C15C/1815

IN THE MATTER OF The Resource Management Act 1991

AND

IN THE MATTER OF A submission on the Proposed Hurunui and Waiau Regional Plan

BETWEEN DIRECTOR-GENERAL OF CONSERVATION

AND CANTERBURY REGIONAL COUNCIL

EVIDENCE OF NICHOLAS JOHN HEAD
FOR DIRECTOR-GENERAL OF CONSERVATION
Dated 12 October 2012

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STATEMENT OF EVIDENCE OF NICHOLAS JOHN HEAD

INTRODUCTION

Qualifications and Experience

1. My name is Nicholas John Head. I am currently employed by the Department of Conservation as a plant ecologist where I have worked for the past 16 years. Previously I was employed by Landcare Research as a botanist for the Rabbit and Land Management Programme and Semi-Arid Lands Programme, based at Alexandra. I have a Master of Science (Hons) degree in plant ecology from Lincoln University and a BSc with a double major in plant ecology and physical geography from the University of Canterbury.

2. I am currently employed as a Technical Advisor – Plant Ecology, Ecosystems and Species for the Department of Conservation, Southern Service Centre, with a particular focus on the management and restoration of threatened plant species and rare ecosystems. I am also responsible for providing a wide range of botanical and ecological advice to staff and the public generally, and I have published numerous articles on Canterbury's threatened plants and ecosystems.

3. I have had extensive experience with assessing sites of significant ecological values in Canterbury. This includes being involved in three Protected Natural Area Programme (PNAP) surveys in Canterbury and I have assessed many sites that form the basis of Significant Natural Areas (SNAs) in numerous District Plans. I have also undertaken a substantial number of botanical assessments throughout Canterbury ranging in size from greater than 20,000 hectares to less than one hectare.

4. I have presented evidence on significance criteria and ecological values at most of Canterbury's District and Regional Council (Regional Policy Statement) Plan hearings, and have been involved in many Resource Management hearings, including in the Environment Court, relating to ecological matters.

5. Over the course of my work, I have gained extensive knowledge of ecological patterns and values in North Canterbury. This work has involved numerous ecological surveys such as tenure review, vegetation monitoring and threatened plant surveys. I recently assessed Lake Sumner's forest margins, and the ecological values of the Hurunui South Branch between the top of the gorge and Lake Mason Stream.

Scope of Evidence

6. I have studied the relevant biodiversity documents and the submissions lodged regarding the Proposed Hurunui Waiau Regional Water Plan (HWP).

7. I have read the Environment Court Practice Note – Expert Witnesses – Code of Conduct 2011 and have prepared my evidence in accordance with the Code and agree to abide by it. I confirm that my evidence is within my area of expertise, except where stated otherwise. I have not omitted to consider material facts known to me that alter or detract from the opinions I express in this statement of evidence.

8. My statement will address issues raised by the Director-General of Conservation (the Director-General) relating to the inadequacies of Zone A, in particular the exclusion the Hurunui Catchment which includes Lake Sumner. In particular my submission will:
    - Provide an overview of the frameworks used for assessing ecological significance in New Zealand.
    - Assess the adequacy of Zone A for identifying highest ecological values within the Hurunui Waiau Water Zone.
    - Discuss the ecological significance of Lake Sumner forest margins and the Hurunui River South Branch.
    - Discuss potential impacts of artificially raising natural lake levels and flooding the Hurunui River valley.
    - Conclusions.

Framework for Assessing Ecological Significance in New Zealand

9. To understand the ecological significance of an area, it is useful to know the background to assessing ecological values in New Zealand, and the subsequent development and use of assessment criteria to allow for the identification of significant ecological values.

10. In New Zealand, ecological assessment criteria have evolved from the Protected Natural Areas Programme (PNAP), which has been the main framework for assessing significant ecological and botanical values in New Zealand. The PNAP was initiated in 1981 by the National Parks and Reserves Authority because of concern that New Zealand's protected natural area system did not represent the full range of natural diversity, and that natural areas were continuing to be lost (Kelly and Park 1986).

11. To provide a framework for assessing this natural diversity, the country was subdivided into 268 Ecological Districts (EDs) and 85 Ecological Regions (ERs) (McEwen 1987). Each ED has a distinctive pattern of climate, geology, landforms and biological features. Adjacent districts with closely related characteristics form Ecological Regions. The ED remains the most appropriate scale for conducting PNAP surveys, as it provides an appropriate context to assess the significance of a site.

12. The PNAP uses standardised scientific field survey and analysis to identify Recommended Areas for Protection (RAP) that represents the very best sites in an ED. Site selection is based on applying seven selection criteria that are widely used internationally in evaluating nature conservation values (O'Connor *et al.* 1990). The criteria are: representativeness, diversity and pattern, rarity and special features, naturalness, size and shape, buffering/surrounding landscape and boundaries, and long-term ecological viability. Definitions of these criteria are provided in Appendix 1.

13. PNAP (or similar) surveys continue to be undertaken throughout New Zealand by Central and Local Government using the same or similar criteria. The ED spatial context and criteria provide a rigorous and objective framework for the

identification of ecological values throughout New Zealand. They have formed the basis for assessing nature conservation values in New Zealand in major projects where it is necessary to identify botanical and ecological values at the local, regional and national scale. They have been deemed appropriate for determining significance in terms of Section 6(c) RMA (1991) (Whaley et al. 1995).

Land Environments of New Zealand (LENZ) and the National Priorities for Protection

14. More recently, Landcare Research has developed the Land Environments of New Zealand (LENZ) classification as a tool to assist in identifying significant values and protection priorities. LENZ is a national classification of New Zealand environments using climate, landform and soil variables to predict areas of similar ecosystem character (Leathwick *et al.* 2003). In many ways LENZ supports the ED framework and is a guide to the likely pre-human pattern of terrestrial ecosystems and biodiversity.

