BEFORE THE HEARINGS PANEL
FOR THE PROPOSED QUEENSTOWN LAKES DISTRICT PLAN

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of Hearing Stream 14: Wakatipu Basin hearing and transferred Stage 1 submissions related to Arrowtown and Lake Hayes

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STATEMENT OF EVIDENCE OF GLENN ALISTER DAVIS ON BEHALF OF QUEENSTOWN LAKES DISTRICT COUNCIL

ECOLOGY – WAKATIPU BASIN VARIATION AREA

28 May 2018

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1. INTRODUCTION

1.1 My full name is Glenn Alister Davis. I am Director and Principal Environmental Scientist of e3Scientific Limited (**e3s**). I have been in this position since 2007. I have 20 years' postgraduate work experience in environmental management. I have a BSc in Ecology and MSc in Geography.

1.2 I have worked as a professional ecologist in the Queenstown Lakes District (**District**) for the last 12 years. During this time, I have worked on a wide range of projects for the agricultural and land development sectors and for Queenstown Lakes District Council (**QLDC**). In addition, I have also held a contract with Land Information New Zealand to support the assessment of discretionary activities on high country pastoral leases under the Crown Pastoral Lease Act. Many of these projects have triggered the Operative District Plan (**ODP**) indigenous vegetation site standard.

1.3 In 2009 I was engaged by QLDC to commence the first stage of the process to identify, assess and include further areas of significant indigenous vegetation and significant habitats of indigenous fauna, as outlined in Appendix 5 of the ODP. I completed this first stage (initial identification) in collaboration with three Queenstown based ecologists - Neill Simpson, Dawn Palmer and Simon Beale. In conjunction with QLDC I have implemented Stages 2, 3 and 4 of the Assessment Criteria.

1.4 I was engaged to provide evidence on behalf of QLDC for the hearings of Stage 1 of the Proposed District Plan (**PDP**). Specifically, I provided evidence on:

(a) Chapters 33 (Indigenous Vegetation & Biodiversity);
(b) Chapter 34 (Wilding Exotic Trees);
(c) Expert ecologist evidence for the following rezoning hearings:
    (i) Hearing Stream 11 Ski Area Sub Zones;
    (ii) Hearing Stream 12 Upper Clutha; and
    (iii) Hearing Stream 13 Queenstown.

1.5 I have now been engaged by QLDC to provide evidence in relation to Hearing Stream 14. My evidence relates to Wakatipu Basin Variation.

1.6 Although this is a Council hearing, I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014 and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person.

1.7 The key documents I have used, or referred to, in forming my view while preparing this brief of evidence are:

(a) Bayer, T. K., Schallenberg, M., & Martin, C. E. (2010). Investigation of nutrient limitation status and nutrient pathways in Lake Hayes, Otago, New Zealand: A case study for integrated lake assessment. New Zealand Journal of Marine and Freshwater Research, 42(3), 285-295. doi:10.1080/00288330809509956

(b) Cromarty, P., & Scott, D. A. (1995). A Directory of Wetlands in New Zealand. Wellington: Department of Conservation.

(c) Derraik, J., Rufaut, C., Closs, G., & Dickinson, K. (2005). Ground invertebrate fauna associated with native shrubs and exotic pasture in a modified rural landscape, Otago, New Zealand. New Zealand Journal of Ecology, 129-135.

(d) Gange, A.C., Lindsay, D.E. and J.M. Schofield (2003). The Ecology of Golf Courses. Biologist 50: 2, pp 63-68.

(e) Goodman, J. M., Dunn, N. R., Ravenscroft, P. J., Allibone, R. M., Boubee, J. A., David, B. O., . . . Rolfe, J. R. (2013). Conservation status of New Zealand freshwater fish. Department of Conservation. NZ Threat Classification Series 7.

(f) Hanski, I. (1998). Metapopulation dynamics. Nature 396, pp 41-49.

(g) Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., . . . Rolfe, J. (2016). Conservation Status of New Zealand Reptiles, 2015. New Zealand Threat Classifiction Series 17. Wellington: Department of Conservation.

(h) Hydrosphere Research. (2017). Lake Hayes Restoration and Management Plan. Dunedin: Hydrosphere Research Ltd.

(i) Landcare Research. (2016). Our Environment Basemap. Wellington.

(j) Landcare Research. (2017, June). Naturally Uncommon Ecosystems: Lake Margins. Retrieved from Landcare Research: www.landcareresearch.co.nz

(k) Landcare Research. (2018). Retrieved from Our Environment: http://ourenvironment.scinfo.org.nz/home

(l) LAWA. (accessed 2018, May 01). Retrieved from Land Air Water Aotearoa: https://www.lawa.org.nz/explore-data/otago-region/river-quality/clutha-river/mill-creek-(fish-trap)/

(m) Leathwick, J., Wilson, G., Rutledge, D., Wardle, P., Morgan, F., Johnston, K., . . . Kirkpatrick, R. (2003). Land Environments of New Zealand. Auckland: David Bateman Ltd.

(n) Meurk, C. (1997). Rediscovering & Restoring Natural Heritage in the Wakatipu Basin. Landcare Research Contract Report: LC9697/081.

(o) Moore, S. C. (2000). Photographic guide to the freshwater algae of New Zealand. Dunedin: Otago Regional Council.

(p) New Zealand Birds Online, 2015. Accessed May 2015.

(q) New Zealand Freshwater Fish Data Base. Accessed May 15 2018. https://nzffdms.niwa.co.nz/

(r) NIWA. (accessed 2018, May 1). Retrieved from LakeSPI Lake Submerged Plant Indicators: https://lakespi.niwa.co.nz/lake/54190

(s) ORC. (2009). Otago lakes' trophic status. Dunedin: Otago Regional Council.

(t) ORC. (2014). Investigation into the Wakatipu Basin Aquifers. Dunedin: Otago Regional Council.

(u) ORC. (2016a). Regional Plan: Water for Otago. Dunedin: Otago Regional Council.

(v) ORC. (2016b). Water quality for the Arrow Basin area. Dunedin: Otago Regional Council.

(w) ORC. (2017). Update of scientific information for the Arrow catchment: 2012-2017. Dunedin: Otago Regional Council.

(x) O'Toole, C., Donohue, I., Moe, S J., & Irvine, K. (2008). Nutrient optima and tolerances of benthic invertebrates, the effects of taxomonic resolution and testing of selected metrics in lakes using an extensive European data base. Aquatic Ecology, 42(2), 277-291.

(y) Patrick, B. (1994). The importance of invertebrate biodiversity : an Otago Conservancy review. Conservation Advisory Science Notes No. 53, Department of Conservation, Wellington. 13p.

(z) Robertson, H.A.; Baird, K.; Dowding, J.E.; Elliott, G.P.; Hitchmough, R.A.; Miskelly, C.M.; McArthur, N.; O'Donnell, C.F.J.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. (2017). Conservation status of New Zealand birds, 2016. New Zealand Threat Classification Series 19. Department of Conservation, Wellington. 23 p.

