BEFORE THE ENVIRONMENT COURT
AT CHRISTCHURCH

ENV-CHC-2009-193, ENV-CHC-2009-175, ENV-CHC-2009-181, ENV-CHC-2009-183, ENV-CHC-2009-184, ENV0CHC-2009-187, ENV-CHC-2009-190, ENV-CHC-2009-191, ENV-CHC-2009-192

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of appeals under clause 14(1) of the First Schedule to the Act in relation to decisions on Plan Change 13 to the Mackenzie District Plan
BETWEEN	**FEDERATED FARMERS OF NEW ZEALAND (INCORPORATED) MACKENZIE BRANCH**
	HIGH COUNTRY ROSEHIP ORCHARDS LIMITED AND MACKENZIE LIFESTYLE LIMITED

(continued next page)

STATEMENT OF EVIDENCE OF DR SUSAN WALKER ON BEHALF OF THE MACKENZIE GUARDIANS INCORPORATED
DATED: 09 SEPTEMBER 2016

Ruby Haazen
Supervised by Duncan Currie
21 Shaddock Street
Eden Terrace
AUCKLAND
Phone (021) 144 3457
Email: rghaazen@gmail.com

Richard Allen
Solicitor
Unit 1, 26 Putiki Street
PO Box 78326
Grey Lynn
AUCKLAND
Phone: (09) 362 0331
Email: richard@richardallenlaw.co.nz

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MOUNT GERALD STATION LIMITED

MACKENZIE PROPERTIES LIMITED

MERIDIAN ENERGY LIMITED AND GENESIS ENERGY LIMITED

THE WOLDS STATION LIMITED

FOUTAINBLUE LIMITED & OTHERS

R, R AND S PRESTON AND RHOBOROUGH DOWNS LIMITED

HALDON STATION

Appellants

AND **MACKENZIE DISTRICT COUNCIL**

Respondent

STATEMENT OF EVIDENCE OF DR SUSAN WALKER

INTRODUCTION

1. I am an ecologist, researcher, and research programme leader in the Crown Research Institute Landcare Research, based in Dunedin, where I have worked since 1997.

2. I have MSc (1994) and PhD (1997) degrees in from the University of Otago. I have published more than 60 peer-reviewed scientific journal papers and book chapters in international and national literature, and produced more than 40 internally peer-reviewed contract reports.

3. My primary fields of expertise are

    3.1. the botany, ecology, and conservation management of modified indigenous ecosystems of the dry eastern rainshadow zone of South Island New Zealand ('dry inland South Island');

    3.2. biodiversity assessment, including measurement and reporting of the biodiversity and conservation outcomes and achievements of policies (including tenure review under the Crown Pastoral Land Act), approaches (for example, biodiversity 'offsets') and incentives (including economic or market-based instruments);

    3.3. quantitative field sampling and measurement of biodiversity components and assessment of ecological significance;

    3.4. national and regional long-term changes in New Zealand's land cover and indigenous bird fauna.

4. I have also published scientific papers and written reports about the ecology and conservation of threatened plants, evolutionary patterns of plant richness,

radiation and endemism, and effects of climate change on New Zealand's indigenous biodiversity, among other subjects.

5. I have particular expertise and field experience in the ecology of dryland ecosystems on the floor of the Upper Waitaki basin (hereafter 'Mackenzie Basin') and the basin floors of Central Otago and Queenstown Lakes districts.

6. My postgraduate studies from 1993 to 1997 investigated temporal changes in the vegetation of dry grassland and shrubland ecosystems in the Upper Clutha area (within Queenstown Lakes District) and Central Otago District and I have since undertaken research and field investigations in many parts of dry inland South Island. Between 2004 and 2013 I led a government-funded 'Outcome Based Investment' programme of ecological research into the biodiversity of New Zealand 'drylands' with partners and end-users including the Department of Conservation (DOC)[1] and the Queen Elizabeth the Second National Trust.

7. I currently lead a government-funded research programme addressing risks and threats to indigenous biodiversity across New Zealand landscapes, including landscapes in dry inland South Island. Much of this research addresses ecological responses to management and invasion, and past and future trajectories of habitat change. It has involved experimental ecosystem restoration trials, monitoring and long-term change assessment, and vegetation, lizard, and invertebrate surveys in dryland ecosystems, including in the Mackenzie Basin, and is published in international and national peer-reviewed journals. My present research includes investigation of targeted incentives to maintain indigenous biodiversity on private land in New Zealand in collaboration with policy and economic researchers.

8. I have often been engaged to write contract reports, give oral presentations, and provide advice to central and local government agencies such as Land

[1] A list of abbreviations used in my evidence is appended (S Walker, evidence-in-chief 9 September 2016, Appendix 1).

Information New Zealand (LINZ), DOC, and Regional and District councils on matters of ecology and biodiversity assessment and protection including under the RMA. For example, in 2004 I formulated the Threatened Environment Classification, a foundation for the first of four government national priorities for protecting rare and threatened native biodiversity on private land, and I have since authored associated journal papers, updates and user guides.[2] I am regularly invited to present ecological information at public fora and to give talks and advice to a range of statutory and community organisations.

9. I have understanding of land management and use effects on terrestrial biodiversity and ecosystems of eastern South Island, especially those in the Mackenzie Basin and Central Otago. I have experience in applying planning provisions, such as indigenous vegetation clearance rules and ecological significance assessment criteria in District and Regional Plans, and experience of whether they protect ecological values in practice. I have provided expert evidence for Resource Management Act (RMA) hearing panels, the Environment Court and the High Court. In recent years much of this work has concerned ecology and ecological changes in the Mackenzie Basin.

10. I have read the Environment Court code of conduct for expert witnesses, and I agree to abide by it. I have prepared this evidence in accordance with that code. I confirm that my evidence is within my area of expertise, except where I state I am relying on the evidence of another person. I have acknowledged the material and expertise relied on in the preparation of this evidence and in forming my opinions.[3] To my knowledge I have not omitted to consider any material facts known to me that alter or detract from the opinions I express in this evidence.

11. I have not knowingly used or referred to information collected during my ecological site investigation of Simons Pass and Simons Hill stations in January 2013 for the purpose of the Royal Forest and Bird Protection Society's intended

[2] Walker et al. (2006), Cieraad et al. (2015), Walker et al. (2015).

[3] S Walker, evidence-in-chief 9 September 2016 Appendix 2.

appeal. I have appended a copy of an access agreement,[4] which I understand prevents me from using information gathered on that visit for any purpose other than that appeal.

SCOPE OF EVIDENCE

12. I have been asked by Mackenzie Guardians to describe the ecological elements of the Mackenzie Basin's outstanding natural landscape and recent trajectories of change, and how proposed provisions PC13 might affect these. In preparing my evidence I read the following material:

    12.1. Interim Decision No [2011] NZEnvC 387 (issued 14 December 2011)

    12.2. PC13 Section 293 Package (November 2015);

    12.3. The amended (post consultation) PC13 Section 293 Package (May 2016);

    12.4. Statements of evidence of Mr Harding, Ms Harte, Mr Fairgray, and Mr Densem[5] on behalf of the Mackenzie District Council;

    12.5. Statements of evidence on behalf of appellants (19 August 2016).

13. The ecological evidence of Mr Harding is within my area of expertise. I consider that it is accurate, and rely on it. My evidence provides additional ecological context. Specifically, I:

    13.1. describe the ecological patterns across the basin floor contributing to the outstanding natural landscape of the Mackenzie Basin (Part I, page 6);

[4] S Walker, evidence-in-chief 9 September 2016 Appendix 3.

