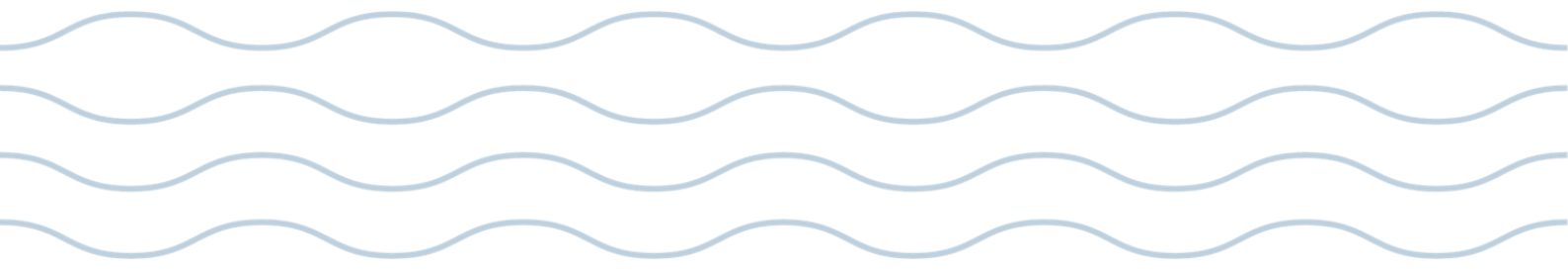


Bendigo-Ophir Gold Project

Terrestrial Invertebrate Survey



September 2025



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Abbreviation List

Abbreviation	Term	Meaning
ANOVA	Analysis of Variance	Statistical test that analyses the variance both between two or more groups, and within them, in order to compare their means
AEE	Assessment of Environmental Effects	Report that will be informed by the surveys completed by Habitat NZ Ltd and other relevant ecology companies.
BOGP	Bendigo-Ophir Gold Project	Is the topic of the resource consent application for which this survey has been completed.
CIT	Come-In-Time	Area of land with gold resource containing a Mineral Resource Estimation (MRE) (2021) of 59,000oz of gold at a grade of 1.5g/t
DOC	Department of Conservation	New Zealand government agency charged with conserving natural and historic heritage within the country
DDF	Direct Disturbance Footprint	550ha area of land within the BOGP study area covering gold mining and ancillary activity areas that cause direct habitat loss. Includes a 150m buffer.
ESA	Ecological Study Area	5,000ha area of land composed of a mix of grazing lands, leasehold Crown land, and Crown land, with the BOGP sits. For the purpose of the reports, the ESA is divided into two zones, being the Direct Disturbance Footprint (DDF) and Surrounding Landscape (SL) areas
ELF	Engineered Landform	Overburden rock stack where rock is placed, engineered to achieve geochemical outcome.
eDNA	Environmental DNA	Emerging technique that analyses the genomic make-up of a sample (e.g. water, sediment, animal gut) to see what organisms may have been present
EPA	Environmental Protection Authority	New Zealand government agency responsible for regulating activities within the country that affect the environment
GLMM	Generalised linear mixed model	Model that uses random effects as well as fixed effects. It accounts for variation within groups, and allows a dependent variable with a non-normal distribution
GIS	Geographic Information System	Computer based tool that connects spatial information and data about locations to the location
MGL	Matakanui Gold Limited	New Zealand company wholly owned subsidiary of Santana Minerals Ltd
MRE	Mineral Resource Estimation	Evaluation estimating the grade and tonnage of an ore in a deposit
NZTCS	New Zealand Threat Classification System	System used within New Zealand to assess the conservation status of species
NMDS	Non-metric multidimensional scaling	Distance-based ordination technique that visualises the level of similarity between sites, in reduced dimensions
PERMANOVA	Permutational Multivariate Analysis of Variance	Statistical test for data with multiple variables, that reshuffles and repeats, in order to compare the variation between groups, to that within groups

Abbreviation	Term	Meaning
RM sites	Representative monitoring sites	Sites selected using a stratified random approach
RMA	Resource Management Act	Resource Management Act 1991
RAS	Rise and Shine	Area of land with gold resource containing a MRE (2024) of 2,217,000oz of gold at a grade of 2.3g/t
SRX	Srex	Area of land with gold resource containing a MRE (2021) of 174,000oz of gold at a grade of 1.1g/t
SRE	Srex East	Area of land with gold resource containing a MRE (2021) of 11,000oz of gold at a grade of 1.3g/t
SE	Standard error	Estimate of the difference between the sample mean and population mean
SL	Surrounding Landscape	Area within the ESA that is not part of the DDF. Provides the ecological context to the BOGP area.
TSF	Tailings Storage Facility	Engineered structures designed and constructed to hold mineral waste (tailings) generated after the gold has been recovered at the processing plant.
TM sites	Targeted monitoring sites	Sites where high invertebrate species richness/ diversity was considered likely, based on the qualities of the habitat

Executive Summary

This document presents a comprehensive invertebrate survey throughout the Bendigo Ophir Gold Project (BOGP) Ecological Study Area (ESA), which will inform the project's Assessment of Environmental Effects (AEE). It establishes a comprehensive baseline of the terrestrial invertebrate communities within the ESA. Results demonstrate the area's invertebrate biodiversity and emphasise the importance of thoughtfully addressing potential consequences of planned mining operations. The information contained herein informs the AEE and will guide the implementation of an effective terrestrial invertebrate management framework at the site.

Background

Matakanui Gold Limited (MGL) is proposing to establish the BOGP, which comprises a new gold mine, ancillary facilities, and environmental mitigation measures for Bendigo and Ardour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The BOGP involves mining four identified gold deposits referred to as Rise and Shine (RAS), Come in Time (CIT), Srex ("SRX") and Srex East ("SRE"). The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in Shepherds Valley – which includes a conventional gold processing plant and water treatment plant, a tailing storing facility, two engineered landforms, internal haul roads, topsoil stockpiles, water pipelines, underground utilities and electrical supply with non-operational infrastructure located on the adjoining Ardour Terrace. The BOGP also involves taking groundwater from the Bendigo Aquifer for mining-related activities and the realignment of Thomson Gorge Road via Ardour Station.

Habitat NZ Ltd conducted a comprehensive invertebrate survey across the ecological study area (ESA) to inform the project's AEE. The ESA spans approximately 5,000 hectares, comprising two zones being the Direct Disturbance Footprint (DDF) and the Surrounding Landscape (SL). The survey aimed to assess terrestrial invertebrate presence, richness, diversity, and community composition across the ESA. Various methods were employed, including light trapping, pitfall trapping, foliage beating, wooden discs, and manual searches. These were conducted over two field seasons (2023/2024 and 2024/2025).

Key Findings

- **Invertebrate Diversity and Abundance:** A total of 29,565 invertebrate specimens were collected during field surveys, representing at least 119 families across 25 orders. 222 native species and 29 introduced species were identified, with the remaining taxa being indeterminate at the species level.
- **Notable Species:** 18 notable species were identified, including moths (Lepidoptera), grasshoppers (Orthoptera), beetles and weevils (Coleoptera). These were comprised of:
 - Four 'Threatened' species of moth (one 'Nationally Critical', one 'Nationally Endangered' and two 'Nationally Vulnerable')
 - Four new species: one species of weevil and three species of ground beetles
 - Nine 'At Risk' species: eight moth species (six 'Declining' and two 'Uncommon') and one 'Declining' species of grasshopper.
 - One unassessed species of moth thought to be of conservation importance.

Of the above species, only one was found exclusively within the DDF. This was the 'At Risk – Declining' grasshopper, *Phaulacridium otagoense*, represented by 15 specimens found at six sites throughout the DDF.

- **Invertebrate communities:** The overall community structure and diversity were similar between the DDF and the SL. Targeted monitoring sites (TM sites) showed richer and more diverse invertebrate populations than representative survey sites (RM sites).
- **Seasonal Variations:** Significant seasonal variations were observed for moth communities, with higher species richness and abundance recorded in late summer compared to early summer.
- **Patchiness:** Invertebrate distributions were uneven, with variations in abundance and diversity seen between sampling sites.
- **Specific associations between notable species and specific host species:** Several notable species have specialised plant relationships, such as the threatened *Pseudocoremia cineracia* moth, which is closely associated with *Olearia odorata*, and a potential new Curculionidae species, which is thought to be closely associated with *Taramea*. The specific host-plant of the critically endangered moth *Sporophyla oenospora* remains unknown.
- **Broad habitat types are poor predictors of invertebrate communities across the ESA:** Broad habitat types did not significantly affect invertebrate diversity. Native scrubland and shrubland had more distinct invertebrate communities, suggesting unique conditions or data variability for these habitats.
- **Importance of differing survey techniques:** No single monitoring method captured all invertebrate communities, but the combined techniques covered most major invertebrate groups.

Conclusions

The invertebrate survey provides a detailed baseline of the terrestrial invertebrate community within the ESA. The findings highlight the terrestrial invertebrate diversity of the area and the need for careful consideration of potential impacts from proposed mining activities. Data within this report informs the AEE and will support the development of an effective terrestrial invertebrate management regime at the site.

1 Introduction

1.1 Bendigo-Ophir Gold Project

Matakanui Gold Limited (MGL) is proposing to establish the Bendigo-Ophir Gold Project (BOGP), which comprises a new gold mine, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell.

The BOGP is located within the footprint of Minerals Exploration Permit 60311, which is held by MGL under the Crown Minerals Act 1991. MGL also has land access agreements with Bendigo and Ardgour Stations. The BOGP is located adjacent to land administered by the Department of Conservation (DOC), including the Bendigo Historic Reserve, the Bendigo Conservation Area and the Ardgour Conservation Area.

The BOGP involves mining four identified gold deposits named Rise and Shine (RAS), Come in Time (CIT), Srex (SRX) and Srex East (SRE). The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley, with an additional general and administration area located on the adjoining Ardgour Terrace.

Figure 1 below provides an overview of the footprint associated with the establishment, operation and rehabilitation of the BOGP, which includes a maximum disturbance footprint of 550 hectares.

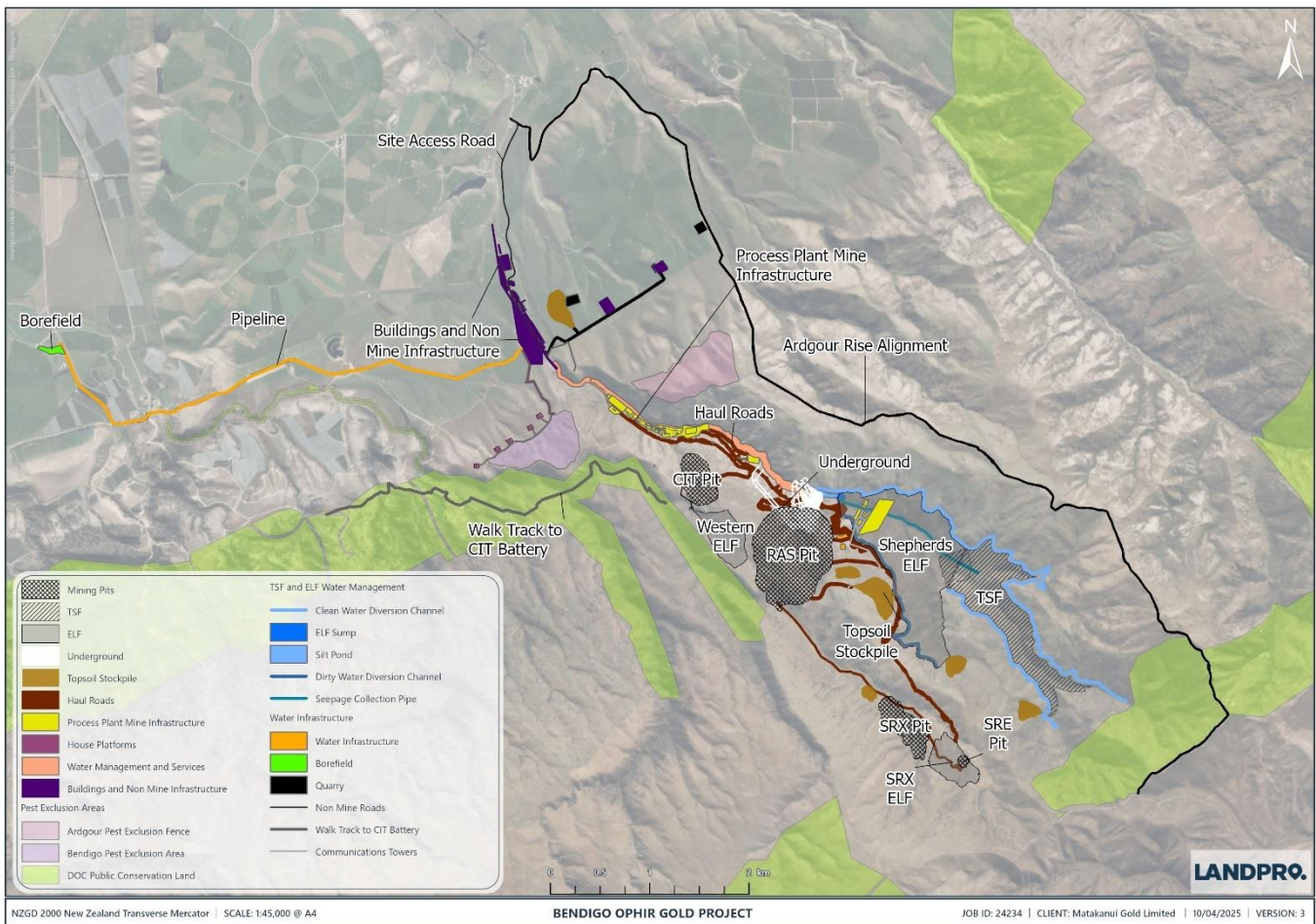


Figure 1. Overview site layout of the Bendigo-Ophir Gold Project (BOGP)

A full description of the various activities comprising the establishment, operation and rehabilitation of the BOGP is provided in the Assessment of Environmental Effects (AEE) prepared by Mitchell Daysh Limited, with the BOGP including the following components:

- The establishment of the RAS Open Pit and Underground Mine and SRX Open Pit, which will be rehabilitated to pit lakes at closure
- The establishment of the CIT Open Pit, which will be progressively backfilled with waste rock from the RAS Open Pit and rehabilitated to native herb fields (to integrate with the surrounding area) at the completion of mining activities
- The establishment of the SRE Open Pit, which will be progressively rehabilitated with waste rock before becoming an engineered landform for the adjoining SRX Open Pit ("SRX ELF")
- A conventional hard rock gold processing plant and water treatment plant in the lower reach of Shepherds Valley, along with associated processing infrastructure and ancillary activities, including mine offices, carparking, workshops and equipment servicing infrastructure, a goods warehouse and a fuel depot. The establishment of this mining operations area will also include the realignment of Shepherds Creek
- The establishment of a water storage tank near to the processing plant
- The establishment of a Tailings Storage Facility ("TSF") in the upper reach of Shepherds Valley (including clean water diversion drains), which will utilise waste rock from mining activities within the project site

- The establishment of engineered landforms in the Shepherds Valley (“Shepherds ELF”) and Rise and Shine Valley (“SRX ELF”) to permanently store overburden waste rock
- The establishment of temporary and permanent topsoil stockpiles and biological rehabilitation resource storage areas around the project site
- The taking of groundwater from the Bendigo Aquifer for use in mining-related activities, which will be conveyed to the processing plant via a pipeline over a distance of approximately 6.5 km
- The establishment of supporting infrastructure / activities within the project site, such as the upgrade of Ardgour Road and the extension of Thomson Gorge Road to provide improved access to the BOGP, internal mine access and haul roads, water pipelines and underground utilities, and electricity supply to the project site from Lindis Crossing via a new 66kV overhead powerline that will follow the existing road reserve corridor
- The realignment of Thomson Gorge Road, via Ardgour Station, to provide public access through to the Manuherikia Valley
- Main explosives magazines and emulsion mixing facilities (located outside the project site on Ardgour Station)
- The establishment of non-operational infrastructure associated with the BOGP on the Ardgour Terrace, including an administration office, high voltage substation and temporary construction workers accommodation
- The establishment of a construction and demolition landfill within the Shepherds ELF.

1.2 Report purpose and scope

MGL commissioned a suite of ecological studies to inform the AEE for the BOGP. Habitat NZ Ltd was engaged to assess terrestrial invertebrates across the Ecological Study Area (ESA) which encompasses the BOGP area and surrounding landscapes (see section 2).

This report describes the results of terrestrial invertebrate surveys across the ESA undertaken through the 2023/2024 and 2024/2025 field seasons. It describes:

- Terrestrial invertebrate survey design
- Data collection and analysis methods
- Results and findings of terrestrial invertebrate presence, richness, diversity and abundance
- Comparisons of terrestrial invertebrate community composition between different survey zones
- Details of notable species.

This information will help identify at-risk, threatened, or ecologically significant invertebrate species in the ESA and describe the general invertebrate community across the BOGP area and surrounds. It serves as a basis to evaluate the potential adverse impacts of the BOGP on terrestrial invertebrates in the AEE.

1.3 Terrestrial invertebrates in New Zealand and Otago

Invertebrates perform many roles within ecosystems, playing a key role in shaping plant communities through pollination (>80% done by insects), pest control, wildlife nutrition, and decomposition of plant and animal material (Losey and Vaughan 2006) (Patrick 1988) (IPBES, 2016).

New Zealand has one of the top three most endemic invertebrate populations for a discrete area in the world, with at least 90% of our invertebrates being endemic to New Zealand (Dugdale 1988). There are an estimated 20,000 known invertebrate species in New Zealand, with less than 2% of these being introduced species (Patrick 1994). Some New Zealand invertebrate taxa, such as Lepidoptera (moths and butterflies), particularly stand out for their high levels of endemic species and distinctive characteristics (Dugdale 1988).

The Otago Conservancy area is thought to have 60% of New Zealand's invertebrates within it (Patrick 1994). With 404 invertebrate taxa considered regionally endemic to Otago as of July 2025 (Jarvie 2025). Semi-natural areas with a mix of exotic and native habitats, which are plentiful across Central Otago, are often just as important for invertebrate conservation as fully natural areas (Patrick 1994).

New Zealand's alpine fauna tends to be richer in diversity than the lowlands. In Otago, the mountains hold a diverse range of endemic day-flying Lepidoptera (moths) that require highly specific plant species to feed on (Patrick 1994).

2 Ecological study area

The ESA covers approximately 5,000ha of Bendigo and Ardgour stations with a discontinuous area in the southwest, as shown in Figure 2.

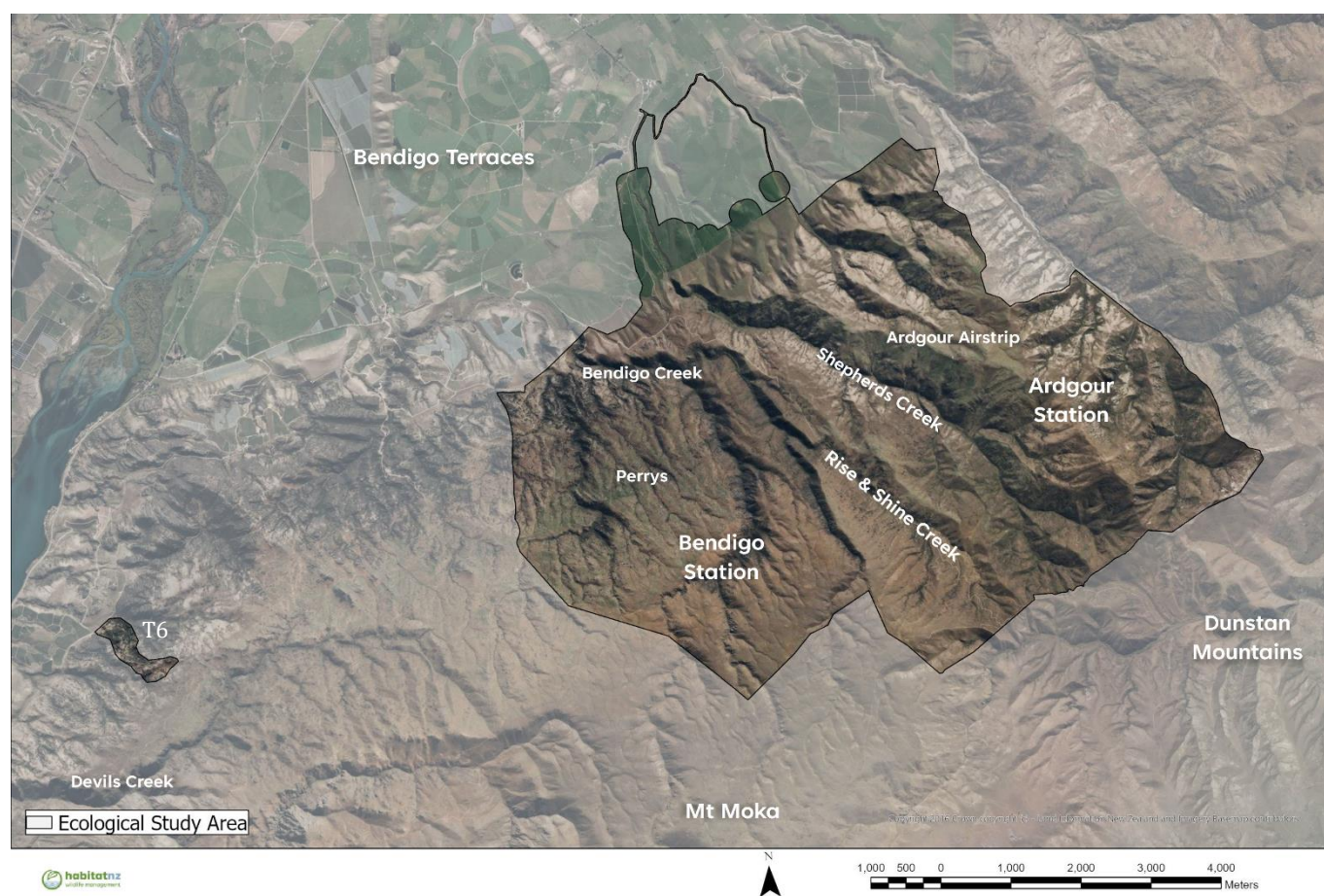


Figure 2. Ecological Study Area (ESA) with key locations for the Bendigo-Ophir Gold Project

After project refinement, a 550ha Direct Disturbance Footprint (DDF) zone for the BOGP was determined, excluding buffers. The DDF covers gold mining and ancillary activity areas that cause direct habitat loss. Subsequently, the ESA is divided into two survey zones for the purpose of considering the results of this terrestrial invertebrate survey (Figure 3):

- Direct Disturbance Footprint (DDF) zone with the addition of a 150-meter buffer to allow for potential effects on invertebrates beyond the boundary of mining activities. For the purposes of this survey the footprint and buffer (inclusively) are termed the DDF
- Surrounding Landscape (SL) zone being the balance of the ESA land outside the area of the DDF. The SL zone includes the discontinuous area (T6) to the southwest and provides the ecological context within which the BOGP sits.

