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Treble Cone Ski Area
Ecology Assessment

Prepared for Cardrona Alpine Resort Limited
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1. Introduction

Cardrona Alpine Resort Limited (CARL) has commissioned Beale Consultants in association with Wildland Consultants and Water Ways Consulting to undertake an ecological assessment of the Treble Cone Ski Area.

The ecological assessment is required by the Department of Conservation as part of the process of approving new concessions for use of the ski area.

The purpose of the assessment is to describe the ecological values of the ski area within a local, district and regional context, to identify areas that should be excluded from land disturbances owing to their inherent sensitivities and to specify remedial and mitigation measures that align with the restoration protocol established between DOC and the previous lessees Treble Cone Investments Limited. This is provided as Appendix 1.

2. Ecological Context

The ski area is located on the Harris Mountains in western Otago within the Matukituki and Motatapu catchments. A large part of the Motatapu catchment including the ski area lies on the western perimeter of the Wanaka Ecological District as shown on Figure 2-1.

The Wanaka Ecological District is described in McEwen (1987) as "*Broad glacier formed basins of Lakes Wanaka and Hawea surrounding steep mountains to 2350 m a.s.l; mainly schist, glacial outwash gravels in wide valleys; wide rainfall gradient, mainly stoney steepland soils; depleted tussockland extensive on mountains, beech forest mostly in gullies, bracken fernland on lower slopes…"*

The ski area is formally protected as it is located within the Motatapu Conservation Area and the North Motatapu Conservation Area. Much of the land abutting the eastern and southern side of the conservation areas lies in the Motatapu QE II Open Space Covenant which in turn abut the Mount Soho and Coronet Peak Open Space Covenants. The extent of these protected areas relative to the ski area is shown on Figure 2-2.

The ski area spans the low alpine to high alpine bioclimatic zones, extending from *c.* 1250 m asl near the base facility in the Home Basin to 2088 m asl at the summit rocks.

The low and high alpine zones are influenced by frequent strong winds from north-westerly to south-westerly quarter, sub-zero temperatures and snow cover that can lie from early June until late October.

Land Environments of New Zealand (LENZ) which is hierarchical in scale also provides a useful assessment of ecological context. LENZ groups together land environments throughout the country with similar environmental characteristics such as climate, landform, geology and soils as these influence the distribution of indigenous vegetation patterns. LENZ classifies the sub-zone into two broad Level 1 six land Level IV environments.

The ski area and surrounding alpine country spans two Level 1 environments; Environments Q and T which are the dominant environments of the mountains of the south-eastern South Island. The most detailed Level IV classification provides more insight into the nature of the physical attributes of the land environments within and surrounding the ski area as listed in Table 2-1.

Figure 2-1: Ecological Districts

Figure 2-2: Areas of formally protected land west of Wanaka.

Table 2-1: Land Environments (Level IV) of the ski area

LENZ	Description	Threat Category	% Indigenous vegetation cover remaining	% formally protected
Q1.1c	Very steep mountainous terrain; well drained soils of moderate fertility from schist. Cold temperatures, moderate solar radiation, slight annual water deficits.	5	91.23	19.26
Q1.2a	Very steep mountains, well drained soils of moderate fertility from schist rock, colluvium and basalt. Very cold temperatures, moderate solar radiation, no annual water deficits.	6	98.99	36.51
R1.1b	Steep mountains, well drained soils of moderate fertility from schist.	6	99.98	59.2

LENZ	Description	Threat Category	% Indigenous vegetation cover remaining	% formally protected
	Cold temperatures, moderate solar radiation, no annual water deficits.			

The columns titled Threat Category, % indigenous vegetation cover and % formally protected are derived from the Threatened Environment Classification (TEC) 2012, which combines data from three national spatial databases; LENZ, the Land Cover Database (LCDBv4.0, based on 2012 satellite imagery), and a 2012 update of the national protected areas network. The TEC was developed by Landcare Research to help identify places in New Zealand in which the terrestrial indigenous ecosystems, vegetation types and habitats are much reduced and poorly protected nationally (Walker et al, 2012).

Indigenous vegetation cover prevails in land environments Q1.1c, Q1.2 and R1.1b in the low to high alpine zones where there has been a lower level of disturbance to the vegetation due to harsh climatic conditions and the mountainous terrain. These land environments generally cover mountainous terrain above approximately 1,100 metres asl in the Wanaka Ecological District as illustrated on Figure 2-3.

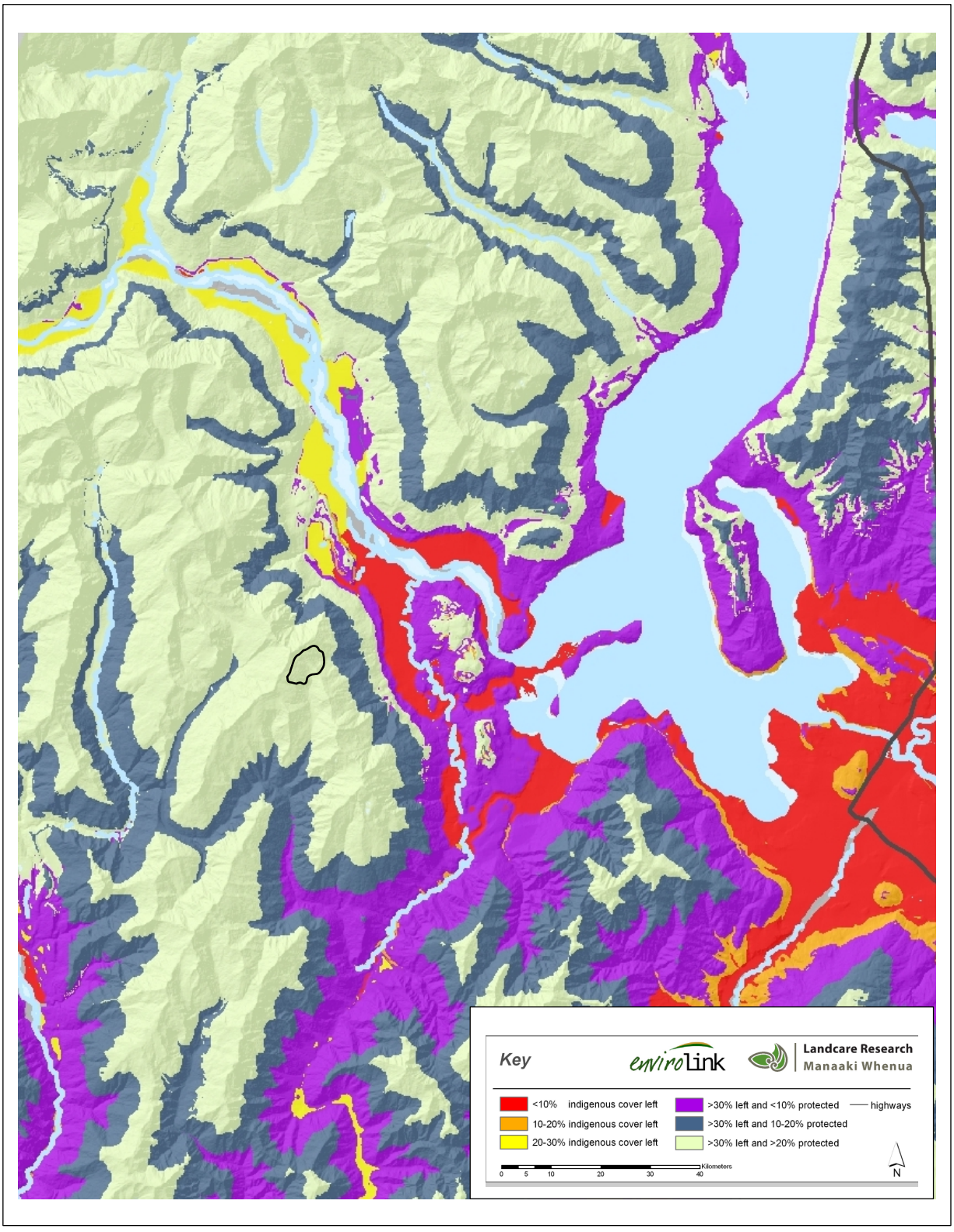

Figure 2-3: Threatened Environments

3. Methodology

A desktop assessment was initially undertaken in advance of the site walk overs. This included a review of relevant literature, including Conservation Resources reports and scientific reports on botanical and invertebrate values and examination of Google Earth imagery and QLDC aerial imagery to assess at a broad scale the vegetation types and habitats that occur in the ski area and surrounding land.

A terrestrial ecologist conducted walk over surveys within and bordering the ski area on 29 April and 1 May 2020 and 11 and 15 January 2021 encompassing the Home Basin, Saddle Basin, Motatapu Basin, the lower Motatapu chutes, part of the Hollywood Bowl and Tim's Table as depicted on Figure 3-1. During the walk overs the condition, extent and diversity of the vegetation communities and habitats were recorded along with flora and avifauna encountered. Where necessary plant specimens were collected for further identification. The walk over survey on 11 January 2021 was conducted in and around Tim's Table in the company of a botanist with survey effort dedicated to wetland vegetation including late snowbank vegetation and areas of scree and rock outcrops.

Fieldwork conducted by Water Ways Consulting involved an assessment of stream condition and macroinvertebrate sampling in the Home Basin and Saddle Basin on 6 May 2020 and on 8 January 2021 while a herpetologist from Wildlands conducted a survey of potentially suitable lizard habitat on 15 January 2021. Reports detailing these assessments are provided in Appendices 3, 5 and 6 and summarised in Sections 6.2 and 7.

In addition, a desktop invertebrate assessment has been undertaken by Wildlands to complete the overall assessment. A stand-alone report of the assessment is provided in Appendix 4 and summarised in Section 6.3.

Figure 3-1: Treble Cone Ski Area

4. Historical Vegetation

Paleoecology studies of late Pleistocene and Holocene vegetation history in Central Otago indicate that snow tussock grassland would have prevailed along with mixed snow tussock/shrub and herbfield communities above the historic bushline (McGlone, 1995).

Following the arrival of Polynesians, fire became a major influence leading to replacement of extensive areas of forest with tussock grasslands and shrubland in the lowland and montane zones.

Mark (2012) reports that many alpine grassland communities in the South Island rain shadow have been transformed through more than a century of extensive pastoral farming. Managed and accidental fires and grazing have according to Mark, modified many grassland communities to the extent that in places snow tussocks have been superseded by an induced vegetation cover. This includes less palatable plants such as blue tussock (*Poa colensoi),* alpine fescue tussock (*Festuca mathewsii*), false Spaniard (*Celmisia lyallii*) and golden Spaniard (*Aciphylla aurea*). False spaniard is especially common in the Home Basin and in places forms extensive patches within narrow leaved snow tussock grassland reflecting the influence of past burning practices. The effects of pastoral farming on the vegetation cover are much less apparent in the North Motatapu catchment headwaters including the Saddle Basin.

The development of ski trails has resulted in the replacement of areas of slim and narrow leaved snow tussock grassland along the trail alignment with a vegetation cover dominated by exotic grassland species. In places Dracophyllum shrubland has been affected by snowcat traffic especially on the more exposed ridge crests.

Problem weeds such as Californian thistle are localised in distribution, colonising the margins of ski trails near the base facility.

5. Terrestrial Ecological Values

5.1. Vegetation Types

5.1.1. Overview

The Treble Cone ski area and surrounding low to high alpine country features relatively unmodified intact expanses of indigenous snow tussock grasslands encompassing a diverse range of landforms and constituent plant communities and habitats. These are:

- Dracophyllum shrublands;
- Wetlands (Seepages and stream margins);
- Boulderfields;
- Fellfields, scree and rock outcrops;
- Cushionfields; and
- Snowbanks.

The distribution of these plant communities and habitat types across the ski area reflect the wide altitudinal range, topography and geological and hydrological processes inherent to the ski area and surrounding low to high alpine country.

Figure 5-1 shows the general distribution of these vegetation and habitat types in the ski area.

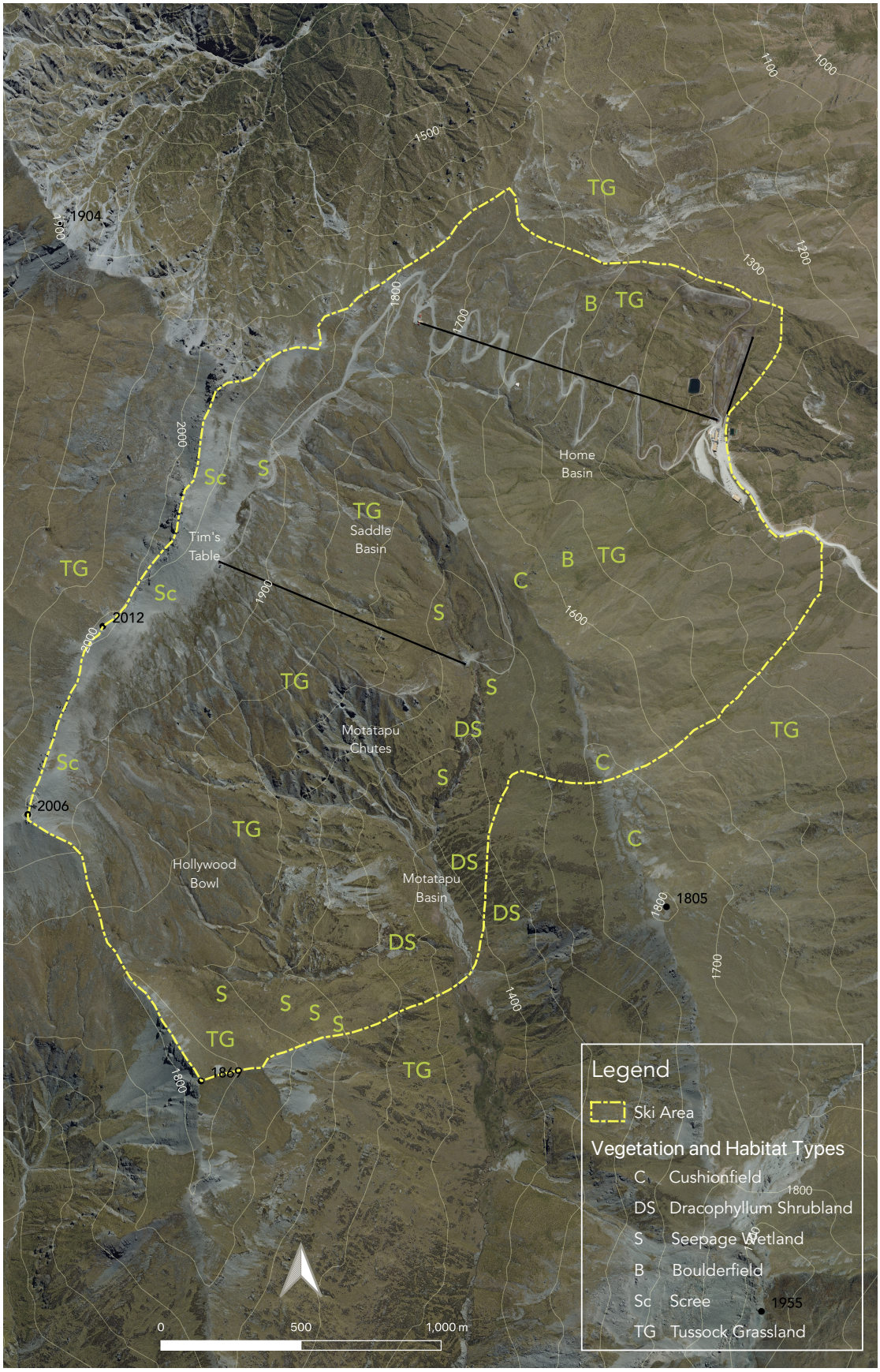

Figure 5-1: General distribution of vegetation types and habitats in the Treble Cone Ski Area.

5.1.2. Snow tussock grassland

The snow tussock grassland across the ski area comprises grassland dominated by slim-leaved snow tussock (*Chionochloa macra*) especially across the south facing slopes in the Saddle and Motatapu Basins and Hollywood Bowl between *c.* 1350 to *c.* 1900 m asl while narrow leaved snow tussock (*Chionochloa rigida*) is the dominant snow tussock species on the lower slopes of Home Basin up to *c.* 1500 m asl. Another species of snow tussock, snow patch grass (*Chionochoa oreophila*) is much more localised in distribution associated with snowbanks in the Saddle Basin above c. 1800 m asl.

The grassland across the ski area is generally in good condition with a percentage tussock cover around 70% to 80%. On some of the lower slopes in Home Basin, the narrow leaved snow tussock grassland cover is sparse due to the influence of previous fires and in these situations occurs in association with herbfields dominated by false spaniard (*Celmisia lyallii*). In other depleted grassland areas such as in parts of Hollywood Bowls, herbfields of *Celmisia viscosa* predominate. Cushion plants such as *Scleranthus uniflorus, Raouli grandiflora, Raoulia subsericea* and *Kellaria childii* are also more common in depleted areas.

Throughout both basins inter-tussock plants commonly encountered include blue tussock (*Poa colensoi*), the speargrasses *Aciphylla montana var. montana* and *Aciphylla kirkii*, sub-shrubs, mat forming and creeping plants such as *Coprosma petriei*, *Leucopogon fraseri*, the native daphne (*Pimelea oerophila*), everlasting daisy (*Anaphalioides bellidioides*), and *Gaultheria depressa* var. *novae zelandiae*. Common herbaceous plants include *Celmisia densiflora, Celmisia viscosa, Celmisia gracilenta, Brachyglottis bellidioides, Gentianella divisa, Anisotome flexuosa, Viola cunninghamii* and *Wahlenbergia albomarginata.*

Figure 5-2: Slim snow tussock grassland near the Saddle Base chairlift terminal at *c.* 1,560 metres asl looking in the direction of Pt 1869. Bright green shrubs of the whipcord *Veronica hectorii* Subsp. *demissa a*re scattered amongst the tussocks.

In addition to areas of *Dracophyllum* shrubland, other important woody shrubs occurring amongst the grassland generally as scattered plants are the whipcord hebe (*Veronica hectorii*) and mountain cottonwood (*Ozothamnus vauvilliersei*).