(aa) Ryder Environmental. (2018). Waterfall Park: Mill Creek - Assessment of Aquatic Ecology Effects. Dunedin: Ryder Environmental Limited.

1.8 All references to PDP provision numbers, are to the Council's Reply version of those provisions (unless otherwise stated).

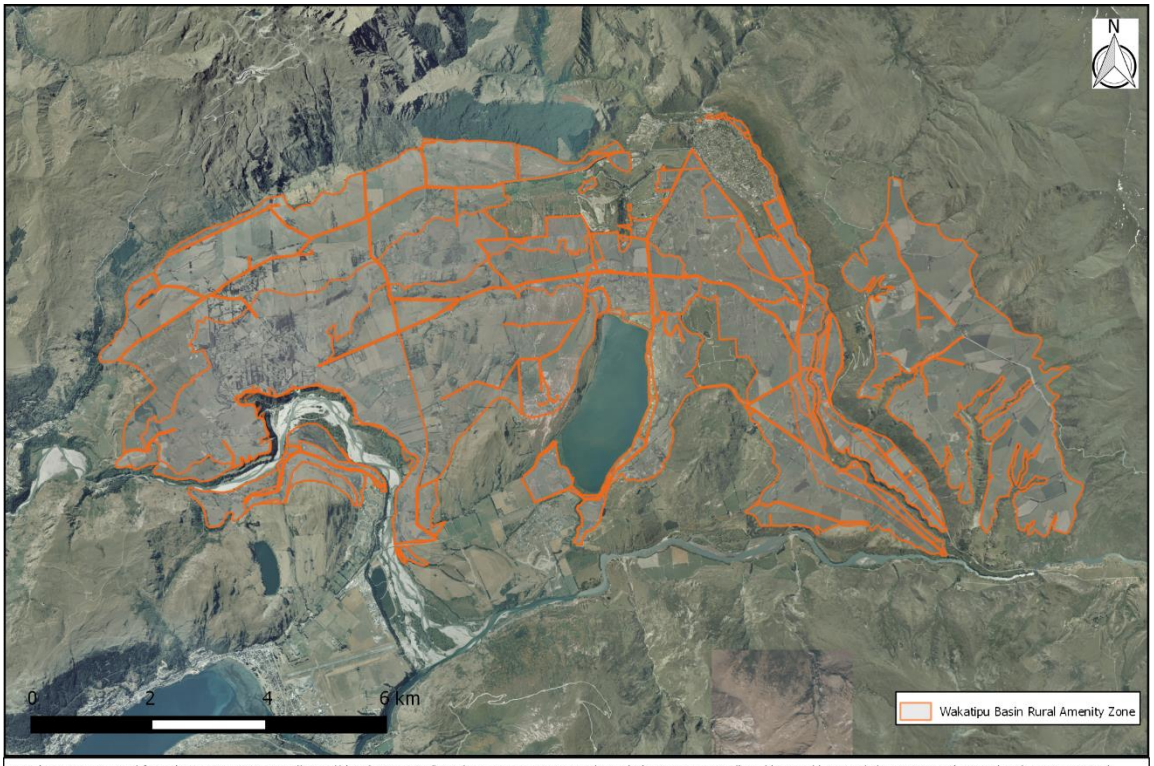
2. OVERVIEW / SCOPE

2.1 Part of the purpose of this hearing is to consider submissions relating to land within the Wakatipu Basin Rural Amenity Zone (**Amenity Zone**). In order to support a review of submissions and consider possible implications of changes to the PDP on ecological values, QLDC engaged e3Scientific Limited (**e3S**) to prepare ecological evidence to set out the ecological values remaining within the Amenity Zone and restoration opportunities.

2.2 The area defined as the Amenity Zone for the purposes of this assessment is presented in

2.3 , and includes both the Amenity Zone and the Wakatipu Basin Lifestyle Precinct, a Sub Zone of the Amenity Zone.

Figure 1: Area comprising the Wakatipu Basin Rural Amenity Zone.



Aerial Imagery sourced from the LINZ Data Service (https://data.linz.govt.nz/layer/51910-otago-075m-rural-aerial-photos-2004-2011/) and licensed by Terralink International Limited and Otago Regional Council for re-use under the Creative Commons Attribution 4.0 International licence. The 'Wakatipu Basin Rural Amenity Zone' (or Proposed District Plan Stage 2 Wakatipu Basin Zone) is sourced from the Queenstown Lakes District Council; all data is copyright reserved by QLDC, and under Crown Copyright Reserved and Creative Commons Attribution 3.0 New Zealand licence.

2.4 I understand that there are other rezoning submissions being considered in this hearing (outside the scope of the Amenity Zone). I have not been instructed to consider them specifically and that land has not been subject to the study.

3. EXECUTIVE SUMMARY

3.1 The original pre-settlement vegetation is predicted to have consisted of beech and podocarp forests on the hillsides surrounding the Wakatipu Basin, with shrubland, tussock grassland and wetlands on the Basin floor.

3.2 The Wakatipu Basin has had a long history of burning and pastoral activity, which has resulted in extensive loss of indigenous ecosystems, vegetation and habitats.

3.3 Introduced trees, shrubs and pasture now dominate the Basin landscape.

3.4 The remaining systems with indigenous flora and fauna components within the Wakatipu Basin are associated with the remnants of shrubland, wetlands, and watercourse habitats, along with surviving populations of native bird, fish, invertebrate, aquatic macroinvertebrate, and lizard species. The remaining native vegetation within the Basin is highly degraded, isolated, and generally small in scale, however, it is utilised by the remaining faunal values within the Basin.

3.5 The remnant grey shrubland patches that are present within the Basin predominantly consist of matagouri (*Discaria toumatou*) with scattered *Coprosma propinqua and Olearia spp*. The shrubland patches lack the diversity of the original communities, however they continue to provide ecological value as they provide habitat for indigenous invertebrates, lizards and birds and are valuable in supporting potential future restoration projects.

3.6 A range of wetlands and riparian habitat remains in the Basin. This habitat is now largely dominated by introduced species such as soft rush (*Juncus effusus*), willows (*Salix* species), and swards of introduced grasses however indigenous species such as *Carex secta* do persist and ecological values remain as they provide habitat for threatened fish and bird species, flood mitigation and act as sediment and nutrient sinks.

3.7 Freshwater habitats have been modified, primarily through the straightening of water courses, loss of riparian vegetation and nutrient and sediment inputs associated with landuse within the Basin. However, freshwater bodies in the Basin remain an important habitat for aquatic plant species such as the native milfoils and charophyte species found in Lake Hayes, fish and aquatic macroinvertebrates and threatened species including the 'Nationally Endangered' Central Otago roundhead galaxiid (*Galaxias anomalus*) which has been recorded in the upper reaches of Mill Creek.