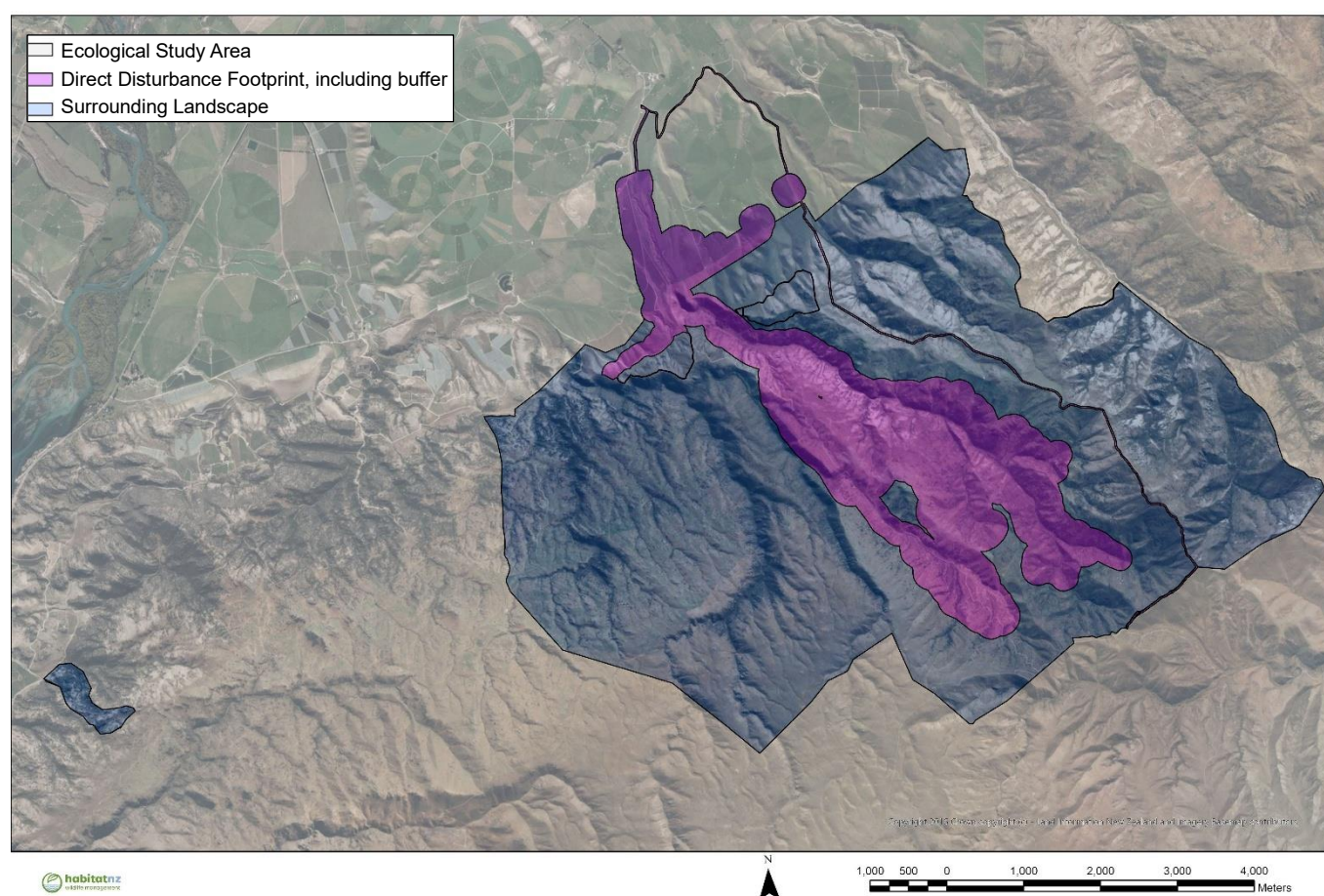


Figure 3. Bendigo-Ophir Gold Project Direct Disturbance Footprint zone and Surrounding Landscape zone.

The ESA is dominated by existing sheep and beef grazing lands and includes a mix of semi-arid private grazing land, leasehold Crown land, and Crown land administered by the Department of Conservation (DOC). It has moderate topography, with hills rising from the Bendigo terraces at 370 mRL in the west to approximately 1,200 mRL on the face of Mt Moka in the east. There is a diverse range of habitats for terrestrial invertebrates with vegetation across most of the area being grey scrub, tussock, and other low-growing vegetation. For a full description of vegetation and habitat see the Bendigo-Ophir Gold Project: Vegetation Values Assessment (RMA Ecology Ltd. 2025a). The site also contains wetlands and streams, details of which can be found in the Bendigo-Ophir Gold Project: Wetland Values Assessment (RMA Ecology Ltd. 2025b).

3 Methods

The following sections describe the design, methodology and timings for terrestrial invertebrate field surveys across the ESA, and the desktop assessment to compliment findings and assess nearby ecological context.

3.1 Desktop assessment

Records and observations of terrestrial invertebrates were pulled from the Global Biodiversity Information Facility (GBIF) system; an open access international network and data infrastructure used to collate records across various platforms. Records within the Dunstan Mountain were included in the search and included information from the following sources¹:

- iNaturalist Research-grade Observations
- Natural History Museum (London) Collection Specimens
- International Barcode of Life project (iBOL)
- Estonian University of Life Sciences Institute of Agricultural and Environmental Sciences Entomological Collection
- Santa Barbara Museum of Natural History - Invertebrate Zoology
- Hegg et al. (2022) revision of cave wetā genus
- Hegg et al. (2019) diversity and distribution of cave wetā
- Auckland Museum Entomology Collection
- New Zealand Arthropod Collection - Symbiota
- Bee Biology and Systematics Laboratory
- New Zealand Arthropod Collection (NZAC)
- INSDC Sequences

Non-terrestrial invertebrates, such as freshwater mayflies, were not included in the search parameters.

3.2 Field survey design

Sites selected for terrestrial invertebrate surveys included:

- Representative monitoring sites (RM sites) selected using a stratified random approach to ensure spatial representativeness across the ESA
- Targeted monitoring sites (TM sites) where high invertebrate species richness/ diversity was considered likely based on habitat values/quality
- Targeted ad hoc locations that were under-represented or more likely to include target species.

The RM sites and TM sites (Figure 4) were also used to assess other biodiversity values as part of the broader ecological survey programme for the BOGP. Each of these site selection processes are discussed below.

¹ GBIF.org (17 April 2024) GBIF Occurrence Download <https://doi.org/10.15468/dl.ytknff>



3.2.1 Representative monitoring sites (RM sites)

The process for selecting terrestrial invertebrate survey sites was informed by the initial BOGP study area at the time of study design. The following factors were considered when selecting these primary ecological survey locations across the ESA:

- The balance of surveying effort between land within the initial BOGP study area and the SL, with the BOGP study area receiving higher weighting for survey effort (per unit area)
- Requirements of other ecological surveys for the AEE (e.g. lizard surveys, vegetation surveys)
- Safety of access (e.g. inaccessible, steep, unstable ground).

Locations for the RM sites were randomly selected using the following process:

- A grid measuring 800m x 800m was overlaid across the ESA using GIS, and the centroid of each grid was determined
- The centroids of 24 grids were randomly chosen as RM sites; 12 within the initial BOGP study area and 12 within the SL. This weighted survey effort in favour of the area likely to be impacted by the BOGP, given its smaller size.

The 24 chosen RM sites were further refined after on-ground assessments of terrain, access and representative features. Two RM sites were removed after considering logistical achievability (time, distance, resources, safety). Another was removed due to cattle frequenting the site and interfering with monitoring equipment. A fourth location was removed from the wider programme after one light trapping survey had been undertaken. Terrestrial invertebrate surveys were carried out at the remaining 20 RM sites.

After most field studies had been completed, and before final analysis of data, the refined DDF was identified from within the initial BOGP study area. This resulted in a final balance of:

- 11 RM sites within the DDF
- 9 RM sites in the SL
- One additional RM site in the SL (site 12) where only light trapping was undertaken.

The randomised RM sites provided thorough coverage of the ESA. Centroids of the site locations are shown in Figure 4.

3.2.2 Targeted Monitoring sites (TM sites)

High-quality habitat locations were identified following a preliminary site assessment and were chosen to represent areas that would likely hold the highest ecological values across the ESA. In addition to the 20 randomly selected RM sites, six high-quality habitat areas were identified: three from each of the initial BOGP study area and the SL to give a balanced design. Terrestrial invertebrate surveys were undertaken along transects between 200 to 400m in length, located within each chosen high-value habitat area (Figure 3).

3.2.3 Targeted hand collection sites

A variety of ad hoc sites, targeting key habitat and vegetation types, were also spot-checked for terrestrial invertebrates throughout the study. A select few locations were revisited for more intensive and systematic searches after initial findings of important species (see section 3.3.5 for details).

This approach minimises any gaps in understanding species presence, particularly for species that may be 'of concern' or hard to detect using other methods. Hand search locations included targeted searches of:

- Taramia (spaniard grass) for weevils
- Ardour Airstrip and similar habitats within the DDF for *Sporophyla oenospora*
- Flowering Viper's bugloss for bumblebees (*Bombus* spp.)
- Areas of Raoulia
- Areas of Vittidinia
- Rock and scree areas
- Areas of audible intense cicada activity, at 50-100m intervals while travelling along tracks when cicada were heard from the stationary vehicle
- Other sites of interest based on observation and feedback from field teams assessing other ecological aspects. This included collection of specimens from areas outside the ESA to use as comparisons for species identification and to gain an understanding of distribution across the wider landscape.

Ad hoc searches for *Inophloeus* were also conducted at the type locality on the Crown Range and Remarkables to compare with specimens collected in the ESA. Additional searches were undertaken on Mt Moka, outside the ESA, in response to an *Inophloeus* observation recorded on iNaturalist in November 2024. While not part of the specimen collection process, two additional *Inophloeus* species with similar characteristics to those collected in the ESA and Mt Moka were used for comparison purposes (see section 4.1.6, Coleoptera).

Further targeted searches were also conducted for *Sporophyla oenospora* outside of the single recorded location it was found during the survey. These additional searches focussed on areas within the DDF in presumably suitable habitat like the recorded location. Further details can be found within the Lepidoptera (moths and butterflies) in Section 4.1.6.

3.3 Data collection

The following techniques were implemented to collect samples of various terrestrial invertebrates throughout the ESA:

- Light trapping for moths and night-flying insects
- Pitfall traps for ground-dwelling invertebrates including beetles
- Bush beating for vegetation-dependent species that are unlikely to be trapped with light traps or pitfall traps
- Systematic manual searches for airborne species active during the daytime, and other insects that might be missed by other methods
- Wooden discs for ground-dwelling terrestrial invertebrates and longer-term monitoring
- Ad hoc manual searches for target species or across specific habitat types.

Malaise trapping was excluded as a method as it predominantly captures species such as Hymenoptera and Diptera, which are less studied and lack specialist taxonomists in New Zealand to interpret such surveys. Detailed descriptions of the selected techniques are provided below.

3.3.1 Light trapping

Overview

Light trapping is a technique used to monitor nocturnal insects that can be hard to observe because of their night-time activity (Sheikh *et al.* 2016). Light trapping is suitable for studying moths (Lepidoptera) but can also collect adult aquatic insects and other invertebrates such as beetles (Patrick 2016). It is an effective method for inventory as it can collect many samples with resource and cost efficiencies (Patrick 2016).

This technique employs a light source, often incorporating UV light, to intercept nocturnal invertebrates in flight. It's not that insects are attracted to the light itself; rather, the artificial illumination disorients their navigation and alters their flight trajectory (Fabian *et al.* 2024). Insects may be either hand collected from a white sheet laid out under the light source if the trapping is manually undertaken², or can be captured in a collection chamber if the light is unattended. Unattended light traps use transparent plastic vanes around the light source to direct circling insects through a funnel into a holding container. A power source and light sensor or timer enable automatic trap operation.

² Manual collection of samples using a light trap during this study is considered a method of hand collection

The effectiveness of light trapping is dependent on wind and weather conditions (Jonason *et al.* 2014), although the level of influence may vary between species (McGeachie 1989). The Department of Conservation's light trapping protocol suggests warm, humid nights with cloud cover, little wind, and no full moon as the ideal conditions (Patrick 2016). The timing of light trapping can also influence its outcomes, as various invertebrate species are active at different times of the year or throughout the night.

Surveys require standardisation to enable valid comparisons (Patrick 2016). There are many potential variables when light trapping, from abiotic conditions to the type, lux levels and hours of operation of the light traps. Using identical automatic light traps, set to operate simultaneously across multiple sites, provides comparable abiotic sampling conditions and minimises variability due to equipment.



Figure 5: Installed light trap at Centroid 11

Survey process

Light trapping was conducted following the Department of Conservation's best practice protocol for invertebrates (Patrick 2016). The traps utilised a 12-volt power supply and a light level sensor to automatically function within dusk-to-dawn periods.

During the surveys, identical light traps were utilised. The use of uniform start times and durations, standardised sample collection across multiple sites on the same nights, allowing for valid comparisons of nightly results. The equipment and set-up for each light trap included:

- 300mm 8-watt fluorescent black light tube UV A type lamp with perspex vanes, dusk/dawn light activated automatic timer, connected to a 12v (11aH) battery (see Figure 6)³. Lamps were new or had low prior hours of operation (less than 20 hours) and were well within the best practice guidelines for standardisation (Patrick 2016). Batteries were fully charged prior to use.
- The lamp and vanes were secured to a funnel and collection bucket using bungy cords. The collection bucket was lined with a containment sack for ease of removing samples.
- The traps were set as gaseous kill traps. Egg cartons were placed within the sacks to provide resting surfaces and reduce damage to samples from movement until euthanised.⁴

³ <https://www.entosupplies.com.au/equipment/field/collecting-lights/insect-light-traps-12-volt-d-c-8-watt/>

⁴ Egg carton and containment sacks were not used in December 2023 trapping

Light traps were set on calm, dry nights over two survey periods: December 2023 and March/ April 2024. Traps were set at selected representative sites across the ESA with consideration for comparable elevation and sampling effort between the DDF and SL on each night of trapping.

Consideration was also given to the location of active drilling rig sites to ensure trapping was not attempted near competing light sources.

In total, light trapping was undertaken at 16 RM sites; twelve in each of early summer and late summer (see section 3.4 for details).

Overnight weather forecasts for wind, temperature and rainfall were checked prior to setting, with traps set on nights with no rain forecast and low winds. While overnight temperatures in March/ April dropped below ideal levels of 10° Celsius on some occasions, traps were set and successfully captured a large number of samples on these occasions.

No more than seven traps were set each night, taking into account the logistics of setting and collecting, as well as the resources needed for sorting and identification processes.

Traps were installed near the RM sites centroid marker pegs on a flattened surface and stabilised with earth or rocks, as shown in Figure 5. They were set up in the afternoon and collected the next morning. On collection, moths resting around the traps were added to the sample. Samples were sorted for identification as per section 3.5. Partial samples due to wind disturbing the traps were processed for species presence but excluded from further analysis.

3.3.2 Pitfall trapping

Overview

Pitfall traps are a simple yet effective tool to capture ground-dwelling invertebrates (Brown and Matthews 2016, Sherley and Stringer 2016, Ward *et al.* 2001). The method uses an open container, typically a cup, embedded flush with the ground level, into which invertebrates fall when moving on the ground. A solution in the bottom of the container kills and preserves specimens for later collection. An open-sided cover over the pitfall trap prevents debris or rain from entering the cup.

Pitfall traps can collect large numbers of invertebrates across a wide diversity of ground-active insects, including mobile species of beetles, spiders, grasshopper, ants (Sherley and Stringer 2016) and wētā (Bertoia *et al.* 2023a). As a cost-effective method, pitfall traps are suitable for community richness surveys and can be used to estimate and compare relative abundance between sites (Bertoia *et al.* 2023a), often in conjunction with other invertebrate sampling methods.

Survey process

Pitfall trapping was undertaken in March/ April 2024. Pitfall trapping followed the best practice guidelines outlined in the DOC invertebrate pitfall trapping protocol (Patrick 2016). A hole was dug using an auger into which a length of 90mm PVC pipe was installed. Soil was packed firmly around the top of the pipe ensuring water would drain away and there was no lip when the trap was set.



Figure 6: Light trapping equipment showing lamp and Perspex vanes secured to collection bucket and connected to automatic dusk/dawn timer

At least 25mm depth of propylene glycol was poured into a plastic cup with 90mm diameter which was then placed within the PVC pipe. Stones or rocks were used to create ramps over the edge of the cup in rocky areas with limited soil. An aluminium cover was placed over the top with approximately 30 - 50mm space to prevent rain or debris from entering the cup (Figure 7).



Figure 7. Pitfall trap showing PVC pipe and cup (left) with cover in place (right).

Pitfall traps were open for 14 continuous days each, after which samples were cleared. The contents of the cup were strained through a piece of chux cloth to collect samples. Additional rinses with the propylene glycol were undertaken until the cup was clear. The drained chux cloth was placed in a sample jar and 70% alcohol was added for preservation until the sorting and identification process was completed (see section 3.5). The PVC pipe was removed from the pit and the hole filled.

Pitfall traps were installed in groups of five at each RM site. A centre pit was positioned as close as practicable to the centroid marker peg, with the other pitfalls within four quadrants of a grid with each trap approximately 10m from the centroid (see Figure 8).

Whilst the arrangement of traps attempted to achieve a quincunx pattern, actual trap positions were influenced by terrain, creeks, cattle tracks and ability to achieve adequate pit depth given frequent underlying rocks.

Twenty pitfall traps were installed along each of the six TM sites. The pitfall traps were strategically positioned along the general transect line to sample ground-dwelling species across various available habitats. Placement of pitfalls were similar to that shown in Figure 9 below for wooden discs.

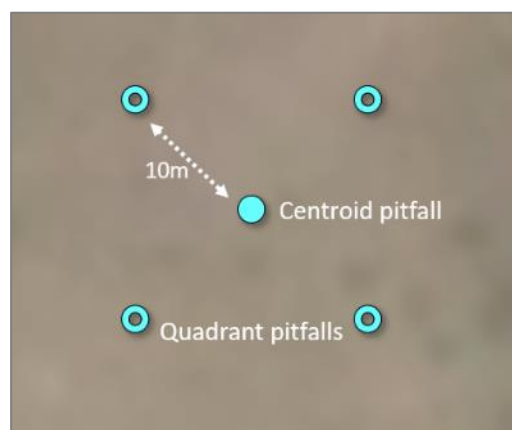


Figure 8. Typical quincunx arrangement of pitfall traps and wooden discs at representative survey sites

3.3.3 Wooden discs

Overview

Wooden discs are artificial habitat that uses a section of a tree trunk placed on bare soil to replicate natural fallen logs. The discs offer a moist environment for various ground-dwelling invertebrates, including spiders, beetles, wētā, snails, slugs, worms, harvestmen, centipedes, millipedes, and slaters. Spiders and carabid beetles are among the first to colonise (Bowie and Frampton 2004).

Wooden discs are a non-destructive manual search method, allowing the disc to be lifted and invertebrates identified and recorded prior to replacing the disc (Bowie and Frampton 2004). They are a useful technique for longer-term monitoring of ground-dwelling invertebrates as discs left in place can be checked for many years (Bowie and Frampton 2004, Sherley and Evans 2016, Bowie *et al.* 2018).

Survey process

Wooden discs were installed in late winter 2024 following best practice outlined by Bowie and Frampton (2004).