The native grass *Rytidosperma pumilum* and the alpine clubmoss (*Lycopodium fastigiatum*) are common throughout the grassland along with a varied array of mosses and lichen species.

Mouse ear hawkweed (*Pilosella officinarum*), tussock hawkweed (*Hieracium lepidulum*) and catsear (*Hypochaeris radicata*) are more prevalent on the lower slopes in the Home Basin where areas of exposed soil exists.

5.1.3. *Dracophyllum* shrubland

Distinct areas of shrublands dominated by trailing neinei (*Dracophyllum pronum*) occur on many exposed ridge crests and spurs especially on south facing slopes in the Saddle and Motatapu Basins, as shown on Figure 5-3.

Figure 5-3: Dracophyllum shrubland covering steep slopes in the headwaters of the tributary of the North Branch of the Motatapu River.

5.1.4. Wetlands (Seepages, Flushes and Stream Margins)

Seepages and flushes[1] are common wetlands in the ski area especially in the head of the North Motatapu tributary and across the Hollywood Bowl Basin. They are mostly unmodified and support a high diversity of indigenous plant species. Exotic plants are generally scarce. Many of these species form distinctive sedgelands, turf, cushionfield[2] and mossfield communities with scattered rushes. In many of the wetlands, sedgeland, turfland, cushionfield and mossfield occur as a mosaic.

Seepage and flush wetlands are classified as naturally uncommon ecosystems (Williams, 2007).

Notable species include the sedges bog rush (*Schoenus pauciflorus*) which forms purplish-red dense tufts across the wetlands, *Isolepis aucklandica* that forms extensive grass like patches and bright

[1] Seepages are located primarily where groundwater diffuses to the surface, especially at a change of slope (Johnson & Gerbeaux, 2004). Seepages tend to be wetter for longer periods than flushes, which are often formed by a periodic pulse of water following rain (Johnson & Gerbeaux, 2004). Flushes fall within Johnson & Gerbeaux's (2004) wetland class of seepage.

[2] A structural class having a cover of cushion forming plants between 20-100%, exceeding other growth forms. Cushion plants include herbaceous, semi-woody and woody plants that form convex cushions.

green cushionfields dominated by *Oreobolus strictus*. Turf communities are often dominated by *Coprosma perpusilla* Subsp. *perpusilla*, *Caltha obtusa*, *Celmisia sessilifolia,* and *Epilobium pernitens.* Tufts of *Agrostis muelleriana* are common components of many of these wetlands. In many of the bog rush dominant seepages shrubs of *Hebe pauciramosa* are numerous.

Figure 5-4: A large seepage dominated by bog rush (*Schoenus pauciflorus*) in the vicinity of the Motatapu chutes.

Figure 5-5: Extensive seepage areas between spurs on undulating terrain below Pt 1869 as outlined.

The higher altitude wetlands on Tim's Table, are characterised by extensive cushionfields and mossfields as shown on Figure 5-6. Cushion forming plants such as *Myosotis glabrescens* and

Raoulia subulata are notable botanical features with the former also occurring along the damp rocky margins of the stream draining the wetland shown in Figure 5-6.

On wet gravel surfaces associated with stream margins below the Motatapu Chutes and in the Motatapu Basin, small cushions of *Centrolepis ciliata*, mats of *Gunnera dentata* and creeping stems of *Epilobium atriplicifolium* along with loose tufts of *Uncinia divaricata* are often encountered.

Patches of the snow marguerite (*Dolchoglottis lyalli*) are distinct features of the stream edges throughout the ski area when in flower.

Figure 5-6: Wetland featuring mosaic of sedgeland, cushionfield and mossfield on Tim's Table.

5.1.5. Snowbank Communities

The majority of the snowbanks are located across the upper parts of the Saddle Basin and in and around Tim's Table and across parts of the Hollywood Bowls. A typical snowbank is shown on Figure 5-7.

The snowbanks support a high diversity of plant species adapted to seasonally to permanently wet conditions. These include dense cushions of *Donatia novae-zelandiae*, *Phyllachne rubra*, *Kelleria croizatii*, and *Myosotis pulvinaris*, mats of Coprosma perpusilla subsp. *perpusilla*, *Coprosma atropurpurea*, *Caltha obtusa*, *Montia calycina*, *Euphrasia zelandica*, *Ourisia caespitosa* and extensive patches of the grass like *Carex lachenalia.* Emergent above the looser mats are conspicuous flowering heads of the button daisy *Leptinella pectinata* and the rhizotomous buttercup *Ranunculus pachyrrhizus.*

Figure 5-7: Late snowbanks on Tim's Table below an extensive area of stable scree.

5.1.6. Cushionfields

Cushionfields occupy exposed areas usually on ridge crests and spurs in the alpine zone where the soils are shallow and where bare ridges and hummock ground is typically encountered. These conditions are attributed to exposure of the ground to high winds and where there is a shallower depth of snow cover compared to more sheltered basins.

Cushion forming plants are the dominant plant form although a diverse assemblage of sub-shrubs, herbs and grasses occur amongst the cushion plants.

The dominant cushion plant is *Dracophyllum muscoides* although *Raoulia hectorii, Raoulia grandiflora, Hectorella caespitosa, Anisotome imbricata, Phyllachne rugosa,* and *Phyllachne colensoi* are also common cushion plants in the cushionfields.

Non cushion plants commonly present are *Hebejeebe densifolia, Celmisia brevifolia, Celmisia laricifolia, Epilobium tasmanicum, Chionohebe thomsonii, Gentianella divisa, Acaena saccaticupula, Anisotome lanigera, Craspedia lanata* var. *lanata, Brachyscome longiscapa, Luzula pumila* and a variety of fruticose lichens.

Figure 5-8: Extensive cushionfields on ridge crest separating Home Basin from Saddle Basin at c. 1700 m asl.

5.1.7. Boulderfield Communities

Distinct areas of stable boulderfield comprising large rock debris occur in the Home Basin between 1500 to 1550 m asl as indicated on Figure 5-1 and as shown on the cover page. A smaller less stable area of boulderfield occurs amongst trailing neinei shrubland on the lower slopes of Hollywood Bowls.

These boulderfields provide suitable habitat and shelter for a variety of shrubs, sub-shrubs, club mosses and ferns.

Figure 5-9: Mountain shield fern (*Polystichum cystostegia*) and creeping mapou (*Mrysine nummularia*) are generally confined to areas of boulderfield particularly favouring rocky clefts.

Characteristic plants often growing on rock faces or in rocky clefts include shrub and sub-shrubs such as creeping mapou (*Myrsine nummularia*), porcupine scrub (*Melicytus alpinus*), *Coprosma cheesmanii* and *Coprosma depressa*, herbaceous plants with a creeping habit such as *Geranium sessiliforum*, *Lagenifera cuneata* and *Epilobium glabellum*, the clubmoss *Huperiza australiana* and various ferns, including prickly shield fern (*Polystichum vestitum*), thousand leaved fern (*Hypolepis millefolium*) and dwarf strap fern (*Grammitis poepiggiana*).

5.1.8. Fellfield, Scree, Bluff and Rock Outcrop Communities

The ski area has extensive areas of fellfield, screes, bluffs and rock outcrops, most notably associated with the Motatapu Chutes and the higher alpine areas above 1900 m asl. These habitats are colonised by specialist rock dwelling plants along with other species that also typically occur in cushionfields and snowbanks reflecting the prevailing moisture retaining south to east aspects to these particular landforms. Specialist plants encountered on these rocky surfaces include the purple willow herb *Epilobium purpuratum*, *Parahebe planopetiolata*, *Carex pterocarpa* and the grasses *Koeleleria* cheesmanii and *Poa pygmaea*.

Figure 5-10: Fellfield vegetation above Tim's Table at *c.* 2000 m asl with cushions of *Hectorella caespitosa* and *Chionohebe thomsonii*, flowers of creeping mountain foxglove *Ourisia caespitosa* and tufts of blue tussock (*Poa colensoi*) evident in foreground.

5.1.9. Exotic Grassland

Exotic grassland prevails across the ski trails in the Home Basin as a result of oversowing with exotic grasses following trail formation. Common species observed on the ski trails are the pasture grasses browntop (*Agrostis capillaris*), sweet vernal (*Anthoxanthum odoratum*) and herbaceous plants such as white clover (*Trifolium repens*), *Lotus pedunculatus*, sheeps sorrel (*Rumex acetosella*), dandelion (*Taraxacum officanle*), mouse-ear hawkweed and tussock hawkweed.

5.2. Flora

A total of 164 plant species were recorded within the Treble Cone Ski Area, of which 150 (92%) are indigenous and 14 (8%) are exotic. A list of the recorded plant species is provided in Appendix 2.

The high diversity of indigenous plant species recorded reflects the diverse range of habitats present in the ski area, the wide altitudinal range and its transitory position between the wetter alpine areas to the west towards the Main Divide and the drier alpine areas of Central Otago.

The low number of recorded exotic species reflect the low intensity of pastoral modification and use that has occurred in the past prior to the establishment of the ski area.

During the walk over surveys six plant species of conservation interest were observed that are classified as At Risk or as Data Deficient. These are listed in Table 5-1:

Table 5-1: At Risk and Data Deficient flora recorded in the Treble Cone Ski Area.

Species	Habitat	Conservation Status
Myosotis glabrescens	Wetland cushionfields and damp scree/stream margins	Data Deficient
Epilobium purpuratum	Fellfield and screes	At Risk – Naturally Uncommon
Anisotome capillifolia	Fellfield and screes	At Risk - Declining
Veronica planopetiolata	Fellfield and screes	At Risk – Naturally Uncommon
Carex pterocarpa	Fellfield and screes	At Risk – Naturally Uncommon
Poa pygmaea	Fellfield and screes	At Risk – Naturally Uncommon

5.3. Exotic Plants

A total of twelve species of exotic plants were observed on-site. These include Californian thistle (*Cersium arvense*), sheeps sorrel, white clover, mouse ear hawkweed and tussock hawkweed (*Hieracium lepidulum*) are common component of the inter-tussock groundcover especially areas of tussock grassland that have been modified by pastoral farming activities. These species have the potential to displace indigenous plant communities owing to their competitive attributes.

Californian thistle grows in small patches on the shoulders of the main ski trail in the Home Basin generally in the vicinity of the base building up to *c.* 1400 metres asl. Mouse ear hawkweed and tussock hawkweed was observed up to *c.* 1500 metres asl colonising bare areas of soil, the former as tight mats amongst indigenous sub-shrub and herbaceous inter-tussock plant communities. These weeds are highly invasive and have the propensity to spread vigorously especially across disturbed sites where the vegetation cover has been modified or cleared. Migration of the weeds up slope is a possibility due to the effects of climate change.

Californian thistle was not observed in the upper reaches of the Motatapu North Branch tributary. Both hawkweed species are more prevalent at lower altitudes in the Home Basin.

Russell lupin (*Lupinus polyphyllus*) is also present along of the stream margins on the lower slopes of Home Basin and is presently localised in its distribution.

Although localised in their distribution, Californian thistle, Scotch thistle and Russell lupin are of conservation concern owing to their ability to rapidly invade snow tussock grassland. Control of these species is therefore necessary to ensure they do not spread beyond known areas of infestation in the vicinity of the base building.

6. Fauna

6.1. Avifauna

Native birds observed during the site inspections were New Zealand Pipit (*Anthus novaeseelandiae*) and Australasian Harrier (*Circus approximans*).

New Zealand Pipit was observed mostly on the higher tussock grassland slopes in the Home Basin often alighting on favoured roosting sites such as rock outcrops. New Zealand Pipit has a conservation status of At Risk-Declining.

The Australasian harrier was observed soaring over the tussock grasslands up to an altitude of 1700 metres asl in the Home Basin and Saddle Basin. Australasian harrier is not threatened.

The Atlas of Bird Distribution in New Zealand, 1999-2004 indicates records for New Zealand Falcon and kea in the general ski area over this survey period.

Suitable breeding and feeding habitats exist across parts of the ski area for New Zealand (Eastern) Falcon (*Falco novaeseelandiae*) and kea (*Nestor notabilis*). The boulderfields, rock outcrops and bluffs that exist in the Home, Saddle and Motatapu Basins provide suitable breeding sites for both species. The tussock grasslands and shrublands provide suitable food sources for falcon in the form of hares and large insects such as grasshoppers and beetles while providing a variety of shoots, fruits, leaves, seeds and invertebrates for kea (Heather et al, 2005).

New Zealand Falcon and kea are classified as At Risk – Recovering and Nationally Endangered respectively.

While no recent records exist for Rock wren (*Xenicus gilviventris*), suitable habitat exists in the ski area. Rock wren are found from 900 m to 2500 m in altitude favouring dense sub-alpine and alpine scrub and stable rock falls are interspersed with low shrubbery to bare rock in exposed situations[3]. These habitats occur on the lower slopes of the Hollywood Bowls where extensive areas of trailing neinei scrub occurs within boulderfields, rock outcrops and low bluffs. The closest records for rock wren are from the Mount Roy area, based on the Atlas of Bird Distribution records. It has a conservation status of Nationally Endangered.

6.2. Herpetofauna

A survey for indigenous lizards was undertaken by Wildlands on 15 January 2021 under good conditions favouring emergence and detectability of all potential lizard species. During a three-day survey for the Department of Conservation by Wildlands in December 2019, orange spotted gecko (Mokopirirakau “Roys Peak”; Threatened- Nationally Vulnerable) were identified in an area 0.8-1 kilometre south of the Treble Cone ski area to beyond End Peak. Apart from orange-spotted gecko the December 2019 survey revealed no other lizard species which covered a range of habitats and examined altitudes between 1,050-2,100 metres asl.

Detection of orange-spotted gecko and assessment of potential habitats was therefore the main focus of the 15 January survey. This involved a thorough assessment of the most likely looking habitats in the ski area within their known altitude range (1,100 – 1,800 metres asl.). These ‘most likely’ areas were small boulderfields. However visual assessments deemed these marginal habitat for orange-spotted geckos. At all of these boulderfields the vast majority of liftable rocks were turned without orange-spotted geckos or any evidence of their presence being observed (i.e. droppings or shed skins).

Wildlands report that another gecko species, the Kawarau gecko (*Woodworthia* “Cromwell”; At Risk-Declining) has been recorded ~5 km to the east near Diamond Lake, but is not known to occupy altitudes above 1,200 metres, nor is it known from this far west, so is deemed unlikely to occur in the Treble Cone ski area.

[3] nzbirdsonline.org.nz

A search of records of skinks in the DOC Herpetofauna database show four skink species occur in the Roys Peak and Mount Alpha area ~13 km to the east of the Treble Cone ski area. These are McCann's skink (*Oligosoma maccanni*; Not Threatened), southern grass skink (*Oligosoma* aff. polychroma; Clade 5; At Risk- Declining), Nevis skink (*Oligosoma toka*; Threatened- Nationally Vulnerable), and lakes skink (*Oligosoma* aff. chloronoton "West Otago"; Threatened- Nationally Vulnerable); however, none of these species are known to venture as far west as the ski area. However cryptic skink (*Oligosoma inconspicuum;* At Risk- Declining) has been recorded around Glenorchy and in the Rees Valley. This skink is more associated with damper, western areas of Otago (than the aforementioned skink species), and is thus deemed to be the most likely skink to be present in the Treble Cone ski area. However, cryptic skink were not observed in damp, rocky, or shrubland areas that were targeted during both the December 2019 survey and the survey on 15 January 2021, and are thus deemed unlikely to be present. Furthermore, other ecologists undertaking surveys in the ski area did not sight this skink or any other lizard species.

Based on the above information it is thought unlikely that skinks occur in the Treble Cone ski area. Orange-spotted gecko could still possibly occur in the ski area, despite not being detected, but if they occur (deemed a low likelihood) they are likely to be in low abundance or only occupying small areas of scree or small boulderfields.

6.3. Invertebrates

The ski area supports a typical range of western Otago and specifically Harris Mountain indigenous invertebrates as reported by Wildlands. This finding is based on surveys conducted over the summers of 1991 and 2003 which resulted in a total of 122 invertebrate species representing seven insect Orders and a peripatus species being found in the alpine parts of the ski area. These include several large bodied and flightless insects such as the stonefly (*Holcoptera magna*), speargrass weevil (*Lyperobius spedenii*), female ghost moth (*Aoraia senex*) and chafer bettle (*Scythrodes squalidus*).

Two of the invertebrate species present in the ski area are of conservation concern. These are the black shield bug (*Hypsithocus hudsonae*), classified as At Risk-Declining and the large geometrid moth (*Xanthorhoe frigida*) classified as Nationally Vulnerable.

Wildlands report five other moths found in the ski area that are nationally rare species and poorly known in terms of their ecology and distribution. These are an undescribed species in the genus *Scythris*, the carmbid moth *Scoparia caliginosa* and the geometrid moths *Helastia salmoni*, *Asaphodes exoriens* and *A. periphaea*. These species are only known from the alpine sites in Central and Western Otago but with very few known localities.

Further details on the invertebrate fauna recorded in the ski area including a schedule of species according to host plants/habitat types forms Appendix 4 to this report.

6.4. Animal Pests

Sign of hares was evident across much of the ski areas with droppings and effects of browse regularly observed.

Stoat footprints were observed on snow cover on the Saddle Track at around 1700 metres asl. It is likely that ferrets, weasels and hedgehogs are also present based on trapping records from Brow Peak near Arrowtown where ferrets and weasels were caught at over 1300 m asl and hedgehogs above 1,000 m asl.

7. Aquatic Ecological Values

Surveys of streams in the Home Basin and Saddle Basin were conducted by Water Ways Consulting Limited on 6 May 2020 and 8 January 2021 to assess the aquatic ecological values of the sampled streams.

The samples streams in the Home Basin form part of the catchment of an unnamed tributary of the Motatapu River while in the Saddle Basin the sampled streams are the northern most headwaters to an unnamed tributary of the North Branch of the Motatapu River. A total of fourteen sites located on various tributary streams in the Home Basin and five sites on tributary and main stem streams in the Saddle Basin were surveyed and sampled.