3.8 Lake Hayes and its remaining margin wetland provides important habitat for fish and aquatic macroinvertebrate species. Aquatic plant species, such as native milfoils and charophyte species found in Lake Hayes (NIWA, accessed 2018) provide food, shelter and oxygen to fish and macroinvertebrates.

3.9 While the ecological values of the Basin have been in a general decline for a long period, ecological restoration undertaken by volunteer groups and through subdivision consents are providing support to the remaining indigenous habitat for native species within the Basin. These restored areas can contribute to the network of remnant habitat patches within the Basin and will enable species to move between larger more intact native shrubland and beech forest on the lower slopes of the hills that surround the Basin.

4. EXISTING ENVIRONMENT

4.1 The study area for the ecological assessment (as shown in

4.2 above) encompasses the Basin floor and the Crown Terrace (collectively, and subsequently, referred to as the **Wakatipu Basin/Basin**). The ecological context and values of this study area are described herein, as well as that of the wider Wakatipu Basin, where necessary to provide context for the biodiversity that is present.

Physical Environment

4.3 The Wakatipu Basin has a relatively stressful climate due to the inland location of the Basin. The semi-continental conditions of the Basin results in climatic extremes of relatively cold winters and hot summers. The Basin experiences high sunshine hours in summer, while during winter snow can fall regularly and the ground can be frozen for prolonged periods. The Basin floor lies between 380 and 400 masl, with ridges and hills reaching up to 600 masl within the Basin floor. The Crown Terrace (included in the WBZ) lies at 600 – 700 masl, and the surrounding mountains between 1651 masl (Coronet Peak) and 2319 masl (Remarkables).

Biological Environment – Terrestrial Habitat

Historical Vegetation

4.4 The Wakatipu Basin has had a long history of burning and pastoral activity, which has resulted in extensive loss of indigenous ecosystems. Prior to human settlement the Basin would have consisted of beech and podocarp forests on the hillsides surrounding the Basin, with shrubland, tussock grassland and wetlands on the Basin floor (see **F** below, which shows the

expected original vegetative cover of the Basin) (Leathwick, et al., 2003) (Meurk, 1997) (Landcare Research, 2018). Within the Wakatipu Basin, human clearance of indigenous vegetation started around the 1300s with Māori using fire to clear routes for access to food and additional resources (i.e. silcrete, and later pounamu) (Hamel, 2001). Regeneration after these fires consisted of shrubland and tussock grassland.

4.5 Clearance of vegetation on the basin floor was undertaken to allow wheat to be grown (including on the Crown Terrace) and limited pastoral farming. Soil fertility declined from the 1860s from a combination of over-grazing on native tussock grassland and intensive wheat harvesting. In the late-1800s invasive weed species started to dominate the landscape, due to European settlers clearing with fire and sowing exotic grass seed to allow for continued sheep grazing and cropping. Over time, a number of small land holdings dominated the Basin landscape, focused on a mixed food crop. Small wetlands and water courses would also have been present within the valley floor, and in depressions on top of ridgelines, however many of these have been drained and straightened to allow for more intensive farming and cultivation of the land.

Extant Indigenous Vegetation and Habitat

4.6 The significant loss of indigenous ecosystems within the Wakatipu Basin has been recognised in the New Zealand threatened environment classification. Error! Reference source not found. presents the threatened environments within the Wakatipu Basin and shows that much of the Basin now lies within environments that have less than 20% indigenous vegetation cover remaining.

4.7 The key remaining indigenous habitats within the Basin are grey shrubland and wetlands, however these are typically small, have low diversity and are infested with weeds (see Error! Reference source not found.). The isolated shrubs or remnant patches of native grey shrubland are typically confined to steeper, or less accessible sites (e.g. gullies and rock outcrops). Species usually found within the grey shrubland include matagouri (*Discaria toumatou*), mingimingi (*Coprosma propinqua*), *Muehlenbeckia complexa*, bush lawyer (*Rubus* spp.), and porcupine shrub (*Melicytus alpinus*), with the occasional native broom (*Carmichaelia petriei*) and kowhai (*Sophora microphylla*). Indigenous sedges and rushes (e.g. *Carex secta, Carex*

coriacea, *Juncus edgariae*, and *Juncus pallidus*) are found within the remaining wetlands and along stream margins in the Basin.

4.8 Introduced trees, shrubs and pasture dominate the Basin landscape. Problematic exotic species include sweet briar (*Rosa rubiginosa*), broom (*Cytisus scoparius*), hawthorn (*Crataegus monogyna*), willow (*Salix* spp.), sycamore (*Acer pseudoplatanus*), elder (*Sambucus nigra*), blackberry (*Rubus fruticosus*), gorse (*Ulex europaeus*), douglas fir (*Pseudotsuga menziesii*) and larch (*Larix decidua*). Along with exotic pasture grasses (e.g. brown top), these exotic species invade indigenous communities (e.g. native tussock, grassland, and scattered shrubland), and with the clearance of native vegetation that has occurred within the Basin, exotic species have established without restriction and outcompete remaining native vegetation.

4.9 In summary, historical and present-day activities within the Basin have resulted in a biological environment now dominated by exotic pasture and introduced trees. The remnants of indigenous ecosystems that persist within the Basin are typically small, isolated, and degraded.

Figure 2: Expected original vegetation of the Wakatipu Basin.

