UNGULATE EFFECTS ON INDIGENOUS BIODIVERSITY VALUES IN THE UPPER MAKAREWA CATCHMENT, SOUTHLAND

providing outstanding ecological services to sustain and improve our environments

Wildlands

R7004

UNGULATE EFFECTS ON INDIGENOUS BIODIVERSITY IN THE UPPER MAKAREWA CATCHMENT, SOUTHLAND

Severely browsed forest on Lora Glen.

Contract Report No. 7004

October 2023

Project Team:
Kelvin Lloyd – Field work and report author

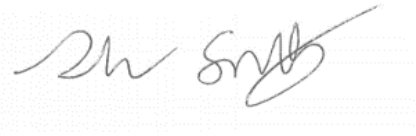
Prepared for:
Thriving Southland Association Incorporated

DUNEDIN OFFICE: 764 CUMBERLAND STREET, DUNEDIN 9016
Ph 03-477-2096, 03-477-2095

HEAD OFFICE: 99 SALA STREET, P.O. BOX 7137, TE NGAE, ROTORUA
Ph 07-343-9017; Fax 07-343-9018, email ecology@wildlands.co.nz, www.wildlands.co.nz

CONTENTS

Reviewed and approved for release by:



Des Smith
Senior Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

The Makarewa Headwaters Catchment Group (MHCG) in Southland has established a project (funded by the Thriving Southland Association Incorporated) to better understand the impact of feral ungulates (mainly deer) on the farming community and also on indigenous biodiversity. The upper Makarewa Catchment drains the western Hokonui Hills, and most farms in the catchment retain areas of mature or regenerating indigenous forest, that provides extensive habitat for feral ungulates.

The MHCG seeks a better understanding of the damage occurring in the indigenous forest including the impact on regeneration, soil erosion, sediment runoff and the ability of the landscape to retain water in severe weather events. The group also wishes to understand potential 'tipping points' or thresholds that if exceeded, might constrain the recovery of indigenous biodiversity.

Wildland Consultants were contracted to undertake a field survey of regenerating and mature forest habitats in the project area and assess the effects of feral ungulates in these areas. This report summarises the results of the field survey and provides suggestions for monitoring.

2. ECOLOGICAL CONTEXT

2.1 Landforms and land cover

The MHCG project area is dominated by moderately steep-sided hills with broad, gentle ridge crests. These are mostly covered with indigenous forest and scrub, but the exotic shrubs gorse (*Ulex europaeus*) and broom (*Cytisus scoparius*) are also common on hill slopes and in incised gullies. Valleys between the hills have flat or gently rolling land.

2.2 Protected areas

There are several areas of public conservation land in the project area. Conservation Area – The Cone Forest protects several areas of mature indigenous forest in the south-west, while Conservation Area – Bare Hill Forest protects mostly regenerating forest in the north-east. The project area also has many QEII covenants, which complement the areas of conservation land (Figure 3).

2.3 Ecological districts and land cover

The project area is largely within the Hokonui Ecological District. Land cover within the project area is dominated by 'high producing exotic grassland' (65%) but the next highest cover is 'indigenous forest' (12%), followed by 'exotic forest' (6%), 'gorse and/or broom' (4%), 'matagouri or grey scrub' (3%), 'low producing grassland' (3%), and 'tall tussock grassland' (2%).