[5] M A C Harding, evidence-in-chief 15 July 2016, P Harte, evidence-in-chief 15 July 2016, J D M Fairgray, evidence-in-chief 15 July 2016, G H Densem, evidence-in-chief 15 July 2016.

13.2. categorise pressures on ecological features and describe their different effects (Part II, page 14);

13.3. describe the extent of loss of ecological features to active changes in land use (Part III, page 20);

13.4. provide an opinion on the ecological significance of remaining indigenous ecosystems of the basin floor (Part IV, page 23);

13.5. provide an opinion on how well they would be protected in practice by PC13[6] (Part V, page 27).

I. ECOLOGY OF BASIN-FLOOR LANDFORMS AND ECOSYSTEMS

14. The floor of the Mackenzie Basin[7] is largely made up of depositional landforms[8] (mapped in Figure 1 in Appendix 4 to this evidence): principally glacially derived moraines (within which are ephemeral wetlands and tarns formed in kettleholes) and inland outwash gravel surfaces (outwash plains and terraces, meltwater channels and fans), which are cut by braided rivers.[9] Seepages and flushes issue from moraine and outwash slopes and scarps, and there are some inland sand

[6] As proposed in the amended post consultationPC13 Section 293 Package of May 2016.

[7] In this evidence, the 'floor of the Mackenzie Basin' (or the 'Mackenzie basin floor') means the areas contained within Tekapo, Pukaki, and Omarama Ecological Districts (EDs) (McEwen 1987). Tekapo and Pukaki EDs lie within the Mackenzie District, and Omarama ED is within Waitaki District. In this evidence 'The basin floor in Mackenzie District' means Tekapo and Pukaki EDs.

[8] These landforms are described and mapped in Barrell et al. (2011), who comment on the outstanding glacial geomorphology of the Mackenzie Basin. The glaciers terminated in a broad low-relief basin so landforms are '*spectacularly preserved*', and are revealed in detail by the removal of native forest and shrubland. The geomorphology is also important to science, especially to understanding of the earth's climate system (Barrell et al. 2011, 2013, 2014; Doughty et al. 2015).

[9] **Moraines** are material transported and directly deposited by retreating glaciers. **Ephemeral wetlands** dry out in summer months, whereas **tarns** remain wet. **Outwash gravel** surfaces are deposits that have been transported varying distances from the moraine by meltwater. **Moraines** and **outwash gravel surfaces** are also cut by Holocene **alluvial surfaces** (not regarded as historically rare ecosystems) associated with the **braided rivers**. The **braided rivers** and associated **alluvial surfaces** were formed in the last 11,700 years, following the end of the last (Tekapo) advance of the Late Otiran glaciation.

dunes.[10] Where they retain indigenous vegetation, these landforms are regarded as historically rare terrestrial ecosystems.[11]

15. The basin floor in the Mackenzie District supports the greatest area and variety of historically rare ecosystems of any part of New Zealand. An outstanding attribute of the District is that these ecosystems still remain largely undeveloped and occur together in intact and continuous sequences. This is no longer the case in Waitaki District, or in other South Island districts, where these sequences of landforms occur but their indigenous cover has mostly been cleared.

16. The biological diversity[12] and distinctive ecology[13] of the basin floor derives from variation in species habitats across, between and within the historically rare ecosystems and associated alluvial surfaces, wetlands and freshwater habitats. For the terrestrial biota, the three essential sources of this variety are:

    16.1. the landform sequence;

    16.2. the aridity gradient; and

    16.3. within-ecosystem topographic and micro-topographic variation.

17. The most spatially extensive landforms are moraines and outwash gravel surfaces (Figure 1 in Appendix 4). Moraines dominate the higher north-western basin floor

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[10] **Seepages and flushes** develop where groundwater emerges on hillsides, forming permanently saturated soils with nutrient- and oxygen-rich water. **Inland sand dunes** were formed from river sand; the most extensive examples on the bed of the Tasman River were drowned by the raising of Lake Pukaki.

[11] Referred to and listed by M A C Harding, evidence-in-chief 15 July 2016 para 17. The three IUCN Red List categories for threatened ecosystems are *critically endangered*, *endangered*, and *vulnerable* (in order of descending threat; Rodriguez et al. 2011). Holdaway et al. (2012) categorised New Zealand **moraines** as *vulnerable* but noted that **dry moraines** (such as those in the Mackenzie Basin) would be *critically endangered*. **Ephemeral wetlands, outwash gravels** and **inland sand dunes** are considered *critically endangered*, **braided rivers** and **seepages and flushes** *endangered*, and **tarns** *not threatened*.

[12] In this evidence I use the term biological diversity in the sense of 'the variety of life'. Components of this variety exist at many different levels of organisation, including ecosystems, habitats, communities, species and genes.

[13] M A C Harding, evidence-in-chief 15 July 2016 para 20.

and are most extensive in Tekapo Ecological District (ED). They originate from four main glacial advances. Younger, steeper, more rugged moraines from the late Otiran (Mt John and Tekapo) advances are closest to the lakes and mountains. Moraines from older, early Otiran (Wolds and Balmoral) advances have more subdued rolling topography, are often loess-mantled and extend further south-east.

18. Outwash gravel surfaces originate within the higher moraines and dominate the lower south-eastern basin floor, covering much of Pukaki ED (Figure 1 in Appendix 4). Meltwater channels and plains of outwash gravels from younger advances have cut through both moraines and outwash surfaces of earlier advances and extend to the south-eastern margins of the basin.

19. A strong, generally northwest to southeast climate gradient of increasing aridity (dryness) runs broadly parallel with this landform sequence. Rainfall decreases and evapotranspiration and annual moisture deficits generally increase with greater distance from the main divide (Figure 2 in Appendix 4).

20. The aridity gradient arises from a combination of this climatic gradient and changes in soil characteristics. Deeper soils, with reasonably good moisture holding capacities, are more common in higher, wetter parts of the basin.[14] Soils of outwash gravels and alluvial surfaces in the drier southeast are characteristically stony (imparting excessively-rapid drainage), shallow, and often have exceptionally low moisture holding capacities due to extremely low clay content.[15] On river terraces, soils (where present) may be merely thin veneers of

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[14] In the authoritative text on the basin's soils, Webb (1992) distinguishes soils of the western humid (>800 mm annual rainfall), moist subhumid (550–800 mm) and dry subhumid (<550 mm) zones which parallel the basin's landform and aridity gradient. The deepest soils are on the toes of fans issuing from hillslopes around and within the basin in the dry subhumid zone (Grampians, Simons, Streamlands, and Curraghmore series). However, soils in the moist subhumid zone, on moraine toeslopes and easy rolling topography of older moraines (Tekapo and Ohau series), and on older loess-mantelled outwash terraces (Pukaki and Wolds series), are generally deeper than those on the intermediate (mainly glacial outwash) terraces (Mackenzie, Sawdon, Edwards series) and young (mainly alluvial) terraces (the even shallower Bendrose-Larbreck and Sawdon-Bendrose-Edwards associations) that cover most of the land area of the dry subhumid zone.