Pine tree (*Pinus radiata*) trunks with diameters of 35cm to 50cm were cut into discs at least 10cm thick. Grass and rocks were cleared from installation sites to expose bare soil. Roots, sticks, and stones were removed, and the ground was levelled to ensure the discs made good contact with the soil, minimising air pockets (Figure 9, left).

Wooden discs were positioned similarly to pitfall traps, with five discs allocated at each RM site (refer to Figure 8) and 20 discs arranged along each TM site (Figure 9, right). Whenever feasible, wooden discs were placed near the site of previous pitfall traps.

Wooden discs were checked in spring, approximately three months after installation. Observations of terrestrial invertebrates were made by a taxonomist, and species/ taxa were identified where possible. Samples were collected and preserved for later identification if they could not be identified in-situ (see section 3.5).

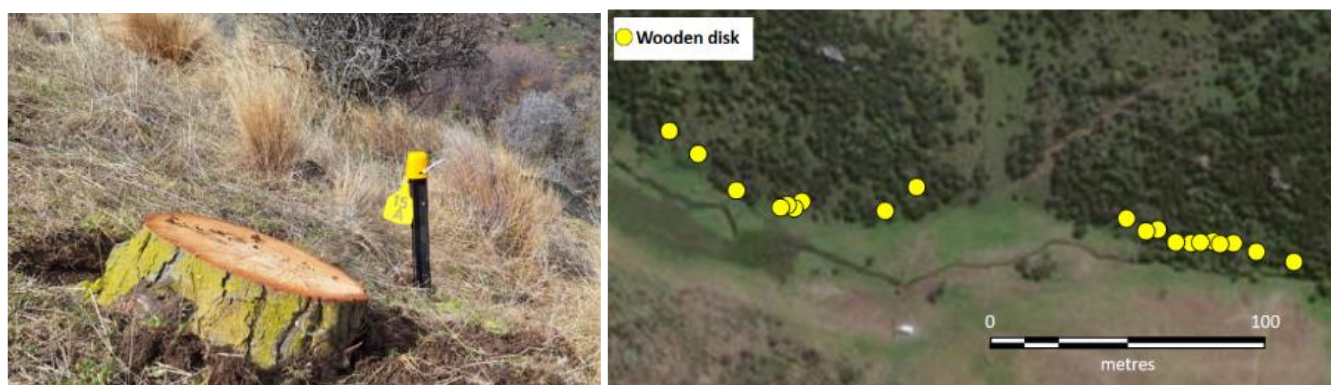


Figure 9. Installed wooden disc (left) and an example wooden disc placement along a transect (right).

3.3.4 Foliage beating

Overview

Foliage beating is a manual search method where branches are beaten with a stick, whilst a large white tray is held under the foliage to collect invertebrates as they drop. Foliage beating is an effective way to quantify invertebrates by observing and/or collecting species that are typical for the vegetation being sampled (Sherley and Evans 2016). Foliage beating is most effective in targeting species such as spiders, caterpillars, aphids, weevils and beetles that cannot fly, as well as insects that move away quickly, or burrow into substrates when disturbed (Sherley and Evans 2016, Montgomery *et al.* 2021).

Foliage beating is typically done by sampling a variety of plants to ensure a wide sample is obtained (Harris *et al.* 1972). It is particularly effective when sampling shrubland plants such as *Olearia bullata* and *Coprosma propinqua*, as they are known for their abundance of invertebrate fauna (Derraik *et al.* 2001). Foliage beating can be a time-efficient way to collect data, particularly for tree- and shrub-dwelling insects (Montgomery *et al.* 2021), and can be standardised by applying consistent sampling methods. Foliage beating and hand searches are typically carried out in tandem and are an effective way to survey a wide range of invertebrate species (Sherley and Evans 2016).

Survey process

Foliage beating was generally performed in line with the DOC protocol for invertebrate search and extraction methods (Sherley and Evans 2016). *Olearia* bushes (*Olearia arborescens*) were targeted for foliage beating based on studies showing this type of vegetation can be associated with high invertebrate species diversity (Derraik *et al.* 2001).

Foliage beating was undertaken at each of the 12 RM sites where light trapping was undertaken in late summer (March/ April 2024). Samples were taken after 10 am on days with fine weather and low winds.

A ground search starting from the centroid marker identified the closest *Olearia* bush to the RM site centroid. Healthy bushes were chosen, visually assessed to have minimal dead branches, 2-3m tall, and accessible on all four sides. If no *Olearia* bush was found within a reasonable distance of the centroid, taken as approximately 15 minutes searching for two people, an alternative species was selected. This occurred in one instance when a suitable kānuka bush was used as a substitute.

The same team collected all foliage beating samples, with the same person beating branches to standardise the collection process as much as possible. A wooden handle was used to firmly tap a branch of the *Olearia* 5 times. Specimens were collected in two 90cm diameter beating trays⁵ (see Figure 10) held to capture specimens falling from between the trunk to the outer edge of the foliage. Any debris was sifted through/ removed by the team of three people, with invertebrates collected using aspirators. This process was repeated three more times, moving around the bush to sample from all four quadrants. Samples were appropriately euthanised and preserved for each taxa and later sorted and identified (see section 3.5).



Figure 10: Foliage beating tray

3.3.5 Manual searches

Overview

Manual search methods encompass a range of techniques to opportunistically catch terrestrial invertebrates. They generally involve looking for invertebrates in known or ideal habitats — manually moving logs, rocks, visually searching foliage/ leaf litter — and catching or extracting samples with sweep nets, containers, or pooters/ aspirators (Sherley and Evans 2016).

⁵ Sourced from www.entosupplies.com.au

Temperature can affect invertebrate activity (Bertoia *et al.* 2023b) and may influence the ability of collectors to detect and catch the target invertebrates (Sherley and Evans 2016), requiring consideration for timing and temperatures during manual searching. Species of interest can be targeted by concentrating search efforts on specific locations, habitat and/or behaviour.

Manual search techniques are also referred to as hand collection. Manual searches are primarily used for general inventory and to determine species presence (Sherley and Evans 2016). Searching methods can be standardised or stratified into units of area/ time spent, to allow some statistical analysis. For distinction in this study, where a manual search method has been standardised, it is described separately (such as foliage beating and wooden discs).

Survey process

Two methodologies for manual searches were implemented:

- Timed manual searches conducted at each RM and TM site
- Searches across at targeted hand collection sites, containing key habitat and vegetation, as outlined in section 3.2.3.

Search methods included:

- Hand searching: manually moving habitat features including logs, rocks, leaf litter, cow dung
- Visual searches on vegetation
- Sweep netting: chasing fast moving/ flying insects such as butterflies, bumble bees, crickets, or sweeping the net through or over foliage to capture any insects in or around it
- Ad hoc manual light trapping at select sites targeting specific species known to be associated with specific habitat, or near Olearia bushes known for their high species diversity (Derraik *et al.* 2001).

While there is no prescribed process for manual searches (Sherley and Evans, 2016), consideration was given to daylight exposure, ambient air temperature, disturbance, vibration, terrain and behaviours of target species. Searches were conducted by multiple people from various field teams.

3.4 Timing

Table 1 summarises the terrestrial invertebrate survey period, methods used, the target species, and the effort distribution across the DDF and SL. The duration of each survey method was:

- Light trapping at RM sites centroid – dusk to dawn for one night
- Ad hoc light trapping for manual searches – from dusk as required for target species
- Pitfall traps – 14 continuous days
- Foliage beating – each bush sampled once
- Wooden discs – 3 months, with one turnover per disc
- Manual searches – one hour per RM site and two hours per TM site during daytime
- Targeted manual searches at hand collection sites – as required for target species.

Table 1. Target species, timing and number of sites/ locations surveyed for each survey method

Method	Target species	Survey period	No. Representative Monitoring Sites		No. Targeted Monitoring Sites		No. Hand collect locations	
			DDF	SL	DDF	SL	DDF	SL
Light trapping	Moths and night-flying insects	Dec 2023	6	6	N/A	N/A	N/A	N/A
		Mar/Apr 2024	5	7	N/A	N/A	N/A	N/A
Pitfall traps	Ground-dwelling invertebrates including beetles	Mar/Apr 2024	11 x 5 pits each	9 x 5 pits each	3 x 20 pits each	3 x 20 pits each	N/A	N/A
Foliage beating	Vegetation-dependent species that are unlikely to fall into a pit	Mar/Apr 2024	5	7	N/A	N/A	N/A	N/A
Manual searches	Airborne species active during the daytime, and other insects that might be missed by other methods	Mar/Apr 2024	11 x 1hr each	9 x 1hr each	3 x 2hr each	3 x 2hr each	N/A	N/A
Wooden disc habitat	Ground-dwelling terrestrial invertebrates and longer-term monitoring	Nov 2024	11 x 5 each	9 x 5 each	3 x 20 each	3 x 20 each	n/a	n/a
Targeted manual search	Target species or habitat types	Feb/Mar 2024	N/A	N/A	N/A	N/A	28	12
		Nov 2024	N/A	N/A	N/A	N/A	5	18
		March 2025	N/A	N/A	N/A	N/A	Several areas of potential habitat for <i>Sporophyla oenospora</i>	Surrounding areas of recorded <i>Sporophyla oenospora</i>

3.5 Data processing

Collected samples were euthanised, stored temporarily if needed, and preserved appropriately for the specimen type (Schauff 2001). All samples were thoroughly sorted and counted as quickly as feasible after collection, adhering to the DOC protocol for sorting invertebrate samples (Chinn 2017).

3.5.1 Specimen identification and recording

Species experts and/or taxonomists undertook the identification of specimens and provided insight into the conservation status of species. Experts included:

- Keith Barber (general sorting and preliminary identification)
- Will Frost (general sorting and preliminary identification)
- Alan Flynn (general sorting, preliminary Hemiptera identification)
- Bede McCarthy (Hymenoptera - ants & wasps)

- Dr. Robert Hoare (Lepidoptera - moths)
- Dr. Dave Seldon (Carabidae - ground beetles)
- Dr. Samuel Brown (Curculionidae - weevils)
- Dr. Cor Vink (Arachnid - spiders)
- Dr. Barbara Barratt (Odontria - scarab beetles).

Invertebrate specimens were identified to species level when possible. If not, they were classified to the lowest feasible taxonomic rank. Many specimens were only identified to genus, family, or order due to either incomplete or poor-quality samples, or unresolved taxonomy. A database was established for record keeping and analysis purposes, identifying:

- Sample collection details of date, location ID/GPS, survey zone, collection method and collector name
- Specimen identification (or genus, family, or order), determiner name, counts and threat classifications for notable species
- Broad-scale habitat type at each location
- Abiotic factors over relevant periods, with weather data sourced from on-site weather stations.

3.5.2 *Threat status*

The threat status of each invertebrate was determined for those identified to species level. There are no regional threat status reports for invertebrates within the Otago Region, except for the velvet worm/peripatus which has not been recorded on or near the BOGP site.

The latest national New Zealand Threat Classification System (NZTCS) was used, where data was available, using the following levels:

- Threatened
- At Risk
- Data Deficient
- Not Threatened
- Non-resident native
- Introduced and Naturalised.

The threat classification for New Zealand Lepidoptera (moths and butterflies) is currently under review, with publication pending. This report incorporates these forthcoming changes to provide the most current information possible. All instances where data is based on a pending classification update are indicated with an asterisk (*) in Appendix 2: Terrestrial invertebrate survey list.

When official threat classifications were unavailable, alternative methods were employed to determine species characteristics as substitutes for formal threat status designations. Desktop reviews and input from species experts helped assess endemism, abundance, and local and national distribution criteria. Species were then categorised accordingly:

- Probable new species
- Not assessed – of importance
- Not assessed – likely not threatened

- Not assessed

Despite this, numerous species remained unassessed due to insufficient data.

For terrestrial invertebrate reporting, **notable species** are those classified as 'Threatened', 'At risk', or 'Data Deficient' under the NZTCS, and those suggested to be 'Not assessed - of importance' by relevant species experts, including any new species.

3.5.3 *Habitat type classification*

The relevant habitat type at each sample collection location was identified using the seven broad-scale categories identified in the 'BOGP: Vegetation Values Assessment' (RMA Ecology Ltd. 2025a), including categories of:

- Exotic pasture
- Mixed depleted herbfield and grassland
- Mixed scrubland
- Mixed tussock shrubland and exotic grassland
- Native dominant scrubland
- Native dominant tussockland
- Native herbland and shrubland.

An additional category, Mosaic, was added for locations with multiple vegetation types present where invertebrates were collected, such as along transects or hand collection areas.

Exotic pasture, mosaic and mixed scrubland categories were not represented at sample sites for light trapping/ foliage beating.

Categories present at the exact monitoring site were used for analysis. Although different habitat types were often found nearby, only the habitat categories present at the specific collection location were considered in the data analysis.

3.6 **Data analyses**

Data analyses were conducted to compare the species composition and terrestrial invertebrate communities of terrestrial invertebrates across the ESA through:

- Identifying notable species and their locations within the ESA
- Describing the invertebrate communities in the ESA by evaluating species presence, relative abundance, and diversity
- Comparing the invertebrate communities between the proposed DDF and SL
- Evaluating the effect of vegetation on invertebrate communities across the ESA
- Evaluating the effect of season on lepidoptera (moths and butterflies) communities across the ESA.

Methods used in the analyses are detailed in the sections below, with results presented in section 4.

3.6.1 Diversity measures

To evaluate invertebrate diversity, the richness (number of taxa), abundance (number of individuals), Shannon-Weiner index, and Simpson's diversity index were calculated.

Shannon-Weiner and Simpson's diversity indices assess sample population diversity by considering richness and abundance. Shannon's index prioritises richness and gives more weight to rare taxa, while Simpson's index focuses on evenness and favours common taxa (Hill, 1973). Combined, these indices offer a thorough overview of invertebrate communities and are commonly used in New Zealand ecological studies.

Genus-level identification was applied to light trapping and manual search data, while family-level was used for pitfall trapping data. Wooden discs and manual searches used species level identification, as most observations were identifiable to this level. Foliage beating relied on order-level identification due to the small, cryptic, and often undescribed invertebrates found with this method. The level of identification was chosen for each method to best balance of retaining observations in the dataset, and the observations providing detailed and meaningful information.

A small number of observations were indeterminate at the level of identification used for their trapping method - these were removed from analyses of richness or diversity but kept for analyses of abundance. Mites and springtails were removed from diversity measures and statistical analyses to avoid skewing or masking data given their abundances in the thousands – they are still represented in the overall description of the site and in any appendix counts.

3.6.2 Statistical analyses

A permutational multivariate analysis of variance (PERMANOVA) with a Sorenson dissimilarity measure was used to compare the overall invertebrate community structure. The model considered survey zone, survey method, and habitat type as predictors.

Generalised linear models (GLMs) and generalised linear mixed models (GLMMs) were used to compare terrestrial invertebrate richness, abundance, and diversity across various factors for light trapping and pitfall trapping respectively. The initial models included the fixed effects of survey zone, habitat type, survey design (i.e. RM and TM sites for pitfall trapping), and survey period (i.e. December 2024 and March 2025 sampling for light trapping), with sample site as a random effect (i.e. to account for differing trap numbers between RM and TM sites for pitfall trapping). As the data was over-dispersed, a negative binomial distribution was used for abundance and richness, while a Gaussian distribution was used for Shannon's and Simpson's diversity indices.

The non-parametric Brown Mood's median was applied for both wooden discs and manual searches, as they had non-normal distributions when transformed, in addition to a high percentage of rank-ties. Only invertebrate abundance was examined for foliage beating, using a one-way ANOVA on the log-transformed data, due to the dataset's limited taxonomic resolution.

Statistical analyses were conducted using R software (R Core Team 2024) with the vegan package (Oksanen *et al.* 2024) for PERMANOVA, lme4 (Bates *et al.* 2015) for linear models, and tidyverse (Wickham *et al.* 2019) for graphics.

3.6.3 Ordination

Ordination analyses visualised the community composition across sample sites, detailing taxa and their abundance for all recorded invertebrates. Non-metric multidimensional scaling (NMDS) displayed this data in two dimensions using a Sorenson dissimilarity measure based on family presence-absence.

NMDS ordination arranges sites in two dimensions according to their similarity, specifically the composition of taxa presence and absences, placing similar sites closer together. Survey zones, sampling strategies (i.e. RM sites, TM sites, and targeted hand collection sites), and habitat types linked to each sample site were overlaid onto distinct NMDS graphs. This was done using convex hulls, which are the smallest shapes that enclose all the sample sites within the given criterion.

Shepard's plots, goodness of fit, and stress values were used to assess the preservation of the original dissimilarities; a stress value below 0.2 signifies a good fit (Kashian *et al.* 2007).

4 Results

This section presents the terrestrial invertebrate taxa documented during desktop assessments and field surveys for the BOGP, along with analyses comparing invertebrate communities between the DDF and SL zones.

The overview of terrestrial invertebrate taxa describes each invertebrate order found across the ESA, including proportions of native versus introduced species and observations on commonly encountered taxa. For species of particular ecological importance, i.e. notable species, descriptions of their ecology and observed distribution across the site are provided within their respective taxonomic sections.

An overview of the count of individuals, and number of distinct taxa in each order, including the proportion of native and introduced species, is provided in Appendix 1, along with the complete list of terrestrial invertebrates found across the ESA in Appendix 2.

4.1 Terrestrial invertebrate taxa

4.1.1 Overview

A total of 29,565 terrestrial invertebrate specimens were collected during field surveying for the BOGP, encompassing five classes: Arachnida (Spiders), Entognatha (Protura, Diplura, and Collembola), Insecta (Insects), Malacostraca (Crustacean), and Myriapoda (Centipedes, Millipedes, Pauropoda & Symphyla). This is considerably larger numbers than comparative studies undertaken in the Central Otago area, largely due to the length and intensity of the survey efforts.

Specimens were from at least 119 families across 25 orders. Of these, 222 species were native, 29 species were introduced, and the remaining taxa were indeterminate at the species level (i.e. only able to be identified to genus, family, or order level). Five of these species are considered 'regionally endemic' and are only found within the Otago region (Jarvie 2025), including three species of spider and two species of moths. None of these species are currently recorded as nationally threatened or at risk.

The array of terrestrial invertebrates to be generally typical of dry Central Otago grassland and tussockland areas, although there are few comparative large-scale surveys within the region. Research field studies and pre-consent baseline surveys vary considerably with methodologies and techniques used, targeted taxa, size of area covered and the overall sampling intensity and effort.

Pre-consent assessment surveys conducted by Bioresearchers (2024) at Macraes Flat found a total of 56 taxa over 14 orders through light trapping and sweep netting. While a survey of higher altitude (850-1000) snow tussock grasslands in East Otago found 464 species across 8 orders.

The overall quantity of invertebrates is most comparable to a survey undertaken in the lowland shrublands of the Rock and Pillar Range (Derraik et al. 2001). This largely centred on foliage beating specific shrubs and found 280 species across 25 orders, with 9116 individuals collected.

While the diversity and range of species differs considerable, there is similarities between the proportions of native, endemic and introduced species. This BOGP field survey found just over 88% of recorded species were native, similar to the proportion of native invertebrates found in the Rock and Pillar Range (90%) (Derraik et al. 2001) and Macraes Flat (73%) (Bioresearchers 2024).

While the general diversity and range of terrestrial invertebrates is largely considered typical of the area, there are a number of Threatened, At Risk or otherwise notable species are present within the BOGP landscape (see Section 4.1.3 for details).

4.1.2 Desktop assessment

Previous records of the GBIF database for terrestrial invertebrates within the surrounding area, taken as the Dunstan Mountain ranges, indicate a range of endemic fauna present around the BOGP site. Approximately 60 species of terrestrial invertebrates were recorded on the GBIF database at the time of assessment, with a range of orders similar to that found during field studies. Approximately 35% of the GBIF recorded species were recorded during field surveys

Records had a high proportion of Lepidoptera species, similar to our field surveys, including the At Risk (Declining) moth *Paranotoreas fulva*. This observation was dated to 2020 and recorded near State Highway 8 approximately 10km from the nearest edge of the DDF.

P. fulva is considered a notable species for the site and was recorded during field surveys within the ESA, more information on the species and its significance is detailed within the overview of notable species (Section 4.1.3) and the description of Lepidoptera (moths and butterflies) (Section 4.1.6).

Of the remaining species that were assessed under the NZTCS, eight are recorded as Not Threatened, predominately crickets and grasshoppers, and one native wasp that was Data Deficient. The full list of species is provided in Appendix 3.

4.1.3 Notable species

A total of 18 notable species were found, as outlined in Table 2. Of these, one species was found only within the DDF – the 'At Risk – Declining' grasshopper *Phaulacridium otagoense*. Nine notable species were found in both the DDF and SL areas, including threatened, at risk, and new species. Eight notable species were only found within the SL, three of which were threatened species represented by only one or two specimens each. These were the moths *Sporophyla oenospora* 'Threatened – Nationally Critical', *Homodotis* sp. A (NZAC (CO)) 'Threatened – Nationally Endangered' and *Pasiphila* sp. 'Olearia' 'Threatened – Nationally Vulnerable'.

S. oenospora was only found within an area considered part of the DDF at the time of the initial terrestrial invertebrate survey, in a location planned for development of the Ardgour Rise road. This small, threatened moth was previously thought to be extinct, and is 'Nationally Critical', the highest possible threat category under the NZTCS. Subsequent modification of the project design and development planning, the Ardgour Rise Alignment has relocated away from the area where *S. oenospora* were found, and the boundary of the DDF adjusted accordingly. Subsequently, this moth is now recorded as being found in the SL.