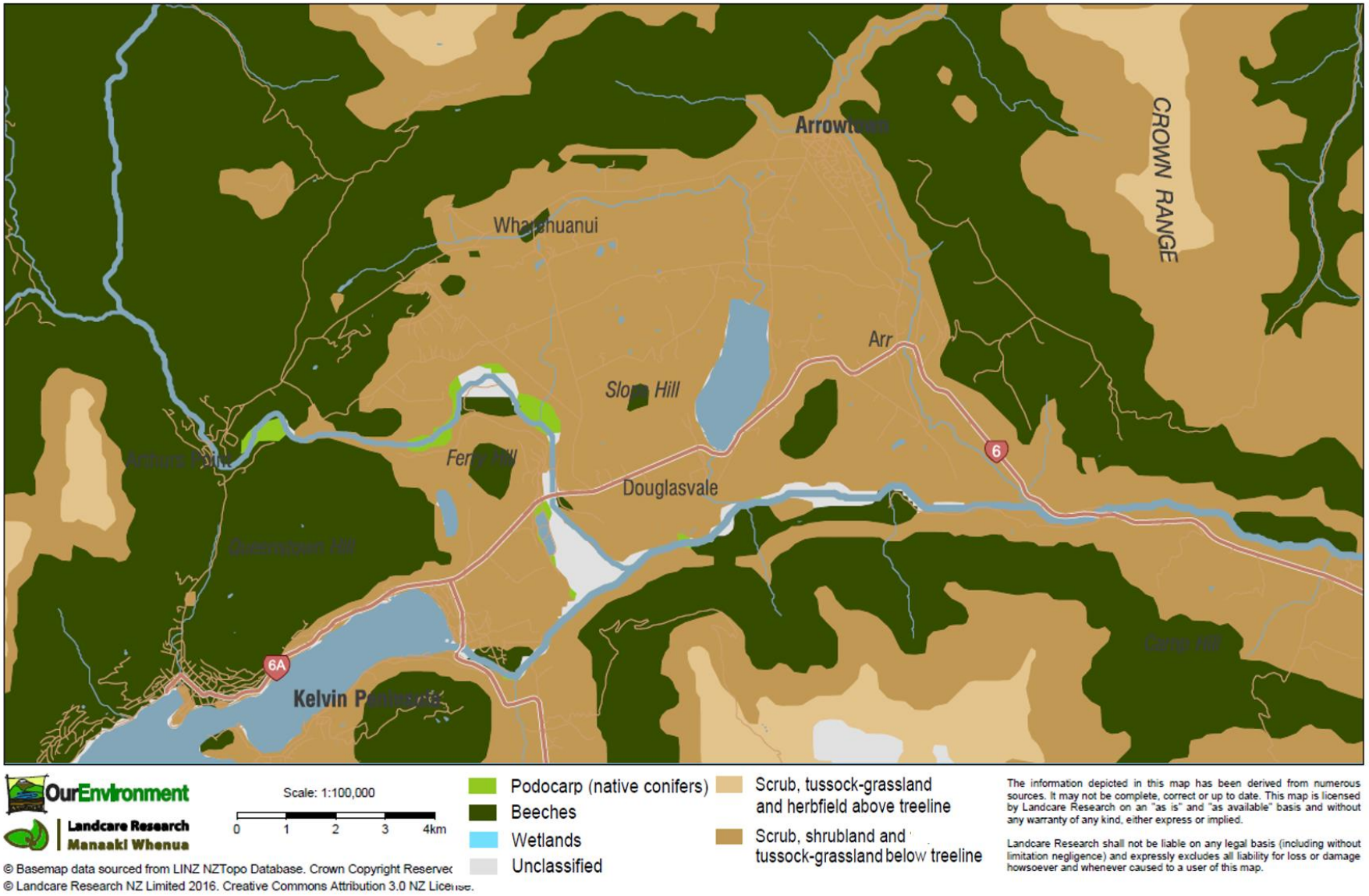


Figure 3: Threatened environment classification of the Wakatipu Basin.

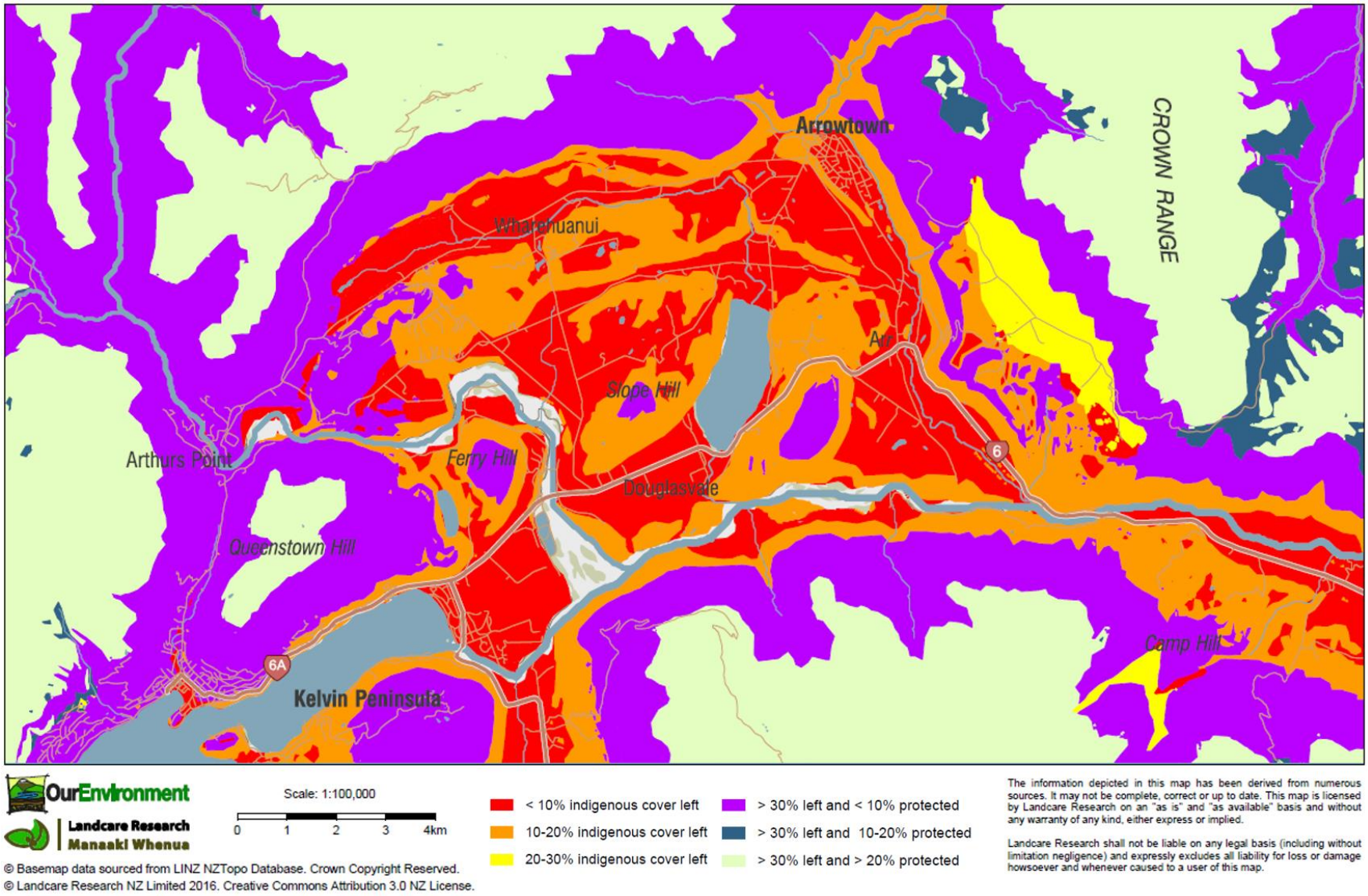
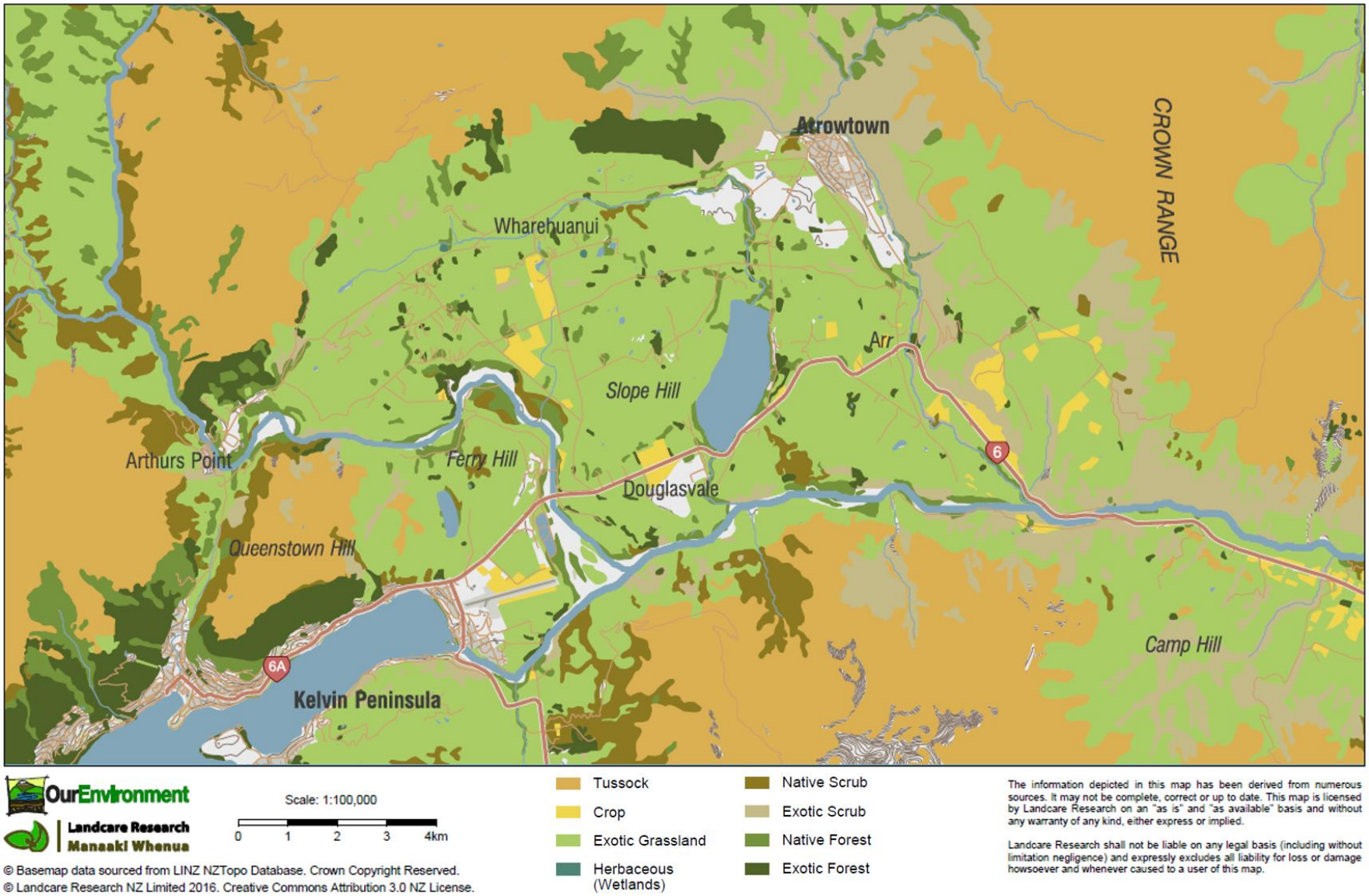