[15] Webb (1992) at page 27.

coarse-textured alluvium. Soil features thus exacerbate climatic aridity: dry climate and shallow stony soils together make the lower, south-eastern outwash plains and alluvial surfaces among New Zealand's most challenging and distinctive environments for plant growth.

21. This landform sequence and parallel aridity gradient drive directional change in species composition and vegetation character, as species adapted to different environmental conditions replace one another in an overlapping sequence. However, complex topography and micro-topography also create strong, biologically important gradients in and patterning of physical habitats at smaller scales within the rare ecosystems. For example:

21.1. Moraine surfaces are undulating or lumpy, strewn with irregular piles of rocks, with kettleholes (depressions left by the melting of ice blocks deposited within the sediment) and other subsidences scattered across them. A disordered amalgam of soil particle sizes and depths has been worked on by wind following deposition, so that deep, fine deposits occur on south and east facing slopes and toes, and northern and western aspects are often stripped, shallow, and stony.

21.2. Outwash gravel surfaces are formed by the reworking and size-sorting of glacial deposits by meltwater. Their subtle surface micro-topographies of low channels and risers form intricate braided patterns. The patterns arise from alternation of sinuous channels and risers in the underlying gravels (formed when the outwash channels, fans and plains were active at the end of the relevant glaciation) and subsequent soil deposition and stripping (deflation) by prevailing winds and possibly occasional extreme wind events.[16]

[16] Dr Trevor Webb (Landcare Research) considers that one or more extreme wind events in the course of the Holocene may have created the characteristic mound and basin micro-topography on Fork series soils south of Lake Tekapo (Webb 1992 p. 39; depicted in Figure 3B of Appendix 4 to this evidence).

21.3. Soil deposition and deflation interact with the orientations of the original outwash channels to form complex patterns of stony phases (which may be ridges or channels) alternating with deeper accumulated soils (which may be ridges or leeward lenses).[17] Shallow soils intermediate between stony and deep-soil phases are often frost-heaved in winter and have a broken, 'fluffy' surface character.

21.4. Important sources of biological variation within and among outwash gravel surfaces in the Mackenzie Basin are the form of micro-topography (two examples are illustrated in Figure 3 in my Appendix 4) and the prominence of its expression. These features determine spatial and temporal patterns of soil moisture, frost heave, and nutrient availability that are critical for plant survival.

22. River terraces typically also have fine-scaled fluvially-derived micro-habitat variation, including numerous exposed stonefields.

23. Marked changes of vegetation, flora and fauna are associated with large-scale changes in landform and the increasing aridity from northwest to southeast across the basin floor, and with smaller-scale micro-topographic variation within and among rare ecosystems.

24. Broad-scale basin-wide trends include:

24.1. Transitions from tall and short tussock grasslands and shrublands and wetland on deeper soils of the north-western moraines to short tussock, cushion, mat and non-vascular (lichen and moss) vegetation on shallower, stonier soils on outwash and river gravels in the drier southeast.

[17] On older outwash surfaces there are also areas of relatively deep, even loess deposits that completely obscure the underlying gravel channel and riser patterns (for example, on Balmoral outwash gravels on the former Maryburn pastoral Lease).

24.2. A flora typical of moist tall tussock grasslands and shrublands in the higher west and northwest grades into a fescue tussock grassland flora with many drier floristic elements in lower moraines of the central basin floor. Outwash surfaces (especially those south and east of SH8) support a distinctive, endemic, often cryptic, slow-growing, diminutive, sparse, and exceptionally drought-tolerant flora.[18]

24.3. Higher moraines are feeding and breeding habitats for waterfowl, wetland and wading birds,[19] and their shrublands support falcon (*Falco novaeseelandiae* "eastern") and forest species such as rifleman (*Acanthisitta chloris*), while drier short tussock grasslands of the central basin floor are favoured habitat for pipit (*Anthus novaeseelandiae*). Sparsely vegetated outwash plains (which occur mainly in the south and east) and alluvial surfaces have a simpler avifauna but are the principal breeding habitats of banded dotterel (*Charadrius bicinctus bicinctus*).

25. Local, within-ecosystem variation includes:

25.1. Moraines support an array of different wetland types, including dense red tussock swamps, *Carex* swamps, seepages, string bogs, bogs, open water streams, riparian wetlands, tarns and ephemeral wetlands.[20] Seasonally dry ephemeral wetlands in kettleholes are particularly biologically distinctive and unusual globally.[21] Their finely intermixed,

[18] The invertebrate fauna is also distinctive and varies across the basin's major broad-scale gradients; this is evident from the information collected across tenure review conservation resources reports (CRR) for pastoral leases on the basin floor.

[19] A list of the bird species found on the basin floor, their principle habitats, and (for native species) their threat status, is appended to this evidence at Appendix 5.

[20] Johnson & Gerbeaux (2004) describe these different wetland types. The complex of moraine wetlands also provides important hydrological storage for the basin's many minor watercourses.

[21] A report describing the ecology and biota of this historically rare ecosystem type is Johnson & Rogers (2003). Patrick (1992) briefly describes their invertebrate fauna.

concentrically zoned short turfs include numerous obligate[22] turf plant species, including a number of threatened taxa.

25.2. Species habitats on moraines can vary within a few metres from lush and permanently moist (e.g. deep leeward soil lenses and seepages) to exceptionally harsh (e.g. dry wind-stripped rocky boulderfields and compacted platforms). This gives rise to conspicuous local vegetation patterning and high local diversity of plant communities and indigenous plant and animal species.

25.3. On outwash plains, the tallest and grassiest vegetation (including tussocks) occurs on deeper, finer textured soil lenses. Stony ridges (Figure 3A in Appendix 4 to my evidence) or basins (Figure 3B) support low-growing cushions and mats of New Zealand's most drought tolerant endemic vascular plants, including subshrubs, dwarf grasses and cryptic dicotyledonous herb and ferns, as well as lichens and mosses. Shallow soils intermediate between the stoniest and deepest elements support the sparsest vegetation and fewest indigenous species.

25.4. Wind-deflated outwash terrace brows (a narrow zone of gentle slope at uppermost limit of the terrace scarp) are a key micro-habitat recognised by botanists for unusual densities of cryptic xerophytic (aridity-loving) endemic plant species.

25.5. Lichens and mosses can contribute high proportions of the ground cover in niches unsuitable for vascular plants on river terraces and stony outwash plain ridges and channels. These non-vascular assemblages are diverse and little-studied, and support distinctive endemic invertebrates such as the endemic robust grasshopper *Brachaspis robustus*.

[22] In the sense of 'by necessity', i.e. not known to occur outside this type of habitat.

26. Though relatively small in area, shrublands add considerably to the biodiversity of the basin floor as important habitats for grazing- and fire-sensitive biota (especially lizards and plants). They occur mainly in relatively fire-protected places such as moraine flanks and ridges, boulder fields, terrace risers, and moist fluvial channels of moraines and outwash plains.