Further field investigations were also carried out for the new species of beetles and weevils, which are potentially threatened, given the lack of population data and large unknowns around the ranges they occupy.

Details and descriptions of each notable species, including where they were found across the ESA and brief descriptions of important characteristics, are discussed below within the subsection relating to their Order (i.e. *S. oenospora* is discussed within the overview of Lepidoptera). Regionally endemic species are also discussed within their Family subsection.

Table 2. Notable terrestrial invertebrate species by threat status, including the number of individuals and number of sites they were found within each survey zone (DDF: Direct Disturbance Footprint, and SL: Surrounding Landscape) and survey period (December 2023, February – April 2024, and October – November 2024). An asterisk () represents a revised NZTCS threat category for NZ lepidoptera currently undergoing review.*

Threat status	Sub status	Notable species	No. of individuals (no. of locations)						
			DDF			SL			Total
			Dec 23	Feb-Apr 24	Oct-Nov 24	Dec 23	Feb-Apr 24	Oct-Nov 24	
Threatened	Nationally Critical	<i>Sporophyla oenospora</i>						2 (1)	2 (1)
	Nationally Endangered*	<i>Homodotis</i> sp. A (NZAC (CO))						1 (1)	1 (1)
	Nationally Vulnerable	<i>"Pseudocoremia" cineracia</i>	1 (1)		1 (1)			2 (2)	4 (4)
	Nationally Vulnerable	<i>Pasiphila</i> sp. 'Olearia'						1 (1)	1 (1)
New Species	Potentially Threatened	<i>Harpalus</i> new sp.		1 (1)			2 (2)		3 (3)
	Potentially Threatened	<i>Inophloeus</i> new sp.		4 (1)	14 (4)		5 (2)	38 (8)	61 (15)
	Potentially Threatened	<i>Megadromus</i> new sp.1					4 (3)		4 (3)

Threat status	Sub status	Notable species	No. of individuals (no. of locations)						Total
			DDF			SL			
			Dec 23	Feb-Apr 24	Oct-Nov 24	Dec 23	Feb-Apr 24	Oct-Nov 24	
	Potentially Threatened	<i>Megadromus</i> new sp.2					2 (1)		2 (1)
At Risk	Declining	<i>Phaulacridium otagoense</i>		15 (6)					15 (6)
	Declining*	<i>Agrotis admirationis</i>	55 (4)			6 (1)		6 (1)	67 (7)
	Declining*	<i>Asaphodes recta</i>		5 (1)			12 (3)		17 (4)
	Declining*	<i>Elachista helonoma</i>		1 (1)			2 (2)		3 (3)
	Declining*	<i>Ichneutica toroneura</i>	39 (4)	54 (1)		67 (5)			160 (10)
	Declining*	<i>Nyctemera annulata</i>					1 (1)		1 (1)
	Declining*	<i>Paranotoreas fulva</i>						5 (1)	5 (1)
	Uncommon*	<i>Ichneutica sistens</i>		58 (3)			418 (6)		476 (9)
	Uncommon*	<i>Meterana exquisite</i>			2 (1)			1 (1)	3 (2)
	Not Assessed	Of importance	<i>Scythris</i> sp.1						10 (1)

4.1.4 Arachnida

Araneae (spiders)

Overall, spiders were identified across 22 families. Of the identified species, 28 (87.5%) were native to New Zealand, and four species (12.5%) were introduced. Some taxa were unable to be classified to species level due to the quality of the specimen.

The identified species also included three regionally endemic species only found within Otago, including *Pakeha maxima* (Cycloctenidae), *Rinawa otagoensis* (Hahniidae), and *Cyclotenus duplex* (Cycloctenidae).

The regionally endemic *P. maxima* and *R. rinawa* were some of the most abundant spiders collected, along with *Anoteropsis hiliaris* (Lycosidae) and *Uliodon* sp. (Zoropsidae), all of which are not threatened and common in Otago. In contrast, only a single specimen of the regionally endemic *C. duplex* was found at one high-value TM site, *C. duplex* is also not threatened.

Capturing species in small quantities, especially those encountered only once, was much more common than capturing species in larger numbers.

Eight of the identified species have not yet been assessed under the NZTCS.

Opiliones (harvestmen)

Harvestmen from two families, Neopilionidae and Triaenonychidae, were encountered in pitfall traps throughout both survey areas within the ESA, each represented by at least one distinct taxon. The sole species identified to the species level, *Forsteropsalis marplei*, has yet to be evaluated under the NZTCS (Sirvid *et al.* 2020).

Pseudoscorpiones (psuedoscorpions)

Pseudoscorpions, small yet widespread arachnids, inhabit leaf litter or bark and were discovered in pitfall and light traps throughout both survey areas.

Mites

Mites were frequently found across the ESA and often appeared in large numbers in pitfall traps, sometimes exceeding hundreds of individuals per trap. Most mites belonged to the superorder Acariformes, with Trombidiformes being the most common, while few Sarcoptiformes were identified.

4.1.5 Entognatha

Springtails

Three orders of springtails were observed, with Collembola and Poduromorpha numbering in the thousands, while significantly fewer Entomobryomorpha individuals were identified.

4.1.6 Insecta

Blattodea (cockroaches/termites)

Among the few collected cockroach specimens, one was identified as the native bush cockroach, *Celatoblatta* spp., while the other specimens were indeterminate at the family level.

Coleoptera (beetles and weevils)

Of the Coleoptera identified to species level, a total of 26 species (81.25%) are native to New Zealand and six species (18.75%) are introduced, with the remaining taxa unknown or indeterminate at the species level. Interestingly, nearly half of the identified taxa were represented by only one specimen each.

The most common species were the introduced strawberry root weevil (*Otiorhynchus ovatus*) and the native striped chafer beetle (*Odontria striata*). *O. striata*, usually found in Otago, feeds on the roots of native tussock and pastoral species, occasionally becoming pests (Barrat and Campbell 1982, Barrat 1983).

Very few native coleoptera species found have been assessed under the NZTCS. Only two species, a springtail (*Artystona obscura*) and darkling beetle (*Mimopeus elongatus*), have a categorisation of 'Not Threatened'. Three new species of beetles, and one new species of weevil, were found across the ESA and are described below.

***Harpalus* 'new sp.'** (new species – potentially threatened): a new species of ground beetle belonging to the Carabidae family, found both inside and outside of the DDF. The species currently has no known life history or habitat associations, beyond what is inferred from similar species and the limited number of specimens collected. These beetles are likely primarily nocturnal predators found in various terrestrial habitats, which typically include hiding under stones, logs, or in soil crevices during the day. Given the lack of data around the species range and population size, the new *Harpalus* species would currently qualify for a 'Data Deficient', and potentially threatened, conservation status (D. Seldon, *pers comm*, December 2024).

***Megadromus* 'new sp.1' & 'new sp.2'** (new species – potentially threatened): two previously undescribed species of *Megadromus* carabid beetles were collected from the SL. One species (*M.* 'new sp.1') represents a new taxon known only from four specimens collected from three sites (RM site 5 and TM sites 5 & 6). Given the limited occurrence, similar to the new *Harpalus* species, *M.* 'new sp.1' would also qualify for a 'Data Deficient', and potentially threatened, conservation status (D. Seldon, *pers comm*, December 2024).

There is less certainty whether the second undescribed carabid beetle (*M.* 'new sp.2') represents a new species, with only two specimens collected from one site (TM sites 5). While this potentially new species is closely related to either *M. sandgeri* or *M. vagans*, definitive new species classification would require extensive investigation. This would include comparative analysis with specimens from several neighbouring localities, including Bold Peak, Ben Lomond, Maniototo, and Mount Maungatua, to assess population-level morphological variation. As with *M.* 'new sp.1', this taxon would currently be classified as 'Data Deficient' with potential threat implications pending further investigation (D. Seldon, *pers comm*, December 2024).

Specimens were collected from a diverse range of habitat types, which included 'Native Dominant Tussockland', 'Exotic Grassland', 'Mixed Tussock Shrubland' and 'Native Dominant Scrubland'. The specific host plant or habitat requirements for the species are unclear, and life history traits remain unknown, particularly given the small number of specimens. The extent to which the populations may extend outside of the surveyed ESA is unknown.

***Inophloeus* 'new sp.'** (new species – potentially threatened): a new species of weevil recorded from various locations across the ESA and wider landscapes (Figure 11). Both morphological assessment and genetic analysis confirm its 'new species' status, with potential classification as threatened under the NZTCS (S. Brown, *pers comm*, November 2024).

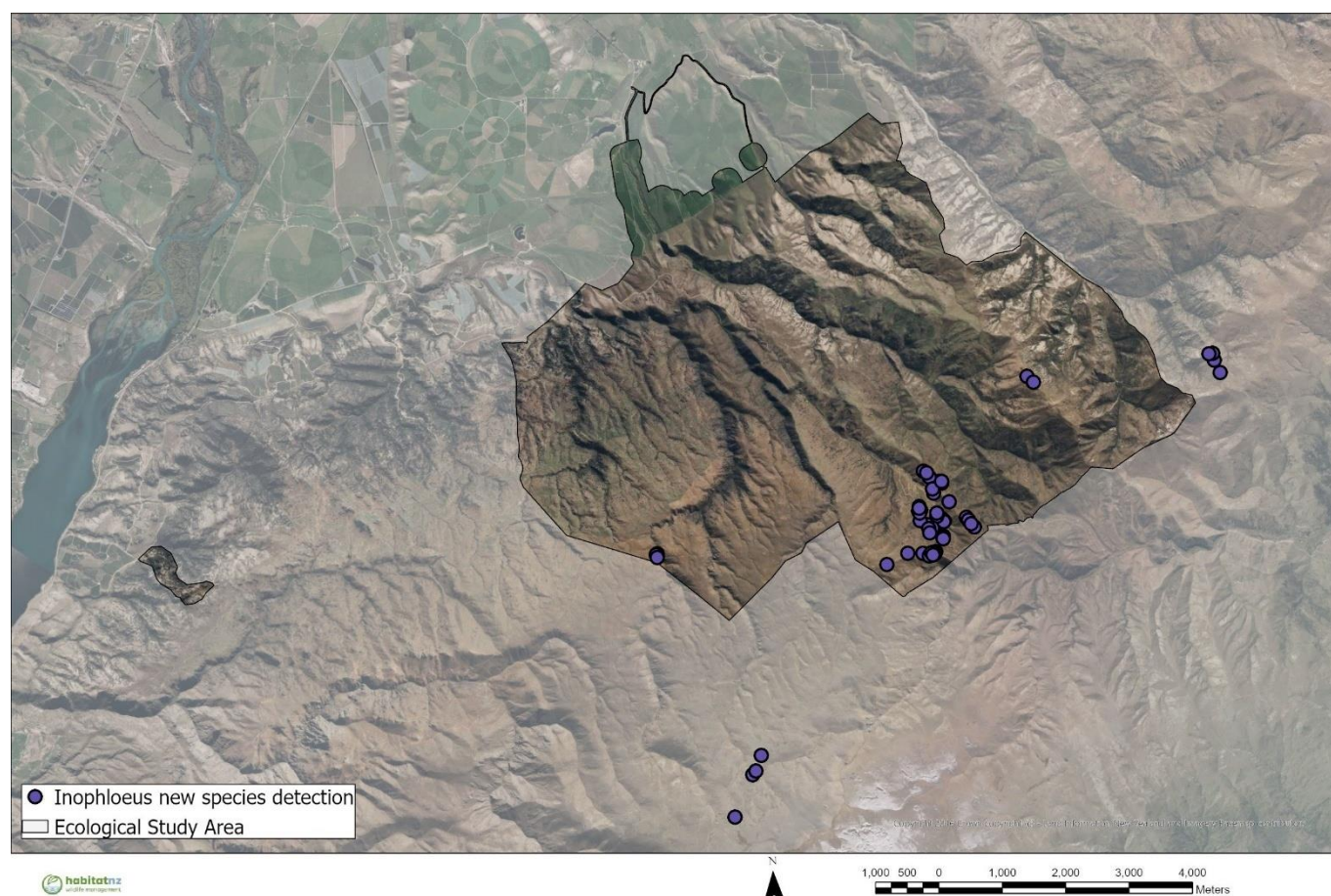


Figure 11. Locations where *Inophloeus* 'new species' was found during the BOGP terrestrial invertebrate survey

The weevils were collected from pitfall traps at two sites (TM sites 2 and 5) as well as various hand collection sites including SRE, Mt Moka, Thompson's Saddle, the top of Ardgour Rise, and Upper Dry Creek. No specimens were found during searches around South Bendigo and Devil's Creek. Searches conducted above the Mt Moka track specifically looked for specimens on *Aciphylla hectorii*, a smaller taramea species not found elsewhere in the ESA. Several *Inophloeus* 'new sp.' specimens were found in this location following a posting on iNaturalist of an *Inophloeus* record at Mt Moka in November 2024.

The new species of weevil found through manual searches were mostly found on flowering taramea plants, although not always on the flower heads. One specimen was found walking across low-growing *Hieracium* plant several metres from a taramea plant. Specimens were also found in pitfall traps in the general area of taramea, although not always directly under the plants.

Extensive manual searching of taramea outside the flowering season yielded very few individuals (n=1), indicating that these weevils are very hard to find through manual searches at times when taramea are not in flower. When considering how *Inophloeus* 'new sp.' were located at different times of the year, pitfall traps appear to be more effective at catching *Inophloeus* 'new sp.' than manual searching when taramea are not in flower, with the inverse being true when taramea are in flower. While no formal counts were carried out, the densities of the *Inophloeus* 'new sp.' appear to differ between areas of taramea throughout the landscape. Some flowering taramea patches had large numbers of weevils (up to eight individuals on a single flower), while other patches had no weevils when searched thoroughly (manual searches conducted with three people for more than 15 minutes).

Further genetic analyses were conducted to examine population variability across locations, prompted by morphological variations observed during field surveys. DNA sequencing was conducted on 17 weevil specimens to determine genetic relationships among *Inophloeus* 'new sp.' populations. The analysis included 13 specimens from Bendigo and 4 specimens of *I. inuus* from the Remarkables and Crown Range.

Results confirmed that all specimens from the BOGP terrestrial invertebrate survey represent a single new species, including the Mt Moka specimen initially suspected as being different. Genetic differentiation measurements showed the Bendigo species differs from *I. praelatus* (Rock and Pillar Range) by 2.6%, from *I. inuus* by 5.4%, and from *I. sulcifer* (Mt Dobson, near Tekapo) by 7.9%.

Dermaptera (earwigs)

Earwigs primarily included unidentified individuals, along with two introduced species of European earwigs, *Forficula dentata* and *F. Auricularia*.

Diptera (flies)

Although at least 16 distinct taxa of Diptera were identified, many were indeterminate at the family level. Among these, fungus gnats from the family Mycetophilidae were the most abundant. Four native species were identified, including several fungus gnats and a flower-pollinating hoverfly (*Melangyna novaezelandiae*).

Hemiptera ("true bugs")

Hemiptera from at least ten families were observed, with more than half of the specimens not identified to the species level. Of those identified to species level, seven (77.8%) of these are native species that have not been evaluated under the NZTCS, with the remaining two (22.2%) being introduced. Among the identified families, froghoppers (Cercopidae), cicadas (Cicadidae), and spittlebugs (Aphrophoridae) were the most common.

The cicada collection featured a range of species such as the pink cicada (*Kikihia rosea*), tussock cicada (*Kikihia angusta*), and yodelling cicada (*Maoricicada clamitans*). Most of the specimens were collected using manual search techniques.

Additional families within the Hemiptera order comprise aphids (*Aphidae*), stilt bugs (*Berytidae*), leafhoppers (*Cicadellidae*), scale insects (*Coccidae*), seed bugs (*Lygaeidae*), damsel bugs (*Nabidae*), and shield bugs (*Pentatomidae*).

The meadow spittlebug, *Philaenus* spp., was identified. Originally from Europe, this is now widespread across New Zealand. It feeds on a variety of plants (Thompson *et al.* 2023) and spreads the plant vine disease, *Xylella fastidiosa* in Europe (Sandanayaka *et al.* 2017). There is growing concern about the meadow spittlebug's potential to transmit this disease if it is accidentally introduced into New Zealand (Sandanayaka *et al.* 2017).

Hymenoptera (social insects)

Hymenoptera were identified across thirteen families, with over one-third of the specimens remaining unidentifiable at the family level. Of the identified species, eight are native to New Zealand (66.6%), and four (33.3%) have been introduced. None of these have been evaluated under the NZTCS.

Ants belonging to the Formicidae family were the most prevalent, representing fifty percent of all Hymenoptera specimens collected. Although numerous specimens were not identified, three native species were documented: *Chelaner antarcticus*, *Huberia striata*, and *Prolasius advena*.

Introduced hymenopteran species comprised of the Asian paper wasp (*Polistes chinensis*) and three of the four bumblebee species found in New Zealand: *Bombus terrestris*, *Bombus hortorum*, and *Bombus ruderatus*.

Six families of parasitic (parasitoid) wasps were identified, such as the native lemon tree borer wasp (*Xanthocryptus novozealandicus*) and the white butterfly pupal parasitoid wasp (*Pteromalus puparum*). Other Hymenoptera taxa featured native spider-hunting wasps, a native assassin bug, and an endemic plasterer bee from the South Island (*Leioproctus fulvescens*).

Lepidoptera (moths and butterflies)

Lepidoptera were represented across at least 24 families, with a total of 153 identified species. Of these, 144 species (94.1%) are native to New Zealand, and nine species (4.6%) are introduced. Almost all the native species have yet to be evaluated under the NZTCS.

Two regionally endemic moths only found within Otago, *Dichromodes gypsotis* and *Tingena lassa*, were recorded from single specimens found within the Bendigo Historic Reserve. *Dichromodes gypsotis* has been recorded in several areas of Otago, including the Dunstan Terraces, and *Tingena lassa* is considered common within its restricted range. Both species frequent rock tors with larvae that feed on lichens. There were 13 threatened, at risk or notable lepidoptera species identified in the ESA, of which seven were found in both the DDF and SL, with six found only in the SL (refer to Table 2 in section 4.1 for an overview). Descriptions of these notable species are provided below. All instances where unpublished NZTCS classification information has been included, are indicated with an asterisk (*) next to the threat category.

Sporophyla oenospora (Threatened – Nationally Critical): a very rare pyralid moth previously found throughout the Canterbury and Otago drylands, with only two specimens recorded near the Ardgour airstrip (SL) in November 2024 (Figure 12). This species has experienced severe population declines and range reductions since the 1990s due to the deterioration of its preferred short-turf habitats (Hoare and Patrick 2022). Prior to this BOGP terrestrial invertebrate survey, the last confirmed record of *S. oenospora* was in 2008, when it was found in Thompspon’s Gorge at a similar elevation (R. Hoare, *pers comm*, December 2024).



Figure 12. Ardgour airstrip location where *Sporophyla oenospora* (‘Threatened: Nationally Critical’) was found in November 2024 during the BOGP terrestrial invertebrate survey.

This moth species is typically associated with salt flats and dry grasslands, particularly where patches of bare earth mix with low-growing vegetation (Hoare and Patrick 2022). *S. oenospora* remains poorly understood, with its complete life cycle remaining undocumented. While it is likely that caterpillars are associated with an endemic, low-growing herbaceous plant or dwarf shrub (Hoare and Patrick 2022), this is undocumented, and the host plant is currently unknown. The moth has been observed in association with native *Geranium* plants, which may serve as host plants. However, this relationship has not been confirmed through direct observation or by rearing the caterpillars. There is a notable presence of *Erodium cicutarium*, an introduced plant from the same family as *Geranium*, at the Ardgour airstrip. This plant may serve as an alternative food source for the moth's caterpillars, though this is speculation at the time of writing.

The initial discovery of *S. oenospora* at the Ardgour airstrip prompted further investigations. Targeted hand searches were conducted across the discovery area, and discussions were held with MGL management regarding appropriate responses, given that the *S. oenospora* were located directly in a zone planned for road development.

Subsequent targeted searches, including manual searches and non-lethal light traps, were made of the area during March 2025, when no additional *S. oenospora* moths were found. The search did yield three pyralid caterpillars, two of which were heavily parasitized by an unknown fly (parasitoids were in pupation at time of writing) and died during observation. The third caterpillar showed signs of poor health at about the same time and was euthanised to preserve it for genetic analysis. DNA was extracted and sequenced to confirm that the caterpillars were *Agrotis* sp. And not *S. oenospora*.

These searches also extended into the DDF boundaries to further assess the potential presence of *S. oenospora* within the DDF. Manual searches were focussed on areas that had similar habitats to the airstrip, with consideration to conditions such as plant species, elevation, aspect, and grazing regime. While there was evidence of lepidoptera damage on native geranium plants this was likely from other species as the larvae found on this plant were identified as species other than *S. oenospora*.

The decision was made by MGL management to relocate the Ardgour Rise Alignment to avoid the airstrip area. The new location features significantly different habitat characteristics to those at the airstrip. Both the vegetation structure and plant species composition in this relocated area differ substantially from the original road location where *S. oenospora* was discovered, suggesting the new location is less likely to impact this sensitive species. While an effort has been made to search the DDF specifically for *S. oenospora* it's absence in the area cannot be confirmed, particularly as the preferred habitat or specific host-plant species is not known.

