POTENTIAL PREDATOR ELIMINATION SITES FOR THE SOUTHERN LAKES SANCTUARY, QUEENSTOWN LAKES DISTRICT

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EXECUTIVE SUMMARY

- The Queenstown Lakes District displays an impressive diversity of ecosystems and habitats that are home to some of Aotearoa New Zealand's most unique plants and animals. In their mission to protect and conserve this taonga and push towards Predator Free 2050, Southern Lakes Sanctuary commissioned Wildland Consultants Ltd to prepare an initial assessment of potential invasive predator elimination sites within the Queenstown Lakes District.

- Five sites were proposed that aimed to meet the criteria of Predator Free 2050 and further criteria provided by Zero Invasive Predators. Criteria used to assess each site fell into three broad categories, each with several components. These categories included: biodiversity and ecological values, feasibility, and the likelihood of success.

- The Rees/Dart River System ranked highest amongst the proposed predator elimination sites.
  - This site is around 105,000 hectares and has a single main point of increased risk of incursion (<1,200 m.a.s.l.) on the perimeter, significantly increasing the site's defensibility.
  - Significant biodiversity and ecological values are present and include diverse habitats from high alpine environments to lowland wetlands, and large continuous swathes of indigenous forests. The site contains extensive important habitat for several significant bird species, with large portions identified as Important Bird Areas. The northeastern region is also identified as a lizard hotspot, with the site also a stronghold for long-tailed and short-tailed bats.
  - Several large Ecological Management Units are also present, with a large portion also designated a World Heritage Area by UNESCO (Te Wāhipounamu).
  - Given the accessibility to most of the site, and the sites location in the Queenstown Lakes District, community uptake and the feasibility of implementing elimination strategies will likely be high.

- The Matukituki River site ranked closely behind the Rees/Dart River system. This site displays many similar ecological values as the Rees/Dart site, though lizard hotspots and extensive bat records are absent. The Matukituki and the Rees/Dart sites share a proposed boundary, lending to the possibility of expansion from one to incorporate the other once successful eradication of the initial site is achieved.

- Intensive aerial predator elimination operations in the proposed sites could lead to a high knock down of predators, creating near zero densities over large parts of the Project Area. However, reinvasion will occur, thus incursion response planning will need to be rigorous and comprehensive to capitalise on any initial gains made.

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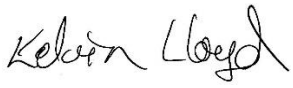
Reviewed and approved for release by:



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1. INTRODUCTION

1.1 Overview

The Southern Lakes Sanctuary represents a consortium of collaborating groups and organizations dedicated to extensive mammalian predator control and the restoration of indigenous biodiversity within the Queenstown Lakes District (the 'Project Area'). Encompassing a remarkable range of indigenous ecosystems, habitats and taonga, the project area stretches from the Rees-Dart Rivers to Makarora, and includes Lakes Wakatipu, Wānaka and Hāwea. Wildland Consultants (Wildlands) have had the privilege of participating in the Southern Lakes Sanctuary project from its inception, conducting the primary scoping study (Wildlands 2020a).

The Project Area, defined by the Queenstown Lakes District boundary (Figure 1), includes the catchments of Lakes Wakatipu, Wānaka and Hāwea, several additional valleys including those of the Shotover, Arrow, and Cardrona Rivers (among others), as well as urban and peri-urban areas of Wānaka and Queenstown. It also includes areas of Mt Aspiring National Park and part of Te Wāhipounamu South West New Zealand World Heritage Area, which is internationally recognised by UNESCO for its exceptional and outstanding natural characteristics. In addition, New Zealand is a signatory of the United Nations Environment Programme (UNEP) Convention on Biodiversity (1992) and has committed to "Ensure and enable that by 2030 at least 30% of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of Indigenous peoples and local communities including over their traditional territories".

The Project Area falls within the Otago Region. The Otago Regional Council Biodiversity Strategy has a key objective to ensure the preservation of all indigenous species and the ecosystems that sustain them. To achieve this, community-led predator control initiatives are promoted and encouraged.

The greatest threats to the indigenous fauna of New Zealand are arguably mustelids (*Mustela furo, M. nivalis, M. erminea*), rats (*Rattus rattus, R. norvegicus, R. exulans*) and brushtail possums (*Trichosurus vulpecula*). These are also the species identified for elimination by PF2050. However, in districts like Queenstown Lakes, feral cats (*Felis catus*) are also an important consideration in tussock grassland and forested habitats, as are European hedgehogs (*Erinaceus europaeus*) in lowland and braided river habitats. A detailed description of the target species within the Project Area, and species-specific management approaches, are discussed by Wildland Consultants (2020a).

The aim of this project is to undertake a desktop assessment to identify five potential predator elimination sites within the Queenstown Lakes District that are ≥20,000 hectares in size, and evaluate and rank them based on:

- Likelihood of success: defendable geography, practicality of implementation (logistics), likely cost.
- The diversity of existing indigenous fauna habitats, and indigenous fauna values that could be enhanced through predator elimination.
- Potential indigenous fauna values i.e., the potential for the sites and its habitats to host reintroductions.

It is envisioned that mammalian predator elimination in the top ranked site would follow methods like those undertaken in the Perth River by Zero Invasive Predators (Nichols *et al.* 2020; see section 2 for a summary). Any predator elimination project undertaken in the top ranked site would also aim to meet the Predator Free 2050 criteria for funding.

1.2 ZIP criteria

In addition to the overarching criteria of PF2050, an interview with Zero Invasive Predators Chief Executive Al Bramley led to the following considerations when selecting elimination sites:

High rainfall ecosystems – are desirable as the ecology is top down driven, meaning predators are not always supported by large amounts of primary prey species (except in beech forest following masts).

Elevation – high elevation appears a good barrier to incursions at 1,200 metres above sea level. In areas below this, making the size of high-risk areas as small as possible is important**.**

Habitats as barriers – alpine areas provide good defence against incursions, especially areas with permanent ice and snow. In the Perth River, rats do not appear to disperse across ≥1,200 metres above sea level. Rivers and large bodies of water are also desirable, in particular, fast flowing and steep rivers which can stop possum dispersal.

Logistics - aerial tools are important and therefore minimising flight distances between take-off and elimination sites is an important consideration.

Social considerations – iwi support is important, particularly in relation to the use of aerial tools.

Land tenure – it is easiest if land tenure ship is as simple as possible. Public Conservation Land is therefore ideal.

1.3 Predator Free 2050 criteria for funding landscape scale elimination projects

The top ranked elimination areas should have characteristics that, if elimination is achieved, align with the criteria and interim goals of Predator Free New Zealand 2050 (PF2050). These are summarised from the PF2050 website as:

Scale and geophysical attributes – the project should be ambitious in scale. Geophysical attributes will include "defendability" of the area once predators are eliminated.

Figure 1: The Project Area, Queenstown Lakes District, New Zealand.

Biodiversity gain – the project should contribute to substantial biodiversity gains across the land area under consideration. The protection and/or establishment of habitat that will improve outcomes for New Zealand's priority endangered species should be identified.

Alignment with PF2050 mission and interim goals – the proposal should clearly demonstrate alignment to the PF2050 goals and show how it will assist achievement of the government's interim 2025 goals.

Timing and measurability of gains – the proposal should offer credible evidence of the timeframe in which the goals are to be delivered. Intermediate milestones that the proponents believe will provide compelling evidence of progress on the plan, and against which they are willing to be measured, should be specified.

Land owner support and participation – projects should show evidence of collaboration between all relevant landowners and interested parties (i.e., adjoining landowners, Māori, DOC, Local Councils, etc) that will ensure multiple land owner support across the target landscape.

Māori partnerships – where a Māori entity is not the project lead, relevant Māori hapu or iwi should be involved in the formation of the project and be collaboratively engaged in the ongoing delivery. Where applicable, PF2050 Limited are seeking projects that have or are proposing to have a strong emphasis on Māori collaboration and partnerships.

Management (expertise and capacity) – the project management team should have proven experience and capacity given the scale and complexity of the proposal and demonstrate that they have access to the technical resources required to deliver the project.

Funding and level of co-investment – the proposal should provide sufficient evidence of the sources of funding, proposed or existing, for at least the potential for 2:1 matching funding from parties who are shown to be compatible, have the capacity, and are willing to commit cash and other resources to achieving the project goals.

Community support – the proposal should clearly articulate the degree of local community support for the project and how they will be engaged and their opinions heard in the design and implementation of the plan.

Health & Safety – the proposal should be able to demonstrate that the participants are aware of their responsibilities under the Health and Safety at Work Act 2015 (HSWA), that the project is committed to ensuring the health and safety of its workers and others affected by the work it carries out.

Research innovation – opportunities for the proposal to contribute to the advancement of scientific research in the predator free area such as by field trialling and evaluating the effectiveness of a novel technology or combinations of technologies and management systems should be specified.

Sustainability of gains – the proposal should address the need to secure predator free status for the proposed project area including the basis on which investors can have confidence that future landowners of properties within the project area can be required to maintain the predator free status of that land.

Contribution to wellbeing – the project should identify how it contributes to improving living standards by enhancing natural, human, social and financial/ physical capital.

Exit Strategy – the proposal should address how the project goals and predator free status can be sustained post PF2050 Limited investment.

2. PREDATOR ELIMINATION

2.1 Limiting dispersal

For predator elimination to be successful, the distributional ranges and dispersal capabilities of the target species need to be considered. The elevational ranges of invasive predators in New Zealand vary among species. However, Foster *et al*. (2022) showed that the upper elevational limits of invasive mammalian predators in New Zealand can extend beyond 2,000 metres above sea level (m.a.s.l.). The Project Area is very mountainous, with many large ranges (e.g. Young Range, Huxley Range, Richardson Mountains and the Main Divide). However, while the peaks themselves often reach elevations of over 1,500 m.a.s.l., few ridgelines are continuously over 1,500 m.a.s.l.; many saddles and valleys fall below 1,000 m.a.s.l. This has important implications when selecting and monitoring geophysical barriers to movement. However, Foster *et al*. (2022) also noted that the likelihood of dispersal across potential elevational barriers varied with species, and that habitat corridors across barriers are a significant factor in the dispersal of predators into new areas. Thus, while elevation as a barrier alone may not be sufficient given relatively low contiguous elevations, incorporating low value habitats (such as permanent snow and ice) and large bodies of water at the perimeter will decrease the chance of incursion.

Many of the target species are also very good swimmers. Norway rats, for example, are able to swim up to 1 kilometre. Few bodies of water >1 kilometre wide are present in the Queenstown Lakes District, with Lakes Wānaka, Wakatipu and Hāwea the obvious exceptions.

2.2 Dual 1080 application

Until recently, the focus of 1080 operations have been ongoing suppression of invasive predator populations in New Zealand. With the announcement of the goal to be predator free by 2050, focus has shifted towards local elimination of pests as we move to complete national-scale removal (Russell *et al*. 2015).

Typically, large-scale aerial 1080 operations consist of a single non-toxic pre-feed application followed by a single toxic application (Dilks *et al.* 2020). This regime has a number of shortfalls, ultimately resulting in target species surviving (Elliott and Kemp 2016). Toxic bait will likely not be found by every animal of the target species, resulting

in populations recovering and requiring ongoing control. Natural food may also be in high enough supply to make target animals ignore toxic bait. As an acute toxin, symptoms from ingestion of 1080 are also rapid. If a lethal dose is not eaten quickly enough before sublethal toxicosis occurs, animals can become averse to the feed used as bait (Morgan *et al*. 2002; Nugent *et al.* 2019).

Recently, modified baiting operations to remove mammalian predators at large spatial scales in New Zealand have proven effective. Trials have tested the efficacy of multiple pre-feeds, increased frequency of toxin applications within seasons, and investigated the use of different feeds as lures, as well as the effects of increased sowing rates (Bell 2017; Nugent *et al.* 2019).

In the Perth River valley (*c.*10,000 hectares), Nichols *et al.* (2020) trialed a modified aerial 1080 baiting regime that consisted of two toxin applications with various cereal baits and lures, each with preceding non-toxic pre-feeds and sowing at higher rates than normal. This was largely successful in significantly reducing the relative abundances of brushtail possums, ship rats and stoats by 99% from the area, with minimal impact on non-target species.

All pre-feed and toxin baits used in their first treatment were Wanganui #7 double orange-lured 6g cereal pellets. For pre-feed applications in treatment 1, a sowing overlap of 10% was adopted, giving a ground cover of 2kg ha^{-1}. For toxic baits (0.15% 1080), a 50% sowing overlap was adopted, providing ground coverage of 4kg ha^{-1}. In treatment 2, toxic baits were RS5 double cinnamon-lured 6g cereal pellets. Both pre-feed baits were sown with a 10% overlap at 1kg ha^{-1}, with toxic baits (again with 0.15% 1080) sown with 50% overlap at 4kg ha^{-1}. These regimes are summarised in Table 1.

Table 1: Toxin application used by Nichols et al. (2020) in the Perth River Valley.

Toxin Application 1: Wanganui #7, double orange-lured	
Pre-feed 1	6g pellets 2kg Ha^{-1}
Pre-feed 2	6g pellets 2kg Ha^{-1}
1080 baiting	6g pellets 4kg Ha^{-1}
Toxin Application 2: RS5, double cinnamon-lured	
Pre-feed 1	6g pellets 1kg Ha^{-1}
Pre-feed 2	6g pellets 1kg Ha^{-1}
1080 baiting	6g pellets 2kg Ha^{-1}

2.3 Management of incursions

Key to the success of any conservation effort is monitoring. While the risk of incursions across high elevation barriers is not zero, efforts should focus on those areas deemed at greater risk, for example parts of the perimeter that are <1,200 m.a.s.l. Networks of

chew cards, ink tunnels and camera traps are currently the best and most efficient tools in the arsenal for detecting invasive predators (Nugent *et al.* 2019; Dilks *et al.* 2020; Glen and Peace 2020). To provide control data and assess the effectiveness of elimination efforts, monitoring devices should be deployed several weeks before both treatments and remain in the field for at least several weeks after.

While high-risk areas should be the focus of monitoring, it must be stressed that incursions can still occur in what are deemed lower risk areas. Monitoring throughout the proposed areas at lower intensity is therefore still recommended.

An ongoing problem in pest eradication efforts is reliably confirming that target species have been removed (Pellet and Schmidt 2005). Recent progress has been made in developing pest-absence confirmation models, known as Rapid Eradication Assessments (REA; Kim *et al*. 2020), and provide a potential tool to assess the success of pest eradication efforts in the Queenstown Lakes District.

2.4 Caveats on eliminating predators

Although intensive dual 1080 operations can create near zero predator densities, the dispersal capabilities of the predator species mean that incursions back into the treated area will always occur. Here we provide options for initial large-scale pest eradication efforts based on current knowledge of the target species and the environments they are known to inhabit. We stress that pockets of invasive mammalian predators will persist within the elimination areas. Pest animals are adaptable, resilient and can never be fully predictable. This is especially so when elimination management is attempted at large scales.

Early detection of incursions, or pockets of resistance, will be difficult at large spatial scales in rugged country. Therefore, realistically, until such time as new methods or advanced technologies allow for more rapid and efficient detection and mop up of predators, periodic repetition of the intensive 1080 operation is likely to be required for follow up elimination. Otherwise, over time, predators will likely reestablish.

Despite this, the analysis and ranking of elimination sites undertaken below is an important exercise in long term strategic thinking within the district, both within the context of the PF2050 vision, and in terms of protecting indigenous biodiversity from introduced predators at large spatial scales.

3. DETERMINING BIODIVERSITY VALUES IN POTENTIAL ELIMINATION SITES

3.1 Overview

To align with the goals of PF2050, the proposed areas are at a minimum of 20,000 ha and utilize geophysical attributes to increase the practicality of pest elimination and defensibility to incursions post removal. Ecological values were assessed to inform the potential benefits from each proposed area. Maps of current ecosystem types have been produced previously (Wildland Consultants 2020b) and were used to identify areas of important ecological value. Wildlands have also previously mapped potentially

significant fauna habitats (Wildlands 2020c). Here, we mainly relied on confirmed records of fauna to infer current ecological values, though potentially significant habitats were considered for some taxa (e.g. lizards and birds).

Previous vegetation mapping of the Otago region, which built on the Land Cover Database (LCDB), followed Singers and Rogers (2014) classifications of indigenous ecosystem types (modified in some cases by adding new ecosystem types or sub-units). The mapping approach is explained in detail in Wildland Consultants (2020b); Table 1 describes the conversion of indigenous cover type from the LCDB to that of Singers and Rogers (2014), though not all LCDB habitats could be resolved as Singers and Rogers (2014) ecosystems (e.g., "Indigenous forest", mānuka scrub/forest" etc.). LCDB is known to contain widespread thematic and spatial inaccuracies such that, while useful at broad scales, assessment at finer resolution can be inaccurate. The habitat types for this approach are listed in Appendix 1, and are considered in more detail for each proposed elimination area in Section 4.

Table 2: Classification of indigenous LCDB cover classes into Singers and Rogers (2014) ecosystem types.

Indigenous Cover Types (LCDB5)	S&R (2014) Ecosystem Allocation
Alpine Grass Herbfield	The relevant potential ecosystem
Broadleaved Indigenous Hardwoods	VS5 Broadleaved species scrub/forest
Estuarine open water	Estuary
Fernland	VS10 Bracken fernland
Flaxland	WL18 flaxland
Herbaceous freshwater vegetation	The relevant WL ecosystem
Herbaceous saline vegetation	SA3 Glasswort herbfield
Gravel or Rock	Gravel or rock <400m, the relevant potential ecosystem >400m
Indigenous Forest	The relevant MF, CLF, or CDF ecosystem
Landslide	The relevant potential ecosystem
Lake or pond	Lake or Pond
Mānuka and Kānuka	Differentiated using geographic and elevation limits
Matagouri or Grey Scrub	VS6 Matagouri, *Coprosma propinqua*, kowhai shrubland
Permanent snow and ice	Permanent snow and ice
River	River
Sand or Gravel	Sand or Gravel
Sub Alpine Shrubland	CDF2 Dracophyllum, mountain celery pine etc. scrub
Tall Tussock Grassland	The relevant AL ecosystem

The composition, diversity and extent of indigenous habitat types in each site was adopted as a surrogate for each site's indigenous fauna value, and thus their ability to host future reintroductions. While fine-scale habitat preferences can differ among species (as well as within species among regions), indigenous fauna in New Zealand evolved within these habitats, and larger areas of more diverse habitats are generally able to sustain a greater array of fauna. Though at a relatively coarse scale, this approach has allowed each site's relative fauna values to be incorporated into the ranking of each site.

