauna;

(c) document the losses of significant ecological values occurring in the Mackenzie Basin, including edge effects and other reasons facilitating loss;

(d) outline a case study that details a typical scenario for the basin

(e) discuss proposed plan changes to achieve no net loss of indigenous biodiversity, including definitions of improved pasture and indigenous vegetation, vegetation clearance, Farm Biodiversity Plans and Biodiversity Offsetting.

4. SUMMARY

4.1 The Mackenzie Basin comprises naturally rare, glacial-derived outwash and moraine (depositional) ecosystems that is not replicated to any similar extent elsewhere in New Zealand, or the rest of the world. These ecosystems occur across contiguous environmental gradients associated with altitude, aridity, soil age and type. They comprise distinctive habitats and biota that includes a very high number of threatened species that is nationally significant and a national priority for protection.

4.2 At least 91 plant species are classified as threatened or at risk that have been recorded from the outwash and moraine ecosystems, including numerous species that are essentially limited to the Mackenzie Basin's naturally rare ecosystems. The primary threat to species is habitat loss caused by land use change, particularly the intensification of agricultural land use.

4.3 The overriding significant ecological values of the Mackenzie Basin are the large size and intactness of the remaining sequences of undeveloped outwash and moraine ecosystems. This was agreed by the environment court during PC 13 hearing - the whole being more important than any part.

4.4 Maintaining the scale and intactness of the interconnected dryland ecosystem is of paramount importance to maintain the suite of nationally significant indigenous biodiversity present.

4.5 Substantial ecosystem loss has occurred in the Mackenzie Basin, primarily because of intensive agricultural development, but also facilitated by ambiguous definitions in the district plan, as well as a lack of understanding of ecological values. These losses have been most extreme in the Omarama Ecological District (ED), and the lower Pukaki ED. In my opinion, the widespread conversion of dryland ecosystems that has been occurring in the Mackenzie Basin has undoubtedly resulted in the extensive and irreplaceable loss of significant indigenous biodiversity.

4.6 I support the proposed definitions for "Indigenous Vegetation" as well as that proposed for "Improved Pasture". These definitions more accurately reflect the ecological context of the Mackenzie Basin's significant ecological values and they should provide much greater clarity as to when consent should be required.

4.7 I also support the mapping of improved pasture outlined by Mr Harding. From my understanding of the Mackenzie Basin it portrays an accurate indication of where the remaining undeveloped depositional ecosystems occur and therefore the likely extent of significant ecological values present. These maps should form the provisional extent of remaining significant ecological values to be maintained and protected as a matter of national importance.

4.8 Given the importance of many small and distinctive habitats for threatened biota, I am concerned that providing for up to 5000m2 clearance (or unlimited potential clearance where a farm biodiversity plan is provided) through restricted discretionary consents could result in the irreplaceable loss of significant values. More extensive losses could occur through the clearance in SONS associated with the Waitaki Power Scheme operating easement, especially refurbishment. Intensive stock grazing should also be considered as a form of clearance.

4.9 I am seriously concerned about Farm Biodiversity Plans as a mechanism to achieve both development and no net loss. The framework is not fit purpose and I consider that FBPs would facilitate ongoing loss of significant indigenous vegetation and fauna habitats in the Mackenzie Basin.

4.1 Offsetting is not appropriate for the depositional ecosystems of the Mackenzie because of their rarity, threat, habitat complexity and distinctiveness. Any reduction of these ecosystems' extent will cause permanent net loss that cannot be offset or compensated.

5. ECOLOGICAL OVERVIEW OF THE MACKENZIE BASIN

5.1 The Mackenzie Basin largely comprises glacial geomorphology of moraines and low-lying alluvial outwash ecosystems (variously called depositional or dryland ecosystems) formed by successive glaciations. It encompasses 3 EDs (Tekapo, Pukaki, and Omarama[3]) that reflect the finer scale environmental gradients associated primarily with altitude changes and different ages of glacial deposition. The vast majority that remains undeveloped occurs within the Mackenzie District.

5.2 Climatic extremes are a feature of the Mackenzie Basin, with cold winters, strong winds, hot dry summers and semi-arid annual precipitation, especially in the east. These climatic conditions give the Mackenzie Basin its distinctive ecological ('desert'[4]) character, typified broadly by fescue tussock grasslands and shrublands.

5.3 It is important to note that what is generally described as 'tussock grasslands' in the Mackenzie Basin typically comprises mosaics of different plant communities that reflect subtle eco-tones along varying environmental gradients. This includes extensive areas of 'depleted' land as an inherent and common component of the tussock grassland ecosystem - stone-field, mosses, lichen and herb-field with very sparse vascular[5] vegetation.

[3] The ecological character of New Zealand has been divided into areas of similar ecological character called Ecological Regions ("**ER**") by a scientific panel. ERs are further subdivided into ecological districts ("**ED**") that differentiate finer scale patterns of climate, geology and landforms. There are 85 ERs and 268 EDs in New Zealand (McEwen 1987). The ED scale is the accepted framework that underpins ecological significance assessment criteria that are used to determine ecologically significant sites, such as the criteria outlined in the Canterbury RPS and the DOC assessment guidelines. These ecological districts are shown in Map 1 in Appendix 5.

[4] Cockayne, A. H. 1915. Some economic considerations concerning montane tussock grasslands. *Transactions and Proceedings of the Royal Society of New Zealand 1868-1961*, 48: 154-165.

5 Vascular vegetation as opposed to non-vascular vegetation - mosses and lichens that can be common.

5.4 Adaptations to extreme environmental stress (drought, cold and wind) are a feature of the Mackenzie Basin's flora and includes high levels of dormancy, seasonality in growth (spring ephemeral lifecycles[6]), short stature, leaflessness, cushion and mat forms, deep tap roots, and for some species a combination of ephemeral/spring growth and mobility i.e. random patchiness across the landscape in any one year.

5.5 These specific adaptations to the extremes of the Mackenzie Basin climate is reflected in the disproportionately high number of at risk and threatened species that occur in the depleted basin floor habitats (disturbed/open/bare and stony), many of which are not found to any similar extent elsewhere. The importance of the Mackenzie Basin for threatened plants, invertebrates, birds and lizards is documented in **Appendix 1**. Photographs 7 to 9 in **Appendix 6** show some of the Basin's threatened plants and their adaptions.

5.6 European burning and grazing, in combination with the introduction of rabbits in the 1860s and of exotic plant species, has caused widespread depletion of native dryland ecosystems throughout the Mackenzie Basin. Nevertheless, ecological resilience has been a feature of the Mackenzie Basin's ecology – at least until recent widespread agricultural intensification. Descriptions of "denuding" the land can be found in many early accounts[7], along with anecdotal reports of phases of recovery occurring.

5.7 Ecological recovery from over-grazing and weed invasion is most clearly demonstrated from a recent study in the Tekapo Scientific Reserve[8]. This study documents that on the removal of stock grazing, and with the implementation of rabbit control and wilding pine control, there has been a notable recovery of short (*Festuca novae-zealandiae*) tussock grasslands and associated native species on what were extremely depleted moraine and alluvial outwash ecosystems.

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[6] 'Spring annuals' is the generic term used to describe a group of native plant species that only appear briefly in spring when they germinate from seeds which represent a dormant stage over the extremes of summer and winter. Several species of orchids found in the Mackenzie Basin demonstrate these traits, as do other highly threatened plants species including the New Zealand mouse-tail (*Myosurus minimus* subsp *novae-zealandiae*), *Ceratocephala pungens*, pygmy forget-me-not (*Myosotis brevis*) and pygmy goose foot (*Dysphania pusilla*).

[7] Appendix to the Journals of the House of Representatives. 1910. Canterbury Pastoral Runs Classification. National Library of New Zealand. https://atojs.natlib.govt.nz/cgi-bin/atojs?a=d&cl=seach&d=AJHR1910-I.2.1.4.25&sr.

[8] Walker, S.; Comrie, J.; Head, N.; Ladley, K. J.; Clarke, D. 2016. Hawkweed invasion does not prevent indigenous non-forest vegetation recovery following grazing removal. *New Zealand Journal of Ecology*, 40(1) 137 - 149.

6. SIGNIFICANT ECOLOGICAL VALUES IN THE MACKENZIE BASIN

6.1 Where not intensively developed the moraine and outwash ecosystems support significant ecological values when assessed in accordance with the criteria in the Canterbury Regional Policy Statement (CRPS). The key attributes of the Mackenzie Basin's significance are as follows:

6.2 Moraine and outwash ecosystems are classified as originally rare[9]. The extent and variety of these originally rare ecosystems present in the Mackenzie Basin is not replicated elsewhere in New Zealand. They are poorly protected and threatened[10], and consequently, they are a national priority for protection.[11] The national importance of the Mackenzie Basin as a stronghold for rare glacial derived ecosystems and associated biota is described in more detail **Appendix 3** and shown in Map 2 in **Appendix 5**.

6.3 They support native plant communities (broadly fescue tussock grasslands and scattered shrublands) that are representative[12] of what is typical of the Mackenzie Basin's natural indigenous vegetation that includes a diverse and often distinctive biota not found elsewhere in New Zealand.

6.4 They support a disproportionately large number of threatened and at risk species, including several local endemic species (only found in the Mackenzie Basin) and many national strongholds. The threatened plant list provided by Mr Harding[13] identifies at least 91 plant species that are classified as threatened or at risk that have been recorded from the outwash and moraine ecosystems. The national importance of

[9] Williams, P. A.; Wiser, S.; Clarkson, B.; Stanley, M.C. 2007. New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. New Zealand Journal of Ecology, 31(2): 119–128.

[10] Holdaway, R.J.; Wiser, S.K.; Williams, P.A. 2012. Status assessment of New Zealand's naturally uncommon ecosystems. Conservation Biology, 2012.

[11] Protecting our places: Introducing the national priorities for protecting rare and threatened biodiversity on private land. Available at https://www.biodiversity.govt.nz/land/guidance/

12 Representativeness is a key criterion for determining ecological significance in New Zealand. In highly modified Ecological Districts and Land Environments, plant communities that are 'Representative' of the vegetation that was present at around 1840 (European arrival) are usually considered to be significant. Although the plant communities in the Mackenzie Basin lack some of the structural dominance of the grasslands and woodlands thought to have been present in earlier times, they do retain species thought to reflect the general composition of the previous indigenous cover.

[13] Mr Harding's evidence, attachment 1 and 2.

the Mackenzie Basin as a stronghold for threatened and at risk flora and fauna is described in more detail **Appendix 1** and is also discussed by Mr Harding[14].

6.5 Even the most denuded depositional ecosystems are likely to retain significant ecological values as they provide significant habitat for threatened flora and fauna particularly moths[15] and endemic grasshoppers[16]. They also meet other significance criteria through their contribution to biological diversity and pattern, and in particular ecological connectivity[17].

6.6 Over and above the values listed above, the overriding significance is the large size and ecological connectivity of the remaining undeveloped sequences of depositional ecosystems. The attributes of scale and connectively underpins the Basin's ecological integrity that is important to sustain the full extent of significant ecological values present that is of national significance. This includes comprising the largest contiguous area of dryland habitat remaining in New Zealand for banded dotterel (nationally vulnerable)[18].

