Macraes Phase 4 Fast-track

Residual Effects Analysis: Terrestrial Ecology

for: OceanaGold (New Zealand) Limited

Job No: 68766
Version: Final
Date of Issue: 3 September 2026

Document Approval and Revision History

Document title	Macraes Phase 4 Fast-track
	Residual Effects Analysis: Terrestrial Ecology
Prepared for	OceanaGold (New Zealand) Limited
Version	Final
Date	3 September 2026
Filename	E13_MP4Fast_Terrestrialrea_Rev0_020926

	Chris Wedding Ecology Manager
	Dylan van Winkel Technical Director – Terrestrial Ecology
	Michael Anderson Senior Ecologist
Reviewer	Matt Baber Alliance Ecology

Rev. no.	Date	Author(s)
Final	3 September 2026	CW, DvW, MA

Reference: Bioresearches (2026). Residual Effects Analysis: Terrestrial Ecology. Report for OceanaGold New Zealand Limited

Cover Illustration: Golden Bar pit, Macraes, Otago.

Disclaimer:

This document has been produced for New Zealand consenting purposes only. Information contained herein must not be relied on for investment purposes.

Table of Contents

List of Tables

List of Figures

List of Appendices

Glossary

Term	Definition
20 m precautionary allowance / buffer	A 20 m area surrounding parts of the direct impact footprint for which total loss of terrestrial ecological values is conservatively assumed for effects accounting. This allowance accounts for potential indirect effects and provides a precautionary basis for determining residual effects management requirements.
Additional conservation benefits	Ecological benefits provided by the residual effects management package that are not relied upon as equivalent replacement for, or to counterbalance, the quantified MP4 residual effects.
Additionality	For biodiversity compensation, gains in indigenous biodiversity that are additional to those that would have occurred without the compensation, including gains additional to minimisation, remediation or offsetting undertaken for the activity.
Avoid	The first step in the effects management hierarchy, requiring adverse effects on indigenous biodiversity to be avoided where practicable.
Averted loss	A conservation benefit achieved by preventing a foreseeable future loss or degradation of biodiversity that would otherwise occur. Within this REA, this principally relates to the removal of plantation forestry at Mt Highlay to prevent future degradation of indigenous lizard habitat.
Benchmark	A reference condition or value against which baseline and predicted post-compensation biodiversity values are assessed in a BOAM.
Biodiversity compensation	Residual effects management that provides additional ecological benefits intended to counterbalance residual adverse effects where strict ecological equivalence, complete quantification, certainty of delivery, or all formal biodiversity offset requirements cannot be demonstrated.
Biodiversity offset	A measurable conservation outcome that meets the requirements of NPS-IB Appendix 3, addresses more than minor residual adverse effects after avoidance, minimisation and remediation have been sequentially applied, and is intended to achieve a net gain in the type, amount and condition of indigenous biodiversity.
Biodiversity Offset Accounting Model	A quantitative decision-support tool used to compare residual biodiversity losses at impact sites with predicted gains from proposed management. The models account for the scale and condition of biodiversity values, timing of gains, implementation risk and uncertainty, and assess biodiversity components and attributes separately.
Counterfactual scenario	The expected biodiversity outcome in the absence of the proposed compensation action, used as the reference scenario when assessing an averted loss benefit.
Durability	The capacity for biodiversity gains arising from residual effects management to be secured for at least as long as the corresponding adverse effects, with appropriate long-term funding, management, monitoring and security. This reflects the NPS-IB principle of long-term outcomes.
Ecological equivalence (like-for-like)	The degree of similarity between biodiversity values affected and those provided through residual effects management, considering biodiversity type, amount, condition, equivalence over time and spatial context. The NPS-IB uses the term “like-for-like” for this concept.
Ecological value	The ecological importance or value of a species, community, habitat, site or area. For terrestrial sites, ecological value reflects the species, communities and habitats

	present and incorporates both quantity, such as rarity or extent, and quality, such as functionality or condition.
Effects management hierarchy	The sequential approach to managing adverse effects on indigenous biodiversity: avoid where practicable; minimise effects that cannot be avoided; remedy effects that cannot be minimised; provide biodiversity offsetting for more than minor residual effects where possible; provide biodiversity compensation where offsetting is not possible; and avoid the activity if compensation is not appropriate.
Finite endpoint	The defined future point at which the biodiversity outcome of a BOAM is assessed, and losses and predicted gains are compared.
Irreplaceability	The uniqueness and replaceability of an affected biodiversity value and the extent to which it contributes to the overall conservation value of a network of areas. Within the REA it is used to consider the extent to which an affected value can realistically be recreated or secured elsewhere. The NPS-IB definition also recognises interactions with vulnerability, complexity and rarity.
Level of effect	The overall seriousness of an ecological effect, determined by combining the magnitude of the effect with the ecological value of the affected biodiversity or ecological feature.
Magnitude of effect	A measure of the extent or scale of an ecological impact and the degree of change it will cause.
Minimise	The second step in the effects management hierarchy. Where an adverse effect cannot practicably be avoided, it is minimised where practicable.
Net gain	For biodiversity offsetting under the NPS-IB, an outcome demonstrated through a like-for-like quantitative loss-gain calculation where biodiversity values at the offset site are equivalent to or exceed those lost at the impact site, considering biodiversity type, amount and condition. This should be distinguished from the REA-specific "Net Positive" outcome categories below.
Net Loss	An outcome where the available evidence indicates that the proposed compensation actions will not fully counterbalance the corresponding residual adverse effects. The remaining net loss is assigned a level of Very Low, Low, Moderate, High or Very High.
Net Positive (modelled)	An outcome where quantitative biodiversity modelling predicts that gains will exceed the corresponding residual losses after accounting for relevant factors such as time lags, implementation risk, confidence and discounting.
Net Positive (unmodelled)	An outcome where the type, scale, location and expected effectiveness of the proposed conservation actions indicate that biodiversity gains are likely to outweigh the corresponding residual losses, based on professional ecological judgement and available evidence rather than a quantitative biodiversity model.
Remedy	The third step in the effects management hierarchy. Where adverse effects cannot practicably be minimised, they are remedied where practicable before residual effects management is considered.
Residual adverse effects	Adverse ecological effects remaining after measures to avoid, minimise and remedy effects have been applied.
Residual effects management package	The integrated package of conservation actions proposed to address residual terrestrial effects, including habitat protection, revegetation and enrichment planting, stock exclusion, pest plant management, mammalian pest and predator

	control, plantation removal, legal protection, monitoring and adaptive management.
Time horizon	The period over which the biodiversity outcome of a proposed management action is assessed or calculated.
Uncertain	An outcome where the proposed actions are expected to counterbalance losses, but the available information is insufficient to determine whether the resulting benefits will exceed, equal or fall short of the corresponding residual adverse effects.
Vulnerability	The susceptibility of an ecosystem, habitat or species to loss, degradation or other harmful change. The NPS-IB describes vulnerability in terms of the degree of threat faced and the extent to which biodiversity is susceptible to, or able to adapt to, harmful impacts or change.

List of Abbreviations and Acronyms

Abbreviation / acronym	Full term
BOAM	Biodiversity Offset Accounting Model
BRWRS	Back Road Waste Rock Stack
DCC	Dunedin City Council
DOC	Department of Conservation
DVT	Direct Vegetation Transfer
EcIA	Ecological Impact Assessment
ETS	New Zealand Emissions Trading Scheme
FTAA	Fast-track Approvals Act 2024
GPUG	Golden Point Underground
MEEA	Murphy Ecological Enhancement Area
MP4	Macraes Phase Four Project
MTI	Mixed Tailings Impoundment
MWMS	Mine Water Management System
NPBV	Net Present Biodiversity Value
NPS-IB	National Policy Statement for Indigenous Biodiversity 2023
OGNZL	OceanaGold (New Zealand) Limited
ORC	Otago Regional Council
ORPS	Otago Regional Policy Statement 2021
REA	Residual Effects Analysis
RMA	Resource Management Act 1991
SGS	Southern grass skink
SIPO	South Island pied oystercatcher
SNA	Significant Natural Area
TAR	Threatened and At Risk
TSF	Tailings Storage Facility
WA	Wildlife Act 1953
WDC	Waitaki District Council
WRS	Waste Rock Stack

1 Executive summary

1.1 Purpose and scope

This Terrestrial Residual Effects Analysis Report assesses whether the conservation actions proposed for the Macraes Phase 4 Project (MP4 or the Project) are adequate to address residual adverse effects on terrestrial indigenous biodiversity after measures to avoid, minimise and remedy adverse effects have been applied.

The assessment focuses principally on ecological values for which the Ecological Impact Assessment (EcIA) identified a Moderate or higher residual level of effect. These effects are treated as more than minor and require further management under the effects management hierarchy. The report also identifies benefits for affected values with Low or Very Low residual effects and additional conservation benefits for ecological values that are not directly affected by MP4. Residual effects on natural inland wetlands are assessed separately in the Wetland Residual Effects Analysis Report.

The assessment has regard to the biodiversity compensation principles in Appendix 4 of the National Policy Statement for Indigenous Biodiversity 2023 (NPS-IB). Biodiversity Offset Accounting Models (BOAMs) have been applied as quantitative decision-support tools for indigenous vegetation, McCann's skink, southern grass skink, kārearea / eastern falcon, banded dotterel / pohowera and South Island pied oystercatcher / tōrea. The models compare quantified losses with predicted conservation gains at defined assessment endpoints and apply adjustments for time lags, risk and uncertainty.

The proposed residual effects management package is characterised as biodiversity compensation rather than a formal biodiversity offset. Although the package has been designed to provide benefits that are as closely related as practicable to the affected ecological values, full equivalence, complete quantification and certainty of delivery cannot be demonstrated for all values. Positive BOAM results are therefore described as net positive outcomes rather than definitive predictions of 'like for like' net gain under the NPS-IB offsetting principles.

1.2 Residual adverse effects

MP4 will result in the permanent loss and modification of terrestrial vegetation and fauna habitat. The assessed indigenous habitat effects comprise approximately 90.01 ha of narrow-leaved snow tussock (hereafter snow tussock), 3.06 ha of dry shrubland and 0.26 ha of schist rock habitat when the 20 m precautionary allowance for potential indirect effects is included. The corresponding direct losses are approximately 75.42 ha, 2.22 ha and 0.16 ha, respectively.

The affected terrestrial habitats support Threatened, At Risk, Data Deficient and locally uncommon plants, indigenous terrestrial invertebrates, three indigenous lizard species and a range of indigenous birds. The affected avifauna habitat areas used in the BOAMs are 235.99 ha for kārearea and 130.38 ha each for banded dotterel and South Island pied oystercatcher.

Following avoidance, minimisation and remediation, the principal residual effects requiring further management comprise:

- a Very High residual effect on indigenous snow tussock;
- a Moderate residual effect on schist rock habitat;
- High or Moderate residual effects on the terrestrial invertebrate assemblage and several notable invertebrate taxa;
- a Moderate residual effect on McCann’s skink and Very High residual effects on southern grass skink and kōrero gecko;
- Moderate residual effects on kārearea, banded dotterel and South Island pied oystercatcher; and
- species-specific effects on TAR plants, including a subset for which successful salvage, propagation, transfer or long-term establishment cannot be predicted with high confidence.

Dry shrubland has a Low residual level of effect under the current EcIA assessment. It is nevertheless included in the residual effects management package because shrubland restoration and protection can be delivered alongside measures addressing higher residual effects and will contribute to habitat continuity, indigenous diversity and landscape-scale ecological function.

1.3 Residual effects management package

The objective of the terrestrial biodiversity compensation package is to provide additional and enduring ecological benefits that, at the package level, are expected to outweigh the residual terrestrial effects of MP4. The package combines revegetation, protection and enhancement of existing habitat, stock exclusion, weed management, predator exclusion and suppression, improved ecological connectivity, legal protection and averted habitat loss.

The proposed actions are concentrated within OceanaGold New Zealand Limited landholdings in the Macraes Ecological District. This enables the actions to protect existing indigenous biodiversity, expand and reconnect fragmented habitats, and support the recovery of indigenous plant and fauna communities within the same ecological district as the affected values.

Table 1-1. Summary of the proposed terrestrial residual effects management package

Management area	Principal actions
Murphy Ecological Enhancement Area and Murphys Link	Establish a 252 ha predator-exclusion fenced area; undertake landscape-scale mammalian pest control across an approximately 1,170 ha surrounding buffer; protect and enhance approximately 336.22 ha of existing snow tussock, 40.88 ha of dry shrubland and 26.9 ha of rock habitat; and establish an approximately 395.54 ha legally protected connection between the MEEA predator-exclusion fence and Redbank Covenant.
Cranky Jims Link	Establish approximately 50.59 ha of dry shrubland planting; protect and enhance approximately 6.6 ha of existing dry shrubland and 0.6 ha of rock habitat; connect Cranky Jims Shrubland Covenant with Island Block Covenant; and progressively enrich the restored shrubland with indigenous broadleaved and podocarp species.
Mt Highlay Station	Remove approximately 265 ha of recently established plantation forestry to avert future degradation of indigenous lizard habitat; establish approximately 175.65 ha of snow tussock planting, including approximately 15 ha of specialised tor-edge flora planting using rock-associated and TAR plant species; and protect and enhance approximately 18.7 ha of existing tussock, 0.7 ha of dry shrubland and 4.1 ha of rock habitat.

The areas of tussock, shrubland and rock habitat protected within MEEA, its surrounding buffer and the Murphys Link form components of the wider spatial package. They are not separate areas that can be added together to calculate a total management area. Vegetation direct transfer and other measures undertaken within the Project Footprint as avoidance, minimisation or remediation are also not counted again as compensation.

The package addresses the affected values through complementary ecological mechanisms. Revegetation is intended to increase habitat extent, indigenous cover and species diversity over the longer term. Protection and enhancement of existing habitat provide earlier ecological benefits and reduce the effects of the time required for planted vegetation to establish and mature. Predator exclusion and suppression are intended to increase lizard abundance and avifauna breeding success. Removal of the Mt Highlay plantation is intended to prevent the future loss of indigenous lizard habitat that would otherwise occur as the plantation canopy develops.

1.4 Predicted ecological outcomes

Predicted outcomes are described using four categories:

- **Net Positive (modelled)**: Quantitative biodiversity models predict that gains will exceed the corresponding residual losses after accounting for relevant factors such as time lags, implementation risk, confidence and discounting. This category has the strongest evidential basis because the predicted outcome is supported by quantitative analysis, although it remains biodiversity compensation where strict like-for-like equivalence or all formal offset requirements have not been demonstrated.

- **Net Positive (unmodelled)**: The type, scale, location and expected effectiveness of the proposed conservation actions indicate that the resulting biodiversity gains are likely to outweigh the corresponding residual losses.
- **Uncertain**: The proposed actions are expected to counter-balanced the losses, but the available information does not provide an adequate basis for determining whether those benefits will exceed, equal or fall short of the corresponding residual adverse effects.
- **Net Loss**: The available evidence indicates that the proposed compensation actions will not fully counterbalance the corresponding residual adverse effects. A residual net loss is therefore predicted after the expected benefits of the compensation actions have been considered. The remaining effect is assigned a level of Very Low, Low, Moderate, High or Very High, with the basis for that conclusion and any relevant uncertainty clearly identified.

Outcomes are assigned separately to each affected biodiversity component so that positive results for one value do not obscure a deficit or uncertain outcome for another (Table 1-2).

Table 1-2. Predicted outcomes for ecological values with residual adverse effects

Biodiversity value	Impact quantum and residual effect	Compensation Actions	Predicted Residual Outcome
Narrow-leaved snow tussock	Up to 90.01 ha loss or degraded. Residual effect: **Very High**.	**175 ha** of tussock planting at Mt Highlay; **336.22 ha** tussock at MEEA fenced, pest-controlled and **18.66 ha** tussock at Mt Highlay; fenced, pest-controlled	**Net Positive (modelled)** for restoration planting only. Additional stock fencing, protection and predator control is more than 5.5 times the extent lost.
Dry shrubland	Up to 3.06 ha loss or degraded. Residual effect: **Low**.	**50 ha** of dry shrubland planting at Cranky Jims Link; Fence, protect and pest control: **40.88 ha** shrubland at MEEA **6.58 ha** at Cranky Jims Link; **0.74 ha** at Mt Highlay;	**Net Positive (modelled)** for restoration planting only. Additional stock fencing, protection and predator control is nearly 29 times the extent lost.
Rock outcrops and tors	Approximately 0.16 ha of direct loss and 0.26 ha when the 20 m buffer is included. Residual effect: **Moderate**.	**15 ha** rock edge planting at Mt. Highlay; Fence, protect and pest control: **31.54** ha rock and tor habitat at MEEA, Cranky Jims & Mt Highlay combined	**Net Positive (unmodelled)** Targeted planting around approximately 15 ha of existing rock outcrops, about 58 times the area lost Pest management and long-term protection of existing rock habitat is more than 170 times the affected extent.
29 TAR Plant species	Species-specific: 20 species assessed as likely to experience moderate or higher residual effects: 7 spp. – Very High 5 spp. – High 8 spp. – Moderate 4 spp. – Low 4 spp. – Very Low 1 spp. – Negligible b	Propagation and restoration for some species in compensation planting schedules for tussock, rock edge, dry shrubland and wetlands. Salvage and propagation for all TAR flora, ex-situ management for 6 TAR plant species with Very High residual effects.	Species-specific: 16 species assessed as likely to experience moderate or higher residual effects: 5 – Very High 4 – High 7 – Moderate 5 – Low 5 – Very Low 3 spp. – Net positive (unmodelled)
Terrestrial invertebrates	Approximately 325 ha of potentially suitable habitat is affected within the footprint and precautionary buffer. Residual effect: **High** for the project-wide assemblage and several notable	Snow tussock and dry shrubland planting; protection of existing vegetation and rock habitat; establishment of identified host plants; pest plant management, stock exclusion and improved habitat continuity.	**Net Positive (unmodelled)** for several notable taxa and **Uncertain** for the remainder.

Biodiversity value	Impact quantum and residual effect	Compensation Actions	Predicted Residual Outcome
	taxa, with **Moderate** or lower effects for other taxa.		The package is expected to increase host-plant availability, indigenous vegetation cover, litter and structural complexity. No quantitative invertebrate BOAM conducted.
Indigenous lizards	Approximately 238.7 ha of suitable habitat is affected, with an estimated 155,564 lizards potentially present. Residual effect: **Moderate** for McCann's skink and **Very High** for southern grass skink and kōrero gecko.	A 252 ha predator-exclusion fence; approximately 1,170 ha additional predator-control buffer; the 395.54 ha Murphys Linkand lizard release area; protection of existing tussock, dry shrubland and rock habitat; removal of approximately 265 ha of plantation forestry at Mt Highlay; and habitat restoration.	**Net Positive (modelled & unmodelled)** The BOAM predicts positive outcomes for the two modelled skinks. However, southern grass skink retains a modelled deficit in snow tussock habitat, with the proposed fence estimated to address approximately 20% of that component. Kōrero gecko has not been quantitatively modelled but for both kōrero gecko and the southern grass skink deficit, unmodelled positive outcomes are predicted.
Kārearea / eastern falcon	Approximately 235.99 ha of suitable habitat affected. Residual effect: Moderate.	Predator exclusion and landscape-scale predator control across MEEA and its buffer; protection and restoration of open-country, tussock, dry shrubland and rock-associated habitat.	**Net Positive (modelled)** The BOAM predicts a positive outcome for kārearea.
Banded dotterel / pohowera	Approximately 130.38 ha of suitable habitat affected. Residual effect: Moderate.	Landscape-scale predator control over open and lightly vegetated habitat within the MEEA package.	**Net Positive (modelled)** The BOAM predicts a positive outcome for banded dotterel.
South Island pied oystercatcher / tōrea	Approximately 130.38 ha of suitable habitat affected. Residual effect: Moderate.	Landscape-scale predator control over open-country habitat within the MEEA package.	**Net Positive (modelled)** The BOAM predicts a positive outcome for SIPO.
Otago skink, grand skink and podocarp-broadleaved forest values	These values are not identified as directly affected residual-effect components of MP4.	Predator exclusion at MEEA, Murphys Link, habitat protection and podocarp-broadleaved enrichment at Cranky Jims Link.	**Net Positive (unmodelled)** Potentially important additional conservation benefits at the species, ecosystem and landscape scales.

1.4.1 Additional conservation outcomes

The package will provide additional conservation benefits that are not relied upon as equivalent replacement for the quantified MP4 residual effects. These include:

- protection and predator exclusion for a threatened Otago skink population within MEEA;
- improved protection and landscape connectivity for threatened grand skink habitat through the MEEA and Murphys Link;
- enrichment planting at Cranky Jims Link to initiate succession towards highly depleted podocarp-broadleaved forest; and
- improved connectivity and buffering between MEEA, Redbank, Cranky Jims and Island Block protected areas.

These outcomes add to the ecological merit of the package but do not substitute for measures required to address the affected snow tussock, rock habitat, TAR plants, invertebrates, lizards and avifauna.

1.5 Monitoring, adaptive management and security

The predicted outcomes depend on the proposed actions being implemented at the stated scale, legally and financially secured, maintained for an appropriate duration, and achieving the assumed ecological responses.

Monitoring will assess both implementation and ecological outcomes for vegetation, lizards, avifauna and pest management. It will include early establishment monitoring, longer-term outcome monitoring, measurable performance targets, reporting requirements and adaptive management triggers.
Where monitoring identifies that an action or ecological outcome is not progressing as expected, management responses may include infill or replacement planting, revised planting methods or species mixes, additional weed or browser control, changes to predator management, further habitat enhancement or other contingency actions appropriate to the identified shortfall.

Completion of fencing, planting, predator control or other management actions will not, by itself, demonstrate that the residual effects management package has succeeded. Success will require the intended ecological outcomes to be achieved and maintained for a duration appropriate to the long-term or permanent residual effects.

1.6 Overall conclusion

The proposed terrestrial biodiversity compensation package provides a coordinated, landscape-scale response to the residual terrestrial ecological effects of MP4 within the Macraes Ecological District. The package combines revegetation, protection and enhancement of existing indigenous habitats, stock exclusion, pest plant and browser control, mammalian predator management, improved ecological connectivity, and the avoidance of further habitat degradation. Collectively, these actions are expected to increase the extent and condition of indigenous snow tussock and dry shrubland, improve the quality and security of retained rock, snow tussock and shrubland habitats, reduce predation pressure on indigenous fauna, and strengthen ecological linkages between existing protected areas. The package will also provide additional conservation benefits for taoka species, Otago skink, grand skink and depleted indigenous forest components.

The BOAM analyses predict modelled positive compensation balances for indigenous snow tussock, dry shrubland, McCann's skink, kārearea, banded dotterel and South Island pied oystercatcher. Positive compensation outcomes are also expected for several affected values with lower residual effects. These modelled and predicted outcomes indicate that the package is likely to generate substantial and enduring biodiversity gains, provided that the proposed actions are implemented at the stated scale and achieve the assumed ecological responses.

A positive outcome has not, however, been demonstrated for every affected biodiversity value. A residual shortfall remains for southern grass skink, while the outcomes for kōrero gecko, schist rock habitat, terrestrial invertebrates and some TAR plant species remain uncertain. These value-specific limitations cannot be displaced by positive results for other biodiversity components or by a positive aggregate model output. They must remain explicit in the assessment of residual risk and in the design of monitoring, contingency and adaptive management measures.

The package is therefore appropriately characterised as biodiversity compensation rather than as a formal biodiversity offset. Although the proposed actions have been designed to provide benefits that are as closely related as practicable to the affected values, ecological equivalence, complete quantification and sufficient certainty cannot be demonstrated for all biodiversity components. The BOAM outputs should accordingly be interpreted as decision-support information that assists with evaluating the scale and likely performance of the compensation package, rather than as proof that no net loss or a formal biodiversity offset has been achieved.

Subject to the identified uncertainties, the current evidence supports the conclusion that the type, scale, location and expected effectiveness of the proposed actions are likely to result in positive biodiversity effects that outweigh the residual terrestrial adverse effects of MP4 at the overall package level. This conclusion depends on the final management areas and actions being confirmed, the compensation measures being additional and enduring, appropriate legal and financial security being established, and implementation occurring within the specified timeframes.

The adequacy of the package will ultimately depend on ecological outcomes rather than the completion of management activities alone. Monitoring must therefore assess both package-level performance and the outcomes for individual biodiversity components. Where monitoring identifies that predicted gains are not being achieved, or that a value-specific shortfall is greater than anticipated, timely corrective action will be required. The compensation package should only be regarded as successful where the intended ecological outcomes have been achieved and maintained for a duration commensurate with the permanent and long-term residual effects of MP4.

2 Introduction

OceanaGold (New Zealand) Limited ("**OGNZL**") currently undertakes open pit and underground gold mining operations at the Macraes Operation located at Golden Point Road, Macraes Flat, East Otago. As part of their ongoing operations, OGNZL continually review the remaining life of the Macraes Operation in light of updated knowledge of the gold resource and the economics of mining.

Reflecting recent exploration success and optimisation work, together with higher gold prices, the Macraes Phase Four Project ("**MP4**" or "**the Project**") seeks to extend the life of mining at the Macraes Operation until at least 2039. The Project, which will enable ongoing gold production at a rate of approximately 130,000 ounces per annum, is identified as a Listed Project in Schedule 2 of the Fast-track Approvals Act 2024 ("**FTAA**") as a project providing significant national or regional benefits.

To support the development of the substantive application for the Project, OGNZL has engaged Bioresearches to provide this Terrestrial Residual Effects Analysis Report and, to the extent required, identify any necessary management and operation measures to address any such effects.

2.1 Site Location and Description

OGNZL owns and operates the Macraes Operation at Macraes, approximately 30 km northwest of Palmerston in the Otago Region. The Macraes Operation is the largest gold mine in New Zealand and, since commissioning in 1990, has produced more than 6 million ounces of gold.

Macraes Flat is situated on an elevated plateau at approximately 500 m above sea level. The plateau is flanked by the Taieri Ridge to the northwest, Shag Valley and Horse Range to the east, and the coastal hills and extinct volcanic cones of Palmerston and Waikouaiti to the southeast. Macraes Road provides access to Macraes Flat and the Macraes Operation, connecting to State Highway 85 to the east and State Highway 87 (SH87, the Middlemarch–Hyde Road) to the west.

The environment within and surrounding the Macraes Operation has been shaped by historic and current mining activities. Figure 2.1 shows the arrangement of the major mine features at the Macraes Operation. In summary, the current components of the Macraes Operation include:

- Numerous open pits (both operational and non-operational);
- Two underground mines (Frasers, now closed, and Golden Point, which is actively mined);
- Waste rock stacks at various stages of operation and rehabilitation;
- A network of haul roads and general mine service tracks;
- A Processing Plant;
- Five tailings storage facilities (three inactive, one active but nearing capacity, and one under construction and currently receiving tailings);
- An extensive network of water management infrastructure, including diversion drains, silt ponds, sumps, pit lakes, and freshwater storage reservoirs;
- Two consented but not yet constructed water storage reservoirs (Camp Creek Dam and Coal Creek Dam); and
- Associated infrastructure supporting ongoing operations, including district roads, powerlines, workshops, offices, and associated water and amenity facilities.

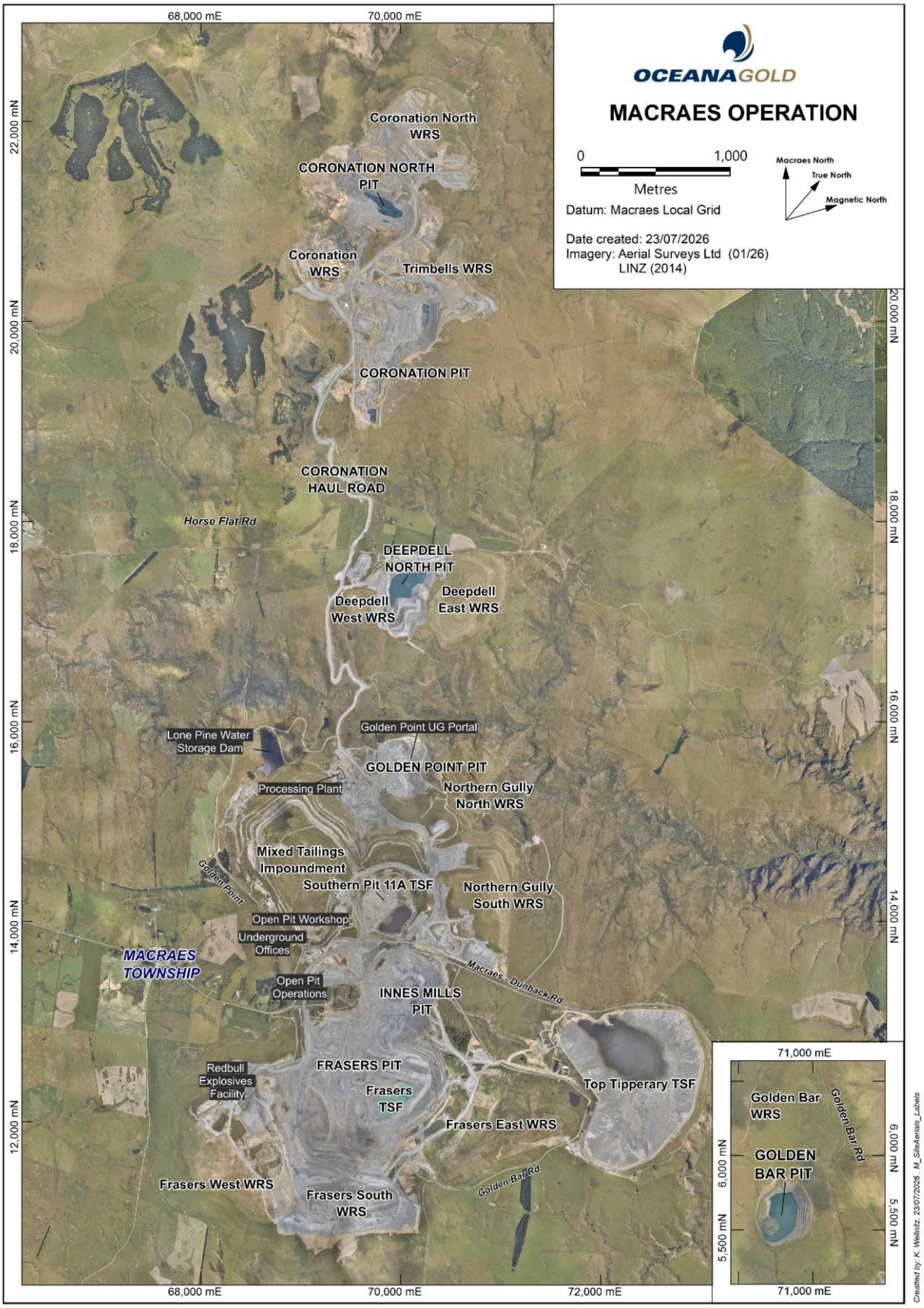


Figure 2.1. Existing site layout at the Macraes Operation (as of July 2026)

2.2 Project Overview

The Project is made up of the following proposed key activities:

- **Open pit extensions** at Coronation, Coronation North, Innes Mills, and Golden Bar.
- **Underground mine expansion** through further development of the Golden Point Underground mine (“**GPUG**”).
- **Tailings management**, including:
    - Construction of the Frasers Tailings Storage Facility (“**FTSF**”) Stage 3 to accommodate a total tailings storage of up to 153 Mt; and
    - Hydraulic mining and relocation of tailings from the Mixed Tailings Impoundment (“**MTI**”), Southern Pit Option 10 TSF (“**SP10**”), and Southern Pit Option 11A TSF (“**SP11**”) to FTSF.
- **Waste rock disposal**, including increased storage capacity within open pits and at existing waste rock stacks at Coronation, Coronation North, Innes Mills, Golden Bar, Golden Point, and Frasers.
- **Water management infrastructure and operations**, including:
    - Construction of Camp Creek and Coal Creek water storage dams for flow and water quality management;
    - Construction, operation and maintenance of a Water Treatment Plant; and
    - Ongoing operation and maintenance of the Mine Water Management System (“**MWMS**”).
- **Infrastructure and roading works**, including:
    - Realignment of Macraes Road in two stages; and
    - Relocation of the Open Pit Mining Workshop.
- **Ecological enhancements**, including establishment of:
    - Murphys Ecological Enhancement Area (“**MEEA**”) near Murphys Creek, including predator fencing, access tracks, and site facilities;
    - Mt Highlay restoration area;
    - Cranky Jims Link shrubland enhancement area;
    - Murphys Link tussock protection area; and
    - Additional compensation measures for residual ecological impacts.
- **Mine closure and rehabilitation activities**, including rehabilitation of mining landforms, creation of pit lakes, dry capping of tailings storage facilities, and revegetation in accordance with closure objectives.

An overview of the proposed activities which make up the Project is shown in Figure 2.2 and Figure 2.3 below.

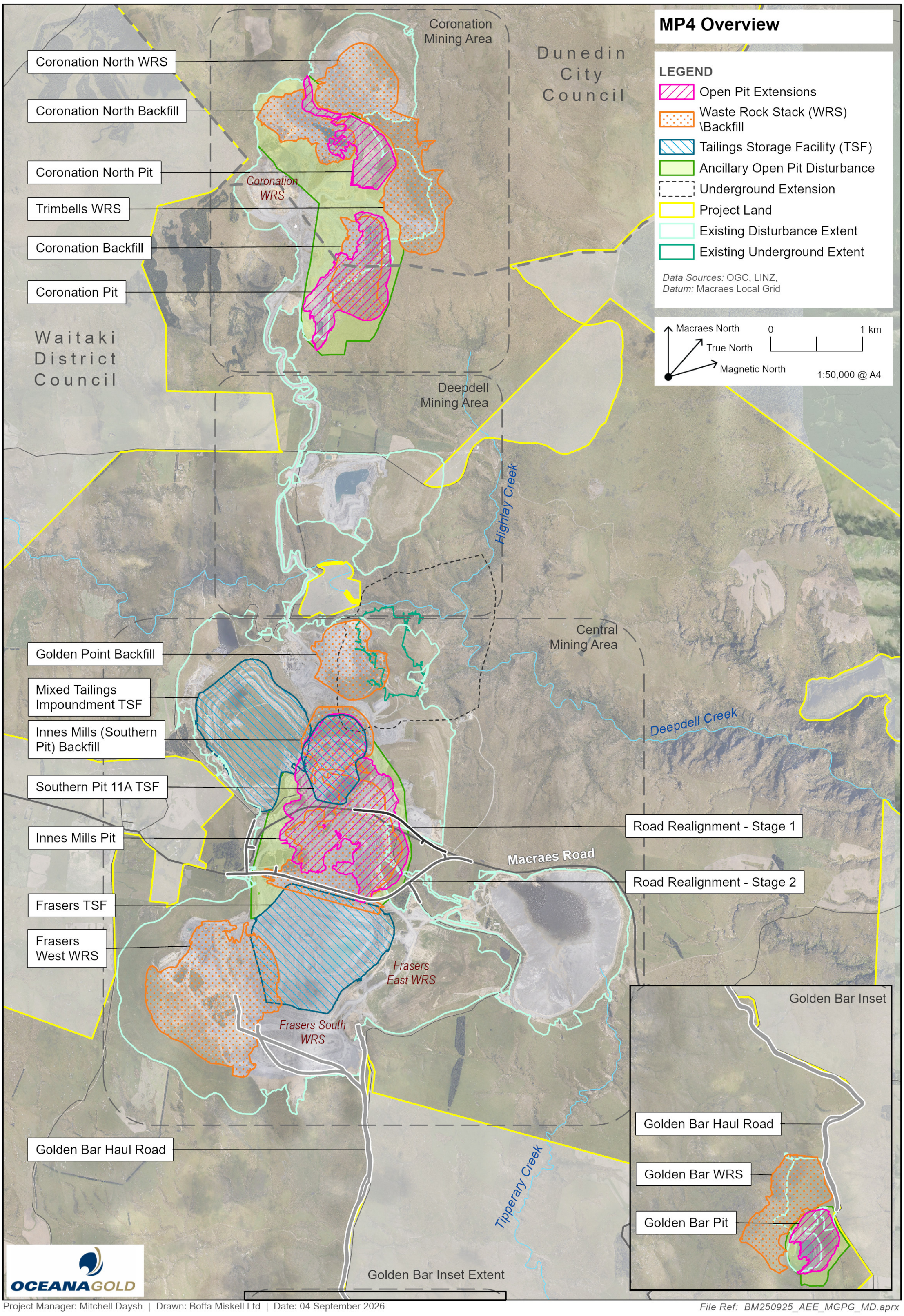
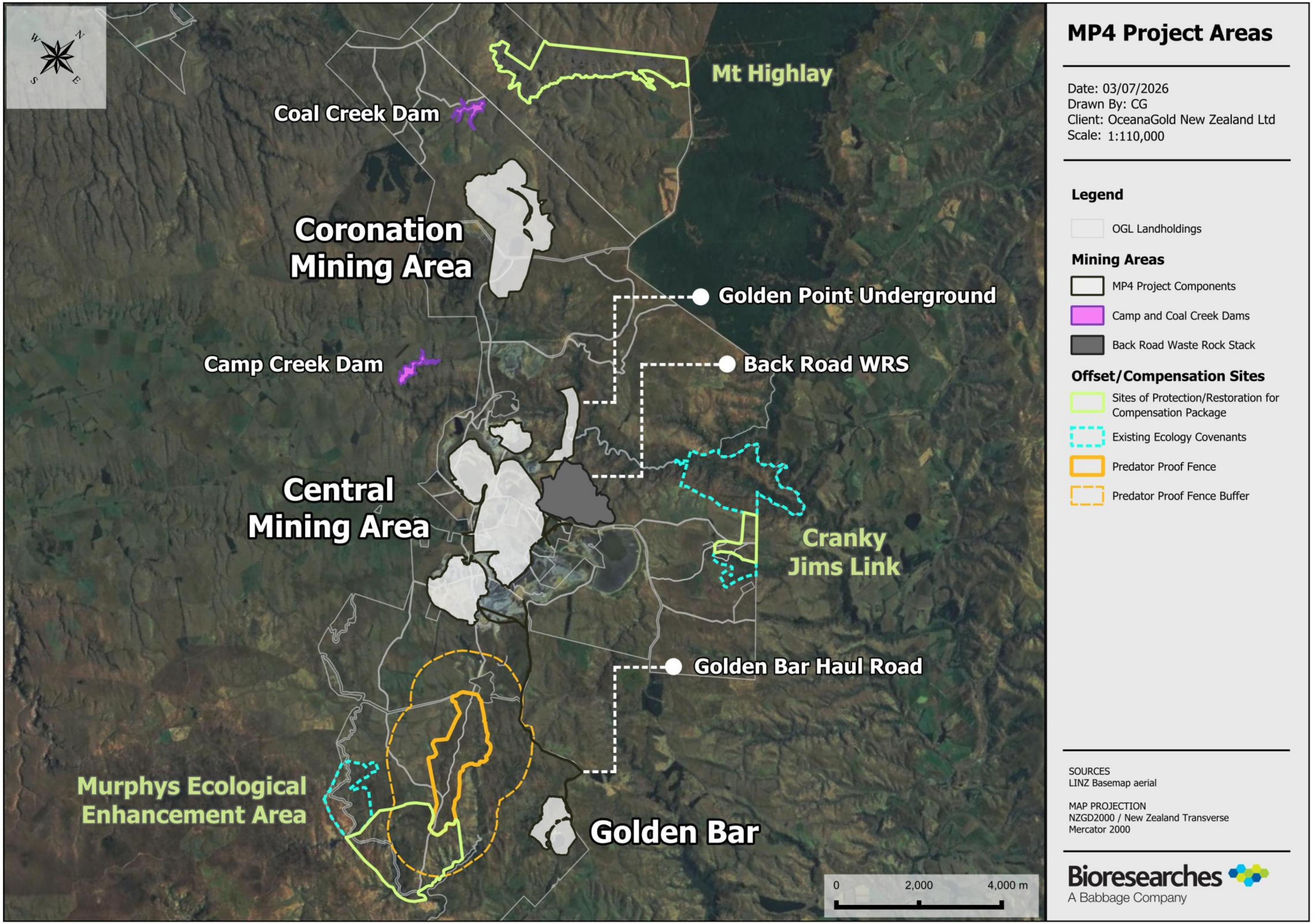


Figure 2.2. MP4 Overview Plan

Figure 2.3. (following page): Overview of Macraes MP4 areas



Mt Highlay
Coal Creek Dam
Coronation Mining Area
Golden Point Underground
Camp Creek Dam
Back Road WRS
Central Mining Area
Cranky Jims Link
Golden Bar Haul Road
Murphys Ecological Enhancement Area
Golden Bar
0
2,000
4,000 m
MP4 Project Areas
Date: 03/07/2026
Drawn By: CG
Client: OceanaGold New Zealand Ltd
Scale: 1:110,000
Legend
OGL Landholdings
Mining Areas
MP4 Project Components
Camp and Coal Creek Dams
Back Road Waste Rock Stack
Offset/Compensation Sites
Sites of Protection/Restoration for Compensation Package
Existing Ecology Covenants
Predator Proof Fence
Predator Proof Fence Buffer
SOURCES
LINZ Basemap aerial
MAP PROJECTION
NZGD2000 / New Zealand Transverse Mercator 2000
Bioresearches
A Babbage Company

2.3 Sequencing of Activities and Proposed Work Dates

The project is not being progressed in stages. Rather, all activities that comprise the MP4 project are included in this substantive application. Those activities are anticipated to occur across a period of 13 years, with OGNZL proposing to commence the MP4 project as soon as the necessary approvals are obtained.

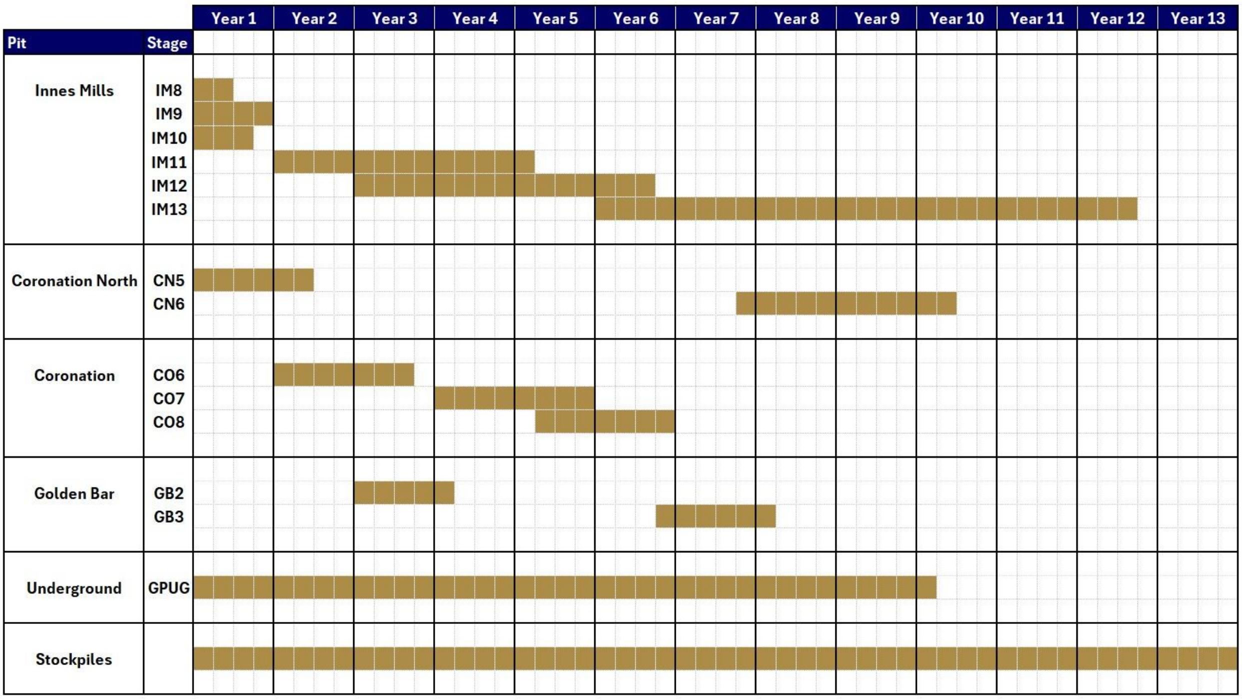
The activities described herein are expected to be generally sequenced as follows:

- The continuation of Innes Mills Pit mining from Year 1 to Year 12;
- The continuation of Coronation Pit mining from Year 2 to Year 6;
- Relocation of tailings from Southern Pit TSF and MTI from Year 2 to Year 12 to facilitate mining of Innes Mills Stage 13 (IM13);
- The continuation of Golden Bar Pit mining mostly in Year 3 and in Year 7;
- The continuation of GPUG mining from Year1 to Year 10;
- The continuation of Coronation North mining from Year 1 to Year 2 and then from Year 7 to Year 10;
- Associated replenishment of stockpiles throughout the MP4 mine life; and
- Full site rehabilitation to commence in Year 11 and be completed by approximately end of Year 13.

Mine planning is fluid at complex multi-pit operations such as the Macraes Operation. Precise timing of activities depends on a range of factors and operational requirements may facilitate changes to the sequencing of some activities.

Table 2-1 shows the anticipated sequencing of the proposed MP4 activities across the life of the project.

Table 2-1. Anticipated sequencing of MP4 activities



2.4 Purpose and scope

The purpose of this report is to determine the adequacy of the type and quantum of conservation actions required to counterbalance significant residual losses (flora and fauna habitats) expected as a result of the Project. Significant residual effects are those that are considered to have a moderate or higher level of effect after measures to avoid, minimise or remedy have been implemented, as determined by the Ecological Impact Assessment ("EcIA"; Bioresearches 2026f) under the EIANZ's ecological impact assessment guidelines (EcIAG). The conservation actions identified in this analysis report are quantified and measured against losses of similar values and modelled using the Biodiversity Offset Accounting Model (BOAM, developed by Maseyk and others (Maseyk *et al.* 2015, 2018).

Biodiversity offsetting and compensation are recognised under the National Policy Statement for Indigenous Biodiversity (NPS-IB) as tools appropriately used to address significant residual effects on ecological values, once avoidance, remediation and mitigation have been applied (Appendix 3, NPS-IB, 2023).

This Residual Effects Analysis (REA) report (E13) sits within a series of 18 ecology-focused documents relating to the MP4 Project. Terrestrial and wetland values are identified and described in other documents (E2–E6, Table 2-2).

A summary of the Project's application of the effects management hierarchy is provided in the EcIA report (Bioresearches 2026f; E7)—see Table 3-1 for a summary of avoidance, remediation and mitigation actions applied. This REA report should, therefore, be read in conjunction with the EcIA and other reports listed in Table 2-2, which detail measures taken to avoid, minimise, and remedy effects prior to residual effects management.

Table 2-2. Ecology Documents prepared for the proposed Macraes Phase 4 Project. Current document highlighted.

Document #	Document name	Aspects covered	Author
E1	Terrestrial and Wetland Ecology Summary		Bioresearches (2026a)
Ecological Assessments			
E2	Assessment of Vegetation and Wetland Values	Terrestrial vegetation and wetlands	Whirika (2026)
E3	Assessment of Invertebrate Values		Bioresearches (2026b)
E4	Assessment of Lizard Values		Bioresearches (2026c)
E5	Assessment of Avifauna Values		Bioresearches (2026d)
E6	Assessment of Bat Values		Bioresearches (2026e)
E7	Ecological Impact Assessment	Terrestrial and wetland ecosystems and fauna	Bioresearches (2026f)
Ecological Management			
E8	Vegetation and TAR Flora Management Plan	Indigenous vegetation and threatened plants (wetland and terrestrial)	Bioresearches (2026g)
E9	Wetland Management Plan	Wetlands and TAR wetland plants	Bioresearches (2026h)

Document #	Document name	Aspects covered	Author
E10	Invertebrate Management & Monitoring Plan		Bioresearches (2026i)
E11	Lizard Management & Monitoring Plan		Bioresearches (2026j)
E12	Avifauna Management Plan		Bioresearches (2026k)
Residual Effects Analysis and Management			
E13	Residual Effects Analysis: Terrestrial Ecology	Residual effects analyses for vegetation and fauna	Bioresearches (2026l)
E14	Residual Effects Analysis: Wetlands	Residual effects analyses for wetlands	Bioresearches (2026m)
E15	Residual Effects Terrestrial Restoration Plan	Compensation planting and vegetation restoration	Bioresearches (2026n)
E16	Residual Effects Wetland Restoration Plan	Planting and restoration for wetlands	Bioresearches (2026o)
E17	Ecological Impact Assessment: Pest-proof fence construction	Terrestrial and wetland ecosystems and fauna	Bioresearches (2026p)
E18	Pest Control and Elimination Plan	Animal pest management	Alliance Ecology (2026)

2.5 Statutory context

The statutory context is set out in more detail in the EcIA. Further information is provided here, where relevant for biodiversity offsetting and compensation.

2.5.1 Fast-track Approvals Act 2024 (FTAA)

The purpose of the FTAA is to facilitate the delivery of infrastructure and development projects with significant regional or national benefits. The system is intended to be a ‘one-stop-shop’ for resource consents under the Resource Management Act 1991 (RMA) and includes approvals required (for the purposes of this Project) under the Wildlife Act (1953). The purpose of the FTAA, which is to facilitate the delivery of infrastructure and development projects with significant regional or national benefits, is to be given greater weight in the consideration of applications for approvals than other relevant matters discussed below.