The surveys involved a qualitative assessment of the state of the sampled streams including stream morphology, bed substrate, flow characteristics, riparian vegetation, stream bank erosion and degree of sedimentation along with kick net collections of macroinvertebrate samples taken from four sites for laboratory analysis.

The macroinverebrate (MCI) scores for the samples collected in the Home Basin varied from 93 to 133 and for the Saddle Basin 110 to 111 indicating macroinvertebate communities of excellent quality.

Based on the on site visual assessments and analysis of the macroinvertebrate samples, Water Ways Consulting have assessed the streams as overall exhibiting excellent habitat and water quality.

The survey results and site photographs taken at each of the sampled sites are set out the Waterways Consulting reports in Appendices 3 and 5.

8. Summary of Ecological Values

A summary of the ecological values of the ski area as observed during the walk over surveys and as documented by Wildlands and Waterways Consulting are set out in Table 8-1.

Table 8-1: Summary of Ecological Values

Indigenous Vegetation Communities and Habitat Types	**Description**
Snow tussock grassland	Extensive areas of relatively unmodified snow tussock grassland occurs across the ski area beyond the ski trails. The snow tussock grasslands provide suitable breeding and feeding habitat New Zealand Pipit. The grasslands support a diversity of invertebrate fauna during parts of their life cycles.
***Dracophyllum* shrubland**	Extensive areas of unmodified *Dracophyllum* shrubland cover occurs within the lower parts of the Saddle Basin, Hollywood Bowls and Motatapu Basin. The shrublands especially where they occur within boulderfields or stable rockfall areas provide suitable breeding and feeding habitat for kea and rock wren.
Wetlands and Stream Margins	Extensive unmodified wetlands occur in the ski area especially in the Hollywood Bowl and in the lower and upper Saddle Basin.

	The wetlands are floristically diverse and support a corresponding diverse range invertebrate fauna during parts of their life cycles.
Cushionfields	The cushionfields are in good condition and lack evidence of disturbance beyond the ski trails. The cushionfields are floristically diverse and support a range of invertebrate fauna during parts of their life cycles.
Snowbanks	The early and late snowbanks that occur on the higher slopes of the ski area exhibit a high level of diversity. The snowbanks support a range of invertebrate fauna during parts of their life cycles.
Boulderfields	The boulderfields support specialist plants including a relatively high diversity of shrubs and sub-shrubs species and ferns. The boulderfields support a range of invertebrate fauna during parts of their life cycles.
Fellfields, Screes, Bluffs and Rock Outcrops	The bluffs and rock outcrops in particular provide suitable breeding habitat for New Zealand Falcon. The fellfields, screes, bluffs and rock outcrops support specialist plants including the purple willowherb (*Epilobium purpuratum*) that is classified as At Risk-Uncommon. These rocky areas support a range of invertebrate fauna during parts of their life cycles.
Aquatic Habitats	The macroinvertebrate communities of streams sampled in the ski area and generally unmodified nature of riparian vegetation coupled with a lack of stream bank erosion provide for excellent instream habitat quality.

9. Assessment of Terrestrial Ecological Values

The ecological value of indigenous vegetation communities and habitats of indigenous fauna that comprise the ski area has been assessed using current best practice methods provided by the Environment Institute of Australia and New Zealand (EIANZ 2018). These include evaluation criteria that can be used to assign ecological values at the ecosystem, habitat, community and species level.

The assessment matters and attributes used to assign ecological values to the ski area are listed in Table 4 of the EIANZ Guidelines which are transposed in Table 9-1 below.

In addition, Table 9-1 includes the assessment criteria naturalness which is part of the suite of criteria set out in the DOC guidelines for assessing significant ecological values.

Table 9-1: Attributes to be considered when assigning value or importance to a site or area of vegetation/habitat/community

Matters	Attributes
Representativeness	Criteria for representative vegetation and aquatic habitats: • Typical structure and composition • Indigenous species dominate • Expected species and tiers are present • Thresholds may need to be lowered where all examples of a type are strongly modified Criteria for representative species and species assemblages: • Species assemblages that are typical of the habitat • Indigenous species that occur in most of the guilds expected for the habitat type
Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats: • Naturally uncommon, or induced scarcity • Amount of habitat or vegetation remaining • Distinctive ecological features • National priority for protection Criteria for rare/distinctive species or species assemblages: • Habitat supporting nationally Threatened or At Risk species, or locally uncommon species • Regional or national distribution limits of species or communities • Unusual species or assemblages • Endemism
Diversity and Pattern	• Level of natural diversity, abundance and distribution • Biodiversity reflecting underlying diversity • Biogeographical considerations – pattern, complexity • Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation

Ecological Context	• Site history, and local environmental conditions which have influenced the development of habitats and communities • The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) • Size, shape and buffering • Condition and sensitivity to change • Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material • Species role in ecosystem functioning – high level, key species identification, habitat as proxy
Naturalness	• The relative absence of human disturbance or modification

The scores or rankings that are assigned to each ecological feature for each matter listed in Table 9-1 are high, moderate and low. These scores are in keeping with those specified in Section 5.2.1 of the EIANZ guidelines.

The scores assigned to each assessment matter with respect to the ski area are provided in Table 9-2.

Table 9-2: Scoring of the ecological values of the ski area.

Matters	EIANZ Score	Explanation
Representativeness	High	The plant communities and associated habitats that occur in the ski area beyond the ski trail and infrastructure developments are relatively unmodified and typically representative of plant communities and habitats that occur throughout the alpine areas in the Wanaka ED and the adjacent Richardson ED.
Rarity/distinctiveness	High	The ski area likely supports three bird species and at least two invertebrate species that are either nationally threatened or at risk. The alpine plant communities and those associated with rocky habitats are likely to support plant and invertebrate species that are endemic to Central and Western Otago. The wetlands and snowbanks are distinctive as they have developed as a result of a gradual accumulation of peat or mineral soils over a long period of time. The cushionfield communities are also distinctive as they occur on the more climatically exposed alpine areas where shallow skeletal soils occur.

		The snowbanks and seepages are classified as naturally uncommon ecosystems.
Diversity and Pattern	High	The ski area contains highly diverse assemblages of indigenous vegetation and habitat types. These are the narrow leaved, slim snow and snow patch tussock grasslands, *Dracophyllum* shrublands and diverse plant communities associated with wetlands, snowbank communities, cushionfields, boulderfield, fellfield, rock outcrop and screes. The diversity of habitats provides resident native birds and invertebrates a range of breeding, shelter and feeding opportunities.
Ecological Context	High	The tussock grassland and Dracophyllum shrubland and the more discrete areas of wetland and cushionfield in the ski area are part of a continuous tract of alpine vegetation associated with the Harris Mountains allowing for unimpeded dispersal and movement of indigenous fauna via ecological corridors and pathways. A large part of the Harris Mountains including the ski area is formally protected under the management of DOC and the QEII National Trust. The ski area by virtue of its size and shape supports diverse indigenous alpine vegetation communities that are in good condition thereby allowing them to maintain a full range of ecosystem functions which contributes to their resilience. At a more localised level the tussock grasslands in the ski area serve an important buffering function for the wetlands and stream margins.
Naturalness	High	A large part of the alpine areas in the Wanaka and Richardson Ecological Districts including much of the ski area exhibit a high degree of naturalness. This is attributed to the continuous or uninterrupted expanse of snow tussock grassland that is in relatively good condition and the general lack of exotic plant species beyond the ski trails.

Determining an ecological value score for the ski area overall is based on the descriptives set out in Table 6 of the EIANZ Guidelines which are transposed in Table 9-3.

Table 9-3: Scoring of ecological value of ski area.

Value	Description
Very high	Area rates High for 3 or all the four assessment matters listed in Table 9-1. Likely to be nationally important and recognised as such

High	Area rates High for 2 of the assessment matters. Moderate and Low for the remainder, or Area rates High for 1 of the assessment matters. Moderate for the remainder. Likely to be regionally important and recognised as such.
Moderate	Area rates High for one assessment matter. Moderate and Low for the remainder, or Area rates Moderate for 2 or more assessment matters. Low to Very Low for the remainder. Likely to be important at the level of the Ecological District.
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Area rates Very Low for 3 matters and Moderate. Low or Very Low for remainder.

The ecological value of the ski area based on the EIANZ assessment matters and scoring criteria is very high. This score is attributed to the high scores allocated to all five of the assessment matters set out in Table 9-2.

10. Areas of Ecological Sensitivity

Areas of ecological sensitivity exist across many parts of the ski area and are vulnerable to human induced disturbances. These areas are:

- wetlands (seepages);
- snowbanks;
- stream margins;
- cushionfield communities;
- Dracophyllum shrublands; and
- fellfields, rocky outcrops and screes.

The plants associated with these communities generally have narrow ecological tolerances and lack the ability to adapt to alterations to their habitat.

The main threat to the wetland communities is changes to their water regime due to changes that either decrease water supply or significantly increase from runoff from tracks or other bare areas created during ski-field development.

A further threat to the wetlands is from sedimentation caused by runoff from gravelled areas and from exposure of underlying soils. Sufficient quantities of sediment derived from surface water runoff can cause die back in downgradient wetlands. Sediment runoff can also alter nutrient levels increasing the susceptibility of wetlands to weed invasion.

Cushionfield communities generally occurring on the ridge crests and spurs are also sensitive to disturbance. Cushion plants such as *Dracophyllum muscoides* is especially prone as they have deep tap roots making them difficult to uplift without breaking the tap root. The soils under the cushionfields are generally shallow and rocky increasing the vulnerability of these vegetation communities to disturbance.

Wetland, snowbank, *Dracophyllum* shrubland and cushionfield communities have a limited ability to recover from physical disturbance brought about by loss of plant cover, crushing, compaction, exposure of the underlying peaty and mineral soils and alteration to drainage patterns. The climatic rigours of the alpine environment can lead to further deterioration of the affected vegetation cover due to the effects of frost heave, sun and wind.

11. Generic Ecological Effects

Skifield developments can cause direct and indirect adverse ecological effects where these involve earthworks and indigenous vegetation clearance and modification. The magnitude and level of effect will vary depending on the nature and scale of the development and the ecological value of the affected indigenous vegetation and associated habitats.

11.1. Direct Ecological Effects

Establishment of ski-field infrastructure such as chairlifts, ski trails, snowmaking infrastructure and service lines as shown on Figures 11-1 and 11-2 involve earthworks and either permanent or temporary indigenous vegetation clearance. Temporary indigenous vegetation clearance occurs when the affected vegetation is uplifted and then reinstated is a progressive fashion as earthworks are being undertaken. During construction of buildings and other structures such as chairlift stations the uplifted vegetation from within the development footprints may require storage at designated sites for a short period of time before it is reinstated around the perimeter of the completed buildings and structures.

Permanent clearance of indigenous vegetation is usually of a smaller scale than temporary clearance activities, as this equates solely to areas of land occupied by buildings and other structures.

Modification of indigenous vegetation occurs where vegetation is crushed as opposed to cleared usually as a result of the passage of wheeled or tracked machinery such as excavators.

The site restoration protocol (Appendix 1) sets out a number of remedial measures around vegetation uplifting, storage and reinstatement, aftercare and monitoring with the purpose of maximising vegetation recovery across disturbed sites.

11.2. Indirect Ecological Effects

Indirect ecological effects on indigenous vegetation as noted in Section 10 can arise where tracking and other forms of land disturbance alter the hydrology of streams and wetlands and cause sedimentation, adversely affecting instream habitat quality and wetland functioning.

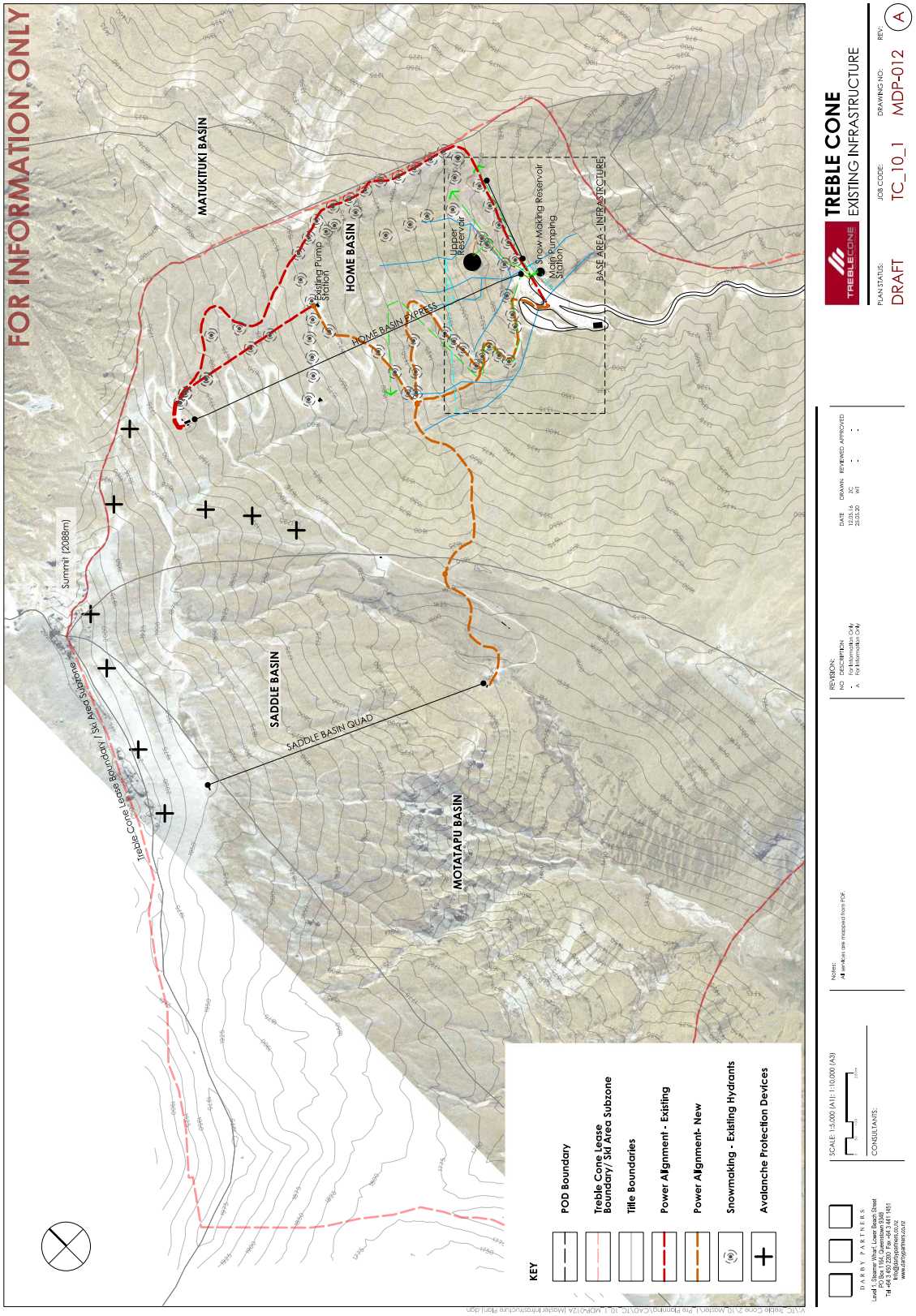

Figure 11-1: Treble Cone Ski Area - Existing infrastructure

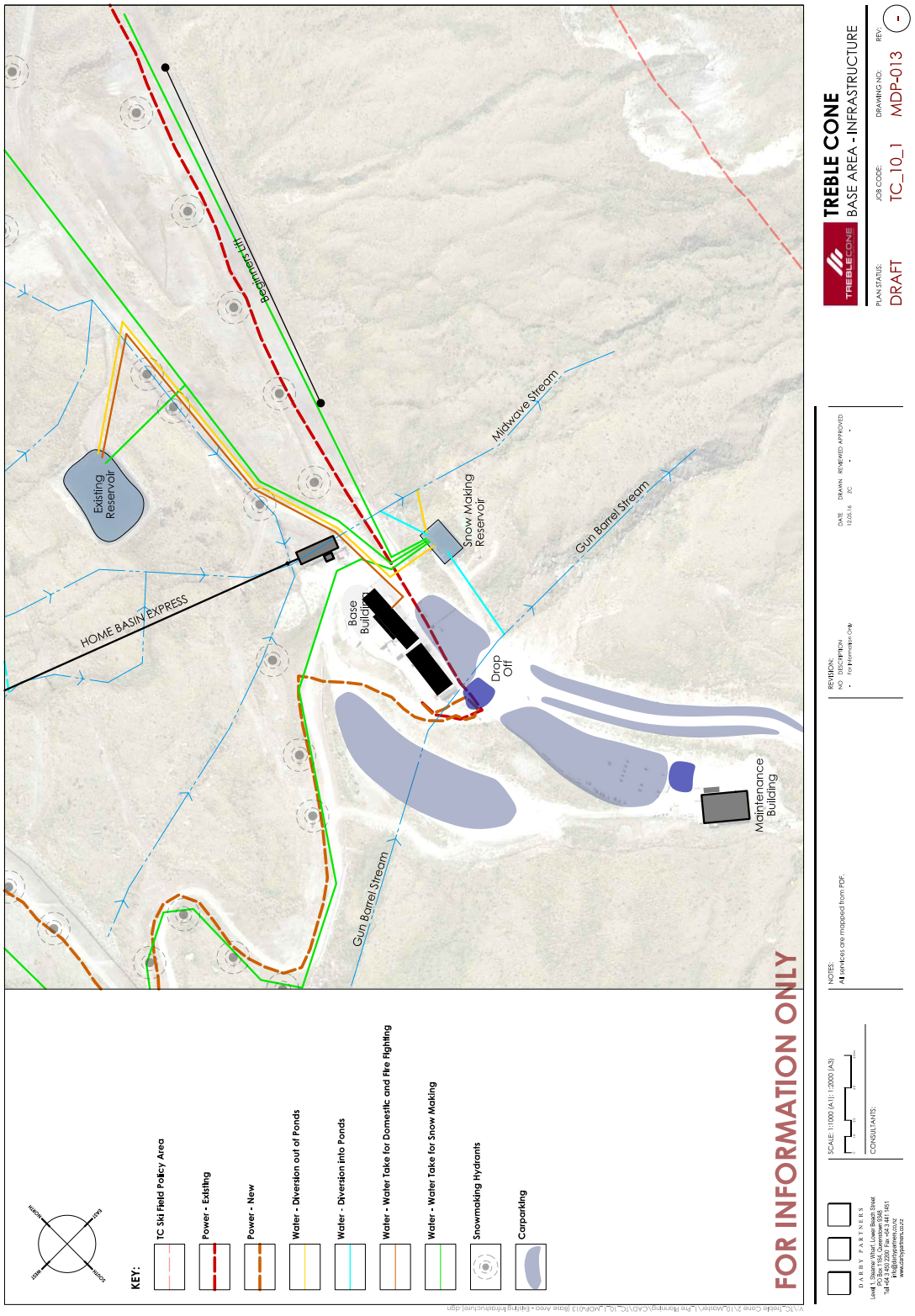

Figure 11-2: Base Area - Existing infrastructure

12. Avoiding and Mitigating Adverse Effects on Sensitive Plant Communities and Habitats

Wherever possible disturbance of wetlands, *Dracophyllum* shrublands and cushionfields by machinery should be avoided in view of the sensitivities of these plant communities and inability to recover once disturbed.