Figure 4: Present day vegetation cover of the Wakatipu Basin.



Biological Environment - Freshwater Habitat

4.10 Bordered by three rivers, the Shotover River to the west, the Kawarau River to the south and the Arrow River to the east, the Wakatipu Basin is a significant junction in the surface water hydrology of the Clutha/Mata Au catchment. Within the Wakatipu Basin, aquatic habitats can be broadly divided into three water body types:

(a) Lakes and ponds;
(b) Rivers, streams and creeks; and
(c) Wetlands and swamps.

4.11 I address each of these in the following paragraphs.

Lakes and Ponds

Lake Hayes

4.12 The only lake within the study area is Lake Hayes. This is a small, shallow, glacial lake, with a maximum depth of 33 m, surface area of 2.74 km^2, and catchment size of 44 km^2. Catchment land use is primarily beef and sheep grazing on exotic pasture and a significant amount of urban development including golf courses (LAWA, accessed 2018).

4.13 Lake Hayes' water quality has steadily decreased since the 1960's and it has been classified as being in a eutrophic state since 2009. Algal blooms have occurred with increasing frequency during this time and currently the lake suffers from severe blooms of the dinoflagellate alga *Ceratium hirundinella* on an annual basis (Hydrosphere Research, 2017). This illustrates the lakes ongoing poor water quality issues with high nutrient loadings (LAWA, Accessed 2018). Groundwater-fed springs account for 30% of the nutrient inputs and the remaining nutrients enter this shallow lake via surface flow (Bayer, Schallenberg, & Martin, 2010). The main tributary to Lake Hayes is Mill Creek. The outflow is via Hayes Creek which discharges into the Kawarau River.

4.14 State of the Environment (**SOE**) water quality monitoring for Lake Hayes is carried out monthly by the Otago Regional Council (**ORC**) and has found that nutrients, such as phosphorus, regularly exceed the relevant Schedule 15 water

quality limits from the Regional Plan: Water for Otago (2016), and nitrogen and *Escherichia coli* (*E. coli*) occassionally exceed limits (ORC, 2016a; ORC, 2016b; Ryder Environmental, 2018). *E. coli* levels from the ORC recreational water quality sampling at the Lake Hayes Mill Creek shallows have been 'unsuitable for swimming' three times over the 2017/2018 summer. This summer season has had consistently higher *E. coli* sample concentrations than the last three seasons sampled (LAWA, accessed 2018).

4.15 The ecological health of the lake is currently classed as 'moderate' with a LakeSPI[i] score of 26%, indicating that the presence of invasive aquatic macrophytes is higher than native species within the lake (NIWA, Accessed 2018). Native submerged macrophytes present in the lake include: charophyte species (*Nitella spp, Chara spp.*), native pondweeds (*Potamogeton spp.*) and turf communities. The invasive Canadian pondweed *Elodea canadensis*, is also present.

Rivers, Streams and Creeks

Mill Creek

4.16 Mill Creek is the major tributary of Lake Hayes and has a catchment area of 55 km^2. The headwaters of Mill Creek originate at the base of Coronet Peak and terminate at Lake Hayes. The creek is largely spring-fed, although downstream of the Millbrook waterfall, groundwater level contours are lower than the surrounding Mill Creek water levels suggesting that the mid to lower section of the creek (from the Millbrook waterfall to Lake Hayes inflow) is above the water table and loses water through creek bed infiltration to the aquifer (ORC, 2014).

