BEFORE THE HEARINGS PANEL

IN THE MATTER 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 DR SUSAN WALKER ON BEHALF OF THE ENVIRONMENTAL DEFENCE SOCIETY
DATED: 12 FEBRUARY 2021

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STATEMENT OF EVIDENCE OF DR SUSAN WALKER

INTRODUCTION

1. I am an ecologist, researcher, and research programme leader in the Crown Research Institute Manaaki Whenua – 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') including the Mackenzie Basin;

    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; and

3.5. the dynamics of indigenous birds and introduced rodents across New Zealand forests.

4. I have also researched and published scientific papers and written reports about the ecology and conservation of threatened plants, evolutionary patterns of plant richness, radiation and endemism, effects of climate change on New Zealand's indigenous biodiversity, and movements of inland-migrant birds, among other subjects. I regularly collaborate and publish with policy and economics researchers on topics of policies, rules and incentives that affect indigenous biodiversity.

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. 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 the present I have led 'Outcome Based Investment' and later 'Strategic Science Investment Fund' (SSIF) government-funded research programmes into the biodiversity of New Zealand 'drylands'. 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.

6. I have often been engaged to provide ecological advice in reports or oral presentations to central and local government agencies such as Land Information New Zealand (LINZ), DOC, the Ministry for the Environment (MfE) and Regional

and District councils on matters of ecology and biodiversity assessment and protection including under the RMA. 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. In 2018 I received the New Zealand Ecological Society's Ecology in Action award which recognises contribution to the application of ecological knowledge, including communication, education and transfer of ecological science.

7. 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 of whether they protect ecological values in practice. Since 2009 I have provided expert evidence for a number of Resource Management Act (RMA) hearing panels, the Environment Court and the High Court concerning ecology, ecological changes and development proposals in the Mackenzie Basin. I observed the large-scale clearance enabled by the 'improved pasture exemption'[1] in the Mackenzie District Plan and provided ecological evidence which contributed to temporary suspension of that exemption in 2016.

8. My recent and ongoing research relevant to this hearing includes

[1] The exemption from the clearance rules 12.1.1.g & 12.1.1.h relating to short tussock and cushion and mat communities that applied when the vegetation had been 'oversown and topdressed at least three times in the last 10 years prior to new clearance so that the site is dominated by clovers and/or exotic grasses'

8.1. investigation of cross-boundary effects of intensive land use on remaining areas of indigenous dryland vegetation (Canterbury Plains and Mackenzie basin)[2]

8.2. causes of decline in inland *Lepidium* species, which are three threatened (Nationally Critical) plant species endemic to dry inland South Island basins.[3]

9. 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. 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.[4]

SCOPE OF EVIDENCE

10. I have been asked by the Environmental Defence Society to summarise the ecological features and significance of the Mackenzie Basin's indigenous biodiversity; its recent trajectories of change; and to provide an opinion on how provisions in MDC's proposed Plan Change 18 (PC18) might affect these.

[2] The study was funded by central government through MBIE's Strategic Science Investment Fund to Crown Research institutes. The results are published in two reports (Walker et al 2019; Walker 2020) commissioned by Canterbury Regional Council (CRC) for their use.

[3] This work in Central Otago, the Mackenzie Basin and Kura Tāwhiti (Castle Hill) is ongoing and funded by DOC and MBIE's Strategic Science Investment Fund ('SSIF'), and the Regional Initiatives Fund (DOC and CRC).

[4] 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 appeal. An access agreement prevents me from using information gathered on that visit for any purpose other than that appeal.

11. In preparing my evidence I read the following material:

    11.1. PC13 Eleventh Decision, 2017 (Decision No. [2017] NZEnvC 53) and the ecological evidence relied on by the Court

    11.2. Stage 1 District Plan review - indigenous biodiversity section - Section 32 evaluation (10 December 2017)

    11.3. Technical Report – Ecology; Evidence of Mike Harding, Environmental Consultant, 10 December 2020 (hereafter 'Mr Harding's evidence')

    11.4. Report on submissions and further submissions; Report prepared by Liz White, Consultant Planner, 14 December 2020 (hereafter 'Ms White's evidence') and the associated Attachment.

12. I am familiar with the planning documents[5] and the technical terms in Mr Harding's evidence and adopt the abbreviations tabulated on his page 3.

13. The ecological evidence of Mr Harding is within my area of expertise. I consider that it is accurate and rely on it. Mr Harding's evidence does not comment on all matters in my evidence, however.

14. Much of my evidence focuses on the Mackenzie Basin floor. This is an ecologically distinctive area made up of the Tekapo, Pukaki, and Omarama Ecological Districts (EDs) (McEwen 1987) (Figure 1). Tekapo and Pukaki EDs lie within the Mackenzie Basin Subzone of Mackenzie District,[6] and Omarama ED is within Waitaki District.

[5] Including the Canterbury Regional Policy Statement and the Proposed National Policy Statement for Indigenous Biodiversity

[6] As mapped in the document 'Mackenzie Basin Subzone Planning Maps Oct11.pdf' on the MDC website (http://www.mackenzie.govt.nz/includes/download.aspx?ID=118126, which I accessed 26 January 2021).

The Eastern Mackenzie Basin, and the northernmost portion of the Western Ranges, lie outside the Mackenzie Basin Subzone.