15. LENZ is used in the Government's 2007 statement on national priorities for the protection of indigenous vegetation where less than 20% remains within Level IV (1:50,000 scale) Land Environments (MfE 2007). LENZ is also used in the Government's recent proposed National Policy Statement (NPS) on indigenous biodiversity (MfE 2011) and Environment Canterbury's Proposed Regional Policy Statement (PRPS) (ECan 2011). The 20% threshold is based on ecological theory which shows a dramatic loss in biodiversity when indigenous ecosystems are reduced to less than 20% of its previous extent (Walker *et al.* 2007). Land environments that contain less than 10% of its original cover are classified as Acutely Threatened, and between 10-20% as Chronically Threatened. Land environments that retain 20-30% indigenous cover are classed as At Risk. Whereas those with greater than 30% cover but less than 10% protected, and those between 10-20% protected, are classified as Critically Under-Protected and Chronically Under-Protected respectively (Walker *et al.* 2007).

16. Protecting indigenous vegetation that remains on Acutely Threatened and Chronically Threatened land environments is National Priority 1 of the Government's priorities for the protection of indigenous biodiversity on private land (MfE 2007). Other national priorities include:

- protection of ecosystems that have become rare such as wetlands (National Priority 2);
- protection of naturally rare ecosystems (National Priority 3);
- protection of habitats for At Risk and Threatened species (National Priority 4).

17. Preventing the loss of indigenous biodiversity per se (and its restoration) is a national priority generally in New Zealand (MfE 2000), especially on At Risk and poorly protected LENZ (MfE 2007). These policies and priorities are also consistent with the Proposed NPS on indigenous biodiversity (MfE 2011) and Environment Canterbury's PRPS (ECan 2011) and Biodiversity Strategy (ECan 2009).

Adequacy of Hurunui Waiau Water Zone A

18. As to the adequacy of the proposed Zone A, it is unclear how the current boundary has been arrived at or what assessment criteria have been used to determine high ecological values and what should or should not be included.

Not what they are indicating!!!

19. As it is currently mapped, Zone A incorporates the Waiau Catchment (including the Lewis Pass tributary rivers) which aligns broadly with the Balaclava and Lewis EDs, but also includes lesser parts of Miromiro and Sumner EDs (McEwen, 1987). Level IV Land Environments of New Zealand (LENZ) classifies most of Zone A as occurring in the central mountains (upper slopes and alpine peaks) (P1.2d, P2.1b, P2.1d) and Central Dry Foothills (mid -lower slopes) (LENZ E1.4c and E4.2a), with small LENZ of Central Upland Recent Soils (chiefly valley floors) (K1.1b) also present (Leathwick et al. 2003). Zone A predominately occurs within public conservation land, with the exception of pastoral lease properties that occur in the south eastern part of the Zone.

20. Zone A contains ecosystems and plant communities that range from highly natural and representative of the original pre-human character of the relevant EDs and LENZ, through to highly modified farmland. Much of Zone A retains its original vegetation which is comprised of extensive sequences of predominately mountain beech forest, diverse sub-alpine snow tussocklands and shrublands, screes and valley floor shrublands.

21. The most natural ecosystems in the best condition occur on public conservation land in the catchments of the Lewis, Nina, upper Boyle, upper Doubtful, upper Hope and upper Waiau rivers. These areas have not been affected by, or are recovering from, stock grazing and the effects of pastoralism generally (although grazing by feral animals has probably caused some compositional changes).

22. Native plant communities become more modified, fragmented and reduced in extent in the drier eastern part of the zone, on land that is, or was until recently pastoral lease (e.g. St James Station), and where climate and topography have been more conducive to agricultural development on pastoral lease land. Modified areas are typically characterised by short tussock grasslands and native scrub communities with varying proportions of exotic species, but also include extensive areas of exotic scrub (gorse, broom, conifers) as well as some highly developed paddocks.

23. I agree that much of Zone A as it is currently mapped has high ecological values. However, excluding the Hurunui catchment (North and South Branch) from Zone A is completely incongruous, as the Hurunui catchment contains some of the best examples of highly original ecosystems within the entire Hurunui Waiau water zone. These include intact sequences highly natural red, silver and mountain beech forests, valley floor shrublands, diverse subalpine and alpine ecosystems on public conservation land (Lake Sumner forest Park). It also includes nationally significant populations of threatened native birds as discussed in the evidence of Mr Grant, which are no longer extant in the Waiau Catchment. As a result of these values, the Hurunui catchment has been a

major focus for management by the Department, involving extensive animal pest control. This has further increased the ecological integrity and value of the Hurunui catchment.

24. Moreover the Hurunui catchment includes some of the highest ecological values present within the Hurunui Waiau Zone that are not replicated within the Waiau catchment. These include the Lake Sumner and Hurunui South Branch which are in my view of national and regional significance respectively. My following evidence will discuss the values of Lake Sumner and the Hurunui South Branch (between the gorge and Lake Mason Stream) in more detail.

Ecological Values of Lake Sumner forest margins

25. Lake Sumner is one of several large glacial lakes that occur along the eastern rain shadow zone of the Southern Alps. It occurs in the Sumner Ecological District (ED) which is within the Puketeraki Ecological Region (ER) (McEwen, 1987). Level IV Land Environments of New Zealand (LENZ) classifies the terrestrial environments surrounding Lake Sumner as occurring in Central Dry Foothills (LENZ E1.4c and E4.2a), with small LENZ of Central Upland Recent Soils (K1.1b) also present (Leathwick et al. 2003).