2.5.2 Resource Management Act 1991 (RMA)

While the FTAA provides an alternative consenting pathway to standard RMA processes, decision-makers are still required to have regard to RMA-based policy and planning instruments. The purpose of the RMA is to achieve sustainable management of natural resources. Important elements of this are the maintenance of indigenous biodiversity and the protection of significant indigenous vegetation and habitats. The RMA outlines management of adverse effects on the environment through avoidance, remediation, and mitigation (note that the *effects management hierarchy* is more specifically defined in the NPS-IB and identified below). While decisions under the FTAA are not made for the purpose of the RMA, that purpose, and consideration of documents written to guide actions and decision-making to achieve that purpose, still have some weighting in the decision-making process.

2.5.3 Wildlife Act (1953) (WA)

The WA provides legal protection to listed species classed as wildlife. It controls how people interact with wildlife, including all native birds, bats, frogs, lizards, and some invertebrates. Note, it does not cover plants or freshwater fish. A recent Amendment Bill (2025) has key provisions that aim to balance the practicalities of lawful activities that may incidentally harm or kill wildlife. It should be noted, therefore, that the amendments enable the Department of Conservation to impose conditions on authorisations to mitigate adverse effects of wildlife – if the overall effect of granting the authority will be protective of wildlife.

2.5.4 National Policy Statement for Indigenous Biodiversity (NPS-IB, 2023)

The NPS-IB supports the purpose of the RMA and provides direction to councils to protect, maintain and restore indigenous biodiversity in the terrestrial environment, requiring at least no further reduction nationally. It is relevant to the proposal because the Project is within the terrestrial environment, and it contains indigenous biodiversity as defined in Section 1.6 (Interpretation) of the NPS-IB.

The NPS-IB requires that indigenous biodiversity that is not protected by a Significant Natural Area (SNA):

a. Is managed by applying the effects management hierarchy (avoid, minimise, remedy, offset, compensate), where those effects are significant.
b. is managed to give effect to its Objective and Policies, where those effects are not significant (Section 3.16 (2)).

2.5.4.1 Tangata whenua

The NPSIB recognises tangata whenua as kaitiaki of, and partners, in the management of indigenous biodiversity (NPSIB, Policy 2). Consultation with mana whenua has been undertaken and is ongoing. Schedule 97 of the Ngai Tahu Claims Settlement Act 1998 lists 52 taoka Manu (bird) species and 39 taoka plant species. The EcIA identifies 16 bird species that are considered taoka species. One of them (kārearea / eastern falcon) has been identified to potentially have residual effects that are addressed within this report, and other taoka forest bird species, such as pīhoihoi, pīwakawaka, riroriro and kōparapara/ korimako, are also expected to benefit from substantial narrow-leaved snow tussock (hereafter, snow tussock) and dry shrubland restoration and pest animal control.

Ten taoka plant species were identified within the EcIA, which are included collectively under snow tussock and dry shrubland ecosystems and considered throughout the values and effects management process (including specific provision in restoration schedules). While no Kārara (lizards) are listed in Schedule 97, the April 2026 Statement of Evidence of Jade Watkin (Ecology and Kāi Tahu) affirms the cultural value of kārara / lizards (including tussock [currently known as southern grass skink] and McCann's skink) as "*spiritual guardians of wāhi tapu and urupā, are respected kaitiaki, and are part of the whakapapa of Kāi Tahu*". Both of these species are considered to have residual effects and are included within the compensation package detailed within this report.

2.5.5 Regional/ District Plans and Policies

At a regional and district level, the Project is located within the Otago Region and spans the Waitaki District and Dunedin City District. Relevant planning instruments include the Otago Regional Policy Statement 2021 (ORPS), the Regional Plan: Water for Otago, the Waitaki District Plan, and the Dunedin City District Plan (Second Generation Plan).

The ORPS is the principal statutory planning document for Otago. It was prepared by Otago Regional Council for the purpose of giving effect to the RMA and the NPS-IB.

These documents provide RMA policy direction on the management of indigenous biodiversity and habitats and are relevant considerations for managing the ecological effects of the proposal.

3 Summary of residual adverse effects

The Ecological Impact Assessment (document E7, Bioresearches 2026f) identifies **Moderate or higher residual effects that require a specific response** for narrow-leaved snow tussock grassland (**Very High**), rock outcrops and tors (**Moderate**), 20 of the 29 affected TAR plant species, 11 of the 17 assessed terrestrial invertebrate taxa, McCann's skink (**Moderate**), southern grass skink and kōrero gecko (**Very High**), and kārearea, banded dotterel and South Island pied oystercatcher (**Moderate**).

The remaining assessed effects are either **Low to Very Low** and, while they do not independently drive the need for compensation, these have been demonstrably covered by the o0076erall package. These comprise the **Low** effect on dry shrubland, nine TAR plant species with Low or Very Low effects, six invertebrate taxa with **Low** effects, New Zealand pipit, silvereye and fernbird. Separately, the package provides opportunities to benefit biodiversity values for which MP4 has **no identified residual effect**, including Otago skink, grand skink, pīpipi, miromiro, and tūī, depleted dryland podocarp–broadleaved forest, and ecological connectivity between existing protected habitats. These are additional project-enabled conservation gains—they are not relied upon as substitutes for addressing unrelated significant residual effects but are relevant to the Panel's consideration of the overall scale, durability and ecological merit of the package.

The proposed compensation is predicted to produce **Net Positive outcomes for all three affected habitat types**, including modelled gains for snow tussock and dry shrubland and an unmodelled gain for rock and tor habitat. For TAR plants, propagation and restoration is expected to counterbalance predicted losses for some species, including low-level effects to net positive outcomes for 13 species. Seven invertebrate taxa are predicted to achieve unmodelled Net Positive outcomes, although outcomes remain uncertain for the other 10 because species-level responses cannot be quantified reliably. McCann's skink is predicted to achieve both modelled and unmodelled Net Positive outcome, while southern grass skink may retain a modelled residual shortfall, but a Net Positive outcome overall due to unmodelled compensation benefits. The outcome for kōrero gecko is also a predicted, but unmodelled, Net Positive outcome. Modelled Net Positive outcomes are predicted for kārearea, banded dotterel and South Island pied oystercatcher, with further Net Positive outcomes predicted for New Zealand pipit and silvereye; the outcome for fernbird remains uncertain. Overall, the package addresses all Moderate or higher effects, provides coverage for lower-level effects, and delivers additional conservation benefits beyond those strictly required to respond to MP4's residual effects.

The residual effects are determined through the assessment undertaken in document E7 (EcIA). A summary of the values, effects and mitigation approach to avoid and minimise adverse effects as a result of the project, as well as the residual effects following the application of avoid, minimise and remedy measures.

Potential residual indirect effects, including loss or degradation of adjacent values, are assessed as having some potential to be significant at up to 20 m from the direct loss footprint (refer to EcIA; Document E7), and this extent has been conservatively added to all impact quanta used for modelling.

Table 3-1. Summary of ecological components within MP4 direct loss footprint and residual levels of effect

Indigenous component	Ecological value	Areal extent (ha.)	Magnitude of effect (after mitigation)	Level of residual effect
Terrestrial habitat Type				
Snow tussock	High	90.01	High	Very High
Dry Shrubland	Moderate	3.06	Low	Low
Rock outcrop / tor	Very High	0.26	Low	Moderate
TAR Flora				
Dwarf broom (*Carmichaelia corrugata*)	Very High		Very High	Very High
Indigenous St John's wort (*Hypericum rubicundulum*)	Very High		Very High	Very High
Wetland daisy (*Lagenophora barkeri*)	Very High		Low	Moderate
Lobelia ionantha	Very High		Very High	Very High
Leptinella pusilla	Very High		Moderate	High
Rytidosperma thomsonii	Very High		High	Very High
Sonchus novae-zelandiae	Very High		Very High	Very High
Acaena buchananii	Very High		Moderate	High
Narrow-leaved speargrass (*Aciphylla subflabellata*)	Very High		Low	Moderate
Tufted hair grass (*Deschampsia cespitosa*)	Very High		Very High	Very High
Epilobium insulare	Very High		Negligible	Low
Euchiton polylepis	Very High		Very High	Very High
Juncus pusillus	Very High		Moderate	Moderate
Lobelia perpusilla	Very High		High	High
Dwarf greenhood orchid (*Pterostylis tristis*)	Very High		Moderate	High
Delicate bluegrass (*Anthosachne falcis*)	High		Negligible	Very Low
Desert broom (*Carmichaelia petriei*)	High		Low	Low
Colobanthus strictus	High		Moderate	High
Juncus distegus	High		Negligible	Very Low
New Zealand mint / hīoi (*Mentha cunninghamii*)	High		Negligible	Very Low
Rytidosperma buchananii	High		Moderate	Moderate
Wetland grass (*Agrostis pallescens*)	Moderate		Moderate	Moderate
Brachyscome longiscapa	Moderate		Negligible	Low
Hooker's mountain daisy (*Celmisia hookeri*)	Moderate		Negligible	Negligible
Lagenophora pinnatifida	Moderate		Moderate	Moderate
Poa pusilla	Moderate		Low	Moderate
Shawia bullata (formerly *Olearia bullata*)	Moderate		Low	Low
Oxalis rubens	Moderate		Low	Very Low
Porcupine shrub (*Melicytus* aff. *alpinus* 'Otago')	Moderate		High	Moderate
Invertebrates				
Invertebrate community (Project wide)	High	325	Moderate	High
Orocrambus sophistes	Very high		Moderate	High
Agrotis admirationis	High		Moderate	High
Asaphodes recta	High		Moderate	High
Dasyuris partheniata	High		Moderate	High
Nyctemera annulata	High		Low	Low
Orthodera novaezealandiae	High		Low	Low

Indigenous component	Ecological value	Areal extent (ha.)	Magnitude of effect (after mitigation)	Level of residual effect
Pasiphila sp. A (NZAC 04285480 "Carmichaelia")	High		Low	Low
Patagoniodes farinaria	High		Low	Low
Samana acutata	High		Moderate	High
Theoxena scissaria	High		Moderate	High
Bityla sericea	Moderate		Moderate	Moderate
Wiseana fuliginea	Moderate		Moderate	Moderate
Wiseana mimica	Moderate		Low	Low
Zelandobius uniramus	Moderate		Moderate	Moderate
Hemiandrus maia	Low		Moderate	Low
Mecodema sp. "Oamaru"	Moderate		Moderate	Moderate
Orocrambus cf. *cyclopicus*	Moderate		Moderate	Moderate
Lizards				
McCann's skink	Low		High	Moderate*
Southern grass skink	High		High	Very High
Kōrero gecko	High		High	Very High
Avifauna				
Eastern falcon	Very High	235.99	Low	Moderate
Banded dotterel	Very High	130.38	Low	Moderate
South Island pied oystercatcher	Very High	130.38	Low	Moderate
New Zealand pipit	High		Low	Low
Silvereye	High		Negligible	Very Low
Fernbird	High		Negligible	Very Low

*As discussed in section 6.4.3.9 of the EcIA, under the EcIAG Table 8 framework, the combination of Low value and High magnitude yields a Low level of residual effect for McCann's skink. However, in the professional judgement of the authors, this has been conservatively revised upward to a Moderate overall level of residual effect, as a deliberate deviation from the Table 8 outcome.

4 Residual effects management

4.1 Overview

The terrestrial residual effects management package addresses residual adverse effects of MP4, as identified in the Ecological Impact Assessment, following avoidance, minimisation and remediation. Its objective is to demonstrate how enduring ecological benefits outweigh residual terrestrial effects, while also acknowledging that this conclusion does not establish a net positive outcome for every affected value.

The Terrestrial Ecology Residual Effects Management Package has been designed to:

1. Quantify residual adverse effects and demonstrate modelled positive compensation balances for Moderate or greater residual effects where the available data support defensible application of a biodiversity accounting model, while clearly identifying any value-specific residual shortfalls or uncertain outcomes;
2. Address Moderate or greater residual adverse effects through conservation actions that restore, enhance or protect the same or ecologically related values, as closely as practicable, within the surrounding Macraes landscape;
3. Demonstrate a modelled positive compensation balance for dry shrubland, being the principal biodiversity component with a Low residual effect included in the BOAM, and identify the additional benefits expected for other values with Low or Very Low residual effects without attributing a modelled net positive outcome where this has not been demonstrated; and
4. Provide additional conservation benefits for biodiversity within the surrounding landscape by protecting, improving and connecting areas of high biodiversity value, including rare, depleted or otherwise important values that are not directly affected by MP4. These additional benefits are not relied upon as equivalent replacement for identified MP4 residual effects.

The package includes habitat protection, revegetation and enrichment planting, stock exclusion, pest plant management, mammalian pest and predator control, plantation removal, legal protection, monitoring and adaptive management. These measures are intended to operate as an integrated, long-term conservation programme rather than as a collection of isolated actions.

The location, scale and sequencing of the actions have been designed to improve ecological connectivity across the wider Macraes landscape. Existing areas of tussock grassland, dry shrubland, rock habitat, wetlands and other indigenous vegetation will provide source habitats and populations around which restoration and enhancement can occur. Revegetation, enrichment planting and the protection of intervening habitat will progressively expand and enhance connectivity within these areas, reduce their isolation and improve the ability of indigenous species to move, disperse and recolonise across the landscape.

This landscape approach is intended to counterbalance the fragmentation and reduction of habitat associated with the Project by establishing a larger, more coherent and more securely managed network of indigenous habitat. It will also strengthen ecological connections between residual effects management areas and other high-value habitats, including existing covenants and areas supporting threatened invertebrates, lizards, birds and flora.

4.2 A compensation approach

Appendix 3 of the NPS-IB sets out 11 principles for Biodiversity Offsetting in New Zealand. Of these, Principle 3 (Net Gain) requires a like-for-like quantitative loss/ gain calculation (type, amount, condition) to demonstrate that the indigenous biodiversity values at the offset site(s) are equivalent to or exceed those being lost.

BOAMs (Maseyk et al., 2015, 2018) have been applied where suitable quantitative data are available to assist in assessing the adequacy of the proposed residual effects management package. However, iterative changes to both the Project footprint and the compensation package mean that some quantitative datasets collected during field investigations may no longer be sufficiently representative of the final impact and compensation areas, or sufficiently robust to demonstrate the strict ecological equivalence required for biodiversity offsetting. Accordingly, while the BOAMs provide a useful quantitative decision support tool for assessing predicted losses and gains, the residual effects management package is characterised as biodiversity compensation rather than a biodiversity offset.

In undertaking biodiversity compensation, the BOAM is still used to ensure that the overall residual effects management approach otherwise aligns with the principles of biodiversity offsetting, and that values and gains are as close as possible to like-for-like exchanges. It is further noted that the additional biodiversity gains, anticipated from the overall compensation package, are laid out in more detail in Table 5-3.

To demonstrate conservatism in effects analyses, other precautions and sensitivities have been applied to the residual effects modelling, including:

- Modelled the additional 20 m impact buffer as lost, to account for potential indirect effects and provide a precautionary basis for determining residual effects management requirements.
- Separate lizard models for each species and habitat type (tussock, dry shrubland, other modified environments) to account for variation in abundance for McCann's and southern grass skinks.

In addition to these measures, an analysis of vulnerability and irreplaceability was undertaken, and is detailed in Appendix A.

4.3 Biodiversity values addressed

The principal residual effects carried forward from the EcIA comprise:

- permanent loss and modification of indigenous snow tussock grassland and rock habitat;
- Direct harm and loss or degradation of habitat affecting indigenous lizards;
- loss and degradation of habitat used by indigenous avifauna; and
- Direct harm and loss or degradation of habitat supporting indigenous terrestrial invertebrates.

The compensation measures proposed for each value differ according to the nature of the effect and the feasibility of generating a corresponding ecological benefit.

In broad terms:

- Vegetation and habitat losses are addressed through revegetation, protection and enhancement of existing indigenous vegetation.
- Lizard effects are addressed through predator exclusion, habitat protection and enhancement, vegetation restoration and removal of plantation forestry where this is expected to avert further habitat degradation. Avifauna effects are addressed principally through landscape-scale predator control, protection and enhancement of habitat, and restoration of indigenous vegetation.
- Invertebrate effects are addressed through restoration and enhancement of snow tussock and dry shrubland habitat, establishment and retention of indigenous host plants, increased vegetation structure and improved continuity between habitat areas.

The copensation package will also provide benefits for biodiversity values that are not directly affected by MP4, including Otago skink, potentially grand skink and depleted podocarp and broadleaved forest components. These are additional conservation benefits. They are not relied on as direct or equivalent replacement for affected snow tussock, rock habitat, lizards, avifauna or invertebrate habitat.

4.4 Ecological context

The Macraes Ecological District is a highly modified pastoral and mining landscape. Indigenous tussock grassland, dry shrubland and rock habitat occur as part of a fragmented mosaic with extensive areas of exotic pasture, while indigenous forest is largely confined to small remnants. Much of the tussock and shrubland reflects the persistence, regeneration and colonisation of indigenous species in areas subject to less intensive land use. OGNZL's landholdings therefore retain substantial ecological values and provide significant opportunities to improve habitat condition, extent and connectivity through coordinated conservation management.

These opportunities include protecting and improving existing indigenous habitats through livestock exclusion, mammalian pest control, weed management and legal protection, while also increasing habitat extent and diversity through native revegetation and enrichment planting. Together, these actions can improve habitat condition, buffer retained vegetation, strengthen ecological connections and support the recovery of indigenous plant and fauna communities.

This context provides the basis for the residual effects management package. The proposed actions are focused on locations where coordinated management can protect existing values, restore degraded habitats and reconnect areas that are currently fragmented. By combining habitat protection, active management and ecological restoration, the package is intended to achieve broader and more durable conservation outcomes than isolated replacement planting alone.

4.5 Sequencing and implementation

Residual effects will be implemented in a sequence that minimises the delay between ecological loss and ecological gain. Where practicable, legal protection, stock exclusion, pest animal control, weed control and site preparation will begin before or concurrently with the relevant project effects.

Measures that may generate relatively immediate benefits, such as stock exclusion, predator control and prevention of further plantation development, are distinguished from revegetation and enrichment actions that require longer periods to establish ecological function. Relevant time lags are incorporated in the BOAMs or addressed qualitatively where they cannot be modelled reliably.

The Residual Effects Terrestrial Restoration Plan (E15) and associated Pest Management Plan (E18) provide the detailed implementation requirements, including site preparation, planting, ecosourcing, maintenance, monitoring, reporting and corrective action.

4.6 Durability and additionality

The ecological benefits relied on in this assessment must be secured and maintained for a duration appropriate to the residual effects being addressed. As the principal habitat losses are permanent, the compensation areas will be subject to long-term legal protection, and OGNZL will establish and fund a Trust to provide for the management of the MEEA in perpetuity. The Pest Control and Elimination Plan prepared by Alliance Ecology (2026) provides for pest management through to 2050, including predator elimination within the approximately 252 ha MEEA predator-exclusion area and pest suppression within the surrounding management areas. The predator-exclusion fence itself has an expected operational lifespan of approximately 35–50 years, subject to ongoing inspection, maintenance and repair. The 2050 timeframe therefore represents the current committed period for implementation of the pest management programme, rather than the duration of protection of the MEEA. The perpetual management of the MEEA through the Trust provides a mechanism for continued management beyond this period, informed by monitoring, fence condition and the ecological outcomes being achieved.

4.7 Cultural considerations and additional conservation benefits

The project approach recognises that Kā Rūnaka does not support the establishment of large areas of uniform tussock where alternative restoration methods may provide better ecological outcomes. It also recognises that conversion of productive pasture to tussock may not be supported by the local community. These considerations have not reduced the ecological objectives of the compensation package but have informed a more diverse and enduring restoration design.

This includes targeted enrichment of restored shrubland at Cranky Jims Link to support succession toward a mixed podocarp-broadleaved forest ecosystem, which is otherwise regionally extinct within the Macraes Ecological District. The forest restoration also has the potential to provide cultural benefits through the establishment of plant species recognised as culturally significant or identified in the project planting schedules as taoka. This includes several podocarp and broadleaved species, including tōtara, matai, kahikatea, kānuka, kōhūhū, tī kōuka and kōwhai. This potential cultural benefit does not imply that the restoration addresses all cultural effects or that Kā Rūnaka has endorsed the detailed planting design. Rather, it provides a basis for continued engagement with mana whenua regarding species selection, ecosourcing, implementation, monitoring and the cultural outcomes sought from restoration. The package therefore reflects consultation outcomes while avoiding the attribution of views to the applicant, mana whenua or the local community beyond those they have formally expressed.

The compensation package is also expected to provide cultural benefits through the restoration, protection and reconnection of habitat for indigenous birds and lizards. The establishment of structurally diverse shrubland and, over time, podocarp-broadleaved forest at Cranky Jims Link will increase nesting, shelter and foraging habitat for indigenous shrubland and forest birds.

The project documents identify several taoka manu that are present within, or may benefit from restoration and pest management in, the wider Macraes landscape, including pīwakawaka, riroriro and kārearea. The shrubland restoration model also includes an explicit target for increasing indigenous shrubland bird diversity as vegetation structure and cover develop.

Although indigenous lizards are not listed as taoka species in Schedule 97 of the Ngāi Tahu Claims Settlement Act 1998, kārara have recognised cultural significance to Kāi Tahu. They have been described as part of Kāi Tahu whakapapa, as respected kaitiaki, and as spiritual guardians associated with wāhi tapu and urupā. Restoration and protection of shrubland, tussock and rock habitat, together with improved landscape connectivity and sustained pest control, therefore, have potential cultural as well as ecological benefits by supporting the persistence of kārara within their wider ancestral landscape.

The ecological basis for these benefits is supported by the habitat requirements of the lizard species present. Shrubland provides shelter, foraging resources and dispersal habitat for McCann's skink, southern grass skink and kōrero gecko, particularly where it occurs in association with tussock, gullies and rock outcrops. The Cranky Jims Link and MEEA components of the compensation package will protect and reconnect these habitat types, while pest exclusion and landscape-scale predator control are expected to improve the condition and resilience of resident lizard and bird populations.

4.8 Overall conservation legacy

Collectively, the package represents a coordinated landscape-scale conservation programme. It improves the extent, condition, connectivity and security of indigenous habitat; creates a large predator-excluded refuge; protects habitat associated with threatened Otago skinks; restores tussock, shrubland, wetlands and riparian margins; and installs foundations for a future podocarp forest. These outcomes are materially broader than standard construction mitigation and are central to the ecological case for MP4.

5 Overview of compensation package

The Project provides a multitool approach to biodiversity compensation, including:

1. **Revegetation** to create new terrestrial ecosystems and habitats (secure long-term gains);
- **Protection and enhancement** to actively improve existing ecosystems and habitats (shorter term gains through mammalian pest control/elimination and weed management, and addresses time-lag associated with maturation of planting); and
2. **Averted loss** (intervention to prevent future biodiversity decline).

These approaches are often combined within offset and compensation packages, but they address different dimensions of biodiversity loss, operate on different timescales, and can carry different levels of risk and ecological equivalence.

These compensation actions will be delivered at three locations (Figure 5.1) within OGNZL's Macraes landholdings and within the immediate surrounding landscape at:

1. Murphys Ecological Enhancement Area (MEEA, south).
2. Cranky Jims Link (adjacent to Cranky Jims Shrubland Covenant, east); and
3. Mt Highlay, to the north-west.

An overview of the major conservation benefits at the three locations are detailed in Table 5-1, Table 5-2 and mapped in Figure 5.1 below.

Table 5-1. Overview of total planting and protection of existing biodiversity values for MP4.

Terrestrial habitat / biodiversity value	Mt Highlay	Cranky Jims Link	MEEA pest-exclusion fence	Murphys Link	Total / project-wide response
Revegetation actions					
Tussock grassland (modelled Net Positive)	175 ha	0	0	0	175 ha
Dry shrubland (modelled Net Positive)	0	50 ha	0	0	50 ha
Rock outcrop / tor edge planting*	15 ha*	0	0	0	15 ha*
Total revegetation					225 ha
Protection					
Tussock grassland	18.66 ha	0	134.87 ha	201.35 ha	354.88 ha
Dry shrubland	0.74 ha	6.58 ha	7.37 ha	33.51 ha	48.20 ha
Rock outcrops and tors	4.07 ha	0.56 ha	7.79 ha	19.12 ha	31.54 ha
Non-indigenous fauna habitat	143.6				143.6
Total habitat protection					578.22 ha
Biodiversity values / species					
Plants					
TAR flora	Species-specific TAR planting within tussock and tor-edge restoration, including 8,799 dwarf broom, 139,779 narrow-leaved speargrass and 49,076 desert broom plants.	TAR flora incorporated within shrubland restoration, including 7,730 desert broom and 1,065 *Shawia bullata*.	Protection of existing TAR flora and habitat, together with pest and browser management.	Protection and management of existing TAR flora and suitable receiving habitat.	Species-specific salvage, propagation, establishment and monitoring are provided through the TAR flora management programme. Compensation planting can be quantified for a subset of affected species; outcomes for other species remain dependent on species-specific management.
Invertebrates					
Orocrambus sophistes and *Orocrambus cf. cyclopicus*	Approximately 250,357 narrow-leaved snow tussock host plants within the Mt Highlay planting programme.	General habitat benefit from shrubland restoration.	Protected habitat and pest management.	Protection of existing tussock and associated habitat.	Major increase in host-plant availability combined with habitat protection. Species response remains uncertain.

Asaphodes recta and *Nyctemera annulata*	Approximately 27,594 fireweed (*Senecio dunedinensis*) host plants within tor-edge planting.		Wider habitat protection and pest management.	Wider habitat protection.	Species-specific host-plant establishment supplemented by the wider habitat package.
Dasyuris partheniata	Approximately 139,779 narrow-leaved speargrass host plants.	.	Wider habitat protection and pest management.	Wider habitat protection.	Substantial increase in host-plant resource, although the species-level response remains uncertain.
Pasiphila sp. A, *Samana acutata* and *Theoxena scissaria*	Carmichaelia host-plant establishment within tussock and tor-edge restoration.	Carmichaelia establishment within shrubland and enrichment planting.	Protection of existing habitat and pest management.	Protection and improved habitat continuity.	Approximately 173,347 Carmichaelia host plants across Mt Highlay and Cranky Jims Link.
Bityla sericea	General habitat benefit.	Approximately 11,033 *Coprosma* host plants within Stage 1 shrubland planting.	Wider habitat protection and pest management.	Wider habitat protection.	Species-specific host-plant establishment supplemented by habitat protection.
Other notable terrestrial invertebrates	Approximately 175 ha tussock restoration and tor-edge enhancement.	Approximately 50 ha shrubland restoration.	Habitat protection and mammalian pest elimination within the 252 ha fenced area.	Habitat protection, connectivity and pest suppression.	Benefits arise from increased indigenous vegetation extent and structure, host-plant availability, habitat protection and mammalian pest management. Species-specific gains cannot be quantified reliably for all taxa.
Lizards					
McCann’s skink	Removal of approximately 265 ha of plantation forestry to avert future habitat degradation, together with tussock and rock-habitat restoration.	Additional restored shrubland habitat.	Predator elimination within the 252 ha fenced area.	Protected habitat, connectivity and principal lizard release area.	Predator management, habitat restoration and protection, and averted habitat loss. Species-specific BOAM predicts a positive outcome.
Southern grass skink	Approximately 265 ha of averted plantation-related habitat degradation together with tussock restoration.	Additional restored shrubland habitat.	Predator elimination within the 252 ha fenced area.	Protected habitat, connectivity and lizard release habitat.	Combined modelled and unmodelled benefits from predator management, habitat protection/restoration and averted habitat loss.
Kōrero gecko	Plantation removal, rock-habitat protection and tor-edge restoration.	Additional rock and shrubland habitat protection.	Predator elimination and protection of rock, tussock and shrubland habitat.	Rock-habitat protection and improved habitat continuity.	Rock-habitat protection, predator management and improved connectivity. No species-specific BOAM was possible because density data are unavailable.
Birds					

Kārearea / eastern falcon	Restoration and protection of open tussock and associated habitat.	Additional restored shrubland habitat.	Predator elimination within 252 ha MEEA.	Additional protected habitat.	Predator suppression across the wider MEEA management area, combined with habitat restoration and protection. BOAM predicts a Net Positive outcome.
Banded dotterel / pohowera	General open-country habitat benefits.	Limited direct benefit.	Predator elimination within 252 ha MEEA.	Protected open-country habitat.	Landscape-scale predator management across suitable breeding and foraging habitat. BOAM predicts a Net Positive outcome.
South Island pied oystercatcher / tōrea	General open-country habitat benefits.	Limited direct benefit.	Predator elimination within 252 ha MEEA.	Protected open-country habitat.	Landscape-scale predator management across breeding and foraging habitat. BOAM predicts a Net Positive outcome.
New Zealand pipit / pīhoihoi	Approximately 175 ha tussock restoration and protection of open habitat.	Potential additional habitat.	Predator management.	Protected open-country habitat.	Expected to benefit from extensive tussock restoration and mammalian pest management.
Silvereye / tauhou	Limited direct benefit.	Approximately 50 ha shrubland restoration.	General pest-management benefit.	Habitat protection and improved connectivity.	Increased extent and structure of indigenous shrubland habitat.
Fernbird / mātātā	Limited direct benefit.	Dry shrubland restoration and enhancement.	General pest-management benefit.	Habitat protection and improved connectivity.	Potential benefit from shrubland restoration and pest management, although the species-specific outcome remains uncertain.
Additional conservation values					
Otago skink, grand skink and podocarp-broadleaved forest	Mt Highlay contributes wider landscape habitat restoration.	Approximately 21 ha of progressive podocarp-broadleaved enrichment within restored shrubland.	Predator elimination protects the only currently known Otago skink population on OGNZL landholdings.	Improves protection and connectivity of habitat associated with grand skink.	Additional conservation benefits that are not relied upon to counterbalance quantified MP4 residual effects.

*Dedicated shallow soil species planting is part of 175 ha tussock community planting and does not count towards total revegetation

Table 5-2. Overview of compensation actions for terrestrial biodiversity.

Conservation Site	Conservation Benefits
MEEA: Pest-exclusion fence and landscape buffer 1,170 ha	- 252 ha predator-exclusion fence - 134.9 ha tussock protected inside fence - 7.37 ha dry shrubland protected inside fence - 7.79 ha rock outcrop & tors protected inside fence - 1,179 ha of mammalian predator suppression surrounding the fence - 100% uplift in lizard populations within the fence - Additional protections for threatened Otago skink, invertebrates, birds and their habitats
MEEA: Murphys Link 395 ha	A large, managed refuge for relocated lizards and protected habitats - 201 ha existing tussock grassland - 33.51 ha existing dry shrubland - 19 ha rock outcrop and tors - Connects MEEA with Redbank Covenant, including habitat associated with threatened grand skink
Mt Highlay Restoration 265 ha	A large area of immature pine plantation (3–4 yr old saplings). Plants will be removed to avert habitat loss from conversion to closed-canopy plantation forest. - 265 ha lizard habitat loss averted - 175 ha tussock restoration planting, including TAR flora and: o 15 ha of dedicated shallow-soil flora around rock tors and outcrops - 4 ha existing rock outcrop and tor habitat included and enhanced within covenant
Cranky Jims Link 57 ha	A strategic opportunity to buffer Cranky Jims Shrubland Covenant and connect it with Island Bock Covenant to the north. - 50 ha of dry shrubland restoration including TAR flora - 6.5 ha additional dry shrubland protection. - 0.56 ha additional rock outcrop and tor protection (and enhancement of these habitats) - 21.4 ha enrichment planting of podocarp broadleaf forest, including taoka flora species to enable a future forest type that is functionally extinct in the ecological district. - Habitat expansion for TAR forest birds recorded within Cranky Jims Covenant.

Figure 5.1. (Over page) Overview of the key Compensation sites within the MP4 Landscape.

COMPENSATION PACKAGE

MACRAES PHASE 4

Three sites for terrestrial compensation package components are proposed, along with additional sites for wetland compensation actions

Wetland Residual Effects

The compensation package targets wetland and riparian habitats across multiple sites throughout OGL landholdings. Compensation actions will improve wetland extent, condition, hydrology, flora and riparian function. Key creation, restoration, enhancement and protection measures include:

- *6.9 ha of sedgeland*
- *5.6 ha copper tussock wetland*
- *1.9 ha of degraded ephemeral wetland*
- *0.2 ha of seep wetland*
- *0.1 ha of shrubland wetland*
- *1.8 ha indigenous herbaceous wetland*
- *9 ha of unclassified wetland*

Mt Highlay

Integrates tussock restoration, VDT (Vegetation Direct Transfer) and the ongoing protection of lizard habitat through an "averted loss" approach

- *175 ha of Tussock Planting, including 15 ha of rock edge flora restoration*
- *Removal of 265 ha of exotic pine preventing the future degradation of lizard habitat*

Cranky Jims Link

Buffers and connects Cranky Jims Shrubland Covenant with Island Block Covenant to the north, with 50 ha of dry shrubland planting followed by enrichment to transition towards a podocarp-broadleaf forest, a functionally extinct ecosystem within the Macraes' ecological district

Murphys Ecological Enhancement Area

A large, managed refuge for lizards, as well as protected habitat for birds, invertebrates and indigenous vegetation communities.

- *252 ha Predator Exclusion Fence*
- *1,170 ha landscape-scale mammalian pest control*
- *395 ha continuous covenant connecting MEEA to Redbank (Murphys Link)*

Connection of MEEA (known Otago skink population) to Redbank Covenant (grand skink population) links two 'Threatened' fauna species within the region

5.1 MurphysEcological Enhancement Area (MEEA) and Murphys Link

The MEEA provides an opportunity to secure and improve a large, connected area of indigenous habitat within the wider modified Macraes landscape. Its value lies not only in protecting individual vegetation and habitat types, but also in managing them as an integrated ecological system.

Permanent stock exclusion, predator management and legal protection will improve habitat condition, reduce ongoing pressures and allow indigenous vegetation and fauna populations to recover over time. The scale and configuration of the area will also strengthen connections between tussock grassland, dry shrubland and rock habitats, support movement and dispersal by indigenous fauna, and improve ecological resilience. Strategic management towards the Redbank Covenant will further extend these benefits by improving connectivity with habitat supporting endangered grand skink.

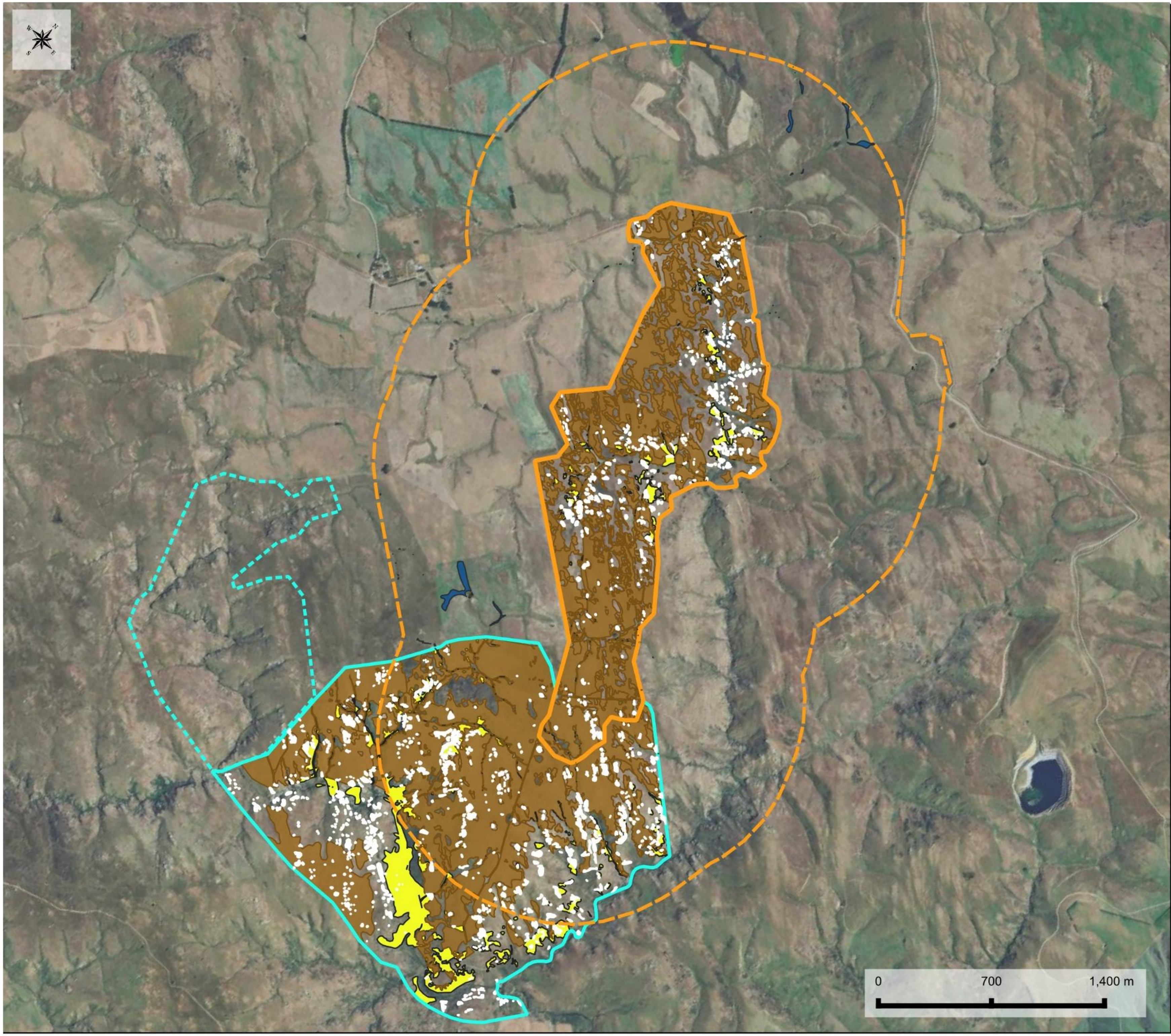
The MEEA encompasses the following key compensation actions:

- Establishment of a 252 ha predator-exclusion fence to create a predator-free sanctuary for indigenous lizards, including McCann's skink, 'At Risk' southern grass skink, 'At Risk' kōrero gecko and 'Threatened' ('Regionally Endangered') Otago skink, incorporated into the compensation package through expanding the fenced area, following discovery at the MEEA in February 2026.
- Landscape-scale pest control across an approximately 1,170 ha buffer surrounding the fenced area.
- 354.9 ha of existing snow tussock, stock-fenced and protected in perpetuity
- 40.88 ha of existing dry shrubland will be stock-fenced and protected in perpetuity
- 31.5 ha of rock habitat will be stock-fenced and protected in perpetuity
- Strategic protection and pest control to:
    - Improve habitat connectivity via Murphys Link towards the high value Redbank Covenant (which supports endangered grand skinks)
    - Enhance habitat for invertebrates, lizards and avifauna

5.1.1 Construction of the MEEA predator-exclusion fence

The MEEA fence will be constructed within 5 years of consent being issued, and it is estimated to take 18 months to 2 years to construct the fence. Pest eradication in the MEEA fence will be completed during the first winter after fence construction is completed, and maintenance of the fence will be funded by OGNZL until 2050. Post-2050 the MEEA—as well as Cranky Jims link and Mt Highlay compensation areas—will be transferred to a special purpose trust which will be funded by a closure capitalisation fund set up by OGNZL. At this stage the parties to the trust and its governance have not been confirmed.

Figure 5.2. (Over page) MurphysEcological Enhancement Area, showing a 252 ha predator-exclusion fence, Murphys Linkand landscape wide predator control.



MEAA

Protected Vegetation

Date: 23/07/2026
Drawn By: CG
Client: OceanaGold New Zealand Ltd
Scale: 1:31,500

Legend

OGL Landholdings

Redbank Covenant

Proposed Actions

Predator Exclusion Fence: 252 ha

Predator Control Buffer: 1170 ha

Murphy's Connection: 395 ha

Vegetation Protected via Covenant

Rock Outcrop: 26.96 ha

Tussock grassland: 336.25 ha

Dry shrubland: 40.88 ha

SOURCES
Google Earth Aerial: November 2024

MAP PROJECTION
NZGD2000 / New Zealand Transverse Mercator 2000

Bioresearches
A Babbage Company

5.2 Cranky Jims Link

Cranky Jims Link will restore indigenous vegetation between the Cranky Jims Wetland Covenant (49 ha), Cranky Jims Shrubland (47.2 ha) and Island Block covenant (291.55 ha), reconnecting two currently isolated areas of significant protected habitat. This will increase the effective area of indigenous habitat, reduce fragmentation and edge effects, and improve opportunities for indigenous fauna to move between feeding, shelter and breeding habitats. Progressive enrichment planting will also support succession toward podocarp-dominant dryland forest, an ecosystem type that is functionally extinct within the Macraes Ecological District.

Cranky Jims Link encompasses the following key compensation actions:

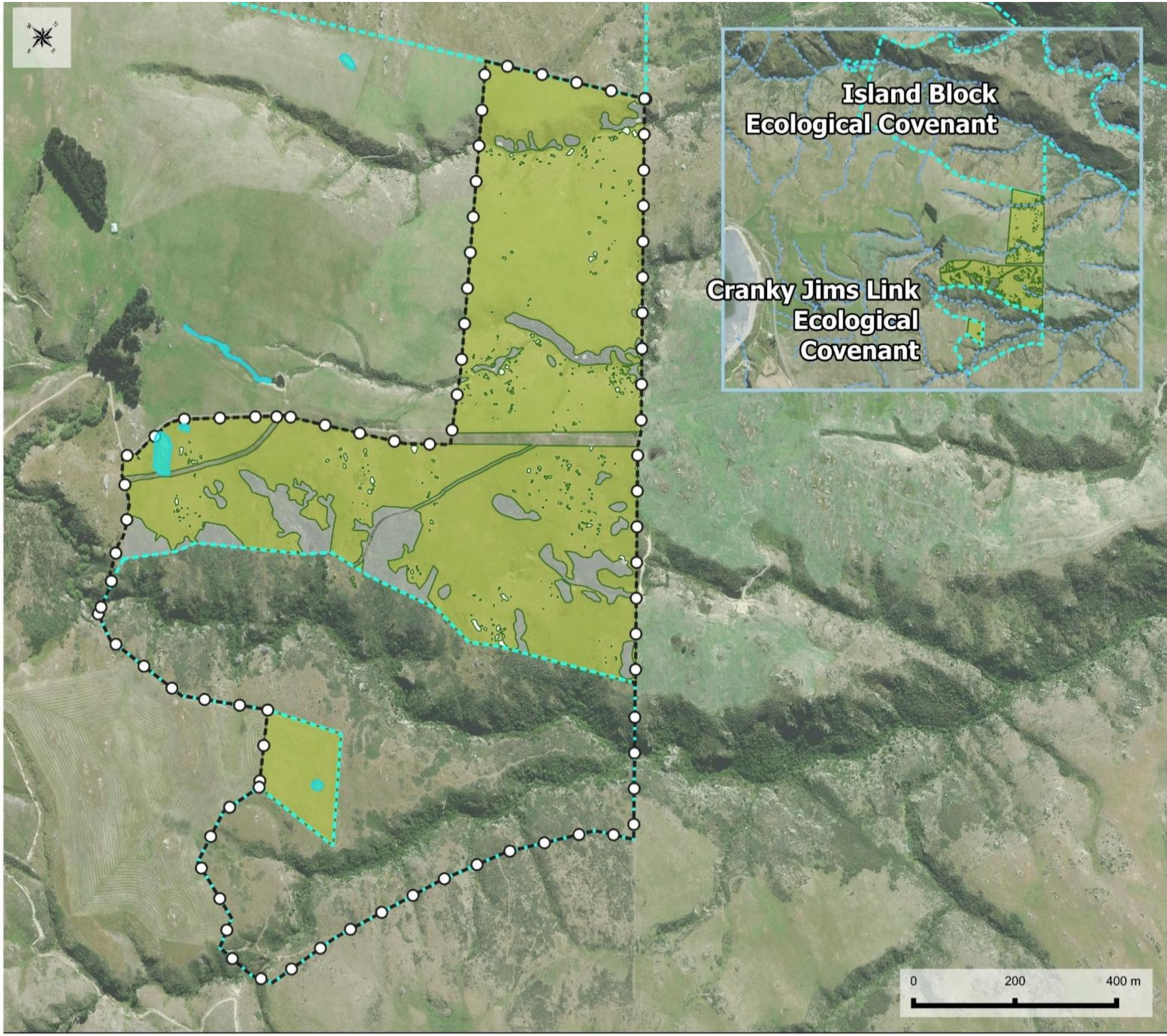
- Approximately 50.59 ha of dry shrubland and dry shrubland restoration planting
- 0.56 ha of Tor and rock outcrop protection
- 6.58 ha of existing dry shrubland protection
- Buffer benefits for Cranky Jims Shrubland covenant, including reduced pest browser and predator incursions.

Cranky Jims Shrubland Covenant currently supports an area of significant remnant indigenous dry shrubland forest within the Macraes ED. Its vegetation includes kōhūhū, broadleaf, tī kōuka, horoeka, kōwhai, makomako, putaputawētā, kāhāhā and indigenous ferns, transitioning upslope to matagouri, mingimingi, *Coprosma crassifolia* and desert broom.

Cranky Jims Link will connect existing covenants (Cranky Jims Shrubland Covenant and Island Block Covenant) through restoration planting, which will be progressively enriched to support succession toward podocarp-dominant dryland forest, a functionally extinct ecosystem type within the Macraes ED. The re-establishment of dry shrubland as a precursor to future podocarp forest therefore represents a rare and significant ecological restoration opportunity within the Macraes ED.

The restoration is expected to benefit indigenous invertebrates, lizards and birds, including taoka flora and fauna species associated with dryland shrubland and forest. By improving habitat condition, connectivity and resilience across both covenants, Cranky Jims Link provides a rare opportunity to reconnect protected habitat and initiate recovery of a highly depleted indigenous ecosystem.

Figure 5.3. (Over page) Cranky Jims Link showing approximately 50.59 ha of proposed dry shrubland restoration actions between two existing covenants.



Cranky Jims Link

Dry Shrubland Restoration

Date: 23/07/2026
Drawn By: CG
Client: OceanaGold New Zealand Ltd
Scale: 1:10,000

Legend

Existing Ecological Covenants

Proposed Dry Shrubland Planting: 50.59 ha

Proposed Stock-Proof Fencing

Existing Indigenous Habitat Within Proposed Restoration Area

Rock Outcrops - 0.56 ha

Dry Shrubland - 6.57 ha

SOURCES
Google Earth Aerial: November 2024

MAP PROJECTION
NZGD2000 / New Zealand Transverse Mercator 2000

Bioresearches
A Babbage Company

5.3 Mt Highlay

The Mt Highlay Station plantation comprises approximately 265 ha of recently established three-year-old plantation forest. At this early stage, the planted pines remain small enough for removal to be practicable, while much of the underlying indigenous habitat is still present and capable of recovery. Removing the plantation saplings will, therefore, avert the progressive degradation and eventual loss of indigenous dryland habitats—including lizard habitat, snow tussock grassland, dry shrubland and rock outcrops—that would occur if the plantation were left to mature.

Under the current land-management regime, the plantation is expected to develop into closed-canopy forest within 20 years. As the trees mature, increasing canopy cover and shade will progressively suppress indigenous groundcover and shrubland species, alter soil and microclimatic conditions, and reduce the extent and quality of indigenous habitat. These changes will substantially modify the composition and function of the existing vegetation communities and affect the fauna that depend on them.

The indigenous lizard species present at Mt Highlay Station are strongly heliothermic, relying on open, sun-exposed habitat for basking and thermoregulation, as well as the fine-scale mosaic of tussock, shrubland, rock and low vegetation that provides shelter, foraging habitat and movement pathways. A mature plantation would progressively eliminate these features, rendering much of the site unsuitable for open-habitat lizard species. This is supported by data from a monitoring project carried out on OGNZL landholdings that demonstrated an exceptionally low (near zero) abundance of lizards beneath pine plantation near Coronation North, with re-establishment of lizard populations in the area in the years following harvesting (Ahika 2021, Tweed & Thorsen 2021, Wildlands 2026).