4.17 SOE monitoring of Mill Creek consistently exceeds water quality limits for nitrogen concentrations and occasionally exceeds limits for *E. coli*, phosphorus, and turbidity (ORC, 2016a; ORC, 2016b; Ryder Environmental, 2018;). Comparisons of the 'state' of Mill Creek to other upland rural sites within New Zealand place it in 'the worst 50% of sites' for turbidity, nitrogen, and phosphorus; and in 'the worst 25% of sites' for *E. coli* and ammoniacal nitrogen (LAWA, Accessed 2018).

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i Lake Submerged Plant Indicators (LakeSPI) is a method of characterising the ecological condition of lakes based on native and invasive aquatic plants growing in them. Higher LakeSPI percentages are associated with better ecological health.

4.18 Periphyton present in Mill Creek are dominated by the filamentous algae *Oedogonium* and mat algae diatom *Fragilaria* (Ryder Environmental, 2018). Both species can be abundant in slow flowing waters (i.e. channel margins) and *Fragilaria* is often present within nutrient enriched waters (Moore, 2000). The invasive algae *Didymosphenia geminate* (Didymo) is also present in the creek (Ryder Environmental, 2018).

Hayes Creek

4.19 Hayes Creek is piped under the road from the outfall at the southern end of Lake Hayes and flows south before joining the Kawarau River. Water quality is not known but assumed to be similar to that of Lake Hayes.

Wetlands and Swamps

Lake Hayes Margin Wetland

4.20 The Lake Hayes Margin wetland covers 16.9 ha along the southern and western margins of Lake Hayes and is classified as a Regionally Significant Wetland under Schedule 9 of the Regional Plan: Water for Otago (2016). The Regional Plan identifies this wetland as having a high diversity of indigenous wetland flora and fauna including raupo (*Typha orientalis*) and *Carex secta*. Lake margins are identified as being a naturally uncommon ecosystem (Landcare Research, 2017).

Biological Environment - Terrestrial Fauna

4.21 The indigenous vegetation communities that remain within the Wakatipu Basin are small in scale, highly degraded, and typically isolated from each other. The loss and degradation of indigenous habitats has resulted in a significant loss of faunal diversity. However, the remnants that do persist within the Basin provide important habitat for remaining indigenous wildlife, which I address in the following paragraphs.

Avifauna

4.22 The Wakatipu Basin provides habitat for a wide variety of native and introduced bird species. Native species that are present throughout the Basin include tui

(*Prosthemadera n. novaeseelandiae*), bellbird (*Anthornis m. melanura*), grey warbler (*Gerygone igata*), South Island fantail (*Rhipidura f. fuliginosa*), paradise shelduck (*Tadorna variegata*) and the harrier hawk (*Circus approximans*). The Wakatipu Basin also supports threatened species, including the 'At Risk – Recovering' Eastern falcon (*Falco n. novaeseelandiae*) and occasional sightings of 'Nationally Vulnerable' South Island kaka (*Nestor m. meridionalis*).

4.23 The wetlands and water bodies within and surrounding the study area also support a diverse range of native bird species. Threatened species include the 'Nationally Critical' black-billed gull (*Larus bulleri*), 'Nationally Endangered' black-fronted tern (*Chlidonias albostriatus*), 'Nationally Vulnerable' Southern crested grebes (*Podiceps cristatus australis*), banded dotterel (*Charadrius b. bicinctus*), 'At Risk – Naturally Uncommon' black shag (*Phalacrocorax carbo novaehollandiae*) and 'At Risk – Naturally Uncommon' Australian coot (*Fulica atra australis*) (New Zealand Birds Online, 2015; Robertson *et al*., 2017).

4.24 Native and threatened bird species have been observed utilising the range of indigenous and exotic habitat that is present within the Basin for activities such as breeding, nesting, foraging and hunting.