26. *Threatened land environments of New Zealand* (Walker et al. 2007) identified the majority of the surrounding terrestrial environments of Lake Sumner as having no threat category. The inlet delta and outlet terraces are classified as At Risk and a small portion of lake edge north of the outlet is identified as Chronically Under-Protected.

27. Lake Sumner margins and catchment slopes retains extensive original forest cover of predominately mountain beech and red beech which remains notably intact and highly natural. Large areas of second growth hardwood forest and scrub occur on the sunny faces of the Brothers Range on Lake Station, which occurs in a mosaic of manuka and kānuka, broadleaf, kowhai and numerous other hardwood trees and shrubs. A detailed description of the plant

communities present at various locations around the lake is attached in Appendix 2.

28. The lake margin is especially notable for its diversity of hardwood species which are rare or absent away from the lake edge under beech forest. These include kowhai, *Olearia* spp, lancewood, mountain five-finger, kohuhu, karamu, lancewood, southern rata, kamahi and many more. The presence of southern rata and kamahi is especially notable as both species are rare in Canterbury (Wardle 1991). The relatively extensive lake edge fringe of southern rata is one of approximately 12 recognised sites for this species in Canterbury and one of only four small stands in North Canterbury (*pers. com*. Dr Philip Simpson, Canterbury Crimson Trail - Project Crimson). Native sedges and high diversity of native 'turf' species occupy the more regularly inundated lake edge adjoining the forested margin complementing a diverse and complex lake edge ecotone.

29. Lake margins are classified as historically rare terrestrial ecosystems (Williams et al. 2007). New Zealand's naturally rare ecosystems are those that were uncommon before human colonisation. They comprise less than 5% of New Zealand's land area. They are typically associated by unusual geology and/or environmental conditions and characteristically support distinctive plant communities and species, as is highlighted by the comparative diversity and complexity of Lake Sumner's forest margins and lake edge. Moreover, recent threat assessment of New Zealand's naturally rare ecosystems has classified lake margins as nationally vulnerable, increasing the imperative for their protection (Holdaway and Wiser et al 2012).

30. Lake Sumner's forest margin is also important as a seasonal food source for native birds evidenced by the presence of kereru and tui that are commonly observed feeding on flowering kowhai that is abundant only in the forest margin (pers. Obs.). The importance of Lake Sumner for wildlife was recognised by Adcock (1994) who identified Lake Sumner as a nationally important wetland (Wetland of Ecological and Representative Importance (WERI)). Taylor et al. (1998) also recognised Lake Sumner as a Site of Special Wildlife Interest

(SSWI). ECan's inventory of Canterbury's rivers and lakes identified Lake Sumner as having outstanding natural values (Daly 2004).

31. At the national scale, New Zealand's classification of Freshwater Ecosystems (FENZS) (Snelder 2006) groups Lake Sumner into the mild, deep and large class (D1). Other similar lakes in Canterbury in the D1 class include Lake Coleridge, Lake Tekapo, Lake Pukaki, Lake Ohau, Lake Benmore, Lake Waitaki and Lake Aviemore. An assessment of the relative values of these lakes based on multiple terrestrial and hydrological attributes, identified Lake Sumner as the most natural and best condition of all the similar Canterbury lakes (Snelder 2006).

32. Lake Sumner is also the only large lake of its type in Canterbury that remains unaltered by dams and/or retains intact original vegetation in its catchment and margins. All other comparable lakes in Canterbury have been dammed and/or altered which has caused the loss of important natural lake edge ecosystems. In addition, all other comparable lakes have very little original native vegetation remaining. Accordingly, Lake Sumner stands out as the only predominately natural lake of its type remaining in Canterbury. This adds substantially to its overall significance and importance. A comparison of Lake Sumner to other comparable lakes is shown in Table 1 below and from the photos in Appendix 3.

Table 1 – Canterbury lakes of similar class (D1 – FRWNZS) and estimated degree of modification

Lake	Hydrology	Forest Remaining	Natural lake edge
Lake Sumner	Natural	>90	yes
Lake Coleridge	Raised	<5	no
Lake Tekapo	Raised	<1	no
Lake Pukaki	Raised	<1	no
Lake Ohau	Semi natural – modified/controlled	<10	Semi-natural
Lake Benmore	Artificial	<1	no
Lake Waitaki	Artificial	<1	no
Lake Aviemore	Artificial	<1	no

Assessment of Ecological Significance

33. The following assessment in Table 2 below uses standard assessment criteria, as discussed above, which provide an appropriate and objective method for assessing ecological significance.

Table 2 –Ecological assessment of Lake Sumner margins

Representativeness	**High:** Highly representative of the range of original vegetation communities and composition. Only example of a natural lake edge ecosystem remaining in ED and Canterbury.
Diversity and pattern	**High:** Includes major altitude, aspect, slope variation and natural ecotones and intact natural sequences.
Rarity and special features	**High:** Last intact example of natural lake edge ecosystem of its type in Canterbury. Includes rare and unusual plant associations around lake edge such as southern rata and kamahi, both rare plants in Canterbury. Lake margins are classified as naturally rare ecosystems. Identified as a WERI and SSWI
Naturalness/intactness	**High**: The area has very high naturalness as it remains predominately in original condition and little modified by humans.
Size, shape and	**High**: The site is relatively large and of compact shape. It is very

buffering	well buffered by natural features (ridgelines and spurs). It is surrounded by conservation land. The large size and compact shape, intactness, naturalness, buffering, natural functioning etc. means that the area meets essential criteria for long term viability (Park, 2000).
Connectivity:	**High:** It includes intact and natural vegetation sequences and ecotones that occur across intact environmental gradients associated with aspect, altitude and slope variation.
Long-term viability	**High:** -Demonstrates ecologically robust healthy functioning
Fragility and Threat	**Low/high:** Fragility low in the absence of human modification.