27. Rock-strewn moraines, bouldery scarps, fans, and river terraces, as well as grasslands, are important habitats of the endemic lizard fauna (described in my Appendix 5).

28. A further source of biological diversity is the placement of rare ecosystems within the overall climate gradient, which alters the particular species and communities associated with their type and their fine-scale habitat-patterning. For example, the Ohau Downs outwash plain in Waitaki District (with 'only' a 400–500mm annual moisture deficit) lacks some of the threatened xerophytic endemic plants of outwash plains found, for example, on the Tekapo-Greys Hills outwash and alluvial sequence in Mackenzie District (with 500–700mm annual moisture deficit). Conversely, the Ohau Downs outwash is distinctive in supporting plant communities and species that are absent on outwash surfaces in drier zones.

29. The underlying landform, climate, soil, and micro-topographic patterns of the basin floor were present throughout the Holocene, and I expect that they gave rise to a complex and varied mosaic of pre-settlement ecosystems, habitats, flora and fauna, with striking sequences and gradients in character from north-west to south-east, and considerable micro-habitat diversity.

30. In my opinion it is likely that drier landforms and features[23] supported relatively sparse vegetation throughout the Holocene. The level of local endemism in their cryptic flora suggests that these habitats originated early in the Pleistocene and remained unforested during interglacials because of their dryness. These are not landforms that could have supported the continuous tussock grasslands which

[23] Especially the stony channels and risers of outwash plains, and alluvial river terraces.

dominated in wetter parts of the basin following post-settlement fires. Therefore, although human settlement and use has brought considerable change,[24] an impression that vegetation cover has become disproportionately depleted in drier parts of the basin may not be fully warranted.

II. PRESSURES AND THEIR EFFECTS

31. I describe pressures on the native biological diversity of the basin floor in three categories: chronic, transformational, and exacerbating. Chronic pressures have relatively slow and persistent adverse effects from which there can be some recovery. Transformational pressures act more rapidly and are less reversible (or irreversible) because they take ecological conditions outside the capacity of the indigenous plants and animals to survive at all. Exacerbating pressures worsen effects of chronic and transformational pressures.

32. Predation is a chronic pressure which continues to deplete populations of native invertebrates, lizards and birds. For example, studies have quantified the effects of predation by multiple mammal predators on the basin's populations of inland-breeding wading birds, terns, and gulls.[25] Predation is likely to have played a major role in local and national-scale declines in these bird species between the 1970s and early 2000s.[26] Endemic freshwater fishes are also preyed upon, mainly by introduced salmoniids.[27]

33. A more visible chronic pressure is removal of plant biomass through burning of vegetation and grazing by stock and feral animals such as rabbits and hares. This

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[24] M A C Harding, evidence-in-chief 15 July 2016 paras 13 & 14

[25] I refer in particular to endemic wrybill (*Anarhynchus frontalis*), banded dotterel (*Charadrius bicinctus bicinctus*), black stilt (*Himantopus novaezelandiae*), New Zealand/South Island pied oystercatcher (*Haematopus finschi*) black-fronted tern (*Chlidonias albostriatus*) and black-billed gull (*Larus bulleri*), and native pied stilt (*Himantopus himantopus leucocephalus*).

[26] For example, those seen between the two national Atlases of Bird Distributions (1970s and early 2000s); a period before land-use change could have made a major contribution to their declines.

[27] Mainly trout and salmon. A key reference is McIntosh et al. (2010).

has led to progressive depletion of native cover, especially shrubland and tussock,[28] and to the dominance of hawkweed.[29]

34. Like Mr Harding, and for the same reasons given in his paragraphs 48 and 49,[30] I do not share a commonly held view that hawkweed is a cause of ecological degradation in the basin's vegetation. Furthermore, I concluded from research at Lake Tekapo Scientific Reserve (LTSR)[31] that '*hawkweed invasion is unlikely to be an impediment to the recovery from grazing of highly depleted short-tussock grasslands and herbfields on the floor of the Upper Waitaki Basin. Indeed, hawkweed cover may facilitate recovery, or its effects may be merely neutral*'.

35. In my opinion a simpler and more plausible explanation for depletion of indigenous cover (and associated changes) is grazing, especially by rabbits. Hawkweed largely completed its invasion of the basin floor between 1990 and 2000,[32] and has stabilized at between about 20 and 50% cover depending on landform and environment. Data from the Mackenzie Basin Grazing Trial[33] show that reductions (not increases) in bare soil occurred simultaneously with the invasion of hawkweed into basin-floor short tussock grasslands between 1990 and 2000.

36. At LTSR (described in Appendices 6 and 7 to my evidence) the amount of bare soil approximately halved across moraine and outwash landforms in 18 years

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[28] A contributing ecological reason for this depletion may be that New Zealand's indigenous grasses (including tussock species) are internationally unusual in storing high proportions of their biomass above ground, making them particularly vulnerable to frequent removal of that biomass. Key references to this include Williams (1977), Meurk (1978), Lee et al. (1988), and Craine & Lee (2003).

[29] Mouse-ear hawkweed, *Pilosella officinarum*, formerly *Hieracium pilosella.*

[30] M A C Harding, evidence-in-chief 15 July 2016 paras 48 & 49.

[31] Walker et al. (2016), also referred to by M A C Harding, evidence-in-chief 15 July 2016 para 49, appended to my evidence at Appendix 6.

[32] Aridity appears to have constrained rates of hawkweed invasion, and its potential cover, so that the basin's outwash landforms and river terraces were invaded relatively late and hawkweed cover remains lower there. This was observed by Duncan et al. (1997), at Lake Tekapo Scientific Reserve, and in the Mackenzie Basin Grazing Trial, and is discussed in Walker et al. (2016) (Appendix 6b of this evidence).

[33] The results of that study are described by Meurk et al. (2002).I participated in the field work, undertook the data analyses, co-authored the journal paper, and hold the dataset.

following stock and rabbit removal, across landforms with both high (>40%) and moderate (11 to 23%) initial levels of hawkweed cover.[34] About a quarter of the bare soil reduction was accounted for by increases in litter and dead plant material on the soil surface, suggesting that formerly most litter was consumed by herbivores or blown away. Furthermore, striking increases in lichen cover on arid surfaces (especially river terrace plots 8 and 9 shown in Appendix 6a) suggest that biological soil crusts[35] were suppressed by pastoral management.[36] Although less visually obvious than on vascular plants, grazing effects on litter and crusts in the basin's more arid environments could have profound implications for soil moisture retention and temperature, and ecological processes such as succession, nutrient storage and cycling, and erosion[37].

37. Although fewer now than at historic highs,[38] rabbits clearly continue to have adverse effects on the basin's native plants and vegetation, especially but not only in drier areas. Rabbits are also the primary mainstay of populations of important predators (especially cats and ferrets) on indigenous fauna (including lizards, birds and invertebrates).[39] Furthermore, predation on native fauna can increase markedly when rabbit abundance suddenly declines, because their predators remain abundant but switch to feeding primarily on native prey.[40]

[34] This reduction is shown in Figure 6(a) of Walker et al. (2016) (Appendix 6b of this evidence).