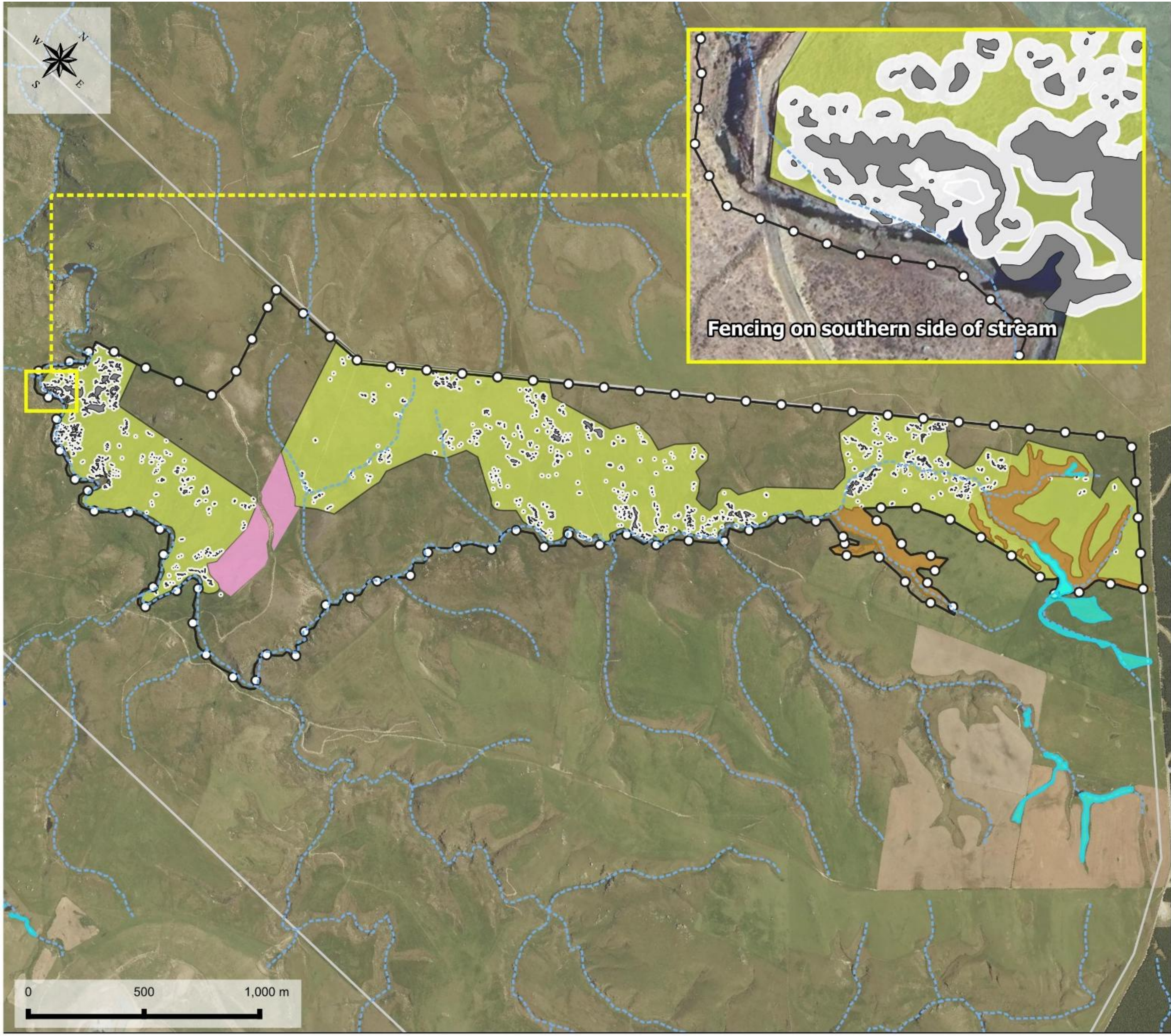
The compensation package will also move the site beyond avoidance of future degradation by actively restoring and securing a substantial area of indigenous habitat. Large-scale tussock revegetation (and relocation) will expand the extent of indigenous grassland (and flora, invertebrate, lizard communities), improve continuity between retained habitat patches and increase the area available for indigenous plants and fauna. The dedicated tor-buffer planting will strengthen the ecological margins around rock outcrops, provide additional habitat for TAR plant species, and reduce the isolation of these locally important features.

Together, these actions will create a larger and more coherent mosaic of continuous indigenous dryland habitat than would otherwise be lost under plantation forestry.

Compensation actions at Mt Highlay Station plantation (Figure 5.4, over page) include:

- Removal of 265 ha of 3-year old planted pine saplings to avert loss of indigenous habitats, particularly lizard habitat;
- 175.65 ha of snow tussock revegetation, including 15 ha of dedicated 5 m tor buffer planting
- 18.66 ha of existing snow tussock protection;
- 0.74 ha of dry shrubland protection;
- 4.07 ha of rock outcrop protection;

Figure 5.4. (over page) Mt Highlay Compensation actions, including tussock and tor restoration



Mt Highlay

Tussock Restoration

Date: 18/07/2026
Drawn By: CG
Client: OceanaGold New Zealand Ltd
Scale: 1:22,000

Legend

Mt Highlay Property Boundary
Rivers/Streams (LINZ)

Compensation Planting (175 ha)

Open Tussock Planting 160.60 ha
Rock Outcrop 5m buffer Planting 15.05 ha
Mt Highlay Fence

Existing Indigenous Habitat

Existing Tussock Of which 18.66 ha protected
Existing Grey Scrub Of which 0.74 ha protected
Identified Wetland
Tors - 4.07 ha within protected area
VDT Area - 7.5 ha

SOURCES
Google Earth Aerial: November 2024

MAP PROJECTION
NZGD2000 / New Zealand Transverse Mercator 2000

Bioresearches
A Babbage Company

5.4 Approach to residual effects on rock habitat, invertebrates and TAR flora

The terrestrial residual effects management package includes compensation actions that are expected to benefit rock-associated habitats, terrestrial invertebrates and Threatened and At Risk (TAR) flora. However, losses and anticipated gains for these biodiversity components have not been separately quantified through a biodiversity accounting model or measured on a direct like-for-like basis. The Project therefore does not claim that the loss of rock outcrops, affected invertebrate communities or associated individual TAR plants will be fully replaced, or that no net loss or net gain will be achieved for each of these components individually.

Compensation for these values is instead incorporated into the design and delivery of the wider terrestrial package. This includes directing restoration and enhancement activities around retained rock outcrops and schist tors, incorporating suitable TAR plants and rock or shallow-soil-associated species into planting and enrichment schedules, protecting existing populations and habitats within compensation areas, and increasing the extent and diversity of indigenous vegetation that supports terrestrial invertebrates.

The wider compensation strategy seeks to achieve an overall positive ecological outcome through substantial increases in the extent, condition, security and connectivity of indigenous vegetation and habitat within the surrounding Macraes landscape. Its principal quantified outcomes relate to the restoration and protection of tussock grassland and dry shrubland, together with landscape-scale pest management, stock exclusion, plantation removal and enduring legal protection.

These actions will also provide material benefits for existing rock habitats, as well as invertebrates and TAR flora. Restoration and enrichment planting will increase the abundance and diversity of indigenous host plants and provide a greater range of food, shelter, breeding sites and microhabitats. Protection and management of existing vegetation will support the persistence and recovery of invertebrate communities and TAR plants already present within the compensation areas. Similarly, restoration around retained rock features will improve their condition, ecological context and connectivity with surrounding tussock and shrubland habitats.

5.4.1 TAR plants

All TAR plants affected by the Project will remain subject to species-specific management, including salvage, propagation, establishment within suitable protected receiving sites, and subsequent monitoring. These measures are intended to minimise plant mortality and retain affected species within the wider Macraes landscape. However, the Project recognises that establishment success will vary among species and that uncertainty remains regarding the effectiveness of salvage and propagation for some taxa.

In addition, several TAR plant species subject to Moderate to Very High residual levels of effect are important components of the compensation revegetation and enrichment planting schedules. For example, the proposed planting includes approximately 8,799 dwarf broom and 139,779 narrow-leaved speargrass/taramea (taoka species) plants. Establishing these species at scale within protected restoration areas will increase their abundance and distribution, contribute to the composition and ecological function of restored dryland communities, and provide habitat and host-plant resources for associated indigenous invertebrates.

These planting actions form a material part of the compensation package, although gains for individual TAR species have not been separately quantified or credited against their losses on a direct like-for-like basis. The Project also recognises that propagation, translocation and establishment success will vary among taxa and that the long-term persistence of planted or salvaged individuals cannot be guaranteed.

Monitoring will assess establishment, survival and condition, identify the need for replacement planting or other management responses, and inform refinement of propagation and establishment methods. Outcomes, management responses and lessons arising from the programme will be documented and reported transparently.

5.4.1.1 TAR Plant Conservation Fund

A TAR Plant Conservation Fund will be established to provide additional compensation for the residual loss of TAR plants that cannot be reliably avoided, salvaged, propagated or established at release sites through the TAR Flora Management Plan. The Fund also recognises the limited ecological and horticultural knowledge available for many affected taxa and the resulting uncertainty in predicted management outcomes.

OceanaGold will contribute $100,000 for the duration of mining operations and the subsequent closure and remediation period of the MP4 project. The Fund will be administered by an independent body or governance group and applied to TAR plant conservation within the Otago Region.

Funding will support conservation of Threatened and At Risk flora within the Macraes Ecological District, including:

- research into the ecology, restoration including propagation, translocation and establishment of poorly understood taxa;
- seed and propagule collection, cultivation and ex situ conservation;
- establishment, enhancement or protection of wild populations;
- weed, stock and pest management around important populations;
- surveys and monitoring to improve knowledge of distribution, abundance and threats; and
- other actions that provide demonstrable and enduring conservation benefits for TAR flora.

Priority will be given to species affected by MP4, particularly those with Moderate to Very High residual levels of effect or for which salvage and propagation outcomes are uncertain. However, funding may also support wider landscape-scale actions for TAR flora where these provide greater or more durable conservation benefits.

Funded actions must be additional to any existing and future statutory and land-management obligations within the Macraes ED. Funding decisions, expenditure, actions and outcomes will be documented and reported annually, with priorities reviewed periodically in response to monitoring results and new ecological knowledge.

5.4.2 Rock outcrops

Rock outcrops and schist tors are recognised as important structural and ecological features that provide habitat for specialist flora and fauna. The physical rock substrate cannot be recreated or replaced like-for-like within an ecologically meaningful timeframe (although it is noted that salvage and relocation of rock substrate as izard habitat is provided for in the Lizard Management and Monitoring Plan. The Project therefore does not claim that the affected rock habitat will be fully replaced or that no net loss or net gain will be achieved for this component individually.

Compensation actions instead focus on protecting and enhancing 44.5 ha of retained rock outcrops and tors as flora and fauna habitats in exchange for the 0.26 ha impacted. At Mt Highlay Station, plantation removal will prevent the progressive shading and degradation of the habitat value of existing outcrops. Restoration and enrichment planting around outcrop margins will incorporate shallow-soil and rock-associated indigenous flora, while stock exclusion, pest management and legal protection will improve habitat condition and security. Restoration of the surrounding tussock and shrubland will also strengthen connectivity between outcrops and adjoining habitats.

These actions provide material compensation benefits for retained rock habitat and associated biodiversity, while acknowledging that the permanent loss of natural rock substrate remains a component-specific limitation of the overall package.

5.5 Additional benefits of the compensation package

5.5.1 Additional benefits for lizards

5.5.1.1 Benefits for Otago skinks inside the MEEA fence

The MEEA predator-exclusion fence provides a significant additional conservation benefit for Otago skinks by maintaining a secure population protected from introduced mammalian predators, the primary threat to species and to New Zealand lizards. The MEEA population is currently the only known Otago skink population on OGNZL landholdings. Although the species was historically more widespread across the property, it appears to have declined substantially in distribution and abundance (Bioresearches 2026c). Consequently, the MEEA fence plays an important role in securing the species' continued presence on OGNZL landholdings and reducing the risk of local extinction. While these outcomes are not equitable to expected adverse effects on other lizard species nor relied upon as compensation for project effects (i.e., presence or uplift of Otago skinks inside the MEEA fence is not included in the compensation model), they represent a significant positive legacy of mine-related conservation management.

The conservation benefits of predator exclusion for Otago skinks and other New Zealand lizards are well established. Reardon *et al.* (2012) recorded increases in Otago skink abundance (66% increase in abundance over the 3-year monitoring period) at Macraes within predator-exclusion fenced areas, demonstrating the capacity of predator exclusion to facilitate population recovery. Similarly, Turner and Norbury (2023) found substantially higher lizard abundance within a predator-free dryland sanctuary in Central Otago than in adjacent areas where mammalian predators remained present, concluding that predator-free sanctuaries provide important opportunities for lizard population recovery and improved population viability. Furthermore, recent evidence from Mokomoko Sanctuary demonstrates that predator exclusion (including mice) can provide significant benefits for Otago skinks, with increased annual recruitment recorded over the past six years (Central Otago Ecological Trust 2026).

The MEEA fence will provide a long-term, legally protected refuge for Otago skink within the Macraes landscape. OGNZL have committed to funding and maintaining the MEEA fence to 2050, after which the MEEA—as well as Cranky Jims Link and the Mt Highlay compensation area—will be transferred to a special purpose trust which will be funded by a closure capitalisation fund set up by OGNZL (at this stage the parties to the trust and its governance have not been confirmed). The fenced population will also provide opportunities for ongoing monitoring and research over this period.

It is also relevant to consider the fence's potential effect on habitat connectivity for Otago skink beyond the MEEA boundary, particularly in relation to individuals potentially present downstream within the Murphys Creek catchment. The fence structure is not entirely impermeable to the species: juvenile Otago skinks, being considerably smaller-bodied than adults, are able to pass through the fence mesh, allowing dispersal and gene flow between populations on either side of the fence to continue following construction. Adult Otago skinks are therefore more likely than juveniles to experience reduced movement across the fence line, and this ongoing juvenile permeability is expected to at least partially mitigate the potential for the fence to isolate populations demographically or genetically over time.

The significance of any reduction in connectivity for Otago skink downstream of the MEEA fence within the Murphys Creek catchment is, in any case, considered low. The presence of Otago skink downstream of the fence has not been confirmed, and in the absence of a known, connected downstream population, the potential for the fence to bisect an existing population — with associated effects on metapopulation dynamics or gene flow across the wider catchment — is not considered a material concern. Further detail on the potential effects of fence construction on Otago skink and other lizard species, including connectivity, is provided in the fence construction Ecological Impact Assessment (Bioresearches 2026p).

The Otago skink response within the MEEA fence is not included in the Project's quantitative compensation accounting. The fence itself is included in the McCann's skink and southern grass skink BOAMs. Protection of Otago skink is an additional conservation gain that contributes to species recovery and aligns with the vision and objectives outlined in the OceanaGold Lizard Management Strategy (OceanaGold 2026); providing enduring biodiversity benefits within the wider Macraes landscape.

5.5.1.2 Buffer pest control area

The approximately 1,170 ha buffer surrounding the MEEA predator-exclusion fence will be subject to landscape-scale pest management as part of the 'fence halo protection' programme (Alliance Ecology 2026). Within this area, key mammalian predators of lizards, including rodents, mustelids, possums, hedgehogs, rabbits, and feral cats (where required) will be suppressed. Details of the proposed management are provided in the Pest Management Plan (Alliance Ecology 2026). Although this programme is not specifically designed to achieve lizard conservation outcomes within the buffer, reductions in predator abundance may provide consequential benefits for resident lizard populations.

Although outcomes are less certain, studies on the mainland also demonstrate that lizard populations can respond positively to control (rather than eradication) of mammalian predators (e.g. Reardon *et al.* 2012; Jones *et al.* 2013; Norbury *et al*. 2013, Appendix D). Evidence from the Macraes area indicates that landscape-scale predator control can result in positive lizard population responses. Reardon *et al.* (2012) found that populations of grand skinks and Otago skinks increased at similar rates under both predator-exclusion fencing (where all mammals except mice were eradicated) and intensive landscape-scale trapping (excluding mouse control), whereas populations at unmanaged sites remained stable or declined.

Similarly, Wilson *et al*. (2017) reported substantially higher densities of small skinks (McCann's, southern grass, and herbfield skinks) in areas subject to predator management (excluding mouse eradication or control) than in unmanaged control sites. Skink densities immediately outside predator-exclusion fences were comparable to those recorded within fenced areas, while densities declined with increasing distance from the fence, becoming intermediate between fenced and unmanaged sites. The authors hypothesised that the permeability of the fence to small skinks allowed movement between fenced and adjacent managed areas, contributing to elevated skink densities beyond the fence boundary. These findings suggest that predator-exclusion fencing, combined with intensive predator suppression in the surrounding landscape, can generate halo benefits for lizard populations extending beyond the fenced area itself.

However, evidence from elsewhere in New Zealand indicates that the effectiveness of landscape-scale predator control depends on the suite of predators being managed. Monks *et al.* (2024) found that southern grass skink populations declined despite predator control targeting stoats and rats, because mouse populations remained abundant and were negatively associated with skink abundance. The authors concluded that predator control programmes may fail to deliver positive outcomes for lizard populations where mouse irruptions occur and are not effectively managed. This risk is particularly relevant in ecosystems subject to periodic seed-masting events, which can drive rapid increases in mouse abundance and potentially negate the benefits of controlling other mammalian predators.

More broadly, Nelson *et al.* (2016) noted that successful lizard recovery in unfenced mainland habitats has generally occurred where predator management was specifically designed to benefit lizards and applied intensively across core habitat areas. Collectively, these studies indicate that meaningful lizard population responses can be achieved through predator management, but outcomes depend on the intensity, spatial extent, and species-specific focus of the control programme.

Accordingly, while the proposed predator management in the MEEA buffer is expected to provide some benefit to resident lizards, particularly given the positive results observed in the Macraes landscape, these benefits are uncertain and cannot be reliably quantified. For this reason, no reliance is placed on predator control within the buffer to achieve the compensation outcomes required for MP4. Instead, the primary compensation mechanism is the MEEA predator-exclusion fence (eradication of all mammals, including mice). Any benefits realised within the surrounding buffer will therefore be additional to, rather than necessary for, achieving the Project's lizard compensation objectives.

5.5.1.3 Murphys Link

Excluding the predator-exclusion fence itself, the MEEA will provide substantial benefits for indigenous lizards through the protection, restoration, and enhancement of a large area of habitat within the wider MurphysCreek catchment. The Murphys Link includes approximately 200 ha of existing snow tussock, 33 ha of dry shrubland, and 19 ha of rock tor habitat that will be stock-fenced and protected in perpetuity. These measures will increase the extent, quality, and long-term security of lizard habitat within an area already known to support populations of McCann's skink, southern grass skink, and kōrero gecko.

A key benefit of the Murphys Linkis the creation and enhancement of habitat connectivity across the landscape. Its strategic placement in the landscape will strengthen ecological linkages between the MEEA predator exclusion fence and the Redbank Covenant, an area recognised for its high lizard habitat values, specifically the presence of 'Threatened' grand skinks. The establishment of a continuous corridor of protected snow tussock and dry shrubland habitat between these areas will facilitate natural dispersal, recolonisation, and gene flow between lizard populations. Improved connectivity is particularly important in fragmented dryland ecosystems, where habitat isolation can limit population resilience and recovery.

Lizards salvaged from MP4 impact areas will be released into suitable habitat within the Murphys Link. However, no reliance is placed on these relocated individuals when assessing the ecological benefits of the enhancement area or the achievement of compensation outcomes. Rather, the benefits of the MEEA arise from the permanent protection and restoration of indigenous habitat and the strengthening of landscape connectivity between important lizard sites. Any contribution made by relocated lizards to local population abundance or viability should, therefore, be regarded as an additional conservation benefit rather than a component required to achieve the Project's biodiversity outcomes.

5.5.1.4 Cranky Jims Link

The Cranky Jims Link will provide long-term benefits for indigenous lizards through the protection, restoration, and reconnection of habitat across a large area of the OGNZL landholdings. The corridor will connect three existing ecological covenants—Cranky Jims Wetland Covenant (97.4 ha), Cranky Jims Shrubland Covenant (47.2 ha), and Island Block Covenant (291.55 ha)—into a single, continuous protected landscape. This will be achieved through the revegetation of approximately 50 ha of indigenous dry shrubland habitat and the protection of 6.5 ha of existing dry shrubland and 0.56 ha of rock tor habitat, increasing both the extent and continuity of habitat available to lizards within the wider landscape.

A key benefit of the corridor is the enhancement of ecological connectivity between the Cranky Jims and Island Block covenants, both of which support high lizard values. Island Block Covenant also benefits from an established intensive predator control programme (including mouse control) over approximately 80 ha, providing an important refuge for indigenous lizard populations. Habitat fragmentation is a recognised threat to lizards because it can restrict dispersal, reduce opportunities for recolonisation, and isolate populations. By creating a continuous corridor of snow tussock, dry shrubland, and rock habitats, the project will facilitate movement between previously separated habitat areas, promoting population connectivity and increasing the resilience of lizard populations over the long term.

The corridor is also expected to improve habitat quality over time. Protection of existing dry shrubland and rock tor habitats will secure important refuge, basking, and foraging resources, while restoration planting will progressively increase vegetation cover, structural diversity, and habitat complexity. As these habitats mature, they will provide additional shelter, prey resources, and dispersal opportunities for lizards throughout the corridor. The longer-term development of dry shrubland, and ultimately podocarp-dominant dryland forest, will further diversify habitat conditions and contribute to the restoration of ecological communities that are now rare within the Macraes ED.

While indigenous lizards are expected to benefit from these actions, no reliance is placed on Cranky Jims Link to achieve compensation outcomes for the MP4 Project. Rather, the corridor represents an additional landscape-scale biodiversity enhancement measure that will improve habitat extent, quality, and connectivity for lizards and other indigenous fauna. Any resulting increases in lizard abundance, occupancy, or population resilience should therefore be regarded as supplementary conservation gains beyond those required to achieve the Project's compensation objectives.

5.5.1.5 Mt Highlay Station averted loss

The Mt Highlay Station plantation comprises approximately 265 ha planted in 2023 with Douglas fir, radiata pine (*Pinus radiata*), and hybrid pine (*P. radiata* × *P. attenuata*) (Forbes 2025). The plantation is registered under the New Zealand Emissions Trading Scheme (ETS) for the purpose of carbon credits. The plantings have exhibited high survivorship and are establishing well, with trees currently around 1 m high in exposed areas and 1.2–1.4 m in more sheltered locations with favourable soils. At this early stage, the pines remain small enough for removal to be practicable, while the habitat for indigenous fauna and flora is still largely intact and capable of recovery.

Surveys undertaken in 2026 confirmed the presence of three lizard species: McCann's skink, southern grass skink, and kōrero gecko, as well as the presence of extensive suitable lizard habitat across the 265 ha site, including open tussock grassland and numerous schist rock outcrops—important refugia for kōrero gecko (E3, Bioresearches 2026c).

As the forest canopy matures, increasing shade will progressively suppress grassland groundcover, alter soil and microclimatic conditions, and substantially reduce the extent and quality of habitat available to lizards. The indigenous lizard species present are strongly heliothermic (sun-loving), relying on open, sun-exposed habitat for basking and thermoregulation, as well as the mosaic of grassland, tussock and other low vegetation, and rock that provides shelter, foraging habitat, and dispersal pathways for lizards. A mature, closed-canopy plantation will substantially degrade or eliminate these features, excluding lizards from much of the habitat they currently use and rendering the site largely unsuitable for both heliothermic and rock dwelling species (Figure 5.5).

This expected outcome is supported by data from a monitoring programme undertaken elsewhere on OGNZL landholdings, the results of which are summarised below.

- A baseline survey of a 3.6 ha area of mature radiata pine (approximately 25–28 years old, with little understorey) near Coronation North was undertaken in December 2020. Prior to pine removal, lizards were surveyed using pitfall trap grids (100 traps total, five inspections each) plus approximately 2–5 hours of hand-searching. The pitfall traps captured a single juvenile McCann's skink from 500 trap inspections (0.002 lizards/ trap inspection), and hand searches failed to detect any lizards beneath the pine canopy, with lizards only recorded on the outer periphery of the forest block (Ahika 2021).
- After pine felling in December 2021 and early February 2022, follow-up lizard monitoring was carried out in the felled pine/slash area in March 2023 and recorded three McCann's skinks in pitfall traps (0.008 lizards/ trap inspection) (Tweed & Thorsen 2021). Monitoring in January 2026, detected 32 skinks (15 McCann's, 17 southern grass skink; 0.08 lizards/ trap inspection), representing a 40-fold increase in catch rate over approximately five years (Wildlands 2026). The increase in lizards was a direct result of the pine removal and the consequent reestablishment of lizards into open, sunny habitats.

Under the current land-management regime at Mt Highlay, the plantation is expected to develop into closed-canopy forest within 20 years. Under the ETS, radiata pine and Douglas fir reach their average carbon stock, and stop earning credits, at 16 and 26 years respectively, at which point harvesting typically occurs, followed by replanting. Under the status quo, this will create a cycle of periodic clearance and regrowth that would not provide long-term security for lizard habitat or populations within the forestry area. Harvesting operations are also likely to cause irreplaceable damage to habitat features such as rock outcrops. While there is some uncertainty around the magnitude of decline in lizard numbers resulting from maturation of pine forest, the Coronation North example suggests catastrophic declines could be expected—potentially as high as 75–80%, or higher. Accordingly, removal of the trees from the Mt Highlay Station plantation will avert this loss.

To avoid significant adverse effects on lizards that would otherwise occur, all planted trees will be removed and the area protected via covenant and stock fencing (see Residual Effects Terrestrial Restoration Plan, E15, Bioresearches 2026n), allowing existing lizard populations and habitat to persist. To confirm that this averted loss claim is valid, the Mt Highlay pine removal was assessed against a recognised framework for determining averted loss validity (Maseyk *et al*. 2021; see Appendix G for the assessment).

To demonstrate that pine removal will avoid adverse effects and avert loss, lizard monitoring over the 16–26 year term need only demonstrate that lizards diversity and abundance have not declined above the 'natural' decline rates identified for each species of lizard under the NZTCS framework (Rolfe *et al.* 2022; Hitchmough *et al.* 2026). Any increase in lizard abundance as a result of improvement in habitat quality (see Section 5 and the Residual Effects Terrestrial Restoration Plan, E15, Bioresearches 2026n) following pine removal, would be considered additional to that necessary to demonstrate averted loss.

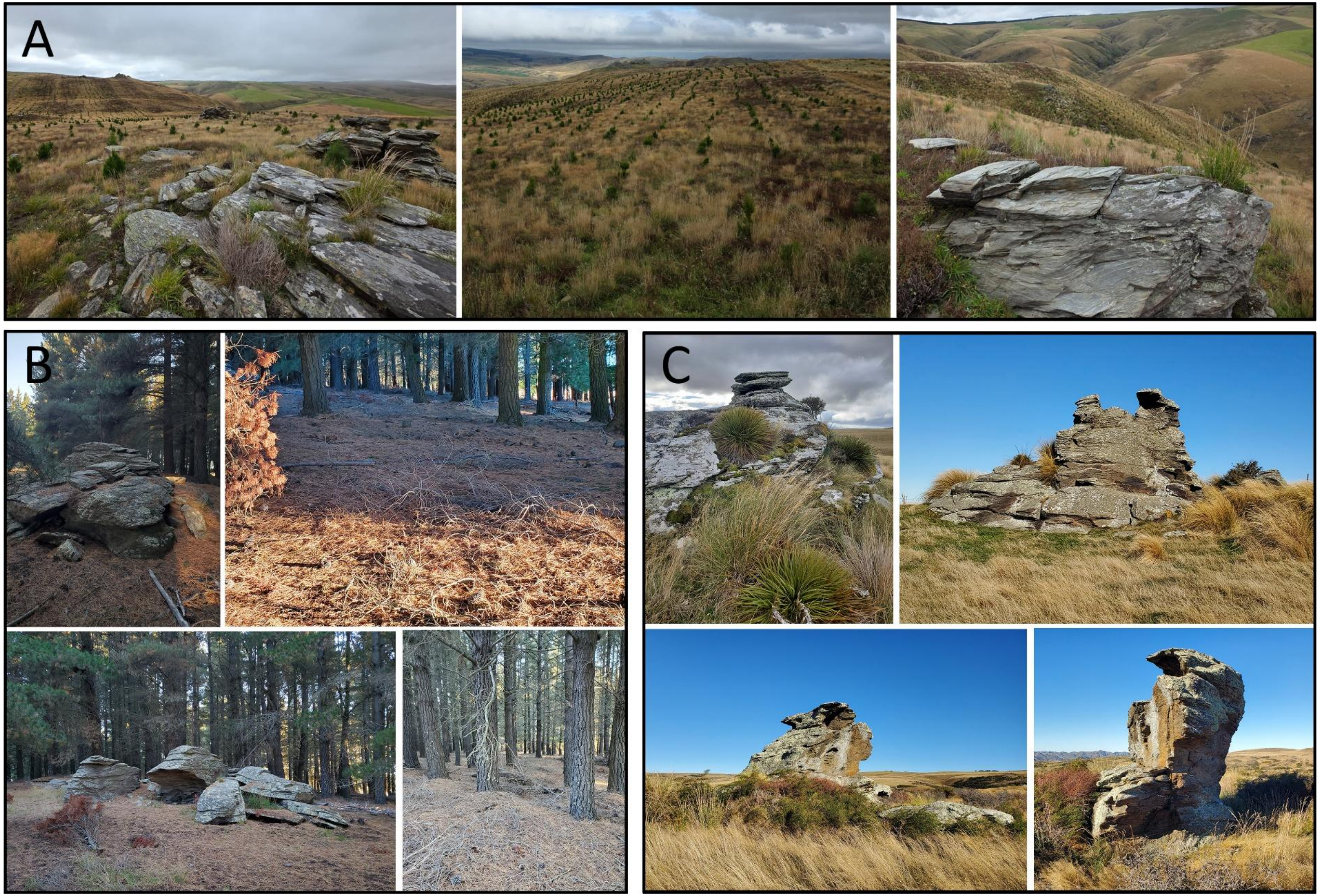


Figure 5.5. Photographs showing the effect of pine plantation on lizard habitat quality. Photo set A – Mt Highlay Station with establishing pine plantation; Photo set B – devoid lizard habitat beneath mature pine plantation on OGNZL landholdings; and Photo set C – natural lizard habitat on OGNZL landholdings.

5.5.1.6 Mt Highlay Station (areas outside of and additional to the 265 ha averted loss site)

Outside of the 265 ha averted loss area where pine will be removed to preserve lizard habitat and populations, an additional 39 ha of land currently supporting lizard habitat will be present inside the proposed Mt Highlay Station fence boundary. This area contains approximately 18.6 ha of existing snow tussock, 0.7 ha of indigenous dry shrubland, 3.6 ha of rock tor habitat, approximately 16 ha of other habitat types (e.g., riparian margin), and 7.5 ha of vegetation (snow tussock) direct transfer, all of which provide important habitat features for lizards, including refuge sites, basking opportunities, foraging habitat, and dispersal corridors. The protection of these habitats will ensure that they remain available to support resident lizard populations and are not subject to future land-use intensification or further habitat degradation.

The rock tor habitats are of particular importance because they provide permanent structural refuges that are often associated with higher lizard abundance and diversity in the Macraes landscape. Protection of these features, together with the surrounding snow tussock and dry shrubland vegetation, will maintain habitat heterogeneity and support a range of microhabitats used by indigenous lizards throughout their life cycles.

Although the protected area is relatively small in comparison with other conservation areas proposed as part of the Project, it contributes to the overall network of protected indigenous habitats across the OGNZL landholdings. By securing representative examples of snow tussock, dry shrubland, and rock tor habitats, the site will assist in maintaining lizard habitat availability and ecological values within the wider Macraes landscape.

While indigenous lizards are expected to benefit from the long-term protection of these habitats, there is no reliance on this area to achieve measured compensation outcomes for the MP4 Project. Rather, the site represents an additional conservation measure that secures existing habitat values and contributes to the broader protection of indigenous biodiversity. Any resulting benefits to lizard populations should, therefore, be regarded as supplementary conservation gains beyond those required to achieve the Project's measured compensation objectives.

5.5.2 Additional benefits for avifauna

5.5.2.1 Murphyspest-exclusion fenced area (MEEA)

The predator-proof fence and associated eradication or exclusion programme provide an avifauna benefit that is distinct from modelled vegetation restoration. The additional outcome is reduced exposure of indigenous birds, their nests, eggs, and dependent young to introduced mammalian predators within the fenced area, restricted to avifauna receptors that were not separately represented in the BOAM.

Studies of New Zealand fenced sanctuaries have found higher densities of several endemic birds within sanctuaries than at comparable sites receiving little mammalian predator control. Tomtit was among the species showing a positive sanctuary response. In contrast, fantail and silvereye did not show a consistent positive response, demonstrating that predator exclusion does not benefit all indigenous birds equally (Bombaci et al., 2018). Evidence from other fenced and restored systems similarly shows that responses vary by species, trophic guild, and habitat context, and that predator exclusion is most consistently beneficial for small insectivorous forest birds and some threatened taxa, rather than all avifauna assemblages (e.g. Innes et al., 2022; Fitzgerald et al., 2021).

The defensible additional outcome is therefore a sustained reduction in predation exposure for non-modelled indigenous birds using the fenced area. A general increase in avifauna abundance or breeding performance is not be claimed on the basis thatquantitiatve evidence from sanctuary studies were predominantly undertaken in North Island forest environments, so cannot be transferred directly to the dryland and shrubland habitats at Macraes.

5.5.2.2 Buffer pest control area

The buffer provides pest control in the unfenced habitat surrounding the predator-proof area. Benefits arising solely from protecting the integrity of the fence, detecting incursions, or maintaining the predator status assumed for the fenced area are delivery safeguards and should not be treated as separate conservation gains.

A distinct additional outcome can be recognised for the unfenced buffer only where pest control achieves sustained suppression over habitat outside the fence and this area was not included in the BOAM. In that circumstance, indigenous birds using the buffer would experience lower exposure to mammalian predators across a larger part of the Murphys landscape than would be provided by the fenced area alone.

The level of confidence is lower than for the fenced area. Unfenced pest-control programmes remain subject to continuing reinvasion, and New Zealand reviews emphasise that biodiversity responses depend on the species controlled, the residual predator abundance achieved, the spatial scale of control, and other limiting factors (Innes et al., 2024). The buffer should therefore be described as complementary predator suppression, rather than as equivalent to predator exclusion within the fence.

5.5.2.3 Murphys Link

Murphys Linkprovides a protected habitat linkage between the fenced MEEA pest-exclusion fence and other habitats in the Murphy's–Redbank landscape. The additional avifauna outcome is improved landscape integration immediately outside the fenced area. The connection reduces the physical isolation of the fenced core and provides a more continuous route through which indigenous birds already present in the wider landscape can move between habitat areas. This conclusion concerns landscape permeability and does not imply that particular species will colonise the connection or increase in abundance.

New Zealand movement data show that the value of habitat connections differs substantially among bird species and that direct evidence remains sparse for many taxa (Innes et al., 2022). Fragmentation research indicates that even narrow habitat linkages can improve functional connectivity for some forest birds, but responses are highly species- and matrix-dependent (e.g. Lindenmayer & Fischer, 2007; Innes et al., 2022). Research at Orokonui Ecosanctuary also found a greater abundance of endemic frugivorous birds inside and immediately outside a predator-exclusion fence than in the surrounding landscape, indicating that benefits from a fenced sanctuary can extend beyond its boundary (Tanentzap & Lloyd, 2017). The Orokonui result involved forest habitat and a different bird assemblage, so it supports the general importance of an integrated surrounding landscape but does not establish a comparable response at Macraes.

5.5.2.4 Cranky Jims Link

The proposed action establishes or strengthens an indigenous habitat connection between the Cranky Jims covenant area and Island Block. The associated increases in vegetation extent, cover, structure, condition, and plant diversity are already represented in the relevant BOAM and are excluded from this assessment.

The additional avifauna outcome is a reduction in the physical separation of existing habitat areas. Movement and gap-crossing were not quantified as BOAM attributes. New Zealand evidence indicates that the effects of habitat fragmentation are species-specific and that information on the movement of many indigenous birds remains limited. Tomtit, which has been recorded in the wider Macraes landscape, is classified as moderately gap-limited, whereas raptors and several other recorded species are comparatively mobile (Innes et al., 2022). The link, therefore, provides a more continuous movement route through the existing habitat mosaic, but the evidence does not support a prediction of increased abundance, breeding success, or use by any particular species.

5.5.2.5 Mount Highlay

The proposal involves the removal of the existing young pine plantation, restoration of indigenous vegetation, and permanent protection of the restoration area. All gains arising from the development of indigenous vegetation, including changes in habitat extent, structure, condition, and composition, are already included in the BOAM.

At present, the pine trees are very young and not yet providing meaningful habitat for indigenous birds. Accordingly, no avifauna benefit is attributed to their removal. However, their removal can be considered an averted future loss, as continued establishment and maturation of the plantation would be expected to progressively reduce suitability for some indigenous fauna, particularly lizards, through shading and habitat homogenisation.

No separate additional avifauna gain should therefore be assigned to Mount Highlay unless the project counterfactual demonstrates that plantation harvesting, renewed mining, or another incompatible land use would otherwise occur, and that the avoided disturbance was not incorporated into the BOAM baseline or its durability assumptions. Covenanting provides long-term security for the modelled restoration outcomes but should not be presented as independently increasing bird abundance.

5.5.3 Additional benefits for plants

In addition to the BOAM outputs, the residual effects package secures approximately 577.03 ha of existing indigenous terrestrial habitat outside restoration gain areas, comprising tussock grassland, dry shrubland and rock outcrop/tor systems (Bioresearches, 2026n). These areas, together with landscape-scale connectivity and protection measures, give rise to additional conservation outcomes described below.

5.5.3.1 Cranky Jims Link

Cranky Jims Link provides additional conservation outcomes through both the protection of existing habitat and improved landscape configuration. Approximately 6.58 ha of existing dry shrubland and 0.56 ha of rock outcrop/tor habitat lie outside the BOAM revegetation area but within the wider protected link. Stock exclusion, weed control and legal protection will secure these habitats from ongoing pastoral and weed pressure, resulting in retention of existing indigenous vegetation and rock-associated plant communities.

The link also reduces separation between the Cranky Jims Shrubland Covenant and Island Block Covenant, improving the spatial continuity of protected indigenous habitat. This represents a landscape-scale configuration benefit not captured in the BOAM, although no specific plant population processes (e.g. dispersal, recruitment or gene flow) are demonstrated.

Within the 50.59 ha restoration area, approximately 21.4 ha is proposed for progressive enrichment planting with indigenous broadleaved and podocarp species. This will accelerate structural and compositional development towards a more diverse dryland forest trajectory, contributing to long-term ecosystem complexity within the BOAM framework.

5.5.3.2 Mount Highlay

At Mount Highlay, additional conservation outcomes arise from the protection of existing indigenous habitats surrounding the restoration footprint. Outside the 175.65 ha revegetation area and the 265 ha plantation removal footprint, approximately 18.66 ha of existing tussock grassland, 0.74 ha of dry shrubland and 4.07 ha of rock outcrop/tor habitat are secured through stock exclusion, weed management and enduring protection. These actions retain existing indigenous vegetation and associated plant habitat values that are not included in the BOAM gain calculation.

These protected areas provide continuity with surrounding indigenous ecosystems and reduce ongoing degradation pressures, complementing the large-scale tussock restoration established through plantation removal.

5.5.3.3 Murphys predator-exclusion fenced area

The 252 ha predator-exclusion fenced area contains approximately 134.9 ha of tussock grassland, 7.4 ha of dry shrubland and 7.8 ha of rock outcrop/tor habitat outside BOAM gain areas. Stock exclusion, weed control and long-term protection will secure these existing indigenous habitats, delivering a clear retention-based conservation outcome. While the magnitude of ecological improvement is not quantified, the removal of grazing and land-use pressure is expected to support natural regeneration processes within these systems. The fenced area also provides a secure environment for planted or translocated Threatened or At Risk plants. These contribute to BOAM richness targets but may also enhance local conservation security for selected taxa where establishment is successful.

5.5.3.4 Murphys pest-control buffer (unfenced area)

Within the wider MEEA, approximately 144.82 ha of tussock, 15.27 ha of dry shrubland and 12.93 ha of rock habitat lie outside the fenced core and are subject to stock exclusion, weed management and protection measures. These actions secure existing indigenous vegetation and rock habitats from ongoing degradation pressures. Landscape-scale mammalian pest control is also proposed across an approximately 1,170 ha buffer surrounding the fenced area. This provides a supporting conservation function by maintaining low pest pressure across the wider landscape, reinforcing the integrity of fenced and restored areas. While no direct plant response has been quantified, this contributes to system resilience and reduces reinvasion risk.

5.5.3.5 Murphys Link

Murphys Link establishes approximately 395.54 ha of legally protected land connecting the MEEA and Redbank Covenant. Within this, approximately 253.98 ha comprises existing tussock grassland, dry shrubland and rock outcrop/tor habitat. Stock exclusion, weed and pest management, and legal protection secure these habitats from ongoing land-use pressure, delivering a substantial retention-based conservation outcome for indigenous vegetation outside the BOAM. The link also provides a continuous protected corridor between major conservation areas, improving landscape-scale habitat continuity across tussock, shrubland and rock systems. While functional plant connectivity has not been demonstrated, this configuration strengthens ecological coherence at a district scale.

5.5.3.6 Project-wide Threatened or At Risk plant actions

The Vegetation and TAR Flora Management Plan provides for salvage, propagation, planting and monitoring of Threatened or At Risk plant species, including taxa not directly affected by mining where appropriate for restoration contexts (Bioresearches, 2026g). While Threatened or At Risk plant richness is already accounted for within the BOAMs, these actions may provide additional species-level conservation security where they support establishment of viable populations beyond modelled richness targets.

A dedicated TAR Plant Conservation Fund ($100,000) provides an enabling mechanism for additional conservation outcomes through research, surveys, ex situ conservation and targeted management. Ecological outcomes will depend on the specific projects funded and their demonstrated results.

Table 5-3. Relationship between residual effects and the proposed package

Biodiversity value	Impact quantum and residual effect	Compensation Actions	Predicted Outcome after compensation is considered
Narrow-leaved snow tussock	Up to 90.01 ha loss or degraded. Residual effect: **Very High**.	**175 ha** of tussock planting at Mt Highlay; **481.04 ha** tussock at MEEA fenced, covenanted and/or pest-controlled and **18.66 ha** tussock at Mt Highlay; fenced, covenanted and pest-controlled	**Net Positive (modelled)** for restoration planting only. Additional stock fencing, protection and predator control is more than 5.5 times the extent lost.
Dry shrubland	Up to 3.06 ha loss or degraded. Residual effect: **Low**.	**50 ha** of dry shrubland planting at Cranky Jims Link; Fenced, covenanted and/or pest controlled: **56.15 ha** shrubland at MEEA **6.58 ha** at Cranky Jims Link; **0.74 ha** at Mt Highlay;	**Net Positive (modelled)** for restoration planting only. Additional stock fencing, protection and predator control is nearly 29 times the extent lost.
Rock outcrops and tors	Approximately 0.16 ha of direct loss and 0.26 ha when the 20 m buffer is included. Residual effect: **Moderate**.	**15 ha** rock edge planting at Mt. Highlay; Fenced, covenanted and/or pest controlled: 44.5 ha rock and tor habitat at MEEA, Cranky Jims & Mt Highlay combined	**Net Positive (unmodelled)** Targeted planting around approximately 15 ha of existing rock outcrops, about 58 times the area lost Pest management and long-term protection of existing rock habitat is more than 170 times the affected extent.
29 TAR Plant species	Species-specific: 20 species assessed as likely to experience moderate or higher residual effects: 7 spp- Very High 5 spp- High 8 spp- Moderate 4 spp- Low 4 spp- Very Low1 spp- Negligible	Propagation and restoration for some species in compensation planting schedules for tussock, rock edge, dry shrubland and wetlands	Species-specific: 16 species assessed as likely to experience moderate or higher residual effects: 5- Very High 4- High 7- Moderate 5- Low 5- Very Low 3 spp- Net positive
Terrestrial invertebrates	Approximately 325 ha of potentially suitable habitat is affected within the footprint and precautionary buffer. Residual effect: **High** for the project-wide assemblage and several notable taxa, with **Moderate** or lower effects for other taxa.	Snow tussock and dry shrubland planting; protection of existing vegetation and rock habitat; establishment of identified host plants; pest plant management, stock exclusion and improved habitat continuity.	**Net Positive (unmodelled)** for several notable taxa and **Uncertain** for the remainder. The package is expected to increase host-plant availability, indigenous vegetation cover, litter and structural complexity. No quantitative invertebrate BOAM conducted.

Indigenous lizards	Approximately 238.7 ha of suitable habitat is affected, with an estimated 155,564 lizards potentially present. Residual effect: **Moderate** for McCann's skink and **Very High** for southern grass skink and kōrero gecko.	A 252 ha predator-exclusion fence; approximately 1,170 ha additional predator-control buffer; the 395.54 ha Murphys Linkand lizard release area; protection of existing tussock, dry shrubland and rock habitat; removal of approximately 265 ha of plantation forestry at Mt Highlay; and habitat restoration.	**Net Positive (modelled & unmodelled)** The BOAM predicts positive outcomes for the two modelled skinks. However, southern grass skink retains a modelled deficit in snow tussock habitat, with the proposed fence estimated to address approximately 20% of that component. Kōrero gecko has not been quantitatively modelled but for both kōrero gecko and the southern grass skink deficit, unmodelled positive outcomes are predicted.
Kārearea / eastern falcon	Approximately 235.99 ha of suitable habitat affected. Residual effect: Moderate.	Predator exclusion and landscape-scale predator control across MEEA and its buffer; protection and restoration of open-country, tussock, dry shrubland and rock-associated habitat.	**Net Positive (modelled)** The BOAM predicts a positive outcome for kārearea.
Banded dotterel / pohowera	Approximately 130.38 ha of suitable habitat affected. Residual effect: Moderate.	Landscape-scale predator control over open and lightly vegetated habitat within the MEEA package.	**Net Positive (modelled)** The BOAM predicts a positive outcome for banded dotterel.
South Island pied oystercatcher / tōrea	Approximately 130.38 ha of suitable habitat affected. Residual effect: Moderate.	Landscape-scale predator control over open-country habitat within the MEEA package.	**Net Positive (modelled)** The BOAM predicts a positive outcome for SIPO.
Otago skink, grand skink and podocarp-broadleaved forest values	These values are not identified as directly affected residual-effect components of MP4.	Predator exclusion at MEEA, Murphys Link, habitat protection and podocarp-broadleaved enrichment at Cranky Jims Link.	**Net Positive (unmodelled)** Potentially important additional conservation benefits at the species, ecosystem and landscape scales.

6 Biodiversity offsetting accounting models

Where quantitative information was available, Biodiversity Offset Accounting Models (BOAMs) were applied to compare residual biodiversity losses at the impact sites with the predicted gains from proposed management at the corresponding residual effects management sites (e.g. tussock grasslands, dry shrubland). The models provide a structured means of testing whether the scale, condition and timing of the proposed gains are likely to be sufficient to address the residual effects and achieve positive outcomes. In this assessment, the BOAMs have been used as decision-support tools to inform the scale and design of the residual effects management package and to provide an initial assessment of its likely adequacy.

The BOAM framework disaggregates biodiversity components into relevant attributes, such as habitat extent, vegetation structure, species composition, habitat condition and ecological function. Quantitative scores are assigned to these attributes at the impact and management sites and used to calculate biodiversity losses and predicted gains over a defined period. The models account for the timing of gains, the risk that management actions may not achieve their intended outcomes and uncertainty in the underlying information through discounting and confidence multipliers. They also require biodiversity components to be assessed separately, so that gains for one value do not obscure losses for another (Department of Conservation 2014).

6.1 Use of BOAMs for 'Compensation'

The current BOAMs are subject to limitations in the available baseline and predictive datasets. These include differences in the type, timing and intensity of surveys undertaken at impact and management sites; incomplete information on the present condition and distribution of some biodiversity values; uncertainty associated with extrapolating survey results across larger habitat areas; and uncertainty regarding the rate, scale and ecological response to proposed restoration, protection and pest-management actions. Some model inputs therefore rely on conservative assumptions, professional judgement or predicted future ecological trajectories rather than directly comparable empirical measurements.

These limitations mean that the current BOAM results do not provide sufficient certainty to demonstrate that all relevant biodiversity offset principles and standards will be met. In particular, the present information may not consistently demonstrate measurable equivalence to the level of confidence required for the package to be characterised as a biodiversity offset. The residual effects management package is therefore described at this stage as biodiversity compensation, notwithstanding that the proposed actions have been designed to address affected values as directly as practicable and that several of the modelled outcomes indicate net positive outcomes for the data provided.

To address the existing information limitations, further baseline and condition data will be collected at the impact and residual effects management sites before relevant works and management actions are implemented. The BOAMs will then be updated and reapplied using the improved datasets, refined management assumptions and confirmed implementation areas. Where the updated modelling and supporting evidence demonstrate that the applicable biodiversity offset principles and standards can be achieved, those components of the package may subsequently be verified and managed as biodiversity offsets. Components for which equivalence, certainty or offsetting standards cannot be demonstrated will continue to be treated as biodiversity compensation.

6.2 Values modelled

BOAMs were applied to four biodiversity components using the best available quantitative information. Tussock grassland was modelled using vegetation plot data, while dry shrubland was modelled using vegetation plot data together with avifauna diversity data from Cranky Jims. Lizard modelling used quantitative baseline monitoring data collected across three broad habitat types. Avifauna modelling was based on predicted improvements in breeding success arising from proposed management, informed primarily by published evidence. Although the models provide a quantitative basis for comparing predicted biodiversity losses and gains, all outcomes are described as biodiversity compensation because limitations in baseline data, ecological equivalence and certainty of predicted outcomes mean that the requirements of a formal biodiversity offset cannot be demonstrated for every modelled value.

6.3 Summary of BOAM results

6.3.1 Interpretation of model outputs

The detailed BOAM inputs, assumptions, supporting evidence and outputs are provided in Appendix B. The models compare quantified residual losses with predicted gains at defined endpoints, with adjustments for time lags and confidence in the proposed outcomes. The results are estimates dependent on the model assumptions and should not be interpreted as precise predictions.