3.2 Bats

New Zealand's only indigenous terrestrial mammals, bats have experienced similar evolutionary histories to birds. Consequently, similar contemporary pressures threaten bat populations, namely the modification and loss of habitat, disturbance and impacts from introduced predators (O'Donnell *et al*. 2010).

Records of bats in New Zealand are held and maintained by the Department of Conservation. Within the Queenstown Lakes District, records of both long-tailed bats (*Chalinolobus tuberculatus*, Threatened - Nationally Critical) and short-tailed bats (*Mystacina tuberculata tuberculata*, Threatened - Nationally Increasing) are present (data from 1990 to present). Most observations are from the Dart-Rees River systems, which are also the only locations short-tailed bats have been recorded. Records of long-tailed bats are also noted along the Makarora River, with scattered records in the upper reaches of the Makarora River, around the Routeburn Flats hut and along the northeastern shore of Lake Wakatipu. Additionally, though not reported in the DOC bat database, records of long-tailed bats have recently been noted by Aspiring Hut users in the Matukituki Valley.

3.3 Lizards

There are nineteen species of Threatened or At Risk lizards known to occur in the QLD (summarised in Table 3), which is relatively high compared to other areas. Additionally, a single Not Threatened species is also known from the area, McCann's Skink (*Oligosoma maccanni*). While some species are reasonably widespread and abundant, such as McCann's skink, most others have restricted distributions and are less abundant. Specifically, high diversity areas include alpine areas over 1,000 m.a.s.l. Records of lizards were supplied by the Department of Conservation who hold and maintain the New Zealand herpetofauna database. Additionally, research grade records from iNaturalist were obtained. From these data, important habitats for At Risk and Threatened lizard species were identified (Wildlands 2020c). Important lizard habitat is present in several parts of the project area.

Table 3: At Risk and Threatened lizard species that have been recorded in the Project Area. Data are from Department of Conservation lizard database, supplemented with records from iNaturalist.

Common Name	Scientific Name	NZ Threat Classification
Grand skink	*Oligosoma grande*	Threatened - Nationally Endangered
Otago skink	*Oligosoma otagense*	Threatened - Nationally Endangered
Tākitimu gecko	*Mokopirirakau cryptozoicus*	Threatened - Nationally Vulnerable
Lakes skink	*Oligosoma* aff. *chloronoton* "West Otago"	Threatened - Nationally Vulnerable
Cascade gecko	*Mokopirirakau "Cascades"*	At Risk - Declining
Orange-spotted gecko	*Mokopirirakau* "Roys Peak"	At Risk - Declining
Jewelled gecko	*Naultinus gemmeus*	At Risk - Declining

Common Name	Scientific Name	NZ Threat Classification
Otago green skink	*Oligosoma* aff. *chloronoton* "Eastern Otago"	At Risk - Declining
Southern grass skink	*Oligosoma* aff. *polychroma* Clade 5	At Risk - Declining
Tussock skink [1]	*Oligosoma chionocloescens*	At Risk - Declining
Cryptic skink	*Oligosoma inconspicuum*	At Risk - Declining
Te Wāhipounamu skink[2]	*Oligosoma pluvilis*	At Risk - Declining
Eyres skink	*Oligosoma repens*	At Risk - Declining
Nevis skink	*Oligosoma toka*	At Risk - Declining
Kawarau gecko	*Woodworthia* "Cromwell"	At Risk - Declining
Mountain beech gecko	*Woodworthia "*southwestern large"	At Risk - Declining
Kōrero gecko	*Woodworthia* "Otago/Southland large"	At Risk - Declining
Southern Alps gecko	*Woodworthia* "Southern Alps"	At Risk - Declining
Short-toed gecko	*Woodworthia* "Southern mini"	At Risk - Declining

3.4 Avifauna

New Zealand boasts a broad and unique array of bird species, many not found anywhere else on Earth. Until relatively recently in evolutionary history, birds in New Zealand have enjoyed an absence of terrestrial predators in relatively stable environments far removed from other land masses. As such, many species now lack traits that aid in resilience to rapidly changing environments and anti-predator vigilance, such as flight.

Table 1 summarises bird species with New Zealand Threat Classifications (NZTC) of Threatened or At Risk recorded in eBird within the Project Area since 2019. The criteria of four years was chosen as it encompasses data since the previous report (Wildlands 2020a) that reported on records up till 2019. Excluding historical data also avoids potential biases from non-recent shifts in species distributions and changes in population abundances.

eBird and iNaturalist are online databases of observations provided by scientists, researchers and amateur naturalists providing real-time data. Given the varying degrees of training and experience of observers, from highly trained researchers to tourists, some inaccuracies in reported data may be present. As it relies on voluntary contribution of data, which can be submitted by anyone, a bias towards areas with greater foot traffic, or popular areas, is also likely. This has implications when using the data to determine 'significant' fauna habitats.

[1] Because tussock skink have recently been taxonomically revised, (formerly southern grass skink, Jewell 2022a) their known distributions are not yet well defined. The purported contact zone of these two species is located within the project site. Genetic testing of suspected tussock or southern grass skink upon observation may determine the species, at any location, as well as determining morphological characteristics.

[2] It is possible that this species has been recorded within the project area, and has previously been identified as *O. inconspicuum*. Prior to the taxonomic revision by Jewell (2022b), several populations of the Te Wāhipounamu skink were recognized as potentially distinct taxa (Hitchmough et al. 2021). Any observations should be recorded and genetic analysis undertaken to determine species.

Table 4: At Risk and Threatened bird species that have been recorded within the Project Area. Data are confirmed records in eBird since 2019.

Common/Māori Name	Scientific Name	NZ threat Classification[1]
Australasian bittern/matuku-hūrepo	*Botaurus poiciloptilus*	Threatened - Nationally Critical
Black stilt/kakī	*Himantopus novaezelandiae*	Threatened - Nationally Critical
White heron/kōtuku	*Ardea alba modesta*	Threatened - Nationally Critical
Rock wren/pīwauwau	*Xenicus gilviventris*	Threatened - Nationally Critical
Black-fronted tern/tarapirohe	*Chlidonias albostriatus*	Threatened - Nationally Endangered
Kea/kea	*Nestor notabilis*	Threatened - Nationally Endangered
Eastern falcon/kārearea	*Falco novaeseelandiae novaeseelandiae*	Threatened - Nationally Vulnerable
Australasian crested grebe/pūteketeke	*Podiceps cristatus australis*	Threatened - Nationally Vulnerable
Blue duck/whio	*Hymenolaimus malacorhynchos*	Threatened - Nationally Vulnerable
Long-tailed cuckoo/koekoeā	*Eudynamis taitensis*	Threatened - Nationally Vulnerable
New Zealand kaka/kākā	*Nestor meridionalis meridionalis*	Threatened - Nationally Vulnerable
Pacific black duck/pārera	*Anas superciliosa*	Threatened - Nationally Vulnerable
Spotted shag/kawau tikitiki	*Phalacrocorax punctatus*	Threatened - Nationally Vulnerable
Wrybill/ngutu-pare	*Anarhynchus frontalis*	Threatened - Nationally Increasing
Australasian pipit/pīhoihoi	*Anthus novaeseelandiae novaeseelandiae*	At Risk - Declining
Black-billed gull/tarāpuka	*Chroicocephalus bulleri*	At Risk - Declining
Banded dotterel/pohowera	*Charadrius bicinctus bicinctus*	At Risk - Declining
New Zealand fernbird/mātātā	*Poodytes punctatus punctatus*	At Risk - Declining
New Zealand pipit/pīhoihoi	*Anthus novaeseelandiae novaeseelandiae*	At Risk - Declining
South Island oystercatcher/tōrea	*Haematopus finschi*	At Risk - Declining
South Island robin/kakaruai	*Petroica australis australis*	At Risk - Declining
Yellow-crowned parakeet/kākāriki	*Cyanoramphus auriceps*	At Risk - Declining
Yellowhead/mohua	*Mohoua ochrocephala*	At Risk - Declining
Pied shag/kāruhiruhi	*Phalacrocorax varius varius*	At Risk - Recovering
Buff weka	*Galliralus australis hectori*	At Risk - Relict
Great cormorant (black shag)/māpunga	*Phalacrocorax carbo novaehollandiae*	At Risk - Relict
Eurasian coot	*Fulica atra australis*	At Risk - Naturally Uncommon

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[1] Robertson et al. 2021.

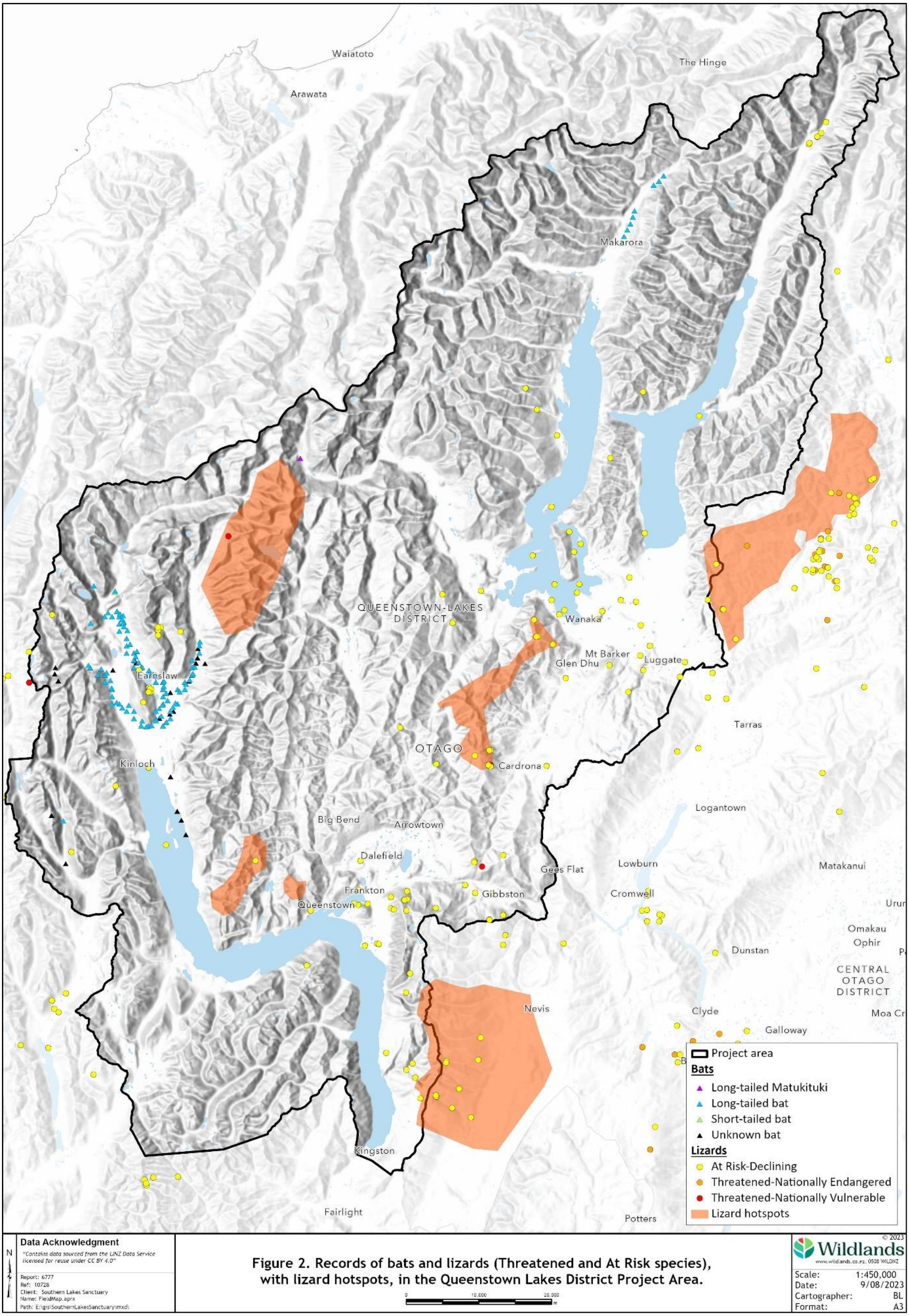

Figure 2. Records of bats and lizards (Threatened and At Risk species), with lizard hotspots, in the Queenstown Lakes District Project Area.

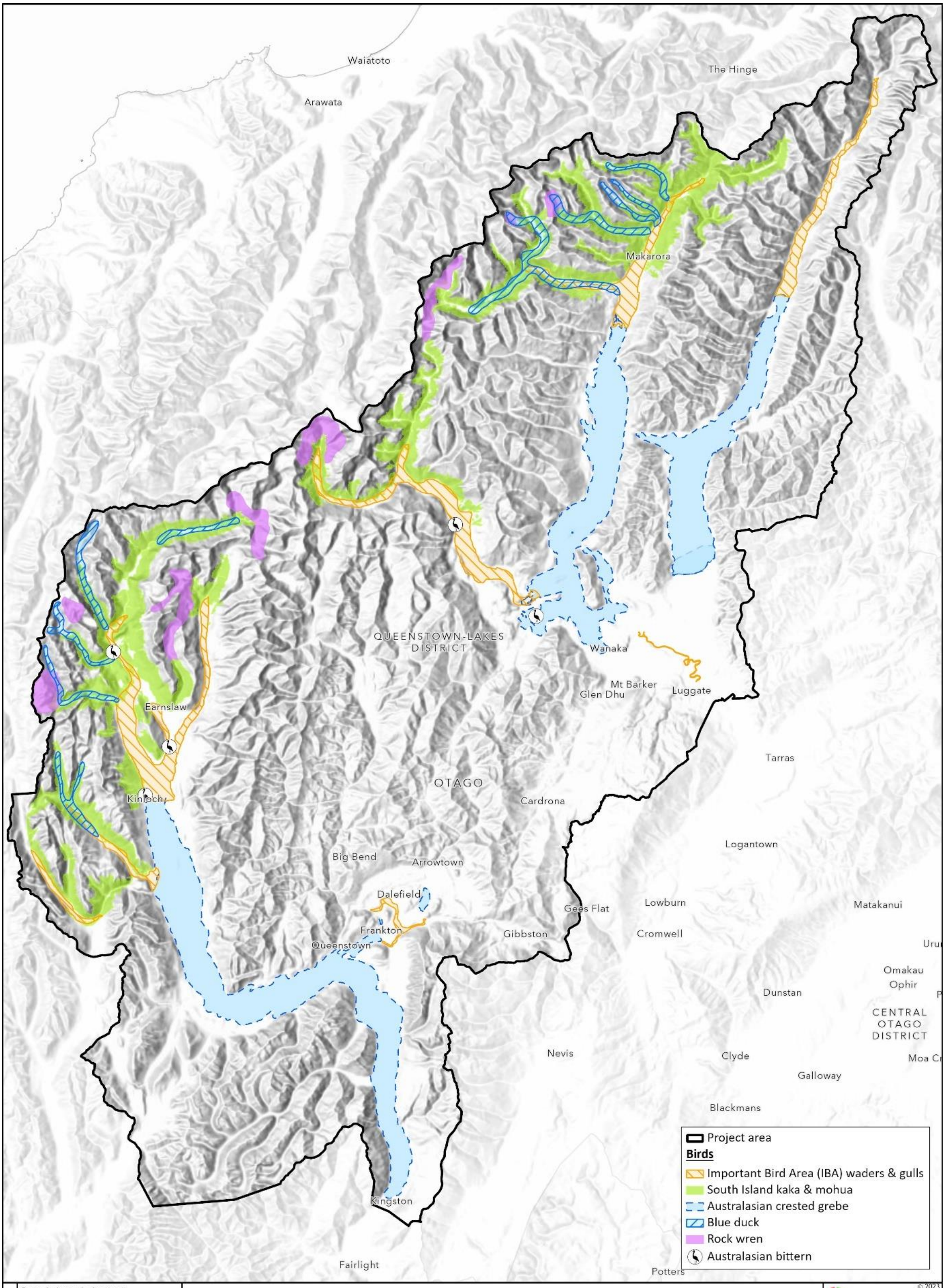

Figure 3: Significant habitats of Nationally Threatened bird species in the Project Area

Important Bird Areas (IBA), developed and proposed over three decades ago by BirdLife International, have been used widely to identify critical bird habitats around the world. The identification of an IBA follows a relatively straightforward set of criteria applicable to both terrestrial and marine environments, resulting in over 12,000 IBAs defined worldwide.

In New Zealand, IBAs have been identified for seabirds, and cover both marine areas as well as coastal locations and sites on land (i.e., braided rivers, estuaries, coastal lagoons and harbours). These assessments were conducted by seabird scientist Chris Gaskin on behalf of Forest and Bird, a BirdLife International partner. The process involved comprehensive reviews of published and unpublished literature, as well as consultations with species experts. Several braided rivers in the project area have been identified as IBAs.

Several other significant bird species are known throughout the Project Area, such as kea (*Nestor notabilis*; Threatened – Nationally Endangered), NZ falcon/kārearea (*Falco novaeseelandiae*; Threatened – Nationally Vulnerable), South Island robin/kakaruai (*Petroica australis*; At Risk – Declining) and yellow-crowned parakeet/kakariki (*Cyanoramphus auriceps*; At Risk – Declining). Given their wide ranges, distributions and overlapping habitat preferences with other significant bird species, as well as for ease of mapping and interpretation, these species have been omitted here. However, they warrant inclusion in future management options, especially at scales smaller than in the present study.

3.5 Invertebrates

We have not included invertebrates in the review of biodiversity values of the Project Area in this report. Invertebrate diversity varies significantly within and among habitat types, and thus will vary across the Project Area. With significant deficiency in data for many taxonomic groups, there is the potential risk of misinforming on current distributions.