34. This assessment demonstrates clearly that Lake Sumner and its catchment contains significant ecological values. Its significance is heightened for being the last and most outstanding example of a natural lake ecosystem in its class remaining in Canterbury (Table 2). Furthermore, given lake margins are classified as naturally rare and nationally vulnerable, this reinforces the importance off Lake Sumner and its catchment as a nationally significant ecosystem and it should be included within Zone A.

Summary of the ecological values of the Hurunui South Branch (from the top of the gorge to Lake Mason Stream)

Ecological Context

35. The Hurunui South Branch occurs in the Sumner Ecological District which is in the Puketeraki Ecological Region (McEwen 1987). Land Environments of New Zealand (LENZ) classifies most of the area as occurring Central Dry Foothills (LENZ E) (Leathwick *et. al.* 2003). Threatened land environments classifies the majority of the valley floor as At Risk, with small areas classified as Acutely Threatened (Walker *et. al.* 2007), although a relatively large proportion lacks data. The adjoining hill slopes are classified as 'less reduced and better protected'.

36. The Hurunui South Branch valley floor, from the top of the gorge to Lake Mason Stream, comprises the following ecosystems and plant communities:

- Cushion and herb fields that that are representative of primary successional plant communities that occur on recent alluvial deposits associated with braided rivers.
- Matagouri dominant shrublands occupy many of the valley floor terraces and stable alluvial fans and are notable for their size and extent. In some places matagouri forms stands of up to four meters tall. These shrublands are highly representative of the original vegetation that occupied these environments and they are highly likely to be the best example remaining in the ED and possibly ER.
- Wetlands occur on poorly drained and/or spring fed terraces, old channels and on moraine depressions. The largest of these is an extensive swamp of approximately 30ha that occupies the poorly drained river flats on the true left toward the southern end of the Woolshed Ridge. Other notable wetlands include several small ephemeral wetlands that occur on lateral moraines that adjoin the slopes Woolshed Ridge. These ecosystems retain turf vegetation that is representative of the pre-human composition
- The short tussock grasslands occupy the dry alluvial valley floors and although modified they are also important for their contribution to the wide range of native plant species that occupy these environments prior to and post human arrival (McGlone 2001; Leathwick *et al*. 2003).
- On the adjoining terraces and lower slopes occur mixed shrublands, short tussock grasslands and remnant old-growth mountain beech forest. The shrublands and beech forest remnants are good examples of the range of woody native plant communities that occupied these environments pre and post human arrival (McGlone 2001) and are notable for their diversity and condition.

37. Although modified generally, these plant communities retain their natural character in terms of species composition, diversity and pattern. The riverbed cushion fields, wetlands and matagouri shrublands (and forests) are of

particular note as they are representative of the original 'pre-human' vegetation. A full description of these plant communities is in Appendix 4.

38. The Hurunui South Branch comprises a notable collection of naturally rare and threatened ecosystems (Williams et al 2007; Walker et al 2007; Holdaway et al 2012) that occur in sequences across the valley floor, adjoining terraces and hill slopes. Accordingly, much of the Hurunui South Branch valley contains ecological values that are of national priority for protection (Williams *et al.* 2007; MfE 2007). For example, braided rivers, inland alluvial surfaces and kettleholes are classified as naturally rare ecosystems (national priority 3); whereas wetlands nationally have undergone a 90% reduction and those remaining are of national priority for protection (MfE 2007, national priority 2). Furthermore, parts of the valley include threatened land environments containing representative native vegetation, which is also a national priority for protection (MfE 2007, national priority 1).

39. For the reasons outlined above, it is my view that the Hurunui South Branch is one of the best examples of a valley floor ecosystem remaining in the ED and possibly the ER. Accordingly, it contains significant ecological values of regional significance and national importance and should also be included in Zone A.

Impacts of raising of the Lake Sumner water level and flooding the Hurunui South Branch

40. Given recent proposals to raise the level of Lake Sumner and flood the Hurunui South Branch river valley, I wish to make the following comments on the potential impacts of such proposals.

41. Any artificial alteration to the natural hydrology and/or an increase in the lake level is likely to cause significant changes to natural vegetation patterns to the lake edge vegetation. Studies in New Zealand that have investigated the impacts of raising lake levels show the death of native tree species (Mark et al. 1977), erosion of lake margins as the lake shore reaches a 'new' equilibrium and associated increased siltation (Pickerill 1977; Single & Bunting 2003).

Notably, increased siltation and reduced water quality as a result of increased erosion was identified as a major threat to important macrophyte communities present in Lake Sumner (De Winton et al. 1991).

42. Based on these studies, I am highly confident that raising the level of Lake Sumner is likely to have the following major adverse effects:

- Loss of the last naturally rare lake edge ecosystem of its type remaining in Canterbury.
- Loss of one of the most distinctive parts of the wider Lake Sumner forest ecosystem.
- Loss of populations of several locally rare tree species that are primarily confined to the lake edge, including southern rata, kamahi, kowhai.
- Loss and/or reduction of an important seasonal food resource for native birds (pers. comm. Colin O'Donnell DOC R&D, Oct 2010).
- Increased lake edge erosion, slope stability issues, sedimentation and degraded water quality with concomitant impacts on the lake ecosystem, such as macrophyte, invertebrate and freshwater mussel communities.

43. Collectively these impacts will result in a permanent change to Lake Sumner and degradation of its ecological integrity. Because of the very high values of Lake Sumner as the only 'intact' and naturally functioning example of a lake ecosystem of its type remaining in Canterbury, the natural rarity and the distinctiveness of the lake edge ecosystem, these impacts take on high significance.