Consistent with the disaggregated BOAM approach, outcomes are assessed separately for each biodiversity component and attribute. A positive combined score does not remove a deficit identified for an individual species or attribute. The results support the assessment of the wider package as biodiversity compensation rather than a strict biodiversity offset.

Appendix B contains seven BOAMs: two vegetation models, separate models for McCann's skink and southern grass skink, and separate models for kārearea, banded dotterel and South Island pied oystercatcher.

6.3.2 Indigenous Vegetation

Separate BOAMs were prepared for narrow-leaved snow tussock grassland and dry shrubland. The models compare the permanent loss of each vegetation type with predicted gains from revegetation at Mt Highlay and Cranky Jims Link, respectively. Vegetation structure and integrity were represented by height, vegetation cover and the proportion of indigenous species, while diversity was represented by indigenous vascular plant richness and Threatened or At Risk (TAR) plant richness. Shrubland bird diversity was also included as a functional attribute of dry shrubland. This disaggregated approach allows outcomes to be assessed separately for each vegetation component and attribute, so that positive results for some attributes do not obscure deficits in others (Maseyk et al., 2015, 2016).

Impact values were derived from vegetation plots within the affected areas. Snow tussock plot data were area-weighted so that each Project area contributed in proportion to the area affected, with the more extensive and higher-value snow tussock at Coronation North receiving the greatest weighting. Predicted revegetation values were informed by project vegetation data, measurements of planted vegetation of known age, proposed planting schedules and the restoration targets specified in the Residual Effects Terrestrial Restoration Plan. The models apply a 3% discount rate and an action-confidence category of 75–90%. Assessment endpoints are 15 years for vegetation structure and integrity, 10 years for plant-diversity attributes and 20 years for shrubland bird diversity.

For narrow-leaved snow tussock (Very High level effect), the BOAM compares a rounded impact input of 90 ha with 175 ha of revegetation at Mt Highlay. The corresponding implementation area is approximately 175.65 ha (Bioresearches, 2026n). The model predicts positive average net component scores for structure and integrity (+0.98) and diversity (+6.66). Deficits are acknowledged for vegetation cover (-11.51) and indigenous vascular plant richness (-4.10). The model predicts an overall positive balance at the component level but does not predict that every affected snow tussock attribute will be fully addressed (Table 6-1).

For dry shrubland (low level effect), the BOAM compares a rounded impact input of 3 ha with 50 ha of revegetation at Cranky Jims Link. The corresponding implementation area is approximately 50.59 ha (Bioresearches, 2026n). Positive scores are predicted for all modelled attributes (Table 6-1).

The vegetation BOAM analyses are presented in Appendix B, with the raw model outputs provided in Appendix C and supporting vegetation data in Appendix E.

Table 6-1. Summary of BOAM output for vegetation components: tussock grassland and dry shrubland

Indigenous Vegetation	Biodiversity Component	Biodiversity Attribute	Net Attribute	Average Net Component
Tussock: 175 planting at Mt Highlay	Structure & Integrity	Height	4.96	0.98
		% cover	-11.51	
		% indigenous spp	9.49	
	Diversity	Richness	-4.10	6.66
		TAR Plant Diversity	17.43	
Dry Shrubland: 50 ha planting at Cranky Jims Link	Structure & Integrity	Height	8.04	4.30
		% cover	3.42	
		% indigenous spp	1.44	
	Diversity	Richness	13.49	16.30
		TAR Plant Diversity	19.11	
	Birds	Shrubland Bird Diversity	9.56	9.56

The BOAMs quantify revegetation outcomes only. Protection and enhancement of existing snow tussock, shrubland and rock habitat, together with stock exclusion, weed and pest management and improved landscape connectivity, are additional components of the compensation package that are not credited in the modelled balances. Similarly, the positive TAR plant-richness scores are community-level attributes and do not demonstrate successful compensation for each affected TAR plant species.

6.3.2.1 Unmodelled vegetation and habitat benefits

The vegetation BOAMs principally quantify revegetation because their area, composition and expected development can be estimated with greater confidence. Protection and enhancement of existing tussock, shrubland and rock habitat, together with stock exclusion, weed control, pest management and improved connectivity, are additional unmodelled gains, including:

- 499.66 tussock grassland will be fenced and/or pest controlled at Mt. Highlay and MEEA
- 87.84 ha dry shrubland will be fenced and/or pest controlled at Mt. Highlay and MEEA and Cranky Jims Link.

Rock habitat was not modelled because its physical structure and associated ecological functions cannot be reliably recreated or represented within a vegetation BOAM. Protection of existing rock habitat is therefore included within the wider integrated compensation package.

- 44.5 ha rock outcrop and tor habitat will be fenced and pest controlled at Mt. Highlay and MEEA and Cranky Jims Link. This includes:
    - 15 ha of rock habitat at Mt Highlay to be edge planted with shallow soil specialist flora, and where these habitats would otherwise be shaded out by maturation of existing 3 year-old pine saplings.

6.3.3 Lizards

BOAMs were used to guide residual losses against anticipated conservation gains in relation to moderate or higher residual effects on two species of lizards: southern grass skink and McCann's skink. The models are based on quantitative data collected from baseline lizard monitoring within three broad habitat types, both in areas that will be impacted by mining activities and in areas that are proposed for compensation.

Each species was modelled as a separate BOAM. This was to ensure that losses and gains were assessed independently for each species, reflecting differences in ecology and habitat use, and response to management between species, and to avoid aggregation effects that could obscure species-specific outcomes (Maseyk *et al.* 2015).

The comprehensive BOAM analysis for lizards is presented in Appendix B, and a summary of the outputs are provided below.

Positive outcomes are predicted for McCann's skink in all three modelled habitat categories: tussock/grassland/rock (+21.7), shrubland (+1.22), and other (+26.99) (Appendix B, Section 5). For southern grass skink, positive outcomes are predicted in shrubland (+0.04) and other habitats (+4.05), but not in tussock/ grassland/ rock, where a net loss is predicted (-35.7) (Appendix B, Section 5).

A BOAM was not prepared for kōrero gecko, as suitable density data were unavailable for either the impact site or the offset site (see Appendix B for further details and discussion). However, the compensation action (i.e., the MEEA predator-exclusion fence) is expected to benefit this species in a similar manner to the other species. This is based on strong evidence of a positive population response in *Woodworthia* geckos following predator elimination inside similar fences, with response magnitudes comparable to those observed in skinks (Turner & Norbury 2023; Trustees of the Central Otago Ecological Trust 2026).

6.3.4 Avifauna

Separate BOAMs were prepared for kārearea / eastern falcon, pohowera / banded dotterel, and tōrea / South Island pied oystercatcher, each of which has a Moderate residual level of effect. The models compare residual habitat losses with predicted improvements in breeding success resulting from mammalian predator management. Each species was modelled independently to avoid gains for one species obscuring a shortfall for another, consistent with the disaggregated BOAM approach described by Maseyk et al. (2015, 2016). Nest success was used as the measurable proxy for breeding success.

For kārearea, the model includes anticipated gains from within the 252 ha predator-exclusion fence at the MEEA, and the predator suppression within the surrounding approximately 1,170 ha management area. The baseline nest-success assumption was informed by contemporary monitoring of eastern kārearea in Central Otago open-country habitats, while the managed benchmark was based on breeding outcomes recorded in predator-managed plantation habitat (Parker et al., 2024; Seaton et al., 2009). The model predicts a positive NPBV score (+45.55).

For banded dotterel and SIPO, gains were modelled within 642.84 ha of suitable open grassland in the surrounding predator-suppression area. Habitat within the predator-exclusion fence was excluded because stock removal and associated vegetation growth are expected to reduce its longer-term suitability for open-ground nesting birds. Baseline and managed nest-success assumptions were derived principally from experimental shorebird research by Norbury et al. (2021). The assumptions for banded dotterel are also supported by earlier breeding studies in South Island braided-river habitats (Rebergen *et al*. 1998), while the SIPO baseline is broadly consistent with long-term breeding results from Canterbury farmland (Sagar et al., 2000). A positive NPBV score is predicted for both species (+17.85).

The comprehensive BOAM analyses are presented in Appendix B, with the model outputs provided in Appendix C. The results indicate modelled positive compensation balances for all three species. Confidence is moderate because the Eastern falcon managed benchmark was derived from a different habitat and falcon ecotype, while the shorebird assumptions rely partly on pooled data from braided-river environments. The outputs should therefore be interpreted as quantitative decision-support information indicating that predicted gains are likely to exceed quantified losses, rather than as definitive evidence of a formal biodiversity offset.

6.3.5 Overall BOAM outcome, uncertainty and interpretation

The vegetation BOAMs predict positive outcomes for snow tussock and dry shrubland. Each of the three avifauna BOAMs also predicts a positive outcome. McCann's skink achieves positive outcomes across all modelled habitats.

A modelled deficit remains for southern grass skink in tussock, grassland and rock habitats, and the outcome for the kōrero gecko has not been quantified.

The predicted outcomes depend on the successful implementation of revegetation and pest management, achievement of the stated ecological responses and maintenance of the actions for the required duration. Monitoring and adaptive management will be required to confirm progress and address any shortfall from the predicted outcomes.

7 Ecological outcomes

7.1 Predicted compensation outcomes

The predicted outcome categories in Table 7-1 provide a framework for classifying predicted biodiversity outcomes after compensation is considered. It distinguishes between modelled and unmodelled net positive outcomes according to the strength of their evidential basis, identifies cases where the balance between gains and losses remains uncertain, and records any predicted net loss by its remaining level of effect. Overall, it makes clear both the expected direction of the outcome and the degree of confidence supporting that conclusion.

Table 7-1. Predicted outcome categories following compensation actions.

Predicted outcome category	Interpretation
Net Positive (modelled)	Quantitative biodiversity models predict that gains will exceed the corresponding residual losses after accounting for relevant factors such as time lags, implementation risk, confidence and discounting. The modelling is also sense-checked against the scale, location and expected ecological effectiveness of the proposed actions. This category has the strongest evidential basis because the predicted outcome is supported by quantitative analysis, although it remains biodiversity compensation where strict like-for-like equivalence or all formal offset requirements have not been demonstrated.
Net Positive (unmodelled)	The type, scale, location and expected effectiveness of the proposed conservation actions indicate that the resulting biodiversity gains are likely to outweigh the corresponding residual losses. The conclusion is not supported by a quantitative biodiversity model and therefore has a lower level of evidential certainty than a modelled net positive outcome. It is instead based on professional ecological judgement, the available ecological evidence, and the scale and durability of the proposed conservation actions.
Uncertain	The proposed actions are expected to counter-balanced the losses, but the available information does not provide an adequate basis for determining whether those benefits will exceed, equal or fall short of the corresponding residual adverse effects.
Net Loss	The available evidence indicates that the proposed compensation actions will not fully counterbalance the corresponding residual adverse effects. A residual net loss is therefore predicted after the expected benefits of the compensation actions have been considered. The remaining effect is assigned a level of Very Low, Low, Moderate, High or Very High, with the basis for that conclusion and any relevant uncertainty clearly identified.

The predicted-outcome categories have been applied separately to each affected terrestrial habitat type and Threatened or At Risk flora or fauna value.

7.1.1 Indigenous vegetation and habitats

All three affected terrestrial habitat types are predicted to achieve net positive outcomes (Table 7-2). Narrow-leaved snow tussock grassland and dry shrubland are supported by both quantitative modelling and broader unmodelled benefits arising from extensive revegetation, protection, pest control and stock exclusion. Rock outcrop and tor habitat is predicted to achieve an unmodelled net positive outcome based on edge planting and the protection and management of a substantially larger area of retained habitat.

7.1.2 TAR flora

Outcomes for TAR plants are variable (Table 7-2). Of the 29 TAR plant values assessed, four species have moved from a significant residual effect before compensation to a non-significant or positive outcome afterward:

- Dwarf broom *Carmichaelia corrugata*: Very High to Uncertain (losses expected to be counterbalanced)
- Narrow-leaved speargrass *Aciphylla subflabellata*: Moderate to Net Positive
- *Juncus pusillus*: Moderate to Low-level Net Loss
- *Lobelia perpusilla*: High to Low-level Net Loss

In addition, net positive outcomes are predicted for desert broom *Carmichaelia petriei* and *Shawia bullata*. The outcome for dwarf broom remains uncertain because, although 8,799 plants are proposed, establishment success is assessed as moderate, and the evidence is insufficient to determine whether gains will fully counterbalance losses. The remaining 23 TAR plant values retain some level of net loss after compensation is considered. These comprise five Very High, four High, seven Moderate, five Low and five Very Low net losses. Accordingly, 16 TAR plant values retain a Moderate or greater net loss, while 10 retain Low or Very Low losses.

7.1.3 Invertebrates

Invertebrate outcomes are mixed and generally carry more uncertainty than other components (Table 7-3). Of the 17 invertebrate values assessed, seven are predicted to achieve unmodelled Net Positive outcomes and 10 remain uncertain. No definite residual net losses are predicted.

The Net Positive outcomes are principally supported by large-scale planting of known host plants or the restoration and protection of suitable habitat. These include approximately 160,034 coral, desert and dwarf broom plants providing host-plant habitat for *Pasiphila* sp. A (NZAC 04285480 "Carmichaelia"), *Samana acutata* and *Theoxena scissaria*, with a further 8,760 climbing broom plants included within the Cranky Jims restoration planting; and 27,594 fireweed plants benefiting *Nyctemera annulata*. More general revegetation and habitat protection support the predicted positive outcomes for *Orthodera novaezealandiae* and *Hemiandrus maia*, as well as benefits for wider invertebrate communities

The 10 uncertain outcomes include species for which substantial host-plant restoration is proposed, but for which the relationship between planting and population response cannot be quantified or predicted confidently, as well as species whose host plants or habitat requirements are poorly understood. These include *Orocrambus sophistes*, *Asaphodes recta*, and *Dasyuris partheniata*, despite extensive planting of narrow-leaved snow tussock, fireweed, and speargrass, respectively. Other uncertain outcomes reflect reliance on broader habitat protection or restoration rather than species-specific measures. These classifications indicate limitations in predicting the magnitude of benefit, rather than an absence of expected ecological benefit.

7.1.4 Lizards

All three lizard species are predicted to achieve Net Positive outcomes (Table 7-3). McCann's skink and southern grass skink are supported by species-specific quantitative modelling as well as substantial unmodelled benefits from predator exclusion within the 252 ha predator-exclusion fence in the MEEA and the removal of approximately 265 ha of plantation forestry at Mt Highlay, respectively. For southern grass skink, a deficit was identified for one of the three modelled habitat categories (tussock/ grassland/ rock); however, forecasting based on expected population growth rates within the predator-exclusion fence predicts that Net Positive outcomes for southern grass skinks in tussock/ grassland/ rock habitat will be achieved within 15-20 years, if not sooner. In addition, the broader unmodelled benefits associated with pine removal at Mt Highlay are expected to outweigh the deficits identified for southern grass skink in tussock/ grassland/ rock habitat.

Kōrero gecko is predicted to achieve an unmodelled Net Positive outcome. Although a species-specific model could not be developed because density data are unavailable, the conclusion is supported by the scale of rock-habitat protection, plantation removal, predator management and improved connectivity between rock, tussock and shrubland habitats. Evidence of a strong positive response by a related Central Otago gecko within predator-excluded habitat (Trustees of the Central Otago Ecological Trust 2026) provides additional support for this conclusion.

It is important to consider the timeframe over which the MEEA fence's predicted benefits for lizards will be achieved. Construction of the fence is estimated to take 18 months to two years and will be completed within five years of consent being issued. Pest eradication within the fence will be completed during the first winter after construction is finished. The fence will be funded and maintained by OGNZL until 2050. The predicted positive outcome for lizards (i.e., a doubling of abundance) inside the fence is expected within five years of pest elimination and can therefore, be achieved well within the 2050 timeframe. After 2050, if fence maintenance ceases and pest incursion follows, lizard populations are expected to decline, returning to baseline densities within a relatively short period (e.g., 5–15 years). However, OGNZL intends to establish a special purpose trust, funded by a closure capitalisation fund it will set up, to continue managing biodiversity benefits into the future. At this stage, the parties to the trust and its governance arrangements have not been confirmed.

7.1.5 Birds

Five of the six avifauna values are predicted to achieve net positive outcomes, while the outcome for fernbird remains uncertain (noting that significant residual effects are not expected for this species). Quantitative models predict net positive outcomes for kārearea/eastern falcon, banded dotterel, South Island pied oystercatcher and silvereye. The outcomes for the three ground-nesting or wide-ranging bird species are principally supported by predator exclusion within the 252 ha MEEA and predator suppression across the surrounding 1,170 ha buffer. Silvereye is predicted to benefit from the 50 ha of shrubland revegetation at Cranky Jims Link.

New Zealand pipit is predicted to achieve an unmodelled net positive outcome based on the expected benefits of extensive tussock restoration and predator management. Fernbird is also expected to benefit from dry shrubland restoration, protection and stock exclusion, but remains uncertain because the species has not been confirmed as resident or breeding within the affected area and no species-specific compensation measure is proposed.

Table 7-2. Predicted outcomes for vegetation and TAR flora ecological components.

Indigenous component	Ecological value	Residual effect	Compensation	Predicted Outcome
Terrestrial habitat Type				
Narrow leaved snow tussock grassland **90.01 ha**	High	Very High	175 ha tussock revegetation at Mt Highlay; 354.88 ha tussock protection, pest control and stock exclusion at MEEA and Mt Highlay	**Net Positive (modelled and unmodelled)**
Dry Shrubland **3.06 ha**	Moderate	Low	50 ha shrubland revegetation at Crankys Link; 56.15 ha shrubland protection, pest control and stock exclusion at MEEA, Mt Highlay and Crankys Link	**Net Positive (modelled and unmodelled)**
Rock outcrop / tor **0.26 ha**	Very High	Moderate	15 ha Rock outcrop/ tor edge planting at Mt. Highlay; 44.5 ha rock tor habitat protection, pest control and stock exclusion at MEEA, Mt Highlay and Crankys Link	**Net Positive (unmodelled)**
TAR Flora				
Dwarf broom (*Carmichaelia corrugata*)	Very High	Very High	8,799 plants included in Mt Highlay planting, moderate likelihood of success	**Uncertain (Net positive – Low net loss)**
Indigenous St John's wort (*Hypericum rubicundulum*)	Very High	Very High	No compensation planting	**Net Loss (Very High)**
Wetland daisy (*Lagenophora barkeri*)	Very High	Moderate	No compensation planting	**Net Loss (Moderate)**
Lobelia ionantha	Very High	Very High	Wetland restoration planting lists	**Net Loss (Moderate)**
Leptinella pusilla	Very High	High	No compensation planting	**Net Loss (High)**
Rytidosperma thomsonii	Very High	Very High	No compensation planting	**Net Loss (Very High)**
Sonchus novae-zelandiae	Very High	Very High	No compensation planting	**Net Loss (Very High)**
Acaena buchananii	Very High	High	No compensation planting	**Net Loss (High)**
Narrow-leaved speargrass (*Aciphylla subflabellata*)	Very High	Moderate	139,779 plants included in Mt Highlay planting, moderate likelihood of success	**Net Positive (unmodelled)**
Tufted hair grass (*Deschampsia cespitosa*)	Very High	Very High	No compensation planting	**Net Loss (Very High)**
Epilobium insulare	Very High	Low	No compensation planting	**Net Loss (Low)**
Euchiton polylepis	Very High	Very High	No compensation planting	**Net Loss (Very High)**
Juncus pusillus	Very High	Moderate	Ephemeral restoration planting lists	**Net Loss (Low)**
Lobelia perpusilla	Very High	High	Ephemeral restoration planting lists	**Net Loss (Low)**

Indigenous component	Ecological value	Residual effect	Compensation	Predicted Outcome
Dwarf greenhood orchid (*Pterostylis tristis*)	Very High	High	No compensation planting	**Net Loss (High)**
Delicate bluegrass (*Anthosachne falcis*)	High	Very Low	No compensation planting	**Net Loss (Very Low)**
Desert broom (*Carmichaelia petriei*)	High	Low	Plantings: 49,076 plants at Mt Highlay 7,730 plants at Cranky Jims Link Moderate likelihood of success	**Net Positive (unmodelled)**
Colobanthus strictus	High	High	No compensation planting	**Net Loss (High)**
Juncus distegus	High	Very Low	No compensation planting	**Net Loss (Very Low)**
New Zealand mint / hīoi (*Mentha cunninghamii*)	High	Very Low	No compensation planting	**Net Loss (Very Low)**
Rytidosperma buchananii	High	Moderate	No compensation planting	**Net Loss (Moderate)**
Wetland grass (*Agrostis pallescens*)	Moderate	Moderate	No compensation planting	**Net Loss (Moderate)**
Brachyscome longiscapa	Moderate	Low	No compensation planting	**Net Loss (Low)**
Hooker's mountain daisy (*Celmisia hookeri*)	Moderate	Very Low	No compensation planting	**Net Loss (Very Low)**
Lagenophora pinnatifida	Moderate	Moderate	No compensation planting	**Net Loss (Moderate)**
Poa pusilla	Moderate	Moderate	No compensation planting	**Net Loss (Moderate)**
Shawia bullata (formerly *Olearia bullata*)	Moderate	Low	Plantings: 1,065 plants at Cranky Jims Link 153 plants in Cranky Jims shrubland wetland Moderate likelihood of success	**Net Positive (unmodelled)**
Oxalis rubens	Moderate	Very Low	No compensation planting	**Net Loss (Very Low)**
Porcupine shrub (*Melicytus* aff. *alpinus* 'Otago')	Moderate	Moderate	No compensation planting	**Net Loss (Moderate)**

Table 7-3. Predicted outcomes for TAR fauna ecological components.

Indigenous component	Ecological value	Residual effect	Compensation	Predicted Outcome
Invertebrates				
Orocrambus sophistes	Very high	High	Host-plant replanting of narrow-leaved snow tussock (*Chionochloa rigida* subsp. *rigida*) at Mt Highlay Station: 233,110 initial plants in the open tussock planting zone and 17,247 plants in the rock-outcrop buffer zone, giving a total initial planting of 250,357 plants. Further benefits are expected from habitat protection and pest management within the MEEA predator-exclusion area, surrounding buffer and Murphys Link, together with associated monitoring.	**Uncertain**
Agrotis admirationis	High	High	No species-specific host plant identified in the Restoration Plan; general benefit from the combined ~175 ha snow tussock (Mt Highlay) and ~50 ha dry shrubland (Cranky Jims Link) revegetation, plus MEEA/buffer/Murphys Linkprotection; release-site monitoring.	**Uncertain**
Asaphodes recta	High	High	Host-plant replanting of fireweed (*Senecio dunedinensis*): 27,594 plants in the Mt Highlay rock outcrop buffer zone.	**Uncertain**
Dasyuris partheniata	High	High	Host-plant replanting of speargrass (*Aciphylla subflabellata*), all at Mt Highlay: 127,802 plants in the open tussock zone plus 11,977 plants in the rock outcrop buffer zone (139,779 plants total). Not recorded at Cranky Jims Link.	**Uncertain**
Nyctemera annulata	High	Low	Host-plant replanting of fireweed (*Senecio dunedinensis*): 27,594 plants in the Mt Highlay rock outcrop buffer zone (shared planting with *Asaphodes recta*).	**Net Positive (unmodelled)**
Orthodera novaezealandiae	High	Low	No species-specific host plant identified in the Restoration Plan; general benefit from the shrubland/tussock revegetation at both sites and the MEEA fence (includes suitable dry shrubland habitat).	**Net Positive (unmodelled)**
Pasiphila sp. A (NZAC 04285480 "Carmichaelia")	High	Low	Host-plant replanting across four *Carmichaelia* species used as TAR insect hosts for this species: coral broom (*C. crassicaulis* subsp. *crassicaulis*), 94,429 plants; desert broom (*C. petriei*), 56,806 plants; dwarf broom (*C. corrugata*), 8,799 plants; and climbing broom (*C. kirkii*), 8,760 plants. This provides a combined initial planting of approximately 168,794 *Carmichaelia* plants across Mt Highlay and Cranky Jims Link.	**Net Positive (unmodelled)**

Indigenous component	Ecological value	Residual effect	Compensation	Predicted Outcome
Patagoniodes farinaria	High	Low	No species-specific host plant identified in the Restoration Plan; general benefit from tussock/shrubland revegetation at both sites and the MEEA/buffer/Murphys Linkprotection package.	**Uncertain**
Samana acutata	High	High	Same host-plant suite and numbers as *Pasiphila* sp. A above (coral broom, desert broom, dwarf broom, climbing broom, with approximately 168,794 plants across Mt Highlay and Cranky Jims Link).	**Net Positive (unmodelled)**
Theoxena scissaria	High	High	Same host-plant suite and numbers as *Pasiphila* sp. A above (approximately 173,347 plants across Mt Highlay and Cranky Jims Link).	**Net Positive (unmodelled)**
Bityla sericea	Moderate	Moderate	Host-plant replanting of three *Coprosma* species, all at Cranky Jims Link Stage 1 pioneer planting: *C. crassifolia* (mikimiki) 3,786 plants; *C. intertexta* 4,348 plants; *C. propinqua* (mingimingi) 2,899 plants (11,033 plants total).	**Net Positive (unmodelled)**
Wiseana fuliginea	Moderate	Moderate	Host plant unknown/not identified, but larvae thought to feed on pasture grasses, which are abundant in the local landscape; general habitat protection package (MEEA, buffer, Murphys Link).	**Uncertain**
Wiseana mimica	Moderate	Low	Host plant unknown/not identified (as above); general habitat protection package.	**Uncertain**
Zelandobius uniramus	Moderate	Moderate	No planting-based host measure (aquatic stonefly); potential benefit of stream habitat protection within the MEEA fence, buffer and Murphys Link; monitoring.	**Uncertain**
Hemiandrus maia	Low	Low	No species-specific host plant identified; general tussock/shrubland revegetation and MEEA/buffer/Murphys Linkprotection package.	**Net Positive (unmodelled)**
Mecodema sp. "Oamaru"	Moderate	Moderate	No species-specific host plant identified (ground beetle); general benefit from revegetation and MEEA fence (includes habitat for this species), buffer and Murphys Linkprotection.	**Uncertain**
Orocrambus cf. *cyclopicus*	Moderate	Moderate	Host-plant replanting of narrow-leaved snow tussock (*Chionochloa rigida* subsp. *rigida*) at Mt Highlay: 250,357 plants (same planting as for *Orocrambus sophistes* above).	**Uncertain**

Indigenous component	Ecological value	Residual effect	Compensation	Predicted Outcome
Lizards				
McCann's skink	Low	High	Predator exclusion within the 252 ha MEEA fence and averted habitat loss through removal of ~265 ha of plantation forestry at Mt Highlay. The species-specific BOAM predicts positive outcomes across all three modelled habitat categories.	**Net Positive (modelled & unmodelled)**
Southern grass skink	High	Very high	Predator exclusion within the 252 ha MEEA fence and averted habitat loss through removal of ~265 ha of plantation forestry at Mt Highlay. The species-specific BOAM predicts positive outcomes for two of the three modelled habitat categories, but unmodelled compensation benefits expected to outweigh modelled deficits.	**Net Positive (modelled & unmodelled)**
Kōrero gecko	High	Very high	Rock habitat protection, plantation removal at Mt Highlay, predator exclusion/ suppression, and improved connectivity between rock, snow tussock and shrubland habitats. No species-specific BOAM was possible due to a lack of gecko density data; a positive response is inferred from *Woodworthia* "Central Otago" gecko counts approximately doubling within a predator-exclusion fence over five years (Turner & Norbury, 2023), but the magnitude of benefit cannot currently be quantified for this species.	**Net Positive (unmodelled)**
Avifauna				
Kārearea / eastern falcon (*Falco novaeseelandiae*)	Very High	Moderate	252 ha predator exclusion within MEEA and 1,170 ha landscape-scale predator suppression within the surrounding buffer.	**Net Positive (modelled)**
Banded dotterel / pohowera (*Charadrius bicinctus bicinctus*)	Very High	Moderate	252 ha predator exclusion within MEEA and 1,170 ha landscape-scale predator suppression within the surrounding buffer.	**Net Positive (modelled)**
South Island pied oystercatcher / tōrea (*Haematopus finschi*)	Very High	Moderate	252 ha predator exclusion within MEEA and 1,170 ha landscape-scale predator suppression within the surrounding buffer.	**Net Positive (modelled)**
New Zealand pipit / pīhoihoi (*Anthus novaeseelandiae*)	High	Low	No species-specific compensation measure. Predicted to benefit from pest control, and large scale tussock planting.	**Net Positive (unmodelled)**
Silvereye / tauhou (*Zosterops lateralis*)	High	Very Low	50 ha shrubland revegetation at Crankys Link	**Net Positive (modelled)**

Indigenous component	Ecological value	Residual effect	Compensation	Predicted Outcome
Fernbird / mātātā (*Poodytes punctatus*)	High	Very Low	No species-specific compensation measure and not confirmed as resident or breeding onsite. Expected to benefit from 50 ha shrubland revegetation at Crankys Link, 87.84 ha shrubland protection, stock exclusion at MEEA, Mt Highlay and Crankys Link	**Uncertain**

7.1.6 Additional conservation outcomes

The residual effects management package will provide additional benefits that are not relied upon to counterbalance the quantified MP4 residual effects. These additional benefits are set out in Table 7-4 below.

Table 7-4. Additional Conservation benefits of the MP4 compensation package.

Ecological value	Proposed benefit	Predicted outcome
Otago skink	Protection and predator exclusion for the population within MEEA.	**Net Positive (unmodelled)**
Dry Shrubland bird species	Protection and predator exclusion within MEEA and Cranky Jims for the species not directly impacted by MP4 footprint (e.g. Tui, bellbird, brown creeper, tomtit). Additional habitat created at Cranky Jim's link with dry shrubland planting.	**Net Positive (modelled)**
Depleted podocarp-broadleaved forest components	Enrichment planting within Cranky Jims Link to initiate succession towards an ecosystem now highly depleted within the Macraes Ecological District	**Net Positive (unmodelled)**
Landscape connectivity	Connection and buffering of MEEA, Redbank, Cranky Jims and Island Block protected areas	**Net Positive (unmodelled)**

7.2 Overall ecological outcome

Overall, the assessments indicate predominantly Net Positive outcomes, supported either by quantitative modelling or by conservation actions of sufficient scale and relevance to provide a strong basis for professional ecological judgement. Lizards, birds, and terrestrial habitat types are generally predicted to achieve Net Positive outcomes. Invertebrates are also expected to benefit materially, although a greater proportion remain uncertain because species-specific habitat requirements and population responses to host-plant establishment or broader habitat management cannot yet be predicted with adequate confidence.

The residual effects management package is expected to deliver substantial benefits for terrestrial vegetation, fauna, habitat condition and landscape connectivity. Additional conservation benefits include improved habitat security for threatened Otago and grand skinks, restoration of ecological connections between protected areas, and the progressive enrichment of dry shrubland toward depleted podocarp–broadleaved forest and its associated flora and fauna.

A positive outcome is not demonstrated for every affected value. Several Threatened and At Risk plants retain residual Net Losses ranging from Very Low to Very High, while the outcome for dwarf broom and several invertebrates remains Uncertain. These value-specific conclusions are not displaced by positive outcomes predicted for other components or for the package in its entirety.

The package is therefore, appropriately characterised as biodiversity compensation rather than a formal biodiversity offset. Taken together, its ecological benefits are expected to outweigh the residual terrestrial effects of MP4 at the package level.

8 Compensation monitoring

Monitoring is required to determine whether the package-level and value-specific biodiversity compensation outcomes are achieved. If an action or ecological outcome falls short of its target, the relevant contingency and adaptive-management actions will be implemented.

Compensation actions and outcomes will be measured annually for five years (planting establishment, lizard populations within the MEEA and at Mt Highlay, Mt Highlay snow tussock revegetation, and Cranky Jims Link dry shrubland revegetation and then once every five years for restoration planting (tussock, dry shrubland) and enhancement (dry shrubland) targets.

The purpose of the monitoring is to:

1. Track and verify that the stated outcomes are met for identified biodiversity attributes.
2. Provide feedback with recommendations for any additional management required to ensure the compensation measures perform against their targets.
3. Identify any requirements for contingency actions early, where any shortfalls could affect compensation outcomes.
4. Provide a monitoring report, following each monitoring occasion, to demonstrate that the compensation is developing as expected and is being appropriately managed and maintained.

Specific details for the compensation monitoring are provided in the Residual Effects Terrestrial Restoration Plan (vegetation and flora) (Bioresearches 2026n), and respective fauna management plans (Bioresearches 2026i, 2026j, 2026k), with a summary provided here.

8.1 Monitoring targets and methods

While ultimate success for the compensation package is expected to be achieved at 15–20 years of vegetation maturation, the targets tabulated below provide an indication of expected values for attributes at each 5-yearly intervals with the gradual development and maturation of the compensation vegetation. Failure to meet biodiversity attribute targets prior to 10 or 20 years may not necessarily result in failure of the compensation package; however, monitoring outcomes that result in values that are short of the targets would inform adaptive management actions, such as the need for additional planting or pest animal management.

Full monitoring targets and contingencies are provided in the Residual Effects Terrestrial Restoration Plan (Bioresearches, 2026n).

8.1.1 Vegetation

Vegetation monitoring will be undertaken in accordance with the Residual Effects Terrestrial Restoration Plan (E15; Bioresearches, 2026n) to determine whether the restoration planting and management outcomes anticipated from the terrestrial biodiversity compensation package are being achieved.

For vegetation planting, monitoring targets are identified in tables Table 8-1 and Table 8-2 to ensure final predicted values are achieved within modelled timeframes.

Vegetation monitoring will use 35 plots within Mt Highlay snow tussock revegetation and 10 plots within Cranky Jims Link shrubland revegetation, based on approximately one plot per 5 ha of planting.

Vegetation monitoring will be undertaken in accordance with the Residual Effects Terrestrial Restoration Plan (E15; Bioresearches, 2026n) to determine whether the snow tussock and dry shrubland restoration actions are establishing successfully and progressing toward the vegetation outcomes assumed in the terrestrial biodiversity compensation package. Monitoring will focus on the revegetation areas at Mt Highlay and Cranky Jims Link. Routine maintenance inspections will be undertaken separately by the planting maintenance contractor, while biodiversity outcome monitoring will be undertaken by a suitably qualified and experienced ecologist.

The monitoring programme will assess plant establishment, growth, indigenous vegetation cover, indigenous species composition, indigenous vascular plant richness, TAR vascular plant richness, weed pressure, pest animal damage and evidence of stock intrusion. Monitoring will also identify species, seed sources, planting zones or localised areas that are performing poorly, so that corrective management can be implemented before these issues compromise the intended compensation outcomes.

Monitoring will commence separately for each planting stage or planting type from the date that planting is completed. This is necessary because planting will be staged across multiple years and, at Cranky Jims Link, will include both pioneer and enrichment planting phases. Each planting stage will therefore have its own Year 1 to Year 5 establishment-monitoring period and subsequent five-yearly outcome-monitoring schedule.

Annual establishment monitoring will be undertaken in Years 1, 2, 3, 4 and 5 following the completion of each planting stage. Annual monitoring will include, as a minimum, an assessment of plant survival and growth, areas or species showing poor performance, weed presence and the effectiveness of weed control, evidence and location of pest animal activity, indigenous vegetation cover, and evidence of stock access such as pugging, browsing, damaged fencing or stock sign. Drone imagery should also be obtained annually during the first five years, where practicable, to provide a consistent spatial record of vegetation establishment and canopy development across each planting area.

Routine maintenance monitoring will support, but not replace, annual ecological monitoring. During the establishment period, maintenance inspections will occur three times annually in Years 1 to 4 and twice in Year 5, with the detailed timing set out in the Residual Effects Terrestrial Restoration Plan. Maintenance records will document plant health, survivorship, locations of significant plant failure, pest plants and their control, pest animal damage, and stock access or fencing damage.

Visual checks for browsing and other plant damage will be undertaken every two months during the first six months after planting where equivalent maintenance checks are not already occurring, and four times annually for the remainder of the first two years. All planting areas will be inspected, with particular attention given to *Coprosma*, *Carmichaelia* and other palatable broadleaved species.

Evidence of pest animal damage affecting more than 5 per cent of plants will trigger immediate review and additional pest animal control. Where particular plant species are experiencing repeated browsing or mortality, guards or cages may be installed, dead plants replaced, or suitable substitute species selected in consultation with the project botanist.

At Year 5, permanent 10 m by 10 m vegetation-monitoring plots will be established within each revegetation area at a minimum density of one plot per 5 ha of planting. Plot locations will be distributed proportionately across the different planting types and environmental settings. At Mt Highlay, approximately 10 per cent of plots will be located within the 5 m rock-outcrop buffer planting zones so that performance of the specialised shallow-soil and tor-associated planting can be assessed separately. Each plot will be permanently marked in the field and recorded using GPS coordinates to allow accurate relocation during subsequent monitoring events. Permanent photo points will also be established within each plot, with the first photographs taken at Year 5.

The permanent plots will be remeasured in Years 10 and 15 at Mt Highlay, and in Years 10, 15 and 20 at Cranky Jims Link. Drone imagery will also be repeated during these five-yearly monitoring events to assess broader vegetation cover and spatial patterns of establishment across the restoration sites. Mt Highlay is modelled to achieve the intended snow tussock compensation outcomes by Year 15, while Cranky Jims Link is modelled to achieve the intended dry shrubland compensation outcomes by Year 20. For vegetation planting, monitoring targets are identified in tables Table 8-1 and Table 8-2 to ensure final predicted values are achieved within modelled timeframes.

The Year 5, Year 10 and Year 15 targets for Mt Highlay and the Year 5, Year 10 and Year 15 targets for Cranky Jims Link are progressive indicators. Failure to achieve an interim target will not necessarily demonstrate failure of the compensation package, but it will trigger review of the cause and consideration of corrective management. The principal vegetation outcome assessment will occur at Year 15 for Mt Highlay and Year 20 for Cranky Jims Link.

Monitoring results will be interpreted using a weight-of-evidence approach. This will consider plot measurements, drone imagery, annual planting records, maintenance reports, photo-point records, weed-control performance, pest animal activity, stock exclusion, climatic events, planting stage and the condition of individual species or planting zones. Site-level averages or medians will not be relied upon in isolation where they conceal substantial localised failure or poor performance within a particular planting zone.

An adaptive-management review will be triggered where monitoring identifies one or more of the following: plant survival or growth is insufficient to support the applicable progressive target; a substantial area or planting zone is performing materially worse than the site-wide result; indigenous cover, species composition or vascular plant richness is not progressing toward the relevant target; TAR plant establishment is below the expected trajectory; weed competition is suppressing indigenous establishment; pest animal browsing affects more than 5 per cent of plants or is causing repeated mortality; stock access or fencing failure is damaging the restoration area; or monitoring indicates that the assumptions used in the BOAM are no longer supported.

Adaptive-management responses may include replacement or infill planting, substitution of poorly performing species, alteration of seed-source locations or propagation methods, changes to planting season or planting technique, installation of guards or cages, increased weed-control frequency, additional pest animal control, repair or reinforcement of stock-exclusion fencing, use of successful experimental methods such as hydroseeding or direct drilling, and review of the relevant BOAM assumptions, assessment endpoint or predicted compensation outcome.

A monitoring report will be prepared following each annual and five-yearly monitoring event. Annual reports will summarise establishment performance, identified risks, maintenance undertaken and any corrective action required. The Year 5 report will include the first permanent-plot measurements and an assessment of progress toward the compensation targets. The Year 10, Year 15 and, for Cranky Jims Link, Year 20 reports will compare results with previous monitoring events, assess progress against the applicable targets, identify any shortfall or uncertainty, and specify whether further management, additional planting, revised timeframes or review of the modelled compensation outcomes is required.

Achievement of the monitoring targets will provide evidence that the vegetation compensation actions are progressing as intended. It will not, by itself, establish that the entire terrestrial compensation package has succeeded. The vegetation results must be considered alongside outcomes for fauna, pest management, legal protection, implementation of all committed actions and any remaining value-specific shortfalls or uncertainties.

8.1.2 Avifauna

Avifauna monitoring will be undertaken in accordance with the Avifauna Monitoring and Management Plan (E12; Bioresearches, 2026k) to determine whether the bird-related outcomes anticipated from the terrestrial biodiversity compensation package are being achieved. This programme is separate from operational monitoring of nests, eggs and chicks during Project works. Operational monitoring is intended to avoid and minimise direct effects during construction and mining activities, whereas residual-effects monitoring is intended to evaluate the longer-term ecological response to habitat restoration, predator exclusion and landscape-scale pest management.

The residual-effects monitoring programme will assess indigenous bird diversity within the dry shrubland revegetation at Cranky Jims Link and changes in the relative abundance and occurrence of banded dotterel, South Island pied oystercatcher and eastern falcon within the MEEA, its associated buffer and the Murphys Link area. Mt Highlay is not included in the avifauna residual-effects monitoring programme at this stage.

A Year 0 baseline survey will be completed before construction of the MEEA predator-exclusion fence and before pest-control operations associated with the compensation package commence. As far as practicable, the baseline survey at Cranky Jims Link will also be completed before restoration planting begins. Existing survey stations will be retained where they adequately represent the compensation areas, and additional permanent stations will be established within the Cranky Jims Link revegetation areas, the MEEA buffer and the Murphys Link area.

Monitoring will use a combination of fixed-station five-minute bird counts and passive acoustic monitoring. The Year 0 survey will establish the permanent monitoring network, survey timing, methods and level of effort to be repeated at subsequent monitoring events. Station selection and survey design will be undertaken by a suitably qualified and experienced ornithologist or ecologist and will provide representative coverage of the principal habitats and management areas. The same stations, methods, seasonal timing and survey effort will be used at each monitoring event wherever practicable to maintain comparability with the baseline.

Residual-effects monitoring will be undertaken in Years 0, 5, 10, 15 and 20. Monitoring reports will be prepared within three months of each event. The Year 0 report will document baseline bird diversity, relative abundance and occurrence, together with the status of restoration planting, predator-exclusion works and pest-management actions at the time of survey. Subsequent reports will compare results with both the Year 0 baseline and preceding monitoring events. The indigenous bird-diversity targets for the Cranky Jims Link dry shrubland revegetation are presented in Table 8-2.

These are minimum targets for species recorded using the revegetation area through the repeatable survey programme. They are intended to indicate progressive habitat use as the planting develops and should be interpreted alongside vegetation condition, habitat structure and pest-management performance.

For banded dotterel, South Island pied oystercatcher and eastern falcon, monitoring will assess whether relative abundance and occurrence are stable or increasing compared with the Year 0 baseline. Measures may include mean detections per five-minute bird count, frequency of detection across stations, passive acoustic detections, the proportion of monitoring stations occupied and the spatial distribution of detections across the compensation areas.

The avifauna BOAMs use improved breeding success as the modelled response to predator exclusion and pest control. Routine monitoring will not attempt to measure breeding success comprehensively across the full compensation area because nests and territories may occur at low densities, be difficult to locate and require substantial repeated survey effort. This is particularly relevant to eastern falcon, which occupies large home ranges and may nest in inaccessible locations. Banded dotterel and South Island pied oystercatcher may also move among suitable habitats within and beyond the monitored areas. Relative abundance and occurrence will therefore be used as practical indicators of the broader avifauna response to management. They will not be treated as direct measurements of breeding success, population size or achievement of the modelled compensation outcomes.

Monitoring results will be evaluated using a weight-of-evidence approach that considers bird-diversity trends, relative abundance and occurrence, survey conditions, species detectability, habitat development, vegetation establishment, pest-management performance, operational nest records where relevant, and wider environmental or population changes. Operational nest records may provide useful supporting information but will not be treated as systematic or representative measures of breeding success across the compensation areas.

An adaptive-management review will be triggered where monitoring identifies one or more of the following: failure to meet the applicable Cranky Jims Link bird-diversity target; a sustained decline in the relative abundance, frequency of detection or area of occurrence of a target species compared with the Year 0 baseline; an apparent loss of a target species from areas where it was previously recorded; failure of habitat development or pest-management performance that could reasonably explain an adverse avifauna trend; or evidence that the monitoring design is not adequately detecting the species or response of interest.

Adaptive-management responses may include additional or more frequent avifauna surveys, review of survey timing or methods, adjustment of pest-management intensity or spatial coverage, review of vegetation establishment and habitat structure, additional habitat enhancement or threat-management actions, and review of the relevant BOAM assumptions or predicted compensation outcomes. Any change to the monitoring programme will be documented and, where practicable, designed to retain comparability with the Year 0 baseline.

The results of each monitoring event will be incorporated into the corresponding terrestrial residual-effects monitoring report. Reporting will identify progress against the bird-diversity targets, trends in the relative abundance and occurrence of the three target species, relevant habitat and pest-management performance, any adaptive-management trigger reached, and any further investigation or corrective action required. The reports will clearly state that relative abundance and occurrence are indicators of response and are not direct measures of breeding success.

8.1.3 Lizards

Lizard monitoring will be undertaken to evaluate the effectiveness of both mitigation and residual effects management measures implemented under the MP4 Project. These comprise two distinct monitoring programmes, each with separate objectives.

1. **Constructed rock pile monitoring** – to assess the success of the rock piles and associated habitat enhancement measures established within Murphys Link to replace rock habitat lost from the MP4 impact footprint. Monitoring will focus on the condition and development of the constructed habitat, including vegetation establishment and survival, as well as the occupancy and use of the rock piles by lizards over time.

2. **Net positive outcome monitoring** – to assess the response of lizard populations within and outside the mammalian predator exclusion fence in the MEEA and demonstrate achievement of the Project's net positive outcome objectives of a doubling or 100% increase in McCann's and southern grass skink population densities within the MEEA fence within five years. Specifically, monitoring will seek to determine whether lizard densities increase by at least twofold relative to baseline conditions following predator exclusion and associated habitat management. The Otago skink population enclosed within the fence will also be monitored to demonstrate the additional benefits of the residual effects management package.

   In addition, monitoring the benefits of pine removal for lizard populations at Mt Highlay Station will be undertaken. This will involve an initial baseline survey to describe the existing state of the lizard populations and habitat availability across the 265 ha area, followed by repeated 5-yearly monitoring over a period of 25 years to describe any changes in lizard populations and habitat extent and suitability.

Details of the monitoring methodology are provided in the Lizard Management and Monitoring Plan (E11; Bioresearches 2026j) but are summarised below for convenience.

8.1.3.1 Constructed rock pile monitoring

Constructed rock piles and associated planted vegetation will be monitored annually to assess their condition, development, and suitability as lizard habitat. Monitoring will evaluate the structural integrity and stability of the rock piles, evidence of erosion or disturbance, and the establishment, survival, and health of planted vegetation. These measures will provide an indication of habitat development, including the availability of refuge, shelter, and foraging resources for lizards. Monitoring results will be used to identify any maintenance requirements and inform adaptive management to ensure the long-term effectiveness of the habitat enhancement measures and their continued suitability for lizard occupancy.

8.1.3.2 Monitoring the benefits of predator exclusion

Baseline monitoring (Year 0) will be completed immediately following construction of the predator-exclusion fence, during a suitable survey period within the recognised South Island lizard season (October–April, inclusive). Monitoring sites will be established and surveyed using pitfall trapping over a 10 trap nights, with nine intervening daily checks. The resulting density estimates will provide the baseline against which future population responses will be measured. Establishing the baseline immediately following fence construction, rather than relying on earlier survey data, will minimise the influence of temporal changes in McCann's and southern grass skink populations and provide a more robust reference point for assessing the effects of predator exclusion.

Following eradication of mammalian pests within the fence, lizard monitoring will be undertaken annually to measure changes in the abundance and density of each skink species. Monitoring will continue until the target outcome—a doubling (100% increase) of skink densities within the fenced area—has been achieved. Based on published studies of predator-exclusion fencing and predator elimination in dryland Otago ecosystems, this response is expected within approximately five years (Turner & Norbury 2023); however, if necessary, monitoring will continue beyond Year 5 until the target has been demonstrably achieved.

Kōrero geckos and Otago skinks will also be monitored within the fenced area. While these species are not included in the quantitative compensation target, this monitoring will provide additional evidence of the ecological benefits of predator exclusion and help confirm that positive population responses are occurring across the broader lizard community. Undertaking this additional outcome monitoring aligns with a strategic theme of the OceanaGold Lizard Management Strategy (van Winkel 2026), which focuses on collecting robust ecological data over time on lizard populations, habitat condition, and the effectiveness of mitigation and conservation actions, with continuous improvement achieved through adaptive management.

8.1.3.3 Monitoring the benefits of pine removal at Mt Highlay Station

At Mt Highlay Station, an averted-loss approach is proposed to protect roughly 265 ha of lizard habitat currently under threat from a 2023 pine planting. Left alone, that plantation is expected to close canopy within 16–25 years and sharply reduce the lizard populations known to use the site (McCann's skink, southern grass skink, and kōrero gecko, across extensive grassland and schist outcrop habitat). Removing all planted trees and protecting the area in perpetuity averts this loss, with the conservative assumption that lizard population size and habitat extent hold static over a 25-year period — an assumption expected to be conservative, since it doesn't credit any population gains from the dryland vegetation regenerating and improving habitat quality over that time.

Outcomes will be tracked via a baseline survey followed by five-yearly monitoring over 25 years, and kōrero gecko occupancy and relative abundance will also be monitored.