The provision of wide tussock grassland buffers around the wetlands and snowbanks are important to ensure the water regime is not altered and that sediment deposition is avoided. Where possible tracks and other land disturbance activities should be constructed downgradient of wetlands to further avoid alterations to surface and groundwater inputs.

Wherever possible, earthworks and other disturbances should be undertaken on tussock grassland owing to the great degree of resilience of the grassland. The salvage and replacement of tussock vegetation during construction of ski-field facilities at Remarkables and Coronet ski-fields is proving to be effective in the reinstatement of affected areas of tussock grassland.

Vegetation reinstatement and other restorative measures specific to the Treble Cone ski area have been formalised through a Site Restoration Protocol agreed to between DOC and the Treble Cone Investments Limited. The latest revision dated May 2015 is provided in Appendix 1.

13. Weed and Animal Pest Control

CARL undertakes annual programmed control of Russell lupin along some of the stream margins in Home Basin. This involves spot spraying with a proprietary or selective herbicide on an annual basis over the early summer months of November and December.

CARL propose to extend these control measures to other weeds of conservation concern. These are Californian thistle which occurs in places alongside the ski trails on the lower slopes in the Home Basin. Surveillance monitoring will be undertaken on an annual basis in early spring to detect any new infestations of Californian thistle and Russell lupin that require control through spot spraying.

To date no programmed control of ferrets, stoats, weasels and hedgehogs has occurred in the ski area. CARL currently undertakes possum control measures as a precaution to protect the electrical supply and other assets in the ski area. It is apparent from trapping in other alpine areas in Central Otago that these predators are increasing in abundance to the detriment of indigenous fauna including threatened avifauna such as kea and rock wren. Anecdotal evidence reported by O'Donnell et al (2016) suggest that predation by these mammals is a serious threat to alpine fauna, warranting predator control. It has been postulated, as reported by O'Donnell et al (2016) that predation risk will increase under future climate change scenarios.

A pest control programme will be prepared as part of CARL's kea conservation programme. This will be prepared in conjunction with DOC detailing matters such as target pests, timing of trapping, trap location and recording.

14. Revegetation Measures

Large scale revegetation of areas affected by ski trail development has taken place adjacent to the Easy Rider ski trail in the Home Basin and along the South Ridge ski trail in the Saddle Basin.

An inspection of narrow leaved snow tussock grassland bordering the Easy Rider ski area that was reinstated in 2005 shows this supports a number of inter-tussock indigenous plants, especially on the barer sites where there is less competition from browntop. These include false spaniard (*Celmisia lyalli*), loose mats of *Raoulia subsericea, Raoulia youngii and Raoulia glabra grandiflora*), patches of *Coprosma petriei*, *Anaphalioides bellidioides, Anisotome flexuosa*, *Leucopogon fraseri*, red woodrush (*Luzula*

pumila), New Zealand harebell (*Wahlenbergia albomarginata)* and the clubmosses *Huperzia australiana and Lycopodium fastigiatum.* In places golden spaniard (*Aciphylla aurea*), mountain cottonwood (*Ozothamnus vauvilliersii*) and false Spaniard (*Celmisia lyallii*) have re-established amongst the tussocks.

The revegetation measures undertaken to date in accordance with the site restoration protocol have been successful and show that the natural diversity and ecological functioning of affected areas of snow tussock grassland will be restored in the long term.

15. Conclusions

The indigenous vegetation types and associated plant communities and habitats in the Treble Cone ski area, with the exception of the developed areas are of high ecological value based on the assessment criteria set out in the EIANZ guidelines.

The indigenous vegetation communities and habitats in the ski area and surrounding alpine areas in the Harris Mountains exhibit a high degree of representativeness, rarity, diversity, distinctiveness, connectivity and naturalness.

Previous and current surveys conducted across the ski area and surrounding alpine areas recorded two at risk bird species, Eastern falcon and New Zealand Pipit and one nationally threatened and one at risk invertebrate species.

Programmed control of predators in the ski area is recommended to safeguard populations of Eastern falcon and New Zealand Pipit and potentially the nationally threatened kea and rock wren owing to existence of suitable habitat in the ski area for these species.

Owing to the ecological sensitivity of the wetland, *Dracophylllum* shrubland and cushionfield plant communities that occur the ski area it is recommended that any areas proposed for development that involve land and vegetation disturbance avoid these communities wherever possible.

The site restoration protocol represents current best practice in ecological management of areas affected by ski-field developments.

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Appendix 1 – Site Restoration Protocol (Revised May 2015)

Site Restoration Protocol between Treble Cone and the Department of Conservation

Revised May 2015

1 Introduction

This protocol sets out the restoration measures required in order to avoid, remedy or mitigate the adverse effects of construction works or earthworks requiring the removal or disturbance of indigenous vegetation within the ski area boundary.

The protocol provides a practical means of achieving agreed environmental outcomes in an area of ecological and scenic importance. The protocols and code of practice provide for:

- Work site control measures
- Vegetation and top soil removal
- Vegetation and top soil storage
- Work site re-planting and restoration
- Ongoing maintenance of restoration planting areas and management of disturbed sites

2 Objective of the Protocol

The objective of this Protocol is to ensure:

1. A clear understanding of the standards and performance expectations is maintained between the Department of Conservation (DOC) and Treble Cone (TCIL) and their contractors regarding the protection, remediation or mitigation of disturbance to soil, vegetation and wetlands.
2. That the vegetation disturbed during the course of construction, installation of services or earthworks is restored as near as possible to its original density and diversity, or has made progress towards the recovery of the required density and diversity at the conclusion of a five year initial maintenance period such that if left undisturbed appropriate restoration is likely to be achieved.

3 Method of Implementation

The primary method of implementation of the protocol will be through the adoption and adherence to the code of practice by all parties and as specified below.

The protocol will be used to inform DOC staff, to alert staff to the requirements and implementation measures contained within the code of practice.

TCIL will require its staff and contractors to adhere to the protocol and code of practice and shall include a reference to or copy of the code of practice in all contracts let by TCIL that are likely to result in the disturbance of soil, vegetation or wetlands.

This protocol is based on the experience and expertise developed by TCIL, DOC and Natural Solutions for Nature Ltd (NSN) since 1986, the inception of major terrain modifications for ski area development.

DOC staff or an independent environmental monitor appointed by DOC will be on-site on a schedule agreed by DOC and TCIL such that practical and reasonable work progress inspections can be undertaken and advice provided to DOC, TCIL and their contractors.

The purpose of monitoring is two-fold.

1. To confirm compliance with conditions relating to environmental protection, remediation and mitigation the achievement of restoration objectives following approved works.
2. To provide advice during the progression of works to minimise the effects on the environment (particularly previously unforeseen effects) or identify and achieve consensus where the need for remediation or mitigation arises during the course of any approved works.

4 Code of Practice

The following code of practice reflects an understanding between TCIL and DOC with regard to how the works can best be undertaken to minimise the effects on soil, vegetation and wetlands, and how these disturbed sites should be appropriately restored in recognition of the high natural and scenic values of the area.

The purpose of the code of practice is

1. to set operational standards that will minimise the impacts on the environment from the works undertaken and
2. to rehabilitate work sites to a high standard ensuring the shortest possible time required for the reinstatement of soil stability, the recovery of disturbed vegetation communities and ensure wetlands downstream of work sites are not adversely affected by sedimentation.

5 Vegetation Clearance

The vegetation of the Treble Cone Conservation area is dominated by *Chionochloa macra* and associated grasses, herbs, cushion plants and low woody (non-cushion habit) species up to an elevation of around 1880 to 1900 metres above sea level (masl). Above this areas of bare ground increase along with rock outcrops and bluff features, soils are thin and poorly developed. The vegetation is characterised by cushion plants, snow bank communities and fellfield.

Seepages, streams and bogs are vegetated by tussock grassland and a variety of herbs and cushion plants.

1. Where possible only contractors experienced at working in alpine environments shall be used. The contractor will have a proven record of working in highly natural environments

and will have a high regard and sensitivity towards achieving quality finished and landscaped works that reinstate the land to a condition as close as possible to its original state, replicating the surrounding natural (undisturbed) environment.

2. Prior to the contractor starting works at the site the Concessionaire shall ensure that an onsite briefing takes place between the jointly appointed environmental monitor and the contractor(s). The purpose of the meeting is to ensure that all parties have a common understanding of the construction zone boundaries, the areas to be used for vegetation stock piling and storage, a plan of how the works will be undertaken, identification of critical works (in terms of the actual or potential adverse effects and their avoidance, remediation or mitigation) and a clear understanding for the standards expected for the earthworks (including stream crossings, the removal and re-instatement of vegetation and topsoil).
3. The contractor must remove the vegetation layer with the prime focus being to minimise the damage to the plants and to maximise the likelihood that whole plants will remain intact, and retain as much root material and soil as possible to maximise the potential for successful re-establishment and survival when transplanted or re-instated.
4. All vegetation uplifted within the approved work zones will be carefully stored in designated areas. Where required, plants may been stockpiled with care, within an area cleared of vegetation, with a maximum of 2 - 3 plants stored on top of each other (pile can be up to about 1 metre high) to reduce smothering and breakage of crowns and stems.
5. Plants shall be placed into piles or laid adjacent and close to the work site rather than being tossed or tumbled out of the bucket of the excavator. Plants must where possible be stored roots down and packed tightly together to prevent drying out and improve ease of handling during replacement.
6. Cushion vegetation affected by earthworks will where possible be lifted as whole plants by digger or hand so that most of the root structure and surrounding soil remains intact. The plants and associated turf and topsoil will be re-instated over the exposed areas as soon as practicably possible.
7. Where possible, vegetation will be progressively or directly reinstated during the course of works. When undertaken by a skilled and experienced digger operator, direct or progressive reinstatement offers a significantly improved chance of plant re-establishment and survival. Plants will be placed into a scrape or depression made by the excavator and soil packed around them to ensure plants are reinstated flush with the surrounding ground.
8. All stored/ stockpiled vegetation must be re-instated within 3 weeks or watered if conditions are very dry and this cannot be achieved. This may require a water tanker to gain access to the work site in extremely dry conditions if works are not near a reticulated water supply and water cannot otherwise be delivered to the site.
9. Alternatively, plants that cannot be reinstated within 3 weeks could be transported and used to reinstate another previously disturbed site requiring supplemental planting.
10. Any surplus plants and turf that cannot be used to restore previously disturbed and recovering sites will be removed from the site in consultation with the DOC representative. Where possible these plants should be sent to a nursery for division, propagation and storage to be returned to the site when needed for the restoration of future work programmes.
11. Where possible, works requiring revegetation using these methods should be undertaken when soil moisture conditions are good, e.g. after snow-melt and prior to the onset of

winter conditions (freeze/ thaw cycles). May 1st is an appropriate deadline for the completion of revegetation work following summer development works.

12. Works undertaken in the vicinity of streams, seepages or bogs or that intercept sub-surface slope drainage must ensure that measures are in place to prevent soil erosion or sedimentation of downstream environments or vegetation communities. These measures must be in place prior to the commencement of works. Monitoring should ensure that measures in place are working effectively.
13. Water intercepted by construction work, installation of services or earthworks must be managed to maintain the integrity and flow to downstream environments. Measures shall be put in place to ensure that water intercepted does not create or contribute to soil erosion and sedimentation in or downstream of the work site.
14. Where required, water tables must be established to prevent water from eroding soil and undermining the successful restoration of vegetation disturbed by works. Water tables should where possible be constructed such that they prevent sediment from being discharged into vegetation within the receiving environment below the outfall of the water tables.

6 Maintenance & Aftercare

The maintenance period shall continue until the pre-disturbance density has been achieved and colonisation of the site by herbs and grasses from the surrounding area is occurring and the process of natural regeneration and recovery is evident, or 5 years, whichever is the lessor.

In the event that sufficient recovery has not been achieved within 5 years, an extended maintenance period with be agreed by TCIL and DOC for the site involved.

Practical maintenance and aftercare of reinstated vegetation is achieved by:

1. The avoidance of additional or subsequent disturbance of recovering areas
2. Management to prevent, control or contain erosion and sedimentation within or downhill of the disturbed area,
3. The removal of any weeds found in the disturbed area.
4. Control of hares should they threatened the re-establishment of vegetation to be mutually agreed by TCIL and DOC.
5. Transplanted or re-instated vegetation should be alive (although some dieback may occur), have shoot initiation, growth, fruiting and flowering within 3 to 5 years. Natural regeneration of some colonising herbs and grasses is likely to occur within 3 to 5 years of remediation works.
6. Should die-back be observed in the re-planted areas during the maintenance period (5 years following the completion of works), or the reinstatement of pre-disturbance plant density (of tussocks) cannot be achieved at any site, or portion of any site, nursery tussock may be required to ensure continued progress towards the restoration of pre-disturbance tussock density. This measure is to protect soil from erosion or adjacent wetlands from sedimentation.

7. The need for supplemental planting will be determined by the independent monitor in consultation with TCIL and DOC.
8. Where plants are to be replaced, with nursery tussock, these should be eco-sourced from a reputable nursery and free of weeds.
9. Where natural regeneration of species associated with the pre-disturbance community are present in the recovering area, the replacement of tussocks may not be required. This should be determined on a case by case or site by site basis following an assessment of overall progress towards restoration goals in the approved work area.
10. Priority for supplemental planting shall be given to steep, erosion prone slopes that cannot be remediated in the course of undertaking the approved works.
11. Where tussocks slump or roll down steep slopes, or slips or landslides occur within the area affected by earthworks, recovered tussocks may be divided (into groups of at least 20 tillers) and replanted following stabilisation of the slope.
12. Where a shortfall of tussocks is likely to occur, available tussocks should be planted at the toe of the slope or where they will filter sediments or buffer wetlands downslope with the remaining area supplemented by nursery grown or propagated tussock.

7 Monitoring

The affected areas shall be monitored prior to the commencement of works, during critical phases of the works, following completion but prior to machinery leaving the site, and over the maintenance period, for up to 5 years following completion of construction, depending on the scale of works, vegetation affected and progress towards recovery.

The purpose of the monitoring is to

- assess the work required to achieve the re-instatement of the vegetation cover,
- assess progress towards re-instatement and restoration of vegetation cover,
- identify soil erosion and sedimentation issues that may or will require remediation or mitigation,
- ensure adverse effects on wetland environments are avoided or appropriately remediated or mitigated,
- detect weed species introduced to the area, and
- Identify management responses to issues arising from proposed and approved works.

Photo monitoring sites may be requested to be set up by the concessionaire and environmental monitor or representative of DOC prior to the commencement of works and shall be monitored for no less than the 5 year maintenance period. These points are to be located outside the area affected by the earthworks.