6.7 Notably, the Environment Court also concluded that much of the ONL is significant vegetation notwithstanding the presence of introduced plants and weeds,[19] and that consequently the ONL is a significant natural area under policy 9.3.1. of the CRPS.

6.8 The context to assessing ecological significance in New Zealand is described in **Appendix 4**.

7. ECOSYSTEM LOSS IN THE MACKENZIE BASIN AND EDGE EFFECTS

7.1 In recent years, especially since about 2000, intensive agricultural practices (irrigation, cultivation, over-sowing and topdressing) have caused widespread loss of

[14] Mr Harding's evidence paragraphs 31 – 32

[15] Patrick, B. H. 1992. Supplement to the Lepidoptera of the Mackenzie Country with recommendations on the conservation. New Zealand Entomologist 15: 48-58.

[16] A list of rare, threatened and endemic invertebrates in the Mackenzie Basin is shown in Appendix 1.

17 Diversity and pattern is a significance criteria in the CRPS.

18 Pers comm Dr Emma Williams, Dept. Conservation, Science and Research Division.
O'Donnell CFJ 2013. The significance of Ohau Downs alluvial outwash plain, Mackenzie Basin, for banded dotterel and other bird species. Department of Conservation File Report DOCDM-130975. Department of Conservation, Christchurch.

[19] PC 13 Decision- Eleventh Decision- 2017, para 236

natural ecosystems and associated indigenous biodiversity across the Mackenzie Basin. Unlike degradation from extensive pastoralism, weeds and animal pests, recent agricultural conversions to exotic pasture has caused the permanent and irreplaceable loss of dryland ecosystems and associated indigenous biodiversity. The extent of ecosystem loss that occurred between 2000 and 2016 is illustrated in **Appendix 2** and Maps 3 and 4 in **Appendix 5**. I note that the map produced by Mr Harding shows loss of significant ecological values has continued between 2016 - 2020[20].

7.2 Ecosystem loss has largely been concentrated on outwash ecosystems, but considerable losses have also occurred on moraine ecosystems (described in **Appendix 2**). Losses have been especially pronounced in the southern basin in the Waitaki District with 47% of the alluvial outwash converted between 2000 and 2016 (Omarama ED). In the Mackenzie District (Pukaki ED) at least 21% had been converted between 2000 and 2016.

7.3 Edge effects resulting from ecological fragmentation from land development are causing further ecosystem degradation and loss of indigenous biodiversity. Edge effects are among the most pervasive threats to remnant ecosystems and associated indigenous biodiversity. They typically favour the growth of exotic plants that causes increased cover and abundance of exotic species that smother native species.

7.4 The severity and extent of edge effects will depend on the type of adjoining land use, as well as topography, wind, soil type, slope and aspect. In the largely flat and windy Mackenzie Basin, water, fertilizer, soil, plastic and seeds etc., can be transported very long distances, and effects have been measured to over 300 m[21]. The predominant vegetation, being open and short stature, offers little resistance to edge effects and opportunities for exotic plants to establish and smother native species.

7.5 Many rare and threatened species present in the Mackenzie Basin depositional ecosystems are particularly sensitive to edge effects because they are often small

[20] The losses mapped as at 2016 shown in this evidence also included areas thoroughly invaded by wilding pines, as well in a few cases areas that had been highly modified by fertiliser, that are not mapped as loss by Harding.

[21] Walker, S. 2020. Measured edge effects on indigenous grassland and shrubland vegetation on low-relief topography in Canterbury. Contract report LC3866. Manaaki Whenua-Landcare Research.

stature, on naturally infertile soils, and sparsely vegetated habitats that are highly sensitive to altered environmental conditions. The increase in irrigation in dryland ecosystems across central Otago is considered to be one of the key factors that has caused population collapse of inland cress that is now all but extinct[22].

7.6 The photographs 1-4 in **Appendix 6** show some examples of edge effects occurring and the degradation caused from increased humidity and fertility.

7.7 Other key factors contributing to the losses of significant ecological values include ambiguous clearance rules and exemptions in the district plan, combined with inadequate recognition and/or the lack of understanding of the potential significant ecological values present. I discuss these further in sections 9 of this evidence.

8. CASE STUDY - MARYBURN OUTWASH

8.1 The Maryburn outwash is typical of the complexity of the wider basin floor to which it is contiguous. It comprises a series of glacial outwash surfaces of varying age and deposition[23]. Despite being very depleted from a long history of pastoralism, with weeds and animal pests common (esp. mouse-ear hawkweed and rabbits), the outwash ecosystem retains representative native plant communities and a high degree of species diversity associated with numerous channels, micro-topographical changes, substrate variation and ages. It provides many specialist habitats that support significant populations of nationally threatened species (Photograph 10 in **Appendix 6**).

8.2 The upper part of the outwash surface, next to SH8, represents the older part of the outwash sequence associated with the Balmoral glacial advance[24]. It contains deeper soils interspersed with numerous pronounced melt-water channels and deflation hollows[25] that are not present to the same extent on the younger surfaces (shown in

[22] Pers com, Jane Gosden, Department of Conservation Technical Advisor – Plant Ecology.

23 Also interspersed through the glacial outwash are 'more recent' alluvial deposits are which are associated with the Maryburn Stream, Irishman Creek and Tekapo River, but these deposits form a relatively minor part of the overall site.

24 Cox, S.C; Barrell, D. J. A (compilers) 2007. Geology of the Aoraki area. Institute of Geological and Nuclear /sciences 1:250,000 geological map 15. Institute of Geological and Nuclear Sciences Ltd, Lower Hutt.

[25] These hollows and stony channels are a natural part of the glacial outwash ecosystem that were formed when the landform was deposited from melting ice. They are not the result of 'recent' soil erosion as some mistakenly assume.

Photographs 5 and 6 in **Appendix 6)**. These features fade out toward the Tekapo River, where it becomes an undulating stony outwash plain associated with the Tekapo glacial advance ("Tekapo outwash").

8.3 The deeper silt deposits and channels support noticeably different species composition reflecting the starkly different habitats of each (silty vs rocky). The deeper silty soils are characterised by sparse fescue tussock[26] and stunted Matagouri that forms structurally dominant cover (from less than 10%, but it can occasionally exceed 20%). Common exotic species include mouse-ear hawkweed and browntop, which can comprise up to and over 25% of the cover.

8.4 Rocky channels and terraces are characterised by rock, lichen, and bare ground. Fescue tussock is noticeably absent in channels and depressions, probably naturally so, owing to being extremely frost affected habitats. The channels and depressions support a distinctive assemblage of native species typified by cushion and mat forming plants, including several threatened species. Features include the local dominance of the native desert poa, and an array of other common native 'desert' species many of which can all form extensive patches. Exotic herbs are common, especially including mouse-ear hawkweed.

8.5 The following threatened species have been recorded on the Maryburn outwash:

Threatened Plants[27] and their key habitats

Leptinella conjuncta	nationally critical	interfluves channels
**Lepidium solandri*	nationally critical	stony channels and terraces
**Carmichaelia nana*	nationally vulnerable	terrace edges and channels
**Carmichaelia vexillata*	nationally vulnerable	silt lobes
Cardamine 'tarn'	nationally endangered	channels
Myosurus minimus subsp. *novae-zelandiae*	nationally endangered	channels
**Convolvulus verecundus*	nationally vulnerable	channels, stony terraces
**Pimelea sericeovillosa subsp pulvinaris*	nationally vulnerable	channels, stony terraces

26. A notable variation to fescue tussock as the dominant species is the presence of silver tussock (*Poa cita*) that is quite extensive across the low terrace adjoining the Maryburn River and the SH8. Silver tussock grasslands are rare in the Mackenzie Basin, typically favouring more fertile sites. Its presence is indicative of the inherent ecological variation present within the outwash ecosystem and mosaics of native plant communities present.

27 The threat rankings for several species on this list (highlighted with an asterisk) have had their threat ranks elevated. This increase in threat status is in response to the extensive habitat loss from land development that has been occurring in the Mackenzie Basin.

**Raoulia monroi*	nationally vulnerable	stony channels
Sonchus novae-zealandia	nationally vulnerable	silt terraces
Wurmbea novae	nationally endangered	silt terraces
**Colobanthus brevicephalus*	declining	channels, stony terraces
**Elymus falcis*	declining	stony channels
**Pterostylis tristis*	declining	silt terraces
**Leucopogon nanum*	declining	silt terraces
**Leptinella serrulata*	declining	silt terraces
Muehlenbeckia ephedroides	declining	channels, stony terraces
**Raoulia beauverdii*	declining	stony terraces
Veronica lilliputiana	declining	channels
Carex decurtata	data deficient	silt terraces
**Dysphania pusilla*	data deficient	channels, stony terraces

Invertebrates[28]

- Robust grasshopper *(Brachaspis robustus)* (nationally endangered)- channels, stony terraces
- *Sigaus minutus* (declining) – silt lobes, channels, stony terraces

Birds

- Black stilt[29] (nationally critical)
- Banded dotterel (nationally vulnerable)
- Black fronted tern (nationally endangered)
- Pipit (declining)
- South Island Pied oyster catcher (declining)

8.6 The ecological values of the Maryburn outwash were initially recognised by the Protected Natural Areas Programme (PNAP) survey[30] undertaken in 1984. From this survey, part of the outwash ecosystem was recommended for protection (RAP 14 - Maryburn Flats), but no actual protection resulted[31]. It was described as:

> "*A representative sequence extending from shingle bed communities, through dryland matagouri, to fescue tussock grasslands characteristic of dry well*

28 With the exception of the two grasshoppers identified to species level, the remainder of invertebrates recorded by the tenure review invertebrate survey were only identified to family level. This means that the survey did not adequately determine whether species of endemic and threatened invertebrates were present, as was likely to be the case.

29 Black Stilt occasionally use the ephemeral stream channels present

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

31 The PNAP scientific advisory panel recommended that the initial RAP boundary be expanded to protect a larger area. Cooper, P.J. (compiler). 1986. Pukaki and Ben Ohau Districts PNAs New Zealand Protected Areas Programme. A report detailing information collected during the 1983-84 survey of the Mackenzie Ecological Region concerning areas proposed for protection. For the Department of Lands and Survey Christchurch. I

drained soils. These were the most extensive vegetation communities in the district. The precise location of this area and its boundary geometry are open to discussion".

8.7 The subsequent tenure review of Maryburn Station in 2002[32] recommended almost all the entire outwash ecosystem for protection. Nevertheless, a considerably smaller area was ultimately protected that mostly comprised the lower, younger and more uniform stony terraces. The deeper soils with pronounced channels on the upper terrace were mostly given freehold title, except for a corridor of protected land that partitions the resulting freehold.

8.8 The Tenure Review surveys on adjoining pastoral leases of Simons Pass, Irishman Creek and The Wolds Station, all resulted in similar outcomes. On all these properties large areas of ecologically significant outwash and moraine ecosystems were given freehold title. Large areas of significant ecological values made freehold have since been lost to development. Map 5 and 6 in **Appendix 5** show the outcomes of these tenure reviews.