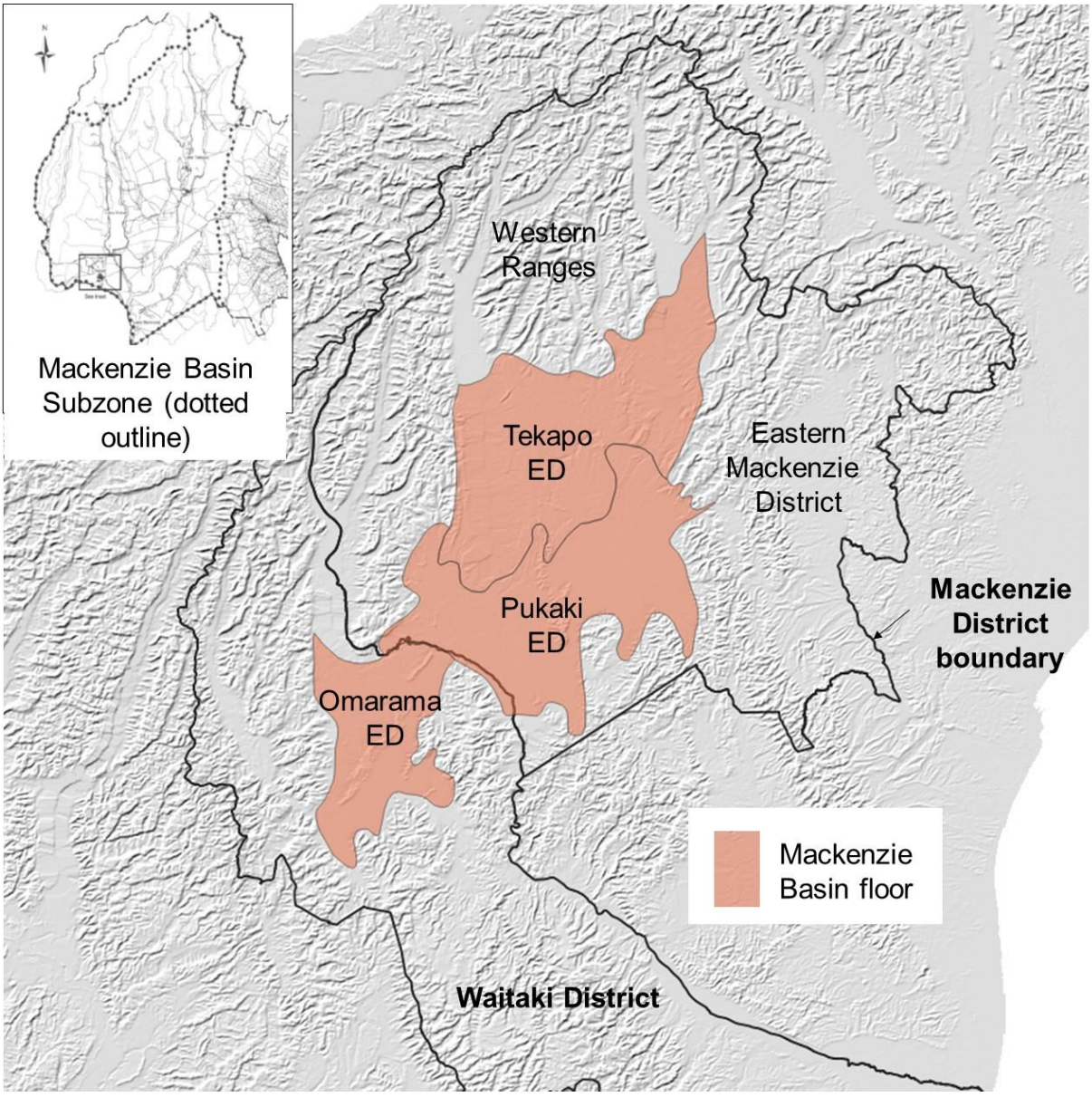

Figure 1. The extent of the Mackenzie Basin floor, made up of Tekapo, Pukaki and Omarama Ecological Districts (EDs) within Mackenzie and Waitaki Districts. The Mackenzie Basin Subzone is shown as an inset (top left) and contains the basin floor in Mackenzie District.

ECOLOGY AND SIGNIFICANCE OF THE MACKENZIE BASIN

15. The biological diversity and distinctive ecology of the Mackenzie Basin floor has been described in evidence for the PC13 11th decision and in the decision itself. Key features are

    15.1. the depositional[7] landforms and associated wetlands,[8] which form the greatest area and variety of naturally uncommon (also known as 'originally rare') ecosystems of any part of New Zealand, and which are nationally threatened[9]

    15.2. the indigenous plant communities of these ecosystems which, despite centuries of modification by fire, pastoralism, and invasive species,[10] still support a diversity of indigenous plant and animal species. Many of

[7] These are principally the glacially derived moraines and inland outwash gravel surfaces (outwash plains and terraces, meltwater channels and fans), which are cut by braided rivers and associated alluvial surfaces such as river terraces and fans. Remaining inland sand dunes are also depositional.

Moraines are material transported and directly deposited by retreating glaciers. **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** (which are not regarded as naturally uncommon ecosystems) associated with the **braided rivers** (which are). 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. **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.

[8] i.e. **ephemeral wetlands** and **tarns** formed in kettleholes within **moraines** (**ephemeral wetlands** dry out in summer months, whereas tarns remain wet)**,** and **seepages and flushes,** which develop where groundwater emerges on slopes (such as **moraine** or **outwash gravel** terrace scarps), forming permanently saturated soils with nutrient- and oxygen-rich water

[9] Mr Harding's evidence paragraph 30. 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*.

[10] Summarised in Mr Harding's evidence, paragraphs 31 and 57 to 63.

these species are endemic, ranked as nationally threatened, at-risk or uncommon,[11] and/or are in decline nationally

15.3. the indigenous biological diversity derives from variation in species habitats across, between, and within the historically rare ecosystems and associated alluvial surfaces, wetlands and freshwater habitats. Three elements of the basin floor landscape and geomorphology are the source of, and sustain, the indigenous biodiversity: the overall northwest to southeast aridity gradient; the landform sequences; and within-landform topographic and micro-topographic variation[12]

15.4. on the basin floor in Mackenzie District, the indigenous 'dryland'[13] ecosystems still, over some large areas, remain undeveloped and occur together in continuous sequences. This is no longer the case in Waitaki District, or in other South Island districts, where indigenous dryland vegetation and rare ecosystems have largely been cleared.

16. The 11th Decision on PC13 found that the Mackenzie Basin ONL[14] was a significant natural area based on CRPS[15] criteria. In recognising this,[16] the Decision noted

[11] Summarised in Mr Harding's evidence, paragraphs 31 and 32

[12] As described in my evidence for PC13 and reproduced in PC13 11th Decision paragraphs 110 to 113.

[13] Dryland environments as defined by Rogers et al. (2005) are those with a mean Penman moisture deficit of greater than 270 mm per annum. They cover about 20% of New Zealand. Water shortage is a primary controlling factor and filter for plants and animals, and most dryland soils are not particularly fertile. In Canterbury, alluvial plains and low-relief terrain in inland basins (Mackenzie, Ashburton, Rakaia, Waimakariri, Ashley, Culverden, Hanmer) are dryland environments; cold winters, strong winds, warm, dry summers, and semi-arid annual precipitation are climatic features of these areas.

[14] the Outstanding Natural Landscape, which I understand is the Mackenzie Basin Subzone.

[15] The Canterbury Regional Policy Statement; specifically Appendix 3 which sets out the criteria for determining ecological significance.

[16] PC13 11th Decision paragraphs 236, 237 and 347

CRPS Criterion 4[17] and the (then)[18] '83 indigenous plants which are threatened or at-risk' that are widely distributed across the ONL. Here I add that many less-developed places across the floor of the Mackenzie Basin also meet other CRPS significance criteria, but at least two apply extremely widely:

16.1. **Criterion 6** applies because the indigenous vegetation occurs mainly on originally rare ecosystems.[19] My Figure 2 shows the extent of moraine and outwash landforms across the basin floor.

16.2. **Criterion 8**[20] applies because remaining areas (that have not been converted) contribute to the connectivity[21] and size needed for the persistence of threatened and at-risk indigenous species (CRPS Criterion 4) and indigenous vegetation on the originally rare ecosystems (CRPS Criterion 6). That is, they provide or contribute to an 'important ecological linkage or network' or provide 'important buffering functions' (CRPS Criterion 8).

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[17] i.e. CRPS Appendix 3 'Rarity/Distinctiveness

…

4. Indigenous vegetation or habitat of indigenous fauna that supports an indigenous species that is threatened, at-risk, or uncommon, nationally or within the relevant ecological district.'

[18] Mr Harding's evidence (and his Attachment 1) show that this list has since grown to 91 species.

[19] i.e. CRPS Appendix 3 Criterion 6

'Rarity/Distinctiveness

…

6. Indigenous vegetation or an association of indigenous species that is distinctive, of restricted occurrence**, occurs within an originally rare ecosystem**, or has developed as a result of an unusual environmental factor or combinations of factors.

[20] i.e. CRPS Appendix 3 'Ecological Context

8. Vegetation or habitat of indigenous fauna that provides or contributes to an important ecological linkage or network, or provides an important buffering function.'

[21] That is, the continuity of sequences, ecological linkages, and networks.