Appendix 2 – Plant Species List

Recorded: 29 April, 6 May 2020 & 11 and 15 January 2021

* denotes exotic plants

Narrow-leaved and slim snow tussock grasslands	
Narrow-leaved snow tussock	*Chionochloa rigida*
Slim snow tussock	*Chionochloa macra*
Blue tussock	*Poa colensoi*
Alpine fescue tussock	*Festuca matthewsii*
	Veronica hectorii Subsp. *demissa*
	Veronica buchananii
	Veronica petriei
	Veronica lycopodioides
	Scleranthus uniflorus
	Phyllachne colensoi
	Kelleria childii
	Kelleria villosa
False spaniard	*Anisotome imbricata*
	Anisotome flexuosa
	Celmisia lyalli
	Celmisia viscosa
	Celmisia gracilenta
Mountain cottonwood	*Ozothamnus vauvilliersii*
Inaka	*Dracophyllum longifolium*
Trailing neinei	*Dracophyllum pronum*
	Dracophyllum rosmarinifolium
Golden Spaniard	*Aciphylla aurea*
	Aciphylla "lomond"
	Aciphylla kirkii
	Aciphylla montana Var. *montana*
	Raoulia glabra
Large flowered mat daisy	*Raoulia grandiflora*
	Raoulia hectorii Var. *Hectorii*
Turf mat daisy	*Raoulia subsericea*
	Coprosma petriei
Everlasting daisy	*Anaphalioides bellidioides*
	Gaultheria depressa Var. *novae-zealandiae*
	Gaultheria crassa
	Gaultheria macrostigma
Native daphne	*Pimelia oreophila* Subsp. *lepta*
	Epilobium atriplicifolium
Glaucous bidibid	*Acaena caesiiglauca*
	Acaena saccaticupula
	Acaena profundeincisa
	Geranium sessiliflorum
	Brachysome sinclarii
	Forstera purpurata
Grassland buttercup	*Ranunculus multiscapus*
	Helichrysum filicaule
	Gnaphalium audax
	Hydrocotyle sp.
Patotara	*Leucopogon fraserii*
	Prasophyllum colensoi
	Carex colensoi
	Carex wakatipu

Red woodrush	*Luzula rufa*
	Luzula pumila
Harebell	*Wahlenbergia albomarginata*
	Viola cunninghamii
Alpine hard fern	*Blechnum penna-marina*
	Rytidosperma pulchrum
	Deyeuxia avenoides
Alpine clubmoss	*Lycopodium fastigiatum*
Tall fescue*	*Festuca arundinacea*
Browntop*	*Agrostis capillaris*
Sweet vernal*	*Anthoxanthum odoratum*
Kentucky bluegrass*	*Poa pratensis*
Dandelion*	*Taraxacum officinale*
Cats ear*	*Hypochaeris radicata*
Mouse eared hawkweed*	*Pilosella officinarum*
Tussock hawkweed*	*Hieracium lepidulum*
Scots thistle*	*Cirsium vulgare*
California thistle*	*Cirsium arvense*
Russell lupin*	*Lupinus polyphyllus*
Sheep's sorrel*	*Rumex acetosella*

Cushionfields

Cushion inaka	*Dracophyllum muscoides*
	Hectorella caespitosa
	Abrotanella inconspicua
	Phyllachne colensoi
	Kelleria childii
	Chionohebe thomsonii
	Raoulia hectorii Var. *hectorii*
	Raoulia grandiflora
	Raoulia subsericea
Turf mat daisy	*Raoulia youngii*
	Anisotome imbricata Var. *imbricata*
	Celmisia brevifolia
	Myosotis pulvinaris
	Hebejeebie densifolia
	Gentianella divisa
	Craspedia lanata Var. *lanata*
	Brachysome sinclarii
Redwood rush	*Luzula rufa*
	Luzua pumila

Seepages, damp rocky slopes and snowbanks

Snow patch grass	*Chionochloa oerophila*
	Phyllachne colensoi
	Phyllachne rubra
	Kelleria croizatii
	Veronica pauciramosa
Bog rush	*Schoneus pauciflorus*
	Marsippospermum gracile
	Montia calycina
Comb sedge	*Oreobolus pectinatus*
	Oreobulus strictus
	Donatia novae-zelandiae

	Caltha obtusa
	Myosotis pulvinaris
	Myosotis glabrescens
	Leptinella pectinata Subsp. *wilcoxii*
	Brachyscome sinclarii
	Ranunuculus maculatus
	Ranuculus pachyrrhizus
	Coprosma perpusilla Subsp. *perpusilla*
	Coprosma atropurpurea
	Craspedia uniflora Var. *uniflora*
	Cardamine sp.
	Gentianella divisa
Yellow snow marguerite	*Dolichoglottis lyalli*
	Celmisia angustifolia
	Celmisia thompsonii
Silver cushion mountain daisy	*Celmisia sessiliflora*
	Celmisia laricifolia
	Parahebe planopetiolata
	Plantago novae-zelandiae
	Gunnera dentata
Mountain foxglove	*Ourisia caespitosa*
	Euphrasia planopetiolata
	Geum cockaynei
	Celmisia haastii Var. *haastii*
	Gaultheria nubicola
	Gaultheria pyrenaica
	Carex gaudichandiana
	Carex lachenaii Subsp. *lachenalii*
	Carex pyrenaica
	Carex acicularis
	Carex wakatipu
	Carex pterocarpa
	Isolepis aucklandica
	Luzula pumila
	Uncinia divaricata
	Epilobium atriplicifolium
	Epilobium glabellum
	Epilobium tasmanicum
	Raoulia subulata
	Centrolepis ciliata
	Acaena saccaticupala
	Viola cunninghamii
White violet	

Fellfields, Boulderfields, Rocky Clefts and Outcrops, Screes

A shrub daisy	*Olearia nummularifloia*
	Dracophyllum pronum
	Dracophyllum rosmarinifolium
	Coprosma cheesemanii
	Coprosma depressa
	Coprosma perpusilla Subsp. *perpusilla*
Creeping mapou	*Myrsine nummularia*
Everlasting daisy	*Anaphalioides bellidioides*
	Chionohebe thomsonii
	Veronica buchananii
	Celmisia angustifolia
	Gaultheria depressa Var. *novae-zealandiae*

	Gaultheria crassa
	Veronica lycopodioides
	Hebejeebie densifolia
Porcupine scrub	*Melicytus alpinus*
Turf mat daisy	*Raoulia subsericea*
	Brachyglottis bellidioides Var. *bellidiodes*
	Colonbanthus buchananii
	Acaena saccaticupula
	Epilobium glabellum
	Stellaria gracilenta
	Anisotome flexuosa
	Gentianella divisa
	Geum uniflorum
	Geranium sessiliflorum
	Lagenifera cuneata
	Prasophyllum colensoi
	Trisetum youngii
	Huperzia australiana
Prickly shield fern	*Polystichum vestitum*
Mountain shield fern	*Polystichum cystostegia*
Alpine hard fern	*Blechnum penna-marina*
Thousand-leaved fern	*Hypolepis millefolium*
	Grammitis poepiggiana
	Phyllachne colensoi
	Hectorella caespitosa
	Anisotome imbricata
	Anisotome capillifolia
	Acaena saccaticupula
	ParaVeronica planopetiolata
	Raoulia grandiflora
	Raoulia thomsonii
	Raoulia youngii
	Celmisia densiflora
	Colonbanthus buchananii
	Pachycladon sp.
	Epilobium tasmanicum
	Epilobium purpuratum
	Koeleria cheesemanii
	Carex pterocarpa
Blue tussock	*Poa colensoi*
	Poa pygmaea

Appendix 3 – Survey for Indigenous Lizards at Treble Cone Ski Area

SURVEY FOR INDIGENOUS LIZARDS AT TREBLE CONE SKI AREA, WEST OTAGO

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R5666

Orange spotted gecko, West Otago

SURVEY FOR INDIGENOUS LIZARDS AT TREBLE CONE SKI AREA, WEST OTAGO

Contract Report No. 5666

January 2021

Project Team:
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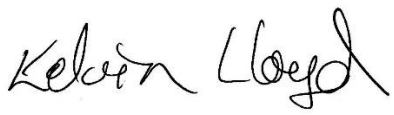
Reviewed and approved for release by:



K.M. Lloyd
Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

Treble Cone Ski Area is located about 20 kilometres west of Wanaka, spanning an altitude range from 1,250-2,088 metres above sea level (asl). The ski resort base facility sits at 1,250 metres asl and Treble Cone itself reaches a height of 2,058 metres asl. Cardrona Alpine Resort Limited who lease the Treble Cone Ski Area have a keen interest in the management of indigenous vegetation flora, and fauna within the area. With this in mind, a better understanding of the indigenous lizard populations around Treble Cone Ski Area was required to inform skifield management.

Wildland Consultants were commissioned to undertake an initial survey of key lizard habitats around Treble Cone Ski Area in order to improve knowledge of the lizard assemblage. This baseline information on lizard populations will help to guide future survey, monitoring, or management actions. This report outlines the methods and results of a survey undertaken in January 2021.

2. METHODS

2.1 Site selection

The survey designed for indigenous lizards around Treble Cone Ski Area firstly involved the selection of appropriate survey sites. The ski area (Figure 1) is approximately 500 hectares in size, and therefore the whole of the area was not able to be comprehensively surveyed for lizards. As such, it was necessary to try and identify areas of specific interest prior to the survey and concentrate surveys on these, while also noting any additional areas of interest during the field surveys.

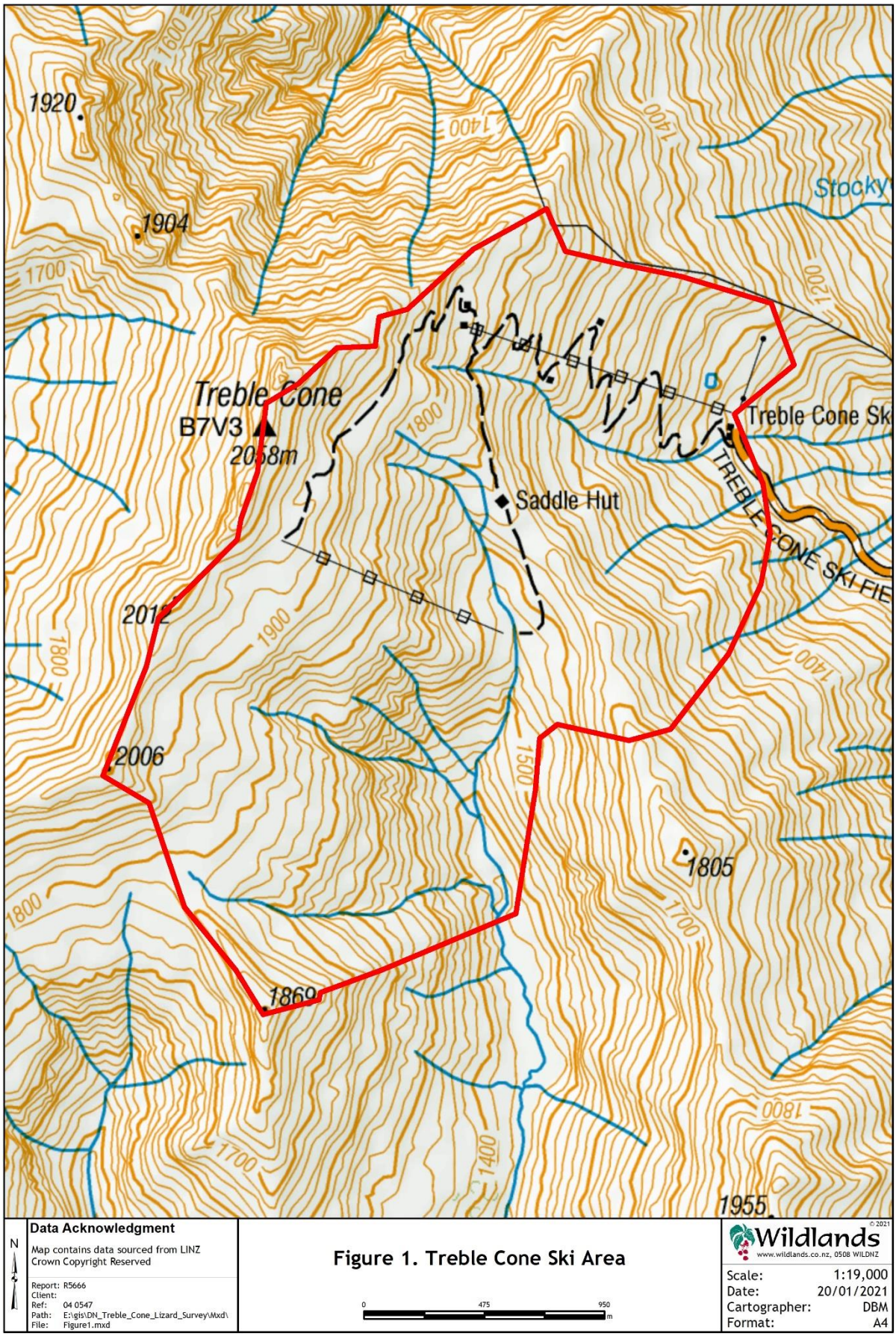
Initial site selection was undertaken using aerial imagery, field guides, and through consideration of the Wildlands knowledge of the various lizard species and their habitat preferences. Desktop mapping identified a few key areas to survey and these areas became starting points for investigation.

Generally, areas with dense vegetative cover, damp habitats, and/or rocky areas (screes, boulderfields, and tors) were favoured for survey, as these types of habitats were deemed most likely to support lizards, such as orange-spotted gecko (*Mokopirirakau* "Roy's Peak) or cryptic skink (*Oligosoma inconspicuum*).

2.2 Lizard species potentially present

A desktop assessment for lizards at Treble Cone Ski Area was first undertaken to describe the lizard species that may be present, their threat status, habitats used, and known distribution. The Treble Cone ski area contains a wide range of potential lizard habitats. Recently, orange spotted gecko (*Mokopirirakau* "Roys Peak"; Threatened-Nationally Vulnerable[1]) were identified in an area south of the Treble Cone Ski Area by the author during a three-day survey for the Department of Conservation. Orange

[1] Hitchmough R., Barr B., Lettink M., Monks J., Reardon J., Tocher M., van Winkel D., and Rolfe J. 2016: Conservation status of New Zealand reptiles, 2015. Department of Conservation, Wellington.



Data Acknowledgment

Map contains data sourced from LINZ
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Ref: 04 0547
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Figure 1. Treble Cone Ski Area

0 475 950 m

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Scale: 1:19,000
Date: 20/01/2021
Cartographer: DBM
Format: A4

spotted geckos were found on a rocky ridgeline between 800-1,000 metres south of the Treble Cone ski area at approximately 1,750 metres asl. This survey covered the area immediately south of the Treble Cone Ski Area southwards to the tarns below End Peak. No other lizard species were observed on this survey which covered a range of habitats and altitudes between 1,050-2,100 metres asl. Thus, orange spotted geckos are deemed the most likely lizard species to be present in the Treble Cone Ski Area (Table 1). Another gecko, the Kawarau gecko (*Woodworthia* "Cromwell"; At Risk-Declining[1]) has been recorded about five kilometres to the east near Diamond Lake, but is not known to occupy altitudes above 1,200 metres, and is not known from this far west, so is unlikely to occur in the Treble Cone Ski Area.

Table 1: Lizard species present (or potentially present) at Treble Cone Ski Area. Conservation status as per Hitchmough *et al*. 2016. The likelihood of occurrence for each species is given based on their known habitat preferences and distribution in the area and surrounds.

Common Name	Scientific Name	Conservation Status	Likelihood of Occurrence	Notes
Orange-spotted gecko	*Mokopirirakau* "Roys Peak"	Threatened-Nationally Vulnerable	Moderate-high	Saxicolous. Found in rocky habitats such as tors, boulderfields, and scree. Recorded at sites 800-1,000 metres south of the Treble Cone Ski Area.
Cryptic skink	*Oligosoma inconspicuum*	At Risk-Declining	Low	Occupies damp areas with dense ground level vegetation. Common in the damper parts of western Otago and Southland.

There are no records of skinks in the DOC Herpetofauna database in the Wanaka area west of Glendhu Bay, with the closest skink reports being from Roys Peak *c.*13 kilometres to the east of the Treble Cone ski area. Four skink species are known from the Roys Peak and Mount Alpha area. These are McCann's skink (*Oligosoma maccanni*; Not Threatened[1]), southern grass skink (*Oligosoma* aff. *polychroma*; Clade 5; At Risk-Declining[1]), Nevis skink (*Oligosoma toka*; Threatened- Nationally Vulnerable[1]), and lakes skink (*Oligosoma* aff. *chloronoton* "West Otago"; Threatened-Nationally Vulnerable[1]); however, none of these species are known to venture this far west towards the main divide in Otago. In addition, approximately 30 kilometres to the west, cryptic skink (*Oligosoma inconspicuum*; At Risk- Declining[1]) has been recorded around Glenorchy and in the Rees Valley. This skink is more associated with damper, western areas of Otago (than the aforementioned skink species), and is thus the most likely skink to be present in the Treble Cone Ski Area. However, cryptic skink still has a low probability of occurrence (Table 1).

2.3 Survey methods

The field survey for indigenous lizards at Treble Cone Ski Area was undertaken on 15 January 2021 in fine sunny weather (16-20°C, clear, light wind). Searches were

[1] Hitchmough R., Barr B., Lettink M., Monks J., Reardon J., Tocher M., van Winkel D., and Rolfe J. 2016: Conservation status of New Zealand reptiles, 2015. Department of Conservation, Wellington.

undertaken using a combination of visually scanning for basking, emergent, or foraging lizards present on rocks or amongst ground-level, tussock, or shrub vegetation, as well as lifting rocks and other suitable retreats to look for lizards sheltering underneath.

Surveys focused particularly on locating orange-spotted gecko and cryptic skink, and reporting any other lizards incidentally encountered. Cryptic skinks were targeted by searching for basking individuals and by lifting rocks in habitats which were damp and/or had dense shrubland cover, such as *Dracophyllum* sp. Orange-spotted geckos were targeted by rock-lifting around rocky tors, talus slopes, and boulderfields within an altitude range of 1,400-1,700 metres asl. A hand-held torch was used to look for geckos (as well as their shed-skins and droppings) in crevices within rock tors.

As much accessible vegetation as possible was thoroughly visually scanned for lizards, or movement that might indicate the presence of lizards. Vegetation at all heights was surveyed. If a lizard was sighted, it was captured (where possible) and photographed. Location (GPS coordinates), date and time of the sighting, vegetation species, life-history stage (adult and sex, or juvenile if too small to differentiate sex), pregnancy status of females, snout-vent length (SVL), vent-tail length (VTL), and any tail loss or injuries (if present), were recorded for each lizard found. For each survey, the date, start time, finish time, person hours, location, habitat, and weather conditions were also recorded.

3. RESULTS

Four main areas were surveyed for lizards within the Treble Cone Ski Area. These areas covered the areas and habitats most likely to hold indigenous lizards within the Ski Area. These areas are depicted below (Figure 2). Areas above 1,800 metres were not surveyed, as lizards are not known to occur above this altitude in Otago. In addition, south facing, steep erosion prone slopes were discounted as these areas had shady unstable habitat and screes too fine to provide habitat for lizard populations.

3.1 Area 1: 1,500 metre boulderfield

A boulderfield at 1,500-1,550 metres asl was identified on the aerial imagery as having potential as habitat for orange-spotted gecko (Plates 1a, 1b). This boulderfield was surveyed for approximately one hour from 10-11 a.m. in the morning in ideal weather conditions (mild and sunny) for locating orange-spotted geckos under rocks (Knox *et al*. 2019). Search effort involved visual survey and rock lifting. Every liftable rock within the boulderfield was turned, but no orange-spotted geckos or evidence of their presence (e.g. shed skins) was found. No other lizard species were sighted.

Plate 1a: Boulderfield at 1,500-1,550 metres asl in the Treble Cone Ski Area.

Plate 1b: Another view of the boulderfield at 1,500-1,550 metres asl in the Treble Cone Ski Area.