8.2 Reporting

Compensation monitoring reports will be prepared at Years 5, 10, 15, and 20, assessing the progress of the revegetation planting against the biodiversity compensation targets and BOAMs. These reports will identify any major contingencies that need to be implemented such as remodelling of any biodiversity attributes in response to actual results or adjustment of timescales and adaptive management.

For lizards, within 90 days of completing baseline monitoring, and within 90 days of the completion of each subsequent annual monitoring event, a monitoring report will be prepared by a suitably qualified ecologist and provided to Council, DOC, mana whenua, and other relevant stakeholders.

At Year 5, a Biodiversity Outcome Report will be prepared and submitted to Council, DOC, mana whenua, and other relevant stakeholders. The report will:

- Assess whether the target doubling of skink density within the fenced area has been demonstrably achieved, and report the responses of McCann’s skink and southern grass skink separately;
- Where the target outcome has not been achieved, identify likely reasons for the shortfall and provide recommendations for adaptive management or contingency measures to improve the likelihood of achieving the target within the shortest practicable timeframe; and
- Summarise monitoring results and evaluate population responses of kōrero geckos and Otago skinks within the fenced area. This information is not required for demonstration of stated positive outcomes.

Where the target outcome has not been achieved by Year 5, annual monitoring and reporting will continue until the required biodiversity outcome has been demonstrated.

8.3 Pest management and monitoring

Details for pest animal management and monitoring for Mt Highlay Station, Cranky Jims Link, and MEEA (including the MEEA predator-exclusion fence, surrounding buffer, and Murphys Link) are provided in a separate dedicated Pest Management Plan (Alliance Ecology 2026).

Detail on pest plant management are presented with planting, monitoring and maintenance methods in the Residual Effects Terrestrial Restoration Plan (Bioresearches 2026).

Table 8-1. Monitoring targets for approximately 175.65 ha snow tussock revegetation – Note: compensation success measured at 20 years. Targets prior to net positive outcome are indicative only and may prompt management response.

Snow tussock revegetation	5 years	10 years	15 years	20 years
Height (m)	0.3	0.5	0.8	1
Indigenous cover (%)	10	20	30	45
Proportion of Indigenous Species	5	15	30	45
Indigenous vascular richness (count)	6	6		
Vascular plan TAR species richness	1	1		

Table 8-2. Monitoring targets for approximately 50.59 ha dry shrubland revegetation – Note: compensation success measured at 20 years. Targets prior to net positive outcome are indicative only and may prompt management response.

Dry shrubland revegetation	5 years	10 years	15 years	20 years
Height (m)	0.3	0.5	1	1.5
Indigenous cover (%)	10	20	45	60
Proportion of Indigenous Species	5	15	30	60
Indigenous vascular richness (count)	8	10	10	
Vascular plan TAR species richness	2	2	2	
Shrubland bird diversity (count)	2	3	4	4

9 Assessment against Biodiversity Compensation Principles

9.1 Principles for biodiversity compensation

Appendix 4 sets out 13 principles for Biodiversity Compensation under the NPS-IB. Each principle is identified in Table 9-1. with supporting evidence of how each principle is achieved for the Project.

Table 9-1. Principles of biodiversity compensation (NPS-IB, Appendix 4) and how these are achieved for MP4.

	Principles / criteria of biodiversity compensation	How these principles are achieved for MP4
1	**Adherence to effects management hierarchy:** A biodiversity offset is a commitment to redress more than minor residual adverse effects and should be contemplated only after steps to avoid, minimise, and remedy adverse effects are demonstrated to have been sequentially exhausted.	Details about the adherence to the effects management hierarchy are provided in Table 3-1 and detailed in the EcIA (document E7). Avoid: BRWRS removed from MP4 project, supports high value flora and fauna, including Regionally At Risk fernbird. Minimise: Species specific effects are minimised through specific methodology, as addressed in management plans (e.g. capture-relocation, Direct Vegetation Transfer / DVT of vegetation, TAR plants, invertebrate habitats).
2	**When biodiversity compensation is not appropriate:** Biodiversity compensation is not appropriate where indigenous biodiversity values are not able to be compensated for. Examples of biodiversity compensation not being appropriate include where: (a) the indigenous biodiversity affected is irreplaceable or vulnerable; (b) effects on indigenous biodiversity are uncertain, unknown, or little understood, but potential effects are significantly adverse or irreversible; (c) there are no technically feasible options by which to secure a proposed net gain within acceptable timeframes.	Refer Appendix A for a detailed analysis of 'offsetability' framework. The major biodiversity components are classed as 'least concern' / not threatened, and or have well understood threats: VS6 (dry shrubland), AL1 (snow tussock), threats are generally considered to be pastoral development, invasive weeds and fire. Restoration opportunities, such as revegetation, browser and weed control measures are well tested. Lizard species: McCann's skink (Not Threatened), Southern Grass Skink and kōrero gecko are both At Risk, but benefits of pest management (exclusion) are well studied and all species recorded occupying highly modified and disturbed environments. The quantitative models predict positive outcomes for several modelled components, but not for every affected value. A Moderate net loss is predicted for southern grass skink, and outcomes remain uncertain for kōrero gecko, rock habitat, invertebrates and some TAR plants. The package is therefore assessed as biodiversity compensation at an aggregate level rather than as demonstrating a net gain for every value.
3	**Scale of biodiversity compensation:** The indigenous biodiversity values lost through the activity to which the biodiversity compensation applies are addressed by positive effects to indigenous biodiversity (including	The package is designed to provide benefits to the same or closely related biodiversity values within the immediate landscape. Package-level adequacy does not displace the Moderate net loss or uncertain outcomes identified for individual values.

	Principles / criteria of biodiversity compensation	How these principles are achieved for MP4
	when indigenous species depend on introduced species for their persistence), that outweigh the adverse effects.	
4	**Additionality**: Biodiversity compensation achieves gains in indigenous biodiversity above and beyond gains that would have occurred in the absence of the compensation, such as gains that are additional to any minimisation and remediation or offsetting undertaken in relation to the adverse effects of the activity.	There are no current or future plans to undertake any of the proposed restoration and enhancement actions identified as required to address the residual effects of MP4.
5	**Leakage:** Biodiversity compensation design and implementation avoids displacing harm to other indigenous biodiversity in the same or any other location.	The biodiversity compensation actions (pest flora and fauna controls and revegetation) will not cause harm to indigenous biodiversity at the site or other locations. In some instances, additional input into dry shrubland is intended to provide a precursor to future forest, however this is a natural trajectory for pioneer ecosystems.
6	**Long-term outcomes:** Biodiversity compensation is managed to secure outcomes of the activity that last as least as long as the impacts, and preferably in perpetuity. Consideration must be given to long-term issues around funding, location, management, and monitoring.	All compensation actions will be legally protected in perpetuity by way of covenant and monitored for a minimum 20 years to ensure offset targets are achieved. Annual and five-yearly monitoring will assess modelled and indicative targets. Adaptive management and contingency actions will address identified shortfalls. Monitoring will report package-level performance and value-specific outcomes separately, without assuming that every value will achieve a net gain. The compensation package is proposed to be established and funded through to at least 2050, aligning its long-term implementation with the national Predator Free 2050 ambition. OGNZL will also establish and fund a Trust to manage the MEEA in perpetuity.
7	**Landscape context:** Biodiversity compensation is undertaken where this will result in the best ecological outcome, preferably close to the impact site or within the same ecological district. The action considers the landscape context of both the Project area and the compensation site, taking into account interactions between species, habitats and ecosystems, spatial connections, and ecosystem function.	All compensation actions will be undertaken on OGNZL land holdings at the Macraes site, within the Macraes ED. This landscape supports the same ecosystem types and species assemblages (particularly vegetation, invertebrates, birds and lizards).

	Principles / criteria of biodiversity compensation	How these principles are achieved for MP4
8	**Time lags:** The delay between loss of, or effects on, indigenous biodiversity values at the impact site and the gain or maturity of indigenous biodiversity at the compensation site is minimised so that the calculated gains are achieved within the consent period or, as appropriate, a longer period (but not more than 35 years).	The BOAMs account for time lags for the components that were quantitatively modelled. Time lags for rock habitat, kōrero gecko, invertebrates and plant values not represented in a BOAM are addressed qualitatively through sequencing, early protection and threat-reduction measures, monitoring and adaptive management.
9	**Trading up**: When trading up forms part of biodiversity compensation, the proposal demonstrates that the indigenous biodiversity gains are demonstrably greater or higher than those lost. The proposal also shows the values lost are not to Threatened or At Risk (declining) species or to species considered vulnerable or irreplaceable.	The package does not rely on trading up as replacement for affected values. Benefits for Otago skink, depleted podocarp forest and other higher-value biodiversity are additional conservation benefits and are not counted as equivalent replacement for unrelated affected values. At Risk and Threatened taxa are within the Project impact areas, and would be restored as far as practicable, through management plans (salvage-relocation, population enhancement elsewhere, and revegetation), and part of this compensation package TAR flora, lizards and birds.
10	**Financial contributions:** A financial contribution is only considered if: (a) there is no effective option available for delivering biodiversity gains on the ground; and (b) it directly funds an intended biodiversity gain or benefit that complies with the rest of these principles.	No separate financial contribution is being provided. The proposed compensation actions are being funded directly by OGNZL.
11	**Science and mātauranga Māori:** The design and implementation of a biodiversity offset is a documented process informed by science and mātauranga Māori.	OGNZL has been engaging with Ka rūnaka throughout the development of ecological assessment and management processes. This has included partnership in lizard relocation work, focus on inclusion of taoka species through all aspects of values assessments and management requirements. The design of the biodiversity compensation is based on established and best practice methods for restoration. Published scientific data and studies, such as lizard density increase or nesting success under pest predator control, removal of exotic browsers on vegetation and flora, have informed modelled benchmarks and expected outcomes.
12	**Tangata whenua and stakeholder participation:** Opportunity for the effective and early participation of tangata whenua and stakeholders is	Tangata Whenua continue to be engaged and provided opportunities for participation in all aspects of ecological management and monitoring.

	Principles / criteria of biodiversity compensation	How these principles are achieved for MP4
	demonstrated when planning for biodiversity compensation, including its evaluation, selection, design, implementation, and monitoring.	Stakeholder feedback has been reviewed following a previous application and considered during updates to the current application. Engagement with stakeholders, including Department of Conservation, Council and Tangata Whenua was undertaken on 20 April 2026. The project approach also recognises that Kā Rūnaka does not support the establishment of large areas of uniform tussock where alternative restoration methods may provide better ecological outcomes. It also recognises that conversion of productive pasture to tussock may not be supported by the local community. These considerations have not reduced the ecological objectives of the compensation package but have informed a more diverse and enduring restoration design.
13	**Transparency:** The design and implementation of a biodiversity compensation, and communication of its results to the public, is undertaken in a transparent and timely manner.	OGNZL will deliver the biodiversity compensation actions and then document its key targets and outcomes through provision of regular monitoring reports and compliance meetings in liaison with Otago Regional Council, WDC and DCC and where appropriate, the Department of Conservation. Contingency reports are part of this plan to ensure that if biodiversity compensation objectives are not met in keeping with the BOAM parameters, further ecological enhancement/offset activities are set out for OGNZL to meet their BOAM targets.

10 Conclusion

The MP4 Project will result in permanent residual effects on terrestrial biodiversity after avoidance, minimisation and remediation measures have been applied. The principal residual effects relate to indigenous snow tussock, schist rock outcrops, terrestrial invertebrates, indigenous lizards, kārearea, banded dotterel, South Island pied oystercatcher, and some TAR plant species. These effects are long term or permanent and require durable residual effects management.

The proposed package provides a coordinated landscape-scale response within the Macraes Ecological District. It includes a 252 ha predator-exclusion fenced area at MEEA, predator control across an approximately 1,170 ha surrounding buffer, an approximately 395 ha protected connection to Redbank Covenant, protection and enhancement of existing indigenous habitat, approximately 175 ha of snow tussock revegetation at Mt Highlay (including approximately 15 ha of tor-buffer planting), approximately 50 ha of dry shrubland revegetation at Cranky Jims Link, and removal of approximately 265 ha of plantation forestry to avert further loss of lizard habitat.

Overall, the package is expected to:

- increase the extent and condition of indigenous snow tussock and dry shrubland;
- reduce predation pressure on indigenous lizards and birds;
- protect and improve retained rock, snow tussock and dry shrubland habitat;
- improve habitat continuity between existing protected areas; and
- provide wider benefits for taoka species, Otago skink, grand skink and depleted forest components.

The modelling and ecological assessment indicate that the package is likely to provide an overall positive outcome for several principal modelled vegetation and avifauna components and for McCann's skink. A Net Loss is predicted for southern grass skink in tussock habitats only. Outcomes remain uncertain for kōrero gecko, terrestrial invertebrates, schist rock habitat and some TAR plants.

The package is therefore appropriately characterised overall as biodiversity compensation rather than as a comprehensive biodiversity offset. Its adequacy depends on the proposed actions being additional, legally and financially secured, implemented at the stated scale, and maintained for the duration of the effects.

On the current evidence, the package is expected to provide substantial ecological benefits that outweigh the residual terrestrial effects at an aggregate level. This conclusion remains conditional on the implementation of measurable monitoring and adaptive management requirements. Completion of the proposed actions alone will not demonstrate success. The required ecological outcomes must be achieved and maintained over time.

11 References

Ahikā Consulting. (2021). Assessment of effects on vegetation and avifauna. Prepared for OceanaGold (New Zealand) Ltd.

Ahika (2021). Baseline lizard survey results summary for Coronation North Extension pine removal. Report prepared for OceanaGold (New Zealand) Ltd. 10 pp.

Alliance Ecology (2026). *Pest Control and Elimination Plan.* Report prepared for OceanaGold (New Zealand) Limited.

Barry (2024). Evaluating Otago green skink (*Oligosoma* aff. *chloronoton* "eastern Otago") habitat use and translocation success. Unpublished M.Sc. Thesis, University of Otago, Dunedin, New Zealand. 119 pp.

Bell, D. J., & Lawrence, S. (2009). New Zealand falcon (*Falco novaeseelandiae*) distribution survey 2006–09. Notornis, 56, 217–221.

Bibby C.J. 1997. Macraes Ecological District: a survey report for the Protected Natural Areas Programme. Unpublished MSc, University of Otago, Dunedin, New Zealand. 203 p.

Bioresearches. (2026a). *Ecology summary document*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026b). *Assessment of invertebrate values*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026c). *Assessment of lizard values*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026d). *Assessment of avifauna values*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026e). *Assessment of bat values*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026f). *Ecological impact assessment*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026g). *Vegetation and flora management plan*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026h). *Wetland management plan*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026i). *Invertebrate management and monitoring plan*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026j). *Lizard management and monitoring plan*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026k). *Avifauna management and monitoring plan*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026l). *Residual effects analysis report: Terrestrial ecology*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026m). *Residual effects analysis report: Wetlands*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026n). *Residual Effects Terrestrial Restoration Plan*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026o). *Residual effects wetland restoration plan*. Report prepared for OceanaGold (New Zealand) Limited.

Bioresearches. (2026p). *Ecological Impact Assessment: Pest-proof fence construction*. Report prepared for OceanaGold (New Zealand) Limited.

Bombaci, S. P., Pejchar, L., & Innes, J. (2018). Fenced sanctuaries deliver conservation benefits for most common and threatened native island birds in New Zealand. *Ecosphere, 9*(11), e02497. doi:10.1002/ecs2.2497

Central Otago Ecological Trust (2026). *Mokomoko Newsletter*. Number 24. June 2026.

De Lange, P. J., Gosden, J., Courtney, S., Jon, A., Barkla, J. W., Beadel, S. M., Champion, P.D., Hindmarsh-Walls, R., Makan, T., Michel, P. (2024). *Conservation status of vascular plants in Aotearoa New Zealand, 2023*. Department of Conversation.

Department of Conservation 2014. Guidance on Good Practice Biodiversity Offsetting in New Zealand. New Zealand Government, Wellington

Department of Conservation: Biodiversity Monitoring and Reporting System: Field protocols for Tier 1 monitoring - invasive mammal, bird, bat, RECCE surveys Version 14.

Fahey, B. D., & Watson, A. J. (1991). Hydrological impacts of converting tussock grassland to pine plantation, Otago, New Zealand. *Journal of Hydrology* (New Zealand), 1-15.

Fahey, B., Payne, J. (2017). "The Glendhu Experimental Catchment Study, Upland East Otago, New Zealand: 34 Years of Hydrological Observations on the Afforestation of Tussock Grasslands." *Hydrological Processes* 31: 2921–2934.

Fitzgerald, N., Innes, J., Watts, C., Thornburrow, D., Bartlam, S., Collins, K., Byers, D, & Burns, B. (2021). Increasing urban abundance of tūī (Prosthemadera novaeseelandiae) by pest mammal control in surrounding forests. *Notornis*, *68*(2), 93-107.

Fox, N. C. (1977). The biology of the New Zealand falcon (Falco novaeseelandiae Gmelin 1788). Unpublished PhD thesis, University of Canterbury, Christchurch, New Zealand.

Fox, N. C. (1978). The distribution and numbers of New Zealand falcons (*Falco novaeseelandiae*). *Notornis, 25*(4), 317–331.

Jones, C., Norbury, G., Bell, T. (2013). Impacts of introduced European hedgehogs on endemic skinks and weta in tussock grassland. *Wildlife Research*, 40: 36–44.

Hitchmough, R., Barr, B., Knox, C., Lettink, M., Monks, J. M., Patterson, G. B., Reardon, J. T., van Winkel, D., Makan, T., & Michel, P. (2025). Conservation status of reptiles in Aotearoa New Zealand, 2025. New Zealand Threat Classification Series 50. Department of Conservation, Wellington.

Holdaway, R.J.; Wiser, S.K. and Williams, P.A. 2012. Status assessment of New Zealand's naturally uncommon ecosystems. *Conservation Biology* 26 (4): 619-629. doi:10.1111/j.1523-1739.2012.01868.x

Holland, J. D., & McCutcheon, R. R. (2007). Satellite tracking a New Zealand falcon (*Falco novaeseelandiae*). *Notornis, 54*(1), 20–27.

Horikoshi, C., Battley, P. F., Seaton, R., & Minot, E. O. (2017). Winter habitat use of New Zealand falcons (*Falco novaeseelandiae ferox*) in an intensively managed pine plantation, central North Island, New Zealand. *New Zealand Journal of Ecology, 41*(2), 193–206. https://doi.org/10.20417/nzjecol.41.31

Hughes, A. O., & Dang, T. D. (2026). Reduction in Suspended Sediment Loads Following Canopy Closure: The Impact of Pasture-To-Pine Plantation (*P. radiata*) Conversion in a Headwater Catchment. *New Zealand Journal of Marine and Freshwater Research*, 60(1), e70024.

Innes, J., Miskelly, C. M., Armstrong, D. P., Fitzgerald, N., Parker, K. A., & Stone, Z. L. (2022). Movements and habitat connectivity of New Zealand forest birds: A review of available data. *New Zealand Journal of Ecology, 46*(2), 3481. doi:10.20417/nzjecol.46.25

Innes, J. G., Norbury, G., Samaniego, A., Walker, S., & Wilson, D. J. (2024). Rodent management in Aotearoa New Zealand: Approaches and challenges to landscape-scale control. *Integrative Zoology, 19*(1), 8–26. doi:10.1111/1749-4877.12719

Kross, S. M., Tylianakis, J. M., & Nelson, X. J. (2013). New Zealand falcon nests suffer lower predation in agricultural habitat than in natural habitat. New Zealand Journal of Ecology, 37(1), 1–8.

Lindenmayer, D. B., & Fischer, J. (2007). *Habitat fragmentation and landscape change: An ecological and conservation synthesis*. Island Press.

Marchant, S. & Higgins , P.J. (editors) (1993). Handbook of Australian , New Zealand & Antarctic Birds. Volume 2, Raptors to lapwings. Melbourne , Oxford University Press. Pages 648-649, 715, 727-734; plate 56.

Maseyk, F., Maron, M., Seaton, R., & Dutson, G. (2015): A Biodiversity Offsets Accounting Model for New Zealand: User Manual. Prepared for the Department of Conservation, Hamilton New Zealand

Maseyk, F. J. F., Barea, L. P., Stephens, R. T. T., Possingham, H. P., Dutson, G., & Maron, M. (2016). A disaggregated biodiversity offset accounting model to improve estimation of ecological equivalence and no net loss. Biological Conservation, 204, 322–332.

Maseyk, F.; Ussher, G.; Kessels, G.; Christensen, M.; Brown, M. 2018. Biodiversity Offsetting under the Resource Management Act. A guidance document. 2018. Prepared for the Biodiversity Working Group on behalf of the BioManagers Group

McGlone, M. S., Mark, A. F., & Bell, D. (1995). Late Pleistocene and Holocene vegetation history, Central Otago, South Island, New Zealand. Journal of the Royal Society of New Zealand, 25, 1–22.

Ministry for the Environment. (2023). National Policy Statement for Indigenous Biodiversity 2023. Ministry for the Environment.

Monks, J.M., Besson, A.A., O'Donnell, C.F. (2024). Landscape scale control of selected mammalian predators fails to protect lizards. *Biological Invasions*, 26 (1): 107_118.

MPI. (2018). "Best Options for Land use following Radiata Harvest in the Gisborne District under Climate Change: Literature Review." Ministry for Primary Industries Technical Paper No: 2018/46. Wellington, New Zealand. Accessed February 2026. https://www.mpi.govt.nz/dmsdocument/30444/send. 74.

Nelson, N.J., Romijn, R.L., Dumont, T., Reardon, J.T., Monks, J.M., Hitchmough, R.A., Empson, R., Briskie, J.V. (2016). Lizard conservation in mainland sanctuaries. In: Chapple DG (ed) *New Zealand Lizards*. Springer, pp 321–339.

New Zealand Government. (1953). Wildlife Act 1953. New Zealand Legislation. https://www.legislation.govt.nz

Norbury, G., Byrom, A., Pech, R., Smith, J., Clarke, D., Anderson, D., Forrester, G. (2013). Invasive mammals and habitat modification interact to generate unforeseen outcomes for indigenous fauna. *Ecological Applications* 23: 1707–1721.

Norbury, G., van den Munckhof, M., Neitzel, S., Hutcheon, A., Reardon, J., Ludwig, K. (2014). Impacts of invasive house mice on post-release survival of translocated lizards. *New Zealand Journal of Ecology*, 38: 322–327.

Norbury, G. L., Price, C. J., Latham, M. C., Brown, S. J., Latham, A. D. M., Brownstein, G. E., Ricardo, H. C., McArthur, N. J., & Banks, P. B. (2021). Misinformation tactics protect rare birds from problem predators. *Science Advances*, 7, eabe4164.

OceanaGold (2026). Lizard Management Strategy. Prepared by van Winkel, D. (Bioresearches) for Report prepared for OceanaGold (New Zealand) Limited.

Parker, G., Rexer-Huber, K. and Mackie, E. (2024). Cardrona Kārearea Conservation Project: Five-year summary report. Cardrona Foundation, Otago.

Pierce, R.J. 2013 [updated 2024]. Banded dotterel | pohowera. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

Pilgrim, J.D., Brownlie, S., Ekstrom, J.M., Gardner, T.A., von Hase, A., Kate, K.T., Savy, C.E., Stephens, R.T., Temple, H.J., Treweek, J. and Ussher, G.T., 2013. A process for assessing the offsetability of biodiversity impacts. *Conservation Letters*, *6*(5), pp.376-384.

Rebergen, A., Keedwell, R., Moller, H., & Maloney, R. (1998). Breeding success and predation at nests of banded dotterel (*Charadrius bicinctus*) on braided riverbeds in the central South Island, New Zealand. *New Zealand Journal of Ecology*, 22, 33–41.

Reardon, J.T., Whitmore, N., Holmes, K.M., Judd, L.M., Hutcheon, A.D., Norbury, G., Mackenzie, D.I. (2012). Predator control allows critically endangered lizards to recover on mainland New Zealand. *New Zealand Journal of Ecology*, 36 (2): 141–150.

Sagar, P. M. (2013, updated 2023). *South Island pied oystercatcher | Tōrea*. In C. M. Miskelly (Ed.), *New Zealand Birds Online*. www.nzbirdsonline.org.nz

Sagar, P. M., Geddes, D., Banks, J., & Howden, P. (2000). Breeding of South Island pied oystercatchers (*Haematopus ostralegus finschi*) on farmland in mid-Canterbury, New Zealand. *Notornis, 47*(2), 71–81.

Seaton, R., Holland, J. D., Minot, E. O., & Springett, B. P. (2009). Breeding success of New Zealand falcons (*Falco novaeseelandiae*) in a pine plantation. *New Zealand Journal of Ecology*, 33(1), 32–39.

Seaton, R., Minot, E. O., & Holland, J. D. (2013). Home range and habitat use of New Zealand falcons (*Falco novaeseelandiae*) in an exotic plantation forest during the breeding season. *Journal of Raptor Research, 47*(3), 223–233.

Singers, N.; Rogers, G. (2014). A classification of New Zealand's terrestrial ecosystems. Science for Conservation 325. Department of Conservation, New Zealand. Wellington.

Tanentzap, A. J., & 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. doi:10.1016/j.biocon.2017.08.001

Tane's Tree Trust (2011): Planting and Managing Native Trees Technical Handbook. David Bergin managing editor.

Tanes Trees Growth and Yield Calculator https://toolkit.tanestrees.org.nz/ Bergin, David and Mark Kimberley: Performance of planted native conifer trees in: Tane's Tree Trust (2011): Planting and Managing Native Trees Technical Handbook. David Bergin managing editor.

Thomas, B., Minot, E. O., & Holland, J. D. (2010). Home range and habitat use of the New Zealand Falcon (*Falco novaeseelandiae*) within a plantation forest: A satellite tracking study. *International Journal of Ecology, 2010*, Article 829702. https://doi.org/10.1155/2010/829702

Thompson, H. M. (1949). East of the Rock and Pillar: A history of the Strath Taieri and Macraes Districts. Otago Centennial Historical Publications, Whitcombe & Tombs, Christchurch.

Trustees of the Central Otago Ecological Trust (2026). *Mokomoko Newsletter*, Number 24, June 2026. 6 p.

Turner, S., & Norbury, G. (2023). Population responses of common lizards inside a predator-free dryland sanctuary. *New Zealand Journal of Ecology*, 47 (1).

Whirika. (2026). *Assessment of vegetation and wetland values*. Report prepared for OceanaGold (New Zealand) Limited.

Whitaker, A. H. (1996). Impact of agricultural development on grand skink (Oligosoma grande) (Reptilia: Scincidae) populations at Macraes Flat, Otago, New Zealand. Science for Conservation 33. Department of Conservation, Wellington.

Wilson, D.J., Mulvey, R.L., Clarke, D.A., Reardon, J.T. (2017). Assessing and comparing population densities and indices of skinks under three predator management regimes. *New Zealand Journal of Ecology*, 41 (1): 84–97.

Appendix A
NPS-IB Compensation Criteria 2 Analysis

1 Purpose and approach

Appendix 4, Principle 2 of the National Policy Statement for Indigenous Biodiversity 2023 (as amended in December 2025) states that biodiversity compensation is not appropriate where indigenous biodiversity values are not able to be compensated for. It identifies three examples where this may apply:

a. the indigenous biodiversity affected is irreplaceable or vulnerable;
b. effects on indigenous biodiversity are uncertain, unknown or little understood, but the potential effects are significantly adverse or irreversible; and
c. there are no technically feasible options by which to secure a proposed net gain within acceptable timeframes (Ministry for the Environment, 2025).

This appendix considers those three matters in relation to the MP4 terrestrial biodiversity compensation package. It does not apply a biodiversity offsetability scoring framework and does not seek to demonstrate strict ecological equivalence or a formal biodiversity offset (Pilgrim *et al*. 2013). Instead, this assessment seeks to evaluate each of these three criteria in detail, to determine if the use of biodiversity compensation is still appropriate, as used here. The assessment recognises that vulnerability, irreplaceability, uncertainty and technical feasibility vary among the affected biodiversity values.

The assessment should be read with the summary of residual effects in section 3, the description of the compensation package in sections 4 and 5, the predicted ecological outcomes in Section 7, and the assessment against the remaining NPS-IB biodiversity compensation principles in Section 9.

1.1 NPSIB Criteria 2a: Vulnerability and irreplaceability

Vulnerability describes the susceptibility of an ecosystem, habitat or species to loss, degradation or other harmful change. Irreplaceability relates to the uniqueness of the affected biodiversity and the extent to which the lost value can be recreated or secured elsewhere.

For biodiversity compensation, these concepts are assessed qualitatively. Threat classification is relevant, but not determinative. The assessment also considers the scale and permanence of loss, the distribution of the value within the Macraes Ecological District and wider region, reliance on specific habitat features, and the practicality of replacing the affected ecological structure or function.

1.1.1 Vulnerability

Vulnerability is defined in the NPS-IB as:

> *"…an estimate of the degree of threat of destruction or degradation that indigenous biodiversity faces from change, use or development. It is the degree to which an ecosystem, habitat or species is likely to be affected by, is susceptible to or able to adapt to harmful impacts or changes. It interacts with the irreplaceability, complexity and rarity to indicate the biodiversity value and level of risk for a given area."*

The vulnerability is assessed for Threatened and At Risk species (plants, birds, lizards and invertebrates) and vegetation types where conservation actions have been carried out as part of the compensation package. It should be noted that this does not include all TAR species but does include species that are not part of the BOAM models. For example, where a TAR plant species is included in the planting list as part of the compensation revegetation for snow tussock or dry shrubland ecosystems, then those plant species are considered part of compensation.

Each species or ecosystem type is scored as vulnerable or not, by consideration of two key criteria[1]. Will the actions result in:

1. an increase to its threat classification or
2. an increase to its risk of extinction.

Our assessment, therefore, incorporates the regional and national threat status, known information about range, distribution, and population size. These factors are used to make a professional judgement to determine if either of these two criteria are met.

1.1.2 Irreplaceability

Irreplaceability is defined in the NPS-IB as:

> *"…a measure of the uniqueness, replaceability and conservation value of biodiversity and the degree to which the biodiversity value of a given area adds to the value of an overall network of areas. It interacts with vulnerability, complexity and rarity to indicate the biodiversity value and level of risk for a given area".*

To assess irreplaceability, population estimates are used for fauna and area (ha) estimates are used for vegetation, for both the impacted area and either the estimated local or national population. Based on these values, an irreplaceability score is determined for each of the biodiversity components that are going to be offset. More detailed justifications are provided for the population estimates in the sections below.

Each ecological component was scored as either irreplaceable or not, as determined by a qualitative scale informed by Pilgrim et al. (2013, Table 1), where:

- **Very High (VH)** = extremely high irreplaceability (≥ 95% loss)
- **High (H)** = high irreplaceability (≥ 10% loss)
- **Moderate (M)** = moderate irreplaceability (≥ 1% loss)
- **Low (L)** = low irreplaceability (≥ 0.1% loss)
- **Very Low (VL)** = very low irreplaceability (< 0.1% loss)
- **Not assessed (—)** = insufficient information or requires professional judgement

[1] *"The threat classification in itself should not preclude the ability to offset, unless there is no proven method to offset and the impact would be potentially significant, e.g. result in an increase to its threat classification or an increase to its risk of extinction."*, sourced from DOC submission, page 5: https://www.epa.govt.nz/assets/Uploads/Documents/Fast-track-consenting/Brookby-Quarry/Comments/Brookby-Quarry-Director-General-of-Conservation-Comments.pdf

1.1.3 Assessment

Table A-1 assesses 54 biodiversity components, comprising three ecosystems and 51 species. Eight species were assessed as Vulnerable: five plant species, southern grass skink, kōrero gecko and *Orocrambus sophistes*. A further two plant species were assessed as uncertain-vulnerable. Vulnerability was assessed as uncertain for another five plant species and unknown for three invertebrate taxa because the available information was insufficient to determine whether the Project would materially increase extinction risk or alter the applicable threat classification. The remaining 36 components, including all three ecosystems and all three bird species, were assessed as Not vulnerable.

Twenty-one plant species received High or Very High irreplaceability scores, comprising 14 High and seven Very High scores. No ecosystem, bird, lizard or invertebrate received a High or Very High irreplaceability score. The elevated plant scores generally reflect the proportion of known Macraes Ecological District sites or populations that would be affected, rather than a conclusion that each species is unable to be compensated for. Several plants with High irreplaceability scores were assessed as not vulnerable because the Project-related loss is not expected to change their regional threat classification or materially increase their risk of extinction. Irreplaceability could not be reliably scored for two plant species because their distribution or population size is insufficiently understood.

Overall, the assessment identifies a relatively small group of biodiversity values requiring particular caution, principally locally restricted or poorly understood TAR flora and two declining lizard species. These findings support the use of value-specific compensation actions, monitoring and adaptive management rather than relying solely on the overall outcome of the integrated compensation package.

Table A-1 . Summary of vulnerability and irreplaceability.

Scientific name	Irreplaceability score	Vulnerability score	National threat status	Regional threat status	Justification
Ecosystems Impacted by MP4					
Narrow leaved snow tussock grassland	**Low** -<0.1 loss 90.01 ha permanent loss (out of an estimated 11,777 ha in the ED)	Not vulnerable	N/A	N/A	Proportion of loss is not anticipated to cause a substantial change in rate of loss across the Region for this ecosystem type, although this may accelerate cumulative loss.
Dry Shrubland	**Low** -<0.1 loss 3.06 ha permanent loss (out of an estimated 3,532 ha in the ED)	Not vulnerable	N/A	N/A	The proportion of loss is not anticipated to cause a significant change in the rate of loss across the Region for this ecosystem type.
Rock outcrop / tor	**Low** -<0.1 loss 0.26 ha permanent loss (out of 31.5 ha mapped for protection within OGL landholdings)	Not vulnerable	N/A	N/A	The proportion of loss is not anticipated to cause a significant change in the rate of loss across the Region for this ecosystem type.
TAR Plants directly impacted by MP4					
Acaena buchananii	**High** - 10 % loss (One plant from one of seven known sites in the ED)	Vulnerable	At Risk – Declining	Threatened – Regionally Vulnerable	Loss of one site represents a significant proportion of the local population and may alter the cumulative rate of regional population loss (decline of 10-30%).
Aciphylla subflabellata	**Moderate** - 1% loss (One plant lost from one of 58 recorded sites in the ED)	Not vulnerable	At Risk – Declining	Threatened – Regionally Vulnerable	Loss of 1-2 individuals from a population of hundreds in the ED is not expected to substantially increase risks to the species in the region (regional trend of 10-30% decline)
Agrostis pallescens	**High** - 30% loss (Sites in impact area cover 23% of these wetlands, is present in ED as scattered plants across several wetlands)	Uncertain	At Risk – Naturally Uncommon	At Risk – Regionally Naturally Uncommon	Regional species trend is stable. Loss of up to one-third of the ecological district population may change the regional conservation status, but it may not be enough loss to trigger this shift.
Anthosachne falcis	**Moderate** - 1% loss (Species frequently found throughout tussock and grassland in the ED)	Not vulnerable	At Risk – Declining	At Risk – Regionally Declining	Considered a frequent component of grassland species in the ED. Loss is not expected to alter the regional conservation status of this species. (decline of 10-30%)
Brachyscome longiscapa	**High** - 10% loss (Two sites of approximately 24 plants to be lost, 9 further sites known in the ED. Additional sites may be present and	Not vulnerable	At Risk – Naturally Uncommon	At Risk – Regionally Naturally Uncommon	Assessed as having a stable population in the region. This Project is not expected to substantially impact more than an extremely small proportion of the local population

	unrecorded due to frequency in appropriate habitat)				
Carmichaelia corrugata	**Very high -** 50% loss (Four sites to be impacted out of seven recorded in the ED)	Vulnerable	Threatened – Nationally Vulnerable	Threatened – Regionally Critical	The impact on *C. corrugata* represents a high proportion of the species from within the ED, where it occurs only in scattered and fragmented populations.
Carmichaelia petriei	**Moderate** 1% loss (An estimated 150 plants to be lost, however the species is widespread in the local landscape)	Not vulnerable	At Risk – Declining	At Risk – Regionally Declining	Impact from the Project not anticipated to alter regional trend (decline of 10-30% from a population of 100,000 mature individuals) or change regional conservation status
Celmisia hookeri	**Moderate** 1% loss (An estimated 1,500 plants to be impacted; however, many sites in the local landscape and ED, including some with populations up to 100,000s of plants)	Not vulnerable	At Risk – Naturally Uncommon	At Risk – Regionally Naturally Uncommon	*C. hookeri* is assessed as having a stable population in the Otago region, and the loss caused by the Project is not anticipated to alter the species' regional conservation status, noting that Otago is the stronghold for the species.
Deschampsia cespitosa	**Very high** -50% loss (The project will cause the loss of the largest population of this species in the ED of c.440 plants. The species has been patchily distributed in the ED from 20 other sites)	Vulnerable	At Risk – Declining	Threatened - Endangered	The impact on this species by the project is anticipated to cause a significant loss to the ED. This may amount to an increase in the predicted regional trend's rate of decline (10-30%)
Epilobium insulare	**High** -5% loss (Six plants from two sites to be lost, a further 50 sites recorded across the ED)	Not vulnerable	At Risk – Declining	Threatened – Regionally Vulnerable	The loss of two sites from 52 recorded in Macraes is not anticipated to substantially increase the rate of decline or threats this species faces.
Euchiton polylepis	**Very high** -20% loss (One plant lost from a total of five known sites in the ED)	Vulnerable	At Risk – Declining	Threatened – Regionally Vulnerable	Loss of one site from a known five in the ED represents a high proportion of the local population. Otago is a regional stronghold for the species, where there is a predicted decline of 10-30%.
Hypericum rubicundulum	**Very high** - 25% loss (Three sites to be lost from a total of 18 known sites in the ED. This population is unique in habitat preferences nationally for the species and there is a possibility of taxonomic revision being required)	Vulnerable	Threatened – Nationally Endangered	Threatened – Regionally Critical	The Project is anticipated to impact around 20% of the local population of this species, which is very rare and at high risk in Otago. There is a chance this local population represents a new taxonomic entity (on the basis of unusual habitat preferences), and so a 20% loss is a substantial impact.

Juncus australis	**Unknown**	Not vulnerable	Not Threatened	Regionally Data Deficient	Loss of one population unlikely to substantially alter the regional population.
Juncus distegus	**High -** 10% loss (Nine sites impacted out of 76 sites recorded in the ED. Only a small number affected relative to the other sites where it has been recorded in the local area)	Not vulnerable	Not Threatened	At Risk – Regionally Declining	Project impact is unlikely to significantly change population size in ED, or change overall regional population trend (declining 10-30%)
Juncus pusillus	**High -** 5% loss (One site to be impacted, known from multiple sites in the ED and often not recorded as not uncommon in the local area)	Not vulnerable	At Risk – Naturally Uncommon	Threatened – Regionally Vulnerable	Loss of one site is unlikely to substantially alter the population size across the ED. *J. pusillus* is frequently seen at Macraes, including in modified habitats.
Lagenophora bakeri	**High -** 5% loss (Three sites impacted and 26 sites recorded in wider ED, including the Highlay Hill covenant where it is very common)	Not vulnerable	At Risk – Declining	Threatened – Regionally Endangered	Loss to the population caused by the Project is not expected to substantially alter the local population, or cause change to regional population trend (declining 10-30%)
Leptinella pusilla	**High -** 10% loss (One site to be lost, an additional 12 sites known from the ED)	Uncertain - vulnerable	At Risk – Declining	Threatened – Regionally Endangered	The loss of one site out of 12 known in the ED may be considered a high proportion of the known local population to justify an increase in threat classification but may also fall within the predicted rate of change for the species.
Lobelia ionantha	**High -** 10% loss (One site to be lost from 31 recorded locations within the ED. Loss is a high proportion of the secure populations in the ED)	Not vulnerable	At Risk – Declining	Threatened – Regionally Endangered	The loss of one site out of 31 known in the ED is not likely to justify an increase in threat classification for the species. However, the impact does represent a loss of one of few secure populations within the ED
Lobelia perpusilla	**High -** 10% loss (One site to be lost from several known in the ED. Loss is a high proportion of the secure populations in the ED)	Not vulnerable	Not Threatened	Threatened – Regionally Vulnerable	The loss of one site out of several known in the ED is not likely to justify an increase in threat classification for the species. However, the impact does represent a loss of one of few secure populations within the ED
Melicytus aff. *alpinus* (c) (CHR 541568; Otago)	**Unknown.** A poorly known species with little information about distinguishing characteristics. Distribution largely unknown.	Uncertain	Data Deficient	Regionally Data Deficient	A poorly known and surveyed species with little information known about distribution and population size.

Mentha cunninghamii	**High** - 5% loss (One site impacted out of eight recorded in the ED, however the species is common enough in the ED that it is not always recorded)	Not vulnerable	At Risk – Declining	At Risk – Regionally Declining	The loss of one site is not anticipated to impact the regional population to the extent of a threat status change or change to the regional population trend (declining 10-30%)
Oxalis rubens	**High** - 10% loss (One site impacted from 12 sites in the ED)	Not vulnerable	Not Threatened	Regionally Data Deficient	The species is expected to be under-recorded in the wider landscape. The loss of one site is not expected to substantially impact the conservation status of this species.
Poa pusilla	**High** - 10% loss (One site impacted from 13 recorded sites in the ED. All recorded sites in ED very small)	Not vulnerable	Not Threatened	At Risk – Regionally Naturally Uncommon	A species with a limited distribution in the ED but considered to have a stable population in the Otago region. The loss of one site from 13 is not expected to substantially alter the overall threats the species faces or the population trend in the region.
Pterostylus tristis	**Very high** - 25% loss (One site impacted out of five recorded sites in the ED. A very cryptic species)	Uncertain	At Risk – Declining	Threatened – Regionally Vulnerable	A highly cryptic species that can be hard to accurately survey. The project has the potential to impact a moderate proportion of the local population.
Rytidosperma buchananii	**Very high** 30% loss (One site impacted and two additional sites known in ED)	Uncertain	At Risk – Declining	At Risk – Regionally Declining	Three plants are to be lost, but a very rare species within the ED. Hard to identify and survey, making the scale of impact on the species difficult to measure.
Rytidosperma thompsonii	**Very high** - 50% loss (One site impacted out of a total of two sites known from the ED)	Uncertain - vulnerable	At Risk – Declining	Threatened – Regionally Endangered	A difficult species to identify and survey, making the scale of impact hard to assess. The project will result in a 50% loss of the known sites for this species in the ED.
Shawia bullata	**Moderate** - 1% loss (c.100 plants within impact area, 109 locations recorded in ED and species is common in gullies and riparian edges in the ED)	Not vulnerable	Not Threatened	At Risk – Regionally Naturally Uncommon	A species with a stable population trend recorded for the region. The impacts of this project are not expected to substantially alter the regional population trend.
Sonchus aff. *novae-zelandiae* (a) (CHR 517718; “grassland”)	**High** - 5% loss (One site impacted out of 15 within the Macraes ED. A species known from few sites with few plants at each. Appears to be less common that previously)	Uncertain	Threatened – Nationally Endangered	Threatened – Regionally Endangered	An entity requiring taxonomic revision, and which appears to be facing an increasing population decline. The loss of two sites from 15 known in the ED is significant and adds to this cumulative loss.

TAR Birds Impacted by MP4					
Charadrius bicinctus bicinctus	**Very Low -**<0.1 loss 235.99 ha of habitat representing territories of an estimated 12 birds affected	Not vulnerable	At Risk – Declining	Threatened – Regionally Vulnerable	No direct injury or mortality to birds is predicted as a result of this project. No alteration to species populations or the regional threat classification for the species is anticipated.
Falco novaeseelandiae novaeseelandiae	**Very Low -**<0.1 loss 130.38 ha of habitat representing approximately 6 birds' territories	Not vulnerable	Threatened – Nationally Vulnerable	Threatened – Regionally Vulnerable	No direct injury or mortality to birds is predicted as a result of this project. No alteration to species populations or the regional threat classification for the species is anticipated.
Haematopus finschi	**Very Low -**<0.1 loss 130.38 ha of habitat representing approximately 27 birds' territories	Not vulnerable	At Risk – Declining	Threatened – Regionally Vulnerable	No direct injury or mortality to birds is predicted as a result of this project. No alteration to species populations or the regional threat classification for the species is anticipated.
TAR Lizards Impacted by MP4					
Oligosoma maccanni	**Low -** ≥ 0.1% loss 0.49% of the estimated Macraes ED population (61,997 of 12,599,874).	Not vulnerable	Not Threatened	Regionally Not Threatened	McCann's skink is widespread, abundant and tolerant of modified habitats. The Project is not expected to change its regional status or materially increase extinction risk.
Oligosoma aff. polychroma Clade 5	**Moderate**: ≥ 1% loss Approximately 1.23% of the estimated Macraes ED population (87,813 of 7,125,132).	Vulnerable	At Risk – Declining	At Risk – Regionally Declining	The Project affects a material local population of a declining species and contributes to permanent habitat loss; a Vulnerable conclusion is retained.
Woodworthia "Otago/Southland large"	**Moderate:** ≥ 1% loss Approximately 1.01% of the Macraes ED population estimate (5,754 of 569,100); low confidence.	Vulnerable	At Risk – Declining	At Risk – Regionally Declining	The calculation uses an informed density because reliable gecko density data are unavailable. The permanent loss and fragmentation of rock habitats may increase local extinction risk.
TAR Invertebrates Impacted by MP4[2]					
Orocrambus sophistes	**Low**: ≥ 0.1% loss Approximately 0.6% of the estimated ED tussock habitat (90 ha).	Vulnerable	Threatened – Nationally Vulnerable		One individual was recorded and not re-detected despite the targeted survey. The species is restricted to inland dry South Island habitats, and females have limited dispersal. A precautionary Vulnerable conclusion is used; the habitat value does not quantify population loss.

[2] For invertebrates, percentages are mapped suitable-habitat proxies within the Macraes Ecological District, not estimated population losses.

Agrotis admirationis	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha).	Not vulnerable	At Risk – Declining		The species is widely but patchily distributed through both main islands and is also recorded outside the impact footprint. The Project is not expected to alter national status.
Asaphodes recta	**Low**: ≥ 0.1% loss Approximately 0.6% of estimated ED tussock habitat (90 ha).	Not vulnerable	At Risk – Declining		The species is widespread through Canterbury, Otago and Southland tussocklands and is recorded in the Murphys compensation area. The habitat proxy does not indicate a national extinction risk increase.
Dasyuris partheniata	**Low**: ≥ 0.1% loss Approximately 0.6% of estimated ED tussock habitat (90 ha).	Not vulnerable	At Risk – Declining		Only one historical larval record occurs at Coronation and the species is widespread across the South Island and lower North Island.
Nyctemera annulata	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha).	Not vulnerable	At Risk – Declining		The species is widespread across OGNZL landholdings and New Zealand. The Project is not expected to change the national status.
Orthodera novaezealandiae	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha).	Not vulnerable	At Risk – Declining		The species is likely widespread in suitable shrubland on OGNZL landholdings and is widely distributed nationally.
Pasiphila sp. A (NZAC 04285480 "Carmichaelia")	**Very Low**: < 0.1% loss Approximately 0.087% of mapped ED shrubland habitat (3.1 ha).	Not vulnerable	At Risk – Declining		The species has a widespread but patchy national distribution and is recorded at several protected sites outside the footprint.
Patagoniodes farinaria	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha).	Not vulnerable	At Risk – Declining		The species is relatively common in the surrounding landscape, widespread in New Zealand and also occurs in Australia.
Samana acutata	**Very Low**: < 0.1% loss Approximately 0.087% of mapped ED shrubland habitat (3.1 ha).	Not vulnerable	At Risk – Declining		The species is widespread in the lower South Island, occurs outside the impact footprint and is not dependent on a unique Project-site habitat.
Theoxena scissaria	**Very Low**: < 0.1% loss Approximately 0.087% of mapped ED shrubland habitat (3.1 ha).	Not vulnerable	At Risk – Declining		The species was recorded outside the impact footprint at BRWRS and is widely distributed through inland Canterbury and Otago.
Bityla sericea	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha).	Not vulnerable	At Risk – Naturally Uncommon		The species is recorded at several Project and compensation locations and is widespread across Otago, although generally at low abundance.

Wiseana fuliginea	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha).	Unknown	Data Deficient		The species is poorly known, is restricted to the southern South Island, and was detected only by eDNA at Coronation. Available information is insufficient to determine the Project-level risk to the species. Vulnerability is therefore Unknown.
Wiseana mimica	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha).	Not vulnerable	Data Deficient		The only Project record is from the Murphys compensation area, and the species is widespread in open country east of the Southern Alps.
Zelandobius uniramus	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha); conservative because records are outside the footprint.	Not vulnerable	Data Deficient		eDNA records are from several sites outside the impact footprint and the species occurs across southern South Island and Stewart Island.
Hemiandrus maia	**Low**: ≥ 0.1% loss Approximately 0.5% of estimated ED tussock/shrubland habitat (93.1 ha).	Not vulnerable	Not Threatened		The species is abundant in tussock and shrubland inside and outside the footprint and is widespread in Otago and Southland.
Mecodema sp. "Oamaru"	**Moderate**: ≥ 1% loss Approximately 1.4% of estimated suitable ED habitat (325 ha).	Unknown	Not listed		The entity is poorly known and is represented by a single Project-area observation. Its distribution and population size are insufficiently resolved to determine the Project-level risk. Vulnerability is therefore Unknown.
Orocrambus cf. *cyclopicus*	**Low**: ≥ 0.1% loss Approximately 0.6% of estimated ED tussock habitat (90 ha).	Unknown	Not listed		The taxon is poorly known and may be endemic to inland Otago drylands. Taxonomic status, distribution and population size are insufficiently resolved to determine the Project-level risk. Vulnerability is therefore Unknown

1.2 NPSIB Criteria 2b: Uncertain, unknown or little-understood effects

The permanent removal of mapped vegetation and habitat within the Project Footprint is well established. Confidence is lower when estimating affected population sizes, indirect effects, post-management survival and the ecological gains that will result from compensation.