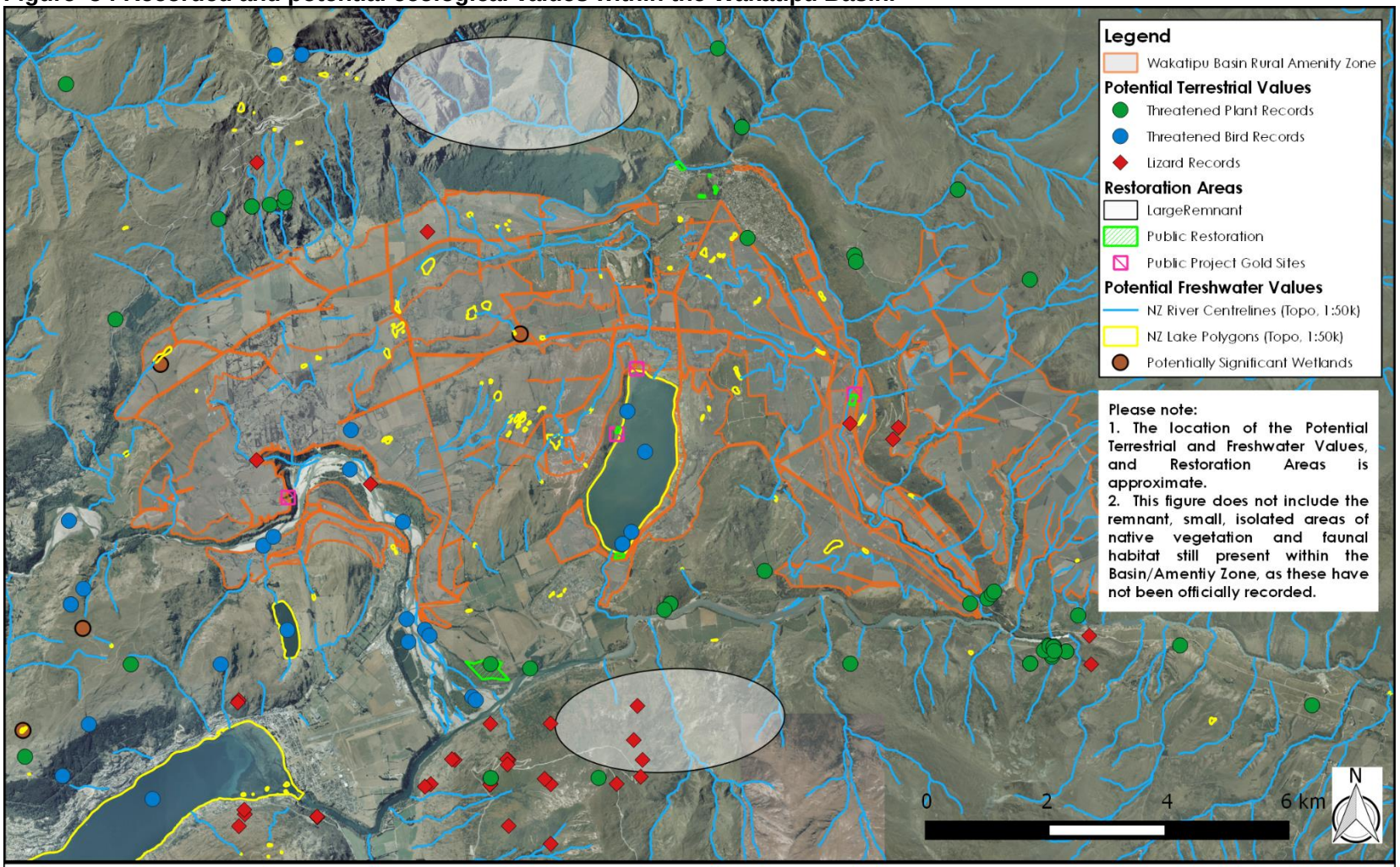
Herpetofauna

4.25 There are three known lizard species within and/or surrounding the Amenity Zone, including two 'Not Threatened' species. These species include:

(a) the McCann's skink;
(b) the short-toed gecko; and
(c) the 'At Risk' korero gecko.

4.26 The likelihood of all other species of lizard existing within the Basin is considered very low. Other lizard species considered include the Southern grass skink (*Oligosoma polychroma*; Clade 5) and cryptic skink (*Oligosoma inconspicuum*); however, there are no reports from near-by areas and these species have not been detected in recent survey work within and around the Amenity Zone (Pers. comm. C. Knox, Wildlands, May 2018). Reported lizard sightings from the DOC Herpetofauna Database are shown in **Figure 5**.

Figure 5 : Recorded and potential ecological values within the Wakatipu Basin.



NZ Lake Polygons (Topo, 1:50k) and NZ River Centrelines (Topo, 1:50k) sourced from LINZ Data Service (http://data.linz.govt.nz/) and licensed for re-use under the Creative Commons Attribution 3.0 New Zealand. Aerial Imagery sourced from LINZ Data Service (https://data.linz.govt.nz/layer/51910-otago-075m-rural-aerial-photos-2004-2011/) and licensed by Terralink International Limited and Otago Regional Council for re-use under the Creative Commons Attribution 4.0 International licence. The records for the 'Potential Terrestrial Values' layers, and the 'Potentially significant wetland' layer, are from multiple sources, including the Department of Conservation (under Crown Copyright ©) and the Queenstown Lakes District Council (all data is copyright reserved by QLDC), both licenced under the Creative Commons Attribution 3.0 New Zealand. Some lizard records sourced from DOC Herpetofauna Database (C. Knox, Wildlands, May 2018).

Invertebrates

4.27 The small, remnant patches of indigenous vegetation provide important habitat for native invertebrates, and likely allow the invertebrates to utilise the surrounding exotic grassland. Retaining areas of modified and patchy indigenous vegetation is important, as these act as biodiversity reservoirs for native invertebrate fauna (Derraik *et al.,* 2005). Continued removal of native shrubland will further lead to the decline of invertebrate species. This is particularly important as New Zealand invertebrate species have a high level of endemism (Patrick, 1994). The value and potential of the modified, small remnant patches of indigenous vegetation within the Wakatipu Basin should therefore not be underestimated.

Biological Environment - Freshwater Fauna

Freshwater Fish

4.28 The New Zealand Freshwater Fish Database and the ORC records identify the following fish species in the Lake Hayes, Mill Creek, and Arrow River (Wakatipu Basin tributaries) catchment (Cromarty & Scott, 1995; ORC, 2016a; ORC, 2017; NZFFD accessed May 2018):

(a) Brown trout (*Salmo trutta*);
(b) Rainbow trout (*Oncorhynchus mykiss*);
(c) European perch (*Perca fluviatilis*);
(d) Common bully (*Gobiomorphus cotidianus*);
(e) Koaro (*Galaxias brevipinnis*);
(f) Upland bully (*Gobiomorphus breviceps*);
(g) Short-finned eel (*Anguilla australis*); and,
(h) Central Otago roundhead galaxiid (*Galaxias anomalus*).

4.29 The Central Otago roundhead galaxiid is currently classified as ‘Threatened – Nationally Endangered’ and koaro is ‘At Risk – Declining’. All of the other fish species are either introduced and naturalised as sport fish (i.e. brown and rainbow trout and perch), or native and ‘Not Threatened’ (Goodman, et al., 2013). Ecosystem values for Mill Creek and Lake Hayes identified in Schedule 1A of the ORC’s Water Plan also include significant habitat for trout, koaro and spawning and juvenile fish habitat (ORC, 2016a).

Aquatic Macroinvertebrates

4.30 Mill Creek benthic macroinvertebrate communities consist of both common and widespread species. The Macroinvertebrate Community Index (**MCI**) scores in Mill Creek indicate 'poor' to 'fair' habitat quality with a median 38% EPT[ii] richness between 2011 and 2016 (Ryder Environmental, 2018; LAWA, accessed 2018).

4.31 Limited macroinvertebrate data is available for other water bodies within the Wakatipu Basin, however, macroinvertebrate communities within Lake Hayes and Hayes Creek could be expected to be representative of the eutrophic state of the lake with low EPT richness and an increase in chironomid larvae (O'Toole, et al., 2008).

5. ECOLOGICAL VALUES SUMMARY

5.1 The ecological values within the Wakatipu Basin are associated with the remnants of shrubland, wetlands, and watercourse habitats, along with surviving populations of native bird, fish, invertebrate, aquatic macroinvertebrate, and lizard species. The remaining native vegetation within the Basin is highly degraded, isolated, and generally small in scale, however, it is highly likely to be utilised by the remaining faunal values within the Basin. For example, the 'At Risk' eastern falcon successfully fledged two juveniles in the breeding season of 2016/2017 in Bush Creek behind Arrowtown in remnant native tussock grassland and grey shrubland (Pers. Obs. R. Teele; **Error! Reference source not found.**).

5.2 The remnant grey shrubland patches that are present within the Basin predominantly consist of matagouri (*Discaria toumatou*) with scattered *Coprosma propinqua and Olearia spp*. The shrubland patches lack the diversity of the original communities, with *Olearia*, kowhai and other *Coprosma* species rarely present. Problematic exotic woody and herbaceous weed species such as broom, briar, hawthorn, elder, woolly mullein, and pasture grasses are now interspersed within the remnant shrubland communities. Although these communities are highly modified, they continue to provide ecological value as

ii EPT are macroinvertebrates that are sensitive to water pollution. These are Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly).

they provide habitat for indigenous invertebrates, lizards and birds and are valuable in supporting potential future restoration projects.