3.2 Area 2: Ridgeline 1,600-1,700 metres asl

This ridgeline near the southeastern border of the Treble Cone Ski Area (Plate 2; Figure 2) held some loose rock and marginal potential to support orange-spotted gecko. This ridge was also targeted as an orange-spotted gecko population is known from this ridgeline 0.8-1 kilometre south of the Treble Cone Ski Area boundary. This area was examined for one hour and all suitable-looking loose rock lifted for orange-spotted geckos. No orange-spotted geckos or evidence of their presence (e.g. shed skins) was found. No other lizard species were sighted.

Plate 2: A ridgeline at 1,600-1,700 metres asl at the southeastern end of the Treble Cone Ski Area.

3.3 Area 3: Motatapu River North Branch

Wetlands, creek edges, talus, and dense *Dracophyllum rosmarinifolium* and *D. pronum* shrubland was surveyed in this area for 1.5 hours (Plate 3). The habitat in this area looked suitable for several skink species known from Central Otago, including McCann's skink, southern grass skink, Nevis skink, cryptic skink, and lakes skink; however, none of these species were located.

3.4 Area 4: Northern slopes near the zigzag track

Boulderfield and talus on these northern slopes of the Treble Cone Ski Area were examined and many suitable rocks lifted to assess the potential presence of orange-spotted gecko. None were located.

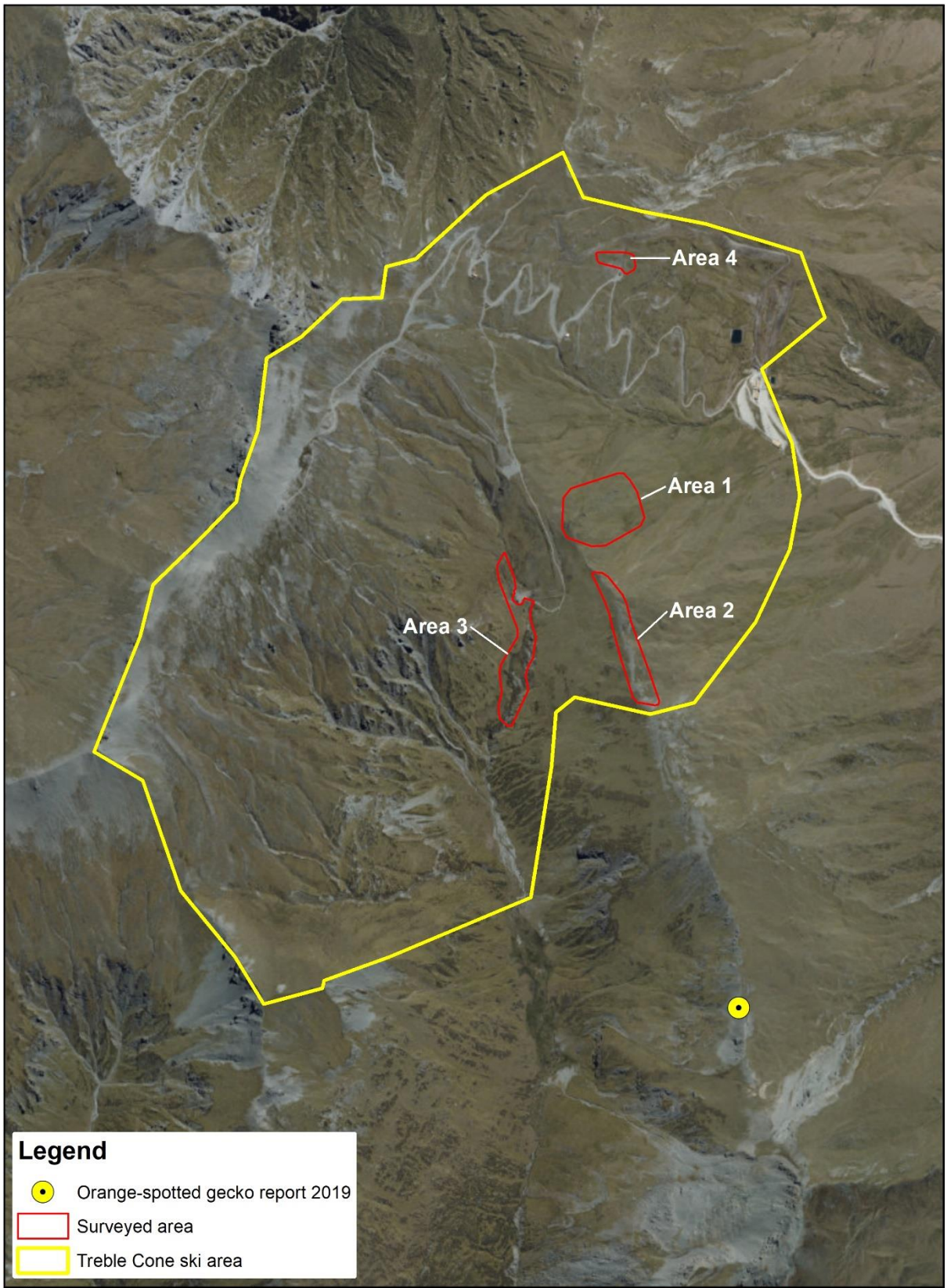

Figure 2. Four areas (red polygons) surveyed for indigenous lizards at Treble Cone Ski Area (boundary in yellow) on the 15 January 2021

Plate 3: The upper catchment of the Motatapu River North Branch at 1,580-1,460 metres asl. Wetlands, loose rock, and dense *Dracophyllum* shrubs were surveyed.

4. DISCUSSION

4.1 Lizard diversity

Lizard diversity at Treble Cone Ski Area is likely to be low and it is possible that lizards are absent altogether. Orange-spotted gecko (*Mokopirirakau* "Roy's Peak) is the most likely species to occur, but no large or significant habitats within the ski area were identified for this species.

4.2 Threatened and At-Risk species

Only orange-spotted gecko (Plate 4) is deemed plausible to occur, based on currently available information and the fact that no skinks have been sighted in the area and surrounds across four days of survey by herpetologists within the Treble Cone Ski Area and adjacent areas to the south. In addition, other ecologists have not noted skinks when undertaking botanical work.

Plate 4: Orange-spotted gecko (Mokopirirakau 'Roy's Peak').

Orange-spotted gecko currently has a threat status of 'Threatened-Nationally Vulnerable'; however, based on recent (*ca*. 2015-2020) discoveries this may be reassessed in the next New Zealand reptile threat assessment to be published in 2021. Since the 2015 threat assessment, five new sites have been discovered for orange-spotted gecko bringing the total number of known sites to twelve. Although often only one to three geckos have been recorded in each location, it is presumed likely that healthy populations are present at all (or at least most) of these locations. The new discoveries include the site one kilometre south of the Treble Cone Ski Area and another site further south near End Peak. In addition, to these populations the species is known from boulderfields, talus, and scree slopes on Roy's Peak and Mount Alpha (near Wanaka), Mount Cardrona, Mount Scott (Crown Range), and two sites each in the Hector Mountains, Richardson Mountains, and Dunstan Mountains.

4.3 Management of lizards at Treble Cone Ski Area

If indigenous lizards are, at any point, identified at Treble Cone Ski Area then they should be considered in management of the area, including minimising human impact on lizards, e.g. accidental crushing of lizards or disturbance to populations by people walking through their habitat, standing on rocks etc. The adverse effects of any further ski-field or other recreational development on lizards also needs to be carefully considered, avoiding lizards where possible, and mitigating adverse effects if they cannot be avoided or remedied. Fire is clearly a risk to all vegetation, flora, and fauna at Treble Cone Ski Area, including lizards (if present). As such, management of fire risk is very important.

If lizards are ever sighted at Treble Cone Ski Area it is important that this is reported to both Cardrona Alpine Resort Limited and the Department of Conservation, Wanaka

office. An ARDS card should also be submitted to the Department of Conservation so that the record can be entered into the national herpetofauna database (Report a sighting: Amphibian and reptile species sightings and observations (doc.govt.nz).

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Appendix 4 – Treble Cone Invertebrates – Biodiversity and Significance

TREBLE CONE INVERTEBRATES – BIODIVERSITY AND SIGNIFICANCE

Brian Patrick

Wildland Consultants Ltd

May 2020

SUMMARY

Treble Cone Skifield on the Harris Mountains of Western Otago, contains a range of natural alpine to high alpine habitats including snow tussock grasslands, scree, cushionfield, herbfield, schist outcrops, streams, wetlands and snowbanks that collectively support a typical range of Western Otago and specifically Harris Mountain indigenous invertebrates, particularly insects. In terms of habitat condition, biodiversity and population size of insects, the skifield area is typical of the Harris Mountains as a whole. In total, 122 invertebrate species representing seven insect Orders and a peripatus species, have been found in alpine and high alpine parts of the skifield.

Apart from the discrete areas of skifield infra-structure the invertebrates are living in a highly natural setting in their natural habitats and on their specialist indigenous plants or in natural waterways and on rock faces.

The skifield area supports many noteworthy insect species and a peripatus. These include several large-bodied and flightless insects such as the stonefly (*Holcoperla magna*), speargrass weevil (*Lyperobius spedenii*), female ghost moth (*Aoraia senex*) (Figure 1) and chafer beetle (*Scythrodes squalidus*).

Two of the invertebrate species present in the skifield area are classified as Threatened by the Department of Conservation. These are the black shield bug (*Hypsithocus hudsonae*) (Figure 4), classified as "At Risk – Naturally Uncommon", and the large geometrid moth (*Xanthorhoe frigida*) which is classified as "Nationally Vulnerable". For each of these species the skifield area holds an important population in the overall conservation of these two species.

Figure 1: The short-winged and flightless female of the ghost moth *Aoraia senex* is found in high alpine cushion field on the Treble Cone Skifield. In contrast the strong-flying males have a wingspan of 5 cm. The species is widely distributed across Otago high alpine areas with adults emerging in February and March.

Five other moths found in the skifield are nationally rare species and poorly known in terms of their ecology and distribution. These are an undescribed species in the genus *Scythris* with its larvae on *Raoulia subulata,* the crambid moth *Scoparia caliginosa* and the geometrid moths *Helastia salmoni, Asaphodes exoriens* and *A. periphaea.* They are all only known from alpine sites in Central and Western Otago but with very few known localities.

The habitats of the invertebrate fauna of the Treble Cone Skifield, and the populations of the invertebrate species appear stable despite living within a dynamic skifield environment. I recommend that long-term

monitoring is installed in several key invertebrate communities to monitor trends in the population numbers of key invertebrate species, both Threatened and characteristic species of the high alpine zone of Western Otago. The monitoring should be repeated every three years if its results are consistent.

The indigenous invertebrates and their natural habitats on the Treble Cone Skifield on the Harris Mountains in Western Otago are significant for the conservation of the invertebrate fauna of this biogeographic area.

Figure 2: The black butterfly is common over scree slopes and areas of bare rock within the skifield area over the summer moths. Its caterpillars feed on grasses in the genus *Poa* growing on the almost bare scree slopes.

METHODS

This report and annotated species list of invertebrates is based on three expeditions to the Treble Cone Skifield on the Harris Mountains above Wanaka in Western Otago. The timing of these three expeditions was:

- 22 January 1991 – day trip to 2055m with Sir Alan Mark
- 6-7 February 1991 – overnight trip with camping at 1850m beside small stream
- 1-2 February 2003 – overnight trip to 2058m – camped at 1640m

Invertebrates were collected by day and night on each day in suitable warm weather. By day a net was used to catch diurnal species and to sweep shrubs and grasses for invertebrates. At night a 240V generator was used to run a 160-watt ultra-violet lamp over a large white sheet, to which nocturnal insects were attracted.

Samples of the insect species found were identified, listed and preserved by pinning, drying and labelling, and the specimens are deposited in the Otago Museum, Dunedin.

Three other expeditions by myself to other parts of the Harris Mountains to survey for the invertebrates have been carried out since 1990, giving a context for the skifield insect fauna and allowing for comparisons of the skifield fauna with that of the mountain range as a whole.

BIODIVERSITY

The diversity of invertebrates found on the **Treble Cone Skifield** on the Harris Mountains of Western Otago is now well known based on these three surveys over the period 1991-2003. Additionally, this insect biodiversity can be put in perspective as several other surveys have been carried out on other parts of the Harris Mountains and many to adjacent alpine areas of Central and Western Otago by the author.

Some of the most noteworthy of the insects are illustrated and discussed by the author in the popular books "**Wild Central**" (Peat & Patrick 1999) and "**Above Treeline**" (Mark *et al*. 2012). These include both of the **Threatened species**, the black shield bug (*Hypsithocus hudsonae*) (Figure 4), classified as "At Risk – Naturally Uncommon" (Patrick 2016), and the large geometrid moth (*Xanthorhoe frigida*) which is classified as "Nationally Vulnerable" (Hoare *et al.* 2017).

The attached, annotated checklist of the insects found on the Treble Cone Skifield lists 122 species, 92 of them moths and butterflies representing 17 families of that diverse insect group, and highlights the biodiversity over seven insect Orders and peripatus that are known from there. While the emphasis was on surveying the moths and butterflies, other conspicuous insects, particularly stream insects were collected and identified also.

All of the prevailing alpine and high alpine habitats present on Treble Cone Skifield support high invertebrate biodiversity, in a New Zealand context, and a range of characteristic insect species of each of those habitats.

Figure 3: The male of the tiger moth species *Metacrias huttoni* is widespread on the Treble Cone Skifield area up to 2000m. Its densely hairy caterpillars are often seen by day feeding on various herbs and grasses. The males fly fast by day over the high alpine vegetation while the flightless females are hidden under rocks in the larval cocoon.

Two traits of these alpine and high alpine insects' standout in this alpine environment. Firstly, many of the species are active by day (diurnal), in groups that at lower altitude are all nocturnal. This is particularly evident in the crambid and geometrid moths, the latter moth family with 11 out of the 19 species present being only active on sunny days.

The other trait is the number of species with short-winged flightless females, or large-bodies and flightless in both sexes. The stonefly *Holcoperla magna* (Peat & Patrick 1999) is an example of the latter with large-bodied, wingless males and females. Species with short-winged females and winged males include the ghost moth *Aoraia senex* (Peat & Patrick 1999) (Figure 1), geometrid *Asaphodes periphaea* and tiger moth *Metacrias huttoni* (Figure 3).

Many uncommon species are found here too including an un-named and poorly known peripatus species. A few peripatus have been found living in the alpine environment in Otago-Southland (Peat & Patrick 1999) but the species found here in rocky areas at 1600m is higher than the other taxa, and requires more research on its identity, ecology and conservation status.

Other uncommon species found here are the following five moths:

- The diurnal, blue-coloured and undescribed scythrid moth in genus *Scythris* with larvae on *Raoulia subulata.* It is known from very few other localities – all in Central and Western Otago mountains.
- The moth *Scoparia caliginosa* is only known elsewhere from the Hector Mountains, Mount Cardrona and its place of discovery which is imprecisely known but somewhere in Central Otago.
- The geometrid moths *Helastia salmoni, Asaphodes exoriens* and *A. periphaea* are Central Otago endemics but known from few places and specimens. Additionally, *A. periphaea* has a short-winged flightless female which severely limits its dispersal ability. For all three their biology is unknown.

THREATENED SPECIES

Two invertebrate species recorded from Treble Cone Skifield are classified by the Department of Conservation as Threatened species. Both are uncommon and based on my field experience, on the Harris Mountains as a whole.

These are:

- The Black shield bug – *Hypsithocus hudsonae* is classified as "At Risk – Naturally Uncommon" (Patrick 2016). It was found active by day on cushionfield at 1900m within the skifield (Figure 4). It is also figured in Mark *et al*. (2012) from the Harris Mountains.
- The large geometrid moth – *Xanthorhoe frigida* is classified as "Nationally Vulnerable" (Hoare *et al*. 2017). The moth was attracted to light at 1850m on Treble Cone, and its larvae are known to be specialists on the cress *Cheesemania* which is found growing on steep rock bluffs (Peat & Patrick 1999).

The populations of these two rare and Threatened species within the skifield area are important in the overall conservation of both of these species.

DISCUSSION

In summary, the indigenous invertebrates and their natural habitats on the Treble Cone Skifield on the Harris Mountains in Western Otago are significant for the conservation of the characteristic invertebrate fauna of this biogeographic area for example the diurnal geometrid *Notoreas blax* (Figure 5) and black butterfly (Figure 2). This is also true for the two Threatened insect species, five rare moths and other species of insect with large-bodied, flightless females (Figure 1) which all have significant populations on the skifield, making these populations important in the overall conservation of these threatened, rare and distinctive species.

Apart from being a natural assemblage of alpine and high alpine species, the conservation of the invertebrate fauna is important here as on the skifield the indigenous invertebrates are subject to a different management regime than those living in Pastoral Leases, National Parks or Conservation Parks. The long-term conservation of this distinctive alpine-high alpine invertebrate fauna will benefit from different management regimes to retain all the species and their diverse biological, ecological and overall conservation needs.

Figure 4: The black alpine shield bug is a Threatened species and has a significant population on Treble Cone Skifield. It is active by day on cushion plants at about 1900m.

Figure 5: The day-flying and colourful daphne moth *Notoreas blax* is locally common in the herbfield and snowbanks of Treble Cone Skifield from 1860-2000m., where its larvae feed on various *Kelleria* species. It featured on a set of New Zealand postage stamps released in February 2020 on the recommendation of the author.

The natural habitats of the indigenous invertebrate fauna of the Treble Cone Skifield, and the populations of their invertebrate inhabitants appear stable despite existing within a dynamic skifield environment. But given the dynamic operational environmental of a working skifield this situation should be monitored to ensure that the key habitats and their invertebrate inhabitants remain stable in terms of habitat quality and population numbers.

I recommend that long-term monitoring is installed in several key invertebrate communities on the skifield to monitor trends in population numbers of key invertebrate species. This monitoring would be achievable if it was selective and included the two Threatened species: black alpine shield bug *Hypsithocus hudsonae* (Figure 4) and moth *Xanthorhoe frigida*, and two species of high alpine moths such as the large Otago endemic ghost moth *Aoraia senex* and the colourful diurnal daphne moth *Notoreas blax* (Figures 1 & 5).