9. PLAN CHANGE 18 - DEFINITIONS AND MAPS OF IMPROVED PASTURE

9.1 Key factors contributing to the irreplaceable losses of significant ecological values in the Mackenzie Basin (and elsewhere) have included ambiguous district plan definitions and related clearance exemptions. This is compounded by the inadequate recognition and/or the lack of understanding of the potential significant ecological values present.

9.2 As described by Mr Harding[33] the current list of sites of natural significance (SONS) listed in the district plan for the Mackenzie Basin is completely inadequate. It only identifies a very small extent, in disparate parts, of the widespread significant ecosystems present. As a result, the majority of significant ecological values are potentially vulnerable to loss.

[32] Additional survey was undertaken specifically for spring annual plants for tenure review in 2012 during which several populations of spring annuals, and other threatened species, were found. Head, N. 2012 Spring Annual Survey on the Wolds and Maryburn Station – Summary Report for Tenure Review. Department of Conservation Christchurch. File ref: DOCDM 1106602.

[33] Mr Harding's evidence, para 41

9.3 Therefore I support the proposed definitions for "Indigenous Vegetation"[34] as well as that proposed for Improved Pasture[35]. These definitions more accurately reflect the ecological context of the Mackenzie Basin's significant ecological values and they should provide much greater clarity to when consent should be required.

9.4 To complement the proposed definitions above, I also support the mapping of improved pasture outlined by Mr Harding. From my understanding of the Mackenzie Basin, the map appropriately indicates where the remaining undeveloped ecosystems occur and therefore the likely extent of significant ecological values present. As I have set out in my evidence, these ecologically significant ecosystems include those that are very depleted. As such, these maps that delineate improved pasture from undeveloped land should form the provisional extent of remaining significant ecological values to be maintained and protected as a matter of national importance[36].

10. VEGETATION CLEARANCE

10.1 The provision for consenting of clearance up to half a hectare (5,000 m2) every 5 years could cause the irreplaceable loss of significant ecological values. The risk to habitats for threatened species is of particular concern that in the Mackenzie Basin often comprises small areas of distinctive habitats, such as hollows/channels, rock patches (glacial erratics), dunes, and edges of banks, or ephemeral wetlands ecosystems that could be entirely lost. In my view, changes are required to avoid potential adverse effects, either as a reduced area of clearance to a maximum of 100 m2, and/or identify key habitats where a more restrictive approach is required.

10.2 Regarding the Waitaki Power Scheme, I agree with Mr Harding[37] that clearance of vegetation within core sites as well as the wider operating easement areas is very

[34] Indigenous vegetation: "Means a community of vascular plants, mosses and/or lichens that includes species native to the ecological district. The community may include exotic species"

[35] Improved pasture: "Means an area where indigenous vegetation has been fully removed and the vegetation converted to exotic pasture or crops – as at May 2020".

[36] The only possible exception is partially developed land where it has been so highly modified from a long history of regular over sowing and top-dressing that no ecological values remain. Nonetheless, in many instances partially developed land will retain significant ecological values for indigenous biodiversity and/or contributing to ecological connectivity and buffering.

[37] Mr Harding's evidence paragraphs 81 to 86

likely to have adverse effects on indigenous biodiversity, especially those areas identified as SONS.

10.3 Concerning the proposed definition of vegetation clearance, I agree with Mr Harding that intensive grazing can be used as a mechanism to clear indigenous vegetation[38] and even where not intended could have this same result. As such, it should be included in the definition of clearance. I understand that the environment court during the PC13 hearing acknowledged that intensive stock grazing could be form of clearance[39].

10.4 Furthermore, the degradation of natural ecosystems caused by edge effects needs to be recognised as a form of clearance, in my opinion. Edge effects arise every time agricultural land use occurs near indigenous vegetation and can occur across large distances.

11. FARM BIODIVERSITY PLANS

11.1 Farm Biodiversity Plans (FBPs) are used in Rule 1.2.1 to provide an exception to the 5000m2 limit[40] on the clearance of indigenous vegetation rule that would otherwise apply under in rule 1.2.2. As a restricted discretionary activity this will limit council's discretion where a FBP is submitted along with a resource consent application. I have serious concerns with the proposed FBPs as a mechanism to provide for both development and ensure no net loss of indigenous biodiversity in the Mackenzie Basin.

11.2 The FBP framework requires significance assessments to be undertaken on a property by property scale on land that is more than likely already recognised to contain significant indigenous biodiversity values. In my opinion this is a reductionist approach that is highly likely to lead to the disregard and fragmentation of significant ecological values and the identification of isolated land parcels that protect only the very best sites.

11.3 As I have set out in my evidence, the full extent of significant ecological values present in the Mackenzie Basin corresponds with the lands beyond those areas which

38 Mr Harding's evidence paragraph 91-92
39 PC13 Decision-Eleventh Decision-2013, [254-256]
40 In para 10.1 of my evidence I discuss reducing the area of permitted clearance to 100m2.

are so developed and modified that no indigenous biodiversity values remain. These developed areas have provisionally been mapped by Mr Harding. The size and connectivity of the Mackenzie Basin's remaining undeveloped ecosystems are key attributes that underpins its ecological integrity and the nationally significant biodiversity values present. The FBP framework as outlined undermines these key ecological attributes because it is likely to facilitate the ongoing loss of the significant indigenous vegetation and fauna habitats.

11.4 Of further concern, there is considerable uncertainty over the efficacy of FBPs. I see no requirement for ecologist peer review to assess the accuracy and quality of the FBP other than by planning staff. Also, the FBP approach does not require significant ecological values which may be identified to be protected. It appears that council staff can decide that significant ecological values can be exchanged for whatever mitigation or offsetting they consider adequate, in combination with a reliance on assurances of compliance that may be promised. The approach therefore provides no reassurance at all that the nationally significant values will be protected.

12. OFFSETTING

12.1 I agree with Mr Harding that biodiversity offsetting in the Mackenzie Basin would be inconsistent with the CRPS Policy 9.3.6 criteria. In my opinion offsetting does not necessarily protect the values which are directly adversely affected by an activity. Use of offsetting in New Zealand is still relatively new and is evolving. The success of offsetting will not be known for many years in most cases. Because of that it is important to have safeguards against inappropriate use. These safeguards include a clear obligation to avoid adverse effects as the first priority, to remedy and then to mitigate. Only once these approaches have been exhausted is it appropriate to consider whether any residual effects can be properly offset. The second safeguard is that any biodiversity offset needs to be developed in accordance with principles agreed internationally through the Business and Biodiversity Offset Programme[41] ("BBOP") and more recently the Government's guidelines on good practice

[41] BBOP 2012. Business and Biodiversity Offsets Programme. 2012. Standard on Biodiversity Offsets, BBOP, Washington, D.C.

biodiversity offsetting in New Zealand[42]. That is that there are limits to what can be appropriately offset.

12.2 In some instances offsetting is not appropriate where ecosystems are vulnerable, significant and/or irreplaceable. The depositional ecosystems of the Mackenzie Basin fall into this category for their rarity, threat, habitat complexity and distinctiveness. In these instances, activities that cause any reduction of ecosystem extent will cause permanent net loss that cannot be offset or compensated.

12.3 Furthermore, the inclusion of the words in the policy "…*unless an alternative ecosystem or habitat will provide a net gain for indigenous biodiversity,* is inappropriate in my view. The inclusion of this wording is ambiguous. It suggests that offsetting could possibly occur at different and/or less valuable sites/habitats to those lost. This is a deviation from the BBOP/NZ government offsetting framework and the need for 'equivalence' ('like for like') when determining the appropriateness of an offset. Without equivalence the 'no net loss' principle is unlikely to be met as it could lead to inappropriate development of sites that cannot be replaced or offset.

13. CONCLUSIONS

13.1 The Mackenzie Basin is nationally significant for its extensive sequences of glacial derived outwash and moraine ecosystems and associated biota that has no equivalents elsewhere in New Zealand, and their protection is a national priority.

[42] NZ Government 2014. Guidance on Good Practice Biodiversity Offsetting in New Zealand. New Zealand Government, August 2014. (available at http://www.doc.govt.nz/about-us/our-policies-and-plans/guidance-on- biodiversity-offsetting/

13.2 Where the moraine and outwash ecosystems are undeveloped, including those that are very depleted, they are likely to be ecologically significant, as found by the environment court.

13.3 The overriding significant ecological value of the Mackenzie Basin is the large size and intactness of the remaining sequences of undeveloped outwash and moraine ecosystems.

13.4 Maintaining the scale and intactness of the interconnected dryland ecosystems in the Mackenzie Basin is of paramount importance to maintain the suite of nationally significant indigenous biodiversity present.

13.5 Substantial ecosystem loss has occurred in the Mackenzie Basin, primarily because of intensive agricultural development, but also facilitated by ambiguous definitions in the district plan, as well as a lack of understanding of ecological values. The widespread conversion of dryland ecosystems has undoubtedly resulted in the irreplaceable loss of significant indigenous biodiversity.

13.6 I support the proposed definitions for "Indigenous Vegetation" as well as that proposed for "Improved Pasture". These definitions more accurately reflect the ecological context of the Mackenzie Basin significant ecological values and they should provide much greater clarity as to when consent is needed.

13.7 I support the mapping of improved pasture as it portrays an appropriate indication of the likely extent of significant ecological values present on undeveloped land. All the undeveloped land should form the provisional extent of remaining significant ecological in the Mackenzie Basin.

13.8 The 5000m2 clearance exemption could result in the irreplaceable loss many small distinctive habitats for threatened biota. More extensive losses could occur through the Waitaki Power Scheme operating easement. Intensive stock grazing and edge effects should also be considered as a form of clearance.

13.9 Farm Biodiversity Plans as a mechanism to achieve both development and no net loss is not fit purpose and they are likely to facilitate the ongoing loss of significant indigenous vegetation and fauna habitats in the Mackenzie Basin.

13.10 Offsetting is not appropriate for the outwash and moraine ecosystems of the Mackenzie Basin because of their rarity, threat, habitat complexity and distinctiveness. Any reduction of these ecosystems extent will cause permanent net loss that cannot be offset or compensated.

Nicholas Head

10 February 2021

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15. APPENDIX 1: THREATENED PLANT SPECIES IN THE MACKENZIE BASIN

15.1 The Mackenzie Basin is notable for containing many of New Zealand's threatened plant species[43]. At least 91 species are classified as threatened or at risk[44] that have been recorded from the basin floor habitats alone[45] (Table 1), including several species that are essentially limited to the Mackenzie Basin's naturally rare ecosystems such as those that comprise the bulk of the application sites.

15.2 The high number of threatened and at-risk plant species present reflects the distinctiveness and rarity of the basin's ecosystems, which support many specialised 'dryland' species with limited distributions outside the Mackenzie Basin. The primary threat to species is habitat loss caused by land use change, particularly the intensification of agricultural land use[46.]

15.3 **Table 1**: Number of Threatened Plants recorded in the Mackenzie Basin floor habitats (2012 Threatened Plant Revision).

Species Threat Rank	**Numbers of Species (brackets = total number nationally in each threat category)**
Nationally Extinct	1 (8) rediscovered 2016
Nationally Critical	8 (155)
Nationally Endangered	10 (62)
Nationally Vulnerable	12 (72)
Declining	25 (102)
Naturally Uncommon	24 (627)

[43] New Zealand's threatened species are classified according to their imminent risk of extinction, by a panel of scientific experts.