It is therefore necessary to distinguish between confidence that an adverse effect will occur and confidence that the proposed compensation action will produce the predicted ecological response.

The uncertainties are material but do not affect every value to the same degree. For snow tussock, dry shrubland, McCann's skink and the three modelled bird species, there is sufficient information to predict the direction and approximate scale of the anticipated response. Greater uncertainty remains for rock habitat, kōrero gecko, terrestrial invertebrates and some TAR plant outcomes. Overall, the effects are well understood (empirical field measurements taken of a variety of flora and fauna attributes). Although there are limitations, these are not resolved by aggregating results across the compensation package. Where limitations have been observed, they are retained as value-specific qualifications in the predicted outcomes and monitoring requirements.

Overall, the compensation package is considered to have ascertained potential impacts and potential outcomes with sufficient certainty for this criterion to have been met.

Table A-2 . Principal uncertainties relevant to the compensation assessment.

Biodiversity value	Confidence in residual-effect assessment	Confidence in the compensation outcome	Principal uncertainty and response
Snow tussock and dry shrubland	High confidence in the affected extent and permanence of removal.	Moderate to high for the broad vegetation response, subject to implementation.	Plant survival, growth, indigenous cover, composition and richness may vary with climate, soils, seed source, weed competition and browsing. Permanent plots, drone imagery, progressive targets and adaptive planting responses are proposed.
Rock outcrops and tors	High confidence that direct removal is permanent.	Moderate to high.	The physical habitat cannot be recreated. The predicted benefit is based on protection and enhancement of retained rock habitat and improved surrounding vegetation rather than like-for-like replacement.
Planted TAR flora	Moderate to high for known plant locations, subject to detection limitations.	Species-specific and generally moderate.	Propagation, transplanting and establishment requirements are poorly documented for some species. Monitoring of marked plants, replacement planting, method refinement and protection from browsing are required.
Terrestrial invertebrates	High confidence in habitat removal and unavoidable mortality, but lower confidence in affected population size.	Low to moderate for many individual taxa.	Detectability, population distribution, host associations, salvage success and recolonisation are uncertain. Host-plant establishment and release-site monitoring will provide evidence of response but may not demonstrate full compensation.
McCann's and southern grass skinks	Moderate to high confidence in habitat use and density estimates. The current figures and assumptions in the main REA and Appendix B supersede the earlier estimates in Appendix A.	High confidence in the direction of response to predator management, but lower confidence in the precise magnitude and timing of that response.	Density estimates depend on detection models, survey data and extrapolation across broad habitat classes. Monitoring within MEEA will test the predicted response. A residual shortfall remains for southern grass skink.

Kōrero gecko	Moderate confidence in presence and habitat association, but low confidence in abundance and the number of animals affected.	Low to moderate.	Reliable density information is unavailable, and the species depends on rock habitat that cannot be physically replaced. Monitoring can assess direction of response but may not establish equivalence with the affected population.
Kārearea, banded dotterel and South Island pied oystercatcher	High confidence that potential habitat will be affected. Lower confidence remains regarding the numbers of breeding birds directly dependent on the footprint. The current South Island pied oystercatcher estimate is 27 birds.	Moderate.	The BOAM inputs rely partly on habitat-based population estimates and breeding-success studies from other locations. Monitoring will assess relative abundance and occurrence, but the programme does not directly measure breeding success for every species.

1.3 NPSIB Criteria 2c: Technical feasibility and acceptable timeframes

The compensation package relies on revegetation, legal protection, stock exclusion, pest-plant and pest-animal control, predator exclusion, landscape-scale predator suppression, plantation removal, habitat connection and ecological monitoring. These actions are technically feasible at a broad level and are based on established conservation-management methods. Their ecological effectiveness nevertheless depends on implementation at the stated scale and on achievement of the required ecological responses.

The revegetation actions provide technically feasible means of securing substantial biodiversity gains within the assessment period identified in the REA. Overall compensation success for both snow tussock and dry shrubland revegetation is measured at 20 years. Within the snow tussock BOAM, structural attributes use 15-year endpoints and diversity attributes use 10-year endpoints. These different endpoints reflect the predicted development of the individual biodiversity attributes and should not be described as separate overall compensation-success dates.

The proposed timeframes are within the maximum 35-year period provided for by NPS-IB Appendix 4, Principle 8. The conclusions remain dependent on implementation of the full planting programme, achievement of the specified performance targets and effective adaptive management where monitoring identifies underperformance.

Table A-3 . Technical feasibility and timeframes of the principal compensation actions.

Compensation action	Principal values addressed	Technical feasibility and anticipated timeframe	Key limitations
Approximately 175.65 ha of snow tussock revegetation at Mt Highlay, including tor-edge and shallow-soil planting	Snow tussock, selected TAR flora, invertebrate host plants, lizards and landscape connectivity	Revegetation, weed control, stock exclusion and browsing management are established methods. REA Table 7-1 measures overall compensation success at 20 years. The vegetation BOAM separately applies 15-year endpoints to structural attributes and 10-year endpoints to diversity attributes.	The programme is large and staged. Outcomes depend on plant supply, climatic conditions, soil suitability, weed and browsing control, and establishment of specialist plants.
Approximately 50.59 ha of dry shrubland revegetation at Cranky Jims Link	Dry shrubland, selected TAR flora, shrubland invertebrates, birds and landscape connectivity	Pioneer and enrichment planting are technically feasible. REA Table 7-2 measures compensation success at 20 years.	Mature shrubland structure and associated habitat will develop gradually. Enrichment planting depends on successful establishment of the pioneer vegetation.
Protection and stock exclusion of retained tussock, shrubland and rock habitat	Vegetation, flora, lizards, invertebrates and birds	Fencing, legal protection and removal of stock pressure can provide immediate protection, with vegetation-condition benefits developing progressively.	Outcomes depend on fence maintenance, continued exclusion of stock, weed control and management of wild browsing animals.
Predator-exclusion fencing within the approximately 252 ha MEEA and predator suppression within an approximately 1,170 ha surrounding management area	Lizards, ground-nesting birds and other indigenous fauna	Predator exclusion and sustained pest suppression are established conservation methods. Ecological responses are expected after target pest levels are achieved and will be assessed through repeated monitoring.	Fence breaches, reinvasion, mouse abundance, variation in pest-control effectiveness and uncertainty in fauna response require continued monitoring and adaptive management.
Removal of approximately 265 ha of plantation forestry at Mt Highlay	Lizards, rock habitat, tussock restoration and landscape connectivity	Plantation removal is technically achievable and will remove shading and avoid further degradation of underlying habitat.	Clearance methods must avoid unnecessary damage to retained rock and indigenous vegetation. Recovery and recolonisation will occur over time and may require supplementary habitat management.

Propagation and planting of selected TAR flora	Dwarf broom, narrow-leaved speargrass, desert broom and tree daisy	Seed collection, propagation and planting are feasible, with species-specific methods supervised by the Project botanist.	Success varies among species. Propagation knowledge, habitat specificity, root disturbance, browsing, weed competition and climatic conditions create residual uncertainty.
Monitoring and adaptive management	All compensation values	Annual establishment monitoring followed by five-yearly ecological outcome monitoring is practicable and provides a mechanism to identify underperformance.	Monitoring does not itself deliver compensation. Consent and management requirements must include enforceable triggers, corrective actions, reporting, funding and responsibility for unresolved shortfalls.

1.4 Overall conclusion

The assessment indicates that vulnerability, irreplaceability, uncertainty and the feasibility of compensation vary materially among the terrestrial biodiversity values affected by MP4. Of the 54 components assessed in Table A-1, eight species were assessed as Vulnerable and two plant species as uncertain-vulnerable. Vulnerability was uncertain for a further five plant species and Unknown for three invertebrate taxa because their distribution, population size, taxonomic status or response to Project effects is insufficiently understood. Twenty-one plant species received High or Very High irreplaceability scores, primarily because the Project would affect a material proportion of their known sites or populations within the Macraes Ecological District.

These results identify biodiversity values for which compensation involves greater ecological risk. They do not, by themselves, establish that compensation is inappropriate for each of those values. Threat classification and proportional loss are relevant considerations but must be considered alongside the scale and permanence of the effect, the distribution of the value outside the Project footprint, the feasibility and likely effectiveness of the proposed conservation actions, and the uncertainty associated with both the effect and the anticipated gain.

However, some material limitations remain, for example, rock outcrop and tor habitat cannot be recreated on a like-for-like basis, and the abundance, distribution and likely response to management of kōrero gecko, several terrestrial invertebrates and some TAR plant species remain uncertain. A modelled shortfall also remains for southern grass skink. The proposed measures, therefore, do not demonstrate strict ecological equivalence or full replacement of every affected biodiversity value and are appropriately classified as biodiversity compensation rather than formal biodiversity offsets.

The compensation package nevertheless comprises technically feasible, additional and enduring conservation actions that are expected to produce substantial gains in indigenous vegetation extent and condition, fauna habitat, ecological connectivity and the protection and management of Threatened and At Risk species. Quantitative modelling predicts positive balances for snow tussock, dry shrubland, McCann's skink, kārearea, banded dotterel and South Island pied oystercatcher. These modelled outcomes are supplemented by the protection and management of extensive areas of tussock, shrubland and rock habitat, predator exclusion and landscape-scale pest control, plantation removal, restoration planting, and species-specific salvage, propagation and monitoring.

On the current evidence, the assessment does not identify any affected terrestrial biodiversity value for which the limits in NPS-IB Appendix 4, Principle 2, make the use of biodiversity compensation categorically inappropriate. This conclusion is subject to the identified uncertainty and does not imply that every affected value will be fully replaced or that no ecological loss will remain. Rather, it reflects a professional judgement that the integrated package is expected to provide additional, measurable and enduring ecological benefits that, at the package level, exceed the quantified and modelled residual losses and provide broader conservation gains across the surrounding landscape.

This conclusion is conditional on legal and financial security for the compensation areas, implementation of all committed management actions, achievement of the specified performance targets, long-term monitoring, and effective corrective or contingency action where monitoring identifies underperformance. Any material change to the Project footprint, affected values, compensation areas or management commitments would require the conclusions of this assessment to be reconsidered.

Appendix B

Analyses supporting the terrestrial biodiversity compensation package

1 Introduction

1.1 Project context

MP4 will result in permanent loss and modification of terrestrial vegetation and fauna habitat after practicable measures to avoid, minimise and remedy adverse effects have been applied. The principal residual effects addressed by the wider terrestrial compensation package relate to indigenous snow tussock, schist rock habitat, terrestrial invertebrates, indigenous lizards, selected indigenous birds and some Threatened or At Risk plants. Detailed descriptions of the Project, ecological values, effects and effects-management hierarchy are provided in the Terrestrial REA and the supporting values and effects assessments.

1.2 Purpose and scope

The purpose of this report is to document the modelled losses and predicted gains for biodiversity values to which BOAMs have been applied, record the principal inputs and assumptions, explain how the outputs have been interpreted, and provide the supporting outcome-based analysis for terrestrial invertebrates. The report addresses terrestrial biodiversity only. Natural inland wetland effects and wetland compensation are assessed separately.

The analyses cover narrow-leaved snow tussock grassland, dry shrubland, terrestrial invertebrates, McCann’s skink, southern grass skink, kārearea, banded dotterel and South Island pied oystercatcher. Not all residual effects or wider conservation benefits can be represented quantitatively. References to rock habitat, Threatened or At Risk flora and kōrero gecko are therefore limited to matters required to explain model scope, assumptions or limitations.

1.3 Relationship to the Terrestrial Residual Effects Analysis Report

This report should be read alongside the Terrestrial REA. The Terrestrial REA contains the broader residual-effects assessment, a complete description of the compensation package, package-level ecological outcomes, monitoring and adaptive-management framework, durability and security considerations, cultural context, assessment against the National Policy Statement for Indigenous Biodiversity compensation principles, and overall conclusion. Raw BOAM outputs and supporting datasets are provided in separate appendices to the Terrestrial REA and are not reproduced here.

2 Compensation Analysis

2.1 Role of biodiversity accounting in the compensation package

BOAMs have been applied where quantitative data were available for both affected values and proposed compensation areas. They provide structured decision support for determining whether predicted gains are likely to exceed quantified losses for the assessed biodiversity component. The models support, but do not replace, ecological assessment and professional judgement concerning the wider compensation package.

3 Biodiversity Offset Accounting Model Framework

The BOAM is a quantitative decision-support tool used to assess whether proposed biodiversity offsets are sufficient to counterbalance residual adverse effects and achieve no net loss, or preferably a net gain, in biodiversity values. The BOAM operates by disaggregating biodiversity into key attributes (such as vegetation structure, species composition, and fauna habitat) and assigning scores to attributes within each component based on condition, extent, and ecological function. These values are then used to calculate a Net Present Biodiversity Value (NPBV) at a finite endpoint, which incorporates time lags, risk of failure, and uncertainty through discounting and confidence multipliers, enabling comparison of biodiversity losses and gains over time (Department of Conservation, 2014).

A key strength of the BOAM framework is its requirement for like-for-like accounting across biodiversity components, ensuring that gains in one component do not mask losses in another. This aligns with best-practice offsetting principles (while acknowledging that the overall outcome would align more closely with ‘compensation’), including equivalence, additionality, and transparency, and supports robust, defensible offset design under the effects management hierarchy. By explicitly accounting for temporal delays and uncertainty, BOAM provides a conservative and structured approach to demonstrating offset adequacy and informing consent conditions and long-term management commitments (Department of Conservation, 2014; Pilgrim *et al.*, 2013).

In this assessment, the BOAM is used as a tool to quantify like-for-like biodiversity losses and gains to the greatest extent practicable, while recognising the inherent uncertainties associated with demonstrating net gains for some biodiversity values. Accordingly, the overall residual effects package is characterised as compensation rather than a strict biodiversity offset. The package has been strategically designed to maximise biodiversity outcomes within the wider landscape by directing restoration, protection and enhancement towards the affected biodiversity communities, while also delivering benefits for other high-value ecosystems and culturally significant flora and fauna. By focusing actions within key compensation areas and strengthening ecological connections, this strategy is expected to deliver biodiversity gains that exceed losses, acknowledging that some of those gains are not like-for-like in all cases.

3.1 Values modelled

The snow tussock BOAM is based primarily on vegetation plot data from impact and compensation sites. The dry shrubland BOAM uses vegetation plot data and includes bird diversity as an attribute informed by data from Cranky Jims. The lizard BOAMs use quantitative baseline density estimates for three broad habitat categories in affected and compensation areas. The avifauna BOAMs assess predicted changes in breeding success using project-specific habitat areas and breeding-season information together with published evidence concerning responses to predator management.

Each species or biodiversity component is modelled separately. This avoids aggregation, obscuring differences in ecology, habitat use, response to management, model confidence and predicted outcome. Terrestrial invertebrates are not modelled because existing information does not provide a defensible quantitative basis for comparing losses and gains across the affected assemblage and notable taxa.

3.2 Interpretation and limitations of model outputs

The results are estimates conditional on the selected impact areas, compensation areas, baseline values, benchmarks, endpoints, confidence categories and ecological-response assumptions. A positive model balance indicates that predicted gains exceed quantified losses within the defined scope of that model. It is not a precise prediction of future population size, a demonstration of regional viability, or evidence that all requirements of a formal biodiversity offset have been met.

Confidence differs among attributes and components. Vegetation forecasts depend on the establishment and development of the planted communities. Lizard forecasts depend principally on the assumed population response to mammal exclusion. Avifauna forecasts depend on the transfer of breeding-success evidence from managed systems to the Macraes receiving environment. These limitations are stated within the relevant component analyses and retained in the interpretation of the overall results.

4 Compensation Analysis

4.1 Modelled Components: Tussock and dry shrubland

This section describes the application and outputs of BOAMs (Maseyk *et al.* 2015) in relation to loss of indigenous vegetation, specifically narrow-leaved snow tussock grassland and dry shrubland. While residual effects are not expected to remain for dry shrubland vegetation and related habitats, shrubland restoration has been incorporated into the broader compensation package because it contributes to the long-term ecological integrity and resilience of the protected landscape. Restoration of dry shrubland improves habitat connectivity, increases indigenous structural and compositional diversity, and complements the net positive outcomes demonstrated through the BOAM for both snow tussock and dry shrubland.

However, the BOAM cannot adequately quantify ecological outcomes for rock habitat. Rock outcrops, such as complex tors, support complex abiotic and biotic values, including habitat for TAR plant species, indigenous lizards, invertebrates and avifauna, many of which depend on the physical structure of the rock itself. As these habitat attributes are difficult to realistically recreated or be robustly modelled within practical restoration timeframes (but refer to LMP for a quantified approach to recreating rock habitat for lizards), compensation for residual effects on rock habitat is best achieved through an integrated ecosystem approach.

Accordingly, the compensation package extends beyond the BOAM-modelled restoration actions and includes the permanent legal protection and stock-proof fencing of extensive areas of existing indigenous habitat, comprising more than approximately 500 ha of snow tussock, 88 ha of dry shrubland and 45 ha of rock habitat (see Table 5-2). These actions secure existing high-value ecosystems and their ecological functions immediately, while the restoration programme delivers longer-term biodiversity gains through revegetation, habitat enhancement, weed and pest animal control, and improved landscape connectivity. Collectively, this integrated package recognises that biodiversity values are expressed across interacting ecosystems rather than individual habitat types and provides a more comprehensive and ecologically robust response to the residual effects of the Project than could be achieved through vegetation modelling alone.

4.1.1 Modelled data

The presented BOAM models are based on quantitative data collected from vegetation plots at impact and compensation sites (Appendix E). The vegetation cover for snow tussock values were modelled using area-weighted averages so that each assessment area (Coronation North, Central, Golden Bar) contributed to the overall project value in proportion to its extent. This approach provides a more representative estimate of vegetation condition across the Project than a simple average, which would give equal influence on sites regardless of their size. In effect, snow tussock at Coronation North, which is of the highest value and represents the largest area of loss, exerts the greatest influence on the modelled values.

4.1.2 Modelled Actions

The biodiversity accounting models focus on revegetation outcomes because these can be quantified with a reasonable degree of confidence in terms of the area established, vegetation composition and expected long-term trajectory. While the overall compensation package also includes substantial protection and enhancement measures, these have not been explicitly modelled because the magnitude and timing of ecological uplift are inherently uncertain. For example, stock exclusion and pest browser removal may also benefit exotic grasses and therefore reduce inter-tussock indigeneity, which would be particularly difficult to actively manage with any confidence over large areas. In addition, moderately dense snow tussock (such as those within degraded pastures) may support higher indigenous plant species richness than very dense snow tussock because greater inter-tussock space allows coexistence of a wider range of herbaceous species. However, dense snow tussock can still provide higher ecological integrity and important habitat values, particularly for indigenous fauna and intact ecosystem processes.

4.1.3 Vegetation impact model inputs

The Impact models quantify the impacted biodiversity, as measured onsite from vegetation plots and survey information. Inputs into the vegetation impact models are described in Table B-1, below.

Table B-1. Impact model inputs and descriptors for vegetation BOAMs- Indigenous Vegetation (Snow tussock and dry shrubland).

BOAMs for impact values of snow tussock and dry shrubland	
Model input category	**Input description**
Biodiversity type	Indigenous Vegetation. This includes: • Snow tussock • Dry shrubland
Biodiversity components	Four components: • Tussock Structure & Integrity • Tussock Diversity • Shrubland Structure & Integrity • Shrubland Diversity
Biodiversity attributes	Quantified biodiversity metrics used to determine impact and offset outcome: Revegetation attributes identified here were selected because they are measurable, change with maturity, and represent traits that are valued within snow tussock and dry shrubland communities: • Height (m) • % indigenous cover • % Proportion of indigenous species • Indigenous Diversity (Richness - count per plot) • TAR plant species (count) Dry shrubland revegetation Attributes: • Height (m) • % indigenous canopy cover (%) • % Proportion of indigenous species • Indigenous Diversity (Richness - count per plot) • TAR plant species (count) • Shrubland bird diversity
Area of impact	Total area of loss in hectares for each vegetation type (includes a 20 m buffer around the impact area, within which total loss is conservatively assumed).

	• Snow tussock – 90 ha, project wide • Dry shrubland – 3 ha, project wide
Benchmark	Benchmarks were set at the highest value reported from 32 snow tussock plots and 20 dry shrubland plots. Refer Appendix E for plot datasets, including highlighted benchmarks
Measure prior to impact	For all vegetation, measures prior to impact were based on multiple plots, from which area-weighted averages of plot data was used. This included: Tussock: 14 plots from Coronation North 10 plots from Golden Bar 2 Plots from Macraes Central Dry shrubland Plots: 3 plots from Coronation North 2 Plots from Golden Bar Averages of snow tussock plot data were area-weighted so that each assessment area contributed to the overall project value in proportion to its extent. This approach provides a more representative estimate of vegetation condition across the Project than a simple average, which would give equal influence to sites regardless of their size. This approach ensures that values at Coronation North (highest value vegetation and largest area) was provided a higher weighting than Golden Bar and Central snow tussock plots, while still accounting for variation at these locations because snow tussock at all locations is included in compensation models. Avifauna data was obtained from records of birds from all bird surveys undertaken at those locations (Coronation, Macraes Central or Golden Bar)- noting that only 'shrubland' bird species were modelled for 'dry shrubland' gains.
Measure after impact	Measure after impact set at zero because vegetation (including 20 m buffer) assumed to be completely lost because of project mining activities.

4.1.4 Vegetation offset model inputs

The BOAM estimate the biodiversity gains predicted from the proposed compensation actions, relative to the values at the compensation site. Inputs relied on data collected from planted vegetation of known age (Appendix E). Snow tussock heights, diameters sourced from planted snow tussock within OGNZL landholdings and planted dry shrubland species from near Flat Top Hill Conservation Area[3] (Central Otago). Flat Top Hill Conservation Area is semi-arid continental climate with some of the lowest rainfall in New Zealand and supporting shallower soils. From this perspective, growth rates are considered to be conservative compared to Macraes. Predicted measures are identified in Table B-2, based on information presented in Appendix E.

[3] Data supplied by Craig Wilson, Whirika

Table B-2. BOAM worksheet inputs used to evaluate compensation for loss of indigenous vegetation .

BOAMs for predicted output (compensation) values of replanted snow tussock and dry shrubland	
Model input category	**Input description**
Discount rate	3% discount in accordance with standard practice and as recommended in the BOAM User Guide (Maseyk *et al.* 2015).
Proposed offset actions	Two compensation actions are proposed: • Revegetation of tussock • Revegetation of dry shrubland
Offset area	Tussock: • 175 ha snow tussock revegetation (Mt Highlay) Dry shrubland: • 50 ha revegetation (around Cranky Jims covenant and link to Island Block Covenant)
Confidence in offset actions	All confidence actions were set to 'Confident (75 – 90%)'. This was based on sizes of planted tall snow tussock within OGNZL landholdings at Macraes, as well as other planted dry shrubland vegetation (Measured from Flat Top Conservation Area) that feature within plant species lists.
Measure prior to offset	All values were set at '0' where planting would be undertaken into pasture or an early-stage pine plantation that currently lacks dry shrubland or snow tussock cover.
Measure after offset	• Predicted values after offset were based on plots and measurements of planted snow tussock or dry shrubland flora of known age (refer Appendix E for planted tussock and dry shrubland measurements). These plant sizes were used to estimate values such as likely canopy height and cover (e.g. snow tussock diameter). • Diversity measures were based on planting schedules, including plant composition and spacing, to predict likelihood of occurrence within an average 10 x 10 m monitoring plot.
Time till endpoint (years)	The finite endpoints (i.e., the endpoint at which the stated outcome is measured) were set as: • 10 years to achieve diversity measures for snow tussock and dry shrubland (richness and TAR plant species assumed establishment of planted species) • 15 years to achieve structure and integrity measures (vegetation growth and cover). • 20 years to achieve diversity for dry shrubland birds

4.1.5 Vegetation Model Results

Positive outcomes are predicted using rounded model inputs of 175 ha of snow tussock and 50 ha of dry shrubland restoration planting (implementation areas approximately 175.65 ha and 50.59 ha, respectively). These results are summarised in Table B-3 (snow tussock values), Table B-4 (dry shrubland values) and Table B-5 (summary of all actions). Raw outputs of the BOAM models are presented in Appendix C.

For snow tussock, the model predicts overall positive outcomes despite some individual structural attributes taking longer to recover. Positive gains are predicted for vegetation height, indigenous species composition, and particularly Threatened and At Risk (TAR) plant richness, while slight deficits remain for total vegetation cover and overall species richness. When considered collectively, the snow tussock component achieves a small net positive outcome (average component gain of 0.98 for structure and integrity and 6.66 for diversity), reflecting the expected recovery trajectory of restored snow tussock ecosystems over time.

The strongest gains are predicted for shrubland. Because only a small area of dry shrubland is affected (3 ha) and restoration and enhancement are proposed across 50 ha, all assessed attributes show substantial net gains. Improvements are predicted for vegetation structure, indigenous cover, species richness, TAR plant richness, and bird diversity, resulting in average net gains of 4.30 for structure and integrity and 13.27 for diversity. These results indicate that the dry shrubland restoration programme is expected to deliver biodiversity outcomes well in excess of those lost through the Project, acknowledging that some aspects of biodiversity loss (rocks, TAR flora habitat) will be protected in the wider landscape through additional stock proofing and covenants.

Table B-3. . BOAM 'Offset Model' worksheet explanation for the compensation of the loss of 90 ha Snow tussock (Project wide).

Biodiversity Component	Biodiversity attribute	Benchmark and justification	Impact value	Measure prior to Impact	Action and confidence	Measure after Offset and time till endpoint	Justification for Measure and confidence (References / data)	Attribute Net Present Biodiversity Value
Narrow-leaved snow tussock Structure and Integrity	Height (m)	**1.7** Highest measured value from all snow tussock plots (recorded at Coronation).	**0.94** Weighted average from all impact snow tussock plots.	**0**	**Revegetation 175 ha** Confident 75-90%	**1 m** (15 years)	Refer Appendix E (Vegetation BOAM data): Tussock vegetation plot measurements and Tussock plant data of known height	4.96
	Integrity (% cover)	**99** Highest measured value from all snow tussock plots (recorded at Coronation).	**59** Weighted average from all impact snow tussock plots..	**0**	**Revegetation 175 ha** Confident 75-90%	**45%** (15 years)	Refer Appendix E (Vegetation BOAM data): Tussock vegetation plot measurements	-11.51
	Proportion of Indigenous Species (%)	**61** Maximum percentage of indigenous species recorded from all snow tussock plots (recorded at Murphy's).	**39.9** Weighted average from all impact snow tussock plots.	**0**	**Revegetation 175 ha** Confident 75-90%	**45%** (15 years)	Refer Appendix E (Vegetation BOAM data): Tussock vegetation plot measurements	9.49
Narrow-leaved snow tussock Diversity	Indigenous vascular plant Diversity (count)	**16** Highest measured value from all snow tussock plots (recorded at Coronation).	**7.8** Weighted average from all impact snow tussock plots.	**0**	**Revegetation 175 ha** Confident 75-90%	**6 spp** (10 years)	Refer Appendix E (Vegetation BOAM data): Tussock vegetation plot measurements and species planting mixes (Restoration planting plan)	-4.10
	Threatened and At Risk (TAR) vascular plant diversity (count)	**2** Total of all TAR species recorded across the snow tussock plots across all sites.	**2** Maximum number of TAR species identified from all plots combined	**0**	**Revegetation 175 ha** Confident 75-90%	**2 spp** (10 years)	Refer Appendix E (Vegetation BOAM data): Tussock vegetation plot measurements and species planting mixes (Restoration planting plan)	17.43

Table B-4. . BOAM 'Offset Model' worksheet explanation for the compensation of the loss of Dry shrubland (Project wide).

Biodiversity Component	Biodiversity attribute	Benchmark and justification	Impact value	Measure prior to Impact	Action and confidence	Measure after Offset and time till endpoint	Justification for Measure and confidence (References / data)	Attribute Net Present Biodiversity Value
Dry shrubland Structure and Integrity	Height (m)	**4** Highest measured value from the shrub plots across all sites.	**0.7** Measured from 2 plots at Coronation North.	**0**	**Revegetation** **50 ha** Confident 75-90%	**1.5 m** (20 years)	Refer Appendix E (Vegetation BOAM data): Dry shrubland vegetation plot measurements and Dry shrubland plant data of known height	8.04
	Integrity (% cover)	**94** Highest measured value from the shrub plots across all sites.	**45** Median cover recorded from 8 plots at Coronation North.	**0**	**Revegetation** **50 ha** Confident 75-90%	**20%** (20 years)	Refer Appendix E (Vegetation BOAM data): Dry shrubland vegetation plot measurements	3.42
	Proportion of Indigenous Species (%)	**90** Maximum percentage of indigenous species recorded in shrub plots across all sites.	**33** Mean percentage of indigenous species recorded from 8 plots at Coronation North.	**0**	**Revegetation** **50 ha** Confident 75-90%	**10%** (20 years)	Refer Appendix E (Vegetation BOAM data): Dry shrubland vegetation plot measurements	1.44
Dry shrubland Diversity	Indigenous vascular plant Diversity (count)	**16** Highest measured value from the shrubs plots across all sites.	**7.5** Median indigenous richness from 8 plots at Coronation North.	**0**	**Revegetation** **50 ha** Confident 75-90%	**9 spp** (15 years)	Refer Appendix E (Vegetation BOAM data): Dry shrubland vegetation plot measurements and species planting mixes (Restoration planting plan)	13.49
	Threatened and At Risk (TAR) vascular plant diversity (count)	**4** Total of all TAR species recorded across the shrub plots across all sites.	**1** Maximum number of TAR species identified from all plots combined	**0**	**Revegetation** **50 ha** Confident 75-90%	**3 spp** (15 years)	Refer Appendix E (Vegetation BOAM data): Dry shrubland vegetation plot measurements and species planting mixes (Restoration planting plan)	19.11

Table B-5. . Summary BOAM output scores dry shrubland birds

Biodiversity Component	Biodiversity attribute	Benchmark and justification	Impact value	Measure prior to Impact	Action and confidence	Measure after Offset and time till endpoint	Justification for Measure and confidence (References / data)	Attribute Net Present Biodiversity Value
Dry shrubland birds	Diversity	**11** **Refer Apendix F**	**3 ha**	**4 (possibly pipit)**	**Revegetation** **50 ha** Confident 75-90%	**4 spp** (20 years)	Impact Areas: Fantail, silvereye, grey warbler recorded Measure at 20 yrs: all impact spp. + bellbird, brown creeper (recorded at Cranky Jims). Refer Appendix F: Bird species lists and indicative benchmark	9.56

4.2 Compensation: Invertebrates

Due to the inability to accurately quantify invertebrate diversity, abundance, and habitat values in a manner that would allow application of a BOAM, compensation for residual effects on invertebrates has been developed using an outcome-based approach. Rather than attempting to demonstrate quantitative equivalence between losses and gains, the compensation package focuses on implementing measures that are expected to improve the protection, condition, and long-term resilience of invertebrate habitats and populations within the wider Project landscape. The proposed compensatory measures are summarised in Table B-6.

The compensation package includes the protection and management of high-quality habitats, habitat enhancement and restoration, retention and enhancement of host plants and key habitat features, predator elimination within a fence and predator control, and ecological monitoring. Collectively, these measures are expected to provide enduring benefits for a wide range of invertebrate species at the landscape scale. However, it is acknowledged that uncertainty remains regarding the magnitude of ecological gains that will be achieved and the extent to which these gains will compensate for Project-related losses. This uncertainty reflects the inherent complexity of invertebrate communities and current limitations in measuring and predicting their responses to management.

Table B-6. Summary of the effects management measures proposed for invertebrates (including 'Threatened', 'At Risk', 'Data Deficient', and other notable species) present in the MP4 Project area.

Species	Level of residual effect	Compensatory measures
Invertebrate community (Project-wide)	**High**	• Replanting various invertebrate host plants at Mt Highlay Station (approximately 175.65 ha) and Cranky Jims Link (approximately 50.59 ha). Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Potential benefits for invertebrates and invertebrate habitat over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA. • Potential benefits for invertebrates and invertebrate habitat over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits for invertebrates and invertebrate habitat over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.
Orocrambus sophistes	**High**	• Replanting host plants (*Chionochloa rigida* subsp. *rigida*) in the approximately 175.65 ha of snow tussock enhancement planting at Mt Highlay Station. Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Potential benefits over approximately 252 ha—including large areas of snow tussock habitat—that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link)—including large areas of snow tussock habitat—that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link, which includes large areas of snow tussock habitat. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

Species	Level of residual effect	Compensatory measures
Agrotis admirationis	**High**	• Potential benefits of replanting approximately 175.65 ha of snow tussock at Mt Highlay Station and approximately 50.59 ha of dry shrubland at Cranky Jims Link. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.
Asaphodes recta	**High**	• Replanting host plants (*Senecio dunedinensis*) in tor buffer planting areas at Mt Highlay Station and *Ranunculus amphitrichus* and *R. ternatifolius* in ephemeral wetland areas. Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Anticipated benefits from 1.8 ha of compensation ephemeral wetland at Cranky Jims link and 0.17 ha at the Murphys Link. • Potential benefits of replanting approximately 175.65 ha of snow tussock at Mt Highlay Station and approximately 50.59 ha of dry shrubland at Cranky Jims Link. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

Species	Level of residual effect	Compensatory measures
Dasyuris partheniata	**High**	• Replanting host plants (*Aciphylla subflabellata*) as part of the approximately 175.65 ha of snow tussock enhancement planting at Mt Highlay and Cranky Jims Link. Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.
Nyctemera annulata	**Low**	• Replanting host plants (*Senecio dunedinensis*) at Mt Highlay Station, and in semi-shaded locations in Cranky Jims Link. Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Other host plants (e.g., Cineraria, groundsel, ragwort) are naturally abundant in the local landscape, including in the areas mentioned below. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

Species	Level of residual effect	Compensatory measures
Orthodera novaezealandiae	**Low**	• Potential benefits of replanting approximately 175.65 ha of snow tussock at Mt Highlay Station and approximately 50.59 ha of dry shrubland at Cranky Jims Link. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA, much of which includes suitable dry shrubland habitat for this species. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link.
Pasiphila sp. A (NZAC 04285480 "Carmichaelia")	**Low**	• Replanting host plants (*Carmichaelia crassicaulis* subsp. *crassicaulis; Carmichaelia corrugata*, *Carmichaelia petriei*) as part of the approximately 50.59 ha of dry shrubland and approximately 175.65 ha of snow tussock enhancement planting at Mt Highlay and Cranky Jims Link, respectively. Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA, much of which includes suitable dry shrubland habitat for this species. • Potential benefits approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

Species	Level of residual effect	Compensatory measures
Patagoniodes farinaria	**Low**	• Potential benefits of replanting approximately 175.65 ha of snow tussock at Mt Highlay Station and approximately 50.59 ha of dry shrubland at Cranky Jims Link. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.
Samana acutata	**High**	• Replanting host plants (*Carmichaelia crassicaulis* subsp. *crassicaulis; Carmichaelia corrugata*, *Carmichaelia petriei*) as part of the approximately 50.59 ha of dry shrubland and approximately 175.65 ha of snow tussock enhancement planting at Mt Highlay Station and Cranky Jims Link. Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA, much of which includes suitable dry shrubland habitat for this species. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

Species	Level of residual effect	Compensatory measures
Theoxena scissaria	**High**	• Replanting host plants (*Carmichaelia crassicaulis* subsp. *crassicaulis; Carmichaelia corrugata*, *Carmichaelia petriei*) as part of the approximately 50.59 ha of dry shrubland and approximately 175.65 ha of snow tussock enhancement planting at Mt Highlay and Cranky Jims Link, respectively. Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA, much of which includes suitable dry shrubland habitat for this species. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.
Bityla sericea	**Moderate**	• Replanting host plants (*Muehlenbeckia*) as part of the rock outcrop creation/ replacement at Mt Highlay Station and MEEA constructed tors. Refer to Lizard Management Plan (Bioresearches 2026j), Vegetation and Flora Management Plan (Bioresearches 2026g), and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Potential benefits of replanting approximately 175.65 ha of snow tussock at Mt Highlay Station and approximately 50.59 ha of dry shrubland at Cranky Jims Link. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA, much of which includes suitable dry shrubland habitat for this species. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

Species	Level of residual effect	Compensatory measures
Wiseana fuliginea	**Moderate**	• Host plant unknown, but larvae are thought to feed on pasture grasses, which are abundant in the local landscape. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.
Wiseana mimica	**Low**	• Host plant unknown, but larvae are thought to feed on pasture grasses, which are abundant in the local landscape. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.
Zelandobius uniramus	**Moderate**	• Potential benefits of stream habitat protection over approximately 252 ha within a predator-exclusion fence at MEEA. • Potential benefits of stream habitat protection over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits of stream habitat protection over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

Species	Level of residual effect	Compensatory measures
Hemiandrus maia	**Low**	• Potential benefits of replanting approximately 175.65 ha of snow tussock at Mt Highlay Station and approximately 50.59 ha of dry shrubland at Cranky Jims Link. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA, much of which includes habitat for this species. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.
Mecodema sp. “Oamaru”	**Moderate**	• Potential benefits of replanting approximately 175.65 ha of snow tussock at Mt Highlay Station and approximately 50.59 ha of dry shrubland at Cranky Jims Link. • Potential benefits over approximately 252 ha that will be protected within a predator-exclusion fence at MEEA, much of which includes habitat for this species. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link) that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

Species	Level of residual effect	Compensatory measures
Orocrambus cf. *cyclopicus*	**Moderate**	• Replanting host plants (*Chionochloa rigida* subsp. *rigida*) in the approximately 175.65 ha of snow tussock enhancement planting at Mt Highlay Station. Refer to Vegetation and Flora Management Plan (Bioresearches 2026g) and Residual Effects Terrestrial Restoration Plan (Bioresearches 2026n). • Potential benefits over approximately 252 ha—including large areas of snow tussock habitat—that will be protected within a predator-exclusion fence at MEEA. • Potential benefits over approximately 1,170 ha (of which 243 ha falls inside the Murphys Link)—including large areas of snow tussock habitat—that will be subject to landscape-scale predator control within the 1 km buffer surrounding the MEEA predator exclusion fence. • Potential benefits over approximately 397 ha that will be subject to stock-proof fencing and predator control within the Murphys Link, which includes large areas of snow tussock habitat. • Invertebrate monitoring at release sites, together with monitoring of host plant relocation and planting success, to evaluate the effectiveness of the proposed management measures.

5 Compensation: Lizards

5.1 Explanation of lizard BOAM

This section describes the application and outputs of BOAMs (Maseyk *et al.* 2015) in relation to moderate or higher residual effects on two species of lizards: southern grass skink and McCann's skink. These models are based on quantitative data collected from baseline lizard monitoring within three broad habitat types, both in areas that will be impacted by mining activities and in areas that are proposed for compensation.

Each species was modelled as a separate BOAM. While the Biodiversity Components and Biodiversity Attributes were identical for both species, measures prior to impact and prior to and after compensation differed between the species. Modelling each species separately ensured that losses and gains were assessed independently for each species, avoiding aggregation effects that could obscure species-specific outcomes (Maseyk *et al.* 2015). It also reflects differences in ecology and habitat use, and response to management between species.

A BOAM was not applied to kōrero gecko because insufficient empirical data were available on gecko densities to quantify losses and gains for this species. However, available research indicates that geckos respond positively to predator exclusion. For example, Turner and Norbury (2023) found that counts of *Woodworthia* "Central Otago" geckos approximately doubled within a mammal-proof fence over a five-year period after accounting for changes in populations outside the fence.

Given the ecological similarities between kōrero gecko and this species and the proposed predator exclusion regime, it is reasonable to expect that kōrero geckos will also benefit from the offset and compensation measures proposed for the Project.

While the nature and direction of the response can be inferred with some confidence, the magnitude of these benefits cannot currently be quantified due to the absence of baseline density data for the species. Consequently, the gecko response to compensation measures was not modelled.

5.2 Model inputs and assumptions

This section provides supporting comments on the model inputs and assumptions for improvements of biodiversity attributes via compensation actions at compensation sites.

5.2.1 Skink density estimates

Lizard density estimates used in the model were derived from quantified data collected during the baseline lizard survey (see Lizard Values Report, Bioresearches 2026c). Specifically, average densities for each species within each habitat type were applied (Table B-7), as these were considered to best represent observed lizard densities across both the impact and compensation sites. The use of consistent density estimation methods across both impact and compensation sites ensures that their relative values remain comparable within the BOAM modelling framework.

Table B-7. Skink density estimates for McCann's skink and southern grass skink (SGS) in different habitat types, derived from N-Mixture modelling (Bioresearches 2026c). Average density values (light blue column) used in the BOAMs.

Impact habitat	Species	skink density - lower	skink density - average	skink density - upper	Based on
Snow tussock	McCanns	150	256	436	GB PIT tussock - N-mixture
	SGS	219	375	637	GB PIT tussock - N-mixture
Dry shrubland	McCanns	495	810	1329	BRWRS shrubland - N-mixture. Best available data.
	SGS	136	224	366	BRWRS shrubland - N-mixture. Best available data.
Other	McCanns	11	41	143	Coronation other - N-mixture
	SGS	8	27	95	Coronation other - N-mixture

5.2.2 Benefit of predator-exclusion fences for lizards

Native lizards in New Zealand are highly vulnerable to predation by introduced mammals, and most species are in decline (Hitchmough *et al.* 2026). While landscape-scale predator control can benefit lizard populations (Reardon *et al.* 2012; Wilson *et al.* 2017), perverse outcomes such as mesopredator release—particularly increases in mouse populations—can occur and may negatively affect lizards (Norbury *et al.* 2014; Monks *et al.* 2024, also see Appendix D). In contrast, predator-exclusion fences provide a more reliable mechanism for lizard recovery on the mainland by effectively removing all mammalian predators (see Appendix D for a more detailed account on the benefits of predator exclusion for lizards). These systems have been shown to stabilise or reverse population declines and improve the viability of both threatened and more common lizard species (Reardon *et al.* 2012; Turner & Norbury 2023).

Empirical studies demonstrate strong positive responses of lizard populations to predator exclusion. For example, Reardon *et al.* (2012) documented recovery of grand and Otago skinks over a three-year period within mammal-proof fences in the Macraes Ecological District, with the greatest gains observed where mice were maintained at very low densities. Similarly, Barry (2024) reported evidence of recruitment, population growth, increased dispersal, improved body condition, and higher capture rates in Otago green skinks following their reintroduction to the fenced Orokonui Ecosanctuary. Importantly, fully fenced systems can achieve near-zero densities of all mammalian predators, including mice. At MEEA, this will be achieved through complete eradication of all mammals within the fence and a zero-density target, supported by incursion response protocols triggered upon detection.

More recently, Turner and Norbury (2023) documented a doubling of common lizard populations, including McCann's, herbfield, and southern grass skinks, over a five-year period within the predator-free Mokomoko Sanctuary. This study provides the most directly applicable evidence for the MP4 BOAM modelling, given the similarity in species assemblage, habitat types, and predator guilds.

Accordingly, a population doubling (100% increase) over five years was adopted as the most appropriate and evidence-based assumption for the BOAM modelling.

5.3 Impact model inputs

Inputs into the two lizard impact models are described in Table B-8 below.

Table B-8. Impact model inputs and descriptors for BOAMs 1 and 2 – McCann's skink and Southern grass skink, respectively. Note the impact model inputs are identical for both species except for pre-impact density meaures for each species in each habitat type.

BOAMs 1 & 2 – McCann's grass skink/ southern grass skink	
Model input category	**Input description**
Biodiversity type	McCann's skink (BOAM 1)/ southern grass skink (BOAM 2) community/ population
Biodiversity component	McCann's / southern grass skink habitats, being: • Tussock/ grasslands/ rock outcrops • Dry shrubland • Other (i.e., riparian, ephemeral wetland).
Biodiversity attributes	Quantified biodiversity metric used to determine impact and offset outcome: • Skink density (number of skinks per hectare)
Measurement unit	Density – Number of individual skinks per hectare (skinks/ ha)
Area of impact	Total area of loss in hectares for each habitat type (includes a 20 m buffer around the impact area, where total loss is precautionarily assumed, and includes consented mining areas where lizard considerations under the WAA are required). • Tussock/ grassland/ rock outcrop (231.9 ha) • Dry shrubland (2.96 ha) • Other (3.84 ha)
Benchmark	Benchmark skink densities were set using the highest density reported in the literature for comparable habitat types under mammalian predator management. Wilson *et al.* (2017) reported approximately 4,000 lizards/ ha; with "lizard" comprising McCann's skinks, southern grass skinks, and cryptic skinks combined, within a mammal-proof fenced site at Macraes Flat where all mammals except house mice were excluded. For the purposes of this assessment, a benchmark of 2,000 individuals/ ha has been applied to each of the two affected skink species, i.e., 2000 McCann's skink/ ha and 2,000 southern grass skinks/ ha. In the absence of measured benchmark habitat-specific density data for each species, the benchmark of 2,000 individuals/ ha per species has been applied broadly across tussock, dry shrubland, and 'other' habitat categories. Benchmarks are based on best available information from published literature (see Bioresearches 2026c and references within). and therefore, are considered appropriate for the BOAM. Accordingly, benchmark values inputs are: • Tussock/ grassland/ rock outcrop (2,000 skinks/ ha) • Dry shrubland (2,000 skinks/ ha) • Other (2,000 skinks/ ha)

<table>
<tr><td>Measure prior to impact</td><td>Measures prior to impact for each habitat type are based on lizard density data collected during the baseline lizard survey (Bioresearches 2026c). These were:
<table>
<tr><th>Habitat type</th><th>McCann’s skink/ ha</th><th>Southern grass skink/ ha</th></tr>
<tr><td>Tussock/ grassland/ rock outcrop</td><td>256</td><td>375</td></tr>
<tr><td>Dry shrubland</td><td>810</td><td>224</td></tr>
<tr><td>Other</td><td>41</td><td>27</td></tr>
</table>
</td></tr>
<tr><td>Measure after impact</td><td>Measure after impact set at zero because all skinks within all habitat types in the impact area (including 20 m buffer) will be completely lost because of the project mining activities.</td></tr>
</table>

5.4 ‘Offset’ model inputs

Inputs into the two lizard ‘offset’ models are described in Table B-9 below.

Table B-9. BOAM compensation gain-model inputs and descriptors for BOAMs 1 and 2 – McCann’s skink and Southern grass skink. Note that the model inputs are identical for both species except for the pre- and post-compensation density measures for each species in each habitat type.

<table>
<tr><th colspan="2">BOAM 1 – Southern grass skink</th></tr>
<tr><th>Model input category</th><th>Input description</th></tr>
<tr><td>Discount rate</td><td>3% discount in accordance with standard practice and as recommended in the BOAM User Guide (Maseyk et al. 2015).</td></tr>
<tr><td>Proposed compensation actions</td><td>The compensation action proposed for lizards (as described in section 4.3 above) involves:
Construction of a mammal exclusion fence in the MEEA, with all mammals eliminated and maintained at zero density within the fence.</td></tr>
<tr><td>Compensation area</td><td>The areal extent of the compensation action is:
A 252 ha MEEA predator-exclusion fence.</td></tr>
<tr><td>Confidence in compensation actions</td><td>For the MEEA predator exclusion fence, the confidence category was assigned as ‘Very confident >90%’ (the highest category) because there is strong evidence for the benefits of predator-exclusion fences for lizard (including McCann’s and southern grass skinks) recovery.</td></tr>
<tr><td>Measure prior to compensation</td><td>For the MEEA predator-exclusion fence, measures prior to compensation were set as the density of skinks measured within each of the three habitat types. Skink densities were calculated based on modelled relative abundance estimates (N-mixture models) derived from the same three habitat types at the compensation site during the baseline survey (Bioresearches 2026c). Average skink density values were used. These were:
<table>
<tr><th>Habitat type</th><th>McCann’s skink/ ha</th><th>Southern grass skink/ ha</th></tr>
<tr><td>Tussock/ grassland/ rock outcrop</td><td>924</td><td>140</td></tr>
<tr><td>Dry shrubland</td><td>534</td><td>81</td></tr>
<tr><td>Other</td><td>620</td><td>94</td></tr>
</table>
</td></tr>
</table>

Measure after compensation	Within the MEEA predator-exclusion fence, skink density metrics assume a 100% increase (doubling) relative to pre-compensation densities. This assumption is supported by evidence demonstrating that skink densities can double within five years inside fenced areas (Turner & Norbury 2023).
Time till endpoint (years)	The finite endpoint (i.e., the endpoint at which the stated outcome is measured) was set as: • Five years from the time of impact, because there is evidence showing a doubling of skink densities can be achieved inside fenced areas at five years (Turner & Norbury 2023; Trustees of the Central Otago Ecological Trust 2026).