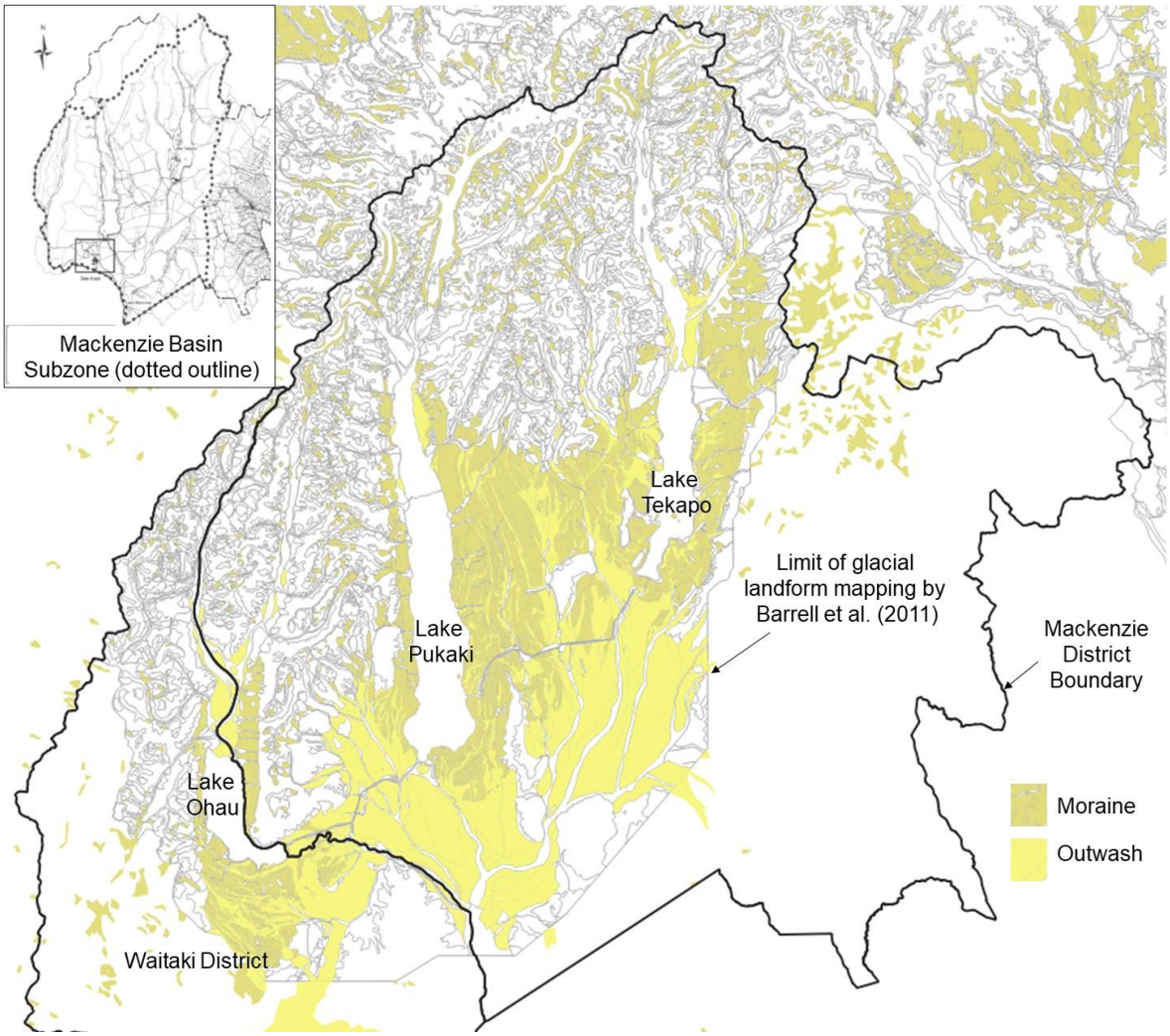

Figure 2. Areas of moraine and outwash depositional landforms identified in the glacial landform mapping undertaken by Barrell et al. (2011) in Mackenzie District.

17. The remaining indigenous ecosystems and plant communities of the Mackenzie basin floor are irreplaceable. That is, their ecological characteristics[22] and their

[22] For example, some of the characteristics and complexities of the ecosystems are described in PC13 11th Decision paragraphs 110 to 113.

environmental[23] and historic contexts are such it is simply not possible to re-create, replace, exchange/trade-off, or 'offset' them.[24] Clearance of indigenous vegetation is not 'capable of being offset and … fully compensated by the offset to ensure no net loss of indigenous biodiversity' and as the IUCN Red List categories of the originally rare ecosystems indicate, no 'alternative' ecosystems or habitats could 'provide a net gain for indigenous biodiversity'.[25] Clearance causes permanent loss that cannot be offset or compensated for.

ECOLOGICAL IMPORTANCE OF SIZE AND CONNECTIVITY

18. In my opinion the remaining areas of the Basin floor that have not been converted could all now be regarded as nationally significant.

    18.1. One reason is outstanding representative value: there is no other place in New Zealand where originally 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, where remaining examples of originally rare ecosystems are typically small and isolated.

    18.2. A second reason for national significance is that, due to the remaining area and connectivity of indigenous vegetation, the Basin floor in Mackenzie District now remains the only place in New Zealand where its suite of dryland species, and the ecosystems that support them, have a realistic prospect of long-term persistence.

[23] For example, harsh and fluctuating physical climates and stony soils are inimical to interventions such as planting unless those natural environmental conditions are ameliorated (and therefore lost).

[24] Ecological reasons are described by Mr Harding in his paragraphs 67 to 70, and implementation problems associated with offsetting are referred to in his paragraphs 66 and 69.

[25] Proposed Policy 6 in Ms White's evidence Attachment 1.

19. In the last two decades, the ability of indigenous species to persist on the Mackenzie Basin floor has been compromised by large-scale loss and fragmentation of remaining indigenous ecosystems. Significant natural areas (in the sense of RMA S6c) have not been protected, not only because areas of significant indigenous vegetation themselves have been widely cleared, but also because the clearance reduced the overall connectivity and buffering required for species' persistence across *remaining* significant areas.

Observed local extinctions

20. In evidence for the Environment Court in 2016, I wrote '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.'[26]

21. There is now clear evidence of directional species loss from isolated fragments[27] of indigenous vegetation in other more developed dryland South Island areas. For example

[26] As reproduced in PC13 11th Decision paragraph 115. As I also stated '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)' and '…I would expect these changes to exacerbate adverse effects of most chronic and transformational pressures on the basin's biota'.

[27] Here, a 'fragment' means an area of undeveloped vegetation surrounded by converted or developed land.

21.1. remaining fragments on the Canterbury Plains[28] have lost high proportions of the indigenous vascular plant species that were previously recorded there.

21.2. populations of endemic inland *Lepidium* species[29] have either gone locally extinct or undergone steep population declines in fragments of indigenous vegetation that they occupied in Central Otago and the mid-Waitaki valley in the 1990s. I surveyed most of their former known sites this summer, and found that plants were either completely absent or that numbers and biomass were desperately low.

22. Precise proximate causes of the above local extinctions and declines has probably varied from fragment to fragment and species to species (e.g. the *coup de grâce* may have been delivered by smothering weeds, or by diseases or pests) and chains of causation may be complex.[30] However, the geographic patterns show

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[28] These extinctions are best documented in the floras of Bankside and Eyrewell Scientific Reserves:

- Molloy (1970) recorded 65 indigenous vascular plant species inside Bankside Scientific Reserve. Surveys by Jenson & Shanks (2005) and Bowie et al. (2016) between them found only 12 of the species recorded by Molloy. Therefore 53 of the indigenous plant species recorded by Molloy appear to have gone locally extinct. Bowie et al (2016) note that none of the 14 species of native Asteraceae (daisy family) recorded by Molloy was recorded in either survey.
- Molloy & Ives (1972 recorded 58 indigenous vascular plant species in Eyrewell Scientific Reserve. A thorough resurvey by Ecroyd & Brockerhoff (2005) recorded only 32 (55%) of those species as still present in the reserve in 2001–2003. Numbers of exotic species had increased greatly between the surveys. Ecroyd & Brockerhoff report that 48 introduced vascular plant species had established since Molloy & Ives recorded the flora.

[29] These are three plant species in the brassica family (Brassicaceae) that are endemic to eastern South Island basins. All three (*Lepidium solandri*, *sisymbrioides* and *kirkii*) are ranked Threatened – Nationally Critical (the highest possible threat ranking in the NZ Threat Classification System).