3.6 Ecosystem Management Units and UNESCO World Heritage Sites

To aid in identifying sites that maximise current ecological gains, as well as areas of cultural, historical and scientific significance, the locations of Ecosystem Management Units (EMU) and World Heritage Sites designated under the United Nations Educational, Scientific and Cultural Organization (UNESCO) were identified. The extents of each covered by the proposed sites were considered in the ranking exercise of Section 7. DOC EMUs are areas of public conservation land identified by DOC as sites that represent a full range of New Zealand ecosystems, while UNESCO World Heritage Sites are considered to be of outstanding value for their cultural, historical, scientific, or natural significance.

4. DETERMINING BARRIERS TO PREDATOR MOVEMENT IN POTENTIAL ELIMINATION SITES

Mammalian pest species in New Zealand are resilient, opportunistic, and highly adapted to varying ecological conditions. Also, as already proven, they have great dispersal capabilities. Thus, the use of natural barriers in the management of pest species need to be applied with a great deal of caution.

4.1 Elevational barriers

High elevations and other geophysical features at altitude, such as mountain ranges and ridgelines, will at best serve to funnel predators to certain areas (i.e. lower elevation saddles and valleys). Well documented in alpine habitats (Cuthbert and Sommers 2002, Smith and Jamieson 2005, Smith *et al.* 2007, Smith *et al.* 2008), stoats are known predators of rock wren (Little *et al.* 2017). Brushtail possums, while more abundant in lower elevation forests, can occur above the treeline in patches of scrub (D. Smith, pers. obs.), and have also been observed well above the treeline in alpine environments of Canterbury (W. Shaw, pers. obs.). Several lines of evidence suggest rat abundance declines with increasing altitude. Rats are known to occasionally be present in alpine areas, with the Matukituki Catchment Group having trapped one above the treeline in the Liverpool Hut area. As might be expected, large glaciated rocky peaks will be impassable by introduced mammalian predators.

4.2 Lakes and rivers

A growing body of evidence suggests fast flowing water courses and large bodies of water can inhibit movement of invasive predators in New Zealand (Etherington *et al.* 2014; Sarre *et al.* 2014; Cook *et al.* 2020). However, many of the target species are especially capable swimmers. For example, Norway rats have been observed to swim distances of over one kilometre (Russel *et al*. 2008), while stoats are known to swim distances of over three kilometres (Veale *et al*. 2012). Given the high ecological value of river habitats, and that river systems are generally enclosed by high elevations, rivers were generally captured where site perimeters could be placed >1,200 m.a.s.l., rather than prioritised as barriers themselves.

While predators may occasionally raft or swim long distances, the large sizes of Lakes Wakatipu, Wānaka and Hāwea will inhibit typical terrestrial dispersal patterns. Where possible, lake edges have been used as perimeters to proposed elimination sites. However, it must be noted that the use of lakes as barriers is not a guarantee against incursions. Monitoring and trapping at lake edges, which present their own unique challenges (e.g. changing water levels and beaches as predator highways), will be required to judge the effectiveness of lakes as barriers.

4.3 Predator Elimination Sites

Site perimeters were oriented to reduce the risk of incursions. A minimum target elevational of 1,200 m.a.s.l. was chosen, which has been adopted in similar predator elimination efforts in the Perth River, New Zealand (Nichols *et al*. 2020). Where perimeter sections inevitably drop below this threshold, such as in valleys and saddles, other geophysical boundaries were utilised. These included lake edges where opposite

shorelines were ≥2 kilometres away (beyond the maximum swim distance of most target species), as well as fast flowing rivers. Segments of <1,200 m.a.s.l. were also kept to a minimum number as well as length. Additionally, the use of 1,200 m.a.s.l. as a minimum boundary meant that the occurrence of less valuable habitat types for most target species (e.g., alpine gravel and stonefields, permanent snow and ice) were maximized on the boundaries. The exceptions to this may be stoats and mice, which are extremely diverse in the habitats they inhabit.

Where proposed site perimeters are along the boundary of the Queenstown Lakes District Project Area, geophysical barriers that would provide buffer areas outside of the Project Area were also reported, though were not considered in the site ranking exercise.

5. ASSESSING THE PRACTICALITY OF IMPLEMENTATION AND RELATIVE COST FOR POTENTIAL ELIMINATION SITES

There are several potential locations that could be used as helicopter take-off locations for aerial operations, including privately owned hangars. Additionally, advanced bases may be established from which helicopters can operate: helicopters can take-off and land wherever there is relatively flat and open ground. However, to allow initial assessment of the relative ease of aerial operations using helicopters, major aerodromes at Queenstown and Glenorchy have been considered here. Additionally, the Aspiring Helicopters operation close to Treble Cone ski area has been included, as well as Back Country Helicopters that operate from Makarora. The use of Wānaka as a potential take-off and landing location has not been included as closer options are available. The distribution of the selected helicopter sites provides a relatively even spread within the Project Area for potential aerial operations to occur from (Figure 4).

Cost estimates for aerial operations, as well as trap setup and checking, were provided by the Client. From these, the relative potential cost of each proposed site was assessed and incorporated into the ranking exercise of Section 7. These costings are not indicative of the final costs for each site, but provide a means of determining the relative feasibility among sites for the purposes of this report.

Trap costs are based on DOC 200 and Double DOC series traps set 100 metres apart on lines one kilometre apart, as per Predator Free guidelines (Predator Free NZ Website, accessed 24 August 2023). These are humane kill traps (National Animal Welfare Advisory Committee draft approved) that target rats, stoats and hedgehogs, while excluding non-target species. Trap setup and checking costs were split between front and back country, with and without the use of helicopters, to reflect the practicalities of accessing and working in the varied landscapes of the Project Area. Costing frameworks considered whether trap networks were also already present within the proposed sites, thus negating initial setup costs. Focus was on deploying trap lines which ran along high-risk incursion areas (<1,200 m.a.s.l.) at the perimeters of each proposed site. Costing frameworks for trap lines and aerial operations for each site are in Appendix 2 and 3 respectively.

6. PROPOSED INVASIVE PREDATOR ELIMINATION SITES

An overall view of the proposed elimination sites, with major airport locations, current DOC EMUs and UNESCO World Heritage Areas, is shown in Figure 4. Each of the five potential areas for predator elimination are then described in detail. While these areas are large, smaller management units are included within some areas as potential starting points. These management units can be viewed as "stepping stones" to eventually achieving larger areas of wider scale predator suppression/elimination in New Zealand. Ranking of sites is covered in Section 7.

6.1 Site 1 – Makarora River and surrounds.

A large area (*c*,82,000 hectares), this site encompasses varied landscapes from lake level (*c*,200 m.a.s.l.) to mountain peaks (>2,000 m.a.s.l.). Located north of Lake Wānaka, the perimeter encloses several rivers, including the Wilkin River, Young River and Makarora River, as well as extensive valley systems.

While mostly taking advantage of high ridgelines, there are two sections of the perimeter that drop below 1,200 m.a.s.l. and would require increased vigilance to incursions. The first runs from high elevation down to the northwestern shore of Lake Wānaka, east along the shore to Boundary Creek campsite, then back to 1,200 m.a.s.l. The second crosses the valley in the headwaters of Makarora River, the Haast Pass Lookout carpark, where it falls to *c*.566 m.a.s.l. These areas of increased risk to incursions are accessible via road.

The perimeter of the proposed area follows ridgelines primarily composed of narrow-leaved and slim snow tussock/shrubland, as well as areas of gravelfields and permanent snow and ice. The area encompasses several habitat types, including long valleys of lower elevation areas of beech and other broad-leaved forests and braided river habitat (Table 5).

Most of this area has been identified as an IBA for waders and gulls, as well as providing important habitat for South Island kaka (*Nestor meridionalis meridionalis,* Threatened-Nationally Vulnerable), mohua (*Mohoua ochrocephala*, At Risk-Declining), rock wren (*Xenicus gilviventris*, Threatened-Nationally Critical) and blue duck (*Hymenolaimus malacorhynchos,* Threatened-Nationally Vulnerable). Additionally, long-tailed bats (*Chalinolobus tuberculatus,* Threatened-Nationally Critical) have been recorded along the eastern shores of Makarora River.

In terms of practicality of predator elimination in this area, Back Country Helicopters operate from Makarora, which is within the proposed area. Situated along the Makarora River, aerial operations could follow the river and its tributaries to their origins, close to the perimeter edges. Maintained walking tracks are also present throughout the major arms of the river system (e.g. Blue Pools, Young River and Wilkin River tracks), though are absent through the rest of the area. This would make it relatively difficult for ground-based operations pre- and post-aerial baiting.

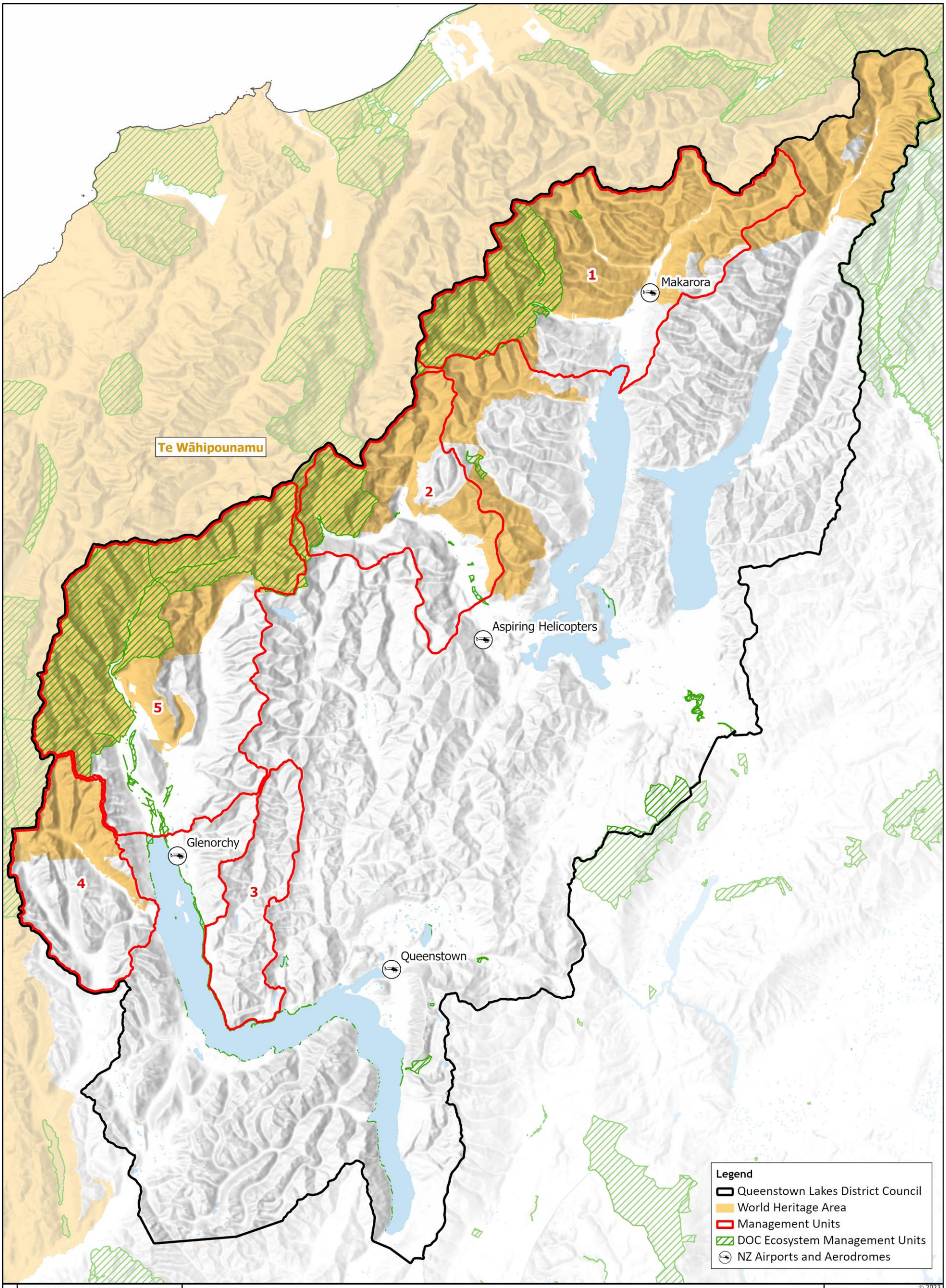

Figure 4. The Project Area with five proposed predator elimination sites, DOC Ecosystem Management Units, UNESCO World Heritage Areas, and potential take off points for helicopter operations.

Table 5: Area (ha) and % cover of indigenous habitats identified in proposed Site 1.

Habitat Type	Area (ha)	%
AH1: Gravelfield/stonefield	1,059	1.36
AH3: Gravelfield/stonefield mixed species cushionfield	6,772	8.70
AL1: Narrow-leaved and slim snow tussockland/shrubland	11,338	14.57
AL6: Mid-ribbed and narrow-leaved snow tussockland/shrubland	16,383	21.06
BR2: Scabweed gravelfield/stonefield	151	0.19
CDF2*: Dracophyllum*, *Phyllocladus*, *Olearia*, Hebe scrub (subalpine scrub)	7,529	9.68
CLF11.2: Silver beech forest	16,238	20.87
CLF11.3: Silver beech forest	9,118	11.72
CLF4.2: Kahikatea, tōtara, matai forest	23	0.03
Gravel or rock	1,246	1.60
Indigenous forest (undefined)	48	0.06
Lake or pond	273	0.35
Makahikātoa scrub and shrubland	1,047	1.35
Mānuka scrub/forest	68	0.09
Permanent snow and ice	1,679	2.16
SC1: Screes and boulderfields	275	0.35
Tall tussock grassland	2,127	2.73
VS10: Bracken fernland	1,887	2.43
VS5: Broadleaved species scrub/forest	498	0.64
VS6: Matagouri, *Coprosma propinqua*, kowhai scrub (grey scrub)	47	0.06

Given the relatively large area proposed, smaller management units are presented. These essentially separate the western, northern and southern sections of the larger Makarora catchment, while minimising areas of increased risk of incursion. Management Unit A (*c.*25,000 hectares) encompasses the Wilkin River system, which is identified as an IBA, as well as key habitat for rock wren, SI kaka, mohua and blue duck (Wildland Consultants 2020c). Management Unit B (*c.*44,000 hectares), while still relatively large, makes best use of the geophysical boundaries of the area to reduce the risk of incursions post elimination. This unit encompasses the mid- to upper-reaches of Makarora River, including Young River and Blue River. This extensive system contains important habitat for SI kaka and mohua, with the braided river system of Makarora River identified as an IBA. Additionally, the tributaries (e.g. Young River, Leven Stream, Ore Stream and Blue River) are identified as key habitat for blue duck, while the headwaters of Young River are important rock wren habitat (Wildland Consultants 2020c). Management Unit C (*c.*13,000 hectares) encompasses Mount Albert Station and lower Makarora/upper Lake Wānaka, and ultimately could connect the previous units, eventually enclosing the entire Makarora River catchment into one management unit (Figures 5 and 6).

Most of this site is composed of DOC public conservation land, with QEII covenanted areas located around Makarora township and slightly north-northeast of Lake Wānaka. Outside of the Queenstown Lakes District Project Area, geophysical barriers that could offer buffers to reinvasion include continuous ridgelines that range from 1.4 to 9.7 kilometres from the site perimeter. Due to the complex nature of the landscape in this area, several sections of this buffer perimeter are below 1,200 m.a.s.l., reducing the effectiveness against incursion (Figure 7). Most of this site also falls under the internationally recognised UNESCO World Heritage Area, Te Wāhipounamu, with the western regions under a DOC EMU.

6.2 Site 2 – Matukituki River, Mount Aspiring.

Site 2 is a large site (*c.*49,000 hectares) that encompasses the Matukituki River. The perimeter makes use of the peaks and ridgelines that surround the Matukituki River and tributaries, with most forming a contiguous line >2,000 m.a.s.l. The perimeter crosses habitats that include mid- and narrow-leaved slim snow tussock/shrubland, gravelfield and stonefields with mixed cushionfield species and sections of permanent ice and snow. Within the area, important habitats include large braided river systems, tall tussock grassland, bracken fernland, as well as large areas of dense mountain and silver beech forests. Small patches of subalpine scrub, Makahikatoa scrub and shrubland, mountain tutu, hebe, whaririki and *Chionochloa* shrubland/tussockland/rockland, as well as patches of Kahikatea, tōtara and matai forest are also present in places (Table 6).

Table 6: Area (ha) and % cover of indigenous habitats identified in proposed Site 2.