Given that the last known occurrence of *S. oenospora* was from Thompson Gorge Road, near the BOGP, observations in this invertebrate survey may represent one of the species' last extant populations. While reduced sampling effort in Central Otago between 2010-2020 could have resulted in the species being overlooked elsewhere, recent intensive surveys by Robert Hoare and Carey Knox at historical *S. oenospora* localities, including Falls Dam and Thompsons Gorge Road, have failed to detect additional populations. This suggests the moth is genuinely rare, rather than being rare due to lack of sampling. ***Homodotis* sp. A (NZAC (CO))** (Threatened – Nationally Endangered): a poorly known and officially unnamed species, found only in the Bendigo Historic Reserve (SL) during nighttime light trapping searches in October 2024. It has previously been found in the Cairnmuir Range, South of Cromwell, and in the Kawarau Gorge in the early 1980's. While the life history and specific host-plant associations are unknown, the species is likely restricted to dry inland shrublands of Central Otago and is likely of high conservation status (R. Hoare, *pers comm*, December 2024).

'Pseudocoremia' cineracia (Threatened – Nationally Vulnerable): commonly known as the looper moth, this is a cryptic species found in the small-leaved *Olearia* shrublands of Western Otago and the Mackenzie Country District. Although the population is currently stable, it has declined due to anthropogenic habitat modification (Hoare *et al.* 2017). A recently discovered population in Marlborough comprises smaller, distinct individuals, which may be a separate unnamed subspecies or a new species altogether (R. Hoare, *pers comm*, July 2024). The larvae of *P. cineracia* feed exclusively on *Olearia odorata* (Patrick 2000), and the adult moth's range is very restricted to less than 100 hectares from its larval host tree. Specimens were found in two locations within the SL and two locations within the DDF, occurring exclusively where *Olearia odorata* was present.

Pasiphila sp. 'Olearia' (Threatened: Nationally Vulnerable): also known as the Olearia Pug Moth, was recorded in the BOGP terrestrial invertebrate survey at the Bendigo Historic Reserve (SL) in late October 2024, none were recorded within the DDF. This species exhibits high habitat specificity, with larvae feeding exclusively on small-leaved *Olearia* species, particularly *O. bullata* and *O. odorata* (R. Hoare, *pers comm*, December 2024). While geographically restricted to Otago and eastern Fiordland regions, the species can achieve high local abundance within suitable habitat patches containing its host plants (R. Hoare, *pers comm*, December 2024).

Agrotis admirations (At Risk – Declining*): is a Noctuidae moth that tends to favour open areas, though widespread and found throughout the South Island it is now in decline. *A. admirations* were identified at various sites using overnight light trapping during the early summer (December 2023) survey period. While its life history traits and specific host plant species are unknown, *A. admirations* was generally recorded in open areas with low growing herbfields and cushionfields.

Asaphodes recta (At Risk – Declining*): is an uncommon moth primarily found in the bogs of the South Island, especially south of the Mackenzie Country district. There are indications that its population has declined over the past century (R. Hoare, *pers comm*, July 2024). The larvae of *A. recta* are believed to feed on various herbaceous plants, including species of *Ranunculus*, which are relatively widespread across the ESA. The specimens were found in overnight light traps at three RM sites in the SL (RM sites 2, 5, and 10) and at one RM site in DDF (RM site 14) during the March 2024 sampling.

Elachista helonoma (At Risk – Declining*): is a locally common moth found in South Island tussock and grasslands. Although its population exceeds 20,000 individuals, it has suffered a significant decline and now occupies less than 10% of its original range (Hoare *et al.* 2017). The larvae of *E. helonoma* are believed to be leaf miners in native tussock grasses, with the silver tussock (*Poa cita*) likely serving as their host plant, as adult moths are frequently associated with it (Patrick and Dugdale, 2000). One specimen was found using overnight light trapping in the SL, and the other two specimens using hand-collect light traps with one found in each of the DDF and SL.

Ichneutica toroneura (At Risk – Declining*): is an endemic specialist of inland dry tussocklands and is restricted to Central Otago and Mackenzie Country (Hoare 2019). The larvae are known to feed on silver tussock (*P. cita*), fescue tussock (*Festuca novae-zelandiae*), and potentially other native tussock species. Previously, *I. toroneura* was found in high abundance during light trapping studies in the Mackenzie Country (White 2002); however, recently it has not been recorded in large numbers (R. Hoare, *pers comm*, July 2024). The presence of high numbers in this survey (c.160 specimens across 10 sites in the ESA) may suggest that the population within the BOGP area represents an important stronghold for the species.

Nyctemera annulata (At Risk – Declining*): are distinctive black and white dayflying moths native to New Zealand. They have striking white spots on black forewings, resembling magpie birds. Their larvae, covered in black and orange hairs, feed on native and introduced species of daisies (*Senecio* spp.), including the pest plant ragwort, in open habitats throughout New Zealand. One specimen of this moth was hand collected from the SL during February 2024.

Paranotoreas fulva (At Risk – Declining): specimens were collected in the Ardgour airstrip area (SL) in November 2024, near the eastern end of the airstrip. This species typically occurs locally in dry, open areas with exposed soil, and like *S. oenospora*, shows a frequent association with inland saltpan environments. While its caterpillars have been found eating *Atriplex* plants in saltpans, they also live in places where *Atriplex* doesn't grow. This suggests they can use multiple host plants (R. Hoare, *pers comm*, November 2024). While not regionally endemic, the species was considered a special Otago moth in the alpine environment by Patrick (1994). This species was previously recorded in 2020 near the BOGP site, outside of the ESA, off the State Highway 8 approximately 10km from the nearest edge of the DDF.

Meterana exquisita (At Risk – Uncommon*): a locally common species of moth associated with small-leaved *Olearia* shrublands. It is occasionally found in coastal areas and as far north as South Auckland where it is very rare in its range (R. Hoare, *pers comm*, December 2024). Loss of *Olearia* shrublands has contributed to the increased threat status for this moth. During the BOGP terrestrial invertebrate survey, it was found in the Bendigo Historic Reserve (SL) at the end of October 2024, and in the DDF at the beginning of November 2024.

Ichneutica sistens (At Risk – Uncommon*): is a local tussock grass and shrubland moth occurring in both the North and South Islands that feeds on tussock species such as *Poa cita* found within the ESA. There is some evidence that this moth has declined (R. Hoare, *pers comm*, July 2024), and the NZTCS status is expected to change from Data Deficient to At Risk. *I. sistens* was found in very high numbers in many locations across the ESA during field surveys. This suggests the area may represent a local stronghold for the population in Otago, although *I. sistens* is also found within other regions of New Zealand.

***Scythris* sp.** (not assessed – of importance): a species of small, slender-bodied, inconspicuous moth. They have a distinctive resting posture with their wings folded tightly around their body. There is some uncertainty to the specific species of *Scythris* found on site as the Scythrididae family contains many taxonomically unresolved and unnamed species (R. Hoare, *pers comm*, December 2024). This species appeared to have a close association with *Carmichaelia* at the BOGP site with several larvae specimens collected off *Carmichaelia* during a night search in November 2024 (SL). The *Carmichaelia* host plant occurs widely within the Otago region, although the plants within the ESA appear to be sparse and in poor condition. Only larvae were found during the field surveys, although adult *Scythris* are typically difficult to find as they are not attracted to light at night.

Neuroptera (net-winged insects)

Among the net-winged insects, fewer than five individuals were recorded, including the introduced species *Micromus tasmaniae*.

Orthoptera (wētā, grasshoppers, and crickets)

All nine Orthoptera identified to species level are endemic to New Zealand. The specimens were largely represented by field crickets (*Bobilla nigrova*) and wētā (*Pleioplectron thomsoni*), with counts exceeding the hundreds in the case of the crickets.

Most of Orthopteran species were classified as 'Not Threatened' with one species of grasshopper that has not been assessed (*Sigaus tumidicauda*). The one notable species is described below.

Phaulacridium otagoense (At Risk – Declining): a short-horned grasshopper which primarily inhabits semi-arid alpine grasslands, preferring drier, more exposed hillsides often grazed by rabbits (Westerman and Ritchie 1984). New Zealand short-horned grasshoppers rely on open areas for basking and will forage in natural and modified grasslands (Watson 1970; Chapman 1987). *P. otagoense* are diurnal insects that find cover under vegetation or rocks during cold temperatures and have a year-long life cycle (Sivyer *et al.* 2018). Recent information suggests that the Dunstan Lake area and Lindis Valley may serve as the last strongholds for the population, which is threatened primarily by habitat modification (Sivyer *et al.* 2018). The species is likely interbreeding with *P. marginale*, a closely related but 'Not Threatened' species of short-horned grasshopper (Sivyer *et al.* 2018) that was also found across the ESA.

The threat status of *P. otagoense* has recently changed from 'Not Threatened' to 'At Risk: Declining', as the population is large but sparse, and facing an ongoing or forecasted decline of 10% to 70% (Trewick *et al.* 2022). *P. otagoense* were collected using pitfall traps and manual searches at several sample sites within the DDF.

Zygentoma (silverfish), Psocodea (lice), and Trichoptera (caddisflies)

There were only a few unidentified silverfish and lice captured in the pitfall traps. Although caddisflies appeared in the light trap samples, they are aquatic invertebrates and thus not included in this report.

4.1.7 Malacostraca

Amphipoda

Amphipods were discovered at several locations and included the Talitridae family, which consists of sandhoppers and landhoppers commonly seen in New Zealand.

Isopoda

The only isopod identified to species level was the common rough woodlouse (*Porcellio scaber*), an introduced and abundant cosmopolitan species that generally feeds on decaying leaf litter. Isopod taxa were more abundant at transects and areas with denser vegetation.

4.1.8 Myriapoda

Centipedes (Chilopoda) were found at several transect and centroid sites across the ESA, and millipedes (Diplopoda) were found at a single sample site. Specimens were only identified to order level.

4.2 Abundance and diversity measures

4.2.1 Overview

In broad terms, the relative abundance, species richness, and diversity of terrestrial invertebrates were comparable between the DDF and SL sites. This pattern was consistent across all sampling techniques, including light trapping, pitfall trapping, wooden discs, foliage beating, and manual searches.

At a high level, there is no significant difference in terrestrial invertebrate communities between survey zone (PERMANOVA, $P > 0.348$) or habitat type (PERMANOVA, $P = 0.075$). There was a significant difference in the assemblage of species found depending on which sampling strategy was used (PERMANOVA, $P > 0.007$). TM sites consistently captured richer and more diverse invertebrate communities compared to the RM sites, and targeted hand collection sites captured a range of species not found otherwise.

Significant variation was observed between individual sites across the ESA, suggesting patchy distribution of invertebrate species. A noteworthy finding was the presence of numerous species recorded in very low abundance, contrasted with a small number of dominant species—particularly evident among Coleoptera and Araneae. This distribution pattern is common in invertebrate community datasets (Magurran, 2004) and has been previously documented in New Zealand spider communities (Ball *et al.* 2022; Lamont *et al.* 2017) as well as beetle assemblages (Ward *et al.* 2014).

Seasonal variations were evaluated exclusively through moth light trapping data, as this was the only formal survey methodology implemented at identical sites across multiple periods. These moth communities exhibited pronounced seasonal differences.

4.2.2 Light trapping

Close to 16,000 moths and night flying insects were collected using light traps at RM sites across the ESA. Overall, the characteristics of moths between the two survey zones were similar, however individual sample sites within each zone exhibited considerable variation, indicating patchiness across the landscape. This is particularly apparent with the abundance of invertebrates caught with light traps, where counts ranged from below 100 to over 3,000 per trap set (Figure 13). This was also seen with richness, ranging from 4 to 21 genera per trap set. The variation between sites was considerably lower during the early summer period (December 2023) compared to the late summer (March/April 2024) survey period.

The abundance, genera richness, and diversity of moths was similar between project zones, when survey period and habitat type were accounted for (all GLMM, $P > 0.05$). The abundance, richness, and diversity of moths did not differ between the five habitat types at the RM sites where light traps were deployed (all GLMM, $P > 0.05$).

The late summer (March/ April 2024) light trapping survey recorded significantly more moths and higher genera richness compared to the early summer (December 2023) survey (both GLMM, $P < 0.02$). As shown in Figure 13, the variation between sites for both moth richness and abundance was also higher in the March 2024 survey. No differences were observed between the survey periods for Shannon's (GLMM, $P > 0.05$) and Simpson's (GLMM, $P > 0.05$) diversity indices. This is likely due to similar ratios of species number to abundance, even though the actual counts varied.

At a species level, across the entire ESA there were 20 species of moths that were recorded during both the December 2023 and March 2024 light trapping surveys. Twelve of these were found in both the DDF and SL, while the remaining eight were only found in one of the survey zones.

Most 'notable species' caught in light traps exhibited strong seasonal variations, often appearing in only one survey period, a specific survey zone, or even a single sample site. Section 4.1 provides detailed descriptions of these species, including their survey timings and locations. Species composition showed significant variation between the survey periods from early (December 2023) to later summer (March/ April 2024).

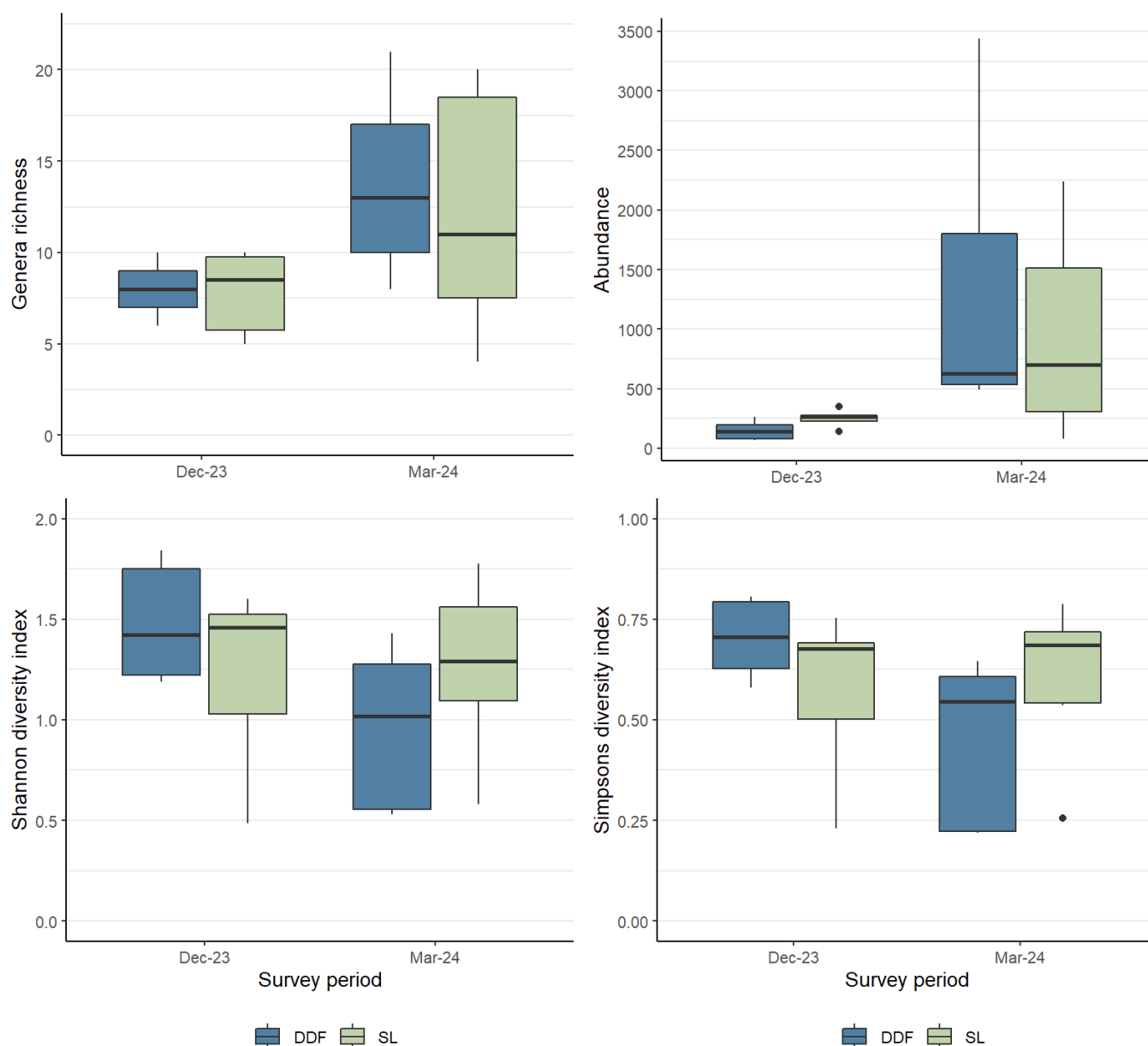


Figure 13. Genera richness (no. of genera), abundance (no. of individuals), Shannon's and Simpson's diversity indices for Lepidoptera collected using light traps between two survey zones (DDF: Direct Disturbance Footprint, SL: Surrounding Landscape) and periods (December 2023 and March 2024).

4.2.3 Pitfall trapping

More than 12,000 terrestrial invertebrate specimens were collected in pitfall traps throughout the ESA, comprising 25 distinct orders. Similar to light trapping results, the DDF and SL survey zones displayed comparable overall characteristics for invertebrates captured using pitfall traps, though considerable variation was observed between individual sample sites within each zone (Figure 14).

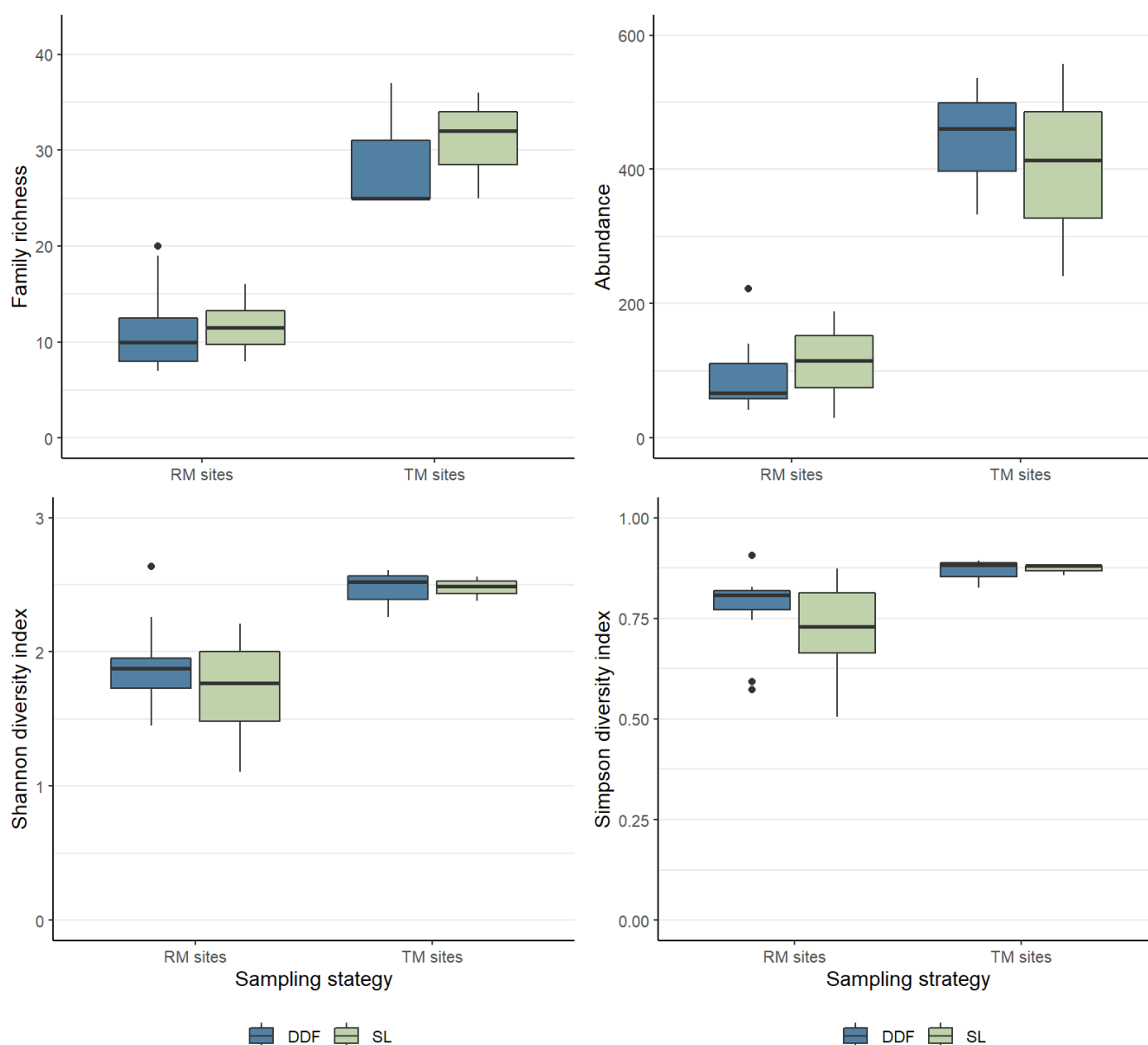


Figure 14. Family richness (no. of families), abundance (no. of individuals), Shannon's and Simpson's diversity indices for terrestrial invertebrates collected using pitfall traps between two survey zones (DDF: Direct Disturbance Footprint, SL: Surrounding Landscape)

This patchiness is apparent with the abundance of terrestrial invertebrates caught in pitfall traps; where RM sites ranged from 30 individuals to over 200 individuals per site, and TM sites ranged from approximately 240 to over 550 specimens per site. 140 different species were found using this method, with 53 species only found in the DDF, and 40 species found only in the SL.