[30] For example, in endemic *Lepidium*, diseases spread with introduced crops and weeds and their pests (especially pathogenic viruses, their aphid vectors, and fungi) are suspected to be playing a role. The white rust (*Albugo*) (an oomycete or type of fungus) blooms on *Lepidium* plants have been associated with rapid and dramatic population declines in smaller sites surrounded by converted land. The first observations of *Albugo* on *Lepidium solandri* in the Mackenzie Basin were made in 2018 and an infection on a population beside the Tekapo River was confirmed in 2019. My current research is to better understand how exotic Brassicaceae viruses, genetic depletion, and fungi are all contributing to declines.

that the ultimate cause is the extent of transformation of the surrounding landscape, which has occurred through indigenous vegetation clearance, intensification and conversion. There are consequent changes in physical (increases in nutrients and moisture) and biotic conditions (invasions of weeds, pests and/or pathogens) within the fragments. But also, seed sources and refuges elsewhere in the landscape, which once enabled species' persistence within those fragments, are now gone.[31] The observed extinctions and declines of indigenous species are therefore inexorable and there are no conservation solutions.

Measured cross-boundary (or 'edge') effects

23. Increased exotic grass cover is one of the most obvious local changes in biotic conditions within remaining indigenous vegetation as surrounding landscapes are converted to more intensive land uses. Increased exotic grass cover leads to competitive exclusion of low-growing indigenous plants[32] and loss of or change in associated native terrestrial and soil fauna. There is now clear evidence that intensive land development is fostering progressive exotic grass invasion into indigenous dryland vegetation, including in the Mackenzie Basin.

24. Our research[33] measured vegetation along transects from the edges to the interiors of 5 fragments of protected indigenous vegetation on the Canterbury

[31] Species persist naturally as dynamic metapopulations – spatially separated populations of the same species which interact. Different populations may go locally extinct and recolonize different sites at different times. However, presence across multiple sites provides insurance and ensures persistence. There are now few or no 'back-up' sites to serve as seed sources for recolonization of remaining patches in Central Otago or the Canterbury Plains.

[32] As explained in Walker et al. (2019) indigenous dryland vegetation is generally open and short in stature, and its species are adapted to naturally stressful and low-productivity (infertile and summer-dry) conditions. Such stress-adapted species compete well for water below ground but have limited ability to grow fast and tall when moisture and fertility increase. As productivity increases, competition among plants increases, and switches from primarily below-ground to above-ground, favouring plants with superior ability to compete for light, which in this context, are especially pasture grasses.

[33] Walker (2020).

Plains (2.3 ha to 10.5 ha) and 5 larger conservation areas in the Mackenzie Basin (36 ha to >4,000 ha). We looked for evidence of attenuating trends in exotic grass cover (i.e. decreases with distance from edges into interiors of the indigenous vegetation) which would show that exotic grass cover was an effect of adjacent land use (an 'edge' or 'cross-boundary' effect). We recognised that effects that penetrate into fragment interiors can cause baseline shifts (i.e. increases in exotic grass cover across whole sites, not only near edges), and that baseline shifts can mask attenuating trends.

25. On the Canterbury Plains, exotic grass cover attenuated from edges to fragments interiors across the maximum distances we were able to measure (up to 120 m) in the three larger fragments. Two smaller fragments[34] had uniformly high grass cover with no attenuation towards their interiors. We concluded '*increased exotic grass cover as a result of adjacent intensive land use may now extend across the full extent of measured indigenous vegetation fragments up to 10.5 ha in size*'.

26. In the Mackenzie Basin, our results show that

    26.1. exotic grass cover decreased with distance into the conservation areas from edges adjacent to irrigated pasture, exotic forestry, and [other][35] indigenous vegetation

    26.2. there was clear attenuation of exotic grass cover with increasing distance from edges with irrigation (which had commenced recently, within the previous 2 to 4 years), and our sampling plots intercepted

[34] These were Bankside Scientific Reserve (2.8 ha) and Eyrewell Scientific Reserve (2.3 ha), referred to in footnote 28 to paragraph 21.1 above.

[35] In our study, the 'other indigenous vegetation' category included a variety of grasslands that had not been completely converted but had usually been subject to some intensification (e.g. oversowing and topdressing). Near the northern boundary of Lake Tekapo Scientific Reserve, 'other indigenous vegetation' included, an area of grassland that is increasingly modified by housing development and other human activities.

local patches of high exotic grass cover as much as 336 m from an irrigated edge (the maximum distance of our measurement). We noted that these effects were evident surprisingly early and are likely to extend further into the indigenous vegetation in future

26.3. a baseline shift to higher overall exotic grass cover had probably already[36] occurred right across the smallest site (36 ha Spring Creek Conservation Area) which had irrigation on three sides

26.4. at one site, an invasion front of the exotic grass Chewings fescue[37] extended well beyond our 336 m maximum distance of our measurement across a moraine landform. This grass front originated from edges adjacent to exotic forestry, and remote images suggest it now extends 850 to 900 metres into the indigenous vegetation.

27. Overall, the study showed that land use practices are already having measurable adverse effects on indigenous vegetation in the Mackenzie Basin at considerable distances beyond their footprints. We do not yet know how much further edge effects will extend after they have continued to develop for decades, but expect them to expand.[38] Furthermore, increased exotic grass cover is only one type of

[36] Irrigation immediately adjacent to Spring Creek Conservation Area appeared to have commenced relatively recently (within 2 to 4 years of the study). However the site lies towards the south of the large corridor of irrigated dairy land beside the State Highway south of Twizel, in Waitaki District which had been irrigated for more than a decade.

[37] The common name of the exotic grass *Festuca rubra*.

[38] For example, Walker et al. (2019) noted

- 'Measurement of effects on indigenous vegetation at one point in time may underestimate future effects because physical changes and biological effects are likely to increase cumulatively over time … ' and
- '…biological effects are outcomes of developing biological processes (such as dispersal, invasion, competition, and succession in terrestrial vegetation, altered soil processes such as decomposition and nutrient cycling), and not only the direct results of spillover of physical materials…'

local edge effect, and there are likely to be other types that are not being measured.[39]

28. The implications of our results for the Mackenzie Basin are

    28.1. the indigenous vegetation appears to be particularly vulnerable to edge effects of land use

    28.2. edge effects from the land uses that are already established in the basin are now progressively modifying and shrinking the area of indigenous vegetation that remains

    28.3. consequences are likely to be progressive depletion of the indigenous flora through local extinctions (as recorded on the Canterbury Plains) and local extinctions of threatened species (as seen in Central Otago)

    28.4. smaller sites and those most surrounded by intensive land uses are likely to become modified most rapidly and completely (as is evident now in Spring Creek Conservation Area)

    28.5. surveys to assess ecological significance to date may have greatly underestimated the extent and width of the undeveloped areas that are significant for their buffering role alone (e.g. under CRPS Criterion 8).[40]

[39]The report cautioned 'Not all types of edge effects have been measured, and this is an important consideration for policies and decisions about setback distances and catchment thresholds. Edge effects on physical factors such as soil phosphate and overnight humidity may occur over larger distances than the factors measured here….'

[40] As explained below (my paragraph 32) these underestimates are especially likely when assessments are undertaken on a property-by-property basis.

Cumulative, region-wide effects

29. Our research[41] also agrees with Mr Harding's evidence[42] that – in addition to local edge effects – intensifying land use activities can have local and regional cumulative physical effects. These may be not only climate alterations (through irrigation), but also overall nutrient enrichment and greater exotic species seed-rain. All are likely to have contributed to the ecological changes and striking losses of indigenous species now evident on the Canterbury Plains and in Central Otago. The same cumulative, region-wide physical changes are likely to be underway in the Mackenzie Basin, as a consequence of recent land development.[43]

Summary

30. In summary, my opinion is that there is strong ecological evidence that the remaining overall size, connectivity and buffering in the Mackenzie Basin will determine how much of its ecological values and indigenous biodiversity will endure and be sustained in future. Continuing to whittle away extent and connectivity will compound the rate at which remaining natural areas are already being modified, and the degree to which the indigenous species they now support will be lost.