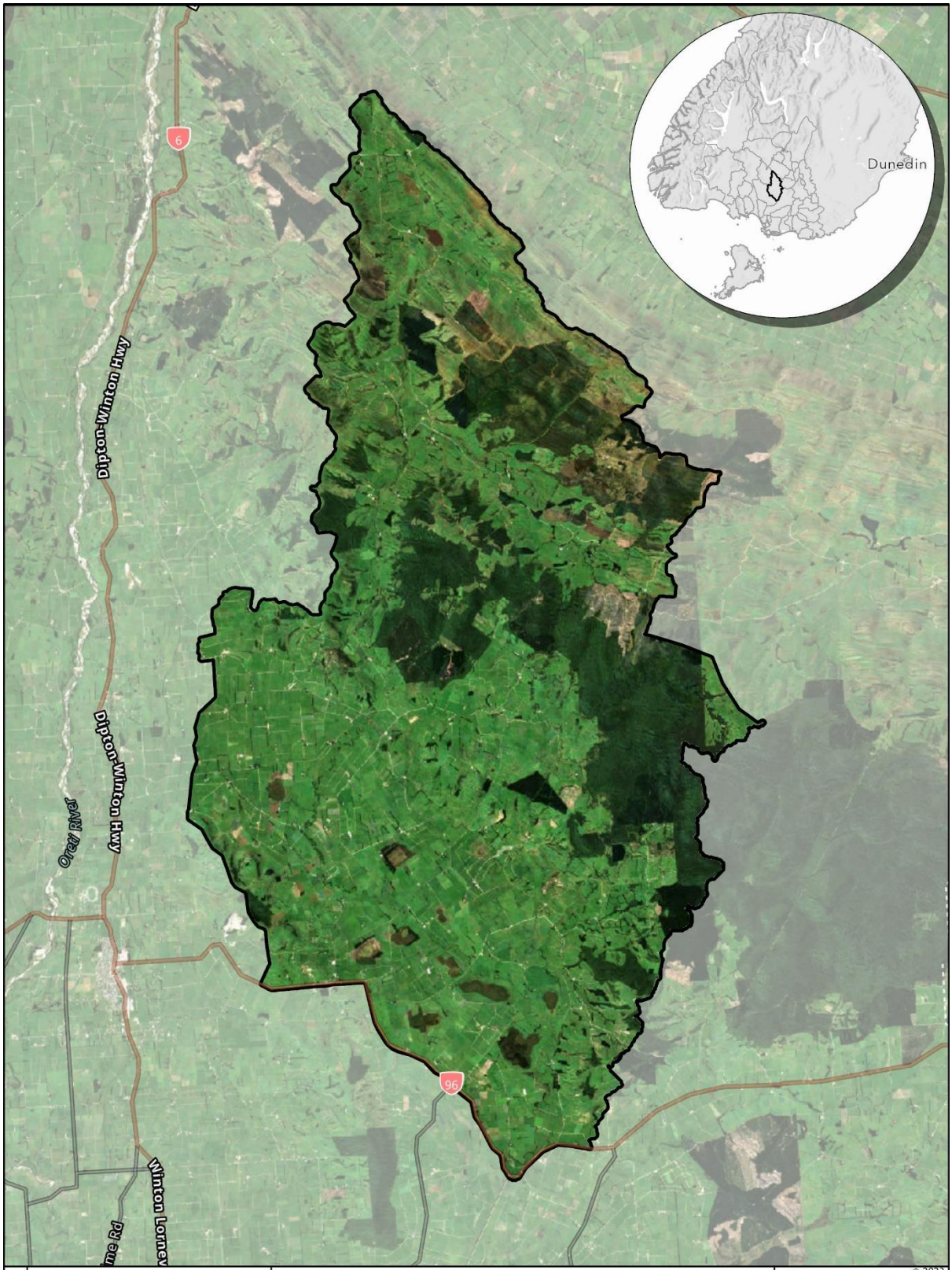


Figure 1. Location of the Makarewa Headwaters Catchment Group

2.4 Potential natural ecosystems

Potential natural ecosystem mapping using the national vegetation classification of Singers & Rogers (2014) mapped a variant of CLF6.5 Kamahi, southern rata, podocarp forest over hill country landforms in the project area. CLF4 Kahikatea, totara, matai forest is mapped over the lower slopes and terraces, while MF4 Kahikatea forest was mapped on wet soils alongside streams. Wetlands dominated by copper tussock (*Chionochloa rubra* subsp. *cuprea*; WL16 Red tussock, *Schoenus pauciflorus* tussockland), wire rush (*Empodisma minus*; WL6 Lesser wire rush, tangle fern, restiad rushland/fernland), and sedges (WL22 *Carex*, *Schoenus pauciflorus* sedgeland) also occur within the project area.

2.5 Threatened Environment Classification

The upper Makarewa catchment largely comprises land environments with more than 20% of their indigenous cover, comprising land environments with 20-30% of their original cover in the southwest, and land environments with more than 30% cover in the north and east. Overall, land environments that are less reduced (>30% cover) cover the greatest proportion (50%) of the project area (mainly in the north), but 23% of the project area is covered by land environments that have less than 10% of their original cover remaining, mainly in the south (Figure 4).

3. SITE DESCRIPTIONS

3.1 Overview

Sites on the following four farms within the project area were visited to assess ungulate damage to indigenous vegetation: Lora Glen, Highfield, Bare Hill, and Moss Burn Ridges (Figure 5).

3.2 Lora Glen

Lora Glen is located in the Silver Stream and Lora Stream catchments and the north-western part of the farm is largely surrounded by areas of mature indigenous forest. Four sites were assessed, Sites 1-3 forming an altitudinal gradient on the east face and crest of a tall hill located west of Silver Stream. Site 4 was on the western slopes of a hill on the east side of Silver Stream (Figure 5). Due to the problems of feral deer on pasture, the landholder has fenced the entire forest margin with a deer fence, to keep the deer away from pasture areas.

3.2.1 Site 1

Site 1 (360 metres above sea level) was sampled in mature forest on a moderately steep, bouldery slope. The canopy was dominated by emergent matai (*Prumnopitys taxifolia*), rimu (*Dacrydium cupressinum*) and southern rātā (*Metrosideros umbellata*), above a broadleaved canopy of kāpuka/broadleaf (*Griselinia littoralis*), piripiriwhata/marble-leaf (*Carpodetus serratus*), kōtukutuku/fuchsia (*Fuchsia excorticata*), tarata (*Pittosporum eugenioides*), māpou (*Myrsine australis*), kaikomako (*Pennantia corymbosa*), makomako/wineberry (*Aristotelia serrata*), *Coprosma linariifolia*, and *Raukaua edgerleyi*.

The relatively open understorey (Plate 1) comprised horopito/pepper tree (*Pseudowintera colorata*), *Coprosma areolata*, kātote/soft tree fern (*Cyathea smithii*), and occasional turepo (*Streblus heterophyllus*), all of which are unpalatable to feral ungulates.

Palatable species such as three finger (*Pseudopanax colensoi*), kapuka, and hupiro (*Coprosma foetidissima*) were only observed regenerating on sites that deer could not reach, including gently-inclined tree trunks and tree forks.

The ground layer was dominated by low palatability piupiu/crown fern (*Lomaria discolor*) and Parsonsia heterophylla seedlings, with occasional heruheru (*Leptopteris hymenophylloides*), kiwakiwa (*Cranfillia fluviatilis*), shield fern (*Polystichum vestitum*), and *Leptolepia novae-zelandiae*. Some shield fern fronds showed signs of browse by feral deer.

Bare soil from tracking by deer was widespread.

Plate 1: Relatively open forest at Site 1, with little understorey.

3.2.2 Site 2

The forest canopy at Site 2 (400 metres elevation) comprised southern rata, kāpuka, piripiriwhata, kōtukutuku, horopito, tarata, and kowhai (*Sophora microphylla*), above a relatively thin understorey of *Coprosma rotundifolia*, horopito, and kātote.

The ground layer was dominated by piupiu, with occasional shield fern, kiwakiwa, bush nettle (*Urtica sykesii*), *Carex uncinata*, and foxglove (*Digitalis purpurea*).