Habitat Type	Area (ha)	%
AH3: Gravelfield/stonefield with mixed species cushionfield	4,972	12.45
AL1: Narrow-leaved and slim snow tussockland/shrubland	10,109	25.31
AL6: Mid-ribbed and narrow-leaved snow tussockland/shrubland	5,329	13.34
BR2: Scabweed gravelfield/stonefield	62	0.16
CDF1: Pahautea, Hall's tōtara, mountain celery pine, broadleaf forest	17	0.04
CDF2: *Dracophyllum*, *Phyllocladus*, *Olearia*, Hebe scrub (subalpine scrub)	2,670	6.69
CDF3: Mountain beech forest	11	0.03
CL11: Mountain tutu, Hebe, whaririki, *Chionochloa* shrubland/tussockland/rockland	15	0.04
CLF10: Red beech, silver beech forest	264	0.66
CLF11.2: Silver beech forest	3,498	8.76
CLF11.3: Silver beech forest	3,334	8.35
CLF12: Silver beech, mountain beech forest	680	1.70
CLF4.2: Kahikatea, tōtara, matai forest	4	0.01
Gravel or rock	1,021	2.56
Indigenous forest (undefined)	44	0.11
Lake or pond	55	0.14
Mānuka scrub/forest	18	0.04
Permanent snow and ice	2,333	5.84
SC1: Screes and boulderfields	69	0.17
Tall tussock grassland	3,421	8.57
TI4: Coprosma, Olearia, matagouri scrub (grey scrub)	5	0.01
VS10: Bracken fernland	1,363	3.41
VS11: Short tussock tussockland	<0	<0.00
VS5: Broadleaved species scrub/forest	298	0.75
VS6: Matagouri, *Coprosma propinqua*, kowhai scrub (grey scrub)	33	0.08
WL22: Carex, *Schoenus pauciflorus* sedgeland	307	0.77
WL8: Herbfield/mossfield/sedgeland	1	<0.00

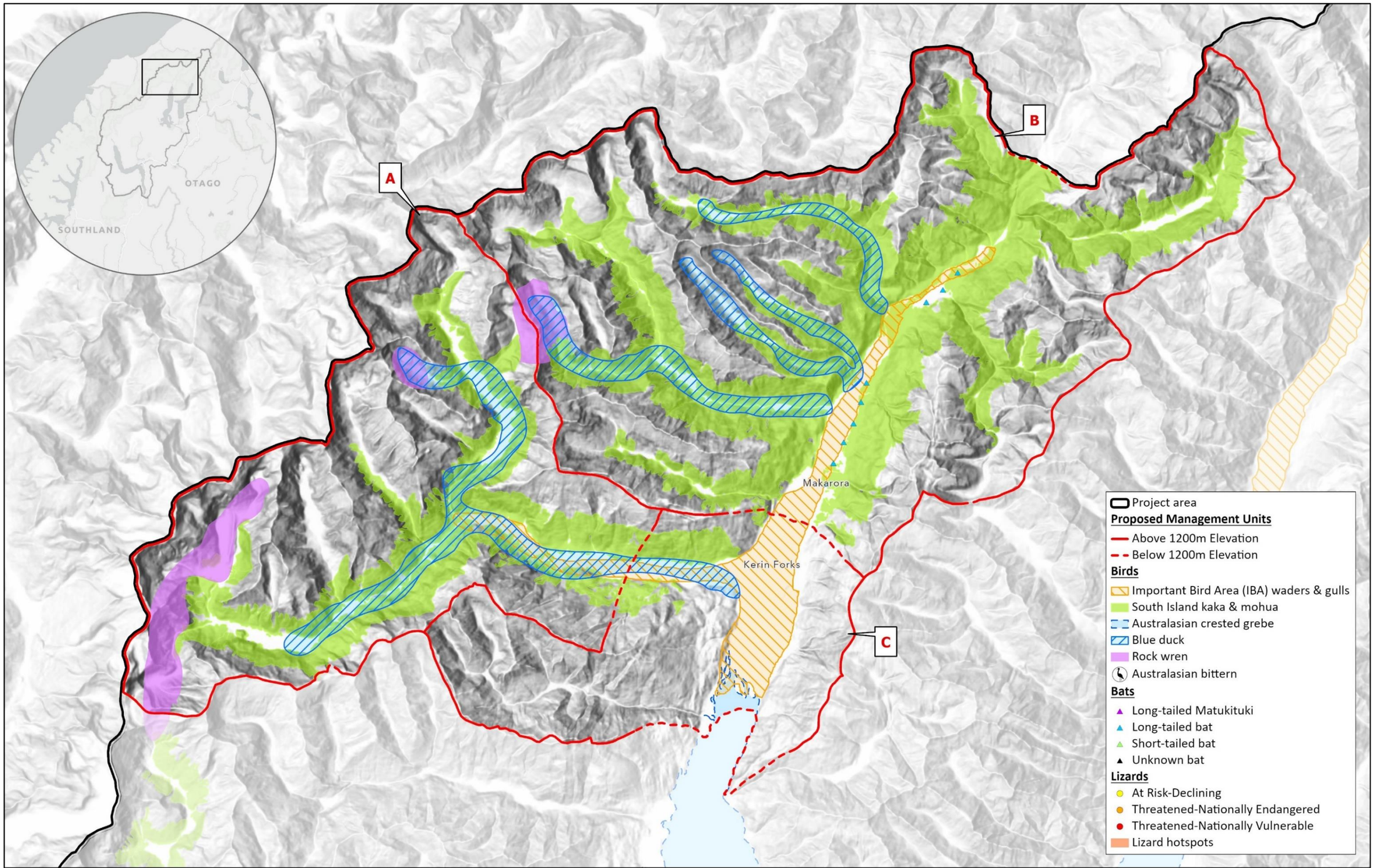

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Figure 5. Proposed site 1, Makarora River, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are ecological values associated with fauna.

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Cartographer: BL
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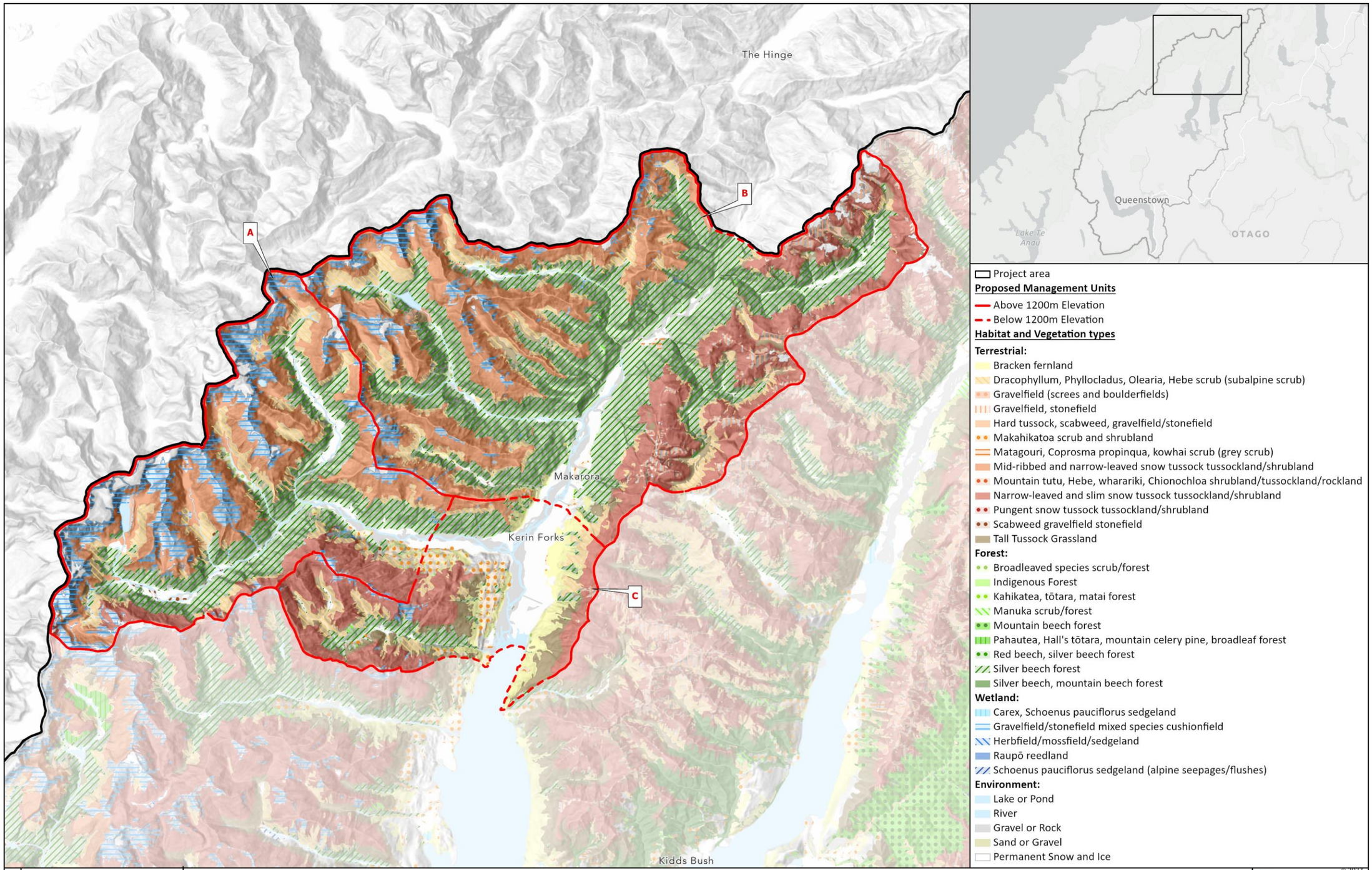

Figure 6. Proposed site 1, Makarora River, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are mapped habitats.

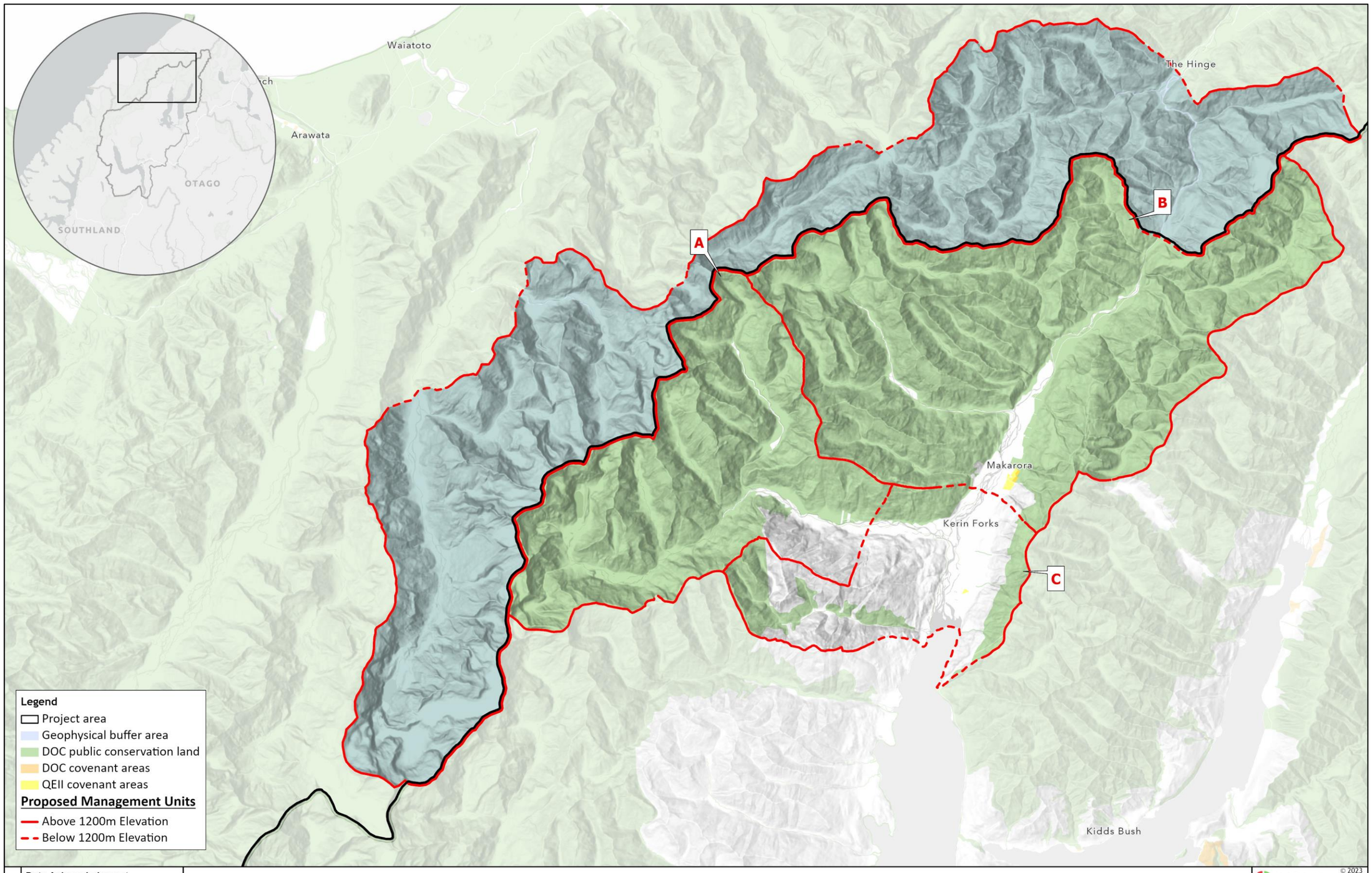

Figure 7. Proposed site 1, Makarora River, with geophysical buffer outside of the project area, and land ownership and covenant details.

The single area at greatest risk of incursion from pest species is the southeastern edge of the site, which is the entrance to the valley system. A distance of around seven kilometres stretches from 1,200 m.a.s.l. on one side of the valley to the same elevation on the other, with elevation dropping to *c.*230 m.a.s.l. at its lowest point. The habitat here is primarily modified farmland.

The braided river system of Matukituki River is an IBA for several bird species. Mid to upper reaches are deemed important habitat for both South Island kaka and mohua, with the upper reaches deemed important for rock wren. Sightings of Australasian bittern (*Botaurus poiciloptilus;* Threatened-Nationally Critical) have also been made throughout the river system in recent years. Other significant bird species recorded within the area include long-tailed cuckoo (*Eudynamis taitensis*; Threatened-Nationally Vulnerable), eastern falcon (*Falco novaeseelandiae*; Threatened-Nationally Vulnerable) and kea (*Nestor notabilis*; Threatened-Nationally Endangered). Long-tailed bat have been recorded in the upper reaches of Matukituki River, with records of At Risk lizards also present south of Glendhu Station.

Aspiring Helicopters operate close to the southeastern edge of the proposed elimination area, thus increasing the practicality and feasibility of aerial operations throughout the Matukituki River system. The river system itself is relatively straightforward, with one major split into East and West Matukituki. Thus, as with Makarora River, the system could be followed relatively easily to the river origins and perimeter edges in aerial operations. Road access in the south- to mid-region of the area would facilitate ground-based operations, while walking tracks and huts along West and East Matukituki tributaries would aid in accessing western and northern regions.

The option for splitting into two smaller management units is available, while maintaining resilience to incursions. Management Unit A (*c.*28,000 ha) encloses the upper West and East Matukituki Rivers, including tributaries, while Management Unit B (*c.*21,000 ha) extends south to include the main reach of the Matukituki river, including Matukituki Station (Figures 8 and 9).

Site two is largely composed of DOC public conservation land, with sections, especially the western Matukituki River, designated DOC covenanted areas. Small areas around Cascade Hut in the western Matukituki River are also QEII covenant areas. The buffer area along the northwestern edge of the Project Area extends between two and eight kilometres from the perimeter of Site 2, with one large section (Waipara River) falling below 1,200 m.a.s.l. (Figure 10). Most of this site also falls under the internationally recognised UNESCO World Heritage Area, Te Wāhipounamu, with the western regions under a DOC EMU.

6.3 Site 3 – Mount Creichton/Larkins

A site of close to 26,000 hectares, the perimeter encompasses Mount Crichton and bisects Mount Larkins. Habitats on the boundary include narrow-leaved and slim snow tussock/shrubland, tall tussock grassland, and gravel/stonefields with mixed species cushionfields. Several points of increased risk of incursion are present in valley sections where habitats include mountain beech and mānuka forest, as well as bracken fernland.

The site utilizes the northern shore of Lake Wakatipu as a barrier to incursion, with distances between adjacent shorelines of >2 kilometres. Exceptions to this are Pig and Pigeon Islands, which could act as "stepping stones" between the western and eastern shores of Lake Wakatipu, and thus should be areas of increased monitoring and trapping.

Habitats within the site include a diverse array of broadleaved scrub/forest, bracken fernland, mānuka forest, tall tussock, cushionfields, subalpine scrub and snow tussockland. Areas of mountain beech are also present (Table 7).

Table 7: Area (ha) and % cover of indigenous habitats identified in proposed Site 3.

Habitat Type	Area (ha)	%
AH2: *Dracophyllum muscoides* cushionfield	239	0.96
AH3: Gravelfield/stonefield mixed species cushionfield	1,718	6.92
AL1: Narrow-leaved and slim snow tussock tussockland/shrubland	7,259	29.25
BR1: Hard tussock, scabweed, gravelfield/stonefield	38	0.15
CDF2: *Dracophyllum*, *Phyllocladus*, *Olearia*, Hebe scrub (subalpine scrub)	2,075	8.36
CDF3: Mountain beech forest	4,395	17.71
Gravel or Rock	22	0.09
Indigenous Forest	4	0.01
Lake or Pond	92	0.37
Mānuka scrub/forest	1,600	6.45
Permanent Snow and Ice	113	0.46
SC1: Gravelfield (screes and boulderfields)	140	0.56
Tall Tussock Grassland	5,830	23.49
VS10: Bracken fernland	896	3.61
VS5: Broadleaved species scrub/forest	388	1.57
VS6: Matagouri, *Coprosma propinqua*, kowhai scrub (grey scrub)	5	0.02

The Mount Crichton area is significant habitat for lizards. Additionally, bats have been recorded along the northeastern shores of Lake Wakatipu, with the potential of bat distributions to extend to within the proposed elimination site (Figures 11 & 12).

Options for aerial bases of operations include Queenstown, which could service the southern regions of the proposed area, and Glenorchy, which is closer to more northern portions. Few maintained walking tracks and huts are present. Most of Site 3 is DOC public conservation land, with areas in the southwestern quarter being DOC covenant land and QEII covenant areas (Figure 13). As the site is not on the edge of the Project Area, no buffer zone is proposed. This site does not fall under any DOC EMU or UNESCO World Heritage Sites.