[41] Walker et al. (2019) reviewed and summarized relevant international literature.

[42] Evidence of Mr Harding paragraph 98.

[43] Evidence of Mr Harding paragraph 38.

APPROACH TO ASSEESMENT OF SIGNIFICANCE

31. I agree with Mr Harding that most 'un-converted' areas on glacially and alluvially derived depositional landforms in the Mackenzie District, including severely degraded areas, are likely to be significant indigenous vegetation or significant habitats of indigenous fauna, but these areas are not recognised in the current plan and schedule.[44] Therefore Mackenzie District's identified Sites of Natural Significance (SONS) are out of date and very seriously inadequate,[45] despite reviews and additions since 2015.[46] I agree that the significance assessment context is changing rapidly with increasing loss and deterioration of these ecosystems and rarity of the basin's indigenous species.[47]

32. Timely survey to update the MDP SONS schedule property-by-property is not feasible for reasons set out by Mr Harding.[48] I add that also, a property-by-property assessment focus is poorly suited to the Basin context where significant indigenous vegetation extends across multiple properties and all contribute to overall size, connectivity and buffering. The extensive un-converted areas that buffer areas on particular properties from cross-boundary effects, and prevent cumulative catchment-scale modification by remaining un-converted, will usually lie on other properties, where they will not be identified when the focus is local. A different approach is needed, which recognises that significant values extend across a large interconnected area, and are not confined to discrete isolated sites.

[44] Evidence of Mr Harding paragraphs 34 and 35, and paragraph 44: '…Most undeveloped (un-converted) land on depositional landforms in the Mackenzie Basin has significant ecological values. The MDP Appendix 1 SONS cover only a small proportion of that undeveloped land'.

[45] Evidence of Mr Harding paragraphs 41 to 45.

[46] Evidence of Mr Harding paragraph 46.

[47] Evidence of Mr Harding paragraphs 34 and 35.

[48] Evidence of Mr Harding paragraphs 46–51.

33. I have looked at the maps of converted and partially-converted land in the Mackenzie Basin in Mr Harding's evidence.[49] I consider that the methods used to identify (fully) converted and partially-converted land are robust for mapping at this scale,[50] and I am comfortable that land areas are likely to have been distinguished adequately for this purpose.[51]

34. In my experience there will be few parts of the areas mapped as un-converted[52] land that will not meet the definition of indigenous vegetation,[53] and few (if any) areas of un-converted land on depositional landforms[54] that do *not* meet CRPS significance criteria. The majority of depositional landforms are originally rare ecosystems[55] and therefore indigenous vegetation that meets CRPS Criterion 6; most un-converted areas on depositional landforms support plant and/or animal species that are threatened, at-risk, or uncommon nationally and therefore meet CRPS Criterion 4; many are important indigenous fauna habitat (CRPS Criterion 10);[56] and all are likely to provide or contribute to an 'important ecological linkage or network' or provide 'important buffering functions' (CRPS Criterion 8).

[49] Evidence of Mr Harding paragraph 48, and his Attachment 2.

[50] Evidence of Mr Harding paragraphs 119 – 124, and his Attachment 2.

[51] Attachment 2. I assume that more detailed mapping work to confirm boundaries at the property scale may be needed in response to a consent application.

[52] i.e. land that has not been either fully or partially converted.

[53] i.e. 'a community of vascular plants, mosses and/or lichens that includes species native to the ecological district. The community may include exotic species.'

[54] referred to in paragraphs 48 and 117–118 of Mr Harding's evidence. Although Mr Harding's evidence did not include a map of the depositional landforms, I am familiar with their extent, and I provide a suggested definition and mapping approach in my paragraphs 48 and 49 below.

[55] My Figure 2 illustrates the extent of the moraine and outwash component of depositional landforms in the Mackenzie Basin.

[56] i.e. 'Indigenous vegetation or habitat of indigenous fauna that provides important habitat (including refuges from predation, or key habitat for feeding, breeding, or resting) for indigenous species, either seasonally or permanently.'

35. Therefore, the areas that have been mapped as un-converted land on depositional landforms are significant in the sense of RMA S6c, in addition to areas mapped in the deficient MDC SONS schedule.

36. I agree that the degree of conversion in the partially-converted category may vary, so checking at a finer scale is needed.[57] Some partially-converted areas may not be completely converted and still meet CRPS criteria (especially those on depositional landforms and considering contribution to size, connectivity and buffering at the Basin scale).

IMPROVED PASTURE

37. Areas mapped as converted land,[58] coupled with the definition of improved pasture,[59] provide an appropriate way to identify areas that are *unlikely* to be significant indigenous vegetation, in my opinion.

38. Also in my opinion, use of the proposed definition and the map of (fully) converted land together[60] provide a clear and sensible way to avoid the ambiguity[61] and hence contestability, of previous 'improved pasture' definitions and exemptions. I agree that the simpler definition of improved pasture and the identification of those areas are both needed[62] to remove the contestability that has led to considerable loss of the Mackenzie Basin's indigenous biodiversity in recent years.

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[57] Evidence of Mr Harding at paragraph 128.

[58] Evidence of Mr Harding paragraph 37, 116–124, and his Attachment 3.

[59] As provided by Mr Harding (paragraph 112) 'Improved Pasture: means an area where, as at May 2020, indigenous vegetation had been fully removed and the vegetation converted to exotic pasture or crops'.

[60] Evidence of Mr Harding Attachment 3.

[61] Evidence of Mr Harding paragraphs 101 to 106.

[62] Mr Harding's evidence paragraph 111.

CATEGORIES OF LAND

39. Based on the maps, the following five categories of land can now be identified and mapped **within the Mackenzie Basin Subzone and western ranges**.[63]

Table 1: Mapped categories of land in the Mackenzie Basin Subzone and western ranges

a) Improved pasture (mapped as converted land)
b) Existing SONS, and surveyed and reviewed SONS
c) Other significant indigenous vegetation (un-converted land on depositional landforms)
d) Partially-converted land
e) Other indigenous vegetation (un-converted land not on depositional landforms).

40. Categories b) and c) in Table 1 are both significant natural areas that are identified and mapped,[64] and warrant the same protection in accordance with RMA S6c.[65] This protection will require avoiding adverse effects.[66] Maintaining the other indigenous vegetation in category e) will also be important for the maintenance of indigenous biodiversity.

[63] As mapped in my Figure 1.

[64] Evidence of Mr Harding paragraph 117.

[65] The currently proposed Rules do not appear to protect the recognised significant indigenous vegetation and fauna values of category c). For example, Rules 1.1.1, 1.2.1.2, 1.2.2.1, and 1.3.2.2 refer only to Site[s] of Natural Significance, which I assume to mean only the existing and reviewed SONS in the MDP.

[66] As described by Mr Harding (paragraphs 65 - 71) and in my evidence below, offsetting or compensation are not feasible and protection requires avoiding adverse effects because any loss is permanent.

41. The greatest remaining uncertainties for categorising land the Mackenzie Basin Subzone, in my opinion, are now limited to

    41.1. partially-converted land (category d of Table 1): review would assign parcels to one of the categories a), b) or e), and

    41.2. category e), of which much is on the slopes of the western ranges[67] (as mapped in my Figure 1), and on the hills and roches moutonnées that emerge from the glacial landscapes such as the Old Man and Mary ranges, Simons Hill, and Grays Hills. I expect that survey would find unidentified significant habitats of indigenous fauna and/or significant indigenous vegetation on this non-depositional land, including some wetlands. Review would assign it to b) or retain it in e).