[44] The threat status of New Zealand's plants has been reviewed and a number of plants that have their primary habitats in the Mackenzie Basin have moved from at risk into threatened. This increase in threat rank directly reflects the habitat losses occurring in the Mackenzie Basin. The latest revision of New Zealand's threatened plant classification is pending publication. The current list and ranks in this evidence reflect the 2012 ranking (de Lange et al 2012) which understates the threat status of many species listed here...

[45] Mr Harding's has updated this list identifying 91 species and should be referred to in Attachment 1 of his evidence ..

[46] Walker, S., Price, R., Rutledge, D., Stephens, R., T; Lee, W.G. 2006: Recent loss of indigenous cover in New Zealand. *New Zealand Journal of Ecology 30:* 169-177.

Data Deficient	1 (77)
Total	81 (1103)

15.4 Threatened plants that occur within the Mackenzie Basin 'floor' habitats are listed in Table 2 below.

Table 2 List of threatened and at risk plants in habitats that occur in Basin floor moraine and outwash habitats.

Extinct	*Coprosma intertexta*
Dysphania pusillum (refound 2015)	*Coprosma virescens*
Nationally Critical	*Deschampsia cespitosa*
Carmichaelia curta	*Hypericum involutum*
Ceratocephala pungens	*Lobelia ionantha*
Chaerophyllum colensoi var. delicatulum	*Luzula celata*
Chenopodium detestans	*Muehlenbeckia ephedroides*
Crassula peduncularis	*Olearia lineata*
Leptinella conjuncta	*Parahebe canescens*
Pseudognaphalium ephemerum	*Pimelea sericeo-villosa subsp pulvinaris*
Triglochin palustris	*Pterostylis tanypoda*
Nationally Endangered	*Pterostylis tristis*
Cardamine (a) (CHR 312947; "tarn")	*Raoulia monroi*
Centipeda minima subsp minima	*Rytidosperma telmaticum*
Crassula multicaulis	**Data Deficient**
Lagenifera montana	*Carex decurtata*
Leonohebe cupressoides	**Naturally Uncommon**
Lepidium sisymbrioides	*Achnatherum petriei*
Lepidium solandri	*Agrostis imbecilla*
Myosurus minimus subsp. novae-zelandiae	*Anthosachne falcis*
Ranunculus brevis	*Botrychium australe*
Wurmbea novae-zelandiae	*Carex berggrenii*
Nationally Vulnerable	*Celmisia graminifolia*
Carex cirrhosa	*Centrolepis minima*
Carex rubicunda	*Colobanthus brevisepalus*
Carmichaelia kirkii	*Convolvulus fracto-saxosa*
Hypericum rubicundulum	*Einadia allanii*
Isolepis basilaris	*Epilobium angustum*
Lachnagrostis tenuis	*Euchiton paludosus*
Myosotis brevis	*Hebe pimeleoides subsp faucicola*
Olearia fimbriata	*Korthalsella clavata*
Rytidosperma merum	*Leonohebe tetrasticha*
Senecio dunedinensis	*Leptinella serrulata*
Sonchus novae-zelandiae f. novae-	*Leucopogon nanum*

zelandiae	
	Montia angustifolia
Declining	*Montia erythrophylla*
Aceana buchananii	*Myosotis uniflora*
Aciphylla subflabellata	*Pimelea prostrata*
Amphibromus fluitans	*Pimelea sericeo-villosa subsp alta*
Carex albula	*Plantago obconica*
Carex tenuiculmis	*Pleurosorus rutifolius*
Carmichaelia corrugata	*Ranunculus maculatus*
Carmichaelia crassicaulis subsp crassicaulis	*Raoulia beauverdii*
Carmichaelia nana	
Carmichaelia uniflora	
Carmichaelia vexillata	
Convolvulus verecundus	
Coprosma acerosa	

INVERTEBRATES OF CONSERVATION VALUE THAT OCCUR IN THE MACKENZIE BASIN (provided by Warren Chinn DOC entomologist)

COMMON NAME	**SCIENTIFIC NAME**	**THREAT STATUS**
Moth	*Orocrambus fugitivellus*	Nationally Critical
Moth	*Australothis volatilus*	Nationally Critical
Ground beetle	*Megadromus* 'Omarama'	Nationally endangered
Moth	*Xanthorhoe bulbulata* (Guenee, 1868)	Nationally Critical
Grasshopper	*Brachaspis robustus*	Nationally Endangered
Weevil	*Hadramphus tuberculatus*	Nationally Endangered
Grasshopper	*Brachaspis* 'lowland'	Nationally Endangered
Moth	*Asaphodes stinaria* (Guenee, 1868)	Nationally Endangered
Moth	*Kiwaia* 'plains jumper'	Nationally Endangered
Grasshopper	*Sigaus minutus*	Gradual Decline
Moth	*Xanthorhoe lophogramma*	Sparse
Scarab beetle	*Prodontria matagouriae* Emerson, 1997	Sparse
Moth	*Helastia angusta*	Range restricted
Moth	*Theoxena scissaria*	Nationally Endangered

Grasshopper	*Brachaspis* 'hunter hills'	Range Restricted
Ground Beetle	*Megadromus sp. 11* 'Benmor	Range Restricted
Moth	*Orocrambus* 'Mackenzie Bas	Nationally Endangered
Moth	*Gadira* 'black/brown' EGW	Data deficient
Fly	*Anabarhynchus albipennis*	Data deficient
Beetle	*Prodontria* 'Ben Ohau'	Data deficient
Moth	*Orocrambus sophronellus* (Meyrick, *1885)*	Data deficient
Moth	*Eurythecta robusta*	Not threatened
Ground Beetle	*Holcaspis ovatella*	Not listed (northern limit Tekapo)
Darkling Beetle	*Artystona lata*	Not listed (uncommon & restricted to Mackenzie basin)
Darkling Beetle	*Mimopeus impressifrons*	Not listed (widespread but northern limit is Mt John)
Darkling Beetle	*Mimopeus opaculus*	Not listed (widespread & present on Mt John)
Darkling Beetle	*Mimopeus convexus*	Not listed (uncommon & present on Mt John)
Weta	*Hemideina* 'furoviarius'	Not listed
Chafer Beetle	*Prodontria minuta*	Not listed
Ground Beetle	*Holcaspis falcis*	Not listed (restricted to Mackenzie Basin, Mt John and Canterbury foothills)

Table 3. Lizard species known from Twizel Area and their conservation status (from Hitchmough et al. 2016).

Common name	**Scientific name**	**Threat status**
Mackenzie skink	*Oligosoma prasinum*	*Nationally Vulnerable*
Scree skink	*Oligosoma waimatense*	*Nationally Vulnerable*
*Lakes skink**	*Oligosoma aff. chloronoton "West Otago"*	*Nationally Vulnerable*
Southern long-toed skink (also known as*	*Oligosoma aff. longipes "southern"*	*Declining*

roamatimati skink)		
Jewelled gecko	*Naultinus gemmeus*	*Declining*
*Large Otago gecko**	*Woodworthia "Otago large"*	*Declining*
*Southern grass skink**	*Oligosoma aff. polychroma Clade 5*	*Declining*
Cryptic skink	*Oligosoma inconspicuum*	*Declining*
*Southern Alps gecko**	*Woodworthia "Southern Alps"*	*Not Threatened*
McCann's skink	*Oligosoma maccanni*	*Not Threatened*

*Member of undescribed cryptic species complex (Liggins et al. 2008; Hitchmough et al. 2016).

16. APPENDIX 2: EXTENT OF ECOSYSTEM LOSS IN THE MACKENZIE BASIN

16.1 The extent of loss to alluvial outwash ecosystems that has occurred within the Mackenzie Basin between 2000 and 2016 is shown in in Table 2 below and Map 3 and Map 4 at the back. These data were obtained using LCDB version IV[47] [48](**"LCDB IV**") to map the extent of ecosystem loss and indigenous vegetation remaining[49]. Data checking and further refinements were undertaken using the latest Google Earth™ and aerial photographs available. Local DOC staff was also asked to 'ground-truth' the data and identify recent areas of cultivation, and areas incorrectly identified as either exotic or native cover[50]. Further analysis has been undertaken to assess the extent of ecosystem loss that has occurred between 2000 and 2016 on alluvial outwash surfaces and moraines, and in each ED**.**

16.2 **Table 2: Indigenous vegetation remaining on naturally rare alluvial outwash ecosystems in the Mackenzie Basin and extent of loss (Hectares).**

Ecosystem per ED	Exotic Ha 2000	Exotic Ha 2016	Indig. Ha 2000	Indig. Ha 2016.	Indig. Ha lost	% lost between 2000-2016
Alluvial outwash Gravels	**16,500**	**38,300**	**87,000**	**65,300**	**21,800**	**25%**
Omarama ED	5,700	14,200	18,000	9,500	8,500	**47%**
Pukaki ED	7,600	19,000	53,800	42,500	11,300	**21%**

[47] LCDB IV can be viewed at: https://lris.scinfo.org.nz/layer/423-lcdb-v41-land-cover-database-version-41-mainland-new-zealand/metadata/.

[48] Landcare Research New Zealand Ltd Infomatics Team. 2015. LCDB v4.1 - Land Cover Database version 4.1, Mainland New Zealand, version date 2015-06-30.

[49] Exotic/developed cover classes used as follows ('Built-up Area (settlement)', 'Deciduous Hardwoods', 'Exotic Forest', 'Forest - Harvested', 'Gorse and/or Broom', 'High Producing Exotic Grassland', 'Mixed Exotic Shrubland', 'Orchard, Vineyard or Other Perennial Crop', 'Short-rotation Cropland', 'Surface Mine or Dump', 'Transport Infrastructure', 'Urban Parkland/Open Space').

[50] Some areas defined as 'High Producing Exotic Grassland' in LCDB are land that has been over-sown and top-dressed (ostd) but not cultivated or irrigated. As a result, these areas contain a higher proportion of exotic 'pasture' species compared to similar ecosystems that remain undeveloped. However, because they have not been intensively developed (irrigation/cultivation), they may also retain native species and significant ecological values. Large areas of moraines south of Lake Oahu and between Lake Pukaki and Tekapo fall into this category.

Tekapo ED	3,100	5,100	15,200	13,200	2,000	**13%**

16.3 This analysis demonstrates that widespread loss and ecological fragmentation of the alluvial outwash ecosystems has occurred since 2000. The Omarama ED, and the lower Pukaki ED, has been most dramatically affected with 47% of the alluvial outwash ecosystems lost between 2000 and 2016 in the Omarama ED, additional to that already lost prior to 2000.

16.4 From my observation, most of these losses have resulted from changes in farming methods: My understanding is that change has occurred with little scrutiny of the significant ecological values that may have been affected, despite there being areas that were considered to have supported significant ecological values.