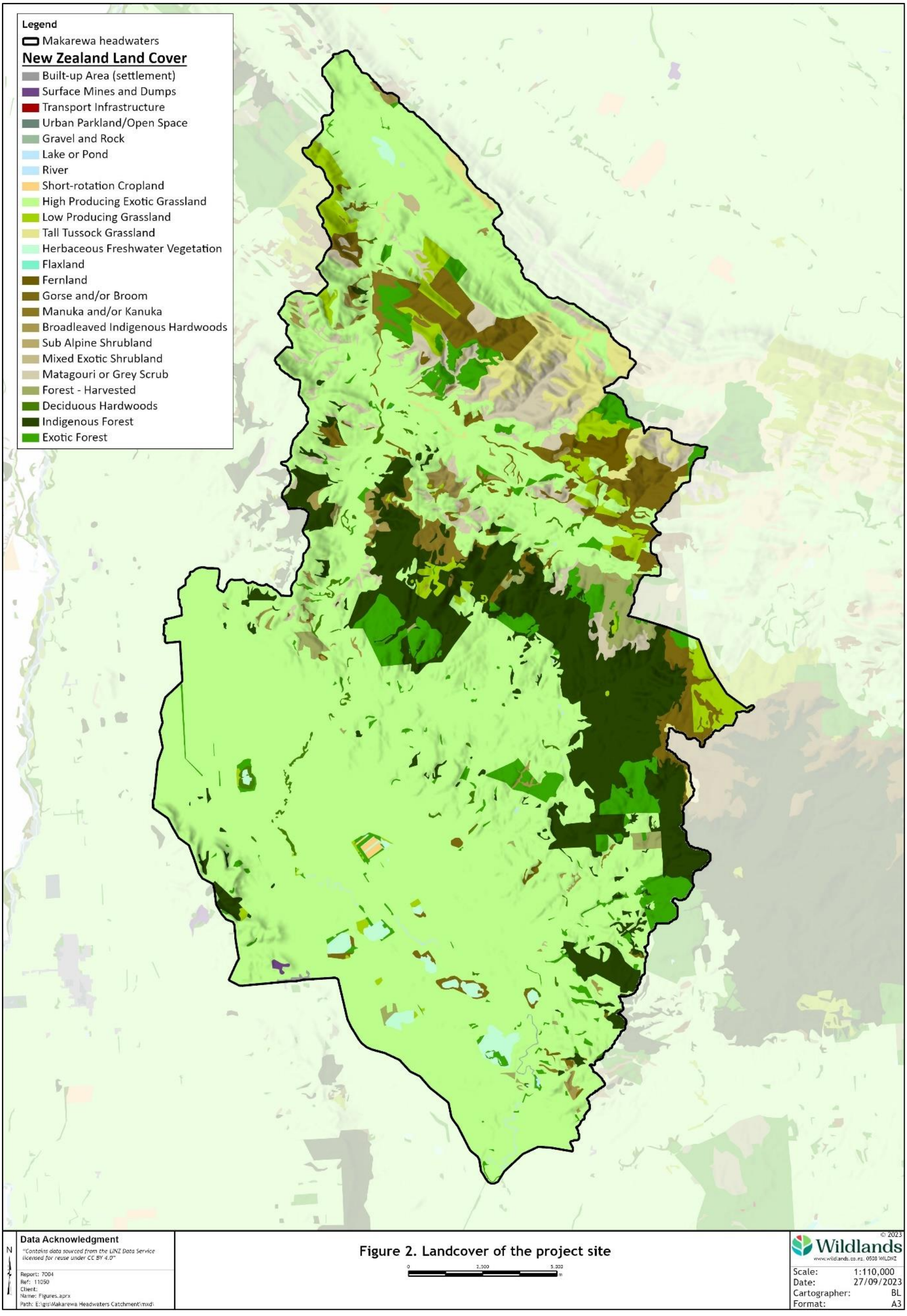


Figure 2. Landcover of the project site

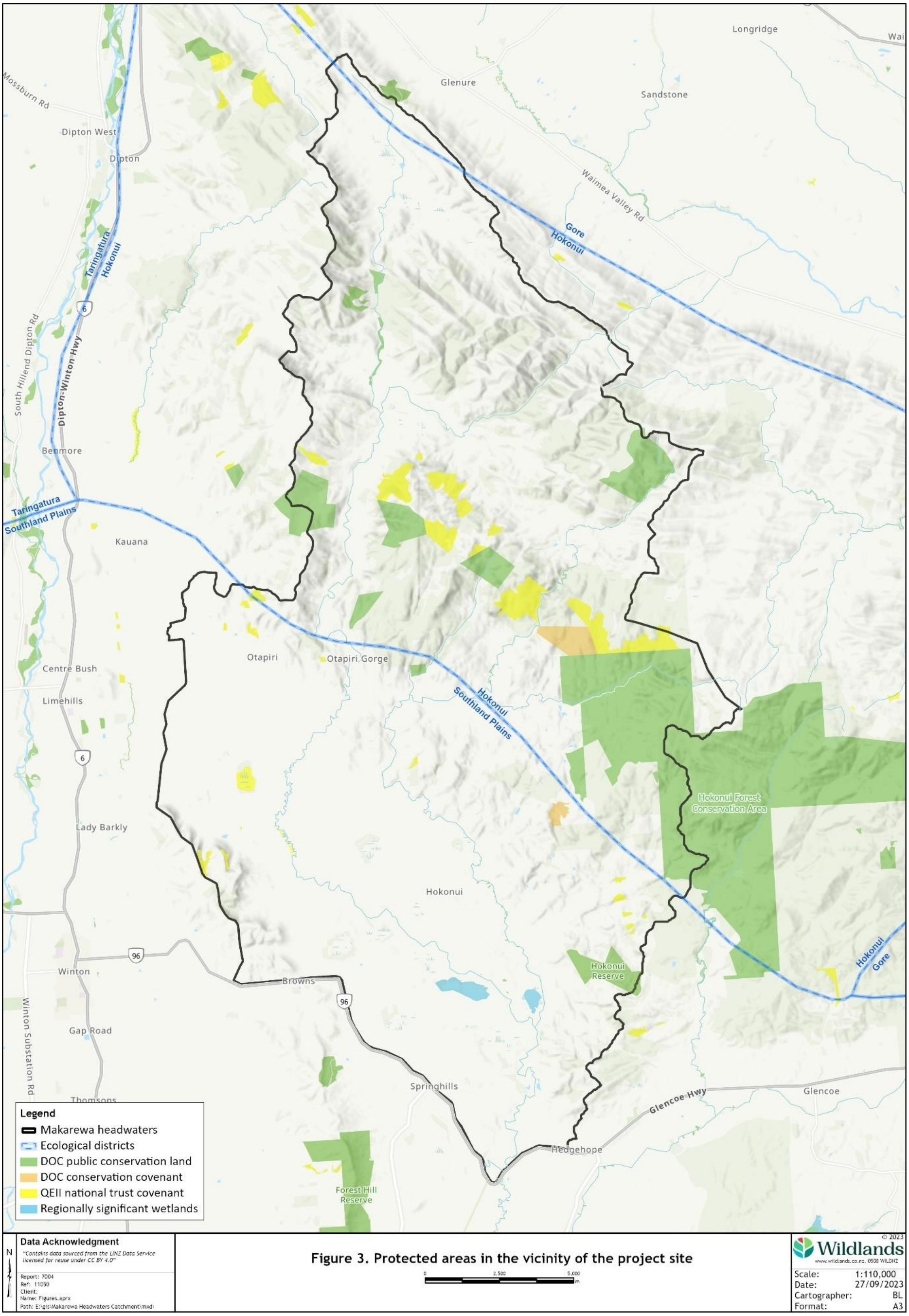


Figure 3. Protected areas in the vicinity of the project site

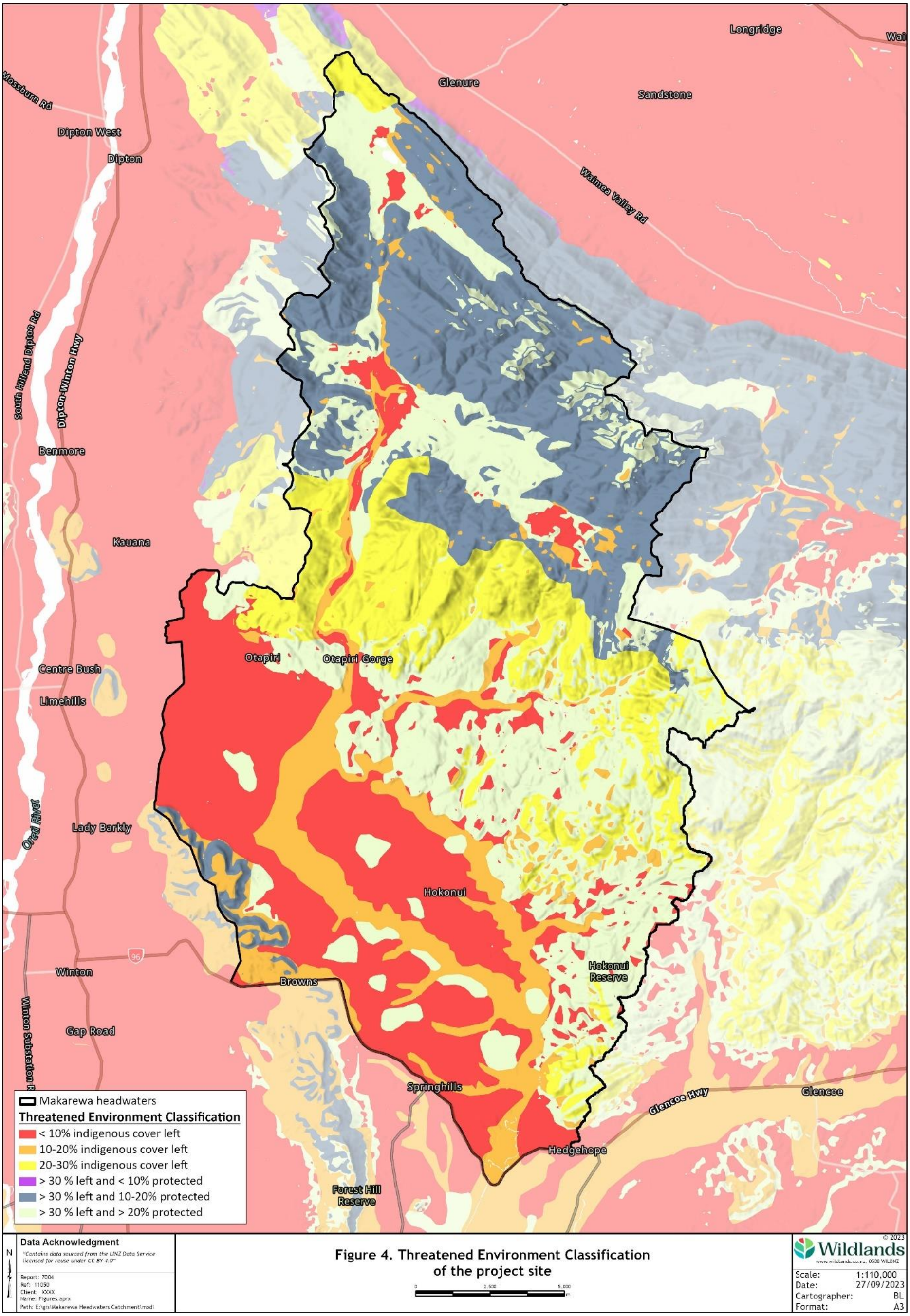


Figure 4. Threatened Environment Classification of the project site

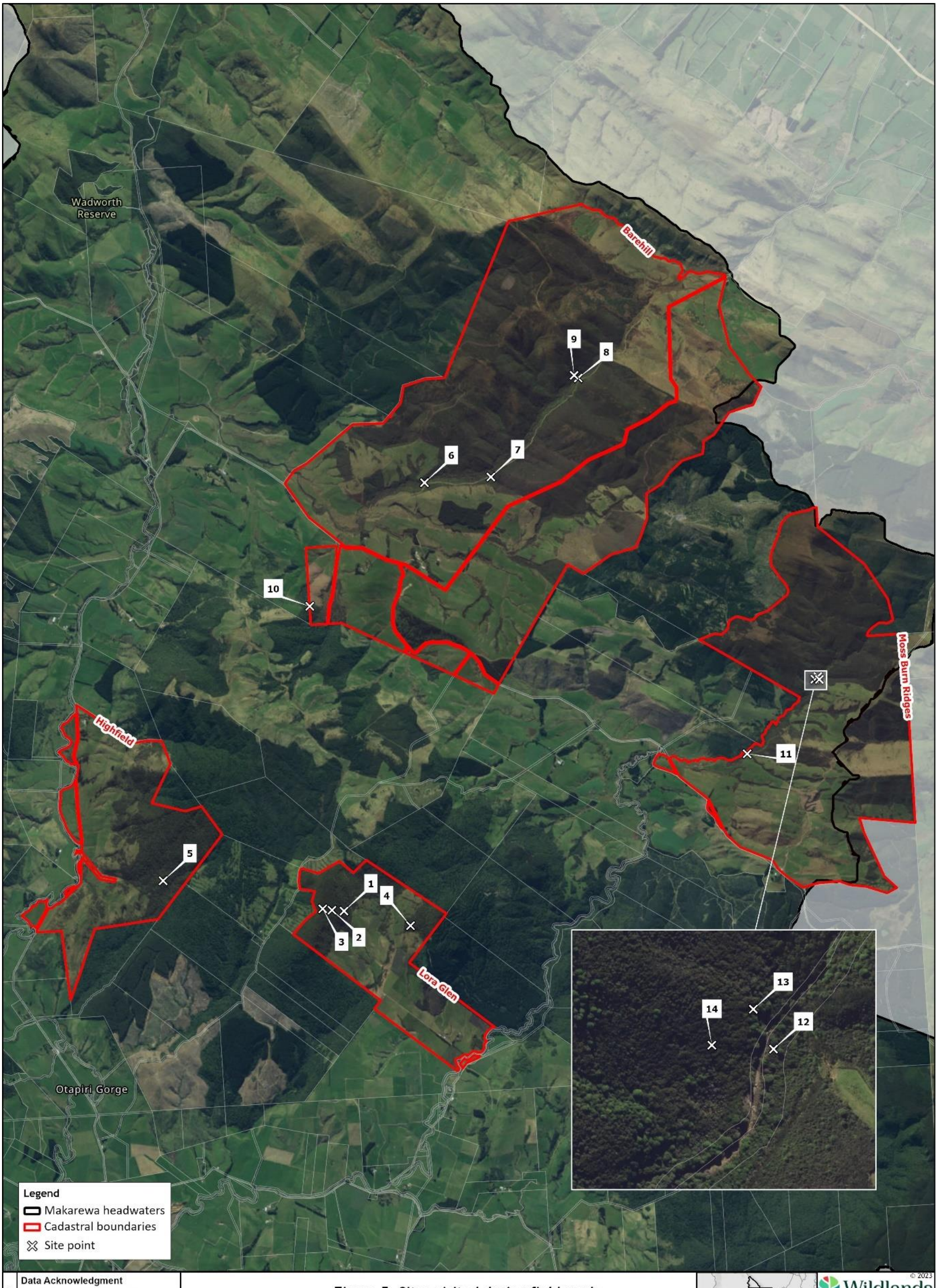


Figure 5. Sites visited during field work.

Many piupiu showed signs of browse (Plate 2). There was no regeneration of palatable indigenous tree species. Wildland Consultants (2023) also noted the scarcity of palatable plants in the understorey.

Plate 2: Significant browse on piupiu/crown fern at Site 2.