[35] Also referred to as 'non-vascular' plant cover or 'non-vascular crust'. These effects are noted on page 146 of Walker et al. (2016) (Appendix 6b of this evidence).

[36] This management is summarised by Espie (1993), appended to my evidence at Appendix 7.

[37] For example, Delgado-Baquerizo et al. (2013) showed that biological soil crusts play key roles modulating several aspects of the nitrogen cycle in a semi-arid ecosystem, including soil nitrogen dynamics with temperature change.

[38] Appendix 8 shows long-term trends in rabbit numbers in three parts of the basin floor.

[39] Native fauna species are taken incidentally, rather than as the major diet item: in the ecological literature this is known as 'hyperpredation', and is described by Courchamp et al. (2000) in a journal paper entitled '*Rabbits killing birds: modelling the hyperpredation process*'.

[40] It is immediately following the control of rabbits that 'prey switching' can have extreme adverse effects on native fauna. Some secondary poisoning of predators can occur but this effect may not be large enough to mitigate prey switching (e.g. 7–15% of ferrets apparently died of secondary 1080 poisoning in the study of Heyward & Norbury (1999)). Numbers of predators may later be depressed by lower rabbit numbers (Norbury & McGlinchy 1996).

Repeated cycles of rabbit control and recovery can therefore have additional detrimental effects on populations of native fauna.[41]

38. I do not regard erosion as a serious or chronic pressure on the basin's biota. Soils erode from lightly vegetated surfaces and deposit on better-vegetated surfaces, often nearby[42], respectively favouring native species that are more and less tolerant of moisture stress and nutrient depletion. This process occurred naturally throughout the Holocene,[43] increased with the advent of pastoral grazing and rabbits,[44] and has probably slowed since the early 1990s with generally lower rabbit numbers[45] and with hawkweed invasion.[46]

39. I share Mr Harding's opinions about the general ecological effects of grazing and browsing in the basin at paragraphs 44 and 45 of his evidence.[47] I add that those effects of traditional, extensive pastoral sheep grazing on biological diversity are slower, more diffuse, less detrimental, and more reversible, than the transformational pressures I describe next. In my experience, a reasonable diversity of indigenous plant species, including threatened and at risk species, usually coexists with mouse-ear hawkweed, rabbits, and extensive sheep grazing[48]. This includes most cushion and mat vegetation, which can initially appear 'hopelessly' depleted and invaded, but is evidently capable of recovery.[49]

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[41] Key references documenting this effect in and around the basin are White (1994) (*Brachaspis robustus* grasshopper), Rebergen et al. (1998), Murphy et al. (2005) and Norbury & Heyward (2008) (braided riverbed birds), and Norbury (2001) (indigenous dryland lizards).

[42] This very local erosion-deposition pattern was documented in by Hewitt (1996).

[43] As described in Webb (1992), the long-term deposition and stripping (deflation) of soils has been one of the determinants of soil pattern.

[44] Causes and some estimates of erosion rates are described by Basher & Webb (1997).

[45] This is described in Appendix 8 to my evidence.

[46] This is described at paragraph 35 of my evidence above.

[47] M A C Harding, evidence-in-chief 15 July 2016 paragraphs 44 and 45.

[48] The vegetation and flora described by Mr Harding based on his field visits correspond with my experience (M A C Harding, evidence-in-chief 15 July 2016 paras 35 to 39).

[49] Lake Tekapo Scientific Reserve in 1993 provides an example of what I would regard as a 'hopeless' appearance coexisting with a diversity of indigenous plant species and with evident capacity for recovery. This is shown in Appendices 6 and 7 to my evidence.

40. I regard wilding conifers as a transformational pressure. They can rapidly establish and exclude indigenous plant communities, and dense stands may create fire-driven ecosystems unparalleled in New Zealand's evolutionary past. Their effects on native ecosystems are unlikely to be reversible, and they are a primary, escalating, and urgent threat to basin's ecosystems and biological diversity, especially (but not only) on moraine northwest of SH8.[50]

41. Direct, indirect, and cumulative[51] effects of active changes in land use are pressures that can transform and completely remove native ecosystems and species habitats. These changes include residential, business, and industrial development and expansion (both urban and rural); afforestation; utilities and infrastructure development (e.g. for transport, hydroelectricity, and electricity and water movement and supply); and pastoral intensification as defined in PC13.[52] In my experience, modern pastoral intensification also often involves herbicide-spraying, subdivision fencing, a change from sheep to other stock animals, [53] and increased stocking intensities, as well as earthworks (e.g. to smooth and/or re-contour the land, lay pipes or cables, or dig canals), and development and installation of new tracks or roads, drains, and various other structures and utilities.

42. Some pastoral intensification practices can allow a subset of existing indigenous species to persist, for example:

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[50] The situation is described in detail in a recently prepared wilding conifer strategy for the basin (Young 2016).

[51] Cumulative and indirect effects are described by M A C Harding evidence-in-chief 15 July 2016 para 76, and in paragraphs 51, 52, and 56.3 of my evidence below.

[52] That is: '*cultivation, irrigation, topdressing and oversowing and/or direct drilling*'.

[53] As noted by Mr Harding: M A C Harding, evidence-in-chief 15 July 2016 paras 87 & 88.

42.1. indigenous plants and fauna may persist through infrequent (e.g. once per decade) broadcast oversowing[54] and topdressing (OSTD) on drier landforms, although some modification of habitats and biota occurs;

42.2. taller native species (e.g. tussocks, shrubs, 'spaniards') can persist with broadcast OSTD on moraines if stocking rates remain low, but the native inter-tussock flora and fauna (which account for most of the ecosystem's biological diversity) is depleted or lost. If stocking rates are increased, degradation and loss of tussocks will occur too.

43. Direct, permanent, and irreversible loss of ecological components of the landscape generally results from modern pastoral intensification practices including (independently or in various combinations) earthworks, irrigation, herbicide-spraying, soil cultivation (including direct drilling), associated application of fertiliser and sowing of exotic seed, cattle or deer grazing, subdivision fencing and/or elevation of stocking rates[55].

44. In the Mackenzie Basin, pastoral intensification activities that degrade ecological values but allow some indigenous species to survive for some time (described at my paragraph 42) may be a prelude to and justification for complete transformation (by activities in my paragraph 43), in my experience.

45. Climate change is predicted to strengthen prevailing westerly winds across New Zealand, delivering more water into the lake headwaters but intensifying rain-shadow effects such as desiccating winds and evaporative demand. Inter-annual climate variability is expected to increase (e.g. more extreme rainfall and wind events, more extreme variation in river flows, more frequent droughts, and more

[54] Broadcasting spreads the seed on the soil or vegetation surface and does not bury it.

[55] Fire may also be used to assist pastoral intensification where the indigenous vegetation to be cleared is tall and dense enough to carry it, for example on moraines beside Lake Pukaki.

extremely hot days).[56] I would expect these changes to exacerbate adverse effects of most chronic and transformational pressures on the basin's biota.[57]

III. LOSS OF ECOLOGICAL COMPONENTS OF NATURAL LANDSCAPE CHARACTER

46. Since 1990, active changes in land use have been responsible for considerable loss and modification of indigenous vegetation and habitats of indigenous fauna in the Mackenzie Basin, and elsewhere in the South Island where comparable vegetation and ecosystems occur (or previously occurred).