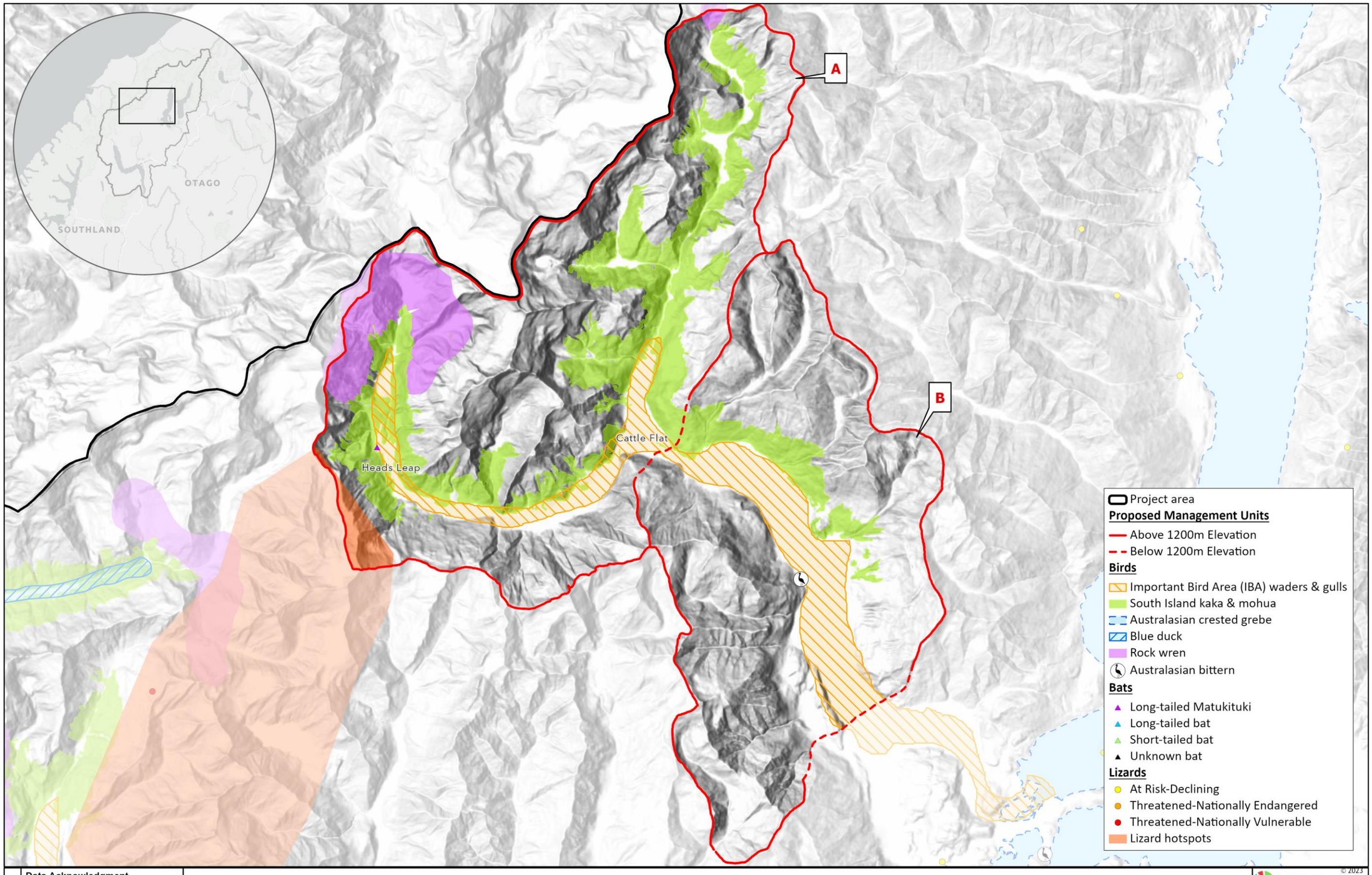

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Figure 8. Proposed site 2, Matukituki River, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are ecological values associated with fauna.

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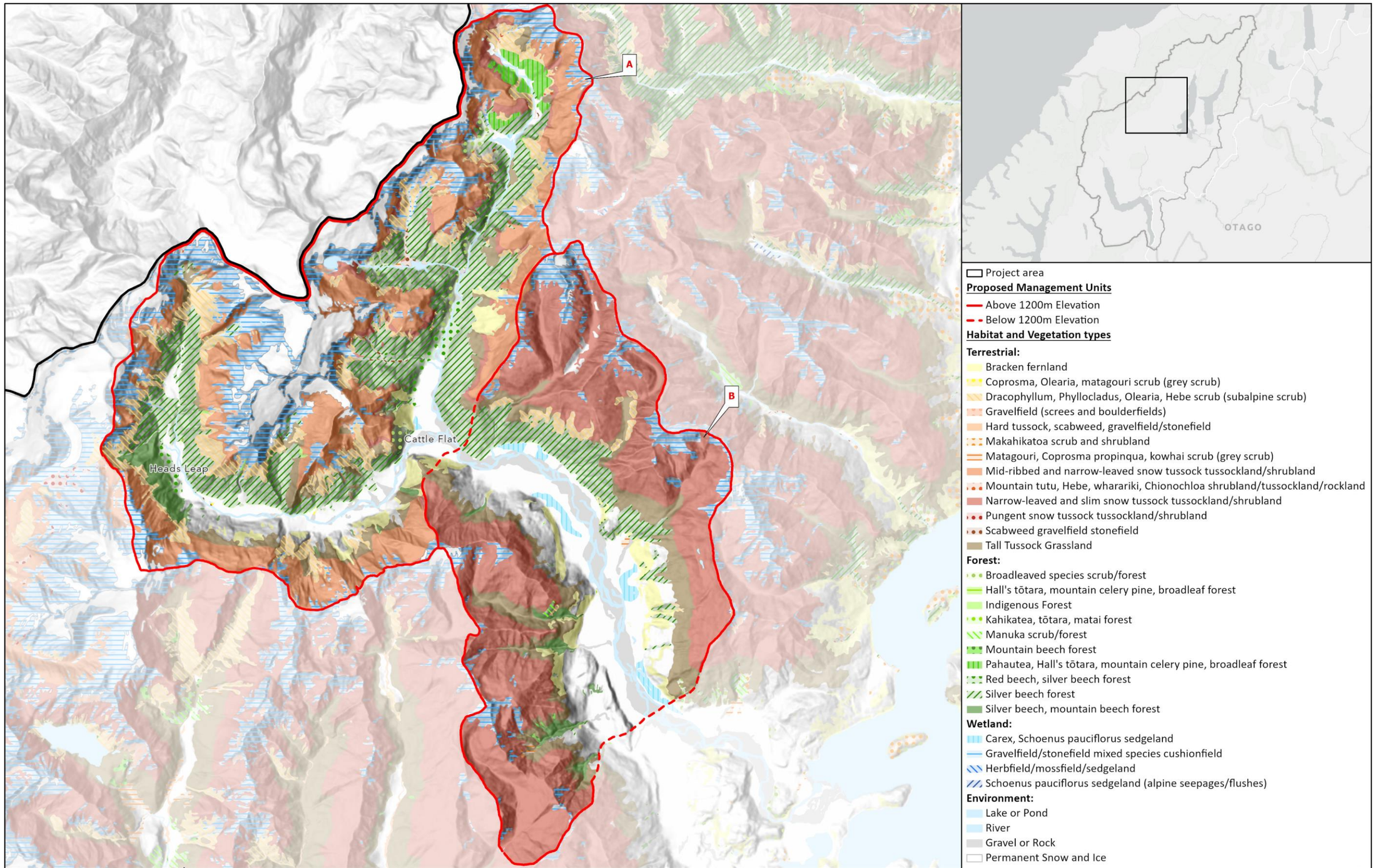

Figure 9. Proposed site 2, Matukituki River, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are mapped habitats.

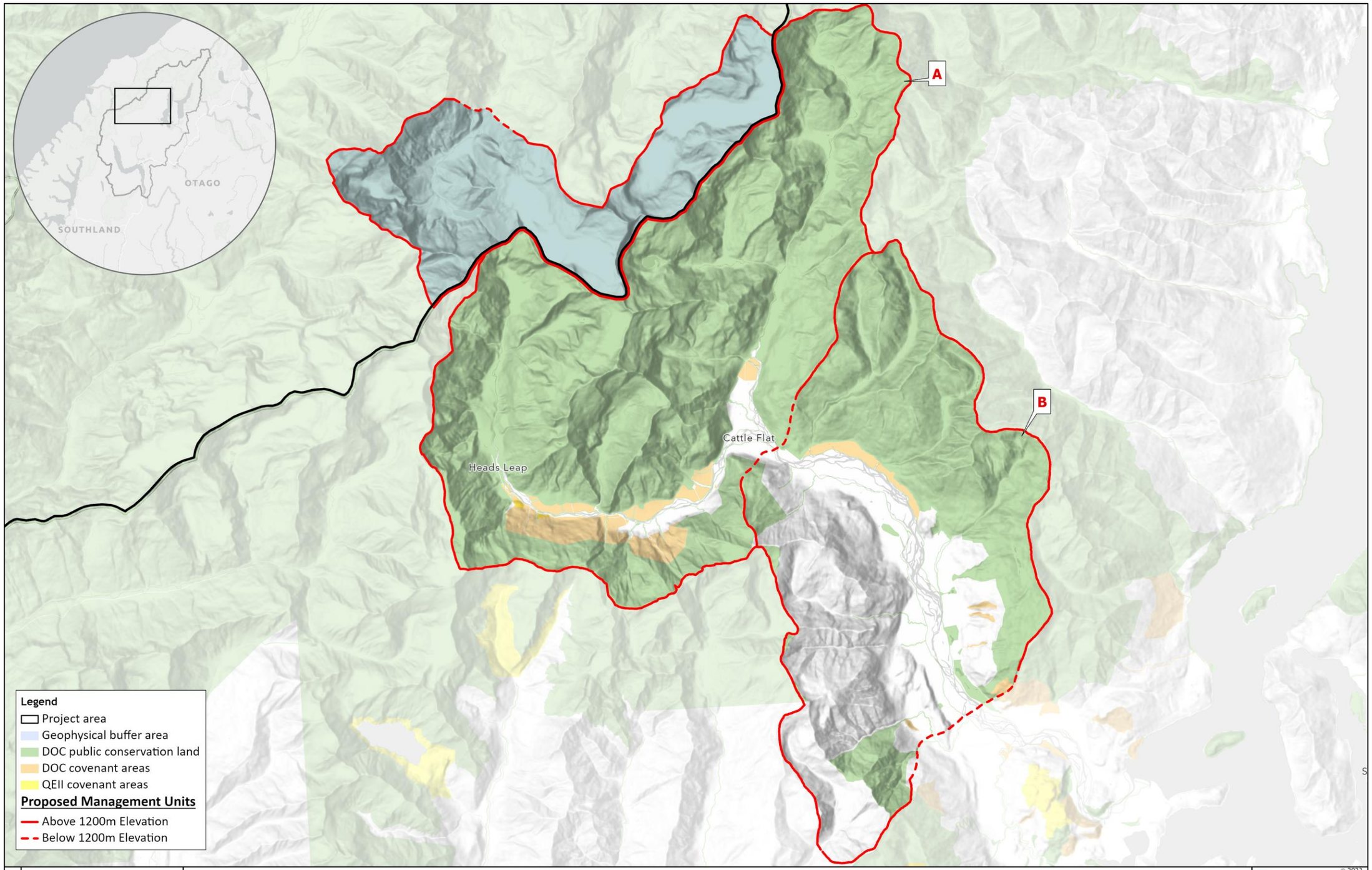

Figure 10. Proposed site 2, Matukituki River, with geophysical buffer outside of the project area, and land ownership and covenant details.

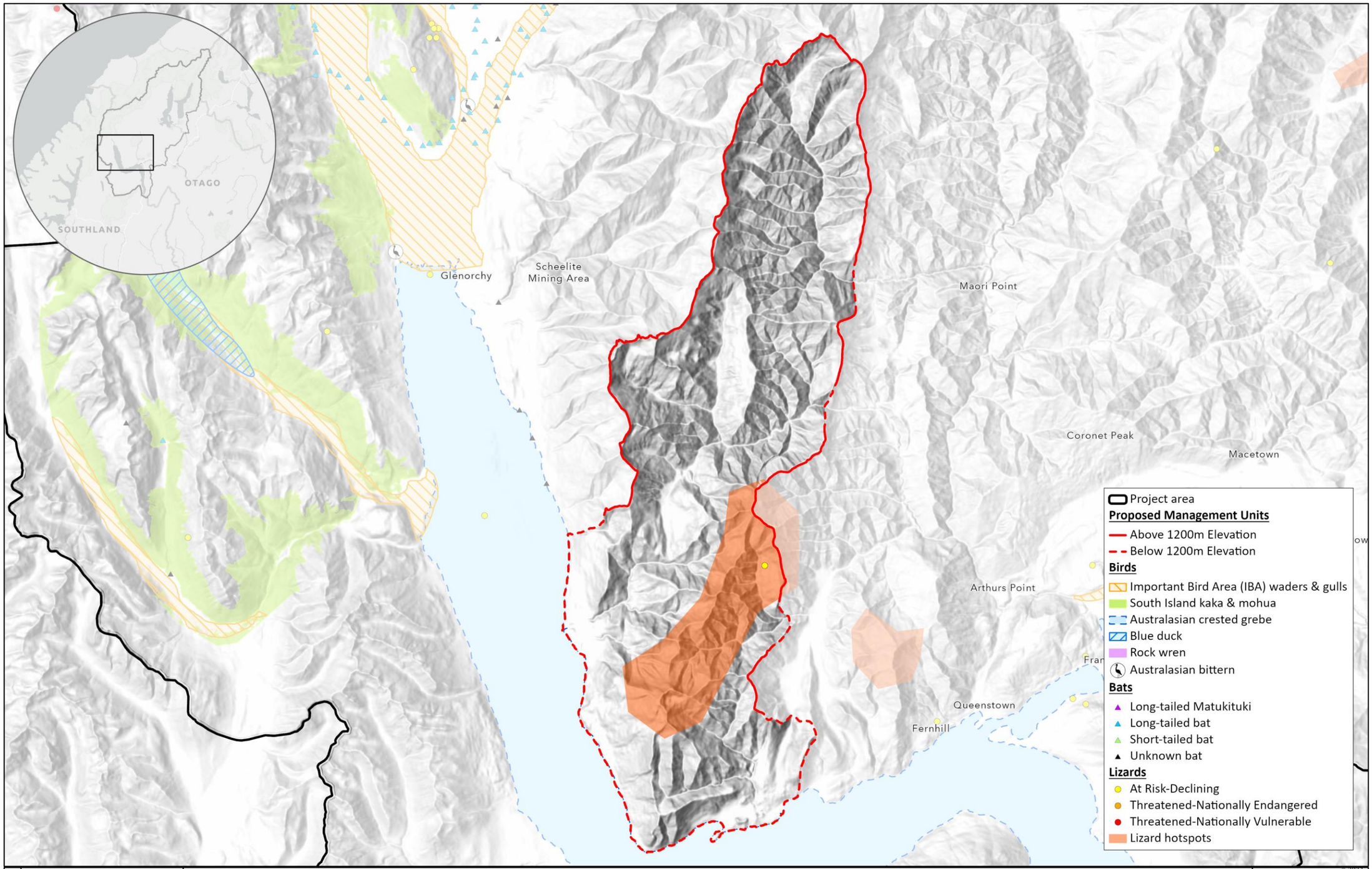

Figure 11. Proposed site 3, Mount Creighton/Larkins, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are ecological values associated with fauna.

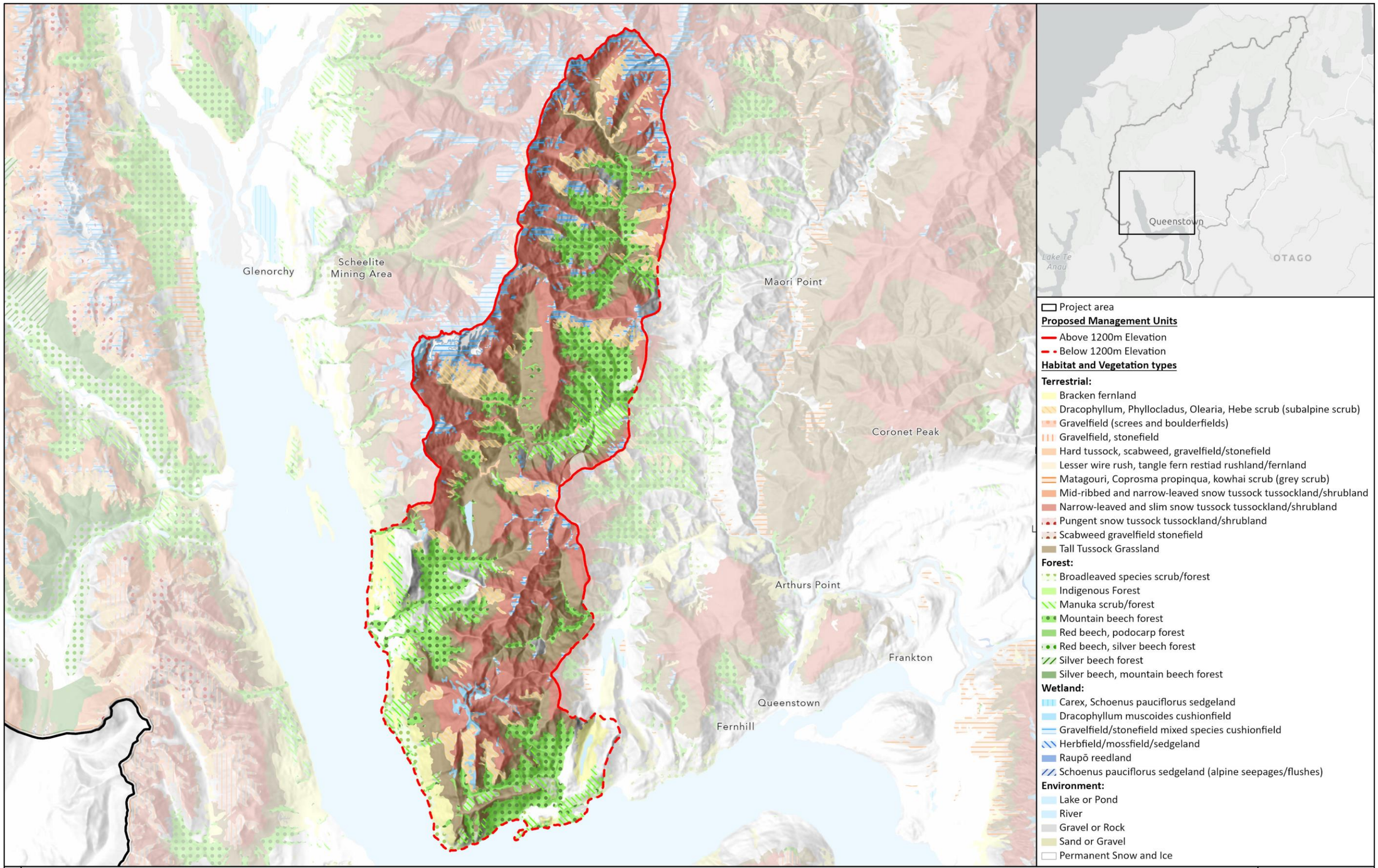

Figure 12. Proposed site 3, Mount Creighton/Larkins, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are mapped habitats.