16.5 One example is the almost complete loss of the Twizel-Omarama Grasslands listed in APPENDIX C (1) of the Waitaki District Plan. That area was considered to have had nationally significant ecological values before changes in farming methods resulted in its conversion to irrigated pasture. It was described in the Waitaki District Plan as follows:

> *"Twizel-Omarama Grassland - Large corridor of semi-natural short-tussock grasslands with a good degree of naturalness. Sparsely dotted with native shrubs and open low vegetation. Important area of short tussock grassland with good diversity of inter-tussock herbs. Invertebrate values are of significance. In terms of size, visibility and condition, it is of national significance".*

16.6 In my opinion, the widespread conversion of dryland ecosystems that has been occurring in the Mackenzie Basin has undoubtedly resulted in the substantial and permanent loss of significant indigenous biodiversity; much of it would likely have complied with the criteria for being a national priority for protection. The extent and pace of land-use change that has already occurred in recent years, highlights the very real risk that ongoing land-use change in the Mackenzie Basin will result in extensive and permanent losses of indigenous ecosystems and species that are still present and which exist almost nowhere else.

17. APPENDIX 3: MACKENZIE'S NATURALLY RARE ECOSYSTEMS

17.1 Naturally rare ecosystems[51] are environmentally distinct areas that comprised less than 5% of New Zealand's land area prior to human settlement. They often have highly specialised and distinctive assemblages of species including relatively high proportions that are endemic, rare and threatened.

17.2 The Mackenzie Basin contains several nationally rare ecosystems that remain relatively undeveloped. They include inland alluvial surfaces, moraines, ephemeral wetlands (kettleholes), inland dunes and braided rivers[52].

17.3 The extent and variety of naturally rare ecosystems present in the Mackenzie Basin is not replicated elsewhere in New Zealand. Collectively these ecosystems occupy almost all the basin floor, where they occur contiguously across relatively intact ecological sequences[53]. They support a disproportionately large number of threatened plant species). In my opinion, this makes them nationally significant.

17.4 The threat status of New Zealand's naturally rare ecosystems[54] has been assessed in accordance with the International Union for the Conservation of Nature (IUCN) criteria. This assessment highlights the vulnerability of these naturally rare ecosystems. Their threat status is classified as follows:

17.5 Outwash gravels - critically endangered;

17.6 moraines – vulnerable (the Mackenzie Basin moraines were noted as being critically endangered);

17.7 Inland sand dunes – critically endangered;

17.8 ephemeral wetlands - critically endangered;

17.9 braided rivers – endangered.

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[51] Williams, P. A.; Wiser, S.; Clarkson, B.; Stanley, M.C. 2007. New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. *New Zealand Journal of Ecology*, 31(2): 119–128 (2007).

[52] Also present to a more minor extent are 'lake margins', 'seepages and flushes'.

[53] Owing to extensive ecosystem losses and fragmentation that has occurred in the Mackenzie Basin, especially in the Omarama and Pukaki EDs, the most intact ecological sequences remaining occur in the Tekapo ED.

[54] Holdaway, R.J.; Wiser, S.K.; Williams, P.A. 2012. Status assessment of New Zealand's naturally uncommon ecosystems. *Conservation Biology*, 2012.

17.10 Map 2 at the back of this evidence shows the extent of inland alluvial surfaces and moraine ecosystems in the Mackenzie Basin, as determined from New Zealand's geomorphological maps[55]. Inland dunes and ephemeral wetlands occur within these two broader classifications, but they have not been mapped owing to the difficulty of depicting them at this scale, because of their relatively small size and scattered distribution. Braided rivers are apparent as linear corridors.

17.11 Inland alluvial surfaces comprise outwash fans and plains. They are characterised, broadly, by fescue tussock grasslands, patchy shrublands of predominately matagouri and porcupine shrubs, sparsely vegetated herbfields and stonefields. Despite being generally uniform in appearance (and typically modified from a long history of human activity) these ecosystems contain a high degree of habitat subtlety because of micro-topographical changes in substrate and aspect associated with numerous glacial meltwater channels and depressions[56.] They provide habitats for New Zealand threatened 'desert flora', such as 'spring annuals' and breeding habitats for banded dotterels.

17.12 Inland dunes are characterised by highly disturbed surfaces reflective of wind eroded dunes. Cushion fields and low shrubs are the conspicuous native cover, which also includes a high diversity of small specialist, dryland native species. There is a high degree of fine-scale habitat diversity associated with dune aspect and deflation hollows, which are characteristic of these ecosystems. Many of the Mackenzie Basin's inland sand dunes were flooded when the lakes were raised for hydro-power. Those remaining typically occur as part of inland alluvial surfaces, or among lateral moraines.

17.13 Moraines comprise a complex glacial topography of undulating and conical hillocks, often dissected by melt-water channels. Large protruding boulders (erratic) are a feature of moraine ecosystems. They support a mosaic of dryland plant communities

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[55] Barrell, D.J.A.; Andersen, B.G.; Denton, G.H.; Smith Lyttle, B. 2013: Glacial geomorphology of the central South Island, New Zealand - digital data. GNS Science Monograph 27a. GIS digital data files + explanatory notes (17 p). Lower Hutt, New Zealand.

GNS QMAP seamless digital data 2013. Geological Map of New Zealand 1:250 000. Lower Hutt, New Zealand. GNS Science.

[56] Maziels, J. 1989. Differentiation of late Pleistocene terrace outwash deposits using geomorphic criteria: Tekapo valley, South Island, New Zealand. *New Zealand Journal of Geology and Geophysics*, *Vol.* 32: 225-241

typified by fescue tussock grasslands, small leaved (and 'micro') shrublands, mixed with diverse herbaceous associations. Plant community composition can change markedly on individual moraines depending on aspect, slope and rockiness.

17.14 Ephemeral wetlands ("kettleholes") are associated with moraines. They occur in moraine depressions where seasonal variation in rainfall and evaporation leads to ponding in winter and spring and often complete drying in summer months. They contain distinctive flora characterised by highly diverse native plant (turf) communities that include numerous threatened plant species. The most extensive and best examples (in New Zealand) occur in the Mackenzie Basin, which reflects the large extent of moraine deposits present.

17.15 In commenting on the conservation significance of ephemeral wetlands and their turfs, Johnson and Rogers (2003[57]) note that "despite their scattered occurrence and small total area in New Zealand, ephemeral wetlands are diverse in their plant communities, extremely rich in their flora, and clearly important as the sole or principal habitat for a high proportion of threatened plant taxa". In my opinion that is an accurate assessment; I would add that New Zealand wetland turf plants and their communities may be unique and therefore significant in a global context for they appear to have no analogues in the Northern Hemisphere.

[57] Johnson, P and Rogers, G. 2003: Ephemeral wetlands and their turfs in New Zealand. Science for Conservation 230. New Zealand Department of Conservation.

18. APPENDIX 4: CONTEXT - NEW ZEALAND'S BIODIVERSITY GOALS AND PRIORITIES

18.1 New Zealand has evolved a biologically unique flora and fauna owing to long periods of isolation from other land masses. The rate of endemism for New Zealand species (i.e. species that are found only in New Zealand) is remarkably high; 85% of plants, 45% of birds, 100% of land mammals and reptiles, and 90% of invertebrates are endemic to New Zealand[58].

18.2 New Zealand has one of the worst records of indigenous biodiversity loss in the world. Some 22% of the New Zealand flora, 61% of birds, 83% of reptiles, and at least 5% of invertebrates are now directly threatened with extinction[59]. A higher proportion of New Zealand's vertebrate species are currently threatened with extinction than in any other country[60].

18.3 The ongoing decline of native species and ecosystems continues and is a pervasive environmental issue[61]. The loss of indigenous species and habitats has been most pronounced in lowland (sea level to 500m) and montane environments (between 500m and 900m). The dry eastern parts of the South Island, where the topography and climate have been particularly attractive for agricultural development, are among the areas that have been most susceptible to species and habitat loss.

18.4 Indigenous ecosystems remaining in these dry eastern parts of the South Island have typically been reduced into small, highly fragmented and modified remnants that are poorly protected. On the Canterbury Plains, for example, less than 0.5% of the land area remains in native cover[62]. Coinciding with this pattern of degradation, the

[58] Ministry for the Environment & Department of Conservation 2000. The New Zealand Biodiversity Strategy. Department of Conservation, Wellington, New Zealand.

[59] Hitchmough, R. (Comp.) 2002. New Zealand Threat Classification System Lists - 2002. Threatened species occasional publication 23 210 p. Department Conservation, Wellington.

[60] Bradshaw, C. J., Giam, X., & Sodhi, N. S. (2010). Evaluating the Relative Environmental Impact of Countries. PLoS One, 5(5), e10440, http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0010440.

[61] Ministry for the Environment 1997. The State of New Zealand's Environment, 1997. Ministry for the Environment Wellington; Ministry for the Environment & Department of Statistics. 2015. Environment Aoteraroa 2015. MfE 2015.

[62] Meurk, C. D.; Steven, J. 1996. Low and High Plains Ecological District, Plains Ecological Region, Canterbury. Department of Conservation unpublished report, Christchurch. 119 p.

majority of New Zealand's rare and threatened plant species occur in low altitude remnants mostly on private land.

The New Zealand Biodiversity Strategy ("NZBS")[63]

18.5 The NZBS was prepared by the New Zealand Government in response to the on-going decline of indigenous biodiversity and to fulfill commitments made under the International Convention on Biological Diversity in 1992. The purpose of the NZBS was to establish a strategic national approach to halt this decline and sustainably manage New Zealand's biodiversity.

18.6 The four goals of the NZBS are aspirational, with Goal 3 (Halt the decline in NZ's indigenous biodiversity) being specifically relevant. Goal 3 seeks to:

> *Goal 3: Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments; and do what else is necessary to…*
>
> *Maintain and restore viable populations of all indigenous species and subspecies across their natural range and maintain their genetic diversity.*

18.7 A revised biodiversity strategy was published in 2020 that reasserts the above goals[64].

The National Priorities for the Protection of Indigenous Biodiversity on Private Land[65] ("National priorities")

18.8 The National Priorities for the Protection of Indigenous Biodiversity on Private Land are intended to provide a better framework for decision-making about protecting biodiversity on private land.

18.9 The four national priorities are summarised below:

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[63] Ministry for the Environment & Department of Conservation 2000. The New Zealand Biodiversity Strategy. Department of Conservation, Wellington, New Zealand. The NZBS can be downloaded from www.biodiversity.govt.nz/picture/doing/nzbs/contents.html.;

[64] Te Mana o Te Taiao – Aotearoa New Zealand Biodiversity Strategy 2020. Department of Conservation, New Zealand

[65] Protecting our places: Introducing the national priorities for protecting rare and threatened biodiversity on private land. Available at https://www.biodiversity.govt.nz/land/guidance/.

National Priority 1

To protect indigenous vegetation associated with land environments, (defined by Land Environments of New Zealand at Level IV), that have 20 percent or less remaining in indigenous cover.

National Priority 2

To protect indigenous vegetation associated with sand dunes and wetlands; ecosystem types that have become uncommon due to human activity.

National Priority 3

To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2.

National Priority 4

To protect habitats of acutely and chronically threatened indigenous species.

Frameworks for assessing significant ecological values in New Zealand

18.10 In terms of identifying significant areas of indigenous vegetation and significant habitats of indigenous fauna, and prioritising the protection of New Zealand's most important sites, it is useful to understand the background to assessing significant ecological values in New Zealand, and the consequent use of criteria for assessing their significance in terms of section 6(c) of the RMA 1991.