44. Flooding the Hurunui South Branch will have similar impacts to those described above, with the permanent loss of nationally important ecological values.

Conclusions

45. Zone A as proposed in the Hurunui Waiau Water Zone Plan only identifies the Waiau Catchment as having high natural values, although it is not clear how these values were identified for Zone A.

46. Analysis of ecological values using appropriate assessment criteria identifies the Hurunui Catchment as having some of the highest values of national significance within the Hurunui Waiau Zone that are excluded from Zone A.

47. Of particular significance and importance is Lake Sumner and its catchment, which is of national significance for being the last predominately natural lake ecosystem of its type remaining in Canterbury. The Hurunui South Branch valley and catchment also comprises ecological values of national and regional significance.

48. It is completely incongruous that the Hurunui Catchment is excluded from Zone A and it inclusion is necessary for the accuracy and adequacy of the Hurunui Waiau Water Zone Plan.

49. The natural hydrological functioning of Lake Sumner is intricately linked to its very high ecological values. Artificially raising the lake level will most likely result in the permanent loss of values. Flooding the Hurunui South Branch valley will have a similar impact.

Nicholas John Head

12 October 2012

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Appendix 1: Criteria for Identifying Nature Conservation Values (O'Connor et al 1990)

Representativeness. This criterion is normally applied in the context of a biogeographical framework. The assessment involves comparing current natural indigenous diversity with that of the past (a specified datum), and focuses on the typical or commonplace, or what is characteristic of an area. A high representative value recognises those ecosystems that were present in the original landscape. In highly modified environments, e.g., lowlands, only some elements of the original ecosystems remain but they can still be rated relatively highly. It is important to ensure representation of the full range of genetic and ecological diversity across all environmental gradients such as climate, altitude and soil sequences. This criterion is complemented by other criteria, as some ecological elements are not well catered for by representativeness e.g. mobile animals, specialised or rare species.

Diversity and pattern. This refers to all kinds of diversity including physical, habitat, biological, genetic and ecological processes. Ecotones are particularly important elements, being transitions between adjacent ecological patterns or communities. They tend to be highly productive, supporting a high species diversity and providing important habitats for species from adjacent communities. In general larger areas contain more diversity, but this is not always the case. Some areas are naturally of low diversity, but support the full range of diversity expected for a particular habitat type or community. This criterion is sometimes referred to as natural diversity.

Rarity and special features. This incorporates rarity in the uncommon sense, and threatened in its classification sense e.g. a nationally threatened species. This criterion is applied to biological, physical and ecological features. It identifies non-typical features, and is a safety net for those not identified through representativeness. Rarity can be natural or human-induced. Special features include endemism, relict distributions, type localities, distribution limits and atypical bedrock. 'Distinctiveness' is another term for 'special features'.

Naturalness. Naturalness refers to a lack of human disturbance or modification. Natural ecosystems are valued more than, as modified ecosystems tend to lose their integrity and their vulnerable species. In reality naturalness is a gradation as there are few, if any, totally natural areas remaining in New Zealand. While ecosystems may be induced or secondary, they can still be valuable for supporting indigenous flora and fauna. Similarly, highly modified areas can be important for supporting the only remaining indigenous biodiversity in local areas. Naturalness is best assessed within an ED context as it varies greatly between districts.

Size and shape, buffering/surrounding landscape and boundaries. These two criteria are best applied together as they are very closely related. In general, larger and compact areas are more highly valued because of their greater life supporting or carrying capacity. Larger areas tend to be characterised by greater natural diversity, and compact areas are less influenced by edge effects. Small areas do however, contribute to total genetic diversity and may have an increased collective value, for example scattered small wetlands used by water birds. This is particularly important in highly modified landscapes where small remnants may be all that remain.

Buffers are zones around core areas of ecological value that help to reduce external influences and maintain their values. They are often natural or semi-natural areas, though they can also be highly modified (e.g. ungrazed riparian pasture).

Activities or threats from surrounding landscapes can have major impacts on the long-term viability of sites, e.g., weed invasion, grazing and nutrient pollution. The ecological processes affecting indigenous ecosystems inevitably extend beyond their obvious physical boundaries e.g. hydrology, pollination and dispersal.

Linkages have important ecological roles between isolated remnants or distant ecosystems. They provide for migration, dispersal and the exchange of genetic material between sites. Linkages encompass all forms of connectivity and are not necessarily linear or continuous. Bennett (1999) reviewed linkages and connectivity in considerable depth and provided many case studies, including one from New Zealand. Evidence for the value of linkages includes many documented examples of

animals using them for movement such as daily and seasonal movements, dispersal and range expansion. Limited experimental results and predictive models also consistently indicate that high levels of habitat connectivity are associated with a greater occurrence and persistence of populations in isolated habitats (Bennett 1999). It is important to maximise the width of linkages to minimise edge effects. Wider linkages also increase the potential diversity of habitats, animal and plant assemblages and natural disturbance regimes.

Long-term ecological viability. This requires an overview of ecological values and ecosystem functioning. Ideally areas of indigenous biodiversity should inherently be able to retain their ecological health and natural values over time. Park (2000) made a distinction between integrity and health. Integrity relates to ecosystems in their natural state that are self-maintaining and resilient. Health has a more narrow meaning and applies to altered ecosystems, which despite containing naturalised biota etc., are still stable and resilient. The best way to achieve long-term viability is by maintaining complete ecosystems. This will be difficult in highly modified areas due to ecosystem fragmentation and adjacent land use effects, so that sites will need greater management input. Restoration potential is an integral part of this concept.