3.2.3 Site 3

Unlike the lower sites, forest on the ridge at 460 metres elevation was dominated by manuka (*Leptospermum scoparium*) (Plate 3) with occasional southern rata, kāpuka, kōhūhū (*Pittosporum tenuifolium*), horoeka/lancewood (*Pseudopanax crassifolius*), horopito, and Hall's totara (*Podocarpus laetus*), There was no understorey, and much bare ground (Plate 3). Sparse *Carex uncinata*, foxglove, creeping clubmoss (*Diphasium scariosum*), and lawyer (*Rubus cissoides*) were present.

Deer faecal piles were frequent in this manuka-broadleaved forest. The presence of palatable species in the relatively young canopy suggests these palatable species regenerated among dense young manuka that feral ungulates avoided. No regeneration of palatable trees is present in the manuka-broadleaved forest now that it has become tall and open.

3.2.4 Site 4

Site 4 (340 metres elevation) comprised mature forest on the other side of the valley, with large emergent trees (Plate 4) of rimu, southern rata, matai, Hall's totara, and kahikatea (*Dacrycarpus dacrydioides*) above a broadleaved canopy of piripiriwhata, kaikomako, kāpuka, kowhai, kātote, horopito, tarata, *Coprosma linariifolia*, and māpou. The understorey was occupied by *Coprosma rotundifolia*, *C. areolata*, horopito, makomako, poataniwha (*Melicope simplex*), mingimingi (*Coprosma propinqua*), tangles of kareao/supplejack (*Ripogonum scandens*), and occasional tūrepo and patē (*Schefflera digitata*).

Plate 3: Relatively bare ground beneath mānuka forest at Site 3.

Plate 4: Emergent matai and denser understorey at Site 4.

The ground layer comprised piupiu, frequent hen and chicken fern (*Asplenium bulbiferum*), shield fern, foxglove, fireweed (*Senecio minimus*), bush rice grass (*Microlaena avenacea*) and *Carex uncinata*.

Hen and chicken fern is normally palatable to deer, but no browse sign was seen on it. Piupiu were only lightly browsed. Regenerating patē were heavily browsed, as were māpou basal sprouts. Rock jumbles were present in the forest, but not sufficient to bar access by deer. No regeneration of other palatable species was observed, apart from occasional hupiro and three finger in elevated sites that deer couldn't reach. Less soil disturbance from tracking was observed in this forest.

3.3 Highfield

A single site at Highfield was assessed, on a broad, gently sloping ridge between the Forest Burn and a tributary of Otapiri Stream. The mature forest at this site was not fenced to exclude stock.

3.3.1 Site 5

Site 5 (280 metres elevation) comprised mature podocarp/broadleaved forest, in which emergent kahikatea, matai, and southern rātā were above a broadleaved canopy dominated by horopito, with occasional kapuka, kotukutuku, tarata, māpou, piripiriwhata, *Coprosma linariifolia*, and kaikomako. Kapuka trees in this forest were generally old and becoming moribund. The dominance of horopito in the canopy suggests a long history of ungulate browse in this forest.

The understorey comprised sparse horopito, *Coprosma rotundifolia*, *C. rubra*, *C. areolata*, kātote, tūrepo, poataniwha, and kaikomako, all unpalatable to ungulate browsing animals. Ground cover comprised sparse shield fern, piupiu, *Netera villosa*, kiwakiwa, water fern (*Histiopteris incisa*), *Notogrammitis billardieri*, and *Parsonsia heterophylla* seedlings.

Piupiu ferns were heavily browsed at this site (Plate 5), and there were occasional areas of bare soil caused by deer tracking.

3.4 Bare Hill

Bare Hill is located in the headwaters of Taylors Stream, a tributary of Otapiri Stream. Taylors Stream bisects the Hokonui Hills and its valley contains riparian kowhai and regenerating forest in which Sites 6-8 were assessed on east- and west-facing slopes. Site 9 was located on the southern margin of the property, in mature forest.

Every year, apart from more intensive 'cull years', 170 feral deer and 170 feral pigs are killed by hunting and trapping on Bare Hill.

3.4.1 Site 6

Site 6 (260 metres elevation) comprised a west-facing slope with young, low, forest of kohuhu, broom, and occasional horoeka above small kiokio (*Parablechnum procerum*), shield fern, and occasional *Coprosma dumosa*. In the gully floor below, stands of

Plate 5: Heavily browsed piupiu and sparse ground cover at Site 5.

mature kowhai trees were present above makomako, kōhūhū, and mingimingi, with abundant shield fern in the ground layer. On the opposite west-facing slope, young forest of kāpuka, kohuhu, makomako, mingimingi, three finger, and piripiriwhata is present above abundant shield fern, shrubby fuchsia (*Fuchsia perscandens*), and lawyer (*Rubus schmidelioides*). No regeneration of kāpuka or three finger was present, and there was heavy tracking by deer. Some wineberry had been stripped of bark by deer.

3.4.2 Site 7

Site 7 (290 metres elevation) comprised a small stand of young kāpuka and three finger, above small kiokio and kātote, above the farm track and adjacent to a small stream. There was notable bark-stripping by deer at this site, with both three finger (Plate 7) and kāpuka (Plate 8) subject to severe bark stripping. The bark-stripped trees remained alive, because the bark stripping did not completely encircle the trunks. Heavy tracking by deer was also evident at this site.

3.4.3 Site 8

Site 8 (370 metres elevation) comprised a steep, west-facing slope below the farm track. Regenerating forest and scrub on the steep slope below the track comprised kōhūhū, piripiriwhata, koromiko (*Veronica salicifolia*), kāpuka, mingimingi, and weeping mapou (*Myrsine divaricata*). Vines of pohuehue (*Muehlenbeckia australis*) and lawyer are frequent in this scrub and forest. The ground layer vegetation comprised abundant shield fern.

Notably, there were occasional regenerating seedlings of kāpuka (Plate 9), three finger, piripiriwhata, and horoeka up to 50 centimetres tall.

Plate 6: Dense kōhūhū forest at Site 6, showing regeneration of unpalatable makomako/wineberry.

Plate 7: Heavy bark-stripping of three finger at Site 7.

Plate 8: Heavy bark-stripping of kāpuka/broadleaf at Site 7.

Plate 9: Kāpuka/ broadleaf regeneration at Site 8.

3.4.4 Site 9

Site 9 (380 metres elevation) comprised the opposite slope on the other side of the stream. Here, kōhūhū, piripiriwhata, kāpuka, weeping mapou, kowhai, horoeka, and ti kōuka/cabbage tree (*Cordyline australis*) form a canopy above abundant shield fern, *Carex* spp, wall lettuce (*Mycelis muralis*), and pohuehue. There was no regeneration of palatable tree species within the forest, but on the steep margins of the stream there was some regeneration of kāpuka, horoeka, and three finger. Hen and chicken fern was only observed in these steep streamside habitats. Three finger were affected by bark stripping in the forest.