18.11 The ecological significance of sites is determined by applying standard assessment criteria[66] within an appropriate biogeographical scale and context, considered to be the Ecological District ("**ED**")[67]. These criteria and ED framework have evolved from the Protected Natural Areas Programme[68] ("**PNAP**") that was initiated in 1981 by the (then) National Parks and Reserves Authority in response to concerns that New Zealand's protected natural area system did not represent the full range of natural

[66] The assessment criteria are: representativeness, diversity and pattern, rarity and special features, naturalness, size and shape, buffering/surrounding landscape and boundaries, and long-term ecological viability (the latter 3 are often combined into a broader *Ecological Context* criterion).

[67] The ecological character of New Zealand has been divided into areas of similar ecological character called Ecological Regions ("**ER**") by a scientific panel. ERs are further subdivided into ecological districts ("**ED**") that differentiate finer scale patterns of climate, geology and landforms. There are 85 ERs and 268 EDs in New Zealand (McEwen 1987). The ED scale is the accepted framework that underpins ecological significance assessment criteria that are used to determine ecologically significant sites, such as the criteria outlined in the Canterbury RPS and the DOC assessment guidelines.

[68] Kelly, G. C.; Park, G. N. eds 1986. The New Zealand protected natural areas programme: a scientific focus. Biological Resources Centre Publication No 4. Wellington, Department of Lands and Survey. Pp. 63-87.

diversity, and that natural areas were continuing to be lost. Importantly, this concern remains to this day and applies particularly to the poorly protected, easily developable lowlands, such as the Mackenzie Basin, that support New Zealand's most threatened ecosystems and species**.**

18.12 The PNAP framework provides an objective and scientific method to identify significant ecological values and prioritise protection of areas in which those values are found in New Zealand. It (or variants of it[69]) continues to be used as the basis for determining the relative significance of indigenous biodiversity throughout New Zealand. For example, the assessment criteria in the Canterbury Regional Policy Statement, and the Department of Conservation's assessment guidelines, are based on the PNAP assessment framework[70].

18.13 **Land Environments of New Zealand**

18.14 Over the last decade, Land Environments ("**L.E.**") of New Zealand[71] have been developed as a tool to provide a more quantitative structural framework to help determine areas of similar ecological character throughout New Zealand. They are based on national geomorphology and climate information. L.E. can be used to predict the likely pre-human pattern of terrestrial ecosystems (patterns and gradients) and indigenous biodiversity[72]. Four levels of detail are available, i.e., 20 (National-scale), 100, 200 or 500 (Regional to District-scale) environments (levels I, II, III and IV).

18.15 **Threatened Land Environment Classification**

18.16 L.E. can also be used to identify where threatened and poorly protected indigenous ecosystems are most likely to occur. The Threatened Environment Classification[73]

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[69] Assessment criteria definitions vary somewhat from the original PNAP and between regional/district plans. Most have also been updated to account for the 4 National Priorities (typically included within the *Rarity* criterion).

[70] The Canterbury RPS merged the *Naturalness* criterion into *Diversity and Pattern*, whereas DOC retained the *Naturalness* criterion in its guidelines as per the PNAP standard.

[71] Leathwick, J.; Wilson, G.; Rutledge, D.; Wardle, P.; Morgan, F.; Johnston, K.; McLeod, M.; Kirkpatrick, R. 2003. *Land Environments of New Zealand*. David Bateman, Auckland. 184p.

[72] Ministerial Advisory Committee 2000b. Biodiversity and private land: final report of the Ministerial Advisory Committee. Ministry for the Environment, Wellington.

[73] Walker, S.; Cieraad, E.; Grove, P.; Lloyd, K.; Myres, S.; Park, T. Porteous, T. 2007: Guide for Users of the Threatened Environment Classification. (Version 1.1, August 2007). Landcare Research Limited.

("**TEC**") uses the national land cover database[74] ("**LCDB**") to determine the extent of remaining indigenous land cover (synonymously 'indigenous vegetation') in each land environment, combined with an assessment of how much of the total land area of an environment is legally protected.

18.17 Category 1 L.E. is those that retain less than < 10% cover of indigenous vegetation. Category 2 L.E. retains 10- 20% cover of indigenous vegetation. L.E. in Category 3 retain between 20% and 30% indigenous cover. Category 4 L.E. are those that retain more than 30% indigenous vegetation but have less than 10% of their total land area protected, and Category 5 have between 10-20% protected.

18.18 The TEC also forms the basis of National Priority 1 for the protection of indigenous biodiversity on private land "*To protect indigenous vegetation associated with land environments … that have 20 percent or less remaining in indigenous cover*". This focus on L.E. in which indigenous cover has been most reduced, recognises that as habitat loss increases, the loss of indigenous biodiversity accelerates. This is because as habitats become smaller and more fragmented, they become less resilient and increasingly vulnerable to degradation from mechanisms such as edge effects. The net result for reduced habitats is that their component species are lost at an accelerating pace[75].

Cieraad, E.; Walker, S.; Price, R.; Barringer, J. 2015. An updated assessment of indigenous cover remaining and legal protection in New Zealand's land environments. Short Communication. *New Zealand Journal of Ecology* 39(2):0-0; Walker, S.; Cieraad, E; Barringer, J. 2015. The Threatened Environment Classification for New Zealand 2012: a guide for users. Landcare Research, 27 p. Landcare Research New Zealand ltd, Dunedin. Wildlands Consultants Ltd. 2013.

[74] The LCDB uses satellite imagery to identity patterns of vegetation (and other land cover) at the relatively broad scale.

[75] Cieraad, E.; Walker, S.; Price, R.; Barringer, J. 2015. An updated assessment of indigenous cover remaining and legal protection in New Zealand's land environments. Short Communication. *New Zealand Journal of Ecology* 39(2):0-0.

19. APPENDIX 5 - MAPS

Map 1 – Ecological Districts in the Mackenzie Basin.

Map 2 – Extent of naturally rare ecosystems (moraines and inland alluvial outwash gravels) in the Mackenzie Basin.

Map 3 - Ecosystem loss depicted in 2000

Map 4 – Ecosystem loss depicted in 2016

Map 5 and 6 -Tenure review outcomes of key Mackenzie pastoral leases

20. Appendix 6 – Photos

Photo 1- 4 Edge effects

Photos – 5 – fescue tussock grassland Maryburn outwash

Photo 6 – depleted outwash channel Maryburn outwash

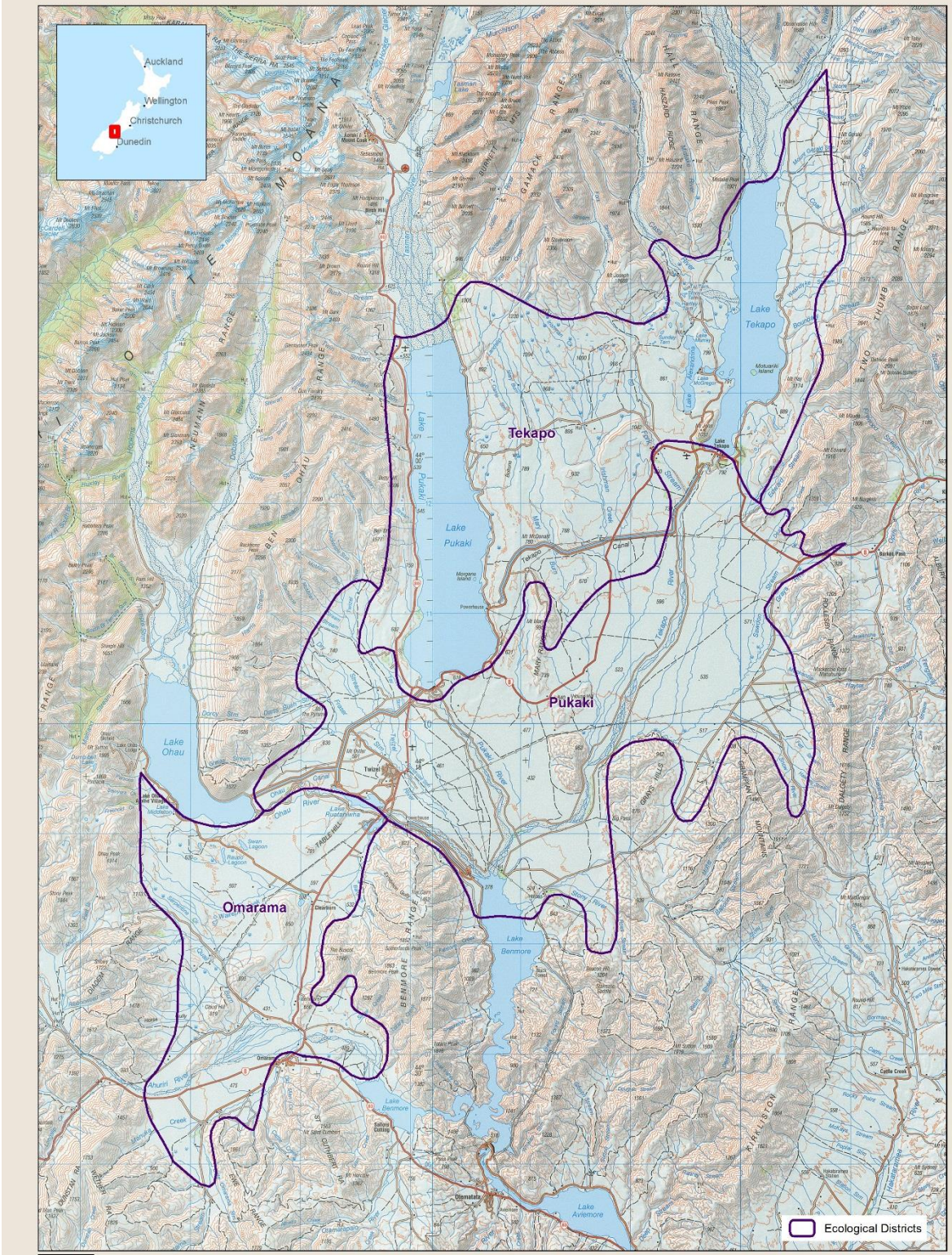
Photo 7: Cushion Pimelea (*Pimelea sericeovillosa subsp pulvinari*s)-nationally vulnerable

Photo 8: Dwarf broom (leafless) (*Carmichaelia vexillata*) -nationally vulnerable

Photo 9: NZ mouse tail (spring annual) (*Myosurus minimus subsp novae-zealandiae*) nationally endangered

Photo 10: Robust grasshopper (*Brachaspis robustus*). Nationally endangered Mackenzie basin endemic