5.5 Model outputs

The results of the BOAM modelling are displayed in Table B-10, showing the net balance for each species of skink within each of the three habitat types subject to moderate or higher residual adverse effects.

All modelled attributes except southern grass skink in snow tussock habitat show a positive compensation score, and approximately 20% of the modelled southern grass skink residual effect is addressed (but see section 5.5 for additional unquantified benefits for lizards).

Table B-10. Impact and compensation model output scores for southern grass skink and McCann's skink.

Habitat	Lizard species	Attribute	Measurement	BOAM impact score	Pest-exclusion fence	Total BOAM offset score	Attribute NPBV (Offset score - impact score)
Tussock/ grassland	Southern grass skink	Density	skinks/ha	-43.48	7.78	7.78	-35.7
Dry shrubland	Southern grass skink	Density	skinks/ha	-0.33	0.37	0.37	0.04
Other	Southern grass skink	Density	skinks/ha	-0.05	4.1	4.1	4.05
Tussock/ grassland	McCanns skink	Density	skinks/ha	-29.68	51.38	51.38	21.7
Dry shrubland	McCanns skink	Density	skinks/ha	-1.2	2.42	2.42	1.22
Other	McCanns skink	Density	skinks/ha	-0.08	27.07	27.07	26.99

6 Compensation: Avifauna

6.1 Explanation of BOAM: Accounting model features

This section summarises how the BOAM has been parameterised for avifauna. The BOAM outputs are used to quantify residual biodiversity losses and determine the scale of compensation required, including the extent and intensity of pest management needed to estimate whether predicted compensation gains exceed quantified losses.

6.2 Biodiversity Components

The biodiversity components used in the avifauna BOAM are the species for which residual effects have been identified:

- New Zealand falcon (*Falco novaeseelandiae*; kārearea)
- Banded dotterel (*Charadrius bicinctus*; pohowera)
- South Island pied oystercatcher (*Haematopus finschi*; tōrea)

Each species is modelled as a separate biodiversity component, with its own set of attributes. This approach ensures that losses and gains are assessed independently for each species, avoiding aggregation effects that could obscure species-specific outcomes (Maseyk *et al.*, 2016). It also reflects differences in ecology, habitat use, and response to management between species.

6.2.1 Biodiversity Attributes

Biodiversity attributes are measurable variables that describe the condition and viability of each biodiversity component. Attributes are selected to represent key ecological processes, be sensitive to management actions, and be supported by empirical data.

For avifauna, breeding success (nest success/hatching success) has been selected as the primary attribute for all three species. This attribute is considered appropriate for the following reasons:

- All three species are known to breed, or have the potential to breed, within both the impact and compensation sites.
- Breeding success is strongly influenced by mammalian predation, which is the primary pressure addressed by the proposed compensation (pest exclusion and suppression).
- Empirical data are available for all three species (or closely related ecological contexts) that quantify breeding success under unmanaged, partially managed, and predator-reduced conditions.
- As these three species are ground-nesting at this site, eggs and chicks are particularly vulnerable to predation, making breeding success a key determinant of population recruitment.

The selected attribute also aligns with the proposed compensation package, which includes both pest exclusion (predator-exclusion fencing) and pest suppression (landscape-scale predator control). This enables direct modelling of expected gains across a gradient of management intensity (baseline, suppression, and exclusion scenarios).

It is acknowledged that breeding success is a proxy for population viability rather than a direct measure of population size. For mobile species such as birds, population responses may also be influenced by factors beyond the site (e.g. dispersal, non-breeding survival, and habitat conditions elsewhere). However, in the New Zealand context, predation during the breeding phase is widely recognised as a primary limiting factor for ground-nesting birds. As such, improving breeding success is considered a robust and tractable mechanism for increasing population recruitment and supporting net gain outcomes.

6.2.2 Benchmarks

The BOAM compares baseline and offset biodiversity values against a defined benchmark, which represents a high-quality reference condition for the relevant biodiversity attribute.

For avifauna, benchmarks have been selected to represent upper-bound breeding success under conditions of minimal or no mammalian predation, informed by the best available empirical data for each species. These include:

- Managed system estimates for New Zealand falcon (e.g. plantation forestry with predator control)
- Experimental predator-reduction studies for banded dotterel and South Island pied oystercatcher (braided river systems)
- Supporting observational studies from South Island open-country and farmland habitats

In all cases, benchmarks represent ecologically plausible but not typical conditions and are interpreted as aspirational targets achievable under effective and sustained pest management. Where multiple data sources are available, preference has been given to:

- Recent studies using robust monitoring methods
- Studies conducted in habitats comparable to the receiving environment (e.g. open-country or farmland systems)
- Data that explicitly quantify the influence of predator management on breeding outcomes

It is acknowledged that true “pristine” or predator-free benchmarks are rarely available for mainland New Zealand systems. As such, benchmarks used in this assessment should be understood as best-available proxies for optimal conditions, rather than absolute ecological maxima. Uncertainty associated with benchmark selection is addressed within the BOAM through conservative parameterisation and the application of confidence factors.

6.3 New Zealand Falcon | Kārearea

6.3.1 Area of habitat impacted

The Avifauna Values Assessment describes kārearea occurrence, habitat use and the landscape-scale basis for interpreting potential territory use across the MP4 Project area. The EcIA subsequently assesses the effects of MP4 on this species, including permanent loss and modification of suitable habitat and potential disturbance associated with mining activities.

Approximately 235.99 ha of habitat suitable for kārearea is included within the impact area used for residual effects accounting. Following implementation of the proposed avoidance, minimisation and remediation measures, including breeding-bird management under the Avifauna Management and

Monitoring Plan, the EcIA assigns a Low magnitude of effect and a Moderate residual level of effect to kārearea. This residual effect is therefore carried forward for biodiversity compensation.

The BOAM assesses this residual effect using the extent of affected habitat and predicted changes in breeding success as the principal biodiversity attribute. The proposed compensation comprises mammalian predator management across the Murphys Ecological Enhancement Area, including predator exclusion within the fenced area and landscape-scale predator suppression in the surrounding management area. The basis for the breeding-success inputs, benchmarks, predicted management response and associated uncertainty is described below.

6.3.2 Falcon breeding success

The principal compensation action proposed for kārearea is sustained mammalian predator management within and around the MEEA. This comprises predator elimination within the approximately 252 ha predator-exclusion fenced area and landscape-scale predator suppression across the approximately 1,170 ha surrounding management area. These actions are intended to reduce predation pressure on nesting birds and thereby improve breeding success relative to unmanaged conditions. Breeding success is therefore used in the BOAM as the principal measure of ecological gain arising from this component of the compensation package. The following sections describe the breeding-success values adopted for predator exclusion and predator suppression, the benchmark against which these gains are assessed, and the associated uncertainty. Together, these inputs provide the basis for assessing whether the predicted improvement in breeding performance is sufficient to counterbalance the residual effect on kārearea. A summary of known information about breeding success is provided in Table B-11

6.3.2.1 Breeding success prior to offset (baseline)

Baseline breeding success for the New Zealand falcon is represented by a value of 50% nest success, based on Parker (2024). This study provides the most recent and locally relevant data, derived from open-country habitats in Central Otago that are comparable to the receiving environment, including pastoral farmland, tussock, and modified landscapes.

The reported value of approximately 50% reflects apparent nest success under largely unmanaged conditions, with limited or no systematic predator control. As such, it is considered a realistic estimate of current breeding performance in similar habitats to the impact site.

This value is preferred over earlier studies (e.g. Fox, 1977) as it is based on contemporary monitoring and better reflects current ecological conditions, including ongoing predation pressure and land-use context. It is therefore adopted as the baseline for BOAM.

6.3.2.2 Breeding success with pest control

6.3.2.2.1 Pest exclusion

Direct empirical estimates of breeding success under full pest exclusion are not available for the New Zealand falcon. However, pest exclusion can be reasonably inferred as a scenario in which mammalian predation is minimised, and other limiting factors (e.g. weather, prey availability) remain.

Given that predation is a primary driver of nest failure, breeding success under pest exclusion is expected to approach the upper range of observed values. The Fox (1977) estimate of approximately 72% nest success provides context that values in this range are achievable in New Zealand systems, albeit without formal predator control and with methodological limitations.

As such, pest exclusion is interpreted as producing breeding success near the upper bound of observed field values, while acknowledging that complete elimination of nest failure is not realistic.

6.3.2.2.2 Pest suppression

Breeding success under pest suppression is best represented by data from managed systems where predator control is applied but not eliminated. Seaton *et al.* (2009) reported 71% nest success and a mean productivity of 1.81 fledglings per nest in plantation forestry subject to predator control.

This value is considered representative of achievable outcomes under active management and reflects improved breeding success relative to unmanaged systems. It is therefore used to characterise the expected response to moderate predator control within BOAM.

6.3.2.3 Benchmark

The adopted benchmark for New Zealand falcon breeding success is 71% nest success, based on Seaton *et al.* (2009). This represents the highest robust contemporary estimate under managed conditions and reflects breeding success where key limiting factors, particularly mammalian predation, are reduced.

Although Fox (1977) reported a slightly higher value (~72%), this has not been adopted as the benchmark due to methodological limitations and the absence of pest control. However, it provides supporting evidence that breeding success values in this range are ecologically realistic within New Zealand.

The benchmark is therefore considered an appropriate upper-bound reference condition for BOAM.

6.3.3 Limitations and uncertainty

The benchmark value is derived from plantation forestry habitat in the central North Island (bush falcon), whereas the receiving environment for the compensation actions is open-country habitat supporting eastern falcon. Differences in habitat structure, prey availability, and predator assemblages introduce uncertainty in transferring this value.
There is limited empirical data quantifying breeding success under different predator management regimes in South Island open-country systems. Available studies use differing metrics (e.g. apparent nest success vs productivity), reducing comparability.

While the Fox (1977) study provides reassurance that similar breeding success values are achievable in South Island systems, it predates modern monitoring approaches and does not reflect managed conditions.

Overall confidence in the benchmark is moderate. The value is supported by the best available contemporary data and is consistent with historical observations, but uncertainty remains regarding habitat differences and transferability. Within the BOAM, this uncertainty is addressed through conservative parameterisation and application of appropriate confidence factors (Appendix B, Section 6).

Table B-11. Summary of New Zealand falcon (*Falco novaeseelandiae*) breeding success metrics reported in selected studies

Study	Location	Study period	Habitat	Breeding success metric	Pest control	Key limitations
Fox (1977)	Eastern South Island (Canterbury, Otago)	1970–1976	Open hill country, snow tussock	Mean 1.88 chicks fledged per nesting attempt; c. 28% nest failure (i.e. **72%** success).	No	Pre-dates widespread predator control; nest success based on apparent success and likely overestimates true productivity; territory size inferred from spacing, not telemetry.
Seaton *et al.* (2009)	Kaingaroa Forest, Central North Island	2003–2006	Exotic pine plantation	Mean 1.81 chicks fledged per nest; **71%** of nests were successful	Yes (1080 possum/rat control)	Results specific to plantation forest; higher prey availability than open country; findings not directly transferable to eastern falcon populations.
Kross *et al.* (2013)	Marlborough	2008–2011	Vineyards vs open hill country	Artificial nests: predation **38%** (vineyards) vs **63%** (hill country); breeding success inferred indirectly	Yes (localised vineyard predator control)	Did not directly measure fledging success; artificial nests may not fully represent real falcon nest outcomes.
Parker (2024)	Upper Clutha Basin and Cardrona Valley, Otago	2019–2023	High country farmland, tussock, peri-urban	11 of 22 nesting attempts were successful (**~50%** apparent success); modelled daily survival equivalent to ~42% true success	No systematic control	Moderate sample size; some nests likely undetected; true productivity likely lower than apparent success; limited ability to assess year-to-year variation.
Bell & Lawrence (2009); Lawrence (2002)	National (multiple regions)	1994–1998; 2006–2009	Mixed (open country, forest, agricultural)	Breeding confirmed at ~3% of records; productivity not quantified	Variable	Presence-only and opportunistic data; not designed to estimate breeding success or territory size.

6.4 Banded Dotterel

6.4.1 Area of habitats

Banded dotterel | pohowera has a Very High ecological value and is confirmed to use open-country and rehabilitated mine habitats within the MP4 landscape during the breeding season. The Avifauna Values Assessment describes the survey records, habitat associations and basis for interpreting the six occupied breeding-season survey locations as a conservative index of potential breeding territories. The EcIA assesses the resulting Project effects on this species.

Approximately 130.38 ha of suitable banded dotterel habitat is included in the impact area used for residual-effects accounting. Following implementation of avoidance, minimisation and remediation measures, including breeding-season management under the Avifauna Management and Monitoring Plan, the EcIA assigns a Low magnitude of effect and a Moderate residual level of effect. This residual effect is therefore carried forward for biodiversity compensation.

6.4.1.1 Habitat within compensation areas (MEEA pest control area)

Within the compensation package, habitat considered suitable for banded dotterel comprises 642.84 ha of exotic grassland located outside the predator-exclusion fence but within the 1 km MEEA pest control buffer. This habitat has been included because it is expected to retain short, open grassland conditions under continued grazing or comparable vegetation management, providing the low vegetation structure and ground visibility required by banded dotterel for breeding and foraging. Banded dotterel use open and lightly vegetated habitats, including riverbeds, outwash surfaces, herbfields, coastal margins and modified pastoral environments where vegetation is sufficiently short or sparse (Pierce, 2013). The exotic grassland within the pest control buffer is therefore considered functionally suitable where sward height remains low, and ground visibility is maintained.

Exotic grassland inside the predator-exclusion fence has not been included as a suitable breeding habitat for the banded dotterel. Stock will be removed from the fenced area, and the exotic grassland is expected to develop taller and denser vegetation relatively quickly in the absence of grazing. This change in vegetation structure is likely to reduce habitat suitability for breeding banded dotterel, which generally require open ground or short vegetation to support nest site selection, predator detection and movement of chicks. The suitable habitat within the compensation package is therefore limited to the 642.84 ha of exotic grassland outside the fence but within the pest control buffer, where predator control is expected to improve breeding conditions while vegetation structure remains suitable.

6.4.2 Breeding success prior to offset (baseline)

Baseline breeding success for banded dotterel is represented by a value of 42% nest success, reflecting unmanaged conditions with no predator control (Table B-12). This value is derived from Norbury *et al.* (2021), based on monitoring of ground-nesting shorebirds in South Island braided river systems.

This baseline is consistent with earlier studies of banded dotterel breeding ecology in similar environments, which report low nest success under unmanaged conditions, primarily due to mammalian predation (Rebergen *et al.*, 1998). These findings indicate that breeding success in the order of 40–50% is typical of open habitats where predator pressure is not actively managed.

Accordingly, the adopted baseline is considered representative of current ecological conditions in the absence of intervention.

6.4.3 Breeding success with pest control

6.4.3.1 Pest exclusion

Breeding success under pest exclusion is represented by 85.25% nest success, derived by removing mammalian predation from observed nest outcomes while retaining all other causes of failure.

From the dataset (Norbury *et al.*, 2021), 231 nests were monitored, with 98 successful and 133 failed (42% success). Of the failed nests, 99 were due to mammalian predation and 34 due to other causes.

Under a pest exclusion scenario, nests lost to mammalian predation are assumed to succeed, while other failures remain. This results in an estimated breeding success of 85.25% (197 / 231 nests). This provides a pragmatic upper-bound estimate of breeding success where mammalian predation is effectively excluded, while acknowledging that other sources of nest failure would still occur.

6.4.3.2 Pest suppression

Breeding success under pest suppression is represented by 56% nest success, reflecting a partial reduction in predation pressure. This value is also derived from Norbury *et al.* (2021), where non-lethal predator deterrence (odour treatment) resulted in a measurable increase in hatching success relative to untreated sites.
The increase from 42% to 56% represents an approximately 1.7-fold improvement in breeding success, demonstrating the sensitivity of nesting outcomes to predator management.

This value is considered representative of realistic gains achievable under moderate predator control regimes.

6.4.4 Benchmark

The adopted benchmark for banded dotterel breeding success is 85.25%, representing conditions where mammalian predation is effectively excluded. This benchmark reflects an ecologically realistic upper-bound, supported by experimental evidence demonstrating that predation is the primary limiting factor on breeding success in open habitats.

When considered alongside earlier observational studies (e.g. Rebergen *et al.*, 1998), the benchmark is substantially higher than typical unmanaged conditions but remains plausible where predator impacts are removed. It is therefore appropriate for use within BOAM as a reference condition against which both baseline and predicted post-compensation biodiversity values are assessed.

6.4.5 Limitations and uncertainty

The breeding success values are derived from a braided river study system, whereas the receiving environment for the compensation actions comprises exotic pasture, brownfield, and snow tussock habitats. Differences in habitat structure, predator assemblages, and disturbance regimes introduce uncertainty in transferring these values to the project context.

The source dataset combines multiple shorebird species, including banded dotterel and South Island pied oystercatcher. While banded dotterel dominate the dataset, species-specific variation in breeding ecology is not fully resolved.

The benchmark value represents a predator-free scenario rather than a commonly observed field condition, and may only be achieved under sustained and effective predator management.
Overall confidence in the adopted values is moderate. The baseline aligns well with historical observations from South Island systems, and the response to predator management is supported by experimental evidence. However, uncertainty remains regarding applicability to modified terrestrial habitats. Within BOAM, this uncertainty is addressed through conservative parameterisation and the application of appropriate confidence factors.

6.5 South Island Pied Oystercatcher

6.5.1 Area of habitat impacted

South Island pied oystercatcher | tōrea (*Haematopus finschi*; SIPO) has a Very High ecological value and is confirmed to make widespread breeding-season use of open-country habitats across the MP4 landscape. The Avifauna Values Assessment describes the species' occurrence, habitat associations and the basis for interpreting 27 occupied breeding-season survey locations as a conservative index of potential breeding territories. The EcIA assesses the resulting Project effects on SIPO.

Approximately 130.38 ha of suitable SIPO habitat is included in the impact area used for residual-effects accounting. Following implementation of avoidance, minimisation and remediation measures, including breeding-season management under the Avifauna Management and Monitoring Plan, the EcIA assigns a Low magnitude of effect and a Moderate residual level of effect. This residual effect is therefore carried forward for biodiversity compensation.

6.5.1.1 Habitat within compensation areas (MEEA pest control area)

The same 642.84 ha of exotic grassland outside the predator-exclusion fence but within the 1 km MEEA pest control buffer is considered suitable habitat for the South Island pied oystercatcher. South Island pied oystercatchers breed inland in the South Island and use a range of open habitats, including riverbeds, farmland and high-country grasslands (Sagar, 2013). Within the MEEA pest control buffer, exotic grassland is likely to provide suitable breeding and foraging habitat where vegetation remains short, open and sufficiently sparse to provide ground visibility. Within the MEEA, South Island pied oystercatchers were detected at four PAM/ABM stations during the breeding-season deployment: S01, S02, S04 and S05, indicating they are already using this location for breeding. Continued grazing or comparable vegetation management is therefore important for maintaining the habitat structure required by the species.

As for banded dotterel, exotic grassland within the predator-exclusion fence has not been included as a suitable breeding habitat for the South Island pied oystercatcher. Following stock removal, the grassland inside the fence is expected to become taller and denser, reducing its suitability for ground-nesting open-country birds. Although South Island pied oystercatchers may forage across a range of modified open habitats, breeding suitability is likely to decline where vegetation becomes too tall or dense. The suitable habitat within the compensation package is therefore restricted to the 642.84 ha of exotic grassland outside the predator-exclusion fence but within the 1 km pest control buffer, where predator control benefits would apply while the open grassland structure is retained.

6.5.2 Breeding success before compensation management (baseline)

Baseline breeding success for South Island pied oystercatcher is represented by 42% nest success, based on the unmanaged (no predator control) component of the Norbury *et al.* (2021) dataset (Table B-12). This value reflects observed hatching success across mixed shorebird species (including oystercatchers) in braided river systems under ambient predation pressure.

This estimate is broadly consistent with earlier farmland studies. Sagar *et al.* (2000) reported a mean hatching success of approximately 47% across a 10-year study in mid-Canterbury pastoral systems. The similarity between these values suggests that the Norbury-derived baseline is a realistic representation of breeding success under unmanaged conditions, despite differences in study design and habitat.

Given that the impact site comprises grassland, tussock, and brownfield habitats in Central Otago, the Sagar *et al.* (2000) study provides particularly relevant contextual support, as it reflects inland farmland systems rather than braided river environments.

6.5.3 Breeding success with pest control

6.5.3.1 Pest exclusion

Breeding success under pest exclusion is represented by 85.25% nest success, derived from the Norbury *et al.* (2021) dataset by removing mammalian predation from observed nest outcomes. Note that this is the same data that is used for banded dotterels. This represents a theoretical upper bound where mammalian predation is effectively excluded, while retaining failure from other sources such as avian predation, weather, and human disturbance.

6.5.3.2 Pest suppression

Breeding success under pest suppression is represented by 56% nest success, based on the predator treatment (odour) results from Norbury et al. (2021). This reflects conditions where predation pressure is reduced but not eliminated.

The study demonstrated approximately a 1.7-fold increase in hatching success under treatment conditions relative to controls, indicating that partial predator management can substantially improve breeding outcomes while still allowing for residual predation. This value is considered representative of achievable outcomes under moderate predator control in open habitats.

6.5.4 Benchmark

The adopted benchmark for South Island pied oystercatcher breeding success is 85.25% nest success, representing the expected outcome in the absence of mammalian predation.

This value is supported by the Norbury *et al.* (2021) analysis and is consistent with the ecological understanding that mammalian predation is a primary driver of nest failure in New Zealand shorebirds. Comparative studies indicate that unmanaged breeding success is typically substantially lower. Sagar *et al.* (2000) reported ~47% hatching success on farmland, with additional chick mortality resulting in lower overall productivity. These findings reinforce that the benchmark represents an aspirational but ecologically plausible upper bound under effective predator exclusion.

6.5.5 Limitations and uncertainty

The primary dataset (Norbury *et al.*, 2021) was derived from braided river ecosystems in the Mackenzie Basin, whereas the receiving environment comprises modified terrestrial habitats, including pasture, tussock, and brownfield areas. Differences in substrate, predator communities, and disturbance regimes may influence breeding success and limit direct transferability.

The Norbury dataset combines multiple shorebird species, including South Island pied oystercatcher, banded dotterel, and wrybill. While oystercatchers were included, species-specific responses to predation and habitat may differ, introducing uncertainty when applying pooled estimates.

Long-term farmland studies (Sagar *et al.*, 2000) indicate broadly similar hatching success under unmanaged conditions, supporting the realism of baseline values. However, these studies also highlight additional sources of failure, including trampling and agricultural activities, which may be more relevant in pastoral systems than in braided rivers.

Overall confidence in the selected values is moderate. data. Robust experimental data support the benchmark and management scenarios and are consistent with independent studies; however, uncertainty remains regarding habitat differences and species-specific responses. Conservative application within BOAM, including appropriate confidence factors, is applied to account for this uncertainty.

Table B-12. Breeding-success values adopted for banded dotterel and South Island pied oystercatcher in the avifauna BOAMs.

Species	Scenario	Breeding success	Basis and application
Banded dotterel	Baseline, no predator management	42%	Observed nest success under unmanaged conditions in Norbury et al. (2021). This is consistent with earlier South Island banded dotterel studies reporting relatively low breeding success where mammalian predators are unmanaged (Rebergen et al., 1998). Used as the pre-compensation biodiversity value.
	Pest suppression	56%	Based on the predator-treatment results of Norbury et al. (2021), representing reduced but not eliminated mammalian predation. Applied to the 642.84 ha of suitable open grassland within the MEEA predator-suppression area.
	Predator-free benchmark	85.25%	Derived from Norbury et al. (2021) by assuming nests lost to mammalian predation would succeed while retaining failures from other causes. Used as the BOAM benchmark rather than as the predicted outcome of the proposed pest-suppression programme.
South Island pied oystercatcher	Baseline, no predator management	42%	Based on the unmanaged component of Norbury et al. (2021). This is broadly consistent with the approximately 47% hatching success reported from long-term SIPO monitoring in Canterbury farmland by Sagar et al. (2000). Used as the pre-compensation biodiversity value.
	Pest suppression	56%	Based on the predator-treatment results of Norbury et al. (2021), representing reduced but not eliminated mammalian predation. Applied to the 642.84 ha of suitable open grassland within the MEEA predator-suppression area.
	Predator-free benchmark	85.25%	Derived from the same Norbury et al. (2021) dataset and represents the theoretical outcome where mammalian nest predation is removed but other causes of nest failure remain. Used as the BOAM benchmark rather than as the predicted outcome of the proposed pest-suppression programme.

6.6 BOAM compensation analysis and justification

The following table (Table B-13) corresponds to the avifauna BOAMs and their respective biodiversity attributes. The tables provide references or data that underpin and justifies the values input to each model. For raw BOAM outputs, please refer to Appendix C.

Table B-13. Avifauna BOAM compensation gain-model explanation

Biodiversity Component (species)	Biodiversity attribute	Benchmark and justification	Impact value	Action and confidence	Biodiversity value after conservation action	Justification for confidence (References/data)
New Zealand falcon (kārearea)	Breeding success (%)	**71%** Highest robust contemporary value under managed conditions (plantation forestry with predator control; Seaton *et al.*, 2009). Slightly lower than Fox (1977; ~72%), but preferred due to more recent methods and managed context.	**50%** Apparent nest success from the Central Otago open-country study (Parker, 2024), representing unmanaged baseline conditions similar to the impact site.	**Pest elimination (predator-exclusion fence) 252 ha** Confidence: 75–90%	**71%** **(2 years)** Assumes breeding success can be increased to a benchmark under sustained predator control.	Moderate confidence. Baseline derived from a locally relevant study; benchmark from a different habitat (plantation forestry, bush falcon ecotype). Supported by Fox (1977), indicating similar upper-bound values achievable in the South Island. Uncertainty due to habitat and ecotype differences.
	Breeding success (%)	**71%**	**50%**	**Pest suppression (landscape predator control) 1170 ha** Confidence: 75–90%	**62%** **(2 years)** Assumes breeding success can be increased to the previous pest control study (Kross *et al.* 2013)	Moderate confidence. Baseline derived from a locally relevant study; benchmark from a different habitat (plantation forestry, bush falcon ecotype). Predicted breeding success under pest control is conservative, as higher values have been achieved elsewhere, but in the North Island in plantation forestry.
Banded dotterel (pohowera)	Breeding success (%)	**85.25%** Derived from Norbury *et al.* (2021) by removing mammalian predation from observed nest outcomes; represents predator-free upper bound.	**42%** Observed nest success under no predator control (Norbury *et al.*, 2021), consistent with unmanaged braided river systems.	**Pest suppression (landscape predator control in exotic grassland only) 642.84 ha** Confidence: 75–90%	**56%** (2 years)	Moderate confidence. Based on a large experimental dataset demonstrating predation effects. Supported by earlier studies (e.g. Rebergen *et al.*, 1998) showing similarly low unmanaged success. Uncertainty due to mixed-species dataset and habitat differences (braided river vs pasture/tussock/brownfield).
South Island pied oystercatcher (tōrea)	Breeding success (%)	**85.25%** As per Norbury *et al.* (2021), representing a predator-free scenario.	**42%** Unmanaged breeding success from Norbury *et al.* (2021).	**Pest suppression (landscape predator control in exotic grassland only) 642.84 ha** Confidence: 75–90%	**56%** (2 years)	Moderate confidence. Norbury *et al.* (2021), supported by long-term farmland studies (Sagar *et al.*, 2000; Sagar & Veitch, 2014), showed similar unmanaged success (~47%). Uncertainty due to species pooling and transferability from braided river to modified inland habitats.

6.7 BOAM Outputs

The avifauna compensation package addresses the Moderate residual effects identified for kārearea, banded dotterel and SIPO through sustained mammalian predator management within the MEEA and surrounding landscape. The proposed management differs between the species to reflect their habitat requirements and the areas expected to remain suitable following implementation of the compensation actions.

For kārearea, the compensation package comprises predator elimination within the approximately 252 ha MEEA predator-exclusion fence together with landscape-scale predator suppression across the surrounding approximately 1,170 ha management area. Both areas are included in the kārearea BOAM because the species uses a broad range of open-country, tussock, shrubland and rock-associated habitats, and predator management is expected to improve breeding success across this wider landscape.

For banded dotterel and SIPO, the modelled compensation package comprises predator suppression across approximately 642.84 ha of suitable open exotic grassland within the wider MEEA pest-management area. Habitat inside the predator-exclusion fence is not included for these species because stock removal is expected to result in progressively taller and denser vegetation, reducing its suitability for open-ground nesting birds. Continued grazing or comparable vegetation management outside the fence is expected to retain the short, open habitat structure used by both species.

The ecological gain modelled for all three species is an improvement in breeding success resulting from reduced mammalian predation (Table B-14). The BOAM therefore compares the residual loss of suitable habitat with the predicted increase in breeding success across the relevant compensation area. The model predicts positive biodiversity balances for all three species, with an NPBV of +45.55 for kārearea and +17.85 for both banded dotterel and SIPO. These outcomes are subject to the assumptions and uncertainty described above and will require monitoring and adaptive management to confirm that the predicted breeding responses are achieved.

Table B-14. Biodiversity components and attributes for avifauna BOAM models supporting the compensation assessment.

Habitat	Bird Species	Attribute	Measurement	BOAM impact score	Pest-exclusion fence	Pest landscape buffer	Total BOAM offset score	Attribute NPBV (Offset score - impact score)
Falcon habitat (All Indigenous Ecosystems and Grassland)	NZ Falcon	Breeding Success	%	-166.19	57.96	153.78	211.74	45.55
Tussock/grassland	Banded Dotterel	Breeding Success	%	-64.88		82.73	82.73	17.85
Tussock/grassland	SIPO	Breeding Success	%	-64.88		82.73	82.73	17.85

7 Integrated Interpretation of Compensation Outcomes

The quantitative analyses predict positive component-level balances for snow tussock, dry shrubland, McCann’s skink and the three modelled avifauna species. These results are subject to the assumptions and confidence limitations stated in the relevant sections. Southern grass skink has positive balances in two habitat categories but retains a modelled deficit in tussock/grassland/rock habitat. Kōrero gecko and 10 assessed invertebrate values remain uncertain because available data do not support quantitative or sufficiently confident outcome predictions.

It should be noted that the results are component specific. For example, positive balances for vegetation, McCann’s skink or birds do not cancel the southern grass skink deficit or resolve uncertainty for kōrero gecko and invertebrates. The wider package includes unmodelled habitat protection, stock exclusion, pest management, revegetation and connectivity benefits. Those actions provide relevant ecological context and support the package-level assessment in the Terrestrial REA, but they are not combined with the BOAM outputs to produce a single numerical biodiversity balance.

Taken together, the analyses support the conclusion that the terrestrial compensation package is expected to provide substantial ecological benefits and, at the package level, is expected to outweigh the residual terrestrial effects of MP4. This package-level conclusion does not imply a positive outcome for every biodiversity value. It expressly retains the modelled southern grass skink deficit and the uncertain outcomes identified above.

8 Overall Conclusion

This report documents the BOAMs and supporting outcome-based analyses used to inform the terrestrial biodiversity compensation package for MP4. Separate models have been applied to vegetation, two skink species and three avifauna species, while terrestrial invertebrates and kōrero gecko have been assessed qualitatively because suitable quantitative data are unavailable.

The models predict positive balances for snow tussock and dry shrubland at the component level, all three McCann’s skink habitat categories, southern grass skink in dry shrubland and other habitats, and kārearea, banded dotterel and South Island pied oystercatcher. Southern grass skink retains a modelled net loss in tussock/grassland/rock habitat. Outcomes for kōrero gecko and 10 invertebrate values remain uncertain. These findings are not aggregated across unrelated biodiversity components.

The analyses support the wider Terrestrial REA conclusion that the coordinated compensation package is expected to produce substantial and enduring package-level ecological benefits. However, strict ecological equivalence, complete quantification and certainty of outcome have not been demonstrated for all affected values. The package is therefore appropriately characterised as biodiversity compensation rather than a comprehensive biodiversity offset.

Appendix C
BOAM Outputs.

BOAM Models for Indigenous vegetation Project-wide (area-weighted averages used for tussock)

Table C-1. BOAM Impact model inputs for loss of 90 ha of snow tussock.

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component		**Biodiversity Attribute**	**Measurement Unit**	**Area of Impact (ha)**	**Benchmark**	**Measure prior to Impact**	**Measure after Impact**	**Biodiversity Value**
1.1	Tussock Structure Integrity	**1.1a**	Height	m	90	1.7	0.936	0	-49.55
		1.1b	% cover	%	90	99	59	0	-53.64
		1.1c	Proportion of indigenous species	%	90	61	39.9	0	-58.87
1.2	Tussock Diversity	**1.2a**	Indigenous species richness	count	90	14	7.8	0	-50.14
		1.2b	TAR species	count	90	2	2	0	-90.00

Table C-2. . BOAM Output model for loss of 90 ha of snow tussock and 175 ha snow tussock revegetation. Model indicates a net biodiversity gain for structure and integrity (0.98) and diversity (6.66) components.

	BIODIVERSITY TYPE	DISCOUNT RATE
1	Indigenous Vegetation	0.03

Step 6: Work through accounting model for each Biodiversity Attribute entering values into light brown cells. At Column K choose method of accounting for time and follow instructions. If using a finite end point, continue on this sheet. If calculating the offset as accrued over time use the Offset Model_5 yearly worksheet.
Step 7: Repeat for additional Biodiversity Components (scrolling down the sheet)

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component		**Biodiversity Attribute**	**Measurement Unit**	**Benchmark**	**Proposed Offset Actions**	**Offset area (ha)**	**Confidence in Offset Actions**			**Measure prior to Offset**	**Measure after Offset**	**Time till endpoint (years)**	**Biodiversity Value at Offset Site**	**Biodiversity Value at Impact Site**	**Attribute Net Present Biodiversity Value**	**Component Net Present Biodiversity Value**
1.1	Tussock Structure Integrity	**1.1a**	Height	m	1.7	Revegetation	175	Confident 75-90%	Finite end point	Continue to Column M	0	1	15	54.51	-49.55	4.96	0.98
		1.1b	% cover	%	99	Revegetation	175	Confident 75-90%	Finite end point	Continue to Column M	0	45	15	42.12	-53.64	-11.51	
		1.1c	Proportion of indigenous species	%	61	Revegetation	175	Confident 75-90%	Finite end point	Continue to Column M	0	45	15	68.36	-58.87	9.49	
1.2	Tussock Diversity	**1.2a**	Indigenous species richness	count	14	Revegetation	175	Confident 75-90%	Finite end point	Continue to Column M	0	6	10	46.04	-50.14	-4.10	6.66
		1.2b	TAR species	count	2	Revegetation	175	Confident 75-90%	Finite end point	Continue to Column M	0	2	10	107.43	-90.00	17.43	

Table C-3. BOAM Impact model inputs for loss of 3 ha of Dry shrubland .

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component		**Biodiversity Attribute**	**Measurement Unit**	**Area of Impact (ha)**	**Benchmark**	**Measure prior to Impact**	**Measure after Impact**	**Biodiversity Value**
1.3	Shrubland structure Integrity	**1.3a**	Height	m	3	4	0.7	0	-0.53
		1.3b	% cover	%	3	94	45	0	-1.44
		1.3c	Proportion of indigenous species	%	3	90	33	0	-1.10
1.4	Shrubland diversity	**1.4a**	Indigenous species richness	count	3	16	7.5	0	-1.41
		1.4b	TAR plant species	count	3	4	1	0	-0.75
1.5	Shrubland Birds	**1.5a**	Shrubland birds	count	3	11	3	0	-0.82

Table C-4. . BOAM Output model for loss of 3 ha of dry shrubland and 50 ha dry shrubland revegetation. Model indicates a net biodiversity gain for structure and integrity (4.30) and diversity (13.27) components.

	BIODIVERSITY TYPE	DISCOUNT RATE
1	Indigenous Vegetation	0.03

Step 6: Work through accounting model for each Biodiversity Attribute entering values into light brown cells. At Column K choose method of accounting for time and follow instructions. If using a finite end point, continue on this sheet. If calculating the offset as accrued over time use the Offset Model_5 yearly worksheet.
Step 7: Repeat for additional Biodiversity Components (scrolling down the sheet)

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
1.3	Shrubland structure Integrity	1.3a	Height	m	4	Revegetation	50	Confident 75-90%	Finite end point	Continue to Column M	0	1.5	20	8.56	-0.53	8.04	4.30
		1.3b	% cover	%	94	Revegetation	50	Confident 75-90%	Finite end point	Continue to Column M	0	20	20	4.86	-1.44	3.42	
		1.3c	Proportion of indigenous species	%	90	Revegetation	50	Confident 75-90%	Finite end point	Continue to Column M	0	10	20	2.54	-1.10	1.44	

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
1.6	Shrubland diversity	1.6a	Indigenous species richness	count	16	Revegetation	50	Confident 75-90%	Finite end point	Continue to Column M	0	9	15	14.89	-1.41	13.49	16.30
		1.6b	TAR plant species	count	4	Revegetation	50	Confident 75-90%	Finite end point	Continue to Column M	0	3	15	19.86	-0.75	19.11	

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
1.5	Shrubland Birds	1.5a	Shrubland birds	count	11	Revegetation	50	Confident 75-90%	Finite end point	Continue to Column M	0	5	20	10.38	-0.82	9.56	9.56

Lizards:

Table C-5. . BOAM Impact Model Inputs (Density) for loss of McCann's skinks from 231.9 ha of tussock/ grassland/ rock, 2.96 ha of dry shrubland, and 3.84 ha of 'other' habitat across the MP4 Project impact area.

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated			
	Biodiversity Component		Biodiversity Attribute	Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
0.1	McCanns (tussock/ grassland/ tor)	0.1a	Density	skinks/ ha	231.9	2000	256	0	-29.68
		0.1b							Not calculated
		0.1c							Not calculated
		0.1d							Not calculated
		0.1e							Not calculated

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated			
	Biodiversity Component		Biodiversity Attribute	Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
0.2	McCanns (shrubland)	0.2a	Density	skinks/ ha	2.96	2000	810	0	-1.20
		0.2b							Not calculated
		0.2c							Not calculated
		0.2d							Not calculated
		0.2e							Not calculated

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated			
	Biodiversity Component		Biodiversity Attribute	Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
0.3	McCanns (other)	0.3a	Density	skinks/ ha	3.84	2000	41	0	-0.08
		0.3b							Not calculated
		0.3c							Not calculated
		0.3d							Not calculated
		0.3e							Not calculated

Table C-6. . BOAM Offset Model Outputs (Predator exclusion fence) for loss of McCann's skinks from 231.9 ha of tussock/ grassland/ rock, 2.96 ha of dry shrubland, and 3.84 ha of 'other' habitat across the MP4 Project impact area.

	BIODIVERSITY TYPE	DISCOUNT RATE
0	#N/A	0.03

Step 5: Biodiversity Attributes will be auto-populated once Cell B11 is populated.
Step 6: Work through accounting model for each Biodiversity Attribute entering values into light brown cells. At Column K choose method of accounting for time and follow instructions. If using a finite end point, continue on this sheet. If calculating the offset as accrued over time use the Offset Model_5 yearly worksheet.
Step 7: Repeat for additional Biodiversity Components (scrolling down the sheet)

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
0.1	McCanns (tussock/ grassland/ tor)	0.1a	Density	skinks/ ha	2000	Predator-proof fence	135	Very confident >90%	Finite end point	Continue to Column M	924	1848	5	51.38	-29.68	21.70	21.70
		0.1b						Low confidence >50% <75%	Choose option							Not calculated	
		0.1c						Low confidence >50% <75%	Choose option							Not calculated	
		0.1d						Low confidence >50% <75%	Choose option							Not calculated	
		0.1e						Low confidence >50% <75%	Choose option							Not calculated	

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
0.2	McCanns (shrubland)	0.2a	Density	skinks/ ha	2000	Predator-proof fence	11	Very confident >90%	Finite end point	Continue to Column M	534	1068	5	2.42	-1.20	1.22	1.22

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
0.3	McCanns (other)	0.3a	Density	skinks/ ha	2000	Predator-proof fence	106	Very confident >90%	Finite end point	Continue to Column M	620	1240	5	27.07	-0.08	26.99	26.99

Table C-7. . BOAM Impact Model Inputs (Density) for loss of southern grass skinks from 231.9 ha of tussock/ grassland/ rock, 2.96 ha of dry shrubland, and 3.84 ha of 'other' habitat across the MP4 Project impact area.

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component		Biodiversity Attribute	Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
0.1	SGS (tussock/ grassland/ tor)	0.1a	Density	skinks/ ha	231.9	2000	375	0	-43.48
		0.1b							Not calculated
		0.1c							Not calculated
		0.1d							Not calculated
		0.1e							Not calculated

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component		Biodiversity Attribute	Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
0.2	SGS (shrubland)	0.2a	Density	skinks/ ha	2.96	2000	224	0	-0.33
		0.2b							Not calculated
		0.2c							Not calculated
		0.2d							Not calculated
		0.2e							Not calculated

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component		Biodiversity Attribute	Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
0.3	SGS (other)	0.3a	Density	skinks/ ha	3.84	2000	27	0	-0.05
		0.3b							Not calculated
		0.3c							Not calculated
		0.3d							Not calculated
		0.3e							Not calculated

Table C-8. . BOAM Offset Model Outputs (Predator exclusion fence) for loss of southern grass skinks from 231.9 ha of tussock/ grassland/ rock, 2.96 ha of dry shrubland, and 3.84 ha of 'other' habitat across the MP4 Project impact area.

	BIODIVERSITY TYPE	DISCOUNT RATE
0	#N/A	0.03

Step 5: Biodiversity Attributes will be auto-populated once Cell B11 is populated.
Step 6: Work through accounting model for each Biodiversity Attribute entering values into light brown cells. At Column K choose method of accounting for time and follow instructions. If using a finite end point, continue on this sheet. If calculating the offset as accrued over time use the Offset Model_5 yearly worksheet.
Step 7: Repeat for additional Biodiversity Components (scrolling down the sheet)

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
0.1	SGS (tussock/ grassland/ tor)	0.1a	Density	skinks/ ha	2000	Predator-proof fence	135	Very confident >90%	Finite end point	Continue to Column M	140	280	5	7.78	-43.48	-35.70	-35.70
		0.1b						Low confidence >50% <75%	Choose option							Not calculated	

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
0.2	SGS (shrubland)	0.2a	Density	skinks/ ha	2000	Predator-proof fence	11	Very confident >90%	Finite end point	Continue to Column M	81	162	5	0.37	-0.33	0.04	0.04

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
0.3	SGS (other)	0.3a	Density	skinks/ ha	2000	Predator-proof fence	106	Very confident >90%	Finite end point	Continue to Column M	94	188	5	4.10	-0.05	4.05	4.05

Birds:

Table C-9. . BOAM Output for loss of 235.99 ha of New Zealand falcon habitat.

Combined kārearea calculation: predator-exclusion gain 57.96 + landscape-control gain 153.78 − impact 166.19 = +45.55. The action-level NPBVs in the raw output subtract the impact from each action separately and must not be interpreted as two independent overall results.

This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute					
Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value
NZ Falcon	1.1a	Breeding Success	%	71	Pest control (Fence)	252	Confident 75-90%	Finite end point	Continue to Column M	50	71	2	57.96	-166.19	-108.23
	1.1b	Breeding Success	%	71	Pest control (Landscape Buffer	1170	Confident 75-90%	Finite end point	Continue to Column M	50	62	2	153.78	-166.19	-12.41

Table C-10. . BOAM Output for loss of 130.38 ha of banded dotterel habitat.

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute					
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value
1.3	Banded Dotterel	1.3a	Breeding Success	%	85.2	Pest control (Landscape Buffer	642.84	Confident 75-90%	Finite end point	Continue to Column M	42.4	56.5	2	82.73	-64.88	17.85

Table C-11. . BOAM Output for loss of 130.38 ha of South Island pied oystercatcher (SIPO) habitat.

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute					
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value
1.4	SIPO	1.4a	Breeding Success	%	85.2	Pest control (Landscape Buffer	642.85	Confident 75-90%	Finite end point	Continue to Column M	42.4	56.5	2	82.73	-64.88	17.85

Appendix D
Benefits of Mammalian Pest Management

1 Benefits of Mammalian Pest Management

Prepared by Helen Blackie (Alliance Ecology)

1.1 Overview

Introduced mammalian predators and browsers are widely recognised as one of the primary drivers of biodiversity decline in New Zealand. Predators such as rats, mice, stoats, ferrets, weasels, possums and feral cats, together with browsing mammals including deer, pigs and goats, continue to exert substantial pressure on indigenous ecosystems by reducing survival and recruitment of native species and altering habitat structure and ecological processes (Innes et al., 2010; Russell et al., 2015; PCE, 2011).

The effects of these species extend across multiple ecosystem components. Predators directly affect indigenous fauna through predation on birds, lizards and invertebrates, while browsing mammals suppress vegetation regeneration, alter plant community composition and reduce habitat quality. Collectively, these impacts can simplify ecosystem structure, reduce biodiversity, limit natural regeneration processes and decrease ecosystem resilience, resulting in long-term declines in ecosystem condition and function (Innes et al., 2010; Forsyth et al., 2013; Tanentzap & Lloyd, 2017; PCE, 2011).

Consequently, pest management has become a cornerstone of biodiversity conservation and ecological restoration throughout New Zealand. Numerous studies have demonstrated that reducing the abundance of introduced mammals can lead to measurable improvements in native species abundance, breeding success, vegetation condition and ecosystem function. National-scale reviews of restoration projects have shown that pest-managed sites consistently achieve better biodiversity outcomes than unmanaged sites, with the greatest gains occurring where multiple pest species are controlled over long timeframes or where pest elimination has been achieved (Binny et al., 2017; Binny et al., 2021).

Pest management is therefore increasingly utilised as a mechanism to address residual ecological effects associated with development projects. By reducing one of the primary ongoing pressures on indigenous biodiversity, sustained pest control can deliver measurable and enduring ecological gains. This approach aligns with the principles of the Government's Guidance on Good Practice Biodiversity Offsetting (DOC, 2014), which recognises that biodiversity outcomes can be achieved where management actions remove limiting pressures, are maintained over the long term, and are supported by robust monitoring and adaptive management programmes.

1.2 Pest mammal impacts in New Zealand

New Zealand's indigenous terrestrial ecosystems evolved in the absence of terrestrial mammalian predators. As a result, many native species developed characteristics that made them highly vulnerable to mammalian predation, including ground nesting behaviour, low reproductive rates, limited dispersal ability and an absence of effective anti-predator responses (Holdaway, 1999; Towns et al., 2006). The introduction of mammals following human settlement has therefore resulted in profound ecological change and is widely recognised as one of the principal causes of biodiversity decline in New Zealand (Atkinson, 2006; Russell et al., 2015).

Today, introduced mammals remain among the most significant threats to indigenous biodiversity. Predatory species such as ship rats (*Rattus rattus*), Norway rats (*R. norvegicus*), mustelids (stoats *Mustela erminea,* ferrets *M. furo* and weasels *M. nivalis vulgaris*), feral cats (*Felis catus*) and brushtail possums (*Trichosurus vulpecula*) affect native fauna through direct predation of birds, reptiles and invertebrates, as well as through competition for food and other resources. Ship rats, for example, are highly adaptable omnivores capable of preying on a wide range of indigenous species while also competing for fruits, seeds and invertebrate prey (Innes et al., 2010; Towns et al., 2006).

Browsing mammals exert a different but equally important influence on ecosystem condition. Deer, pigs, goats and possums can alter vegetation composition and structure by selectively feeding on palatable species, suppressing regeneration, disturbing soils and reducing habitat complexity. These impacts can cascade through ecosystems by affecting food availability, shelter resources and ecological interactions for a wide range of indigenous species (Forsyth et al., 2013; Nugent et al., 2001).

The ecological consequences of introduced mammals are therefore not limited to individual species but extend to broader ecosystem function and resilience. Numerous studies have demonstrated that reducing mammalian pest abundance can improve nesting success and survival of native birds, promote vegetation recovery, increase the abundance of lizards and invertebrates, and enhance overall ecosystem condition (Burns et al., 2012; Innes et al., 2012; Binny et al., 2017; Binny et al., 2021; PCE, 2011). These findings highlight the important role that pest management plays in restoring and maintaining indigenous biodiversity values throughout New Zealand.

1.3 Pest impacts on Lizards

Introduced mammalian predators are recognised as one of the principal threats to New Zealand's indigenous lizards. Rodents, mustelids, feral cats and hedgehogs are all known to prey on skinks and geckos, while some pest species may also affect lizards indirectly through competition for food resources, disturbance of refugia and alteration of habitat condition (Whitaker, 1978; Norbury et al., 2014; Nelson et al., 2016; Turner & Norbury, 2023).

Lizards are particularly vulnerable to mammalian predation because many species are long-lived, slow to mature, have relatively low reproductive rates and occupy ground-level habitats where they are exposed to a wide range of introduced predators (Towns et al., 2006; Nelson et al., 2016). Consequently, even relatively low densities of mammalian predators can suppress lizard survival, recruitment and population recovery, particularly in mainland environments where multiple predator species are present (Reardon et al., 2012; Norbury et al., 2014).