The most effective monitoring method for the moths and bug would be three, 30-minute counts of adults in their habitats, in appropriate weather conditions at the right time of year for adult activity. The starting point for the counts should be marked with a peg to ensure consistency in term of place, with the finishing point for the 30-minute walk being the same marked spot. If counts are consistent in terms of numbers, I suggest repeating monitoring every three years.

The population numbers of the Threatened moth *Xanthorhoe frigida* would be most effectively monitored by counts of its larval hostplant *Cheesemania* on rock bluffs. Again, identifying two populations of this cress within the skifield and making actual counts of it every three years.

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Appendix 5 – Treble Cone Ski Area Assessment of Aquatic Ecological Values - Home Basin

WATER WAYS
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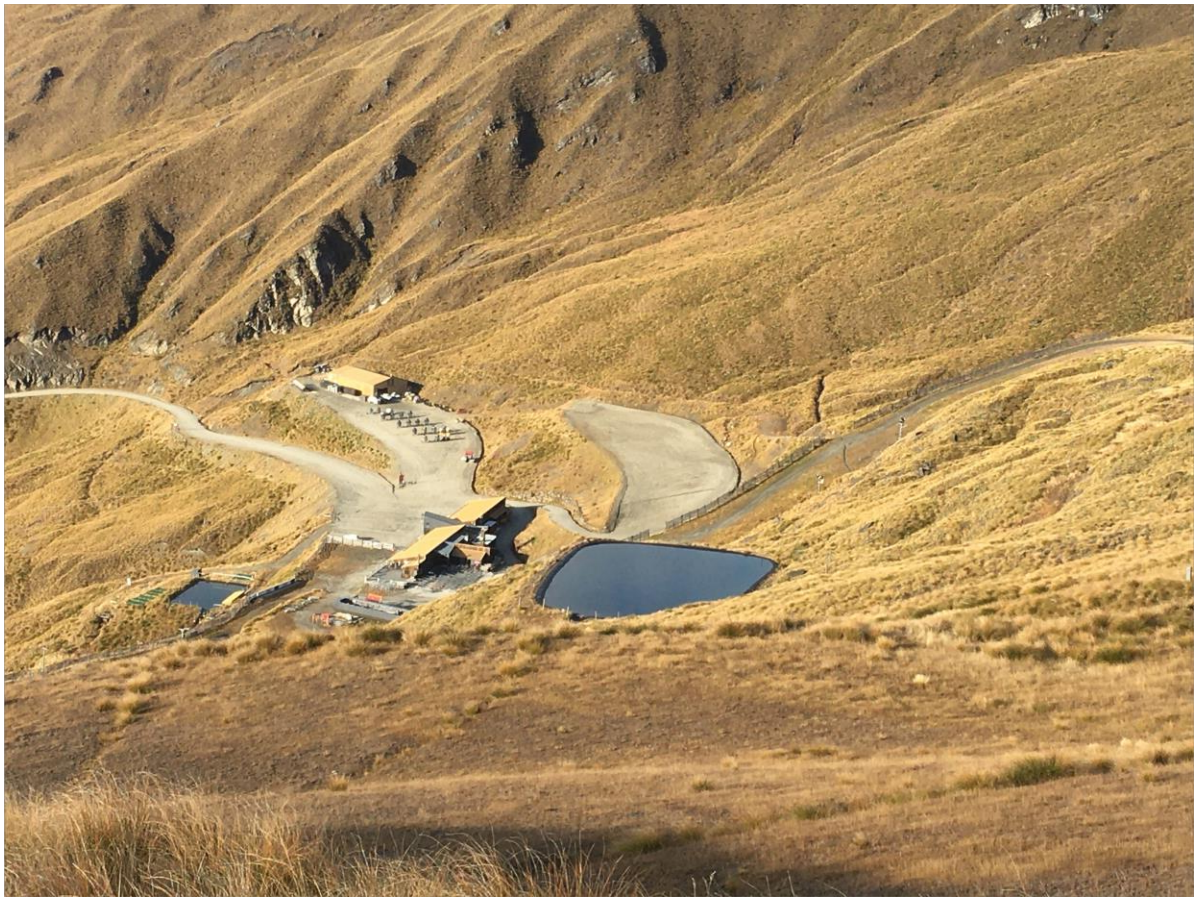
Treble Cone ski area assessment of aquatic ecological values – Home Basin



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Cover photo – Treble Cone base facilities

1 INTRODUCTION

Treble Cone ski area is located in the Matukituki and Motatapu catchments west of Wanaka and is situated on land administered by the Department of Conservation. Cardrona Alpine Resorts Limited presently lease the ski area and this lease is due for renewal.

As part of the lease renewal process an assessment of the ecological values present within the ski area is required.

This report provides an assessment of the aquatic ecological values present in streams in the Home Basin overlooking the Matukituki and lower Motatapu Valleys.

An assessment of the aquatic values present in the streams in the tributary of the North Branch of the Motatapu River, including the Saddle Basin will be undertaken later in the year.

2 METHODS

The Home Basin was visited on the 6 May 2020 and a site walkover was conducted. The walkover ascended to approximately 1550 m and involved a traverse of the basin at this altitude. Once the traverse was completed the walkover descended along the major water course in the basin.

At stream crossing points encountered during the traverse (sites CONE3 to 7) the state of the water course was recorded, the stream was searched for macroinvertebrates and small samples for identification were collected from two sites. Any modifications to the water course, either upstream or downstream of the sites was noted.

Kick net macroinvertebrate samples were collected at four sites near the Treble Cone base buildings (sites Cone11 to 14). Standard kick net practices could not be followed as the stream bed substrate was dominated by boulders and large cobbles that could not be easily disturbed. A sample at each site was collected by disturbing the moveable substrate and brushing invertebrates (by hand) off the immobile substrate particles. All samples were preserved in 70% ethanol and returned to the laboratory for sorting, identification and full counts were made of the invertebrates collected.

Given the altitude of the basin and the steep terrain downslope from the basin no fish sampling was conducted as it was considered that fish will not be able to ascend to the ski field area in these eastern face streams. Koaro (*Galaxias brevipinnis*) is the only fish in the Matukituki catchment that could ascend the steep slope but to get to the ski field this would mean a 850 m vertical ascent which was considered extremely unlikely to occur.

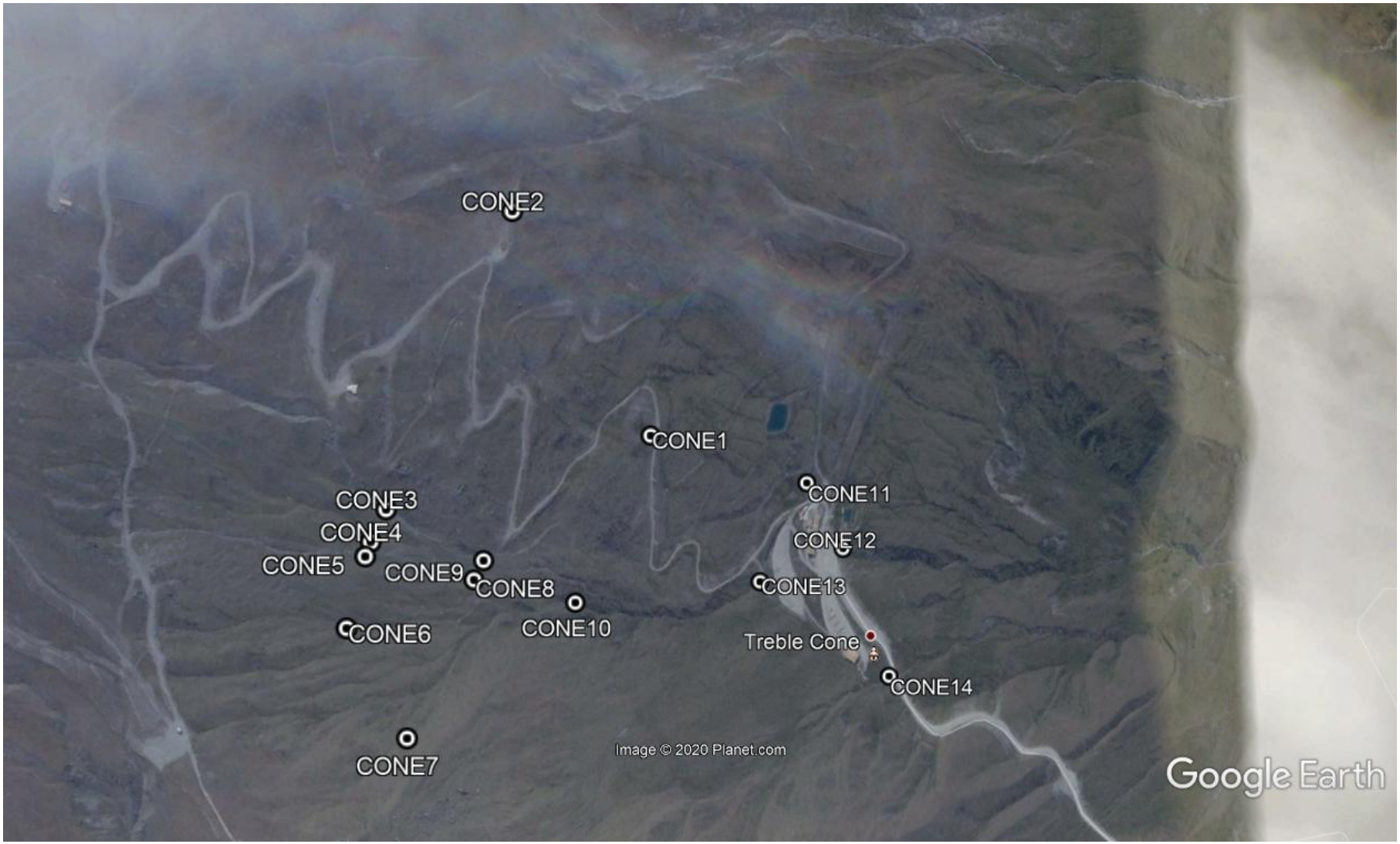

Figure 1: Survey locations on the Home Basin, Treble Cone.

3 RESULTS

3.1 General observations

The site walk over visited fourteen sites to record aquatic values (sites CONE1 to CONE14).

3.1.1 CONE1

This site was a short section of modified stream channel flowing down the access track embankment (Figure 2). The channel was protected from erosion by the placement of flat schist slabs on the stream bed and by well established riparian vegetation. Moss was present on the slabs indicating the channel is stable with little disturbance. *Deleatidium* mayfly nymphs were common on the rocks in this stream.

Figure 2: Site CONE1, a modified channel on the access track.

3.1.2 CONE2

Site CONE2 was at the top of a modified slope on the northern edge of the ski area. No water courses were present at this site confirming no perennial streams are present on this part of the Basin (Figure 3).

Figure 3: The view from Site CONE2 with no stream courses.

3.1.3 CONE3 to 7.

A series of five small streams flow from near the ridge line downslope in the Home Basin. At the 1500-1550 m altitude all the streams were small.

The stream at CONE3 was flowing at approximately 50 ml/s and it is possible this is an ephemeral stream, drying in the summer. It was in a steep V-shaped channel well incised into the hillside (Figure 4). The habitat consisted of steep cascades and occasional very small pools with a maximum depth of 15 cm. No invertebrates were observed when the substrate, stream bed moss and riparian vegetation was searched. The stream channel appeared stable and had no modifications. The riparian vegetation was also intact along the stream edge restricting erosion.

CONE4 was sited on another small steep channel with a good riparian margin and no erosion. The stream was almost complete enclosed by its banks and it had a maximum width of 40 cm and the flow was estimated to be 50 ml/s or less. A search of the stream bed substrate and bank edge vegetation found no invertebrates. Small pools were present and these had a maximum depth of 10 cm (Figure 5). It is likely that this stream is also ephemeral.

CONE5 was sited on a larger stream and has had large rock flows coming downstream from the mountain top in the channel. This stream drains the highest slopes in the basin so has the largest catchment upstream of the survey site. There was sediment (silt to boulder sized particles) deposited along the stream edge and the riparian vegetation was partially buried. Some channel erosion was present but this was limited and appears to be due to the channel being over loaded

with sediment due to the upstream debris flow. The stream was up to 1 m wide and 20 cm deep. A search of the stream bed substrate found macroinvertebrates; *Austrosimulium* larvae were the common and other Diptera and caddisfly larvae were present. Given the presence of invertebrate life and the larger size of this stream it is expected that it is a perennial stream.

Figure 4: The stream channel at Site CONE3.

There were two small stable streams at CONE6 site. Both were narrow, 20 cm and 40 cm wide and had well vegetated riparian margins with saturated moss growth along the stream edges (Figure 7). The smaller stream had a fine sediment stream bed and the larger stream had some gravel and cobble on the stream bed. No invertebrates were found in the smaller stream while flatworms, *Deleatidium*, chironomid larvae and stoneflies (not identified) were present in the larger stream. Both streams had sections where the stream was completely underground or overgrown and not visible from above.

Site CONE7 was sited on a channel depression on the hillside and there was no obvious surface flow at the site. A similar channel was crossed between Sites CONE6 and 7.

Figure 5: A small pool in the stream at site CONE4.

Figure 6: The stream channel at Site CONE5.

Figure 7: One of the small streams present at site CONE6.

3.1.4 Sites CONE8 and 9.

Sites CONE8 and 9 were located downstream of the previous sites near the confluences of the smaller streams. The streams at these two sites have undergone some very localised modification with a 4WD track crossing the streams using culverts. The stream at CONE8 is downstream of site CONE5 and the 4WD track culvert is blocked by debris that has come down the stream. This culvert bloackage has diverted the stream and it flows across to the stream at site CONE9. The CONE8 stream has a stream bed comprised of silt through to boulders. Invertebrates are present in the stream including flatworms and *Deleatidium* and stony cased caddisflies, although the abundance was low. No invertebrates were observed in the stream at CONE9.

Figure 8: The stream at CONE8 looking upstream where sediment has accumulated upstream of the 4WD track.

3.1.5 Site CONE10

Site CONE10 was the water intake location for the Treble Cone base facility. At this location all the upstream tributaries sampled have joined to form this single stream channel. The channel is over 1 m wide and pools are up to 50 cm deep. The stream edge and bed is predominately bedrock and boulder with small areas of cobble, gravel and sand. The stream is incised in a narrow v shaped channel that has a well vegetated riparian zone. The steep is steep with the habitat generally being a cascade with small plunge pools and runs. The water intake structure is the only modification and extends along about 10 m of stream.

Figure 9: Site CONE10 with the water intake looking upstream (left) and downstream (right).

3.2 Sites CONE11- 14

CONE11 is an artificial channel that flows alongside the learners ski slope and under the main chair lift before being culverted under the base facility buildings. The stream was sampled just upstream of the chairlift. At this site the stream has a stable boulder, cobble and gravel bed with some moss on the boulders and cobbles. The riparian vegetation was intact and there was no erosion along the stream. Therefore, while this is an artificial channel it has a very natural character aside from being straight.

Sites CONE12 and 13 are on the main stream located upstream (CONE13) and downstream (CONE12) of a long culvert section that flows under the ski area carpark. Both sites had a boulder, cobble and gravel stream bed that is stable with little erosion. The riparian zone is well vegetated at both sites with tall tussock grasses the most common vegetation. The stream width is approximately 1 m and the maximum channel depth is 25 cm.

Site CONE14 was on the upstream side of the access road on a stream just down the access road from the base buildings. This stream is also a steep cascading stream with a boulder, cobble streambed and an intact tussock riparian zone.

The invertebrate communities at the four sites where diverse with a up to 21 taxa present and the macroinvertebrate community index (MCI) scores all greater than 120 indicating excellent water and habitat quality (Table 1). Pollution sensitive taxa were common with Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies) (EPT taxa) common in the samples. Given the difficulty collecting standardised samples the total macroinvertebrate abundance data can only be considered an indication of abundance, but this does show macroinvertebrates are common in the streams on the lowest altitude parts of basin.

Table 1: Invertebrate sample results.

	CONE11	CONE12	CONE13	CONE14
Taxa richness	21	14	19	17
EPT taxa	8	6	7	9
Abundance in sample	549	447	567	209
% abundance EPT	38	43	37	53
MCI	125	129	126	133
MCI quality class	Excellent	Excellent	Excellent	Excellent

Figure 10: Invertebrate sample sites, CONE11 (top left), CONE12 (top right), CONE13 (bottom left) and CONE14 (bottom right).

4 DISCUSSION

4.1 Aquatic Ecological Values

No fish species are expected to occur in the streams visited. Altitude and access are obvious limiting factors, and also the streams that are above 1500 m are too small and often appear to be ephemeral so will not support fish life.

The macroinvertebrate community is diverse, and the MCI scores (Appendix A) show habitat and water quality is excellent. The invertebrate fauna includes a range of mayflies, stoneflies and caddisflies (Ephemeroptera, Plecoptera and Tricoptera, (EPT taxa)) that are indicators of good water and habitat quality. There was also a range of other taxa present that means the streams support a wide range of invertebrates. While this community is diverse the two megainvertebrates; koura

(freshwater crayfish) and kakahi (freshwater mussel) are not present. Koura has not been reported in the upper Clutha catchment so its absent is expected. Similarly, kakahi requires a freshwater fish as a host for its parasitic larval stage and the absence of fish means kakahi will not be present. In addition, habitat conditions are unsuitable for kakahi as there are few fine sediment stream bed areas for the mussel to burrow in.

4.2 Habitat condition

The stream habitats were generally unmodified and have been retained in a natural state. Most streams reaches have a natural stream bed and the riparian zones have intact native vegetation. Erosion is limited and one active slip at the top of the basin is the only significant source of sediment in the streams. It is notable that the adjacent land area outside the ski basin has a large active erosion area (Figure 11) indicating that these mountain slopes can be unstable. Small areas of stream alteration have occurred around vehicle tracks and there is a water take on the main stream. The streams are also culverted under the access road and base facility area. However, given the size of the ski area these alteration areas are small compared to its total area. The modified channels are all stable and support high quality macroinvertebrate communities (e.g., Site CONE11). The macroinvertebrate collections indicate that the water quality is excellent and therefore water draining from the basin is of excellent quality and will have no detrimental effects on downstream ecosystems.