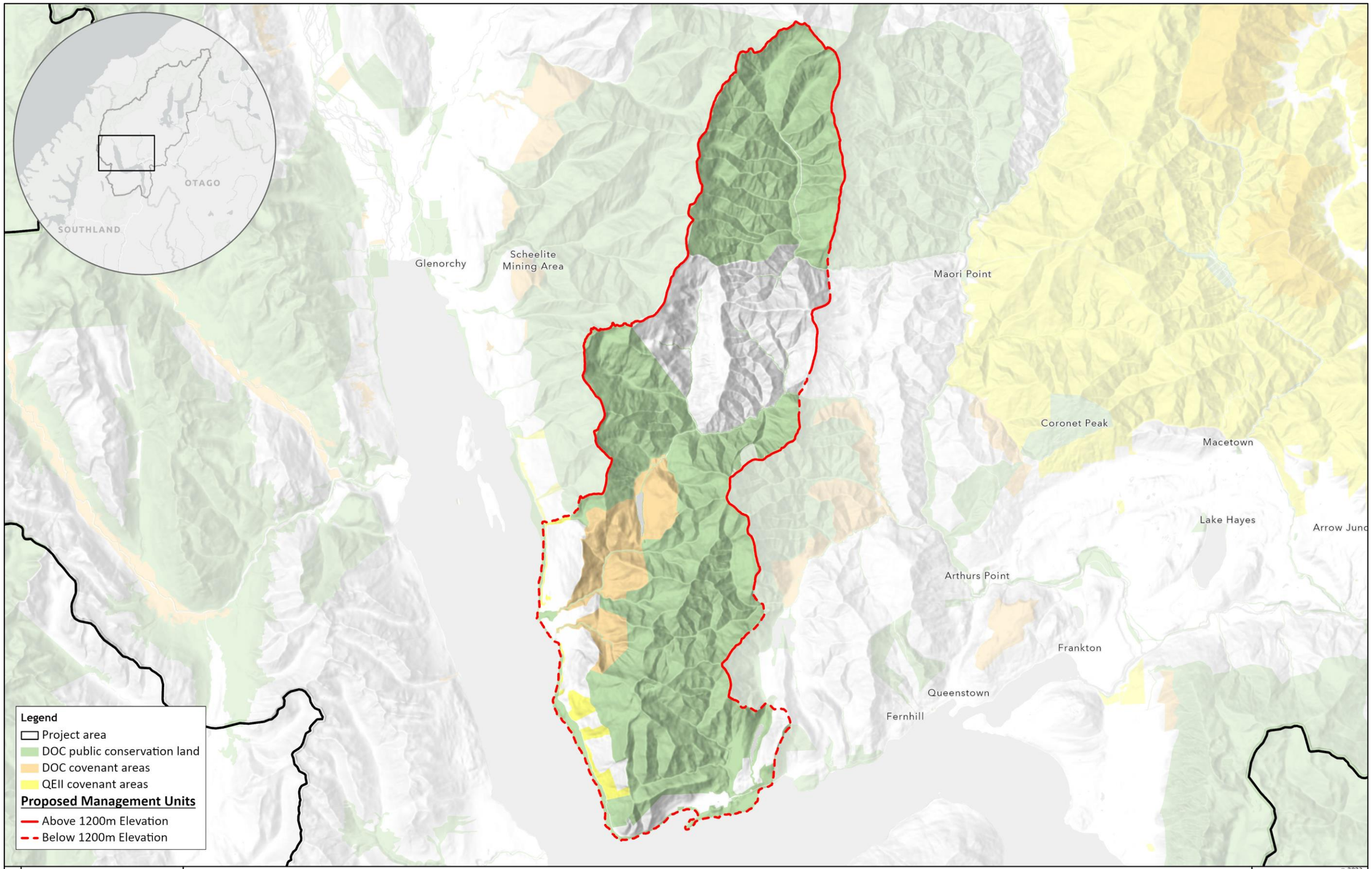

Figure 13. Proposed site 3, Mount Creighton/Larkins, with land ownership and covenant details.

6.4 Site 4 – Greenstone and Caples Rivers

This proposed site is around 35,000 hectares in size and encompasses the Greenstone and Caples Rivers, including the Ailsa Mountains and Steele Creek.

The perimeter makes good use of contiguous high elevation ridgelines, with most sections >1,200 m.a.s.l., providing good defensibility. Habitats where the perimeter is located include mid-ribbed and narrow-leaved snow tussock/shrubland, gravelfield and stonefield with mixed species cushionfields, pungent snow tussockland/shrubland and areas of permanent snow and ice. Sections of increased risk of incursion includes the Mavora Greenstone Saddle (3.3 kilometres long and 738 m.a.s.l.), Elfin Bay (7.4 kilometres long and 320 m.a.s.l.), and the valley where the Greenstone Saddle Campsite is located (3.2 kilometres long, 680 m.a.s.l. at the lowest point).

The area contains significant ecological value, with large areas of mountain, red and silver beech forests at lower elevations. Areas of subalpine scrub, matagouri, coprosma and kowhai scrub are also present in places. Additionally, broadleaved scrub, *Carex* sp. sedgeland, red tussock and mānuka scrub forest are also represented (Table 8).

Table 8: Area (ha) and % cover of indigenous habitats identified in proposed Site 4.

Habitat Type	Area (ha)	%
AH3: Gravelfield/stonefield with mixed species cushionfield	5,660	13.08
AL1: Narrow-leaved and slim snow tussockland/shrubland	10,454	24.16
AL6: Mid-ribbed and narrow-leaved snow tussockland/shrubland	6,362	14.70
BR2: Scabweed gravelfield/stonefield	67	0.15
CDF1: Pahautea, Hall's tōtara, mountain celery pine, broadleaf forest	349	0.81
CDF2: *Dracophyllum*, *Phyllocladus*, *Olearia*, Hebe scrub (subalpine scrub)	2,962	6.84
CDF3: Mountain beech forest	11	0.03
CL11: Mountain tutu, Hebe, whararikі, *Chionochloa* shrubland/tussockland/rockland	31	0.07
CLF10: Red beech, silver beech forest	264	0.61
CLF11.2: Silver beech forest	3,717	8.59
CLF11.3: Silver beech forest	3,332	7.70
CLF12: Silver beech, mountain beech forest	680	1.57
CLF4.2: Kahikatea, tōtara, matai forest	4	0.01
Gravel or rock	1,021	2.36
Indigenous Forest	46	0.11
Lake or pond	55	0.13
Mānuka scrub/forest	18	0.04
Permanent snow and ice	2,579	5.96
SC1: Gravelfield (screes and boulderfields)	87	0.20
Tall tussock grassland	3,492	8.07
TI4: Coprosma, Olearia, matagouri scrub (grey scrub)	5	0.01
VS10: Bracken fernland	1,363	3.15
VS11: Short tussockland	0	0.00
VS5: Broadleaved species scrub/forest	373	0.86
VS6: Matagouri, *Coprosma propinqua*, kowhai scrub (grey scrub)	33	0.08
WL22: Carex, *Schoenus pauciflorus* sedgeland	310	0.72
WL8: Herbfield/mossfield/sedgeland	1	<0.00

Long-tailed and unidentified bat species have been recorded in the site, with the braided river systems noted as important habitat for waders and gulls, blue duck, SI kaka and mohua. Other significant bird species recorded within the area include long-tailed cuckoo, eastern falcon and kea (Figures 14 and 15).

The closest major location from which helicopter operations could occur from is Glenorchy. As with most other areas proposed, this site encloses a major catchment, in this case of the Greenstone/Caples River system. Aerial operations are therefore able to follow the rivers to source. Several walking tracks and huts pass through the site, allowing access for ground-based work through most of the system in pre- and post-aerial operations.

As with most sites, most of Site 4 is DOC public conservation land. DOC covenant areas cover the western Greenstone River, from Greenstone hut, and the entire Caples River. No QEII covenant areas are present in this site. Making most of geophysical barriers outside of the Project Area, the buffer area perimeter ranges from <1 kilometre to 6.4 kilometres from the western edge of Site 4 (Figure 16). Four major sections of the buffer perimeter are below 1,200 m.a.s.l., creating areas of increased risk to incursion. The northern region of this site falls under the internationally recognised UNESCO World Heritage Area, Te Wāhipounamu.

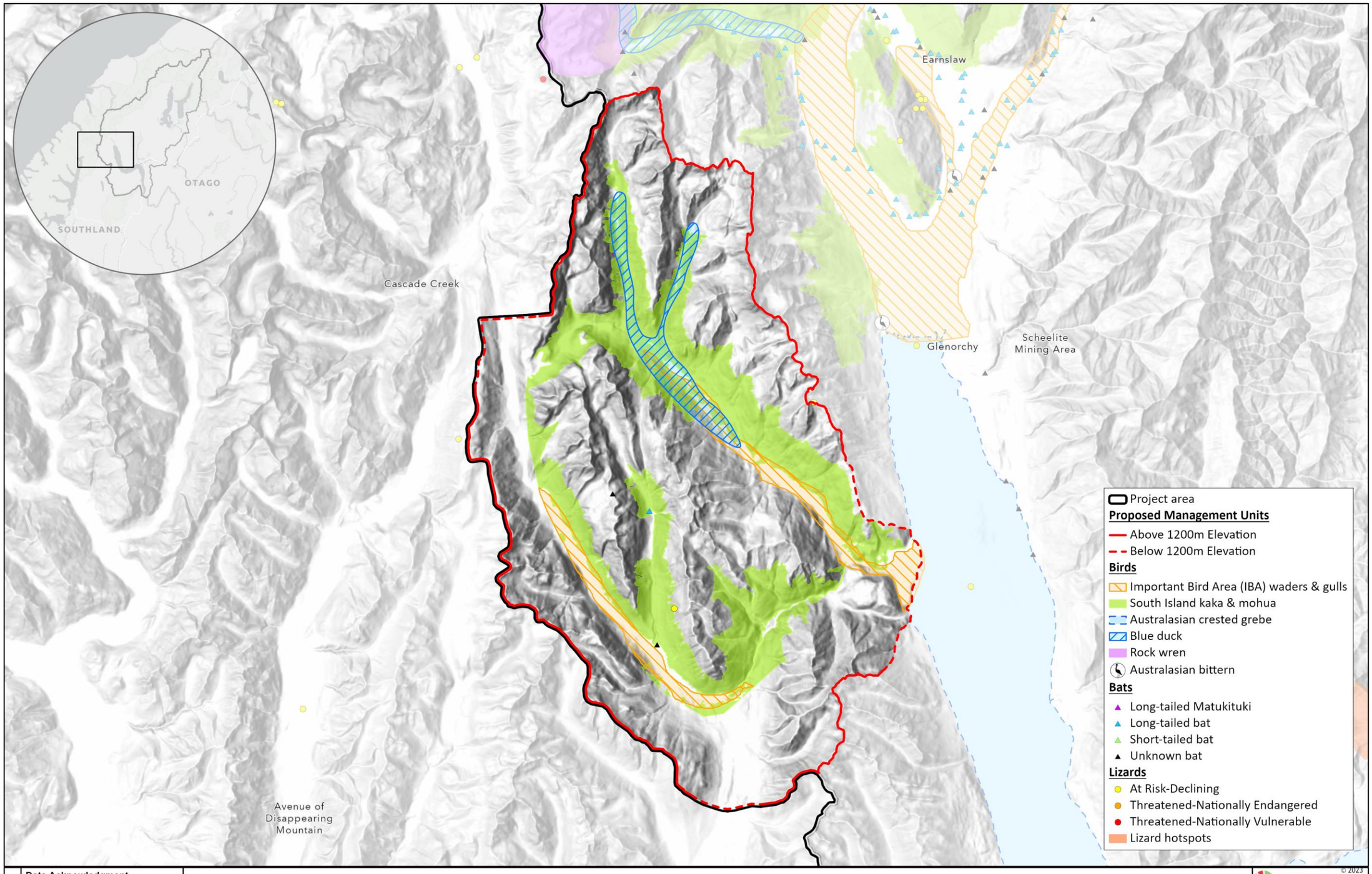

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Figure 14. Proposed site 4, Greenstone and Caples Rivers, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are ecological values associated with fauna.

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Date: 25/10/2023
Cartographer: BL
Format: A3R

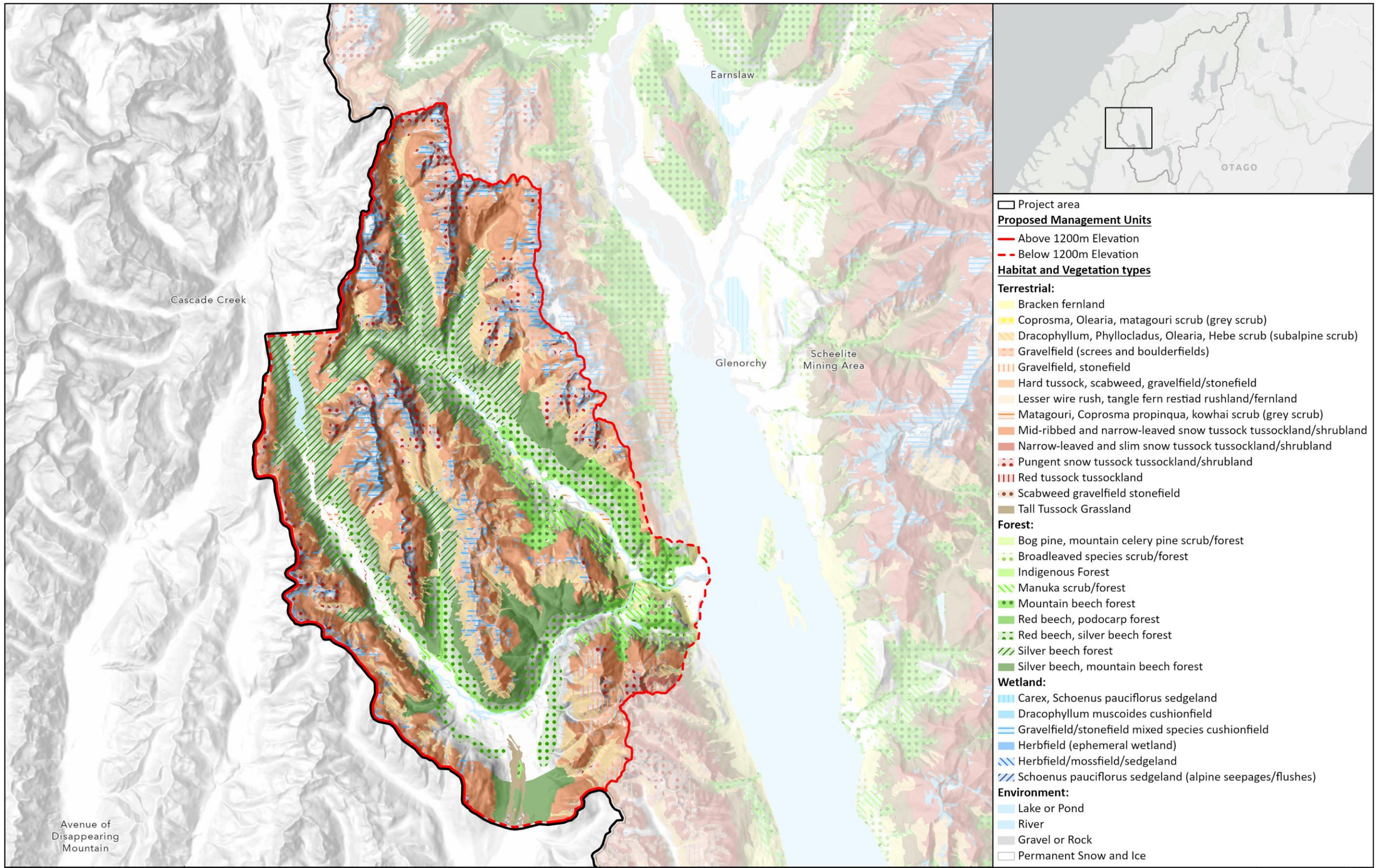

Figure 15. Proposed site 4, Greenstone and Caples Rivers, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are mapped habitats.

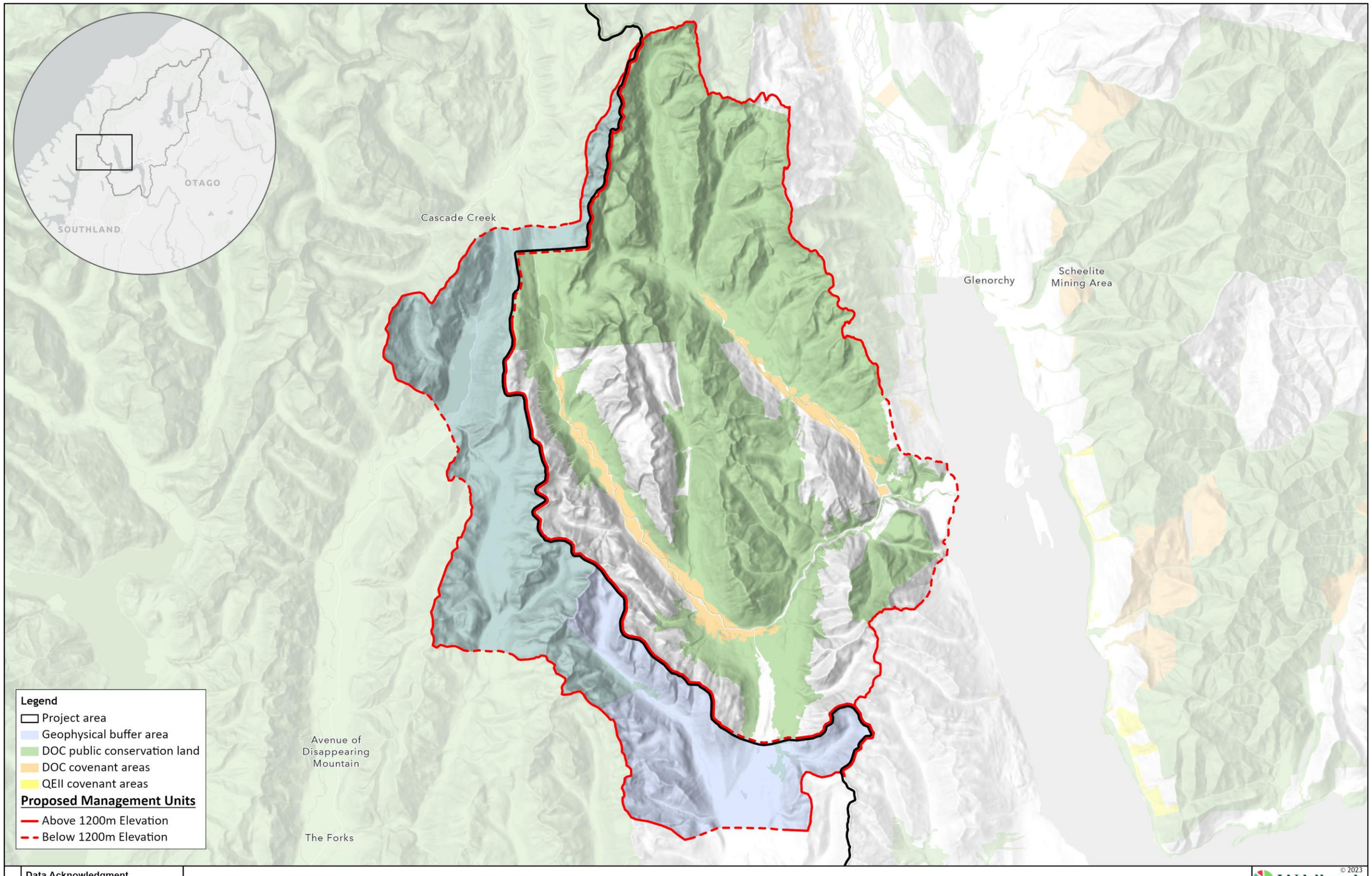

Figure 16. Proposed site 4, Greenstone and Caples Rivers, with land ownership and covenant details.