Photo 11: the largest fluvio-glacial outwash surface in the Mackenzie Basin



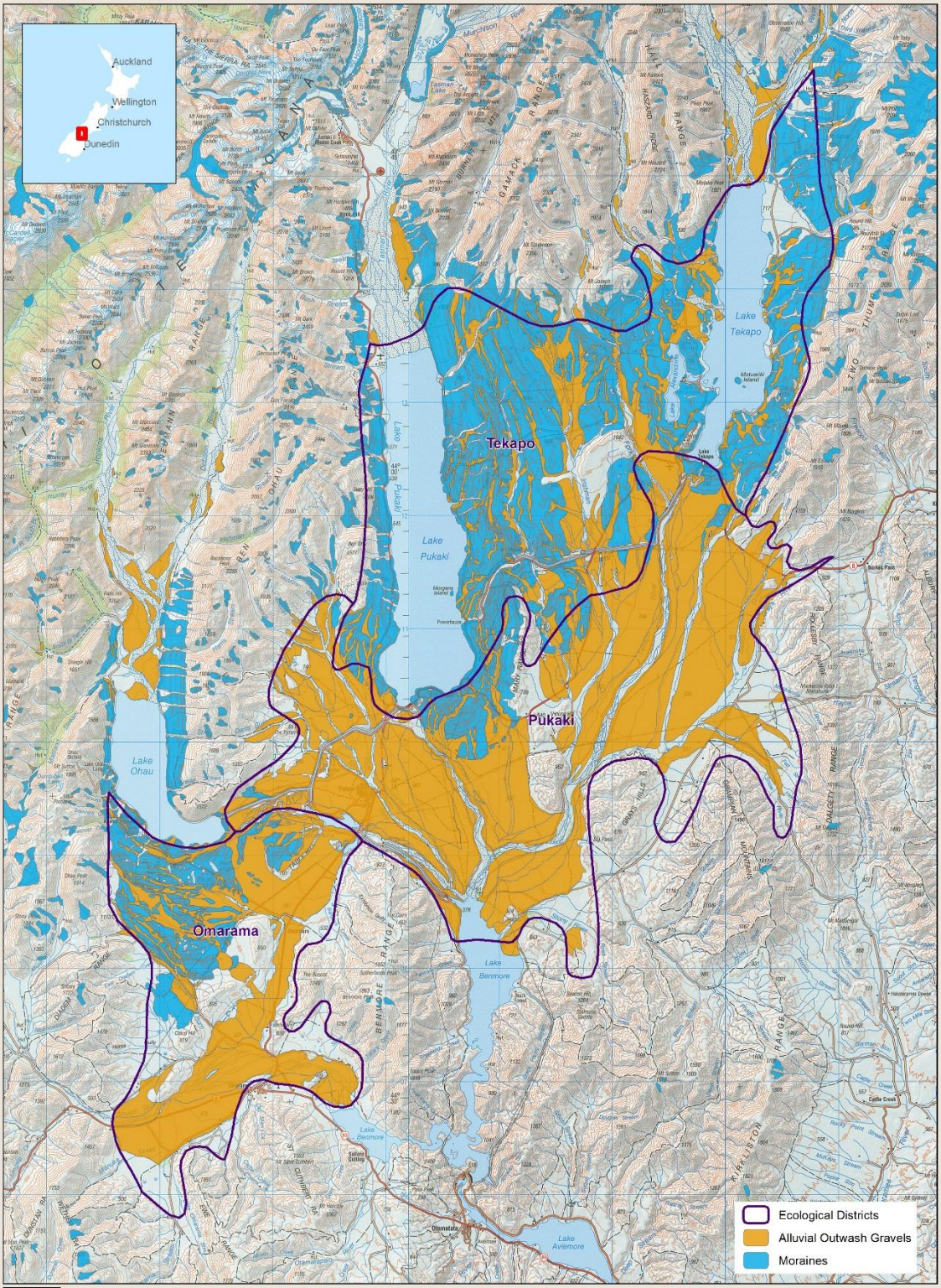
5 Kilometres

Scale at A4 = 1:300,000
NZGD 2000 New Zealand Transverse Mercator
Not for navigation
Crown Copyright Reserved
DOC, Geospatial Services

6/09/2016

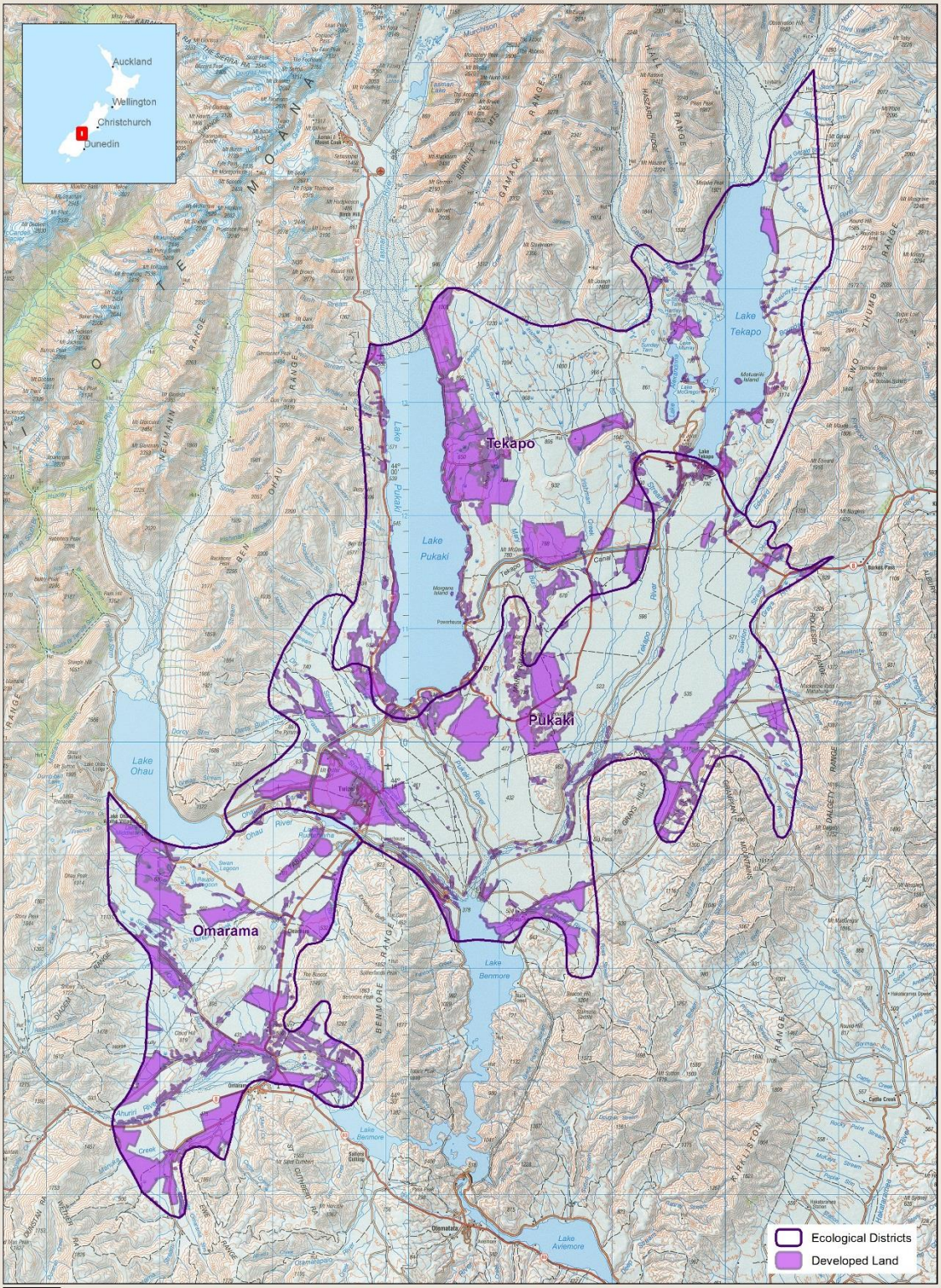
Map 1: Mackenzie Basin Ecological Districts

Department of Conservation
Te Papa Atawhai
New Zealand Government



Map 2: Mackenzie Basin Rare Ecosystems

Department of Conservation
Te Papa Atawhai
New Zealand Government



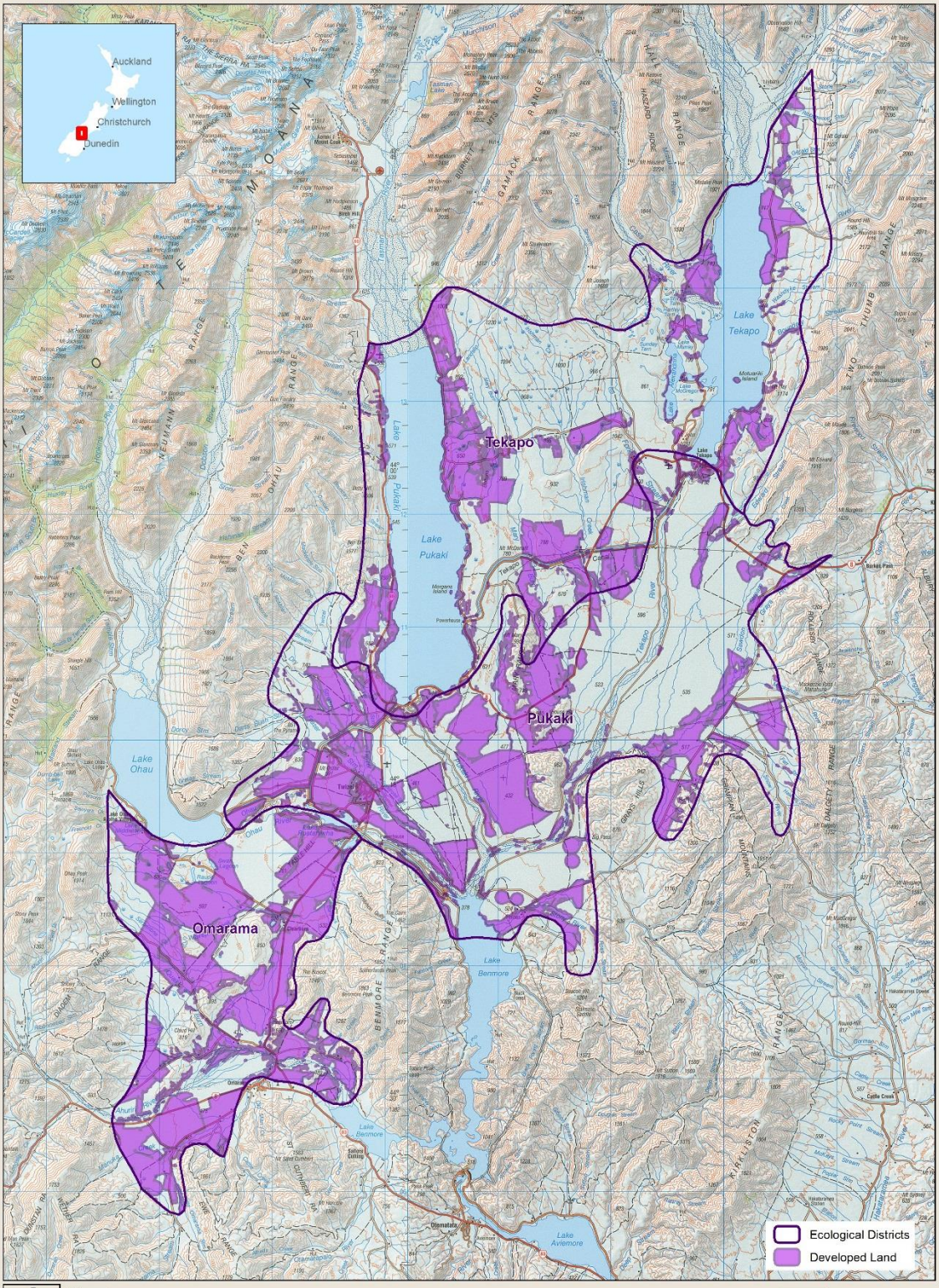
5 Kilometres

Scale at A4 = 1:300,000
NZGD 2000 New Zealand Transverse Mercator
Not for navigation
Crown Copyright Reserved
DOC, Geospatial Services