3.4.5 Site 10

Site 10 (880 metres elevation) was located on north-facing slopes on the south side of the Taylors Stream valley. The vegetation at this site comprised mature forest of manatu (*Plagianthus regius*), kowhai, kōtukutuku, tarata, kāpuka, and makomako. The forest was relatively open but horopito and *Coprosma rotundifolia* were the main understorey shrubs, with occasional mapou, kaikomako, and tree nettle (*Urtica ferox*). The ground layer comprised *Carex* spp., hen and chicken fern, shield fern, and seedlings of *Parsonsia heterophylla*. Regeneration of manatu, makomako, and kaikomako was evident, but no regeneration of more palatable trees such as kāpuka, kōtukutuku, and tarata was observed. There was not much soil disturbance at this drier forest site.

Wildland Consultants (2022) noted many deer tracks and droppings throughout this forest.

3.5 Moss Burn Ridges

Moss Burn Ridges is located on the divide between the Lora Stream catchment, which flows west and south into the Makarewa River catchment, and Otamita Stream which flows east into the Mataura River catchment. The Lora Stream bisects the farm and was the location of four sites. Site 11 was located on the lower catchment, and sites 12-14 grouped together in the upper catchment.

3.5.1 Site 11

Site 11 (290 metres elevation) was located in riparian treeland where the Lora Stream emerges from a gully. Kowhai and kōhūhū trees stand above mingimingi, and shield fern, lawyer (*Rubus cissoides*), *Acaena anserinifolia*, and Chilean flame creeper (*Tropaeolum speciosum*) are present in the ground layer. Kāpuka and kōhūhū have been able to regenerate on the steep bank of Lora Stream. Small seedlings of kōhūhū, kāpuka, and kōtukutuku are present at this site, but unable to grow into taller saplings because of feral deer browse.

3.5.2 Site 12

Site 12 (420 metres elevation) is on the true left bank of Lora Stream about 1.5 kilometres above Site 11. It comprises kāpuka and kōhūhū above mingimingi, *Coprosma dumosa*, makomako, and piripiriwhata above shield fern and *Carex* spp. Some regeneration of piripiriwhata was evident at this site, with several tall saplings present (Plate 10).

Plate 10: Piripiriwhata/marble leaf regeneration at Site 12.

3.5.3 Site 13

Site 13 is on the true right bank of Lora Stream opposite Site 12. Cabbage tree, kōhūhū, and kāpuka form a canopy above an understorey of mingimingi, *Coprosma dumosa*, and piripiriwhata. The ground layer is dominated by shield fern and *Carex* spp. Slight browse was noted on shield fern, and bark stripping from kāpuka.

3.5.4 Site 14

Site 14 is a little downstream of Site 13, and located in tall īnaka (*Dracophyllum longifolium*) scrub. Occasional mingimingi and rōhutu (*Neomyrtus pedunculata*) are present beneath the īnaka shrubs. Shield fern, water fern, *Carex* spp., and fireweed are present in the ground layer. These areas are heavily used and tracked by deer, with considerable bare soil exposed (Plate 11).

4. FERAL UNGULATE EFFECTS

4.1 Deer browse and bark stripping

Variations in the intensity of deer browse are evident across the study site, with dense regenerating forest and scrub, steep streamside locations, and arboreal sites the only places where palatable tree species such as kāpuka, kōhūhū, three finger, and kōtukutuku are regenerating. Mature forests exhibit a long history of ungulate browse, lack a shady subcanopy, and are relatively well-lit and open to walk through. This does not represent a natural state. Normally a dense subcanopy and abundant regeneration would be present in these forests.

The effect of deer browse is not just on foliage, with many young kāpuka, three finger, and wineberry trees damaged by stripping of bark in the regenerating forests.

Plate 11: Heavy tracking by deer beneath inaka scrub at Site 14.
Some browse damage to harakeke is visible at left.

4.2 Palatability scale

The local palatability of plant species found in the project area is summarised in Table 1. Feral ungulates browse the most preferred plant species first, then when it is eliminated, move on to the next most preferred. In sites where low palatability species such as piupiu are heavily browsed (such as Lora Glen Site 2), this means that species of higher palatability will be absent or present only in habitats that deer can't access.

Table 1: Local palatability of tree and fern species found in the project area.

Species	Common Name	Palatability
Griselinia littoralis	Kāpuka/broadleaf	Very high
Pseudopanax colensoi	Three finger	Very high
Asplenium bulbiferum	Hen and chicken fern	High
Fuchsia excorticata	Kotukutuku	High
Myrsine australis	Māpou	High
Pittosporum eugenioides	Tarata	High
Pittosporum tenuifolium	Kōhūhū	High
Schefflera digitata	Patē/seven finger	High
Carpodetus serratus	Piripriwhata/marble leaf	Moderate
Polystichum vestitum	Shield fern	Moderate
Pseudopanax crassifolius	Horoeka/lancewood	Moderate
Aristotelia serrata	Makomako/wineberry	Low
Lomaria discolor	Crown fern	Low
Metrosideros umbellata	Southern rata	Low
Pennantia corymbosa	Kaikomako	Low
Plagianthus regius	Manatu/lowland ribbonwood	Low
Sophora microphylla	Kōwhai	Low
Coprosma spp.	Small-leaved coprosma spp.	Very Low
Coprosma rotundifolia		Very Low

Species	Common Name	Palatability
Cyathea smithii	Katote/soft tree fern	Very Low
Dacrycarpus dacrydioides	Kahikatea	Very Low
Dacrydium cupressinum	Rimu	Very Low
Prumnopitys taxifolia	Matai	Very Low
Pseudowintera colorata	Horopito	Very low

Table 1 does not take account of additive effects of multiple herbivores, such as arboreal herbivores like possums (*Trichosurus vulpecula*). For species of *Pseudopanax* such as three finger and horoeka, possums are major herbivores, and by chewing through the leaf petioles of mature trees, can completely defoliate and kill them. When these species cannot recruit because of deer browse, and mature individuals are killed by possums, population declines can be rapid, resulting in increasingly patchy distributions in the landscape. This is the case with three finger and horoeka in the project area. Both were present mainly in the regenerating forests in the northern part of the project area, and highly restricted in the mature forests to the south.

4.3 Soil disturbance

Feral deer have sharp hooves and tend to cut up the soil and expose it to erosion during rain events. This is particularly likely where deer tracks are adjacent to streams. Heavy deer tracking was observed in the regenerating forests in the north of the project area. This is likely because passage through the regenerating vegetation is more constrained than in the very open mature forests. Soil exposure due to deer tracking was present in the mature forests, but mainly in damper sites and not so extensive as in the regenerating forests.