42. In my opinion, a very similar 5-part categorization could be applied to the eastern Mackenzie District.

    42.1. There will be improved pasture[68] and partially converted land which can be identified by aerial imagery and ground truthing (but have not yet been mapped by MDC)

    42.2. There will also be some existing SONS and surveyed and reviewed SONS, which are probably also inadequate[69]

    42.3. In eastern Mackenzie District, category c) Other significant indigenous vegetation should include forest remnants and originally rare limestone

[67] As mapped in my Figure 1; the Western Ranges include land north of the Mackenzie Basin Subzone.

[68] That is, areas where, as at May 2020, indigenous vegetation had been fully removed and the vegetation converted to exotic pasture or crops.

[69] Mr Harding's evidence does not address this question. However, the SONS are likely to be greatly outdated and it is likely that many other areas meet CRPS significance criteria.

ecosystems, in addition to un-converted land on depositional landforms[70]

42.4. Remaining areas of un-converted land (category e) may, on survey, be assigned to b) SONS or retained as e) other indigenous vegetation.

43. As with the land in the Mackenzie Basin Subzone (Table 1), categories b) and c) in Table 2 can be assumed now to be significant natural areas in the sense of RMA S6c; and both warrant the same level of protection in accordance with s6c, which entails avoiding adverse effects. Areas that remain in e) on review would also be important for the maintenance of indigenous biodiversity.

Table 2: Potential mapped categories of land **in the eastern Mackenzie District**

a) Improved pasture (to be mapped as converted land)
b) Existing SONS, and surveyed and reviewed SONS
c) Other significant indigenous vegetation (un-converted land on depositional landforms, on limestone, and forest remnants)
d) Partially-converted land
e) Other indigenous vegetation (un-converted land not in categories b or c).

[70] These areas may be assumed now to be significant natural areas in the sense of RMA S6c, and can be readily distinguished and mapped from aerial images and other GIS data sources now, providing clarity. I have some reservations about the current quality of wetland maps, and therefore include them in other indigenous vegetation.

OTHER DEFINITIONS AND PROVISIONS

Protection and no net loss

44. I understand that the CRPS requires that significant areas are protected 'so that there is no net loss of indigenous biodiversity values'. However, I disagree with the planner Ms White's assertion that 'no net loss'[71] and protection are the same thing. Ecologically and historically, these are distinct. The term 'no net loss' was introduced to promote offsetting,[72] which involves a compromise between continued development and mitigation. Compromise between development and mitigation differs from protection in plain-english definitions,[73] and is different ecologically,[74] practically and administratively,[75] and in the ecological outcomes that have resulted internationally,[76] in my opinion and experience.

45. I have read the proposed Objective and Policies 2 and 3 for significant indigenous biodiversity values, indigenous vegetation and fauna habitats,[77] and the proposed definition of no net loss.[78] The policies and definitions envisage a compromise

[71] Ms White's evidence paragraph 199 states 'I also disagree with Forest & Bird who consider that no net loss is not the same as protection.'

[72] The no net loss as a goal for wetlands was introduced by President Jimmy Carter's administration in 1977 and adopted as policy by President George H.W. Bush administration in 1989. The policy instigated and enabled trading in wetlands.

[73] The first definitions returned in my google search for 'protect' were 'keep safe from harm or injury', 'preserve or guarantee by means of formal or legal measures' and 'aim to preserve (a threatened species or area) by legislating against hunting, collecting or development'.

[74] Protection entails leaving a site intact (avoiding harm) while the other entails (usually) the removal of the values and displacement in type, space, and/or time.

[75] Summarised in Mr Harding's evidence paragraphs 66 to 71. For example, Mr Harding's opinion is that only ecosystems on very recently-formed land surfaces could readily be replaced like for like (these are risky places with frequent natural disturbances usually avoided by developers). Mr Harding cautions that even there, interim net loss will result which may have significant effects on sedentary species.

[76] There is now a rich international literature on the outcomes of offset schemes with the goal of no net loss. They show that in most instances, development has proceeded while mitigation has failed to meet its objectives or not materialised at all.

[77] Attachment 1 of Ms White's evidence.

[78] Attachment 1 of Ms White's evidence SECTION 3 DEFINITIONS.

reached 'overall' by swapping development for mitigation. Yet the ecological advice MDC has received[79] (which I agree with)[80] is that the significant indigenous ecosystems that occur in the Mackenzie Basin and elsewhere in the District cannot be protected by an exchange of development and mitigation. Because there are no realistic remediation, mitigation or offsetting options for significant indigenous vegetation and fauna habitat (Policy 3), loss to development is permanent, in conflict with Objective 1. A policy for protection for the District's significant indigenous vegetation and fauna habitats that avoids this inconsistency would be simply (for example) 'avoidance of harm and reduction in extent'.

No net loss would require a negative rate of development

46. The proposed Policy 2 envisages a rate of land use and development, including ongoing clearance, which achieves 'no net loss' of significant biodiversity values.[81] A practical complication is that the off-site effects of the land uses already established in the Basin are now progressively, and measurably, reducing and modifying the area of significant indigenous vegetation that remains.[82] It follows, for example, that to achieve 'no reasonably measurable overall

'No net loss: means, in relation to indigenous biodiversity, no reasonably measurable overall reduction in:

a) the diversity of indigenous species or recognised taxonomic units; and

b) indigenous species' population sizes (taking into account natural fluctuations) and long term viability; and

c) the natural range inhabited by indigenous species; and

d) the range and ecological health and functioning of assemblages of indigenous species, community types and ecosystems.'

[79] As set out in Mr Harding's evidence paragraphs 66 to 71.

[80] Paragraph 17 of this evidence.

[81] i.e. proposed Policy 2 'Land use and development, including indigenous vegetation clearance and pastoral intensification, only occurs in a way or at a rate that provides for no net loss of significant indigenous biodiversity values'.

[82] Paragraphs 27 and 28.2 of this evidence.

reduction' in '*c) the natural range inhabited by indigenous species; and d) the range and ecological health and functioning of assemblages of indigenous species, community types and ecosystems*' would require land retirement from current uses. That is, the only rate of development that might now achieve no net loss is a negative rate. Additional vegetation clearance and pastoral intensification will measurably exacerbate the cumulative reduction (net loss) that is currently underway.

Measuring loss

47. In the PC13 hearing, the Environment Court went to some length to elicit spatial data on the extent of conversion, loss, and remaining indigenous vegetation.[83] Because the areas of un-converted land have now been mapped (and can be remapped) in the Mackenzie Basin, MDC can now usefully provide that information for the Subzone; and a specific and measurable policy for significant indigenous vegetation and fauna habitat protection is now possible, which is consistent with the Objective.[84]

Depositional landforms

48. Mr Harding summarises depositional landforms informally as 'moraines, outwash terraces, and riverbeds'.[85] A more formal definition I recommend is '*landforms formed of glacial (e.g. moraine, outwash) and alluvial deposits*' which captures the breadth of depositional landforms. [86]

[83] PC13 Decision-Eleventh Decision 2017, paragraphs 74 to 107.

[84] e.g. 'no measurable reduction in the extent of un-converted land on depositional landforms'. Such a measurable objective would also avoid the problem that 'no reasonably measurable overall reduction' is guaranteed when a baseline state is neither measured nor reasonably measurable, which is the case with attributes in the definition of no net loss.

[85] Evidence of Mr Harding paragraph 37.

[86] Paragraph 15.1 and associated footnote 7 of this evidence.

49. I also recommend that the map of Barrell et al. (2011) are used as the primary digital source for mapping depositional landforms in Mackenzie District. This source is more recent and more detailed (i.e. 1:100,000) than the 1:1,000,000 GNS Geological Map of NZ (also produced by GNS).[87] I recommend that the lower-resolution map is used only in the eastern areas of the Mackenzie Basin that are not mapped by Barrell et al. (2011).

Vegetation clearance

50. The activities currently included in the proposed definition of vegetation clearance[88] are appropriate, but the definition does not incorporate the ecological advice of Mr Harding on grazing,[89] nor off-site (or 'edge') effects of development activities beyond development footprints.[90] Not including intensive grazing and edge effects in the definition would leave loopholes that enable continued clearance and not protection, in my opinion.