47. Figure 4 in Appendix 4 to my evidence shows land areas of moraine and outwash gravel ecosystems remaining on the Mackenzie Basin floor, and areas which had been converted to an exotic cover type at four dates (1990, 2001, 2009, and 2016). The Figure represents a combination of the maps that I compiled for a RMA hearing in 2009[58] (1990 and 2009), with those recently prepared by Mr Nicholas Head of DOC (2001 and 2016).[59]

48. Changes from indigenous to exotic cover after 1990 (shown in Figure 4 in Appendix 4) represent the most rapid rate of indigenous ecosystems and landscape transformation of any area in New Zealand in modern times, with the exception of the Upper Clutha basin floor (in Central Otago and Queenstown Lakes Districts), which was the Mackenzie Basin's closest ecological analogue.

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[56] Mullan et al. (2008), McGlone & Walker (2011), and Renwick et al. (2016) are relevant references.

[57] For example: greater climate variability may hasten the directional loss of species from isolated fragments of natural ecosystems over time (described in paragraph 56.4 of this evidence); increased variation in river flows could have negative effects on breeding wading birds, terns and gulls, both through increased vegetation encroachment on habitat and shelter for predators in dry periods, and greater risk of nest failure due to flooding; there may be greater variability in rabbit numbers and hence more frequent prey-switching to native prey by mammalian predators of rabbits; and there may be more extreme periods of fire hazard from wilding conifers.

[58] Statement of evidence of Susan Walker before the Canterbury Regional Council in the matter of resource consent applications to take and use water in the Upper Waitaki catchment (dated 1 December 2009).

[59] I provided review and comment to Mr Head in the preparation of his maps and I consider them to be essentially reliable. This collaboration is described in Appendix 2 to my evidence.

49. The majority of conversion mapped after 1990 (Figure 4b, c & d, in Appendix 4) occurred through pastoral intensification,[60] and 57.3% of all conversion after 1990 occurred between 2008 and 2016.[61] This supports my own observations and Mr Harding's statement that '*Pastoral intensification has occurred over many years in the Mackenzie Basin, though mostly on a relatively small scale. In recent years, irrigation has prompted pastoral intensification on a larger scale*'.[62]

50. Areas mapped as converted to exotic cover after 1990 include areas of known ecological value, including some 680 hectares of mapped sites of natural significance (SONS), and 1,300 hectares of Recommended Areas for Protection (RAPs) and Sites of Special Wildlife Interest (SSWIs; mostly wetlands).[63] Like Mr Harding,[64] I am aware of other areas of significant indigenous vegetation outside mapped SONS, RAPs, and SSWIs in Mackenzie District that have been lost through land-use change. These losses, largely of historically rare ecosystems, are occurring at an increasing rate.

51. The Mackenzie Basin and Upper Clutha are not alone in having experienced high rates of loss of habitat for indigenous species endemic to the drier parts of inland South Island. The cumulative consequence is that the threat status[65] of many of those species becomes rapidly outdated, and exacerbated. For example, I recently reviewed a list of South Island 'dryland' indigenous plant taxa (of which 81 taxa occur on the Mackenzie Basin floor) pursuant to the upcoming national

[60] For example, I calculated that 91.8% of conversion of habitat for indigenous species between 1990 and 2009 was by pastoral intensification. Construction or urban use accounted for 1.9%, and exotic plantation forestry or densely invaded by wilding trees for 6.4%.

[61] I undertook a GIS spatial overlay that indicates 9.0% of conversion (6,700 ha) occurred before 1990, 19.8% (14,800 ha) between 1990 and 2001, 13.9% (10,400 ha) between 2001 and 2009, and 57.3% (42,800 ha) between 2009 and 2016.

[62] M A C Harding, evidence-in-chief 15 July 2016 para74.

[63] A GIS spatial overlay indicates that these areas include parts (>10 ha) of at least 21 of the 103 RAPs (Recommended Areas for Protection) identified in the Mackenzie Ecological Region Protected Natural Areas Programme survey (Espie et al. 1984) and 9 Sites of Special Wildlife Interest (SSWIs; mostly wetlands) have been converted up 2016. Most of this conversion has occurred since 1990.

[64] M A C Harding, evidence-in-chief 15 July 2016 para 25.

[65] By 'threat status' I refer to classification in The New Zealand Threat Classification System, which is described in Appendix 9 to this evidence.

review of their threat status. I have submitted that 17 Threatened or At Risk taxa of the Mackenzie Basin floor (last reviewed in 2012) may now warrant higher threat status, and a further 11 warrant 'At Risk: Declining' status, rather than 'Not Threatened'. This rate of change and the habitat loss driving it are unprecedented in my professional experience.

52. The basin floor in Mackenzie District is becoming an increasingly important refuge for a suite of Threatened and At Risk New Zealand-endemic plants, lizards, birds, and freshwater fishes,[66] and an unknown (but possibly far larger) number of taxa in less well known groups (e.g. invertebrates, fungi). This is because it is the last place where a connected sequence of their habitats remains, along with the diversity, connectivity, and scale to potentially sustain them in the landscape.

53. Proximate contributing reasons for rapid loss include (in my experience): ineffective rules that allow most vegetation clearance to proceed as permitted activity;[67] granting of discretionary consents to clear indigenous vegetation on pastoral leases;[68] tenure review;[69] granting of irrigation consents by the Regional Council;[70] other farm economics, including changing commodity prices and costs of controlling rabbits and wilding conifers; and constrained budgets of DOC and the Nature Heritage Fund.[71] A higher-level cause may be disparity in public and

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[66] Lizards, birds, and freshwater fishes of the basin are listed in Appendix 5 to this evidence.

[67] This is noted in Interim Decision No [2011] NZEnvC 387 paragraphs 296 & 297.

[68] An example of clearance of identified significant inherent values with discretionary consent is described in Appendix 10 to this evidence.

[69] As noted in the statement of Mr Murray of the Wolds pastoral lease in his evidence (J B Murray evidence in chief para 51), the division of pastoral leases between conservation and 'freehold' tends to encourage pastoral intensification on the privatised land.

[70] For example, J D M Fairgray evidence-in-chief 15 July 2016: *'intensification enabled by irrigation is likely to enable a substantial increase in farm output and farm income*'.

[71] This limits land purchase for conservation and DOC's capacity and willingness to advocate for and manage new areas of weed- and pest-prone land protected through tenure review or such purchases.

landholder interests in maintaining indigenous biodiversity and landscapes,[72] coupled with an absence of meaningful policies and programmes of incentives for landowners to maintain them or disincentives to damage them.

54. I see no reason to expect that pastoral intensification will abate in the Mackenzie District. It has accelerated in the past two years while dairy prices have fallen; there has been no review of the defective vegetation clearance rules; twelve pastoral leases are in the tenure review process[73]; and discretionary consent is granted to clear indigenous vegetation on the District's pastoral leases.