5. ECOLOGICAL PROCESSES AND FUNCTION

5.1 Provision of habitat

The mature forests on Lora Glen and Highfield, which are affected significantly by feral deer browse, still function as important habitat for indigenous avifauna, because a diverse canopy is present in these forests, and some regeneration of unpalatable trees such as makomako is present. Riparian treelands dominated by kowhai in the northern part of the project area are also important in this respect. Key trees in these forests and treelands are kōtukutuku, kāpuka, kowhai, rata, and podocarps, as these provide fruit and/or nectar resources that are important for indigenous birds such as kereru (*Hemiphaga novaeseelandiae*), tui (*Prosthemadera novaeseelandiae*), koparapara/ bellbird (*Anthornis melanura*), and pipihi/silvereye (*Zosterops lateralis*). These avifauna species are in turn important for the dispersal of indigenous trees, by passing seeds from consumed fruit. Podocarps do not fruit every year, so the fruit provided by other broadleaved trees, which fruit every year is important. Makomako/wineberry produces heavy fruit crops in well-lit microhabitats, and this species is not palatable to deer and is regenerating satisfactorily. Makomako is a short-lived tree of early successional vegetation, but is regenerating within mature forest because it lacks a shady subcanopy.

Trees such as kāpuka and matai are notable in forming cavities and thus provide key habitat for indigenous fauna that utilise cavities for nesting or roosting. These include

long-tailed bat (*Chalinolobus tuberculatus*), mohua (*Mohoua ochrocephala*), and rifleman (*Acanthissita chloris*). The western Hokonui Hills are within the known range of rifleman, and could possibly support long-tailed bats.

5.2 Tree recruitment

Most indigenous trees are long lived. Those with a short lifespan of 60-120 years are typical of early successional species such as makomako and kōhūhū. Most broadleaved trees have lifespans of several hundred years, and podocarps have lifespans of up to 1,000 years. Thus most trees have plenty of time to replace themselves by recruiting new individuals.

Feral ungulates interfere with the recruitment process by eating all new saplings of palatable species, thus preventing regeneration. Effective recruitment can occur if this browse pressure substantially decreases, so long as palatable trees remain in the forest canopy. This is the case for all of the mature forests visited.

5.3 Tipping points

Tipping points are reached when palatable species are no longer available to produce seed. The closest tree to a tipping point is kāpuka in the mature forest at Highfield, as most of the kāpuka observed in this forest were older trees that were becoming moribund (Plate 12) and will likely die within the next 10 years or so.

Plate 12: An old, moribund kāpuka/broadleaf tree in mature forest at Highfield.

Some palatable trees have become very rare in the mature forests, and this includes three finger and horoeka. Luckily, these species are more common in the regenerating forests on Bare Hill and Moss Burn Ridges. Maintenance of these populations in regenerating forest is important to enable these species to disperse back to, and establish in the mature forests, if deer become effectively controlled.

Hupiro/stinkwood was only rarely seen in mature forest and only in sites inaccessible to deer. It is close to a tipping point because recruitment of this species now depends on widely scattered individuals. Importantly hupiro occupies the browse tier and cannot grow tall enough to escape deer browse, so very low deer densities would be required on a long term basis to preserve hupiro populations.

The situation is different for taller palatable tree such as kāpuka, kōtukutuku, and tarata. These only need control of deer for a long enough period to enable saplings to grow into trees that exceed deer browse/damage height. These will then form a shady subcanopy and have a long future as canopy trees.

Under this scenario, intensive feral ungulate control could be pulsed in different parts of the project area at different times. Pulses of intense control of 10-15 years duration may be sufficient for regenerating palatable trees to exceed deer damage height.

Intensive deer control would see an immediate response from existing kāpuka and kōtukutuku through growth of coppice shoots.

6. DEER EXCLUSION AREAS

Intensive deer control can be difficult due to deer being highly mobile and thus able to recolonise areas from which deer have been removed. Even low numbers of deer can continue to suppress indigenous regeneration when regeneration has been suppressed for long periods of time.

Consideration could be therefore given to establishing one or more deer exclusion areas by deer fencing an area of mature forest. Given the relatively open understorey in the mature forests, this may not be too difficult. Permanent vegetation plots within the exclusion areas would provide information on the state that can be achieved in the complete absence of feral ungulates.

A rapid vegetation response should be observed in exclusion areas, which would be very apparent to visitors. For this reason, exclusion areas should be accessible.

Depending on the size of a deer exclusion area, it could significantly enhance indigenous biodiversity values.

The ultimate exclusion fencing would protect an area from all mammalian pest animals using an Xcluder fence, but these are expensive projects.

7. MONITORING

7.1.1 Overview

Monitoring of indigenous biodiversity can be resource-intensive and inefficient in providing relevant information for management. The key aspect that should come before any monitoring is designed or implemented, is identification of the purpose of

monitoring. The monitoring proposals below all respond to the purpose of documenting change in indigenous biodiversity following effective control of feral ungulates.

7.1.2 Permanent vegetation plots

Monitoring using permanent vegetation plots following robust methodology would provide high quality data on vegetation response to feral ungulates. Plot methodology should use sapling counts (in 2-3 height categories) below two metres height, and tree stem diameter measurements for individuals above two metres height. Ground cover should be visually estimated, and browse intensity noted on any browsed plants.

Plots of 100 m^2 are the minimum size that should be established. Plot corners should be permanently marked with rebar or other metal rods. Similar methodology provided high quality information from the Orokonui Ecosanctuary (Wildland Consultants 2013), and when remeasured, demonstrated an increase in seedling density adjacent to the Ecosanctuary (Tanentzap & Lloyd 2017)

7.1.3 Photopoints

Photopoints should be set up now and re-photographed in the future once intensive feral ungulate control commences. Photopoints should be permanently marked and direction of the photograph noted. Plastic markers can be used to facilitate this.

7.1.4 Indigenous fauna monitoring

Consideration could also be given to monitoring of indigenous fauna.

Indigenous habitat is sufficiently extensive in the project area to accommodate a network of independent count stations at which five-minute bird counts (5MBC) could be undertaken. In order to show change, at least 50-100 individual counts are required at each monitoring interval, depending on habitat variability.

Terrestrial and freshwater invertebrates can also be surveyed and monitored. For stream quality a range of freshwater macroinvertebrate indices are available. For terrestrial invertebrate monitoring, pitfall traps, light traps, or malaise traps can all be operated in forest, and provide quantitative information on changes in invertebrate composition.

8. CONCLUSIONS

Indigenous forest and scrub within the project area is ecologically important and helps to maintain indigenous biodiversity in the western end of Hokonui Ecological District. Mature forests on Lora Glen and Highfield are particularly impressive in supporting large emergent podocarps and diverse broadleaved canopies. This is despite a very high level of feral ungulate browse in these forests, that is currently preventing regeneration of palatable indigenous tree species. The ecological functions of these forests can be significantly enhanced by effective feral ungulate control or exclusion of feral ungulates.

Regenerating forests on Bare Hill and Moss Burn Ridges are also important in enabling a degree of regeneration of palatable indigenous trees that are scarce in the mature forests, and by including riparian kōwhai treelands which are key sources of food for seed-dispersing indigenous avifauna. Soil exposure along deer tracks in these regenerating forests is considerable, and if this bare soil is washed into headwater streams this may have downstream effects on freshwater habitat quality.