Permitted clearance

51. I have been asked to consider the extent to which Rule 1.1.1 would permit ongoing clearance of significant indigenous vegetation. If this ongoing clearance is to be avoided, exclusion locations specified in Rule 1.3.2 need to include un-converted land identified in categories c in my Tables 1 and 2,[91] and all other

[87] Evidence of Mr Harding paragraph 118

[88] Evidence of Ms White Attachment 1 DEFINITIONS.

[89] Mr Harding's evidence paragraphs 91 and 92.

[90] It is recommended that off-site effects are addressed at two levels: by setting whole-catchment limits and by more local setbacks (Walker et al. 2019; 2020).

[91] That is

- In the **Mackenzie Basin Subzone**: un-converted land on depositional landforms
- In the **eastern Mackenzie District**: un-converted land on depositional landforms, on limestone, and forest remnants

areas meeting CRPS significance criteria, in addition to the (inadequate) mapped and reviewed SONS.

52. In Rule 1.1.1.1, the constraint to within 2 metres of listed structures and features would be insufficient to avoid considerable fragmentation of significant indigenous vegetation by permitted clearance. In my experience, clearance alongside narrow linear features can extend over several kilometres. Therefore an additional limit on total area (for example, 100 m^2) would be advisable, especially where these areas are indigenous vegetation on depositional landforms, mapped or reviewed SONS, or other areas meeting CRPS significance criteria. As well as addressing potential fragmentation, this total-area limit would reduce the chance of permitted clearance compromising small important areas of habitat for Nationally Critical threatened plant species or threatened fauna, such as entire ephemeral wetlands within moraines, or the narrow zones important for xerophytic plants at the brows of outwash terraces.

FARM BIODIVERSITY PLAN EXCEPTION

53. In my opinion, the exception to the indigenous clearance rule proposed for properties with Farm Biodiversity Plans (FBPs) would provide a loophole to continue to clear, degrade and fragment indigenous vegetation and indigenous fauna habitats in the Mackenzie Basin, perhaps very widely. I understand the exception proposes to limit council's discretion where a FBP is submitted along with a resource consent application and envisages compromises between development and mitigation on farms, to be decided on a farm-by-farm basis, adjudicated against the quality of,[92] and predicted future compliance with,[93] a FBP.

[92] Proposed Rule 1.2.1. Matters of discretion part 1.

[93] Proposed Rule 1.2.1. Matters of discretion part 2.

54. First, the exception provides an avenue for council planning staff to consent to further clearance of significant indigenous vegetation and fauna habitats recognised by the Court but not mapped as SONS[94] in the MDP, in exchange for mitigation. And, even if that avenue were closed for significant natural areas, the FBP exception would lead to continuing clearance of 'other' indigenous vegetation that is important to maintain indigenous biodiversity, in my opinion.

55. The proposed matters of discretion in the FBP exemption would give Council wide latitude to decide what indigenous vegetation it may allow to be cleared and what mitigation it may accept in exchange as long as a FBP had been prepared. Exchanges would be made on an ad hoc, subjective, case by case basis. As discussed above, for ecological reasons alone[95] offsetting is not an appropriate method or approach for protecting or maintaining the indigenous vegetation and fauna habitats of the Mackenzie Basin, and it is improbable that any proposal would meet CRPS Policy 9.3.6 criteria[96] or the proposed Policy 6b). Other, looser compromises between development and mitigation invite even greater ongoing loss and continued reduction in the size and connectivity of indigenous ecosystems. This would not protect the District's significant indigenous vegetation and fauna habitats, nor maintain its indigenous biodiversity.

56. The parameters of these FBP exchanges cannot be known in advance and the proposed matters of discretion will be contestable. Indigenous biodiversity is complex, and in the Mackenzie Basin many of its components are small, cryptic, seasonal, and little known or unstudied. Effects of different management

[94] The only areas proposed to be exempt from this approach are narrow: '2. The clearance is not within a Site of Natural Significance or on land above 900m in altitude, and 3. The clearance is not within: a) 75m of a lake, b) 20m of the bank of a river, c) 50m of any wetland.'

[95] As noted in my paragraph 17. Ecological reasons are also set out by Mr Harding in his paragraphs 67 to 70, and Mr Harding also discusses the implementation problems associated with offsetting (paragraphs 66 and 69).

[96] Mr Harding's evidence paragraph 71.

activities and regimes on them are poorly known, can be complicated and counterintuitive,[97] and can take decades to be revealed even by targeted research, in my experience. Therefore assessment of the 'quality'[98] of a FBP, and its demonstrated integration,[99] will present a very wide range of potential subjective considerations, claims, counterclaims and very large uncertainties.[100]

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[97] e.g. long term sustained rabbit control can increase nesting success of threatened ground-breeding birds (terns, dotterels, oystercatchers) through long-term reduction in the densities of predators supported by rabbits and take birds as bykill. However, intermittent rabbit control can actually increase predation on ground nesting adult birds, eggs and chicks because predator densities have built up and they 'prey switch' when densities of their primary prey (rabbits) are suddenly reduced (Courchamp et al. 2000, Norbury 2001).

[98] Proposed Rule 1.2.1 matter of discretion i.

[99] Proposed Policy 8.

[100] Some of these uncertainties will be, for example:

- whether significant indigenous vegetation and significant fauna values have in fact been identified – that is, whether the information provided is complete
- given limited knowledge, whether methods of protection proposed will actually protect the significant indigenous vegetation and significant fauna values at present and in future
- given limited knowledge, whether any methods that are proposed or suggested will maintain or enhance indigenous biodiversity outside significant areas (because there is limited knowledge of outcomes of management actions, advice will often necessarily be a 'best guess'), or whether they will in fact damage indigenous biodiversity.
- given limited knowledge, whether and to what extent activities will mitigate the effects of the development 'on the wider ecosystem' and of impacts on 'connectivity, function, diversity and integrity'.
- ecological monitoring is usually difficult and expensive, and often inconclusive or abandoned; and the characteristics of the Basin's cryptic biota are likely to exacerbate these problems. The technical considerations involved in determining whether monitoring and reporting is 'adequate' are numerous and demanding, and include: what elements and attributes (e.g. which species?, numbers or density or cover etc?) of which biota (plants, birds, invertebrates, fungi) will be measured?; what technical sampling methods will be used?; is the sampling design robust in that are samples independent, is replication sufficient and will the data have the statistical power to actually show ecologically important change with high certainty?; will it be undertaken by the same 'suitably qualified' person(s) over time to ensure consistency?; how often?, will the data will be provided and analysed and reported on by competent and independent people?; what recording and methods are in place to ensure the longevity of the monitoring and access to the data (permanent marking, online databanks etc)?
- even whether the person preparing the plan and doing the assessment is 'suitably qualified' is fraught in my experience. I have assessed reports on a survey required by a resource consent condition, where a 'qualified' person was signed off, but hired and sent into the field unqualified persons who could not identify the plants, and therefore the information and data collected were unreliable.

Assessments of assurances of future compliance with a FBP would involve considerable further uncertainty in my opinion.[101]

57. Application of FBPs to regulation, and to an inland eastern South Island ecological context, may be experimental. In my own searches I found no examples of FBP applications to vegetation clearance under the RMA,[102] nor more generally to ecological contexts similar to the Mackenzie Basin where most of the remaining vegetation is indigenous and ecologically significant. Against (what appears to be) lack of experience of the realities, practicalities, and ecological outcomes of the approach, MDC's evidence on FBPs comes only from the Planner. It is not apparent that they have sought or received ecological input or comment.

WAITAKI POWER SCHEME (WPS)

58. MDC supplied a map showing the core land and operating easements associated with the WPS. As shown in Figure 3, the operating easements cover a considerable proportion of the land area now mapped as SONS in the Mackenzie Basin.