IV. SIGNIFICANCE OF REMAINING BASIN FLOOR ECOSYSTEMS

55. I share Mr Harding's opinion[74] that '*most undeveloped (i.e. uncultivated and un-irrigated) areas on glacially-derived landforms (moraines and outwash terraces) in the Mackenzie Basin are likely to meet the RPS criteria for SONS, except where vegetation is substantially modified by over-sowing, top-dressing, grazing, or wilding conifer spread. Severely degraded sites will, in many cases, meet the RPS criteria for SONS as these sites provide habitat for threatened plant and animal species*'. I also share his opinions on the ecological significance of areas south and east of SH8.[75]

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[72] For example as described in the evidence-in-chief of J D M Fairgray 15 July 2016, in paragraph 5.12: '*…public good benefits are not necessarily considered by the individual owners or operators of farm land. More importantly, even when they are recognised and considered, the significance of these values in their decision-making may not be the same as that attributed by the wider community. Accordingly, economic theory holds that individual owners are likely to choose an outcome (such as a level of management) for areas including or affecting natural landscape heritage that is less than optimal from the community's point of view*'.

[73] A list of current and former pastoral leases and their status in tenure review is appended to my evidence at Appendix 10, and provides examples of recent and proposed outcomes.

[74] M A C Harding, evidence-in-chief 15 July 2016 para 31.

[75] M A C Harding, evidence-in-chief 15 July 2016 para 43, which reads '*… parts of the area south and east of SH8 which lie on naturally uncommon ecosystems (moraines, outwash gravels and ephemeral wetlands) and are uncultivated are most likely to meet the RPS criteria for SONS. Other uncultivated parts of the area (on river gravels) are also likely to meet the RPS criteria as they provide habitat for threatened plant and bird species. … Areas with severe degradation and/or high rabbit numbers should not be excluded from survey, as such areas may still provide habitat for threatened plant and bird species*'.

56. Together these values are nationally significant in my opinion, for contextual reasons beyond consistency with CRPS (and District Plan) criteria. For example:

56.1. There is no other place in New Zealand where historically rare ecosystems occur to such an extent and in natural connected sequences in a relatively low lying landscape. In all other lowland and montane areas most historically rare ecosystems have already been lost to development, and remaining examples are typically isolated.

56.2. As a consequence of recent development, sequences of these particular rare ecosystems are now unreplicated nationally.

56.3. Most species' habitats still represented in the Mackenzie District have undergone extreme loss nationally, with especially high loss-rates in the last two decades. As noted in my paragraph 52, a number of endemic plants, invertebrates, lizards, freshwater fishes, and birds now depend for their persistence largely on the remaining areas of connected and relatively undeveloped habitats still found here.

56.4. It is well-recognised that connected biological sequences and gradients such as these, and sizeable areas, are needed for many species to persist in the face of climatic variability. For example, when a plant species inhabits a connected sequence, wetter parts provide refuge in protracted dry periods, and drier parts provide refuges in extreme wet periods (e.g. when drought-adapted species are overtopped by faster-growing species in the wetter portion of their range). The refuge facility is lost when sequences and gradients are geographically and functionally truncated and fragmented by habitat loss, and thus fragments in fluctuating environments lose species directionally over time.[76]

[76] Interannual climate variability is relatively high in the Upper Waitaki Basin and expected to increase as climate change advances (Mullan et al. 2008; Renwick et al. 2016).

57. The area south and east of SH8 is the only place where extensive, little-fragmented areas of the critically endangered outwash gravel ecosystem type now remain. It is of the most exceptionally high ecological significance in my opinion. I understand that these areas can appear featureless and desertified, of little value for anything but rabbits and hawkweed. However, I regard outwash gravels as the most ecologically and biologically distinctive of the Basin's ecosystems. They and their endemic biota are found nowhere else, and are unquestionably under the greatest threat of imminent clearance and loss.[77] In particular:

57.1. they have special character, especially as last remaining examples of the evolutionary response of the native biota to protracted arid conditions in New Zealand;

57.2. outwash gravels support a greater number of the basin's known threatened or declining plant taxa (29 taxa) than any other type of habitat (even more the highly distinctive ephemeral wetlands, with 20 taxa) and also more naturally uncommon or data deficient plant taxa (12 taxa) than any other. This is shown in Table 1 (below), which sums the number of plant taxa considered to be Extinct, Threatened, or At Risk that I know to occur on seven habitat types on the basin floor;

57.3. undeveloped outwash gravels are a principal breeding habitat for endemic threatened (Nationally Vulnerable) banded dotterel (*Charadrius bicinctus bicinctus*), which is destroyed by pastoral intensification;

[77] Based on the data mapped in Figure 4 in Appendix 4, more than twice the area of outwash ecosystems (35,600 ha, 35% of the area remaining in 1990) was converted as of moraine ecosystems (15,800 ha, 25% of the area remaining in 1990) between 1990 and 2016 across the Mackenzie Basin floor (Omarama, Pukaki, and Tekapo EDs). Outwash gravels lost more than three times the area that moraines did (21,800 vs 7,000 ha) between 2001 and 2016.

Table 1. Number of plant taxa considered to be **Extinct, Threatened**, or **At Risk**[78] in the New Zealand Threat Classification System and known to occur today in different types of rare ecosystems and other habitats on the Mackenzie Basin floor, in two combined categories.

Historically rare ecosystem or type of habitat	**Extinct** (1 taxon) **Threatened** (31 taxa) or **At Risk: Declining** (25 taxa)	**At Risk: Naturally Uncommon** (23 taxa) or **Data Deficient** (1 taxon)
Moraines	15	10
Ephemeral wetlands	20	7
Outwash gravels	29	12
Lake margins	4	2
Braided riverbeds and terraces	5	1
Other wetlands	5	2
Shrublands	9	2
Exclusively in ephemeral wetlands	8	3
Exclusively on outwash	8	2

57.4. perceptions of the ecological value of outwash gravels, and their degree of modification, can be influenced by mistaken assumptions that

57.4.1. they 'should' support continuous tussock grassland (similar to moister moraines);[79]

57.4.2. native flora and fauna have been compromised by hawkweed invasion;[80] and/or

57.4.3. their endemic plants and animals have alternative 'better-condition' habitats;

[78] These categories are described in Appendix 9 to this evidence. I note that a taxon can occur in more than one type of habitat, and hence the sum of values in the table is greater than 79 (the total number of taxa counted). An extant population of *Dysphania pusilla* (categorised as Extinct) was discovered on the Mackenzie Basin floor in 2015.

[79] I provide a contrary opinion in this evidence at paragraph 30.

[80] I provide a contrary opinion in this evidence at paragraphs 34, 36, and 39.

57.5. it is important for species adaptation and evolution to protect biota at environmental limits and extremes, such as those of climatic and edaphic aridity of the basin's south-eastern outwash plains and river terraces. Adaptations in populations near limits represent extremes within a species, enabling them to survive, adapt to and exploit new environmental conditions (e.g. more frequent and protracted droughts expected under climate change).