5.3 Historically, a range of wetland/riparian areas would have been present in the Wakatipu Basin. Remnants of these wetland/riparian areas are present throughout the Basin, which are now largely comprised of introduced species such as soft rush (*Juncus effusus*), willows (*Salix* species), and swards of introduced grasses. Indigenous species such as *Carex secta* do persist in some wetland/riparian areas. While the wetlands are degraded and dominated by introduced species, ecological values remain and provide habitat for threatened fish and bird species, provide flood mitigation and act as sediment and nutrient sinks.

5.4 Freshwater habitats have been modified, primarily through the straightening of water courses, loss of riparian vegetation and nutrient and sediment inputs associated with landuse within the Basin. However, freshwater bodies in the Basin remain important habitat for aquatic plant species such as the native milfoils and charophyte species found in Lake Hayes, fish and aquatic macroinvertebrates and threatened species including the 'Nationally Endangered' Central Otago roundhead galaxiid (*Galaxias anomalus*) which has been recorded in the upper reaches of Mill Creek.

5.5 Lake Hayes and its remaining margin wetland provides important habitat for fish and aquatic macroinvertebrate species. Aquatic plant species, such as native milfoils and charophyte species found in Lake Hayes (NIWA, accessed 2018) provide food, shelter and oxygen to fish and macroinvertebrates.

5.6 While the ecological values of the Basin have been in a general decline for a long period, ecological restoration undertaken by volunteer groups and through subdivision consents are providing support to the remaining indigenous habitat for native species within the Basin. These restored areas can contribute to the network of remnant habitat patches within the Basin and will enable species to move between larger more intact native shrubland and beech forest on the lower slopes of the hills that surround the Basin.

6. CONSIDERATION OF SUBMISSIONS ADDRESSING ECOLOGICAL VALUES

Specific Submissions

6.1 I have been asked by Council to specifically review from an ecological perspective, one rezoning submission.

Submission 2140: Friends of Lake Hayes Society

6.2 The following seven summary points have been made by the Friends of Lake Hayes Society (italics) and my responses are given below (listed (a) to (f)):

Note the fragile state of water quality in Lake Hayes and the impacts that any reduction in this due to increased level of nutrient and sediment input would have on the values it provides as a tourism icon to the district as well as to all of the many and varied users of the lake.

(a) The current water quality of Lake Hayes is poor, and we agree that any further reduction in water quality (via sedimentation or nutrient loading) would have significant impacts to lake users and aquatic life.

Revisit Wakatipu Basin Land Use Planning Study, March 2017 and include impact on Lake Hayes water quality when considering zone boundaries. Include consideration of the important contribution of groundwater to the lake nitrogen budget.

Note that increased residential development allowed by proposed new zoning within the Lake Hayes catchment has the potential to greatly increase the level of nutrients and sediment into Lake Hayes if effective measures are not taken to prevent this.

(b) Any development of land within the Lake Hayes catchment that results in the loss of sediment and adds to nutrient loading could further erode the water quality of Lake Hayes. Strong controls on activities associated with development including earthworks, stormwater run-off, groundwater takes, stream diversion activities and landscaping projects and maintenance work will be necessary to mitigate contaminant loss to the lake.

That the new district plan restricts any further residential or commercial subdivision and building in the Lake Hayes catchment until a suitable reticulated sewerage infrastructure is installed to prevent increased inputs of nutrients and contaminants to the lake.

(c) See my response in (b) above.

Consider implementing a higher threshold for permitted earth works in the Lake Hayes Catchment than that proposed for the rest of the district. This is to take account of the special risk to Lake Hayes water quality posed by increased nutrient and sediment inputs.

(d) This point is valid and should be considered in the context of the Earthworks chapter, given the scientific evidence linking decreased water quality and high sediment loadings.

Actively promote the immediate implementation of water quality data collection for Mill Stream to measure the nutrient and sediment loadings especially in rainfall events. This is needed to provide a critical baseline from which to measure the effectiveness of the provisions of the District Plan to manage risk from earthworks and increased levels of residential development and associated activities over the long term.

(e) The monitoring of water quality during high magnitude rainfall events would further quantify land run-off loadings. However, it is my view that we know the reasons for sediment losses to the catchment and that the focus of district councils should be on driving down contaminant inputs to the lake.

Include regular water quality testing both below and above development site boundaries as part of Resource/Building Consent conditions.

(f) I support the monitoring of water quality during development activities. Monitoring needs to be coupled with a management regime if increased sediment or nutrients are found to enter the water way (although I understand this may be a Regional Council function).

7. RESTORATION PROJECTS AND OPPORTUNITIES IN THE WAKATIPU BASIN

7.1 The Wakatipu Basin has a range of different restoration projects and groups that are working to restore the natural values of the Basin.

7.2 This includes the Wakatipu Reforestation Trust (**Trust**), which grows and then plants eco-sourced native plants on public land in the Basin (see **Figure 5**). The Trust maintains multiple native planting sites, as well as helping with Project Gold sites, which were established by the Department of Conservation to encourage people to grow and look after their own kowhai trees and strengthen enthusiasm for grey shrubland restoration (see Error! Reference source not found.).

7.3 Other community groups include the Wakatipu Wilding Conifer Control Group (**WCG**) and the Arrowtown Wilding Group, which remove wilding conifer species from the hills and mountains surrounding the Wakatipu Basin. There has also been a recent increase in predator control groups within the District, including the formation of the Wakatipu Wildlife Trust to act as an umbrella group. These groups maintain predator traps on public land, or private land with landowner permission.

7.4 Ecological restoration includes both revegetation and pest control and is generally accepted by local authorities as a positive benefit under the RMA, with such benefits often acknowledged in subdivision consent decisions. Ecological restoration projects enhance natural heritage values of a site and the wider Wakatipu Basin, especially when wildlife corridors are maintained or established between patches of fragmented remnant indigenous habitat.

7.5 While habitat fragmentation is a leading cause of decreasing biodiversity, restoration via habitat patch networks can increase biodiversity so long as the key issues of size, quality and degree of isolation of habitat patches are addressed (Gange et al., 2003; Hanski, 1998). The remaining fragmented patches of native vegetation in the Basin provide a network for native bird species to move between larger areas of vegetation, with the restoration and / or re-establishment of such habitats adding to that network of indigenous flora and fauna.

7.6 Restoration of freshwater ecosystems is less common. The Wakatipu Reforestation Trust has one wetland planting site, and a few private landowners have planted around wetlands. The only community group focused on freshwater values are the Friends of Lake Hayes Society. It is understood the Friends of Lake Hayes are working with the ORC to develop a Lake Hayes water quality restoration strategy for the lake.

8. CONCLUSION

8.1 Any rezone or landuse change activity must consider the environmental impact and avoid or mitigate negative impacts. Restoration and re-establishment of indigenous terrestrial and freshwater values, including improved surface and ground water quality, should be a priority for any proposed rezone and/or landuse change.

Glenn Davis
28 May 2018