6.5 Site 5 – Rees and Dart River System

A large site of around 105,000 hectares encompasses the Rees River and Dart River catchments. The perimeter utilizes high and contiguous elevations as boundaries, with habitats that include narrow-leaved and slim snow tussock/shrubland, pungent snow tussock tussockland/shrubland and permanent snow and ice. The single main point of increased risk of incursion (<1,200 m.a.s.l.) is the northern edge of Lake Wakatipu, which is a distance of around 9.6 kilometres between 1,200 m.a.s.l. on either side.

The area holds high ecological value, with the braided river systems important habitat for waders and gulls, South Island kaka, mohua, as well as rock wren. Australasian bittern are also noted in the area. Other significant bird species recorded within the area include long-tailed cuckoo, eastern falcon and kea.

The Earnslaw Burn Valley is important habitat for At Risk lizard species, with many sightings recorded in recent years. Additionally, the entire Rees River and Dart River complex is important habitat for bats, with records of long-tailed bats throughout. It is also the only location in the Project Area with records of short-tailed bat.

Helicopter operations in Glenorchy lie approximately three kilometres south of the southern edge of the proposed Rees/Dart predator elimination area. Most of the area is comprised of riverine valleys, with more open spaces in the southern regions, for example around Mt Earnslaw. Significant and well-maintained walking tracks and huts are also present throughout most of the area.

There is the potential to split the area into smaller management units, using the ridgelines that separate river systems as boundaries. However, this will introduce more areas of potential incursion, namely around Mt. Alfred (Figures 17 and 18).

Most of the Dart River catchment is designated DOC public conservation land, with areas west of Ari/Mount Alfred designated DOC covenant land. DOC public conservation land is less extensive throughout the Rees River system, though a large DOC covenant area is located to the south. No QEII covenant land is present in Site 5 (Figure 19). The Dart River catchment area also falls under the internationally recognised UNESCO World Heritage Area, Te Wāhipounamu.

Table 9: Area (ha) and % cover of indigenous habitats identified in proposed Site 5.

Habitat Type	Area (ha)	%
AH2: *Dracophyllum muscoides* cushionfield	47	0.05
AH3: Gravelfield/stonefield with mixed species cushionfield	15,447	15.83
AL1: Narrow-leaved and slim snow tussockland/shrubland	10,377	10.63
AL6: Mid-ribbed and narrow-leaved snow tussockland/shrubland	16,903	17.32
AL7.1: Pungent snow tussockland/shrubland	5,623	5.76
BR2: Scabweed gravelfield/stonefield	397	0.41
CDF2: *Dracophyllum*, *Phyllocladus*, *Olearia*, Hebe scrub (subalpine scrub)	4,932	5.05
CDF3: Mountain beech forest	10,177	10.43
CLF10: Red beech, silver beech forest	4,827	4.95
CLF11.2: Silver beech forest	721	0.74
CLF12: Silver beech, mountain beech forest	7,116	7.29
CLF9: Red beech, podocarp forest	879	0.90

Habitat Type	Area (ha)	%
Gravel or rock	2258	2.31
Indigenous forest (undefined)	96	0.10
Lake or pond	553	0.57
Mānuka scrub/forest	1511	1.55
Permanent snow and ice	7,403	7.59
SC1: Screes and boulderfields	700	0.72
Tall Tussock grassland	5,299	5.43
TI4: *Coprosma*, *Olearia*, matagouri scrub (grey scrub)	7	0.01
VS10: Bracken fernland	1,533	1.57
VS5: Broadleaved species scrub/forest	40	0.04
VS6: Matagouri, *Coprosma propinqua*, kowhai scrub (grey scrub)	176	0.18
WL13: Sphagnum mossfield	10	0.01
WL14: Herbfield (ephemeral wetland)	1	<0.00
WL17: *Schoenus pauciflorus* sedgeland (alpine seepages/flushes)	7	0.01
WL22: Carex, *Schoenus pauciflorus* sedgeland	522	0.54
WL6: Lesser wire rush, tangle fern restiad rushland/fernland	3	<0.00
WL8: Herbfield/mossfield/sedgeland	10	0.01

7. RANKING THE PROPOSED SITES FOR INVASIVE PREDATOR ELIMINATION

The five potential elimination sites were ranked using a matrix that considered the importance of the current and potential biodiversity values, the feasibility of implementing pest control, and the likelihood of eliminating and defending against invasive predators (Table 11).

Four criteria were used to assess the importance of the biodiversity and ecological values: the composition of indigenous vegetation, the presence of bat records, At Risk/ Threatened lizard Hotspots or important bird habitat, the presence of an Important Bird Area, and the presence and extent of DOC Ecosystem Management Units (EMU) and UNESCO World Heritage Sites.

Feasibility was assessed using six criteria: size of the site, community and landowner/manager uptake (e.g. the distance from nearest human centres and of presence walking tracks), practicality of aerial operations (e.g. the distance from potential take-off locations and the furthest perimeter edge), trap set-up costs, annual trap checking costs, and dual aerial operation costs.

The likelihood of successfully eliminating invasive predators from each site was assessed based on two criteria: the presence and extent of existing control efforts within the site and the presence of geophysical barriers that can reduce the risk of reinvasion from surrounding areas. For the purposes of the extent and presence of existing control operations, data from Wildlands (2020a) were used.

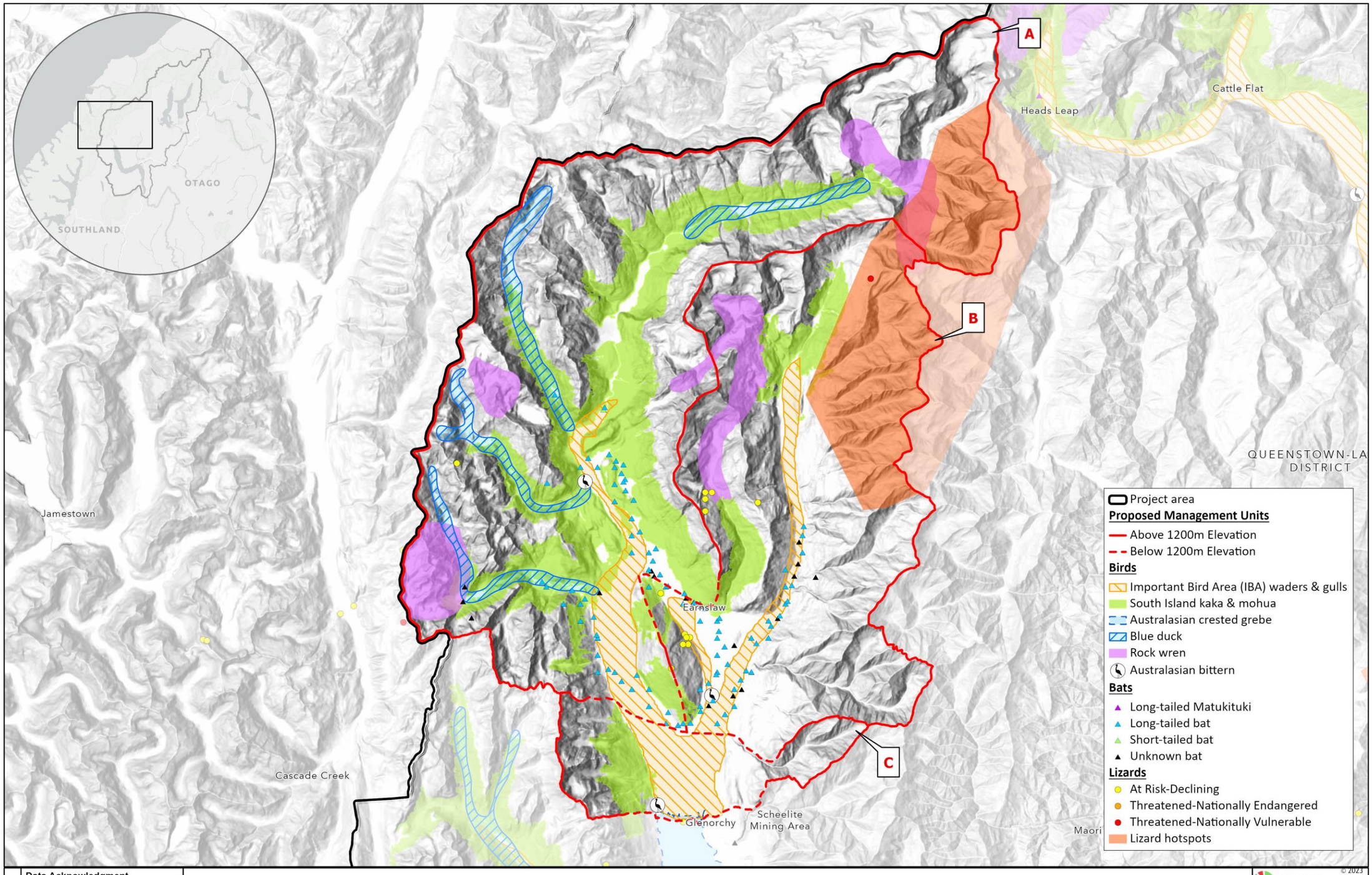

Figure 17. Proposed site 5, Rees and Dart Rivers, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are ecological values associated with fauna.

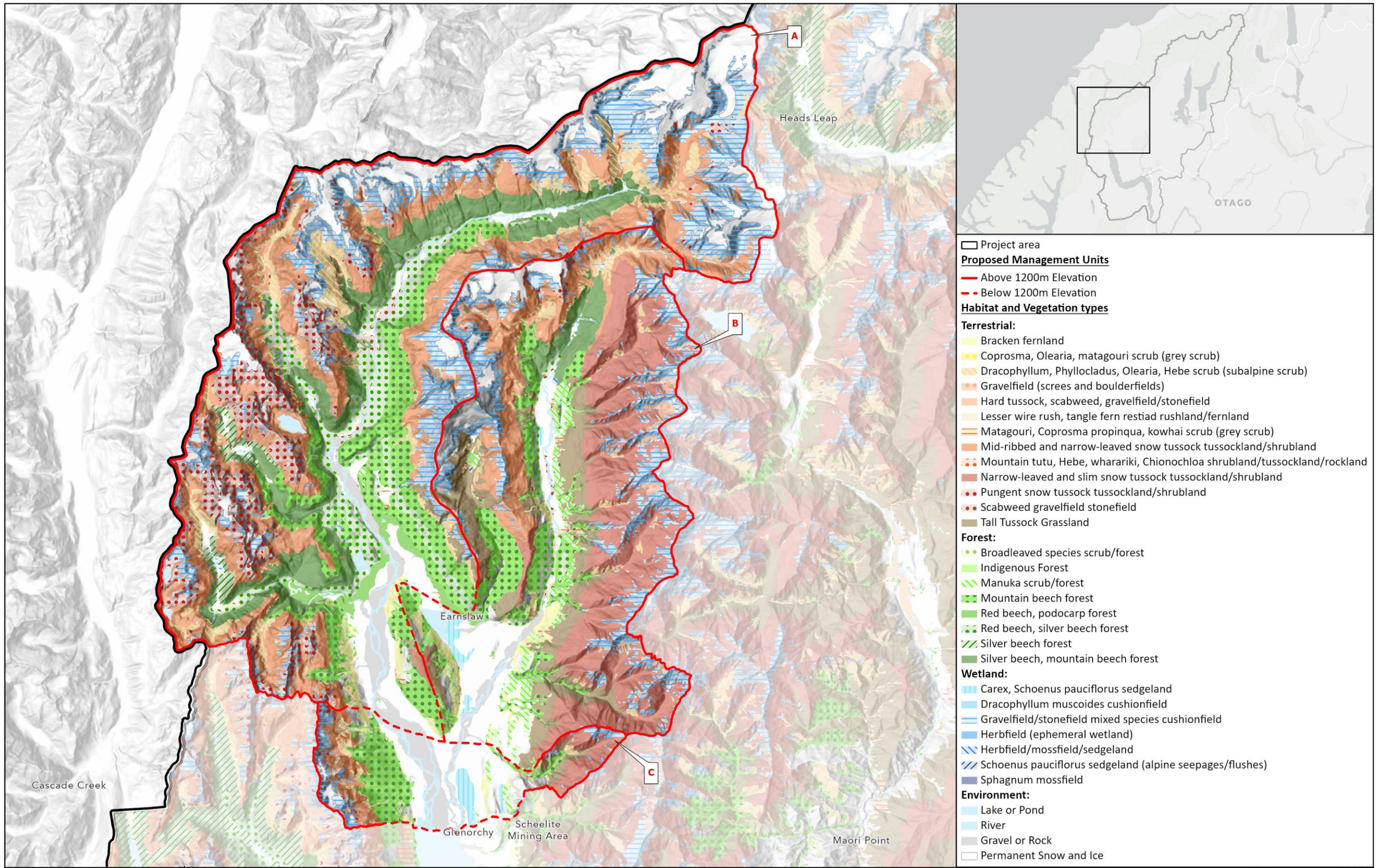

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Figure 18: Proposed site 5, Rees and Dart Rivers, with potential management units for predator elimination options in the Queenstown Lakes District. Shown are mapped habitats.

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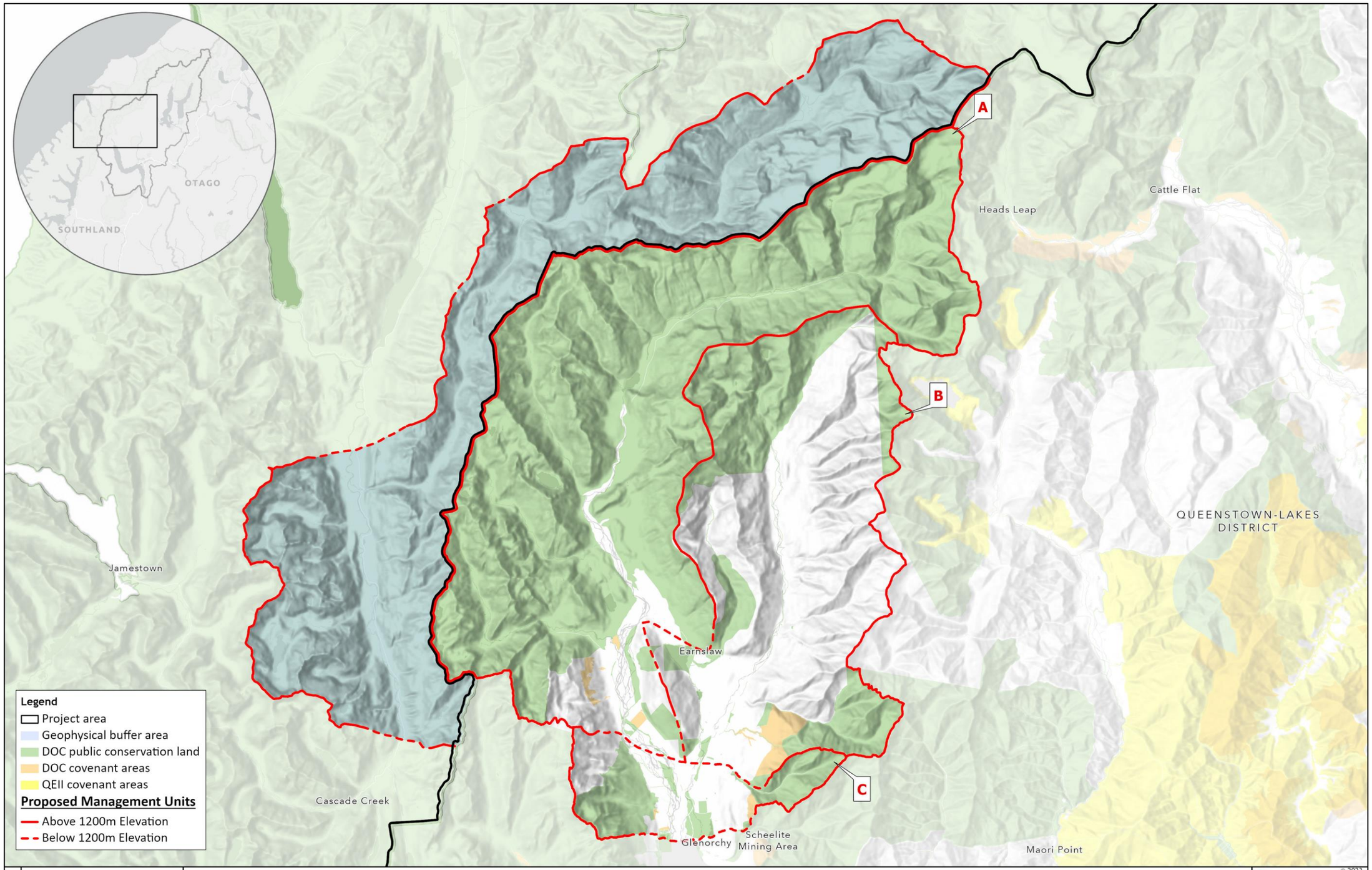

Figure 19. Proposed site 5, Rees and Dart Rivers, with land ownership and covenant details.