As effective control of deer can be difficult due to reinvasion, consideration should be given to constructing deer exclusion areas to enable regeneration within them.

A range of monitoring options are available, all with different levels of cost and intensity. More detailed advice on monitoring (including monitoring costs) can be provided by Wildland Consultants once the MHCG has considered the options outlined above. Monitoring should be set up soon, to enable assessment of the baseline condition of monitored sites.

ACKNOWLEDGMENTS

Guidance to sites and landholder liaison from Mark Thomson is gratefully acknowledged. All the landholders who granted access permission to assess indigenous forest on their properties are thanked. These were Mark and Elspeth Thomson (Lora Glen), Dan and Brett Frew (Highfield), Nick and Alexis Wadworth (Barehill) and Hamish and Lisa Elder (Moss Burn Ridges).

REFERENCES

Tanentzap A.J. and Lloyd K.M. 2017: Fencing in nature? Predator exclusion restores habitat for native fauna and leads biodiversity to spill over into the wider landscape. *Biological Conservation 214*: 119-126.

Wildland Consultants 2013: Baseline vegetation plot survey of the Orokonui Ecosanctuary. W*ildland Consultants Contract Report No. 2866*. Prepared for Orokonui Ecosanctuary Ltd.

Wildland Consultants 2022: Ecological survey: Bare Hill Farm. *Wildland Consultants Contract Report No. 6003bk*. Prepared for Environment Southland.

Wildland Consultants 2023: Ecological survey: 215 Lora River Road. *Wildland Consultants Contract Report No. 6003es*. Prepared for Environment Southland.

PLANT SPECIES RECORDED DURING THE SITE VISITS

Species	Common Name	Plant Type
Aristotelia serrata	Makomako, wineberry	Tree
Asplenium bulbiferum	Mouku, hen and chicken fern	Fern
Asplenium hookerianum	Hooker's spleenwort	Fern
Blechnum discolor	Piupiu, crown fern	Fern
Blechnum fluviatile	Kiwakiwa	Fern
Blechnum procerum	Kiokio	Fern
Carex uncinata	Hookgrass	Sedge
Carpodetus serratus	Piripiriwhata	Tree
Coprosma areolata		Tree
Coprosma dumosa		Shrub
Coprosma foetidissima	Hūpiro, stinkwood	Tree
Coprosma linariifolia	Yellow wood;	Tree
Coprosma propinqua	Mikimiki	Tree
Coprosma rotundifolia		Shrub
Cordyline australis	Tī kōuka, cabbage tree	Tree
Cyathea smithii	Kātote, soft tree fern	Tree
*Cytisus scoparius**	Broom	Shrub
Dacrycarpus dacrydioides	Kahikatea	Tree
Dacrydium cupressinum	Rimu	Tree
*Digitalis purpurea**	Foxglove	Forb
Fuchsia excorticata	Kōtukutuku, tree fuchsia	Tree
Fuchsia perscandens	Climbing fuchsia	Vine
Griselinia littoralis	Kāpuka	Tree
Histiopteris incisa	Mātātā, water fern	Fern
Hypolepis ambigua		Fern
Leptolepia novae-zelandiae	Lace fern	Fern
Leptopteris hymenophylloides	Heruheru	Fern
Leptospermum scoparium	Mānuka	Tree
Lycopodium scariosum	Mātukutuku	Fern
Melicope simplex	Poataniwha	Tree
Metrosideros diffusa	Rātā	Vine
Metrosideros umbellata	Southern rātā	Tree
Microlaena avenacea	Bush rice grass	Grass
Microsorum pustulatum	Kōwaowao, pāraharaha, hound's tongue fern	Fern
*Mycelis muralis**	Wall lettuce	Forb
Myrsine australis	Māpou	Tree
Myrsine divaricata	Weeping māpou	Tree
Nertera villosa		Forb
Notogrammitis billardierei		Fern
Parsonsia heterophylla	Akakaikiore	Vine
Pennantia corymbosa	Kaikōmako	Tree
Pittosporum eugenioides	Tarata, lemonwood	Tree
Pittosporum tenuifolium	Kōhūhū	Tree
Podocarpus laetus	Hall's totara	Tree
Polystichum neozelandicum	Shield fern	Fern
Polystichum vestitum	Pūniu, prickly shield fern	Fern
Prumnopitys ferruginea	Miro	Tree
Prumnopitys taxifolia	Matai	Tree
Pseudopanax colensoi	Orihou, mountain five finger	Tree

Species	Common Name	Plant Type
Pseudopanax crassifolius	Horoeka, lancewood	Tree
Pseudowintera colorata	Horopito	Tree
Raukaua edgerleyi		Tree
Ripogonum scandens	Kareao, supplejack	Vine
Rubus cissoides	Tātarāmoa, bush lawyer	Vine
Rubus schmidelioides	Lawyer	Vine
Schefflera digitata	Patē, seven finger	Tree
Senecio minimus	Native fireweed	Forb
Sophora microphylla	Kōwhai	Tree
Streblus heterophyllus	Tūrepo	Tree
*Ulex europaeus**	Gorse	Shrub
Urtica sykesii		Forb
Veronica salicifolia	Koromiko	Shrub

PHOTOGRAPHS OF DAMAGE
CAUSED BY FERAL DEER

Plate A2-1: Fuchsia failing to coppice due to ungulate browse, Lora Glen.

Plate A2-2: Browsed coppicing shoots of māpou, Lora Glen.

Plate A2-3: Significant browse on shield fern frond, Lora Glen.

Plate A2-4: Removal of soil by deer tracking on a bank, Lora Glen.

Plate A2-5: Exposure of tree roots caused by deer repeatedly browsing on coppicing kāpuka/broadleaf shoots.

Plate A2-6: Broken off piripiriwhata/marble leaf caused by deer browse at Lora Glen Site 4.

Plate A2-7: New foliage after browse damage to pate/seven finger at Lora Glen Site 4.

Plate A2-8: Severe damage to piupiu/crown fern at Highfield.

Plate A2-9: Significant bark stripping of makomako/wineberry at Bare Hill.

Plate A2-10: Significant bark stripping of a kāpuka/broadleaf branch, Bare Hill.

Plate A2-11: Significant bark stripping of kāpuka/broadleaf trunk growing among inaka, Moss Burn Ridges.

Call Free 0508 WILDNZ
Ph: +64 7 343 9017
Fax: +64 7 3439018
ecology@wildlands.co.nz

99 Sala Street
PO Box 7137, Te Ngae
Rotorua 3042,
New Zealand

Regional Offices located in
Auckland, Hamilton, Tauranga,
Whakatane, Wellington,
Christchurch and Dunedin

ECOLOGY RESTORATION BIODIVERSITY SUSTAINABILITY

www.wildlands.co.nz