There were no notable differences in invertebrate family richness, abundance, Shannon's diversity, and Simpson's diversity across survey zones or habitat types (GLMM, >0.05).

Pitfall trapping at TM sites showed higher family richness (GLMM, $P < 0.001$) and Shannon's diversity (GLMM, $P < 0.05$) relative to pitfall trapping at RM sites, although there was not a significant difference in abundance ($P > 0.1$) or Simpson's diversity (GLMM, $P > 0.1$).

4.2.4 *Wooden discs*

In total, 57 specimens were found using wooden discs, with the majority identifiable to at least 16 unique species, while some specimens could only be classified to family or genus level. The most frequently encountered taxa under wooden discs were carabid beetles, scarab beetles, and spiders, along with ants and occasional moths from the Noctuidae family.

Specimen abundance under wooden discs was consistently low, typically limited to one or two individuals per disc when any were present. Several RM sites and two TM sites yielded no terrestrial invertebrates beneath any discs within the site. While there is some variation between sampling sites, as indicated by boxplot ranges (Figure 15), the actual value differences are minimal, with abundances ranging from zero to a maximum of eight specimens at a site.

No statistically significant differences were detected in abundance or diversity measures of terrestrial invertebrate communities between the DDF and SL zones (Brown-Mood Median, $P>0.05$). Similarly, comparisons between RM and TM sites revealed no statistically significant differences in abundance, richness, or diversity of terrestrial invertebrates collected via wooden disc sampling (Brown-Mood Median, $P>0.05$).

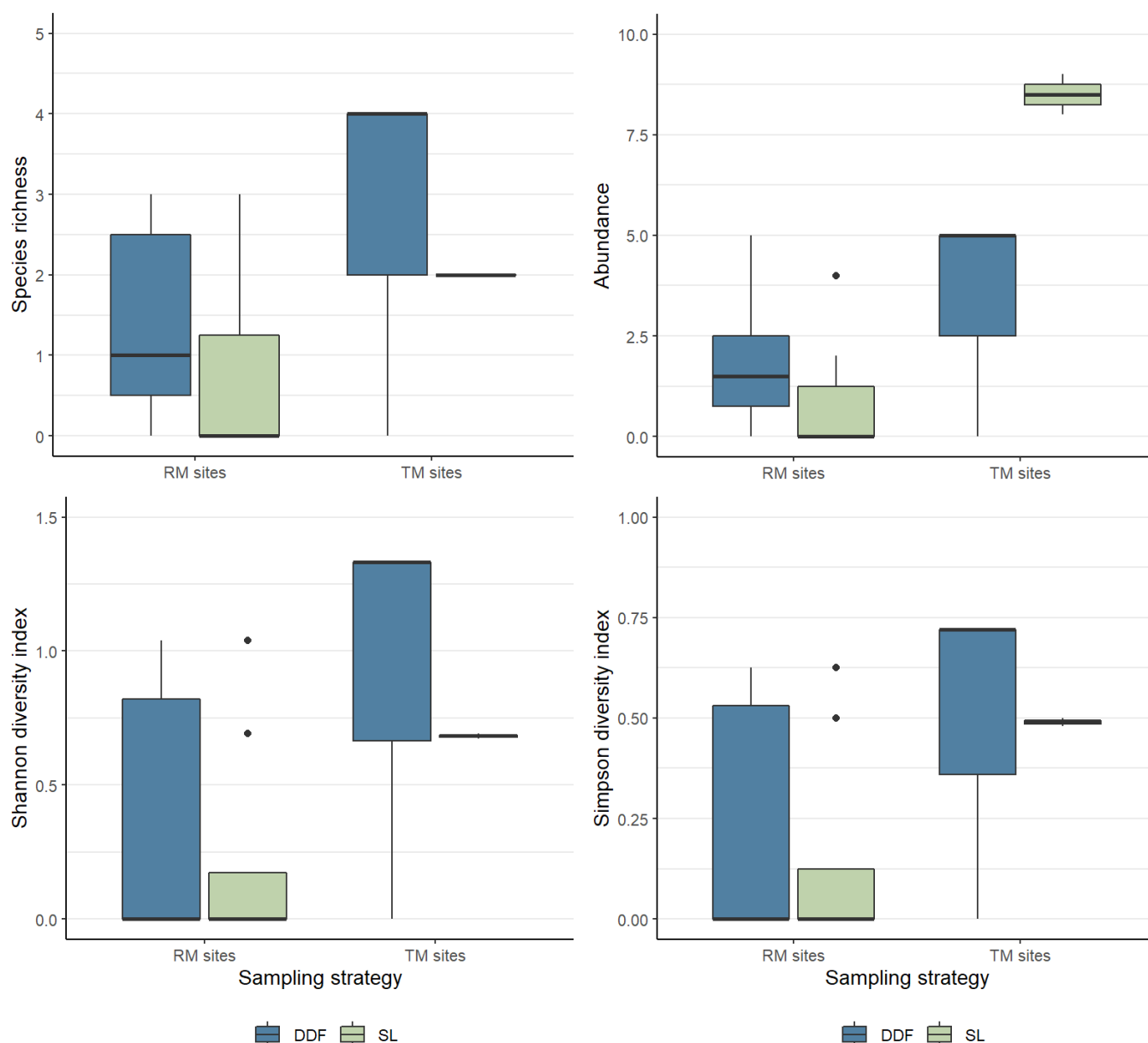


Figure 15. Species richness (no. of species), abundance (no. of individuals), Shannon's and Simpson's diversity indices for terrestrial invertebrates per site, collected using wooden discs, between two survey zones (DDF: Direct Disturbance Footprint, SL: Surrounding Landscape) and sampling strategies (RM sites and TM sites).

4.2.5 Foliage beating

A total of 368 terrestrial invertebrates were collected using foliage beating across the ESA. These were predominantly small specimens that were difficult to classify taxonomically. These specimens represented nine taxonomic orders, with Hemiptera ("true bugs") comprising nearly one-third of all collected individuals, along with a large proportion of spiders, beetles and mites.

Due to the low taxonomic resolution of specimens collected using this technique, statistical comparison of community richness and diversity is not possible. Nevertheless, both survey zones shared most taxonomic orders found during foliage beating. The only differences observed were Orthoptera and Diptera, represented by just three specimens, which were found exclusively in the SL zone but absent from the DDF using this sampling method.

The abundance of terrestrial invertebrates collected per RM site ranged from 12 to 54 specimens (Figure 16) and did not significantly differ between the two survey zones (ANOVA, $P>0.05$).

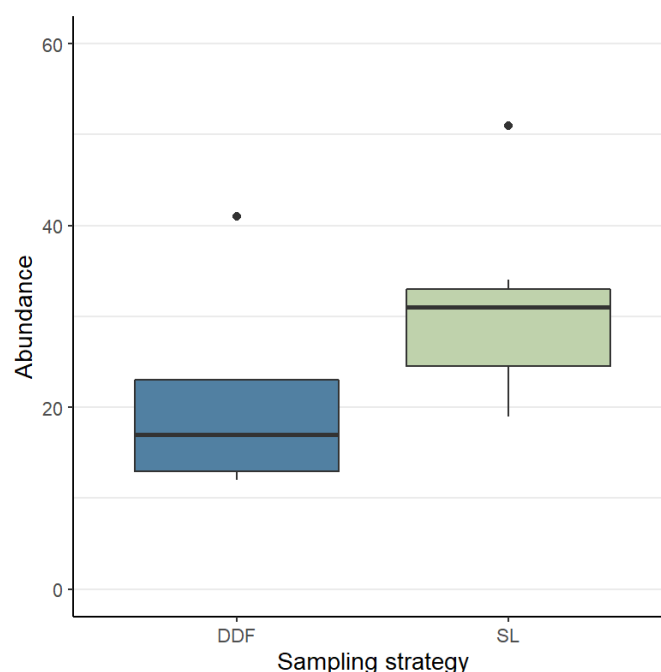


Figure 16. Abundance (no. of individuals) of terrestrial invertebrates per RM site, collected using foliage beating, between two survey zones (DDF: Direct Disturbance Footprint, SL: Surrounding Landscape).

4.2.6 Manual searching

Manual searches conducted at RM and TM sites identified more than 168 specimens representing 45 species, with most classified to a high taxonomic resolution. Manual searching at targeted hand collection sites (separate from RM and TM sites) yielded 135 different species. Due to the potential impact of methodology on results, only the RM and TM data were included in the statistical analyses for this section.

Terrestrial invertebrates were significantly more abundant at TM sites compared to RM sites (Brown-Mood Median, $P<0.01$). TM sites also exhibited significantly higher species richness (Brown-Mood Median, $P<0.01$) and greater diversity as measured by both Shannon's and Simpson's indices (Kruskal-Wallis, $P<0.05$ for both) (Figure 17).

Despite the distinctions between RM and TM sites, comparisons between DDF and SL zones revealed patterns consistent with other sampling techniques, showing no significant differences in terrestrial invertebrate abundance, genera richness, or diversity indices between these zones (Figure 17) (Brown-Mood Median, all $P>0.5$).

Despite searching, no terrestrial invertebrates were collected during manual searches at nine RM sites, although these sites had specimens collected through other sampling methods. Manual search methods can be sensitive to the environmental conditions at the time of the search, and the shorter duration compared to the extended deployment periods of pitfall and light traps likely contributed to lower collection rates.

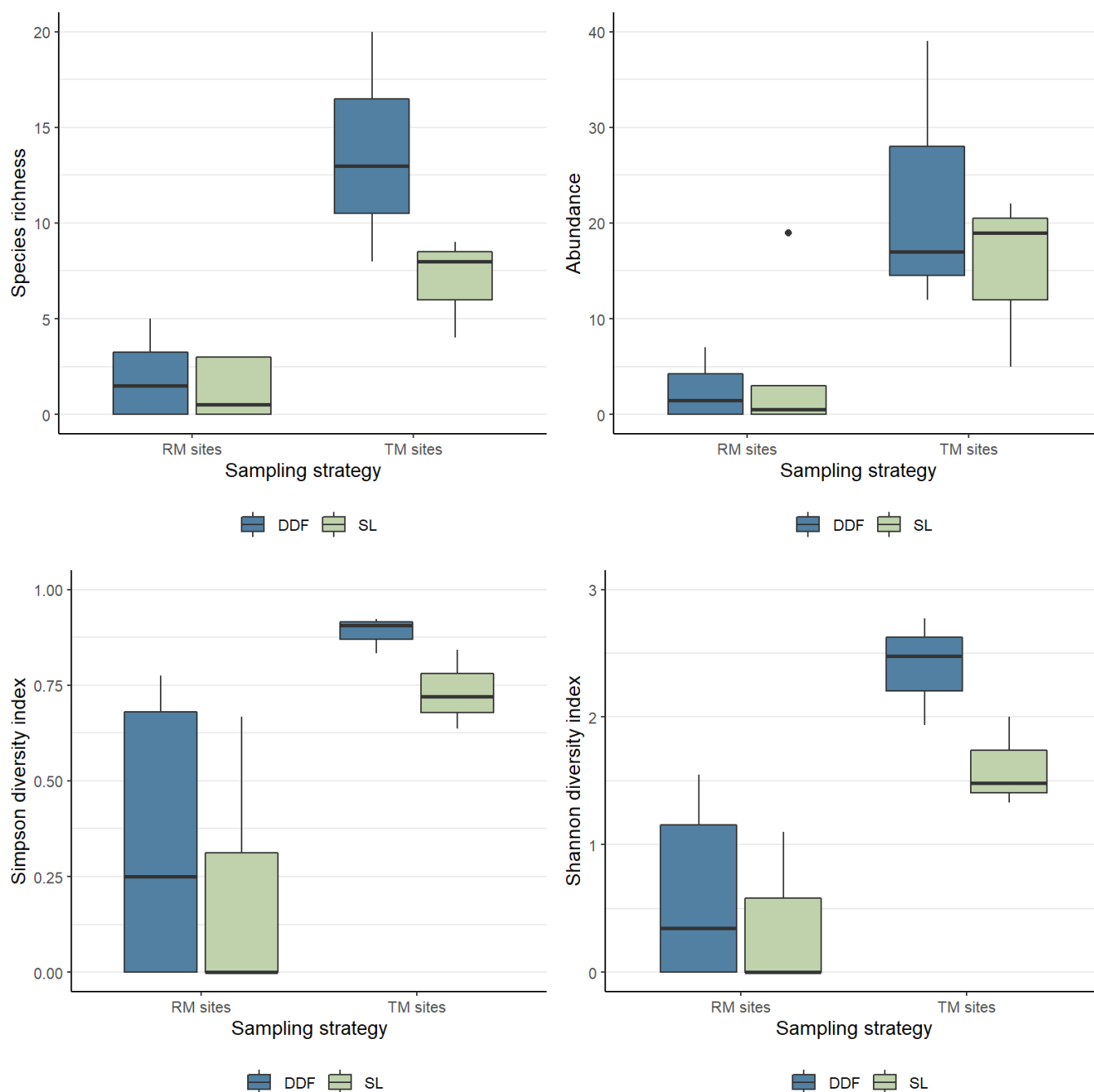


Figure 17. Species richness (no. of species), abundance (no. of individuals), Shannon's and Simpson's diversity indices of terrestrial invertebrates per site, collected using manual searching, between two survey zones (DDF: Direct Disturbance Footprint, SL: Surrounding Landscape) and sampling strategies (RM sites and TM sites).

4.3 Community composition

The community composition of terrestrial invertebrates across each survey zone is comparable. This is evident in the NMDS plot by the substantial overlap of the 'convex hull' overlays representing the two survey zones (Figure 18, left).

Sampling strategies display distinctly different community composition groupings on the NMDS (Figure 18, right). RM sites exhibit greater variation, suggesting higher diversity across these locations, while TM sites cluster more tightly together. Hand collection sites appear separated from both RM and TM sites, indicating they captured a distinctive community composition with fewer shared species compared to other sites. Ad-hoc hand collections frequently targeted species less likely to be captured using formal sampling methods, including day-flying moths, cicadas, and bees.

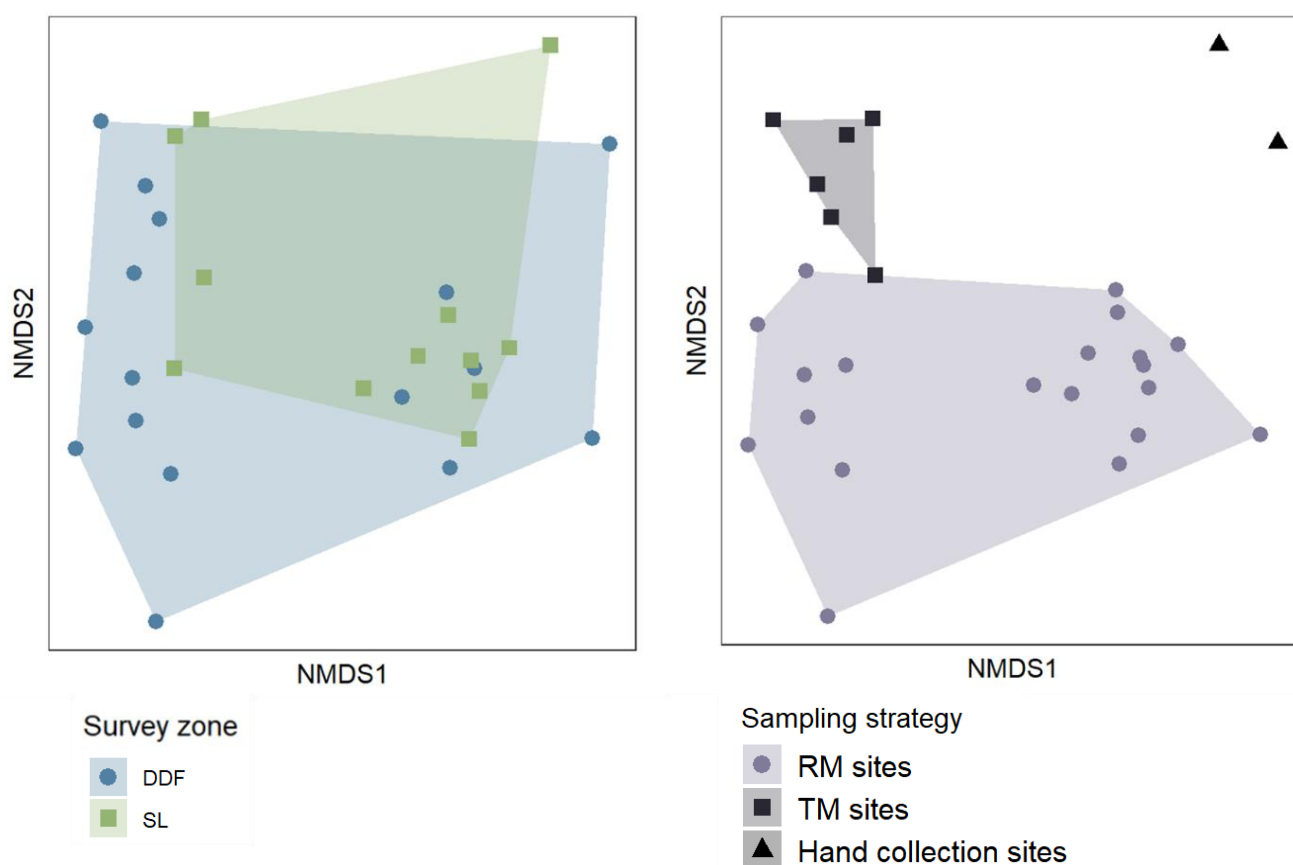


Figure 18. Non-metric multidimensional scaling (NMDS) with convex hulls showing project zone (left) and sampling strategy (right). Each dot on the diagram represents a sample site, with dots that are closer together having more shared invertebrate species found. NMDS used Sorensen's distance matrix on invertebrate presence-absence data, stress 0.1629.

The NMDS ordination reveals some apparent groupings among various habitat types (Figure 19), indicating that the composition of terrestrial invertebrates differs across these habitats. Nevertheless, the observed overlap of these groups suggests that certain taxa are shared between different habitat types to some extent.

NMDS ordination suggests that terrestrial invertebrate community composition shows some association with specific habitat types. The 'mixed scrubland' habitat forms a distinct cluster, indicating invertebrate communities that differ notably from other habitats.

The 'mosaic' habitat also forms a somewhat distinct grouping, though with greater dispersion indicating that community composition is variable among sites within this habitat type. Most of the sampled areas classed as 'Mosaic' habitat types were either transects or hand collection locations.

Most other habitat types exhibit substantial overlap in the central region of the plot, suggesting similarities in the invertebrate communities between the various habitat types. Certain habitats, particularly 'native dominant tussockland', display wide dispersion, indicating considerable variability in invertebrate community composition within this single habitat classification.

When investigating the association between terrestrial invertebrates and habitat type, it is important to consider the impact of specific host-plant relationships many invertebrate species have. Multiple habitat types share some overlap of species, where the plant condition and proportion of dominant plant species differs between the categories. For example, the habitat types 'Native Dominant Tussockland' and 'Mixed Tussock Shrubland and Exotic Grassland' both contain *Poa cita*, a native silver tussock, which is a known host plant to two notable species recorded during field surveys – *Elachista helonoma* and *Ichneutica sistens*. However, the proportion of *Poa cita* and other native tussocks differs between the two habitat type categories. At a wider scale, where broad-scale habitat type differs, areas that support similar specific host-plant relationships may present as sharing the same species.

Additionally, it is important to consider the mapped boundaries of habitat types, and the proximity of neighbouring habitat types. In some cases, a surveyed area or sample site may be close to a different habitat type. Given that many terrestrial invertebrates are mobile, and may disperse large distances, it is not unexpected for the scale of habitat delineation to be too high for some species. While whole communities may not appear strongly associated with these habitat types there is likely smaller-scale associations which have a greater importance for terrestrial invertebrates.