Recent research has highlighted the importance of controlling the full suite of mammalian predators, including mice, in order to benefit lizards. Mice are now recognised as direct predators of lizards and large invertebrates, and their populations can increase rapidly where other predators are suppressed but mice are not effectively controlled. Norbury et al. (2023) found that geckos, skinks and wētā were negatively affected where mouse tracking exceeded 5%, while Monks et al. (2024) found that skink abundance declined over time and was negatively correlated with mouse abundance. These findings indicate that predator control programmes designed primarily for birds or bats may not provide adequate protection for ground-dwelling lizards unless mice and other small predators are also reduced to very low levels.

Mainland lizard recovery is most likely where all key mammalian predators are either eliminated or suppressed to very low densities. Reardon et al. (2012) and Norbury et al. (2014) concluded that intensive, multi-species predator control is required to achieve measurable lizard benefits, while predator-free environments provide the greatest certainty of population recovery. This is particularly relevant to the MEEA, where the proposed predator exclusion fence is intended to remove mammalian predation pressure and provide a secure long-term habitat for resident and translocated lizard populations.

The monitoring undertaken for this Plan (see Section 2.2 – 2.3) confirmed the presence of several mammalian predators known to affect lizards, including rats, mice, hedgehogs, feral cats, ferrets and possums. These detections demonstrate that, in the absence of active management, lizard populations within the MEEA and surrounding landscape are likely to remain exposed to ongoing predation pressure. Accordingly, predator elimination within the fenced area and predator suppression in surrounding management areas are expected to provide important benefits for lizard survival, recruitment and long-term population persistence.

1.4 Benefits of pest exclusion fences

Pest exclusion fences are widely recognised as one of the most effective tools available for protecting indigenous biodiversity in mainland New Zealand. By preventing reinvasion of mammalian pests and enabling their complete removal from enclosed areas, pest exclusion fences can create environments that closely resemble the predator-free conditions historically found on offshore islands (Innes et al., 2012; Burns et al., 2018).

Unlike conventional pest suppression programmes, which typically reduce pest abundance but do not eliminate pests entirely, exclusion fences can achieve zero densities of a wide range of mammalian pest species simultaneously. This provides a level of ecological protection that cannot generally be achieved through trapping or poisoning alone (Innes et al., 2012; Innes et al., 2019). Once pest eradication has been achieved within a fenced area, biodiversity gains can be maintained through ongoing surveillance and rapid response to incursions, greatly reducing the need for repeated landscape-scale control operations.

Pest exclusion fences are particularly important for species that remain vulnerable even at relatively low predator densities. Many indigenous lizard species fall into this category, as population growth and recruitment can be constrained by predation from rats, mice, mustelids, hedgehogs and cats even where predator numbers have been substantially reduced (Reardon et al., 2012; Norbury et al., 2014; Turner & Norbury, 2023).

As a result, predator exclusion fences have become an important component of biodiversity restoration programmes throughout New Zealand. Reviews commissioned by the Department of Conservation have concluded that fenced ecosanctuaries have made a substantial contribution to biodiversity recovery by enabling species reintroductions, restoring ecological processes and protecting species that cannot be adequately conserved through predator suppression alone (Burns et al., 2018).

Research also demonstrates that the greatest biodiversity outcomes are often achieved when pest exclusion fences are integrated with surrounding predator control programmes. This "core-and-halo" approach combines predator elimination within the fenced area with lower-intensity predator suppression in surrounding habitats, reducing reinvasion pressure while extending biodiversity benefits beyond the fence itself (Innes et al., 2019; Parkes et al., 2017; Linklater & Steer, 2018).

1.4.1 General biodiversity benefits

A substantial body of New Zealand research has demonstrated that pest exclusion fences can generate significant biodiversity gains across a wide range of taxa and ecosystem processes.

Long-term monitoring of fenced ecosanctuaries has documented increases in native bird abundance, improved nesting success, recovery of large invertebrate populations, increases in lizard abundance and improved vegetation condition following the removal of mammalian pests (Burns et al., 2012; Innes et al., 2012; Miskelly, 2018; Scofield et al., 2011). Species that are particularly sensitive to mammalian predators often show the strongest responses, with substantial improvements in survival, recruitment and population growth following predator eradication.

Predator exclusion also facilitates the recovery of ecological processes that are often disrupted by introduced mammals. Studies have reported improved seed dispersal, increased pollination services, enhanced seedling recruitment and greater regeneration of mammal-sensitive plant species following pest removal (Isles & Kelly, 2014; Tanentzap & Lloyd, 2017). In addition, predator-free environments provide opportunities for species translocations and reintroductions that would otherwise be unlikely to succeed in mainland landscapes.

Importantly, the benefits of pest exclusion are not necessarily confined to the fenced area itself. Where exclusion fences are coupled with predator management in surrounding habitats, biodiversity gains can extend into adjacent landscapes through increased dispersal of birds and other fauna, enhanced seed dispersal, and reduced predator pressure near sanctuary boundaries (Clarkson & Kirby, 2016; Fitzgerald et al., 2019; Ruffell et al., 2018).

Collectively, the available evidence indicates that pest exclusion fences represent one of the most effective tools available for achieving long-term biodiversity gains in mainland New Zealand, particularly when integrated with wider predator suppression programmes and adaptive management. While predator exclusion fences provide benefits across a wide range of taxa and ecological processes, some of the strongest and most consistent responses have been documented in indigenous lizard populations, which are particularly sensitive to mammalian predation.

1.4.2 Biodiversity benefits - lizards

Numerous studies have demonstrated that lizard abundance, survival and recruitment increase substantially when mammalian predators are either eradicated or maintained at very low densities (Newman, 1994; Reardon et al., 2012; Norbury et al., 2014; Nelson et al., 2016; Turner & Norbury, 2023). Across New Zealand, lizard populations have shown dramatic increases following predator eradication programmes, with some populations increasing more than thirty-fold within a decade of pest removal (Towns, 1991, 2002; Towns et al., 2003; Newman, 1994; Monks et al., 2014; Nelson et al., 2016). Collectively, these studies demonstrate that mammalian predation is often the primary factor limiting lizard populations and that substantial biodiversity gains can be achieved when predation pressure is removed.

One of the most relevant examples for the Macraes Project is the Mokomoko Dryland Sanctuary in Central Otago, a 14 ha predator exclusion sanctuary established specifically to restore dryland lizard communities. The sanctuary supports a range of indigenous lizard species, including grand skinks (*Oligosoma grande*), Otago skinks (*O. otagense*), jewelled geckos (*Naultinus gemmeus*), schist geckos (*Woodworthia* “Otago/Southland large”), McCann's skinks (*Oligosoma maccanni*) and southern grass skinks (*O. aff. polychroma*).

Turner and Norbury (2023) compared lizard populations before and after mammalian predators were removed from within the sanctuary and found that lizard abundance was substantially higher within the predator-free area than in surrounding habitat where predators remained present. Tracking tunnel detections for geckos reached 62% within the sanctuary compared with 12% outside the fence, while skink detections increased to 42% inside the sanctuary compared with only 2% outside the fence (**Figure D.1**). These results demonstrated that even common lizard species remained strongly limited by mammalian predation and responded rapidly once predators were removed.

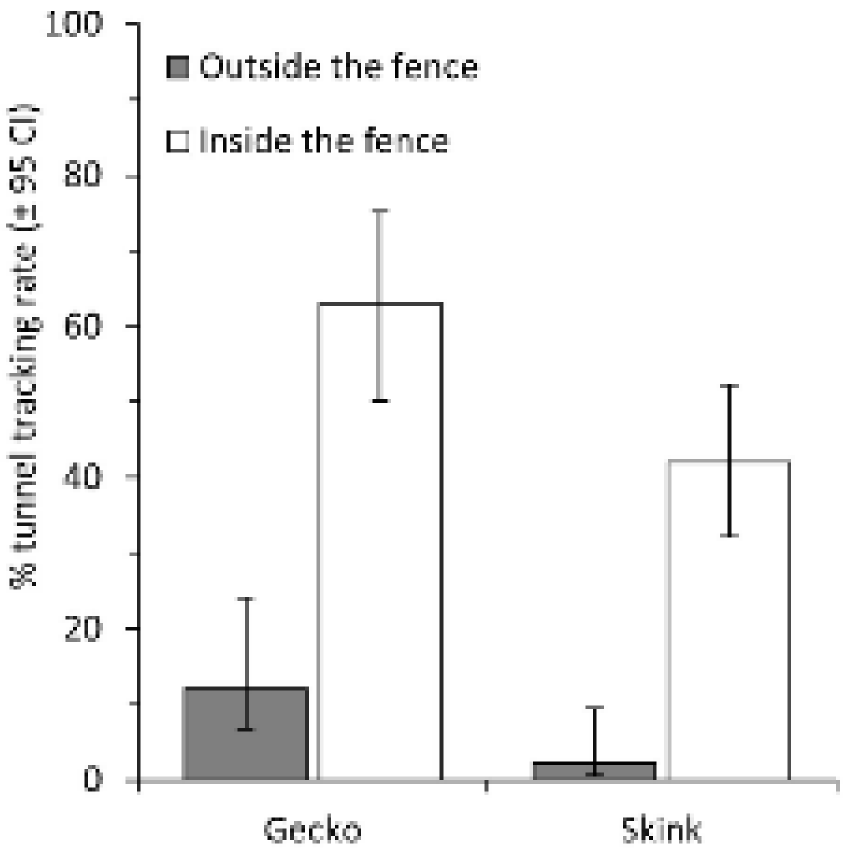


Figure D.1. Tracking tunnel rates (±95% CIs, n = 4) for schist geckos and skinks (McCann's and southern grass) in the presence (outside fence) and absence (inside fence) of predators. Graph sourced from Turner and Norbury, 2023.

More recent monitoring undertaken at Mokomoko Dryland Sanctuary (Mokomoko Dryland Sanctuary, 2026), has further demonstrated strong responses by both common and threatened lizard species following the exclusion of mammalian predators. Since fence construction and pest eradication, populations of grand skinks and Otago skinks have successfully established and reproduced within the sanctuary, producing multiple generations of sanctuary-born offspring. By 2026, at least 73 grand skinks and 78 Otago skinks born within the sanctuary had been recorded, demonstrating ongoing recruitment and population growth (Mokomoko Dryland Sanctuary, 2026).

The success of these populations has contributed to recent improvements in the conservation status of both species, which have been reclassified from *Threatened – Nationally Endangered* to *Threatened – Nationally Increasing*. Mokomoko has been specifically recognised as one of the sites contributing to this recovery, providing strong evidence that predator exclusion can facilitate long-term population growth and recovery of highly vulnerable lizard species (Mokomoko Dryland Sanctuary, 2026).

Importantly, Mokomoko has also demonstrated the effectiveness of recently built predator exclusion fencing for preventing reinvasion by mice. In 2026 it was reported that the site has been free of mice for more than four years, despite mice often being regarded as one of the most difficult mammalian pests to exclude from mainland sanctuaries (Mokomoko Dryland Sanctuary, 2026). This result is likely due to the combination of robust fence design with ongoing surveillance, fence maintenance and rapid incursion response programmes.

Predator exclusion fencing therefore continues to form an important component of contemporary lizard conservation programmes in New Zealand. Recent additional examples include predator-proof fences established to protect critically endangered Alborn skinks on the West Coast, grand skink populations in Central Otago, spotted skinks near Martinborough, and other threatened lizard populations throughout the country. The continued use of predator exclusion fencing by the Department of Conservation and conservation organisations reflects the strong evidence base supporting this approach for lizard recovery.

Given the presence of multiple mammalian predators within the MEEA and surrounding landscape, including rats, mice, hedgehogs, feral cats, mustelids and possums, the proposed predator exclusion fence is expected to provide substantial benefits for resident lizard populations. The MEEA therefore represents a significant opportunity to achieve long-term lizard conservation gains within the Macraes landscape.

In addition, the proposed MEEA predator exclusion area is substantially larger than many existing predator-fenced lizard sanctuaries in New Zealand, including the Mokomoko Dryland Sanctuary. The larger area will support a greater diversity of habitats, larger population sizes and increased opportunities for natural dispersal and population expansion, thereby improving the long-term viability and resilience of protected lizard populations.

1.4.3 Benefits of predator suppression

While predator exclusion provides the highest level of protection for biodiversity values, substantial ecological gains can also be achieved through sustained predator suppression programmes. Integrated pest management approaches that target multiple predator species simultaneously have been shown to reduce predation pressure, improve breeding success and increase population abundance of native fauna across large mainland landscapes (O'Donnell & Hoare, 2012; Innes et al., 2019).By maintaining predator populations at low densities, suppression programmes can improve survival and recruitment of indigenous birds, lizards and invertebrates, while also enhancing the effectiveness of adjacent predator-free areas. The methods required to achieve these outcomes are now well established and widely applied throughout New Zealand, including trapping networks, toxic baiting programmes and integrated adaptive management approaches.

An increasing body of research has also demonstrated that biodiversity benefits generated through pest exclusion fencing can extend beyond the immediate management area, creating what is often referred to as a "halo effect" (Glen et al., 2013). At Maungatautari, tūī abundance increased in surrounding unmanaged habitats following pest eradication within the sanctuary (Fitzgerald et al., 2019), while forest birds including kākā have expanded into urban Wellington following the establishment of Zealandia (Recio et al., 2016). Similar spill-over effects have been documented for vegetation recovery, with increased recruitment of bird-dispersed tree species occurring both within and beyond the boundaries of Orokonui Ecosanctuary near Dunedin (Tanentzap & Lloyd, 2017).

These findings are particularly relevant to the Macraes programme. Predator suppression within the MEEA buffer area is expected to reduce reinvasion pressure on the predator exclusion fence and enhance biodiversity outcomes beyond the fenced area itself. Similarly, predator control within Murphys lizard release area and Cranky Jims will reduce predation pressure on indigenous fauna, support restoration outcomes and strengthen ecological connectivity with the adjacent Island Block Ecological Covenant. Collectively, these actions are expected to deliver biodiversity benefits across a much larger area than could be achieved through predator exclusion fencing alone.

Given the presence of rats, mice, possums, feral cats, mustelids and hedgehogs within the project area, sustained predator suppression is expected to contribute to increased survival and recruitment of indigenous fauna, improved habitat quality and enhanced ecological resilience throughout the wider Macraes landscape.

1.4.4 Benefits of browser control

Introduced browsing mammals, including deer, pigs, rabbits, hares and possums, can substantially affect indigenous vegetation by reducing seedling establishment, suppressing natural regeneration, altering plant community composition and disturbing soils (Nugent et al., 2001; Forsyth et al., 2013; Tanentzap & Lloyd, 2017). These impacts are often most pronounced in restoration areas, where young plants and regenerating vegetation are particularly vulnerable to browsing pressure. Sustained browser control has been shown to improve plant survival, increase recruitment of indigenous species and accelerate vegetation recovery, resulting in improved habitat quality and ecosystem resilience (Forsyth et al., 2013; PCE, 2011).

For Macraes, browser control is expected to provide important benefits for restoration plantings, indigenous vegetation communities and natural regeneration processes. Reducing populations of deer, pigs, rabbits, hares and other browsing mammals will increase the likelihood of successful establishment of tussock, dry shrubland and riparian restoration plantings, while also supporting long-term recovery of indigenous vegetation. Browser management will therefore complement predator control measures by improving habitat quality, increasing ecosystem resilience and helping to ensure that restoration and compensation objectives are achieved across the wider Macraes landscape.

1.5 References

Atkinson, I. A. E. (2006). Introduced mammals in a new environment. In R. B. Allen & W. G. Lee (Eds.), *Biological invasions in New Zealand* (pp. 49–66). Springer.

Binny, R. N., Innes, J., Fitzgerald, N., Pech, R. P., James, A., Price, R., Gillies, C., & Burns, B. (2017). Long-term biodiversity trajectories for pest-managed ecological restoration projects in New Zealand. *Ecological Applications, 27*(3), 686–698.

Binny, R. N., Innes, J., Pech, R. P., Fitzgerald, N., Price, R., & Gillies, C. (2021). Effects of mammalian pest control on biodiversity outcomes across New Zealand restoration projects. *Conservation Biology, 35*(2), 615–627.

Burns, B., Innes, J., Day, T., & Fitzgerald, N. (2012). Ecosystem restoration and biodiversity recovery in New Zealand. *New Zealand Journal of Ecology, 36*(2), 161–170.

Burns, B., Miskelly, C., Innes, J., Day, T., & Fitzgerald, N. (2018). *The contribution of fenced ecosanctuaries to biodiversity conservation in New Zealand*. Department of Conservation, Wellington.

Clarkson, B. D., & Kirby, C. L. (2016). Ecological restoration in urban environments in New Zealand. *Ecological Management & Restoration, 17*(3), 180–190.

Department of Conservation. (2014). *Guidance on good practice biodiversity offsetting in New Zealand*. Department of Conservation.

Fitzgerald, N., Innes, J., Burns, B., & Stewart, G. H. (2019). Halo effects from pest-free sanctuaries: Increased abundance of native birds beyond sanctuary boundaries. *Biological Conservation, 236*, 221–229.

Forsyth, D. M., Coomes, D. A., Nugent, G., & Hall, G. M. J. (2013). Impacts of introduced deer and other ungulates on New Zealand forest ecosystems. *New Zealand Journal of Ecology, 37*(1), 1–11.

Glen, A. S., Pech, R. P., Byrom, A. E., & Nugent, G. (2013). Ecosanctuaries and halo effects in New Zealand conservation. *New Zealand Journal of Ecology, 37*(1), 1–11.

Holdaway, R. N. (1999). A spatio-temporal model for the invasion of the New Zealand archipelago by the Pacific rat (*Rattus exulans*). *Journal of the Royal Society of New Zealand, 29*(2), 91–105.

Innes, J., Kelly, D., Overton, J. M., & Gillies, C. (2010). Predation and other factors currently limiting New Zealand forest birds. *New Zealand Journal of Ecology, 34*(1), 86–114.

Innes, J., Lee, W. G., Burns, B., Campbell-Hunt, C., Watts, C., Phipps, H., & Stephens, T. (2012). Role of predator-proof fences in restoring New Zealand ecosystems. *New Zealand Journal of Ecology, 36*(2), 232–238.

Innes, J., Fitzgerald, N., Binny, R. N., Byrom, A. E., Pech, R. P., Watts, C., & Gillies, C. (2019). Advances in New Zealand pest management and ecosystem restoration. *Journal of the Royal Society of New Zealand, 49*(4), 412–433.

Iles, J., & Kelly, D. (2014). Restoring bird pollination of kotukutuku (*Fuchsia excorticata*) through mammalian pest control. *New Zealand Journal of Ecology, 38*(2), 297–307.

Linklater, W. L., & Steer, J. (2018). Evaluating the ecological effectiveness of fenced sanctuaries in New Zealand. *Pacific Conservation Biology, 24*(4), 342–351.

Miskelly, C. M. (2018). *New Zealand's offshore islands and fenced sanctuaries: Contributions to biodiversity conservation*. Department of Conservation.

Mokomoko Dryland Sanctuary. (2026). *Mokomoko Dryland Sanctuary Newsletter* (February 2026 ed.). Central Otago Ecological Trust.

Monks, J. M., et al. (2014). Recovery of New Zealand lizard populations following mammalian pest eradication. *New Zealand Journal of Ecology, 38*(2), 241–250.

Monks, J. M., et al. (2024). Mouse abundance as a limiting factor for New Zealand skink populations. *Journal of Applied Ecology*.

Nelson, N. J., Monks, J. M., Keall, S. N., Daugherty, C. H., & Hitchmough, R. A. (2016). Conservation of New Zealand reptiles in the presence of invasive mammals. *New Zealand Journal of Zoology, 43*(2), 85–96.

Newman, D. G. (1994). Effects of a mouse (*Mus musculus*) eradication programme and habitat change on lizard populations on Mana Island, New Zealand, with special reference to McGregor's skink. *New Zealand Journal of Zoology, 21*(4), 443–456.

Norbury, G., Byrom, A., Pech, R., Smith, J., Clarke, D., Anderson, D., & Forrester, G. (2014). Invasive mammals and habitat modification interact to generate unforeseen outcomes for indigenous fauna. *Ecological Applications, 24*(7), 1707–1721.

Norbury, G., et al. (2023). Mouse abundance thresholds for lizard and invertebrate conservation in New Zealand drylands. *Journal of Applied Ecology*.

Nugent, G., Sweetapple, P., Coleman, J., & Suisted, P. (2001). *Possum impacts on native biodiversity*. *Science for Conservation* No. 179. Department of Conservation.

O'Donnell, C. F. J., & Hoare, J. M. (2012). Quantifying the benefits of integrated pest management for threatened New Zealand fauna. *New Zealand Journal of Ecology, 36*(2), 171–183.

Parkes, J., Byrom, A., Edge, K.-A., et al. (2017). Conserving biodiversity in New Zealand by eradicating invasive mammals. *New Zealand Journal of Ecology, 41*(1), 1–12.

Parliamentary Commissioner for the Environment. (2011). *Evaluating the use of 1080: Predators, poisons and silent forests*. Parliamentary Commissioner for the Environment.

Reardon, J. T., Whitmore, N., Holmes, K. M., Judd, L. M., Mackenzie, D. I., Norbury, G., & Thorne, D. (2012). Predator control allows critically endangered lizards to recover on mainland New Zealand. *New Zealand Journal of Ecology, 36*(2), 141–150.

Recio, M. R., Mathieu, R., Latham, M. C., & Seddon, P. J. (2016). Recolonisation of urban forests by native birds following predator management. *Biological Conservation, 201*, 350–358.

Ruffell, J., Didham, R. K., & Barrett, P. (2018). Ecological spill-over effects from predator-free sanctuaries. *Biological Conservation, 220*, 1–9.

Russell, J. C., Innes, J. G., Brown, P. H., & Byrom, A. E. (2015). Predator-Free New Zealand: Conservation country. *BioScience, 65*(5), 520–525.

Scofield, R. P., Cullen, R., & Wang, M. (2011). Are predator-proof fences the answer to New Zealand's terrestrial conservation challenges? *New Zealand Journal of Ecology, 35*(3), 312–317.

Tanentzap, A. J., & Lloyd, K. M. (2017). Fenced sanctuaries increase regeneration of bird-dispersed tree species beyond their boundaries. *Conservation Biology, 31*(2), 364–372.

Towns, D. R. (1991). Response of lizard populations to eradication of Pacific rats from islands in northern New Zealand. *Journal of the Royal Society of New Zealand, 21*(2), 119–136.

Towns, D. R. (2002). Interactions between geckos, honeydew scale insects and introduced mammals in northern New Zealand. *Journal of the Royal Society of New Zealand, 32*(2), 321–335.

Towns, D. R., Parrish, G. R., Tyrrell, C. L., Ussher, G. T., Cree, A., Newman, D. G., Whitaker, A. H., & Westbrooke, I. (2003). Responses of lizard assemblages following eradication of introduced rats from New Zealand islands. *Conservation Biology, 17*(4), 1021–1036.

Towns, D. R., Daugherty, C. H., & Atkinson, I. A. E. (2006). Have the harmful effects of introduced rats on islands been exaggerated? *Biological Invasions, 8*(4), 863–891.

Turner, J., & Norbury, G. (2023). Predator exclusion and recovery of dryland lizard communities in Central Otago. *New Zealand Journal of Ecology, 47*(2).

Whitaker, A. H. (1978). The effects of rodents on reptiles and amphibians. In P. R. Dingwall, I. A. E. Atkinson, & C. Hay (Eds.), *The ecology and control of rodents in New Zealand nature reserves* (pp. 75–86). Department of Lands and Survey.

Appendix E
Vegetation BOAM Data

1 Dry shrubland plant species heights

Data from Location: near Flat Top Hill Conservation Area (Source: Craig Wilson, Whirika)

Table E-1. Dry shrubland average plant heights from vegetation plots, as used in BOAM models.

Species	Age class	Age (yrs) mid	Site(s)	No. of plants	Average height (m)	Average growth (cm/year)
Olearia lineata	14–16	15	FTH Roadside	4	3.08	18.5
Olearia lineata	16–17	17	FTH Gully	6	1.98	9.9
Olearia fimbriata	14–16	15	FTH Roadside	6	2.68	15.9
Olearia fimbriata	16–17	17	FTH Gully	3	2.40	12.4
Olearia fimbriata	17–19	18	FTH River DS	2	3.25	16.4
Olearia odorata	14–16	15	FTH Roadside	6	2.27	13.1
Olearia odorata	16–17	17	FTH Gully	6	1.45	6.8
Olearia odorata	17–19	18	FTH River DS, FTH River US	8	1.93	9.0
Sophora microphylla	16–17	17	FTH Gully	4	1.68	8.1
Weighted Average	-	***16.5***		-	***2.19***	***11.6***

Weighted average for age class depending on the number of spp.

Table E-2. Dry shrubland plant heights: raw data.

Species	Age class	Age mid	Site	Height (m)	cm/year	Average height for species + age class (m)
Olearia lineata	14–16	15	FTH Roadside	2.0	11.3	3.08
Olearia lineata	14–16	15	FTH Roadside	3.6	22.0	3.08
Olearia lineata	14–16	15	FTH Roadside	3.7	22.7	3.08
Olearia lineata	14–16	15	FTH Roadside	3.0	18.0	3.08
Olearia lineata	16–17	17	FTH Gully	1.9	9.4	1.98
Olearia lineata	16–17	17	FTH Gully	1.9	9.4	1.98
Olearia lineata	16–17	17	FTH Gully	1.8	8.8	1.98
Olearia lineata	16–17	17	FTH Gully	1.5	7.1	1.98
Olearia lineata	16–17	17	FTH Gully	2.3	11.8	1.98
Olearia lineata	16–17	17	FTH Gully	2.5	12.9	1.98
Olearia fimbriata	14–16	15	FTH Roadside	1.6	8.7	2.68
Olearia fimbriata	14–16	15	FTH Roadside	3.4	20.7	2.68
Olearia fimbriata	14–16	15	FTH Roadside	2.4	14.0	2.68
Olearia fimbriata	14–16	15	FTH Roadside	2.6	15.3	2.68
Olearia fimbriata	14–16	15	FTH Roadside	3.2	19.3	2.68
Olearia fimbriata	14–16	15	FTH Roadside	2.9	17.3	2.68
Olearia fimbriata	16–17	17	FTH Gully	2.5	12.9	2.40
Olearia fimbriata	16–17	17	FTH Gully	2.0	10.0	2.40
Olearia fimbriata	16–17	17	FTH Gully	2.7	14.1	2.40
Olearia fimbriata	17–19	18	FTH River DS	3.5	17.8	3.25
Olearia fimbriata	17–19	18	FTH River DS	3.0	15.0	3.25
Olearia odorata	14–16	15	FTH Roadside	2.5	14.7	2.27
Olearia odorata	14–16	15	FTH Roadside	1.8	10.0	2.27

Olearia odorata	14–16	15	FTH Roadside	1.2	6.0	2.27
Olearia odorata	14–16	15	FTH Roadside	1.7	9.3	2.27
Olearia odorata	14–16	15	FTH Roadside	2.9	17.3	2.27
Olearia odorata	14–16	15	FTH Roadside	3.5	21.3	2.27
Olearia odorata	16–17	17	FTH Gully	1.9	9.4	1.45
Olearia odorata	16–17	17	FTH Gully	1.8	8.8	1.45
Olearia odorata	16–17	17	FTH Gully	0.9	3.5	1.45
Olearia odorata	16–17	17	FTH Gully	1.1	4.7	1.45
Olearia odorata	16–17	17	FTH Gully	0.9	3.5	1.45
Olearia odorata	16–17	17	FTH Gully	2.1	10.6	1.45
Olearia odorata	17–19	18	FTH River DS	1.6	7.2	1.93
Olearia odorata	17–19	18	FTH River DS	1.2	5.0	1.93
Olearia odorata	17–19	18	FTH River DS	2.0	9.4	1.93
Olearia odorata	17–19	18	FTH River DS	1.3	5.6	1.93
Olearia odorata	17–19	18	FTH River US	2.3	11.1	1.93
Olearia odorata	17–19	18	FTH River US	2.3	11.1	1.93
Olearia odorata	17–19	18	FTH River US	2.5	12.2	1.93
Olearia odorata	17–19	18	FTH River US	2.2	10.6	1.93
Sophora microphylla	16–17	17	FTH Gully	1.7	8.2	1.68
Sophora microphylla	16–17	17	FTH Gully	1.1	4.7	1.68
Sophora microphylla	16–17	17	FTH Gully	2.3	11.8	1.68
Sophora microphylla	16–17	17	FTH Gully	1.6	7.6	1.68

2 Tussock plant data

Table E-3. Table of heights and widths of known age snow tussock plants.

Image	Location	Setting	Age (Years)	Height (m)	Width (m)
	Golden Bar WRS	self-seeded on grazed and completed rehab bank	c. 20	1.5	2.0
	Golden Bar WRS	self-seeded on grazed and completed rehab bank	c. 20	1.5	1.6
	Golden Bar WRS	self-seeded on grazed and completed rehab bank	c. 20	2.0	1.5
	Golden Bar WRS	self-seeded on grazed and completed rehab bank	c. 20	1.1	1.5

	Golden Bar WRS	self-seeded on grazed and completed rehab bank	c. 20	0.70	0.90
	Macraes Village	Planted, ungrazed	c. 20	1.7	2.9
	Macraes Village	Planted, ungrazed	c. 20	1.9	3.5
	Macraes Village artwork	Planted, ungrazed	c. 20	1.2	1.4

3 Summary Plot Data

Table E-4. Snow tussock summary data for all vegetation plots. Green shaded cells are applied to the model as benchmarks

Site	Plot number	% cover	Av canopy height (m)	Indigenous spp.Richness	Total Species	% Indigenous spp	TAR plant richness
Murphys	1	9.1		5	14	35.7	0
	2	11.3		5	13	38.5	0
	3	16.3		10	18	55.6	1
	4	19.7		4	10	40.0	0
	5	61.0	70	10			1 (regional)
	6	91.4		11	18	61.1	0
Average for Murphys							
Golden Bar	1	95%	110	14	25	56	1
	2	20.3	80	1	14	7.1	0
	3	98.0	110	2	7	28.6	0
	4	80.0	130	2	12	16.7	0
	5	40.0	110	5	13	38.5	0
	6	23.2	95	2	12	16.7	0
	7	46.7	94	2	7	28.6	1
	8	39.6	120	1	9	11.1	0
	9	45	80	14			1
	10	40	85	4	15	26.7	0
Average for Golden Bar		**43.37**	**101.40**	**4.70**		**25.53981821**	**0**
Central	1	85	155	13	28	46.4	2
	2	77	80	9	21	42.9	1
Average for Central		**81**	**117.5**	**11**		**44.64285714**	
Coronation	1	45	85	5	13	38.5	0

	2	65	80	3	11	27.3	0
	3	99	170	4	9	44.4	0
	4	65	75	12	22	54.5	0
	5	50	90	12	23	52.2	0
Coronation- Waste Rock Stack	6	85	75	13	23	56.5	0
Coronation- Pit edge	7	40	65	14	24	58.3	0
Coronation	8	80	70	8	18	44.4	0
Coronation- Pit edge	9	95	95	13	22	59.1	1
Coronation	10	80	70	16	27	59.3	1
	11	30	110	3	13	23.1	0
Coronation- Pit edge	12	40	65	14	24	58.3	0
Coronation	13	30	80	4	13	30.8	0
	14	95	125	4	15	26.7	1
Average for Coronation		**64.21428571**	**89.64285714**	**8.928571429**		**45.24242263**	**1**
Weighted averages		**59.00650877**	**93.56348501**	**7.836827654**	**0**	**39.8856343**	

Table E-5. Dry Shrubland summary data for all vegetation plots.

Site	Plot Number	Shrub Species	% canopy cover	Av canopy height	Indigeneity	Exotic spp richness	% Indigenous spp	Total TAR spp
Coronation	271	*Discaria toumatou*	40	70	7	16	35	0
Coronation	274	*Discaria toumatou, Muehlenbeckia complexa, Coprosma propinqua*	45	60	8	16	33	0
Coronation	234	*Discaria toumatou, Muehlenbeckia complexa*	50	90	10	12	45	0
Average for Coroation			**45**	**70**	**8**	**16**	**35**	
Golden Bar	114	*Discaria toumatou, Muehelnbeckia complexa*	35	60	6	12	27	0
Golden Bar	BB_06	*Discaria toumatou*	92	170			7	1 (regional)
Average for Golden Bar			**63.5**	**115**	**6**			
Murphys	277	*Discaria toumatou, Muehlenbeckia complexa, Coprosma propinqua, Melicytus alpinus*	55	120	10	13	43	0
Murphys	279	*Discaria toumatou, Muehlenbeckia complexa, Coprosma propinqua, Melicytus alpinus, Rubus schmideliodes var. subpauperatus, Coprosma crassifolia*	70	90	8	7	57	0
Murphys	280	*Discaria toumatou, Muehlenbeckia complexa*	35	70	9	10	47	1
Murphys	281	*Discaria toumatou*	25	60	9	10	47	0
Murphys	236	*Discaria toumatou, Muehlenbeckia complexa*	8	60	9	13	39	1
Murphys	BB_09	*Discaria toumatou, Coprosma propinqua*	75	60			9	0
Murphys	BB_12	*Discaria toumatou, Ulex europaeus, Carmichaelia petriei*	12	40			12	1
Murphys	BB_13	*Discaria toumatou, Corpsma crassifolia, Melicytus alpinus*	78	150			8	0
Murphys	116	*Kunzea robusta, Discaria toumatou, Muehlenbeckia complexa, Melicytus alpinus*	94	200	9	11	45	
Murphys	118	*Discaria toumatou, Muehlenbeckia complexa, Melicytus alpinus*	60	110	16	22	45	0
Average for Murphys			**55**	**70**	**9**		**43**	

Cranky Jims	BB_01	*Discaria toumatou, Coprosma crassifloia, Coprosma propinqua, Helichrysum lanceolatum, Ollearia bullata, Melicytus alpinus*	47	160			15	1 (regional)
Cranky Jims	BB-02	*Discaria toumatou, Melicytus alpinus*	87	170			7	1
Cranky Jims	BB_03	*Discaria toumatou, Rosa rubiginosa, Cystus scoparius*	57	150			8	0
Cranky Jims	BB_04	*Discaria toumatou, Rosa rubiginosa, Carmichaelia petriei, Coprosma propinqua*	75	180			6	1
Cranky Jims	BB_05	*Discaria toumatou, Coprosma propinqua, Olearia bullata, Melicytus alpinus*	91	220			11	1 (regional)

Appendix F

Bird Lists and Shrubland Bird Benchmark list

Species (English | Māori)	Latin Name	National Threat Status	Regional Threat Status	ABM	5MBC	Anecdotal
Species recorded in Cranky Jims (2025-2026 surveys)						
Bellbird | Korimako	*Anthornis melanura*	Not threatened	Not threatened	✓	✓	
Brown Creeper | Pīpipi	*Mohoua novaeseelandiae*	**Not Threatened**	**Regionally Declining**	✓		
Eastern Falcon | Kārearea	*Falco novaeseelandiae novaeseelandiae*	**Nationally Vulnerable**	**Regionally Vulnerable**		✓	✓
Grey Warbler | Riroriro	*Gerygone igata*	Not threatened	Not threatened	✓	✓	
South Island Fantail | Pīwakawaka	*Rhipidura fuliginosa fuliginosa*	Not threatened	Not threatened	✓	✓	✓
Paradise Shelduck | Pūtangitangi	*Tadorna variegata*	Not threatened	Not threatened	✓		
Pied Stilt | Poaka	*Himantopus leucocephalus*	Not threatened	Not threatened	✓		
Silvereye | Tauhou	*Zosterops lateralis*	**Not Threatened**	**Regionally Declining**	✓	✓	✓
Shelduck, Paradise	*Tadorna variegata*	Not threatened	Not threatened		✓	
Spur-winged Plover	*Vanellus miles*	Not threatened	Not threatened	✓		
Tomtit | Miromiro	*Petroica macrocephala macrocephala*	Not threatened	Not threatened	✓		
Tūī	*Prosthemadera novaeseelandiae*	Not threatened	Not threatened	✓		
Benchmark - Species that may be present within shrubland, forest habitat within the Macraes ED (not recorded)						
Morepork | Ruru	*Ninox novaeseelandiae*	Not Threatened	**Regionally Vulnerable**			
Fernbird | Mātātā	*Poodytes punctatus*	**At Risk – Declining**	**At Risk – Declining**			
New Zealand pigeon |Kererū	*Hemiphaga novaeseelandiae*	Not Threatened	Regionally Not Threatened			
New Zealand pipit | Pīhoihoi	*Anthus novaeseelandiae*	**At Risk – Declining**	Regionally Not Threatened			
Rifleman | Tītitipounamu	*Acanthisitta chloris chloris*	Not Threatened	Regionally Not Threatened			
Red-crowned parakeet | Kākāriki	*Cyanoramphus novaezelandiae*	**At Risk – Relict**	**Regionally Critical**			
Sacred kingfisher | Kōtare	*Todiramphus sanctus*	Not Threatened	Regionally Not Threatened			
South Island kākā	*Nestor meridionalis meridionalis*	**Threatened - Vulnerable**	**Regionally Endangered**			
South Island tomtit | Miromiro	*Petroica macrocephala macrocephala*	Not Threatened	Regionally Not Threatened			
Swamp harrier | Kāhu	*Circus approximans*	Not Threatened	Regionally Not Threatened			
Yellow-crowned parakeet |Kākāriki	*Cyanoramphus auriceps*	**At Risk – Declining**	**Regionally Vulnerable**			

Appendix G

Applying the averted loss framework to Mt Highlay Station pine removal for lizards

1 Overview

The following section applies the method of Maseyk *et al.* (2021) to assess whether removing pine at the Mt Highlay Station site would generate a valid averted loss benefit for lizards.

The assessment applies the paper's decision tree to guide consistent, credible estimation of the likelihood of biodiversity loss under both the with-compensation and without-compensation (counterfactual) scenarios. This is considered a compensation measure rather than an offset, as it does not meet a like-for-like quantitative calculation.

At its simplest, the proposed averted loss action involves:

- Averting the loss of an area valuable for lizards, through covenanting the site; and
- Implementing management actions to enhance and improve lizard habitat values, through removal of plantation pine, revegetation planting, and stock-proof fencing.

Together, these actions are considered to avert the loss of lizard habitat and lizard populations at the site.

2 Assessment process

2.1 Identifying the threat

The identified threat is the maturation of pine plantation in an area supporting existing lizard values. By the time the trees have matured—over 16–26 years[4]—canopy closure will have shaded out the open, sun-exposed ground vegetation (Fahey & Watson 1991) and rock outcrop conditions that lizards currently rely on, likely driving lizards out of the area with declines in abundance of 75-80% or more. This is considered a genuine, foreseeable threat and would occur regardless of any compensation measures proposed under the MP4 Project development or development elsewhere on the site due to the pine being registered under the New Zealand Emissions Trading Scheme (ETS).

2.2 Identifying the type of impact

For the purpose of estimating likelihood of loss, impacts on biodiversity can be categorized into two types:

- **Type I** – Impacts are already regulated, i.e. losses would trigger an offset requirement under existing policy or legislation.
- **Type II** – Impacts are not covered by any policy or legislation requiring it to be offset elsewhere.

Foresty registered under the ETS, which involves pine plantation maturation and the associated canopy closure is not subject to a legislative or policy trigger requiring offset or compensation. This makes ETS forests a Type II impact, meaning it can legitimately be counted towards an averted loss estimate.

[4] Maturity, in this context, refers to the age at which average carbon stock is achieved (i.e., the age at which the forest stops earning credits and the trees can be felled). This age varies depending on the species of tree (i.e., 16 years for *Pinus radiata*, 26 years for Douglas Fir).

2.3 Estimating likelihood of biodiversity loss without action (counterfactual scenario)

This is the probability that lizard habitat would be severely degraded or lost if the pine trees are left to mature.

This degradation or loss—due to canopy closure and shading—is a highly predictable outcome of plantation growth, not a stochastic threat. There is high certainty in this because:

- The pine has already been planted three years ago.
- The pine has survived the establishment phase, with high survivorship (85%), and good growth (1–1.4 m tall) (Forest Management Ltd. 2025).
- The trees are registered in the ETS, and as an ETS participant, OGNZL must under law, regularly monitor and report to ensure compliance with the scheme. That is, there are financial and legal responsibilities to ensure the forest grows to maturity (carbon credit obligations). Removing the trees could affect carbon credit payments/ obligations, making it more certain that the trees will be left to mature and canopy closure occur.
- Canopy closure or near closure after 16–26 years is conservative assumption, considering canopy closure of *Pinus radiata* can be achieved in as little as 8 years in New Zealand, including in the Otago context (Fahey & Payne 2017, MPI 2018, Hughes & Dang 2026).
- There is empirical data to demonstrate that lizard populations are exceptionally less abundant (near absent) under pine compared to felled pine areas and under the natural state (Ahika 2021, Tweed & Thorsen 2021, Wildlands 2026).

Furthermore, under the ETS, radiata pines and Douglas Fir reach their average carbon stock and stop earning credits by 16 and 26 years, respectively[5]. At these ages, harvesting of the trees generally occurs followed by replanting. This rotational harvesting creates a cycle of ecological destruction that over the long-term would not provide long-term security of lizard habitat or populations within the forestry area. Indeed, harvesting will likely cause irreplaceable damage to some habitat features such as rock outcrops.

Considering the above, the likelihood of biodiversity loss without action (counterfactual scenario) can reasonably be estimated as very high (approaching certainty) by Year 26 (i.e., the age at which Douglas Fir reaches its average carbon stock, noting the radiata pine would reach this stage a decade earlier).

Using the flow chart for determining future likelihood of loss under a counterfactual scenario (Figure G.), Pathway C—"*likelihood of loss is greater than the recent past rate of loss as there are no mechanisms in place to reduce it*" applies.

[5] https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/deforesting-and-the-ets/applying-to-plant-forest-to-offset-emissions-when-removing-post-1989-forest-land-from-the-ets. Accessed 27/07/2026.

2.4 Estimating likelihood of loss with the action

This is the probability of lizard habitat loss if the pine is removed before canopy closure occurs.

Removing the trees at Year 4 (while still small and before shading effects have begun) effectively prevents the shading process from occurring. Provided removal is complete and the site is not replanted, the likelihood of loss under a compensation scenario can be estimated at close to 0%.

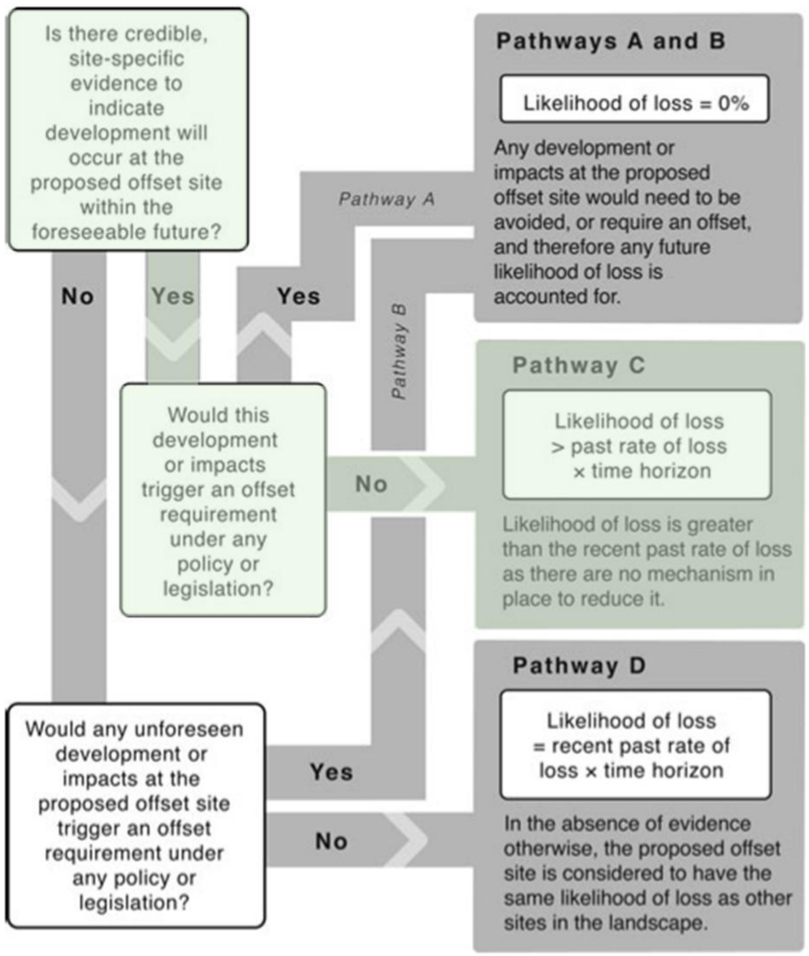
Using the flow chart for determining future likelihood of loss under the compensation scenario (Figure G.), Pathway B—"*Any potential future development at the proposed compensation site would be prevented*" applies.

2.5 Defining the time horizon

The benefit period is considered to align with the timeframe over which the threat would otherwise materialise—i.e. 16–26 years, corresponding to the expected canopy closure age for different trees. For the purposes of this assessment, the defined time horizon is set at 26 years, reflecting the later age of maturity in Douglas Fir.

3 Summary

Since the probability of loss without the compensation action (i.e., the counterfactual scenario—tree maturation) is a magnitude higher than the probability of loss with the compensation action (i.e., the compensation scenario—removal of the trees), there is high certainty that the anticipated tangible gains for lizards will be achieved through an averted loss approach.



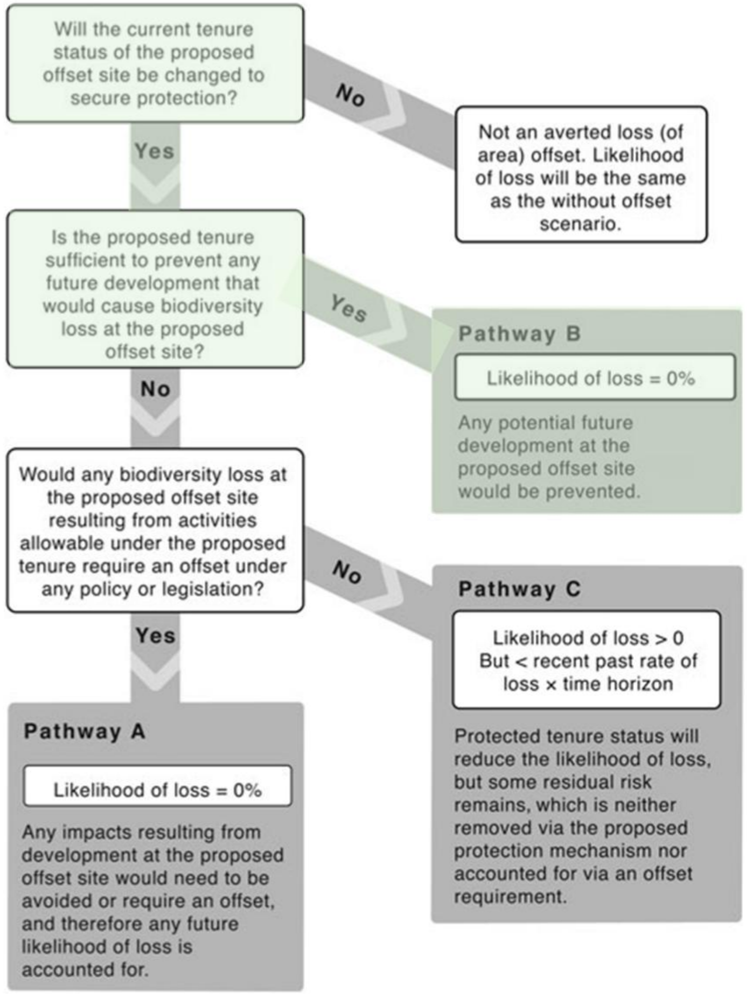


Figure G.1. Process for determining future likelihood of loss (total loss of area) under a counterfactual scenario. The time horizon is the period over which the outcome of the offset is being calculated (e.g. benefit achieved at 26 years). Pathway that applies to the current project is highlighted in green. Adapted from Maseyk *et al.* (2021).

Figure G.2. A process for determining future likelihood of loss (total loss of area) under an offset scenario. The time horizon is the period over which the outcome of the offset is being calculated (e.g. benefit achieved at 26 years). Pathway that applies to the current project is highlighted in green. Adapted from Maseyk *et al.* (2021).

Auckland

Address | Level 4, 68 Beach Road, Auckland 1010
Post | PO Box 2027, Shortland Street, Auckland 1140, New Zealand
Ph | 64 9 379 9980
Fax | +64 9 377 1170
Email | contact-us@babbage.co.nz

Hamilton

Address | Unit 1, 85 Church Road, Pukete, Hamilton 3200
Post | PO Box 20068, Te Rapa, Hamilton 3241, New Zealand
Ph | +64 7 850 7010
Fax | +64 9 377 1170
Email | contact-us@babbage.co.nz

Christchurch

Address | 128 Montreal Street, Sydenham, Christchurch 8023
Post | PO Box 2373, Christchurch 8140, New Zealand
Ph | +64 3 379 2734
Fax | +64 3 379 1642
Email | solutions@babbage.co.nz

Babbage Consultants Australia Pty Ltd – Australia

Address | Suite 4, Level 2, 1 Yarra Street, Geelong,
Victoria 3220, Australia
Ph | +61 3 8539 4805
Email | contact-us@babbage.co.nz

www.bioresearches.co.nz
www.babbage.co.nz
www.babbageconsultants.com.au