Fragility and threat **and** ***management input.*** Fragility refers to a sites inherent vulnerability to environmental change, which is determined by its biological components and its position in the landscape. Threats refer to human or artificial factors which adversely affect the health of a natural area. In highly modified situations where ecosystems are no longer in equilibrium, specific indigenous plants or animals may function as threats. Management input is a measure of how much effort is required to maintain the health of a particular natural area, (e.g. weed control, pest control, or fencing).

Appendix 2 – Field notes Lake Sumner inspection 5/10/2010

A rapid assessment of the botanical values around Lake Sumner was undertaken on the 5 October 2010. The lake was traversed by boat and general botanical descriptions were made of major plant communities present. Several landings were made around the lake edge to enable better description of the plant communities present. The weather was fine although the north-west wind was strong in the afternoon making botanical descriptions somewhat difficult in places. Photos assisted in general interpretation.

The lake was 'high' after recent heavy rain and the forested edge was generally within 10 cm of the water for much of its margin. Although the lake level was considered high at the time of inspection, it was about 850 mm lower than the average run height proposed as part of HWP based on our calculation of the lake level that day.

The south edge of Lake Sumner comprises predominately forested steep and rocky sunny faces of the Brothers Range. The shoreline is predominately steep and rocky with regular bluffs and sporadic shingle beaches, although an extensive shingle beach occurs along the lake edge toward the outlet.

These lake faces comprise an extensive mosaic of hardwood species including large patches of manuka (*Leptospermum scoparium*), kanuka (*Kunzea ericoides*) and old growth red and mountain beech forest (*Nothofagus fusca* and *N. solandri* var. *cliffortioides*). Notable is the transition from manuka dominance on the slopes near Lock Katrine, to kanuka on the sunny slopes and terraces towards the outlet.

The lake edge ecosystem contains a notably mixed composition of high species diversity. Kowhai (*Sophora microphylla*), broadleaf (*Griselinia littoralis*), kohuhu (*Pittosporum tenuifolium*), weeping mapou (*Myrsine divaricata*), *Coprosma linearifolia*, manuka, kanuka, lancewood (*Pseudopanax crassifolius*), *Olearia avicenniifolia*, *Coprosma propinqua*, putaputaweta (*Carpodetus serratus*), *Coprosma linearifolia*, *C. propinqua*, *Corokia cotoneaster*, mountain wineberry (*Aristotelia*

fruticosa) were commonly present. Occasionally present was Hall's totara (*Podocarpus cuninghamii*), black beech and red beech, red matipo, karamu (*Coprosma robusta*), mountain fivefinger (*Pseudopanax colensoi), Hebe traversii, H. salicifolia*, and one plant of southern rata (*Metrosideros umbellata*) was seen. Sunny bluffs were quite common and support specialist species including *Heliohebe raoulii, Parahebe decora* (close to water margin), plume grass (*Dichelachne crinita*) *Rytidosperma* sp, blue tussock (*Poa colensoi*), *Helichyrsum intermedium, Senecio dunedinensis* (?) and *S. quadridentatus*, leather leaf fern (*Pyrrosia eleagnifolia*), *Helichrysum lanceolatum, Rubus squarrosus*, blue wheat grass (*Elymus solandri*).

Lake edge turf communities are common on gentle lake shore gravels and exposed silty banks. Turf communities comprise a high diversity of specialist native plants that are adapted to fluctuating water levels. These turf communities grade into a taller sedge and rush zone, shrubs and forests species with increasing distance away from the lake. Common species present were *Lobelia angulata, Hydrocotyle hydrophila, Leptinella squalida subsp mediana, Plantago triandra, Ranunculus cheesemanii, Gonocarpus aggregatus, Euchiton limosum, Limosella lineata, Lilaeopsis novae-zelandiae, Montia angustifolia, Carex gaudichaudiana, and Carex berggrenii* (At Risk - declining) (de Lange et al. 2009). Bog rush (*Schoenus pauciflorus*), spike sedge (*Eleocharis acuta*), *Juncus edgariae* and *Carex buchananii* and *C. coriacea* are common in the taller sedge zone before merging into shrublands and forest species. Excellent examples of turf communities occur around the northern end of the lake and around Loch Katrine where the lake edge slope is gentle. Extensive swards of *Carex gaudichaudiana* and mixed turf communities also occur on the lake delta. These native sedgelands and turfs occur with numerous various wetlands species such as *Carex buchananii, C. coriacea, Rumex flexuosus, Lobelia angulata, Montia angustifolia*, where they merge into predominately exotic browntop grassland and matagouri shrublands. The presence of these native plant communities at the head of the lake contrasts somewhat with the Boffa Miskell description of this area which considered theses native plant communities as exotic grasslands.

Extensive mountain beech forest occurs toward the outlet were it adjoins a shingle beech. The forest margin is mixed with kowhai, broadleaf, *Coprosma lineariifolia*,

kanuka and *Coprosma propinqua* which forms a distinctive and diverse ecotone compared to the more uniform mountain beech forest behind.

A fringe of *Coprosma propinqua* with an occasional kowhai occurs as an isolated strip between shingle beech and forest margin.

Large patches of old closed canopy kanuka forest occur toward the outlet on terraces, which is mixed with kowhai, sapling mountain beech, lancewood, putaputaweta, and broadleaf. Matagouri (*Discaria toumatou*), *Coprosma propinqua, Corokia cotoneaster Rubus schmidelioides* occurs in patches around the edge. Occasion patches of *Juncus edgariae*, bog rush (*Schoenus pauciflorus*) and *Carex buchananii* occur (in water) around lake edge.