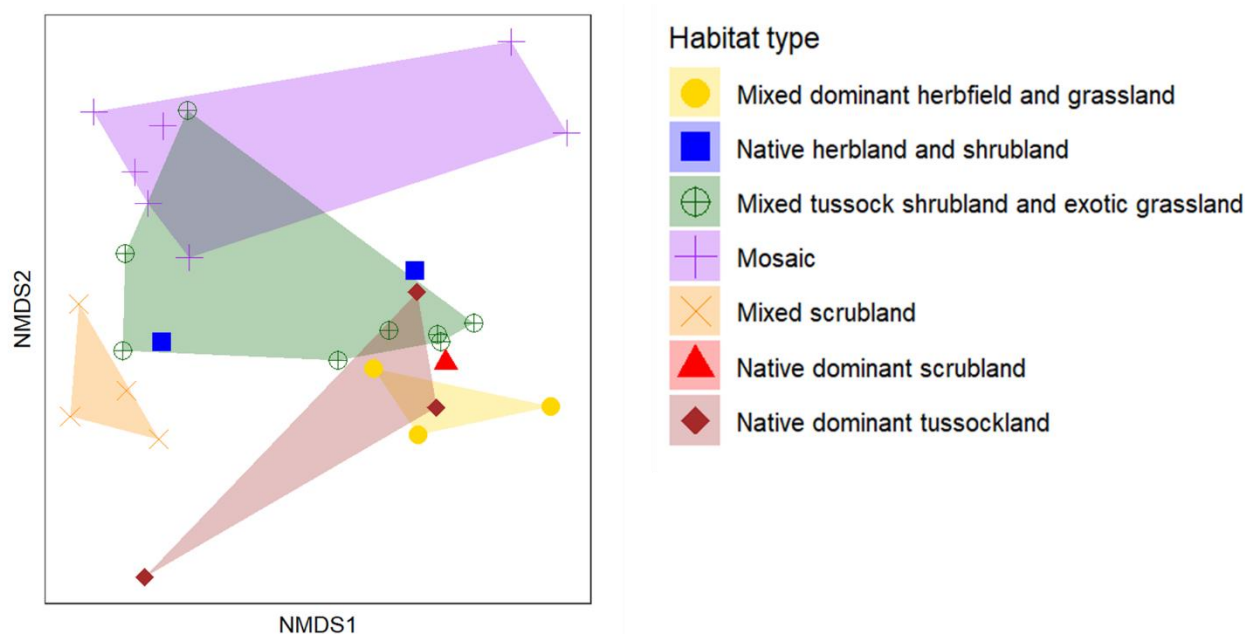


Figure 19. Non-metric multidimensional scaling (NMDS) plot on invertebrate presence-absence data (Sorensen's distance matrix, stress 0.169). Convex hulls show habitat type.

Appendix 1 Overview of Terrestrial invertebrates per Order

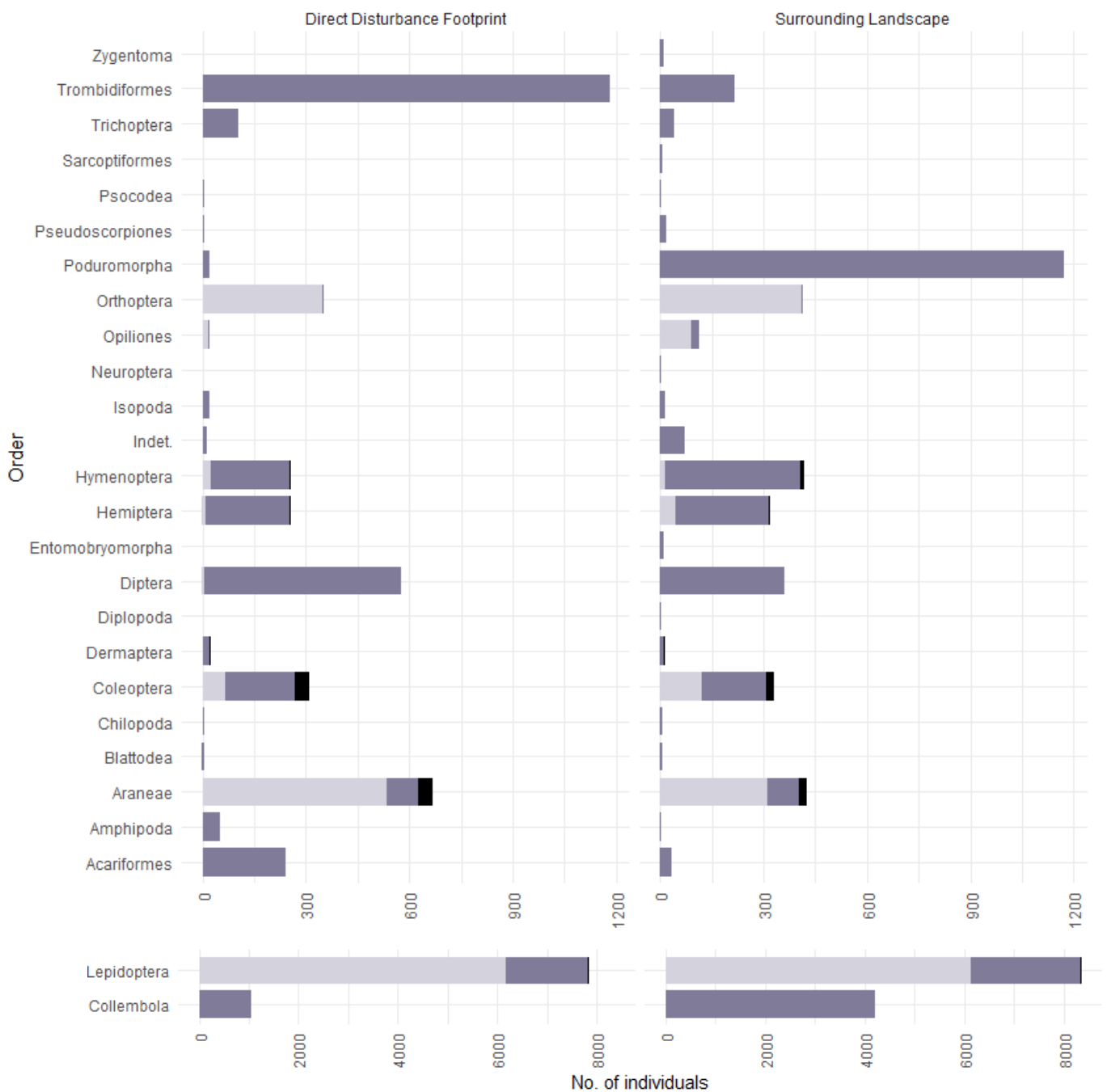


Figure 20. Number of terrestrial invertebrates for each order, collected across the ESA using light trapping, pitfall trapping, manual searching, foliage beating and wooden discs. Proportions of native (light grey) and introduced species (black) are shown, as well as N/A (dark grey) which includes specimens not identified to species level.

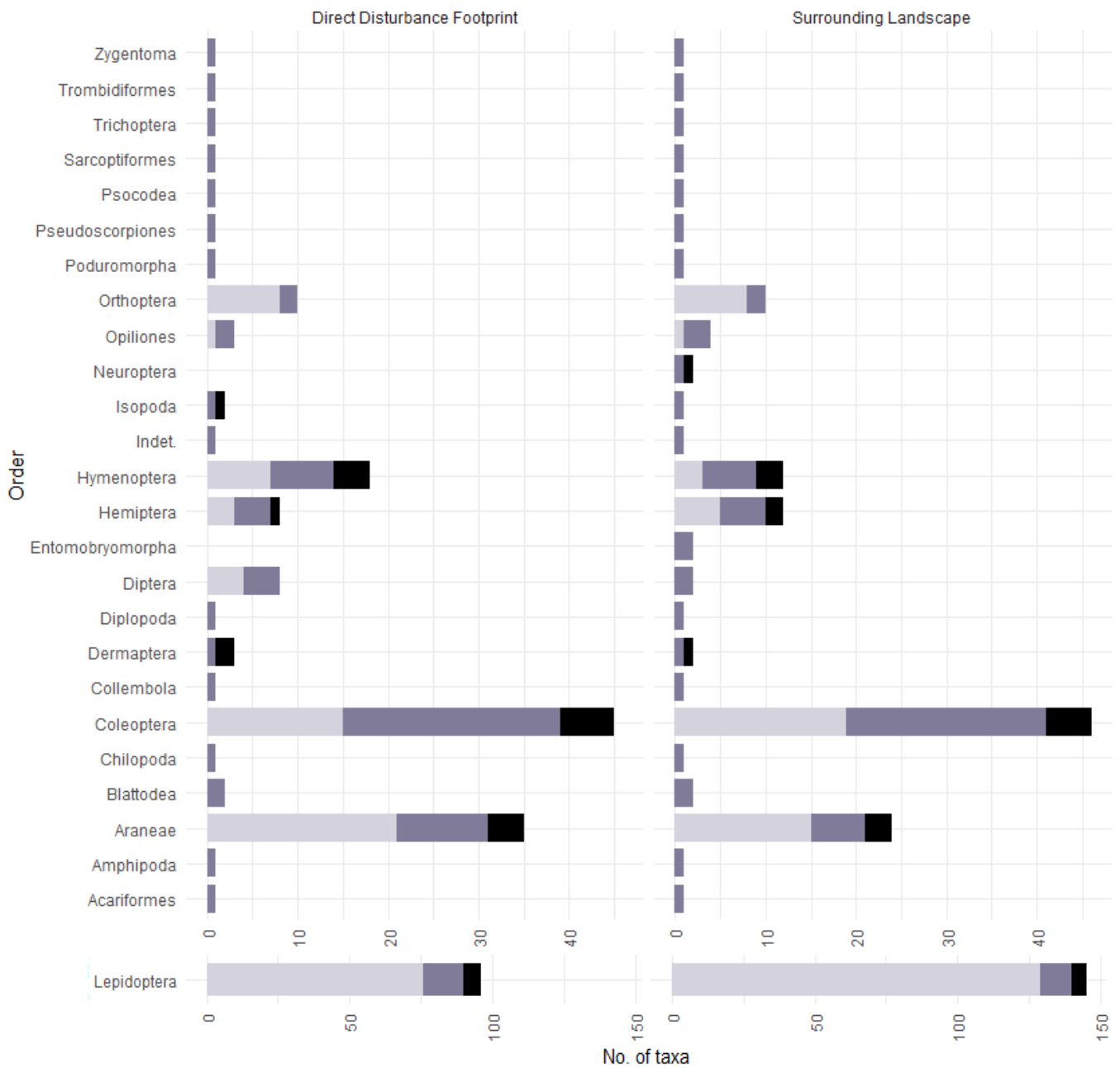


Figure 21. Number of distinct terrestrial invertebrate taxa for each order, collected across the ESA using light trapping, pitfall trapping, manual searching, foliage beating, and wooden discs. Proportions of native (light grey) and introduced species (black) are shown, as well as N/A (dark grey) which includes all taxa not identified to species level.

Appendix 2 Terrestrial invertebrate survey list

Table 3. List of terrestrial invertebrate species, threat status, sample collection location and timing, and counts for the BOGP survey. An asterisk (*) represents a revised NZTCS threat category for NZ lepidoptera currently undergoing review.

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
Arachnida	Acariformes	Indet.	indet. indet.	N/A	N/A		241			32		273
	Araneae	Anapidae	<i>Holarchaea</i> indet.	N/A	N/A					1		1
			<i>Taphiassa punctata</i>	Native	Not Threatened		1					1
		Araneidae	indet. indet.	N/A	N/A		1					1
		Clubionidae	<i>Clubiona contrita</i>	Native	Not Threatened					1		1
			<i>Clubiona huttoni</i>	Native	Not Threatened					1		1
			<i>Clubiona</i> indet.	N/A	N/A		1					1
		Corinnidae	<i>Nyssus coloripes</i>	Introduced	Introduced and Naturalised		18			4		22
		Cyatholipidae	indet. indet.	N/A	N/A					1		1
		Cycloctenidae	<i>Cycloctenus duplex</i>	Native	Not Threatened		1					1
			<i>Cycloctenus</i> indet.	N/A	N/A					2		2
			indet. indet.	N/A	N/A					1		1
			<i>Pakeha maxima</i>	Native	Not Threatened		145			92		237
			<i>Pakeha meridionalis</i>	Native	Not assessed		1					1
		Desidae	<i>Cambridgea agrestis</i>	Native	Not Threatened		2					2
			indet. indet.	N/A	N/A			1				1
			<i>Maniho</i> indet.	N/A	N/A		1					1
			<i>Maniho meridionalis</i>	Native	Not Threatened		26			7		33
			<i>Poaka graminicola</i>	Native	Not Threatened		5			10		15
		Gnaphosidae	<i>Anzacia gemmea</i>	Native	Not Threatened		5			2		7
			indet. indet.	N/A	N/A		11			11		22
			<i>Matua</i> indet.	N/A	N/A		1					1
			<i>Matua valida</i>	Native	Not Threatened		1			2		3
		Hahniidae	<i>Rinawa otagoensis</i>	Native	Not Threatened		94			2		96

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
		Idiopidae	<i>Cantuaria sp.1</i>	Native	N/A					1		1
		Indet.	indet. indet.	N/A	N/A		35			48		83
		Linyphiidae	<i>Haplinis sp.1</i>	Native	N/A		4			2		6
			indet. indet.	N/A	N/A		3			5		8
			<i>Microctenonyx subitaneus</i>	Introduced	Introduced and Naturalised		19			11		30
			<i>Mynogleninae</i> indet.	N/A	N/A		3			1		4
			<i>Parafroneta</i> indet.	N/A	N/A		1					1
			<i>Tenuiphantes tenuis</i>	Introduced	Introduced and Naturalised		2					2
		Lycosidae	<i>Anoteropsis hilaris</i>	Native	Not Threatened		121	3		117	2	243
			<i>Anoteropsis sp.1</i>	N/A	N/A		25	1		13		39
			<i>Anoteropsis sp.2</i>	N/A	N/A		1					1
			indet. indet.	N/A	N/A		1					1
			<i>Notacosa bellicosa</i>	Native	Not assessed			4				4
			<i>Notocosa bellicosa</i>	Native	Not Threatened		1					1
		Mimetidae	<i>Australomimetes sp.1</i>	N/A	N/A		1					1
		Neopilionidae	<i>Forsteropsalis marplei</i>	Native	Not assessed		7					7
		Orsolobidae	<i>Ascuta sp.</i>	Native	N/A					1		1
		Pisauridae	<i>Dolomedes minor</i>	Native	Not Threatened		6					6
		Salticidae	indet. indet.	N/A	N/A		4			4		8
			<i>Trite pollardi</i>	Native	Not Threatened					1		1
		Theridiidae	<i>Euryopsis nana</i>	Native	Not Threatened		1					1
			indet. indet.	N/A	N/A		1			2		3
			<i>Steatoda grossa</i>	Introduced	Introduced and Naturalised		2			8		10
			<i>Steatoda</i> indet.	N/A	N/A					1		1
			<i>Steatoda truncata</i>	Native	Not Threatened		6					6

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
		Thomisidae	<i>Cymbachina (=Diaea) urquharti</i>	Native	Not assessed					1		1
		Zoropsidae	<i>Rinawa</i> indet.	N/A	N/A			1				1
			<i>Uliodon antiquata</i>	Native	Not assessed			1				1
			<i>Uliodon</i> indet.	Native	Not assessed		2					2
			<i>Uliodon sp.1</i>	Native	Not assessed		97			68		165
	Opiliones	Indet.	indet. indet.	N/A	N/A					2		2
		Neopilionidae	<i>Forsteropsalis</i> indet.	N/A	N/A		1			8		9
			<i>Forsteropsalis marplei</i>	Native	Not assessed		16			92		108
			indet. indet.	N/A	N/A		3			5		8
		Triazenychidae	<i>Nuncia</i> indet.	N/A	N/A					7		7
	Pseudoscorpiones	Chthoniidae	indet. indet.	N/A	N/A		1			3		4
		Indet.	indet. indet.	N/A	N/A		4			15		19
	Sarcoptiformes	Indet.	indet. indet.	N/A	N/A		1			4		5
		Neolididae	indet. indet.	N/A	N/A		1			1		2
	Trombidiformes	Caeculidae	indet. indet.	N/A	N/A		1					1
		Trombidiidae	indet. indet.	N/A	N/A		1181			217		1398
Entognatha	Collembola	Indet.	indet. indet.	N/A	N/A		1051			4200		5251
	Entomobryomorpha	Indet.	indet. indet.	N/A	N/A					6		6
		Paronellidae	<i>Salininae</i> indet.	N/A	N/A					3		3
	Poduromorpha	Indet.	indet. indet.	N/A	N/A		20			1171		1191
Insecta	Blattodea	Blattidae	<i>Celatoblatta</i> indet.	N/A	N/A			1		1		2
		Indet.	indet. indet.	N/A	N/A		3			5		8
	Coleoptera	Aderidae	<i>Scraptogetus sp.1</i>	N/A	N/A		1					1
		Anobiidae	indet. indet.	N/A	N/A		1	1		11		13
			<i>Ptinus</i> indet.	N/A	N/A		2					2
		Anthicidae	<i>Anthicus sp.1</i>	N/A	N/A		6			3		9
			indet. indet.	N/A	N/A		1					1

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Pseudocyclodinus sp.1</i>	N/A	N/A					6		6
			<i>Pseudocyclodinus sp.2</i>	N/A	N/A		1					1
		Carabidae	<i>Anisodactylus binotatus</i>	Native	Not assessed		1					1
			<i>Cerabilia</i> indet.	N/A	N/A		1					1
			<i>Harpalus new sp.</i>	Native	New species		1			2		3
			<i>Holcaspis sp.1</i>	N/A	N/A					2		2
			<i>Hypharpax sp.1</i>	N/A	N/A		1			2		3
			indet. indet.	N/A	N/A					1		1
			<i>Mecodema impressum</i>	Native	Not assessed		8	3		2	1	14
			<i>Mecodema tibiale</i>	Native	Not assessed		3	6		8	7	24
			<i>Megadromus new sp.1</i>	Native	New species					4		4
			<i>Megadromus new sp.2</i>	Native	New species					2		2
			<i>Megadromus sandageri</i>	Native	Not assessed		1					1
			<i>Notagonum sp.1</i>	N/A	N/A		2			2		4
			<i>Notagonum sp.2</i>	N/A	N/A					2		2
			<i>Notagonum feredayi</i>	Native	Not assessed					1		1
			<i>Oregus aereus</i>	Native	Not assessed		6	3		4		13
		Cerambycidae	<i>Ptinosoma sp.1</i>	N/A	N/A					3		3
			<i>Ptinosoma sp.2</i>	N/A	N/A		1					1
		Chrysomelidae	<i>Chrysolina hyperici</i>	Introduced	Introduced and Naturalised		6	2		1		9
			<i>Chrysolina</i> indet.	Native	Not assessed			1				1
		Ciidae	indet. indet.	N/A	N/A		1					1
		Coccinellidae	<i>Adalia bipunctata</i>	Native	Not assessed		1					1
			<i>Coccinella leonina</i>	Native	Not assessed					1	1	2

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Coccinella undecimpunctata</i>	Introduced	Introduced and Naturalised		1				2	3
			indet. indet.	N/A	N/A		3			4		7
			<i>Rhyzobius</i> indet.	N/A	N/A					1		1
		Corylophidae	indet. indet.	N/A	N/A		9					9
		Cryptophagidae	<i>Paratomaria</i> indet.	N/A	N/A					1		1
			<i>Paratomaria sp.1</i>	N/A	N/A		1					1
		Curculionidae	<i>Eugnomus dispar</i>	Native	Not assessed					1		1
			indet. indet.	N/A	N/A		17			39		56
			<i>Inophloeus new sp.</i>	Native	New species		4	14		5	38	61
			<i>Nonnotus albanians</i>	Native	Not assessed					1		1
			<i>Nonnotus dispar</i>	Native	Not assessed					2		2
			<i>Otiorhynchus ovatus</i>	Introduced	Introduced and Naturalised		13			17		30
			<i>Sitona obsoletus</i>	Introduced	Introduced and Naturalised		3			2		5
		Elateridae	<i>Arhopalus ferus</i>	Native	Not assessed			1				1
		Erotylidae	indet. indet.	N/A	N/A		1					1
		Indet.	indet. indet.	N/A	N/A		8			41		49
		Latridiidae	<i>Bicava sp.1</i>	N/A	N/A		2					2
			<i>Bicava sp.2</i>	N/A	N/A		1					1
			<i>Cartodere bifasciata</i>	Introduced	Introduced and Naturalised		8			2		10
			<i>Cartodere nodifer</i>	Introduced	Introduced and Naturalised		10					10
			<i>Corticaria</i> indet.	N/A	N/A		10			5		15
			<i>Enicmus</i> indet.	N/A	N/A		1					1
			<i>Enicmus sp.1</i>	N/A	N/A		1			2		3
			<i>Enicmus sp.2</i>	N/A	N/A					2		2
			indet. indet.	N/A	N/A		24			4		28
			<i>Lithostygnus sp.1</i>	N/A	N/A		1			4		5

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
		Leiodidae	indet. indet.	N/A	N/A		2					2
		Melyridae	<i>Dasytes sp.1</i>	N/A	N/A					1		1
		Mycetophagidae	indet. indet.	N/A	N/A		1					1
			<i>Nototriphyllus sp.1</i>	N/A	N/A		2			2		4
		Nitidulidae	<i>Thalycrodes sp.1</i>	N/A	N/A		1					1
		Ptinidae	<i>Ptinus</i> indet.	N/A	N/A					1		1
		Scarabaeidae	<i>Acrossidius tasmaniae</i>	Native	Not assessed		1					1
			<i>Costelytra giveni</i>	Native	Not assessed			1		1		2
			<i>Odontria autumnalis</i>	Native	Not assessed					4		4
			<i>Odontria</i> indet.	N/A	N/A		2	1		3	2	8
			<i>Odontria refuscens</i>	Native	Not assessed					1		1
			<i>Odontria striata</i>	Native	Not assessed	8	1		11	4		24
			<i>Pyronota festiva</i>	Native	Not assessed		1				2	3
			Scirtidae	indet. indet.	N/A	N/A		3		3		6
			Staphylinidae	<i>Aleochara</i> indet.	N/A	N/A		1				1
				indet. indet.	N/A	N/A		83		28		111
				<i>Omalium</i> indet.	N/A	N/A		1				1
				<i>Ptinosa</i> sp.1	N/A	N/A		1				1
				<i>Tachyporus</i> indet.	N/A	N/A		1				1
				<i>Tasgius sp.1</i>	N/A	N/A		1				1
		Tenebrionidae	<i>Artystona obscura</i>	Native	Not Threatened					1		1
			<i>Artystona sp.1</i>	N/A	N/A					1		1
			<i>Mimopeus elongatus</i>	Native	Not Threatened			1			17	18
			<i>Mimopeus elongatus</i>	Native	Not Threatened					1		1
			<i>Mimopeus sp.1</i>	N/A	N/A					1		1
		Zopheridae	indet. indet.	N/A	N/A		5					5
			<i>Tarphiomimus sp.1</i>	N/A	N/A					8		8