Figure 11: Erosion and landslip adjacent to Treble Cone.

5 SUMMARY

One major catchment drains much of the Home Basin. This catchment has a number of small streams at higher altitudes that converge to a single large stream on the lower slopes. This stream system is largely natural and undisturbed aside from one upper stream channel with a high bed load, a 4WD track crossing and a water take. The only major modifications are the culverted sections of

stream at the base facility. There are no fish present in the stream on the Home Basin, and given the altitude and location this is to be expected. Macroinvertebrate communities are of high quality and indicate excellent habitat and water quality. Modified channels are also stable, have good riparian vegetation and high quality macroinvertebrate faunas.

APPENDIX A MACROINVERTEBRATE DATA

Taxa	MCI	Cone 5 Hand	Cone 6 Hand	Cone 11 Net	Cone 12 Net	Cone 13 Net	Cone 14 Net
Ephemeroptera (mayflies)							
Deleatidium	**8**			263	275	341	92
Nesameletus	**9**			73	21	60	14
Plecoptera (stoneflies)							
Austroperla	**9**						12
Halticoperla	**8**						8
Zelandobius	**5**			22	4	12	4
Zelandoperla	**10**		1	83	108	57	30
Trichoptera (caddisflies)							
Aoteapsyche	**4**						2
Hudsonema	**6**			3			
Hydrobiosis	**5**			14		3	1
Oeconesus	**9**			1	1	1	
Philorheithrus	**8**	2					
Zelolessica	**10**		2	14	7	1	2
Coleoptera (beetles)							
Elmidae	**6**			12	15	21	15
Hydraenidae	**8**			5		3	
Hydrophilid	**5**			4	3	1	2
Scirtidae	**8**			17	6	39	17
Diptera (flies)							
Austrosimulium	**3**	8		2		9	
Blephariceridae	**7**				3	4	1
Eriopterini	**9**			2		2	2
Limonia	**6**				1	1	1
Maoridiamesa	**3**		3	1	1	1	
Muscidae	**3**	1			1		
Paralimnophila	**6**			8			
Megaloptera (dobsonflies)							
Archichauliodes	**7**			1			
CRUSTACEA							
Isopoda	**5**			7			
ACARINA							
Acari	**5**					1	
ARACHNIDA							
Dolomedes	**5**			2			
OLIGOCHAETA	**1**			1	1	7	1
PLATYHELMINTHES							
Neppia	**3**		12	14		3	5
Taxanomic richness		3	4	21	14	19	17
EPT taxonomic richness		1	2	8	6	7	9

% EPT taxonomic richness		33	50	38	43	37	53
MCI score		93	130	125	129	126	133
MCI Quality Class		Fair	Excellent	Excellent	Excellent	Excellent	Excellent

Appendix 6 – Treble Cone Ski Area Assessment of Aquatic Ecological Values - Saddle Basin

WATER WAYS
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Treble Cone ski area assessment of aquatic ecological values - Saddle Basin

PREPARED FOR: CARDRONA ALPINE RESORTS LTD

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Cover photo – Saddle Basin and ski lift building

1 INTRODUCTION

Treble Cone ski area is located in the Matukituki and Motatapu catchments west of Wanaka and is situated on land administered by the Department of Conservation. Cardrona Alpine Resorts Limited presently lease the ski area and this lease is due for renewal.

As part of the lease renewal process an assessment of the ecological values present within the ski area is required.

This report provides an assessment of the aquatic ecological values present in streams of Saddle Basin that is located on of the upper reaches of a tributary of the North Branch of the Motatapu River.

2 METHODS

The Saddle Basin was visited on the 8 January 2021 and a site walkover was conducted. The walkover started at the service track culvert crossing the main stream draining the basin at an altitude of 1560 m. The main stream was walked in an upstream direction to an altitude of 1700 m and then traversed across the basin back to the access track at the Saddle Hut.

At stream crossing points encountered during the site walkover (sites CONE15 to 19, Figure 1) the state of the water course was recorded, the stream was searched for macroinvertebrates. Any modifications to the water course, either upstream or downstream of the site were noted.

Kick net macroinvertebrate samples were collected at two sites on the main stream course (sites CONE15 and 16). The samples at each site were collected by disturbing the moveable substrate and brushing invertebrates (by hand) off the immobile substrate particles and washing instream vegetation to remove macroinvertebrates. All samples were preserved in 70% ethanol and returned to the laboratory for sorting, identification and full counts were made of the invertebrates collected.

Electric fishing was conducted at Site CONE15 in the main stream downstream of the service track culvert. Below the fishing reach the stream descends steeply and the start of the steep gradient reach was viewed for fish passage obstructions.

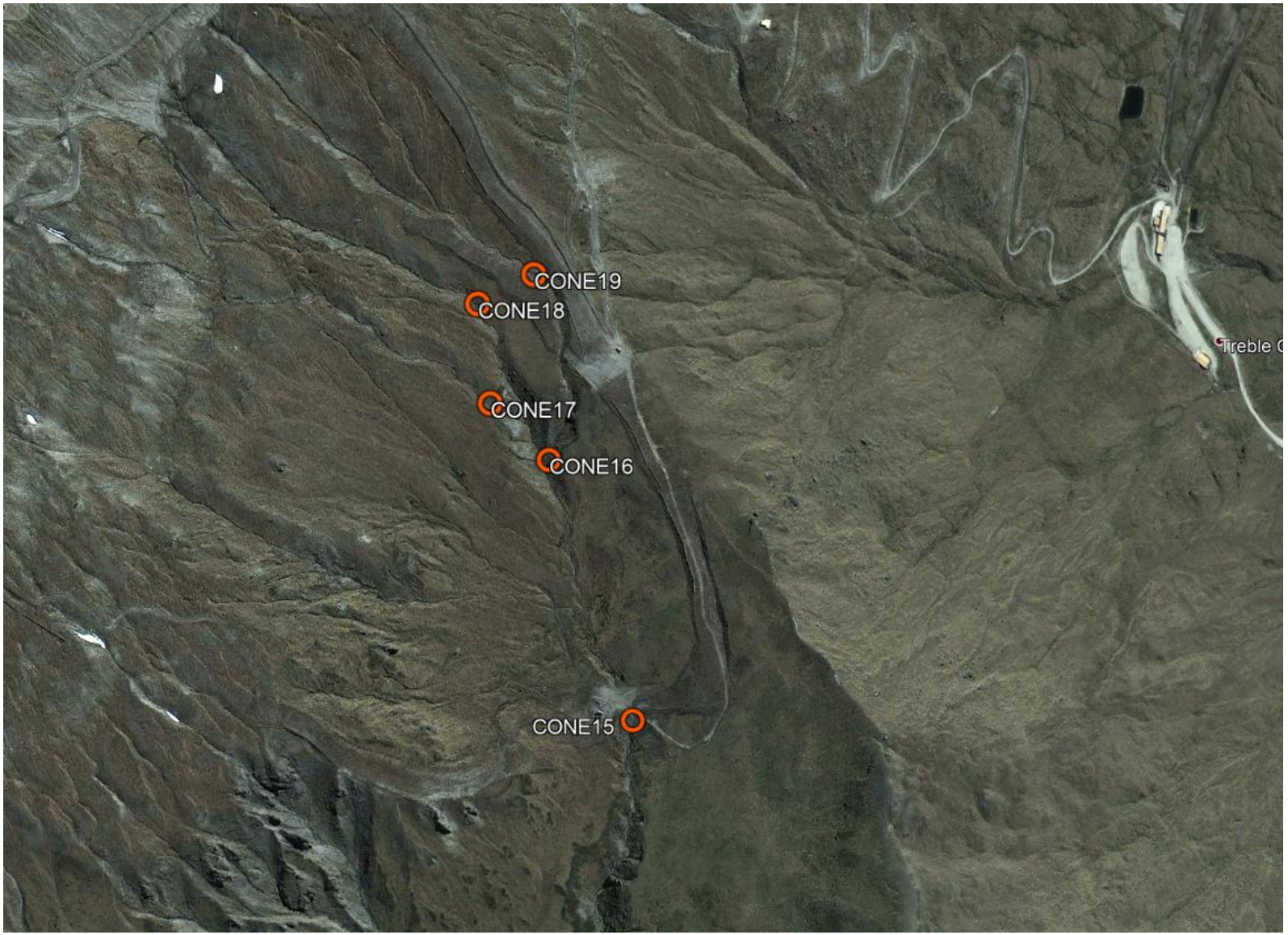

Figure 1: Survey locations on the Saddle Basin, Treble Cone.

3 RESULTS

3.1 General observations

The site walk over visited five sites to record aquatic values (sites CONE15 to CONE19) and walked the main stream course from the service track culvert to an altitude of 1700 m.

3.2 CONE 15

Site CONE15 was located downstream of the service track culvert. The stream at this site had an orange stain on the majority of the stream bed with only the high water velocity areas having none (Figure 2). This orange stain was only present downstream of the culvert and road embankment. Immediately upstream of the culvert the stream bed was clean (Figure 3) and the orange stain was not observed anywhere else in the Saddle Basin.

The riparian zone was composed of native alpine vegetation together with areas of exposed rock along stream margin. The streambed substrate was predominately bedrock and boulder with some cobble and gravel. Turf plant communities were present on the stream edge and emergent rocks in the channel.

A 50 m reach was electric fished and no fish were caught or observed. The electric fishing did collect invertebrates which were almost exclusively *Deleaditium* and *Nesameletus* mayflies with the only exception being an adult stonefly. The downstream fish passage survey found three significant waterfalls (Figure 4) between 50 and 200 m downstream from the site.

The only stream modification in this area was the culvert and road embankment.

Figure 2: Site CONE15

Figure 3: The clean stream bed upstream of the service track culvert.

Figure 4: Waterfall downstream from site CONE15.

3.3 CONE16

Site CONE16 was located at the confluence of the main stream and two tributaries at a point in the valley were the gradient changed from gentle to steep slopes (Figure 5, Figure 6). The stream channel substrate was dominated by boulders with cobbles and bedrock the other major components. The steeper stream sections had some exposed rock riparian margins and scouring during high flow events appears to prevent vegetation from establishing. A section of true right tributary was a near vertical bedrock face with water flowing down it. At the site and downstream alpine vegetation, generally tussocks, were present along the stream margins. Instream vegetation was limited to small patches of moss on stable boulders.

There was no stream modifications present at this site.

Figure 5: Site CONE16 looking downstream.

Figure 6: Site CONE16 looking upstream on the true left tributary.

3.4 CONE17-19.

Sites CONE17-19 were in three generally unmodified tributary streams on gentle to moderately steep slopes upstream of the steep gradient section at CONE16. These sites were at altitudes ranging from 1660 m to 1700 m. Each stream ranged in size from 0.6 m to 1 m wide. All had good riparian vegetation with moss and tussock present to the water's edge. Substrate was dominated by boulder and cobble and the streams appeared to have stable beds. Searches for macroinvertebrates were conducted at all three sites and *Deleatidium* mayflies were common and occasionally flatworms were also found. A single small stonefly nymph was seen at Site CONE18. No caddisflies where observed at any of these three sites.

Sites CONE17 and 18 were unmodified aside from some rubbish in the streams (Figure 7). Site CONE19 had a vehicle crossing point that from the tracks is used by tracked vehicles (Figure 8). This crossing has removed the riparian vegetation for approximately 4 m along both stream banks. No erosion was apparent at the crossing so the modification o the stream was limited to the 4 m crossing.

3.5 Upslope areas

The stream reaches upslope from sites CONE17-19 were all steep and appeared unmodified (Figure 9).

Figure 7: Site CONE18.

Figure 8: Site CONE19 with the track crossing.

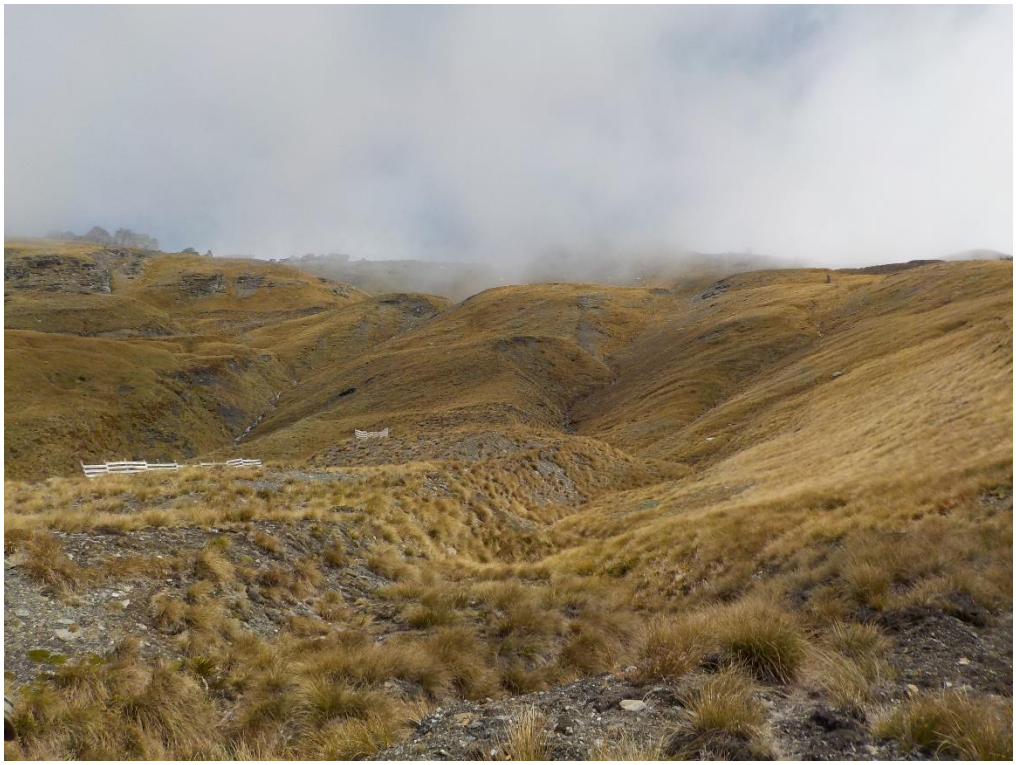

Figure 9: Stream courses upslope from Sites CONE17-19.

3.6 Macroinvetebrate samples

The kick net samples collected at sites CONE15 and 16 were dominated by mayflies, particularly *Deleatidium*. Other taxa, midges, stoneflies, beetles and flatworms were present but rare (Appendix A). Site CONE15 had a greater diversity of species and the presence of the orange staining material has not excluded any species present at site CONE16. The MCI scores for both sites were very similar (110 and 111) giving an MCI quality class of excellent for both sites (Table 1).

Table 1: Invertebrate sample results.

	CONE15		**CONE16**
Taxa richness	6		10
EPT taxa	2		4
Abundance in sample	140		74
% abundance EPT	33.3		40
MCI	110		111
MCI quality class	Excellent		Excellent

4 DISCUSSION

4.1 Habitat condition

The streams in the Saddle Basin are for the most part unmodified and retain their natural ecological values. The two localised changes to the streams are associated with vehicle access. The service track culvert to the ski lift in the basin is the most significant modification with the culvert and embankment. This embankment also appears to be leaching dissolved metal, possibly iron into the stream. This does not appear to be limiting the macroinvertebrates downstream of the culvert as the diversity at site CONE15 is greater than the upstream site CONE16. The second track crossing at

site CONE19 has no apparent effect aside from a small loss of riparian vegetation. Aside from the two track crossing the only other impacts are the occasional piece of rubbish in the streams.

4.2 Fish

No fish species were collected at site CONE15 and the downstream waterfalls block fish passage for all but the climbing fish species. It is possible that koaro, that are present in the catchment, could climb the waterfalls. However, CONE15 is approximately 50 km upstream from Lake Wanaka and also a 1300 m climb in altitude. This makes it unlikely that koaro would access the streams in the Saddle Basin area.

4.3 Macroinvetebrates

The macroinvertebrate community has limited diversity in part due to the complete absence of caddisflies. Caddislies were present in streams on the Home Basin face at all four sample locations but these sites were at an altitude 250 m lower than CONE15 and CONE16 (Water Ways 2020). In the Saddle Basin caddisflies were not preent in the kicknet samples nor was any evidence of them found when searching the stream bed at the other sites. The macroinvertebrate community did indicate via the MCI scores that the stream health is excellent. This is supported by the unmodified nature of the streams and the basin in general.

5 SUMMARY

One major catchment drains the Saddle Basin. This catchment has a number of small streams at higher altitudes that converge to a single large stream on the lower slopes. This stream system is largely natural and undisturbed aside from the service track culvert and one 4WD track crossing There are no fish present in the stream on the Saddle Basin, and given the altitude, location and downstream fish passage barrier this is to be expected. Macroinvertebrate communities are of limited diversity but are high quality and indicate excellent habitat and water quality. .

6 REFERENCES

Water Ways Consulting (2020) Treble Cone ski area assessment of aquatic ecological values. Client report 88-2020 prepared for Cardrona Alpine Resorts Limited.

APPENDIX A MACROINVERTEBRATE DATA

Taxa	MCI	Cone 15 Net	Cone 16 Net
Ephemeroptera (mayflies)			
Deleatidium	**8**	113	47
Nesameletus	**9**	21	13
Plecoptera (stoneflies)			
Austroperla	**9**		1
Zelandobius	**5**		3
Coleoptera (beetles)			
Elmidae	**6**		1
Scirtidae	**8**	2	3
Diptera (flies)			
Muscidae	**3**	1	1
Orthoclad		2	1
Tanyopod	**6**		1
PLATYHELMINTHES			
Neppia	**3**	3	9
Taxanomic richness		6	10
EPT taxonomic richness		2	4
% EPT taxonomic richness		33.3	40
MCI score		110	111
MCI Quality Class		Excellent	Excellent