21/09/2016

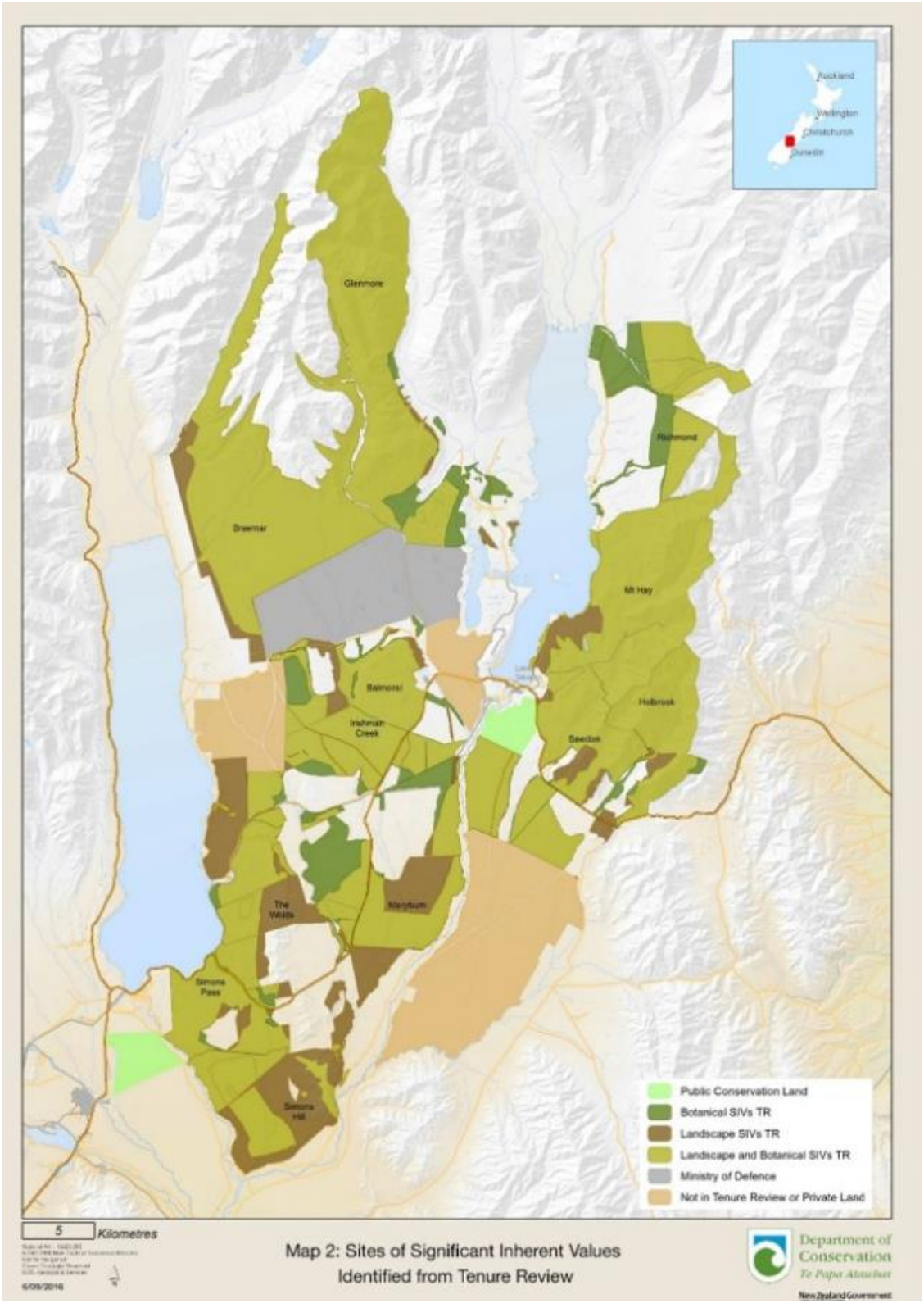
Map 3: Ecosystem Loss 2000

Department of Conservation
Te Papa Atawhai
New Zealand Government

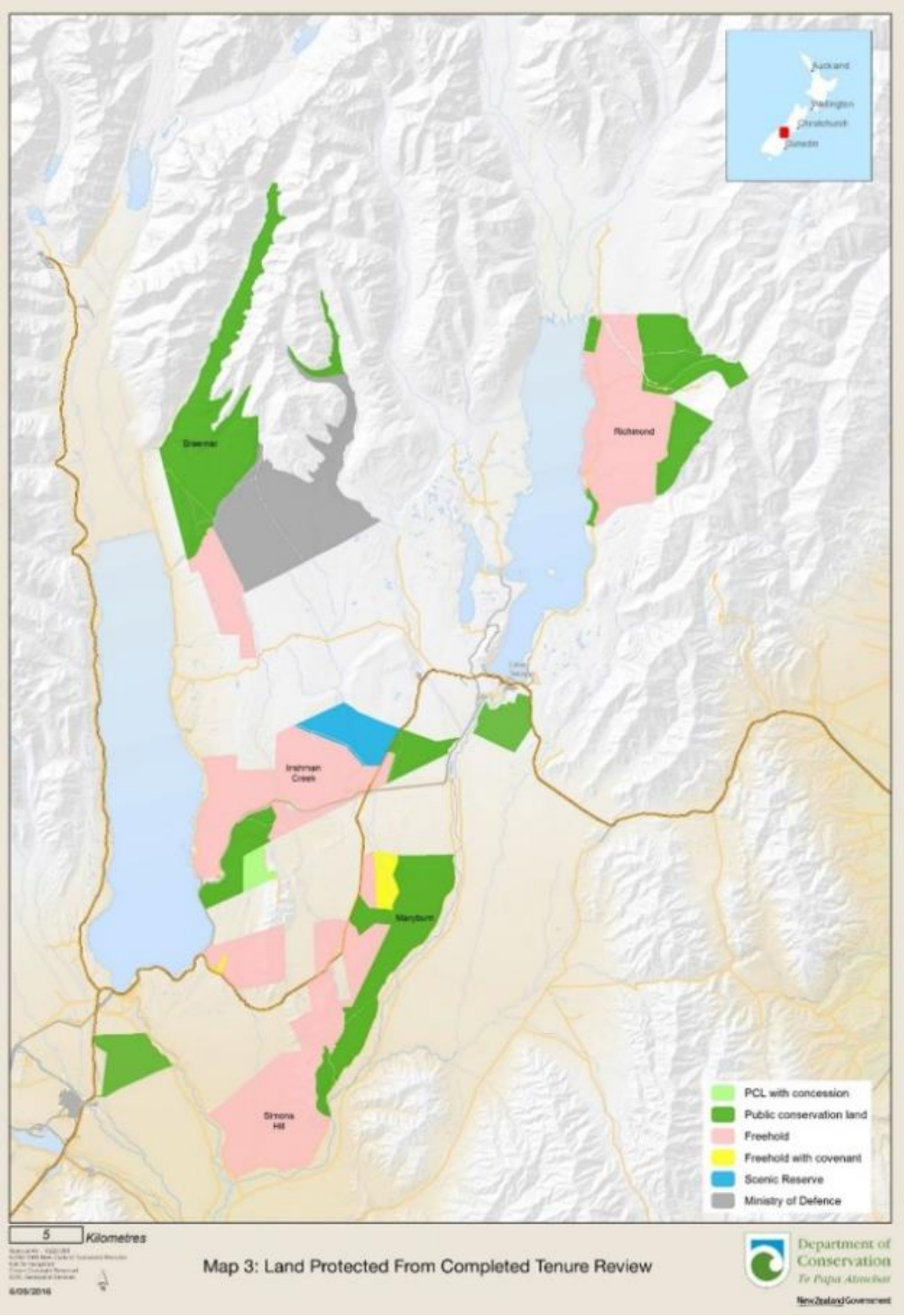


Map 4: Ecosystem Loss 2016

Department of Conservation
Te Papa Atawhai
New Zealand Government


Auckland
Wellington
Christchurch
Dunedin
Glenmore
Richmond
Drenmar
Mt Hay
Balmoral
Irishman Creek
Holbrook
Seerton
The Wilds
Mingtum
Simons Pass
Simons Hill
Public Conservation Land
Botanical SIVs TR
Landscape SIVs TR
Landscape and Botanical SIVs TR
Ministry of Defence
Not in Tenure Review or Private Land
5
Kilometres
6/05/2016
Map 2: Sites of Significant Inherent Values
Identified from Tenure Review
Department of Conservation
Te Papa Atawhai
New Zealand Government

MAP 5


Auckland
Wellington
Christchurch
Dunedin
Richmond
Irishman Creek
Marlborough
Simons Hill
PCL with concession
Public conservation land
Freehold
Freehold with covenant
Scenic Reserve
Ministry of Defence
5
Kilometres
6/05/2016
Map 3: Land Protected From Completed Tenure Review
Department of Conservation
Te Papa Atawhai
New Zealand Government

MAP 6

APPENDIX 6 – PHOTOS

Photo 1: Edge effects, large dust storm in the Mackenzie Basin coming from recently cultivated soils in strong north-west winds. Taken from the evidence of Scott (2016). Photo taken by K Chilton.

Photo 2: Edge effects, agri-lime drifting long distances (>500m) in moderate winds. Photo N Head 2016

Photo 3: Edge effects, invasion of dense exotic grasses into Bankside Scientific Reserve resulting in complete loss of native dryland indigenous species previously present. Photo N Head 2016.

Photo 4: Edge effects, lush pasture species spreading from developed land into terrace edge on the Ruataniwha Conservation Area causing loss of open dryland habitats and native species. Photo N Head 2017

Photo 5: Maryburn outwash showing fescue tussock on deeper soils. Photo N Head ~2012

Photo 6: Maryburn outwash looking toward application area showing of channels and mat vegetation with fescue tussock and stunted matagouri on deeper soils. N. Head ~2012

Photo 7: Cushion Pimelea (*Pimelea sericeovillosa* subsp *pulvinaris*)-nationally vulnerable.

Photo 8: Dwarf broom (leafless) (*Carmichaelia vexillata)* -nationally vulnerable

Photo 9: NZ mouse tail (spring annual) (*Myosurus minimus* subsp *novae-zealandiae)* nationally endangered

Photo 10: Robust grasshopper (*Brachaspis robustus*). Nationally endangered Mackenzie basin endemic

Photo 11: the largest fluvio-glacial outwash surface in the Mackenzie Basin and New Zealand that remains largely undeveloped. (Either side of the Tekapo River, in the Pukaki ED). Other similar outwash terraces south showing numerous circles from recent developments. (Photo taken from ECan satellite mapping)