V. ABILITY OF PC13 TO PROTECT ECOLOGICAL COMPONENTS OF NATURAL LANDSCAPE CHARACTER

58. I share Mr Harding's opinions that pastoral intensification can involve modes of subdivision fencing and changes in stock type with adverse effects on ecological components of natural landscape character[81] and that omitting these practices from the PC13 definition[82] could reduce the security of ecological values. The same applies, in my opinion, to herbicide-spraying and earthworks (used to re-contour the land, infill depressions, and install utilities), which have become common modern pastoral intensification practices with adverse ecological effects, in my experience.

59. I do not share Mr Harding's belief[83] that PC13 will substantially provide for the protection of the ecological components of the natural landscape character of the Mackenzie Basin, for reasons set out below:

59.1. Objective 3B inadequately describes these ecological components (it refers only to '*tussock grasslands*')[84];

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[81] M A C Harding, evidence-in-chief 15 July 2016 para 88.

[82] The proposed definition is '*Pastoral intensification within the Mackenzie Basin Subzone means cultivation, irrigation, topdressing and oversowing and/or direct drilling*'.

[83] M A C Harding, evidence-in-chief 15 July 2016 para 90.

[84] A list of subzone-wide ecological features that I consider to be ecological components of the natural landscape character is appended to my evidence at Appendix 12. I note that in my opinion, the special geomorphological and landform components that underpin the ecological components are also inadequately described in Objective 3B.

59.2. PC13 proposes to make pastoral intensification a non-complying activity in Sites of Natural Significance (SONS), Scenic Viewing Areas (SVAs), Lakeside Protection Areas (LPSs) and Scenic Grasslands (SGs) and '*Scenic Grasslands or tussock grasslands within 1 km of the highway, Haldon Road, Godley Peaks Road and Lilybank Road'* (hereafter 'highway TGs')[85]. SVAs, LPAs, SGs and highway TGs together cover an insignificant fraction of the ecological components of the basin's natural landscape character, including areas likely to be significant indigenous vegetation or significant habitats of indigenous fauna. They plainly fail to provide for the diversity, connectivity, and scale that sustain these values in the landscape, being principally focussed on localised, non-representative features adjacent to roads and lakes[86].

59.3. As determined by Mr Harding,[87] the District's identified SONS are out of date and very seriously inadequate.[88] Most uncultivated and unirrigated areas on glacially and alluvially derived depositional landforms (moraines, outwash gravels, and river terraces) in the Mackenzie District, including severely degraded areas, are likely to be significant indigenous vegetation or significant habitats of indigenous fauna, and are not recognised.

59.4. Many District Plans in eastern South Island have inadequate schedules of SONS, and this has abetted recent widespread loss of significant indigenous vegetation or significant habitats of indigenous fauna, in my experience. Because of the extent, distinctiveness, and increasing rarity

[85] P Harte evidence-in-chief 15 July 2016 para 32. I am not sure how '*tussock grasslands*' are to be assessed in this context and therefore what area they cover.

[86] I map these areas in Figure 5 of Appendix 4 to this evidence. SVAs, LPAs, and SGs together cover 18,900 ha, which is 10.5% of the district's land area. They cover 13.3% of moraines and 8.5% of outwash gravels.

[87] M A C Harding, evidence-in-chief 15 July 2016 para 22.

[88] I map these areas in Figure 5 of Appendix 4 to this evidence. Mapped SONs add 13,600 hectares of land to the area covered by SVAs, LPAs, and SGs together, which is a further 7.5% of the district's land area. They cover a further 2.9% of the district's moraines and a further 6.1% of the district's outwash gravels.

of the ecological values, and current development pressures, I consider this situation in Mackenzie District to be exceptionally acute.

59.5. Mr Harding identifies four practical barriers to undertaking survey to identify and map SONS.[89] I consider that these barriers are insurmountable, at least within a timeframe that would realistically protect the District's significant areas. Survey and listing is a protracted process: those in Waitaki and Queenstown Lakes Districts are incomplete after >9 and 15 years respectively.[90] Furthermore, assessment context is changing rapidly with the increasing loss and rarity of these ecosystems and species. SONS survey and mapping would therefore become outdated before it was complete.[91]

59.6. I have had experience of the Council's capacity and preparedness to intervene and apply District Plan provisions to protect ecological values over the last six years. This experience does not make me confident that PC13's proposed discretionary activity status for pastoral intensification across most of the district's unrecognised significant sites[92] will be applied in a way that will provide for their protection in practice and is commensurate with their national importance.

59.7. I understand that PC13 does not propose to alter the permitted activity status of vegetation clearance for utilities outside mapped SONS and LPAs[93].

[89] M A C Harding, evidence-in-chief 15 July 2016 para 83.

[90] No new SONS have been scheduled in Waitaki District. Queenstown Lakes District notified a new Significant Natural Area (SNA) schedule in late 2015 but some SNAs are being appealed.

[91] This changing context is described in paragraphs 50 to 52 in my evidence. For the same reason, identification of Significant Inherent Values (SIVs) in tenure review rapidly become outdated, as noted in Appendix 10 to this evidence.

[92] That is, those sites outside mapped SONS, SVAs, LPAs, SGs and *'tussock grasslands within 1 km of the highway, Haldon Road, Godley Peaks Road and Lilybank Road*'.

[93] Chapter 16, Rule 1.1 of the Mackenzie District Plan 2004.

59.8. Landscape-scale control of wilding conifers, rabbits, and predators of fauna is required alongside constraints on pastoral intensification in order to protect and enhance ecological components of the outstanding natural landscape of the Mackenzie Basin, in my opinion. I have not seen any robust analysis accompanying PC13 to identify new approaches (such as economic instruments) that could support landholders in achieving these other requirements while limiting pastoral intensification.[94]

SUMMARY

60. I conclude that:

60.1. the biological diversity and ecology of the Mackenzie Basin and its prospects for future persistence derive from, and depend on, the interconnected complexes and sequences of historically rare ecosystems and associated wetlands and freshwater habitats that remain in Mackenzie District. The 'engines' of this variety are the still-extensive (but rapidly shrinking) connected landform sequence, the aridity gradient, and micro-topographic variation within landforms;

60.2. in Mackenzie District, most areas on glacially and alluvially derived depositional landforms (moraines, outwash gravels and river terraces) that have not been cultivated or irrigated, including severely degraded areas, are likely to be areas of significant indigenous vegetation or significant habitats of indigenous fauna, and are not recognised;

[94] For example, a robust analysis, led by the Regional Council, was the basis for (apparently successful) regulation of nutrients in the Rotorua lakes and Lake Taupo. In my opinion, these were situations similar to that facing the Mackenzie District because they involved cumulative land use effects on outstanding natural values, and a need to fundamentally alter the trajectories of land use in order to protect those values.

60.3. these ecological values are being rapidly and irreversibly lost to pastoral intensification in the Mackenzie District and in other Districts with similar ecological features;

60.4. unrecognised significant ecological values extend well beyond the limited areas (including scheduled SONS) where non-complying status for a subset of pastoral intensification activities is proposed in PC13. It is therefore unlikely, in my opinion, that PC13 will successfully curtail their cumulative loss;

60.5. if these ecological components of the outstanding natural landscape are to be sustained in future, there is also a need to provide for landscape-scale control of wilding conifers, rabbits, and predators of fauna.

Susan Walker
9 September 2016

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