Dry turf communities occur sporadically on the shingle beach where it adjoins the low terrace bank. Pohuehue (*Muehlenbeckia axillaris*), *Coprosma atropurpurea, Leptinella squalida* subsp *mediana*, dominate the vegetation, with to a lesser extent *Hydrocotyle microphylla, Stellaria gracilenta, Chaerophyllum rigida, Geranium sessiliflorum, Cardamine* "Scree race" (pers comm. Peter Heenan Landcare Research), *Carex breviculmis, Leucopogon frazerii* and woolly moss (*Racomitrium pruinosum*).

The majority of the northern (shady) edge comprises a narrow rocky edge of approximately 3.0 meters wide which adjoins the steeper slopes of two adjacent mountains (Niggerhead and Macs Knob). Occasional shingle beaches are present where there are embayments. Extensive mountain beech and red beech forest is the dominant vegetation forming extensive and intact sequences. The lake edge ecosystem contains a mixture of hardwood trees and shrubs that merge with sporadic rushes along rocky shoreline. Red beech also relatively common along the edge.

Several plots describe the vegetation adjoining the northern shores of Lake Sumner as follows:

Lake edge plot within 3.0 meters of lake edge and within about 1.0 m of lake level

Adjoining slope plot within 20 meters in from the lake edge.

Lake edge Plot E2449514 N5832556

Lake edge ecosystem occurs across approximately 3.0 m of rocky shoreline between water and adjoining slopes. Open canopy of mountain beech, broadleaf, kowhai, lancewood, putaputaweta. Other species present include hook grass (*Uncinia rupestris*), *Rubus cissoides* and numerous seedlings of before mentioned tree and shrub species.

Dense pole stage mountain beech delineates adjoining mountain beech dominant forest on adjoining slopes from lake edge forest ecosystem on rocky margin.

20 meters up slope from lake edge predominately red beech canopy to around 30 m. Sub canopy comprises *Coprosma lineariifolia*, and mountain and red beech with lancewood rare. Shrub layer dominated by red beech, with mountain beech, lancewood, broadleaf and *Coprosma microphylla* rare. Ground layer primarily litter, with hook grass occasional and *Coprosma propinqua* seedlings rare.

Lake edge rata plot E 2447111 N5834603

Steep rocky bank with southern rata, *Olearia arborescens, Coprosma robusta, Coprosma lineariifolia, Coprosma propinqua, Corokia cotoneaster.*, kowhai, broadleaf, kohuhu, *Blechnum montanum*, kamahi (*Weimania racemosa*), weeping mapou, kanuka, mountain beech, *Schoenus pauciflorus, Poa imbecilla, Gautheria antipoda*, hook grass (*Uncinia uncinata*), *Asplenium appendiculatum, Hebe traversii*, lancewood, hounds tongue.

20 meters in mountain beech canopy with broadleaf, *Coprosma lineariifolia*, lancewood, mountain fivefinger, *Asplenium appendiculatum*, red beech, hound's tongue.

Lake edge plot E2445325 N 5834838.

Large trees of rata dominant along lake edge all rooted below 1.0 m of water line, most within 600 mm of lake. Other species along edge include *Coprosma lineariifolia,*

Archeria traversii, lancewood, broadleaf, kowhai, *Leptecophylla juniperina*, putaputaweta, mountain beech, *Hebe traversii*, *Parahebe decora*, *Schoenus pauciflorus*, hook grass, *Olearia avicenniifolia*, *Coprosma foetidissima*, *Gautheria antipoda*, *Coprosma robusta*, *Blechnum procerum*, *Coprosma propinqua*, *Oxalis magellanica*, red beech

20 meters in mountain beech canopy with broadleaf, *Leptecophylla juniperina*, red beech, *Coprosma microcarpa*, putaputaweta, *Coprosma foetidissima*, lancewood, *Pittosporum anomalum*, *Coprosma microcarpa*, *C. lineariifolia*, broadleaf.

Kamahi on lake edge with southern rata. Multi trunk basal diameter approximately 20 cm. GPS E2445041 N5834750

Lake edge ecosystem dominated by rata through middle section of lake, but gives way to mixed hardwood species toward the western end. High diversity of species such as *Olearia avicenniifolia*, mountain five finger, broadleaf, *Coprosma propinqua*, kowhai, kohuhu, putaputaweta, *Coprosma lineariifolia*, with uniform mountain beech forest behind edge.

Small stand of red beech and kowhai on alluvial fan at Charley's Point. Red beech to approximately 30 m, kowhai approximately 20 m. Fringe of scrub of *Coprosma propinqua*, *C. rigida*, *C. lineariifolia*, mountain wineberry, matagouri, *Rubus schmidelioides* (abundant), prickly shield fern (*Polystichum vestitum*) and occasional kanuka. Cattle sign. Open patches dominated by exotic grasses, such as Yorkshire fog (*Holcus lanatus*), brown top (*Agrostis capillaris*), creeping buttercup (*Ranunculus repens*), white clover (*Trifolium repens*) etc. Surrounding alluvial fan contains scattered matagouri in woolly moss field with dwarf heath, sun orchid (*Thelymitra longifolia*) and common exotic and native alluvial grassland species.

Notable in this patch of forest was an abundance of kereru (*Hemiphaga novaeseelandiae*) that were all feeding on kowhai. Tui (*Petroica australis australis*) were also present in kowhai.

Loch Katrine

More modified than Lake Sumner, especially the south west margin which has lost most of its forest except for a narrow lake edge fringe. Manuka is a common edge species compared to kanuka around Lake Sumner. The western edge forest reduced to a narrow strip of mainly large kowhai, with broadleaf, manuka, *Olearia avicenniifolia*, weeping mapou, lancewood, *Hebe salicifolia* and patches of mixed mountain and red beech present. Most kowhai appear to occur within 500 mm of lake and suggests that much of this remaining forest edge will be drowned.