59. I am familiar with the WPS operating easement areas and their significant indigenous vegetation and fauna habitat values; I agree with Mr Harding's assessment of their values and the effects of vegetation clearance within them.[103]

[101] Both because these actions must occur in the future (after irreversible clearance has occurred), and because New Zealand regulatory agencies' record of achieving monitoring and compliance is poor. Mitigation promised in exchange for clearance in New Zealand often fails to materialise, or does not eventuate at all, and Council follow up and enforcement is patchy.

[102] For example, the report of the Biodiversity Collaborative Group in preparation for the proposed NPS-IB (http://www.biodiversitynz.org/uploads/1/0/7/9/107923093/final_online_-_biodiversity_group_report_1_oct_4pm.pdf) discusses FBPs in terms of concept rather than reality.

[103] Mr Harding's evidence paragraphs 81 to 86.

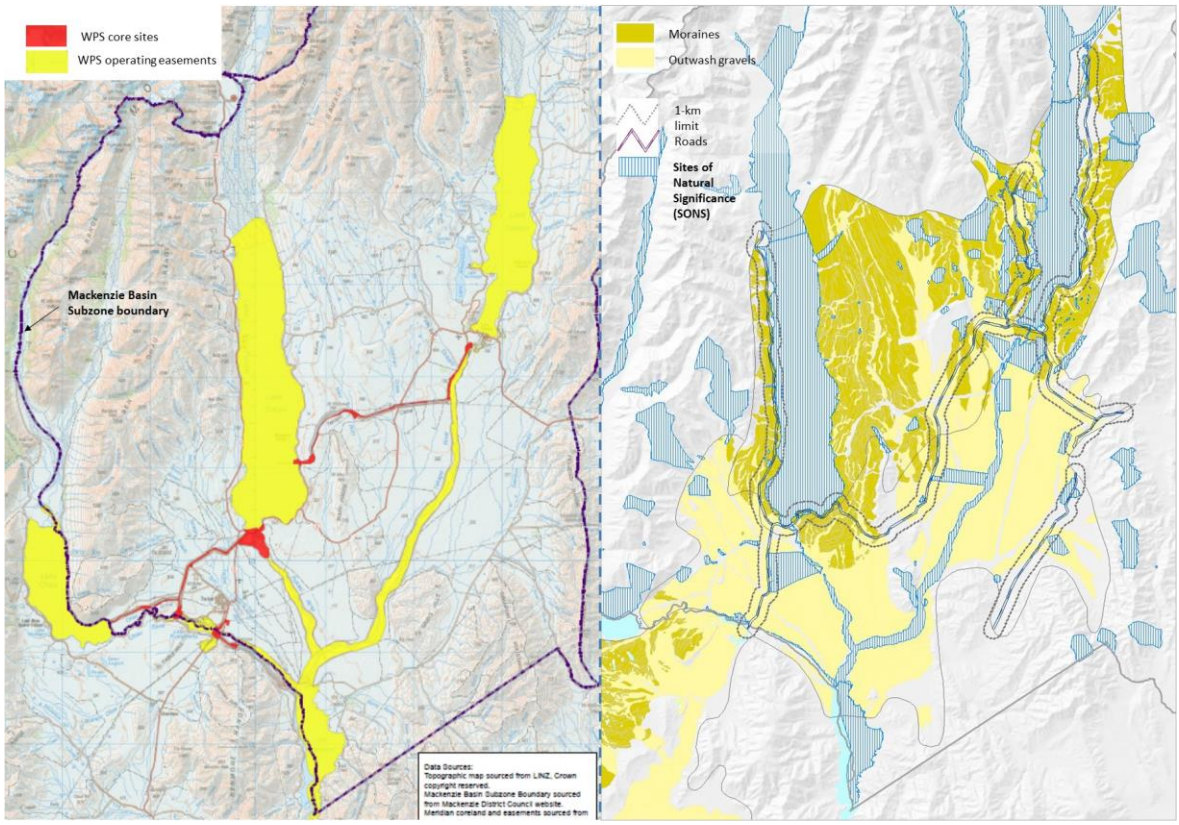

Figure 3. Maps showing parts of Mackenzie District affected by the Waitaki Power Scheme (WPS) (map on the left; prepared in 2010 with core sites shown in red and operating easements in yellow) and the Mackenzie District SONS (as they were in 2016) (map on the right with SONS indicated by the blue hatching).

60. WPS core sites are not spatially extensive, but parts of them will be ecologically significant. In contrast, land mapped as operating easement covers most of the basin's braided riverbeds and associated landforms, which are well recognised to have exceptional ecological significance over most of their area (despite river flows having been modified by the WPS).

61. In my opinion, the proposed regulatory regime for the WPS would not protect these significant inherent values nor maintain the District's indigenous biodiversity. In particular, permitted status for indigenous vegetation clearance across operating easements risks extensive loss of significant vegetation and fauna habitat across the Basin's major braided river corridors. Much loss could be unnecessary and found to be avoidable if resource consent processes were

followed, in my experience. Such avoidance will be important because it will not be feasible to offset, so clearance will result in permanent loss.

CONCLUSIONS

62. The Mackenzie Basin supports widespread, interconnected complexes and sequences of historically rare dryland ecosystems and associated wetlands and freshwater habitats. The remaining indigenous plant and animal communities support a rich diversity of endemic species, including numerous threatened and at-risk species.

63. The Basin's indigenous biodiversity is generated and sustained by extensive and connected areas of indigenous vegetation that span the overall aridity gradient, the landform sequences, and the topographic and microtopographic variation within landforms. The remaining extent and connectivity gives the indigenous ecosystems and species some prospect of future persistence, but has been compromised by irreversible, large-scale loss and fragmentation in recent years.

64. There is strong ecological evidence that maintaining the remaining extent and connectivity of unconverted indigenous vegetation is essential for the future persistence of the Basin's indigenous biodiversity. Continued clearance will compound the rate at which off-site effects are already degrading remaining natural areas, and the degree of indigenous species' declines and loss.

65. The ecological significance of the Basin's remaining indigenous vegetation has been recognised by the Court but not in the proposed PC18. In PC18 protection is proposed for only a seriously deficient schedule of SONS and not for the remaining extensive and recognised significant natural areas.

66. Maps of converted land in the Mackenzie Basin subzone and a new definition of improved pasture usefully identify land that is not indigenous vegetation and unlikely to be ecologically significant, removing ambiguity. Un-converted land

now identifies the extent of remaining indigenous vegetation; indigenous vegetation on depositional landforms is significant in the sense of RMA S6c; and all significant natural areas warrant the same protection. 'Other' indigenous vegetation also contributes to the maintenance of indigenous biodiversity. A comparable mapping exercise can clarify these land categories for the Eastern Mackenzie District.

67. Protection is distinct ecologically from no net loss. Protecting significant natural areas requires avoiding effects, because clearance of significant (and effectively all 'other') areas of indigenous vegetation in the Mackenzie Basin cannot be mitigated or offset but results in permanent loss. Off-site effects are already reducing significant indigenous vegetation, so achieving no net loss would now require retiring land from development.

68. To protect indigenous biodiversity the definition of clearance would need to additionally include mob-stocking and edge effects. I make suggestions for precisely defining depositional landforms.

69. The proposed Farm Biodiversity Plan (FBP) exception provides a new loophole that would give MDC wide discretion to exchange clearance of ecologically significant and other areas of indigenous vegetation for uncertain mitigation. The irreversible, large-scale loss and fragmentation of indigenous vegetation of recent years could therefore continue within and beyond the Basin.

70. Permitting indigenous vegetation clearance in WPS operating easements risks considerable unnecessary and avoidable loss of recognised significant indigenous vegetation and fauna habitat.

Susan Walker

12 February 2021

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