We adopted a semi-quantitative approach to rank each proposed site based on the above components and their respective criteria. For each element of each criterion, a value from 0-1 was assigned. This value was then multiplied by a weighting factor to obtain a score, with those deemed of greater importance weighted greater than those considered less so. Scores were then summed to obtain the overall score for each site proposed; sites with greater scores ranked higher than those that scored lower. The components and their criteria are summarised in Table 10, with results from the ranking exercise in Appendix 3 and Table 11.

The potential elimination site that scored highest was the Rees/Dart River system, which scored 70.1 out of a potential 85 points. This system contains a remarkable array of biodiversity and ecological value. The site contains extensive important habitat for several significant bird species, including rock wren, blue duck, kaka, mohua, Australasian bittern and crested grebe. Large portions are identified as IBAs, with the northeastern region identified as a lizard hotspot. The site is also a stronghold for both long-tailed and short-tailed bats.

The site encompasses several large EMUs, including the lower and upper regions as well as the braided river system of the Dart River. Diverse habitats are present, from high alpine environments to lowland wetlands, with large continuous swathes of indigenous forests throughout. Most of the northern and western regions of this site are also recognized under the UNESCO World Heritage Site, Te Wāhipounamu.

With one potential point of increased risk to incursion (<1,200 m.a.s.l.), the area has relatively good defensibility compared to other sites, with most of the perimeter over 1,500 m.a.s.l. Additionally, given this single high-risk section of the perimeter is very close to human centres (Glenorchy and Kinloch), it is highly accessible. Increased monitoring and trapping efforts here will therefore be much easier than at less accessible high-risk sections of other proposed sites. Additionally, the proximity to major human centres, as well as popular walking tracks (e.g., Rees-Dart, Earnslaw Burn and Routeburn tracks), should lend the site to high community uptake.

Given the proposed site is relatively large (*c.*105,000 hectares), initial establishment of a smaller management unit, with expansion to include adjacent units later, is likely to be the best approach. The Dart River system covers an area of approximately 59,000 hectares. While still over twice the minimum area specified, encompassing the complete Dart River and its tributaries makes best use of the surrounding environment as barriers to incursion. Within this smaller management unit, biodiversity and ecological values are still exceptionally high. Extensive important habitat for significant bird species are present, as well as IBAs and a lizard hotspot in the northeastern section. Additionally, areas where significant records of bats have been recorded are also captured. Indigenous forest is extensive, with almost all of the area managed within several EMUs.

Table 10: Components, criteria, data sources and points weightings for the assessment of potential predator elimination areas.

Component	Criteria	Sources of Information	Weighting
Biodiversity and ecological values (35 Points)	Composition of indigenous vegetation	Land Cover Database version 5.0, Mainland New Zealand	10 points
		Previous habitat mapping based on Singers & Rogers (2014)	
	Presence of bat records, At Risk/Threatened lizard	DOC databases	10 points
	Hotspots or important bird habitat	DOC reports	
		eBird	
		iNaturalist	
	Presence of an Important Bird Area (IBA)	Birdlife International	10 points
	Presence and extent of DOC Ecosystem Management Units (EMU) & UNESCO World Heritage Sites	GIS layers	5 points
Feasibility (30 points)	Size of the site	GIS layers	5 points
	Likelihood of community and landowner/manager uptake	Proximity to towns Consultations with SLS on community and landowner/manager attitudes	5 points
		Existing network	
	Practicality of aerial operations (distance from take-off locations and furthest perimeter edge)	GIS layers	5 points
	Trap set-up costs	Costing framework	5 points
	Annual trap checking costs	Costing framework	5 points
	Dual aerial operation costs	Costing framework	5 points
Likelihood of success (20 points)	Connectivity and overlap with existing predator control initiatives	Existing predator control	10 points
		DOC Pesticides Summary interactive map (1080)	
	Presence of geophysical barriers that reduce risk of incursion	Land Cover Database version 5.0, Mainland New Zealand	10 points
		Google Earth Pro	
		Previous habitat mapping based on Singers & Rogers (2014)	

Table 11: Ranking results of the five proposed predator elimination sites. Scores are out of a potential total of 85.

Site	Description	Score
5	Rees and Dart River system	70.1
2	Matukituki River	66.7
1	Makarora River	62.9
4	Greenstone and Caples Rivers	54.3
3	Mount Creighton/Larkins	39.3

Once establishment and successful eradication and defense has been achieved in Dart River catchment, expansion to include the Rees River system would significantly increase the ecological gains in this area. Expansion would capture a large portion of the identified northeastern lizard hotspot, as well as the remainder of the stronghold for short-tailed and long-tailed bats around Earnslaw Station. Further expansion south, extending the perimeter to the northern edge of Lake Wakatipu, would increase the management area by approximately 8,000 hectares, though would decrease the number and extent of areas at increased risk to incursion (<1,200 m.a.s.l.). This would increase the defensibility of the southern boundary.

The Rees/Dart River elimination site shares its perimeter edge with three other proposed sites (2, 3, and 4). Thus, once established, expansion into adjacent sites would provide mutual protection between the adjacent sites and would increase the practicality and feasibility of undertaking elimination/suppression actions in the neighbouring sites.

The Matukituki River site ranked closely behind the Rees/Dart River system, with 66.7 of a possible 85 points. This site displays many similar ecological values as the Rees/Dart site, such as the presence of IBAs and areas of significant value to other bird species and presence of EMUs. The area is also relatively close to Mt. Aspiring and Aspiring Helicopters, which will likely increase public uptake as well as the feasibility and practicality of aerial operations in the area. However, lizard hotspots are absent compared with the Rees/Dart, and only one bat record is present. The Matukituki and the Rees/Dart site share a proposed boundary, lending to expansion from one to incorporate the other once successful eradication of the initial site is achieved.

8. CONCLUSIONS

Five sites in the Queenstown Lakes District were selected and ranked as potential large scale predator elimination sites based on their defendable geography, biodiversity values, practicality of implementation, and relative cost of implementation. The initial ranking showed that the Rees/Dart River system was ranked as the top site, followed by the Matukituki River system.

Subunits have been identified in these areas that are bordered by rugged mountainous areas, fast flowing rivers, and lakes. Helicopter operators in Glenorchy can readily access the Rees/Dart area, and there are operators based near Mt Aspiring National Park, such as Aspiring Helicopters. The two areas also meet most of the ZIP criteria, being high rainfall ecosystems with habitats as potential barriers, and are on public conservation land, meaning land tenure issues are more easily resolved. The two areas also meet the Predator Free 2050 criteria of scale and geophysical attributes, and

biodiversity gain. Alignment with the remaining Predator Free 2050 criteria would need to be fleshed out as part of a detailed operational plan.

Although the top ranked areas have a lot of positive attributes, elimination of predators in these areas will be enormously challenging. Features that lend areas to increased defensibility are also often features that reduce the accessibility for conservation efforts. Dual 1080 operations will lead to a high knock down of predators, creating near zero densities over large parts of the areas, but reinvasion will still occur despite geographic barriers, and incursion response planning will need to be rigorous and comprehensive to capitalise on any gains made.

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HABITAT TYPES
(as per modified Singers & Rogers 2014 classifications)

Modified Singers & Rogers (2014)/LCDBv5 ecosystem (Wildlands 2020b)

Code	Description
AH1	High alpine; Gravelfield, stonefield
AH2	High alpine; *Dracophyllum muscoides* cushionfield
AH3	High alpine; Gravelfield/stonefield with mixed species cushionfield
AL1	Low alpine; Narrow-leaved and slim snow tussockland/shrubland
AL6	Low alpine; Mid-ribbed and narrow-leaved snow tussockland/shrubland
AL7.1	Low alpine; Pungent snow tussockland/shrubland
BR1	Hard tussock, scabweed, gravelfield/stonefield
BR2	Scabweed gravelfield stonefield
CDF1	Cold forest and scrub; Pahautea, Hall's tōtara, mountain celery pine, broadleaf forest
CDF2	Cold forest and scrub; *Dracophyllum*, *Phyllocladus*, *Olearia*, Hebe scrub (subalpine scrub)
CDF3	Cold forest and scrub; Mountain beech forest
CL11	Cool forest and scrub; Mountain tutu, Hebe, whahariki, *Chionochloa* shrubland/tussockland/rockland
CLF10	Cool forest and scrub; Red beech, silver beech forest
CLF11.2	Cool forest and scrub; Silver beech forest
CLF11.3	Cool forest and scrub; Silver beech forest
CLF12	Cool forest and scrub; Silver beech, mountain beech forest
CLF4.2	Cool forest and scrub; Kahikatea, tōtara, matai forest
CLF9	Cool forest and scrub; Red beech, podocarp forest
SC1	Screes and boulderfields
TI1	Cold temperate inversion (frost flats and hollows); Bog pine, mountain celery pine scrub/forest
TI4	Cold temperate inversion (frost flats and hollows), *Coprosma*, *Olearia*, matagouri scrub (grey scrub)
TI6	Cold temperate inversion (frost flats and hollows), Red tussock tussockland
VS10	Fire modified; Bracken fernland
VS11	Fire modified; Short tussock tussockland
VS5	Fire modified; Broadleaved species scrub/forest
VS6	Fire modified; Matagouri, *Coprosma propinqua*, kowhai scrub (grey scrub)
WL13	Wetland; Sphagnum mossfield
WL14	Wetland; Herbfield (ephemeral wetland)
WL17	Wetland; *Schoenus pauciflorus* sedgeland (alpine seepages/flushes)
WL22	Wetland; *Carex*, *Schoenus pauciflorus* sedgeland
WL6	Wetland; Lesser wire rush, tangle fern restiad rushland/fernland
WL8	Herbfield/mossfield/sedgeland
WL9	Wetland; Cushionfield
Not defined	Indigenous Forest
Not defined	Makahikatoa scrub and shrubland
Not defined	Mānuka scrub/forest
Not defined	Tall tussock grassland

COSTINGS FOR TRAP SETUP AND CHECKING FOR PROPOSED PREDATOR ELIMINATION SITE INCURSION POINTS

Costings were based on frameworks supplied by Southern Lakes Sanctuary. * are incursion points of Management Units (MU). Note that, for completeness, costings for MU incursion points are presented below, though total proposed areas and their incursion points are incorporated into the scoring matrices.

Site	Incursion Point Location	Approx. Distance (km)	Type	# Traps	Install Cost per Trap	Total Install	Checking Cost per Trap (1 year)	Total Annual Checking
1	Haast Pass Lookout (high intensity)	6	Remote (heli in, walk out)	60	$322	$19,300	$586	$35,149.80
	Southern boundary	14	Front country	140	$198	$27,691	$201	$28,149.80
*	Entrance to Wilkin	7	Remote (heli in, walk out)	70	$312	$21,850	$531	$37,149.70
*	South of Makarora town	8	Front country	80	$216	$17,280	$239	$19,150.40
2	Mount Aspiring	8	Front country	80	$216	$17,280	$239	$19,150.40
*	Fog Peak	6	Remote (heli in, walk out)	60	$322	$19,300	$586	$35,149.80
3	Lake Wakatipu shore (from 1,200 masl to 2 km along shoreline)	4	Front country	40	$259	$10,340	$329	$13,150.00
	SE Lake Wakatpu (connecting current traps on shore up to 1,200 masl)	8	Front country	80	$216	$17,280	$239	$19,150.40
	South Eastern Incursion, by Moke Lake	2	Remote (heli in, walk out)	25	$415	$10,375	$1,126	$28,150.00
	Eastern boundary	2	Remote (heli in, walk out)	25	$415	$10,375	$1,126	$28,150.00
	North Eastern boundary	3	Remote (heli in, walk out)	30	$388	$11,650	$972	$29,150.10
4	Northern Greenstone saddle	6	Front country	60	$230	$13,800	$269	$16,150.20
	Southern Greenstone Saddle	3.5	Remote (heli in, walk out)	35	$369	$12,925	$861	$30,150.05
	Elfin bay (1,200 masl to 1,200 masl)	12	Walk in and out	120	$202	$24,220	$210	$25,149.60
5	Glenorchy/Wakatipu shoreline (1,200–1,200 masl, linking southern lines)	11	Front country	110	$204	$22,485	$215	$23,650.00
*	Top of C MU line	8	Remote (heli in, walk out)	80	$305	$24,400	$489	$39,150.40
*	Central line separating A and B Mus	9	Remote (heli in and out)	90	$322	$29,000	$621	$55,899.90

COSTINGS FOR DUAL AERIAL OPERATIONS

Costings were based on frameworks supplied by Southern Lakes Sanctuary using the “worst case” scenario of $500 per hectare for the entirety of the proposed sites.

Site	Total Area (ha)	Cost ($mil)
1	82,000	$82
2	49,000	$50
3	26,000	$26
4	35,000	$36
5	105,000	$106

PROPOSED ELIMINATION SITE RANKING MATRICES

Points allocations for the proposed predator elimination areas in the Queenstown Lakes District. Note: connectivity with existing control initiatives is as at 2019 (Wildlands 2020b).

Invasive predator elimination options	**Biodiversity Values**								
	Habitat			Fauna					
	Cover and Diversity	Value	Score	Bat records/lizard hotspot/significant bird habitat	Value	Score	IBA present	Value	Score
Weight			10			10			10
Site									
1	45% Alpine (AH and AL), >30 CLF, ~10% CDF	0.8	8	Yes/no/yes (rock wren, blue duck, kaka and Mohua)	0.8	8	Yes	0.8	8
2	>50% Alpine (AH and AL), primarily in eastern section. Extensive CLF in mid- to western-areas, ~20%	0.7	7	No/yes/yes (rock wren, kaka, mohua and bittern)	0.7	7	Yes	0.8	8
3	>35% Alpine (AH and AL), CDF (~20%) and Tall Tussock Grassland (>20%) dominated	0.6	6	No/yes/no	0.4	4	No	0.0	0
4	>50% Alpine cover (AH and AL), with ~7% CDF and diverse CLF habitats (~19% cover)	0.7	7	Yes/no/yes (blue duck, kaka, mohua)	0.6	6	Yes	0.9	9
5	50% Alpine (AH and AL), with relatively low CLF (~14%) and CDF (~16%) coverage.	0.6	6	Yes/yes/yes (blue duck, rock wren, kaka, mohua, bittern)	1.0	10	Yes	1.0	10

Invasive predator elimination options	**Biodiversity Values continued**		
	Presence of a DOC EMU	Value	Score
Weight			5
Site			
1	Yes, Wilkin Valley (22,000 ha)	0.8	4
2	Yes, West Matukituki (10,000 ha)	0.8	4
3	No	0.0	0
4	No	0.0	0
5	Yes, Lower (33,000 ha), Upper (18,000 ha) and braided riverbed (<1 ha) of Dart River	1.0	5

Invasive predator elimination options	**Feasibility**								
	Size of the area	Value	Score	Likelihood of community uptake (distance from settlements/public tracks)	Value	Score	Distance to nearest take-off location (kms)	Value	Score
Weight			5			5			5
Site									
1	82,000 Ha (Sub-units of 25,000; 44,000 and 13,000 Ha)	0.8	4.0	Encompasses Makarora	1.0	5	32 (Makarora)	0.8	4.0
2	49,000 Ha (Sub-units of 28,000 and 21,000 Ha)	0.8	4.0	~11km from Glendhu Bay, borders Treble Cone Ski Area	0.8	4	36 (Aspiring Heli)	0.8	4.0
3	26,000 Ha	0.9	4.5	Close to Queenstown and Glenorchy, with urban centres enclose	1.0	5	25 (Glenorchy)	0.9	4.5
4	35,000 Ha	0.8	4.0	Close to Kinloch and Glenorchy, encloses parts of Caples track	0.8	4	23 (Glenorchy)	0.9	4.5
5	105,000 Ha (Sub-units of 59,000; 38,000 and 7,700 Ha)	0.7	3.5	Borders Glenorchy, encloses Earnslaw and Routeburn track	1.0	5	52 (Glenorchy)	0.7	3.5

Invasive predator elimination options	**Feasibility continued**[1]								
	Initial trap setup cost	Value	Score	Annual trap checking cost	Value	Score	Dual aerial operation ($mil)	Value	Score
Weight			5			5			5
Site									
1	$46,990	0.4	1.8	$63,299	0.3	1.5	$82	0.3	1.6
2	$17,280	1.0	5.0	$19,150	1.0	5.0	$50	0.5	2.7
3	$60,019	0.3	1.4	$11,7750	0.2	0.8	$26	1.0	5.0
4	$50,944	0.3	1.7	$71,449	0.3	1.3	$36	0.7	3.7
5	$22,485	0.8	3.8	$23,650	0.8	4.0	$106	0.2	1.2

[1] Costings within the scoring matrices are for complete proposed sites without considering separate MU's.

Invasive predator elimination options	**Likelihood of success**					
	Connectivity with existing control initiatives (2019)	Value	Score	Presence of geophysical barriers	Value	Score
Weight			10			10
Site						
1	Extensive DOC and community trapping, with BFOB 1080 operations throughout	0.9	9.0	Majority >1,200 m.a.s.l., two points of increased risk.	0.8	8.0
2	Extensive community trapping, with BFOB 1080 operations throughout	0.7	7.0	Majority >1,200 m.a.s.l., one point of increased risk.	0.9	9.0
3	Limited community trapping by Mount Creighton	0.3	3.0	>50% below 1,200 m.a.s.l., though a large portion is the shore of Lake Wajatipu	0.5	5.0
4	Extensive DOC and community trapping, with BFOB 1080 operations in northern arm	0.6	6.0	Majority >1,200 m.a.s.l., three points of increased risk.	0.7	7.0
5	Extensive DOC and community trapping, with BFOB 1080 operations throughout	0.9	9.0	Majority >1,200 m.a.s.l., one point of increased risk. Can be reduced in size if extended to the edge of Lake Wakatipu	0.9	9.0

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