Northern side of Loch Katrine contains relatively intact forest margin edge. It has similar characteristics to that around Lake Sumner including a high diversity of species in the edge which becomes less diverse away from the lake edge. Manuka is a common edge plant compared to Lake Sumner.

Appendix 3. Photos of comparable lakes in Canterbury showing high degree of modification compared to Lake Sumner

Lake Tekapo

Lake Coleridge

Lake Pukaki

Lake Ohau

Lake Benmore and Lake Aviemore

Lake Sumner

Appendix 4. Description of plant communities and ecosystems of the Hurunui South Branch between the top of the gorge and Lake Mason.

This summary is based on a rapid botanical assessment of the South Branch of the Hurunui River on the 5th March 2010 between the top of the gorge to Mason Stream. Survey was predominately confined to the valley floor communities and adjoining toe slopes on the true left of the river.

Braided river bed communities are comprised of a variety of specialist native plant species that that are highly representative of primary successional communities that occur on recent alluvial deposits. Cushion plants are a feature of this plant community, such as mat daisies *Raoulia haastii, R. tenuiculmis, R. australis, R, hookerii, R. grabra*, and *Scleranthus uniflorus*. Other common native species include *Coprosma atropurpurea, C. petriei,* dwarf heath, *Pimelea traversii,* wood rush (*Luzula rufa* var. *albicomans)*, *Stellaria gracilenta,* creeping pohuehue (*Muehlenbeckia axillaris*), *Carex breviculmis, Colobanthus strictus* and willow herbs *Epilobium melanocaulon and E. microphyllum.* Mouse-ear hawkweed, silvery hair grass (*Aira caryophylla*), catsear, sheep sorrel (*Rumex acetosella*), sweet vernal (*Anthoxanthum odoratum*), and storks bill (*Erodium cicutarium*) are the predominant exotic species present.

Matagouri dominant shrublands occupy much of the valley floor and are notable for their size and extent. In some places matagouri forms stands of up to 4 meters tall. These shrublands are highly representative of the original vegetation that occupied these environments and they are highly likely to be the best example remaining in the ED and possibly ER. Other native species present include *Carmichaelia australis, Coprosma propinqua,* porcupine scrub (*Melicytus alpinus*), and the lianes (*Clematis marata, Muehlenbeckia complexa, M. australis,* native blackberry (*Rubus schmidelioides*)). Numerous native birds were observed within these shrublands, including bellbird, fantail, grey warbler and silvereye.

Wetlands occur on poorly drained terraces, old channels and on moraine depressions. The largest of these is an extensive swamp of approximately 30ha that

occupies the poorly drained river flats on the true left toward the southern end of the Woolshed Ridge. It is dominated by bog rush (*Schoenus pauciflorus*) and *Carex gaudichaudiana* which forms up to 60% of the cover combined. It occurs in a mosaic with patches of *Carex secta C. sinclairii, C. diandra,* spike sedge (*Eleocharis acuta*), *Juncus edgariae, Ranunculus glabrifolius* and open water. Jointed rush (*Juncus articulatus*) is the most common exotic species present which occurs throughout the wetland. Other common exotic species present include Yorkshire fog (*Holcus lanatus*), soft rush (*Juncus effusus*). Exotic species are especially present around the margins which are more impacted by cattle. Apart from the edges, the core of this wetland remains relatively intact and in good condition.

Other notable wetlands include several small kettleholes that occur on lateral moraines that adjoin the slopes Woolshed Ridge. These ecosystems retain turf vegetation that is representative of the pre-human composition. Common species present in these kettleholes include *Carex gaudichaudiana, Euchiton traversii, Lobelia angulata, Eleocharis acuta, Mazus radicans, Montia angustifolia* (naturally uncommon) (de Lange 2008), *Gonocarpus micranthus* and *Leptinella pusilla.* Kettleholes occur in depressions in climates where seasonal variation in rainfall and evaporation leads to ponding in winter and spring, and with fluctuation so pronounced that it can lead to complete drying in summer months or in dry years. Johnson and Rogers (2003) note that "despite their scattered occurrence and small total area in New Zealand, ephemeral wetlands are diverse in their plant communities, extremely rich in their flora, and clearly important as the sole or principal habitat for a high proportion of threatened plant taxa". New Zealand wetland turf plants and their communities may be of high significance in a global context for they appear to have no analogues in the Northern Hemisphere, where ephemeral wetlands are typically vegetated with plants of much taller stature.

Fescue tussock (*Festuca novae-zealandiae*) and silver tussock (*Poa cita*) grasslands comprise an important component of the vegetation of the alluvial valley floor. They typically occur as part of the wider matagouri shrubland and wetland mosaic on dry alluvial surfaces. Tussock cover is typically sparse and exotic species are common, especially brown top and mouse-ear hawkweed, however, these grasslands contain a

high diversity of native inter-tussock species that make an important contribution to the wide range of native species that occur in these environments (including invertebrates). Common native species present include mat coprosma (*Coprosma atropurpurea* and *C. petriei*), dwarf heath *(Leucopogon frazerii*), *Rytidosperma pumila, Carmichaelia nana, Brachyglottis bellidiodes, Celmisia gracilenta, Brachyscome sinclairii, Geranium brevicaule, Helichrysum filicaule,* and woolly moss (*Racomitrium pruinosum*).

On the adjoining terraces and lower slopes occur mixed shrublands, short tussock grasslands and remnant old growth beech (*Nothofagus colensoi* var. *cliffortioides)* forest. Although these communities were not surveyed in detail, the shrublands and beech forests present on the lower slopes were notable for their diversity, condition and naturalness, and are significant as good examples of the range of woody native plant communities that occupied these environments pre and post Polynesian burning (McGlone 2001). The subalpine communities occur at higher altitudes but these were not inspected.