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Zebitoma</i> indet.	N/A	N/A					1		1
	Dermaptera	Forficulidae	<i>Forficula dentata</i>	Introduced	Introduced and Naturalised		2			3		5
		Indet.	indet. indet.	N/A	N/A		21			11		32
		Labiduridae	<i>Fortificula auricularia</i>	Introduced	Introduced and Naturalised		1					1
	Diptera	Asilidae	<i>Neoitamus</i> indet.	N/A	N/A						1	1
		Calliphoridae	<i>Xenocalliphora</i> indet.	N/A	N/A		2					2
		Chloropidae	indet. indet.	N/A	N/A		3					3
		Indet.	indet. indet.	N/A	N/A		481			303		784
		Mycetophilidae	<i>Anomalomyia guttata</i>	Native	Not assessed		1					1
			indet. indet.	N/A	N/A		69			50		119
			<i>Mycetophila colorata</i>	Native	Not assessed		3					3
			<i>Mycetophila subspinigera</i>	Native	Not assessed		2					2
			<i>Zygomyia</i> indet.	N/A	N/A		1					1
		Phoridae	indet. indet.	N/A	N/A		5			3		8
		Sciaridae	indet. indet.	N/A	N/A		2					2
		Sciomyzidae	<i>Neolimnia</i> indet.	N/A	N/A		1					1
		Syrphidae	indet. indet.	N/A	N/A					4		4
			<i>Melangyna novaezelandiae</i>	Native	Not assessed		1					1
		Tachinidae	indet. indet.	N/A	N/A		2					2
		Tipulidae	indet. indet.	N/A	N/A		5					5
	Hemiptera	Aphidae	indet. indet.	N/A	N/A		10					10
		Aphrophoridae	indet. indet.	N/A	N/A		3			3		6
			<i>Philaenus</i> indet.	N/A	N/A		6			20		26
			<i>Philaenus spumarius</i>	Introduced	Introduced and Naturalised					1		1
		Berytidae	<i>Bezu wakefieldi</i>	Native	Not assessed		3					3

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
		Cercopidae	indet. indet.	N/A	N/A		16			58		74
		Cicadellidae	<i>Arawa</i> indet.	N/A	N/A					2		2
			indet. indet.	N/A	N/A					3		3
		Cicadidae	indet. indet.	N/A	N/A		1					1
			<i>Kikihia angusta</i>	Native	Not assessed		3			5		8
			<i>Kikihia</i> indet.	N/A	N/A		1					1
			<i>Kikihia rosea</i>	Native	Not assessed					15		15
			<i>Maoricicada clमितans</i>	Native	Not assessed					15		15
		Cixiidae	indet. indet.	N/A	N/A						5	5
		Coccidae	indet. indet.	N/A	N/A		1					1
		Indet.	indet. indet.	N/A	N/A		198		20	156		374
		Lygaeidae	indet. indet.	N/A	N/A		4				1	5
			<i>Nysius huttoni</i>	Native	Not assessed		5			6		11
		Nabidae	<i>Nabis biformis</i>	Native	Not assessed					2		2
			<i>Nabis</i> indet.	N/A	N/A		1			3		4
		Pentatomidae	<i>Dictyotus caenosus</i>	Introduced	Introduced and Naturalised		2			1		3
			indet. indet.	N/A	N/A		1					1
			<i>Oechalia schellenbergii</i>	N/A	N/A						1	1
	Hymenoptera	Apidae	<i>Bombus (Bombus) terrestris</i>	Introduced	Introduced and Naturalised		1		2	1		4
			<i>Bombus (Megabombus) hortorum</i>	Introduced	Introduced and Naturalised		1			2		3
			<i>Bombus (Megabombus) ruderatus</i>	Introduced	Introduced and Naturalised		1			4		5
			<i>Bombus</i> indet.	N/A	N/A					1		1
			indet. indet.	N/A	N/A					1		1
		Bethylidae	indet. indet.	N/A	N/A						1	1

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
		Braconidae	indet. indet.	N/A	N/A		1			1		2
		Colletidae	<i>Leioproctus fulvescens</i>	Native	Not assessed		2					2
		Diapriidae	<i>Basalys</i> indet.	N/A	N/A		1					1
			indet. indet.	N/A	N/A		2					2
		Encyrtidae	indet. indet.	N/A	N/A					1		1
		Formicidae	<i>Chelaner antarcticus</i>	Native	Not assessed		14			11		25
			<i>Huberia striata</i>	Native	Not assessed					1	1	2
			indet. indet.	N/A	N/A		76			249		325
			<i>Prolasius advena</i>	Native	Not assessed		1	2				3
		Ichneumonidae	<i>Aucklandella</i> indet.	N/A	N/A		4			8		12
			<i>Degithina</i> indet.	N/A	N/A		1					1
			indet. indet.	N/A	N/A		8			1		9
			<i>Xanthocryptus novozealandicus</i>	Native	Not assessed		1					1
		Indet.	indet. indet.	N/A	N/A		130			126		256
		Pompilidae	<i>Priocnemis conformis</i>	Native	Not assessed		1				1	2
			<i>Priocnemis sp.1</i>	N/A	N/A		4			1		5
			<i>Sphictostethus</i> indet.	N/A	N/A		1			1		2
			<i>Sphictostethus nitidus</i>	Native	Not assessed		1					1
		Pteromalidae	<i>Pteromalus puparum</i>	Native	Not assessed		2					2
		Reduviidae	<i>Empicoris</i> indet.	N/A	N/A		1					1
		Scelionidae	<i>Baeus</i> indet.	N/A	N/A					2		2
		Vespidae	<i>Polistes chinensis</i>	Introduced	Introduced and Naturalised		1					1
	Indet.	Indet.	indet. indet.	N/A	N/A	1	13		1	66		81
	Lepidoptera	Choreutidae	<i>Tebenna micalis</i>	Native	Not assessed					1		1
		Crambidae	<i>Achyra affinitalis</i>	Introduced	Introduced and Naturalised		2			3		5

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Deana hybreasalis</i>	Native	Not assessed					1	1	2
			<i>Eudonia cataxesta</i>	Native	Not assessed						1	1
			<i>Eudonia chalara</i>	Native	Not assessed			1			1	2
			<i>Eudonia exilis</i>	Native	Not assessed						1	1
			<i>Eudonia</i> indet.	N/A	N/A		19			130		149
			<i>Eudonia leptalea</i>	Native	Not assessed						1	1
			<i>Eudonia oculata</i>	Native	Not assessed					2		2
			<i>Eudonia philerga</i>	Native	Not assessed					1	1	2
			<i>Eudonia rakaiensis</i>	Native	Not assessed					1		1
			<i>Eudonia sabulosella</i>	Native	Not assessed						21	21
			<i>Eudonia submarginalis</i>	Native	Not assessed		1			1		2
			<i>Gadira acerella</i>	Native	Not assessed						2	2
			<i>Hygraula nitens</i>	Native	Not Threatened					1		1
			indet. indet.	N/A	N/A	3	985			1023		2011
			<i>Mnesictena flavidalis</i>	Native	Not assessed		8					8
			<i>Orocrambus ?ordishi</i>	Native	Not assessed		2413			607	1	3021
			<i>Orocrambus corruptus</i>	Native	Not assessed						5	5
			<i>Orocrambus cyclopicus</i>	Native	Not assessed		1807			710		2517
			<i>Orocrambus flexuosellus</i>	Native	Not assessed					1	1	2
			<i>Orocrambus</i> indet.	N/A	N/A		312			577		889
			<i>Orocrambus ordishi</i>	Native	Not assessed		1			2		3
			<i>Orocrambus ramosellus</i>	Native	Not assessed		137			200		337
			<i>Orocrambus vittellus</i>	Native	Not assessed		6			1		7
			<i>Orocrambus vulgaris</i>	Native	Not assessed		3			3		6
			<i>Scoparia chalicodes</i>	Native	Not assessed						1	1
			<i>Scoparia exilis</i>	Native	Not assessed			1			5	6

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Scoparia halopis</i>	Native	Not assessed						1	1
			<i>Tawhitia pentadactyla</i>	Native	Not assessed					3		3
			<i>Udea notata</i>	Native	Not assessed		8			10		18
		Depressariidae	<i>Agonopterix alstromeriana</i>	Introduced	Introduced and Naturalised			1				1
			<i>Agonopterix alstromeriana</i>	Introduced	Introduced and Naturalised		1					1
			<i>Phaeosaces apocrypta</i>	Native	Not assessed						1	1
		Elachistidae	<i>Elachista helonoma</i>	Native	At Risk - Declining*		1			2		3
			<i>Elachista</i> indet.	N/A	N/A			1				1
			<i>Elachista</i> sp.1	N/A	N/A		7			2	1	10
			<i>Elachista</i> sp.2	N/A	N/A						1	1
		Epichoristidae	<i>Epichorista siriana</i>	Native	Not assessed		1					1
		Erebidae	<i>Metacrias huttoni</i>	Native	Not assessed		2			15		17
			<i>Nyctemera annulata</i>	Native	At Risk - Declining*					1		1
			<i>Rhapsa scotosialis</i>	Native	Not assessed	1						1
		Gelechiidae	<i>Kiwaia brontophora</i>	Native	Not assessed						1	1
			<i>Kiwaia</i> indet.	N/A	N/A		11					11
			<i>Kiwaia monophragma</i>	Native	Not assessed						1	1
			<i>Kiwaia parapleura</i>	Native	Not assessed		1			2		3
			<i>Kiwaia thyraula</i>	Native	Not assessed					1	3	4
			<i>Platyedra subcinerea</i>	Native	Not assessed		3				1	4
		Geometridae	" <i>Pseudocoremia</i> " <i>cineracia</i>	Native	Threatened - Nationally Vulnerable	1		1			2	4
			<i>Asaphodes abrogata</i>	Native	Not assessed		3			4		7
			<i>Asaphodes aegrota</i>	Native	Not assessed					1		1

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Asaphodes chlamydota</i>	Native	Not assessed			1			1	2
			<i>Asaphodes recta</i>	Native	At Risk - Declining*		5			12		17
			<i>Austrocidaria ?bipartita</i>	Native	Not assessed			1			2	3
			<i>Austrocidaria gobiata</i>	Native	Not assessed		4	1		6		11
			<i>Austrocidaria similata</i>	Native	Not assessed		4			8		12
			<i>Chloroclystis filata</i>	Introduced	Introduced and Naturalised		1					1
			<i>Dichromodes gypsotis</i>	Native	Not assessed						1	1
			<i>Dichromodes</i> indet.	N/A	N/A		8					8
			<i>Dichromodes sphaeriata</i>	Native	Not assessed					1		1
			<i>Epyaxa lucidata</i>	Native	Not assessed						1	1
			<i>Epyaxa rosearia</i>	Native	Not assessed	47	178	1	29	2	1	258
			<i>Helastia ?christinae</i>	Native	Not assessed						1	1
			<i>Helastia christinae</i>	Native	Not assessed		12			8		20
			<i>Helastia corcularia</i>	Native	Not assessed		2				6	8
			<i>Helastia cryptica</i>	Native	Not assessed						1	1
			<i>Helastia</i> indet.	N/A	N/A			1		29		30
			<i>Helastia triphragma</i>	Native	Not assessed						1	1
			<i>Homodotis megaspilata</i>	Native	Not assessed		2				2	4
			<i>Homodotis</i> sp. A (NZAC (CO))	Native	Threatened - Nationally Endangered*						1	1
			indet. indet.	N/A	N/A					5		5
			<i>Ipana junctilinea</i>	Native	Not assessed	9	9	1	23	8	2	52
			<i>Ischalis fortinata</i>	Native	Not assessed						1	1
			<i>Notoreas Simplex</i>	Native	Not assessed						1	1

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Paranotoreas fulva</i>	Native	At Risk - Declining*						5	5
			<i>Pasiphila sp. 'Olearia'</i>	Native	Threatened - Nationally Vulnerable						1	1
			<i>Pasiphila sphragitis</i>	Native	Not assessed			1		1	1	3
			<i>Poecilasthena schistaria</i>	Native	Not assessed						1	1
			<i>Pseudocoremia colpogramma</i>	Native	Not assessed					2		2
			<i>Pseudocoremia indistincta</i>	Native	Not assessed					2		2
			<i>Pseudocoremia rudisata</i>	Native	Not assessed		3			51		54
			<i>Psuedocoremia rudisata ampla</i>	Native	Not assessed			1				1
			<i>Xanthorhoe semifissata</i>	Native	Not assessed		3			2		5
			<i>Zermizinga indocilisaria</i>	Native	Not assessed				2	1		3
		Glyphipterigidae	<i>Chrysorthenches porphyritis</i>	Native	Not assessed					2		2
			<i>Glyphipterix triselenia</i>	Native	Not assessed		7			1		8
		Grassilaridae	<i>Dialectica scalarisella</i>	Introduced	Introduced and Naturalised		1			1		2
		Hepialidae	<i>Wiseana</i> indet.	N/A	N/A	7		1	2		11	21
			<i>Wiseana umbraculata</i>	Native	Not Threatened*				1			1
		Indet.	indet. indet.	N/A	N/A	150	94		322	78		644
		Lycaenidae	<i>Lycaena common copper</i>	Native	Not Threatened*		1			4		5
			<i>Zizina oxleyi</i>	Native	Not Threatened		2			1		3
		Noctuidae	<i>Agrotis admirationis</i>	Native	At Risk - Declining*	55			6		6	67
			<i>Agrotis ipsilon</i>	Native	Not assessed	45	10		48	9	1	113
			<i>Austramathes fortis</i>	Native	Not Threatened*				1		1	2

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Bityla defigurata</i>	Native	Not assessed	1	1		15	47	1	65
			<i>Helicoverpa armigera</i>	Introduced	Introduced and Naturalised	1	3		1			5
			<i>Ichneutica acotistis</i>	Native	Not Threatened*	16		1	13		1	31
			<i>Ichneutica atristriga</i>	Native	Not Threatened*	14	2		16	7		39
			<i>Ichneutica averilla</i>	Native	Not Threatened*				1			1
			<i>Ichneutica barbara</i>	Native	Not Threatened*				3			3
			<i>Ichneutica ceraunias</i>	Native	Not Threatened*				1			1
			<i>Ichneutica disjungens</i>	Native	Not Threatened*	13		1	60			74
			<i>Ichneutica</i> indet.	N/A	N/A	4	8			7		19
			<i>Ichneutica infensa</i>	Native	Not Threatened*	2			16			18
			<i>Ichneutica lignana</i>	Native	Not Threatened*		101		1	491		593
			<i>Ichneutica lithias</i>	Native	Not Threatened*	55		1	223		2	281
			<i>Ichneutica moderata</i>	Native	Not Threatened*	30	30	1	74	20	4	159
			<i>Ichneutica mollis</i>	Native	Not Threatened*				18			18
			<i>Ichneutica morosa</i>	Native	Not Threatened*					12		12
			<i>Ichneutica mutans</i>	Native	Not Threatened*	41	65	1	88	127	7	329
			<i>Ichneutica nullifera</i>	Native	Not Threatened*	4	1			8		13
			<i>Ichneutica omoplaca</i>	Native	Not Threatened*	35	68		113	159		375
			<i>Ichneutica paracausta</i>	Native	Not Threatened*			1	2		1	4
			<i>Ichneutica plena</i>	Native	Not Threatened*	47	2	1	64	37		151
			<i>Ichneutica propria</i>	Native	Not Threatened*	1	38		2	182		223
			<i>Ichneutica rubescens</i>	Native	Not Threatened*		1					1
			<i>Ichneutica scutata</i>	Native	Not Threatened*		22			1		23
			<i>Ichneutica sistens</i>	Native	At Risk - Uncommon*		58			418		476
			<i>Ichneutica sulcana</i>	Native	Not Threatened*					1		1
			<i>Ichneutica toroneura</i>	Native	At Risk - Declining*	39	54		67			160

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Ichneutica ustistriga</i>	Native	Not Threatened*	4		1	4	2		11
			indet. indet.	N/A	N/A		5			2	4	11
			<i>Meterana achthistis</i>	Native	Not assessed		1					1
			<i>Meterana coelena</i>	Native	Not assessed			1				1
			<i>Meterana exquisita</i>	Native	At Risk - Uncommon*			2			1	3
			<i>Meterana tartarea</i>	Native	Not assessed		7			112		119
			<i>Persectania aversa</i>	Native	Not assessed	48	7	1	67	76	1	200
			<i>Physetica caerulea</i>	Native	Not Threatened*	4			1		1	6
			<i>Physetica</i> indet.	N/A	N/A				3			3
			<i>Physetica phricias</i>	Native	Not Threatened*	73	277	1	110	1250	6	1717
			<i>Proteuxoa comma</i>	Native	Not Threatened*		1	1	1	1		4
			<i>Proteuxoa</i> indet.	N/A	N/A	1	5					6
			<i>Proteuxoa sanguinipuncta</i>	Introduced	Non-resident Native Coloniser*					1		1
			<i>Proteuxoa tetronycha</i>	Native	Not Threatened*	123			86		2	211
		Nymphalidae	<i>Argyrophenga antipodum</i>	Native	Not Threatened*		2			2		4
			<i>Pieris rapae</i>	Introduced	Introduced and Naturalised		4			1		5
		Oecophoridae	<i>Chersadula</i> indet.	Native	Not assessed						1	1
			<i>Tingena ?brachyacma</i>	Native	Not assessed			1				1
			<i>Tingena ?griseata</i>	Native	Not assessed						21	21
			<i>Tingena lassa</i>	Native	Not assessed						1	1
			<i>Trachypepla conspicuella</i>	Native	Not assessed						1	1
		Plutellidae	<i>Plutella ?antiphona</i>	Native	Not assessed					1		1
		Psychidae	indet. indet.	N/A	N/A					2		2
		Pterophoridae	<i>Pterophorus innotatalis</i>	Native	Not assessed					1	1	2

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Stenoptilia zophodactyla</i>	Native	Not assessed						1	1
		Pyrilidae	<i>Crocodypora cinigerella</i>	Native	Not assessed		2					2
			<i>Patagoniodes farinaria</i>	Native	Not assessed					1		1
			<i>Sporophyla oenospora</i>	Native	Threatened - Nationally Critical						2	2
		Scythrididae	<i>Scythris sp. near lacustris</i>	Native	Not assessed						10	10
		Stathmopodidae	<i>Stathmopoda aposema</i>	Native	Not assessed					1		1
			<i>Stathmopoda plumbiflua</i>	Native	Not assessed					1		1
		Tineidae	<i>Erechthias fulguritella</i>	Native	Not assessed					1		1
			indet. indet.	N/A	N/A		2					2
			<i>Monopis crocicapitella</i>	Introduced	Introduced and Naturalised		1					1
			<i>Monopis ethelella</i>	Native	Not assessed		1			1	2	4
			<i>Monopis</i> indet.	N/A	N/A		2					2
		Tortricidae	<i>Apoctena persecta</i>	Native	Not assessed					2		2
			<i>Capua semiferana</i>	Native	Not assessed		55	1		51	2	109
			<i>Clepsis divulsana</i>	Native	Not assessed		3			104		107
			<i>Clepsis leucaniana</i>	Native	Not assessed		1					1
			<i>Ctenopseustis</i> indet.	N/A	N/A			1				1
			<i>Cydia succedana</i>	Native	Not assessed					1		1
			<i>Eurythecta zelaea</i>	Native	Not assessed		1					1
			<i>Harmologa amplexana</i>	Native	Not assessed						1	1
			<i>Harmologa</i> indet.	N/A	N/A	1	2			10		13
			indet. indet.	N/A	N/A		16			6		22
			<i>Planotortrix excessana</i> s.l	Native	Not assessed					1		1

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
			<i>Planotortrix</i> indet.	N/A	N/A					1		1
			<i>Strepsicrates ejectana</i>	Native	Not assessed					1		1
		Xyloryctidae	<i>Gymnobathra sarcoxantha</i>	Native	Not assessed		1			5		6
			<i>Hierodoris frigida</i>	Native	Not Threatened*						1	1
			<i>Hierodoris s-fractum</i>	Native	Not Threatened*						2	2
			<i>Izatha convulsella</i>	Native	Not Threatened*						2	2
	Neuroptera	Hemerobiidae	<i>Micromus tasmaniae</i>	Introduced	Introduced and Naturalised					1		1
		Indet.	indet. indet.	N/A	N/A					3		3
	Orthoptera	Acrididae	<i>Phaulacridium marginale</i>	Native	Not Threatened		8			15		23
			<i>Phaulacridium otagoense</i>	Native	At Risk - Declining		15					15
			<i>Sigaust australis</i>	Native	Not Threatened		2			4		6
			<i>Sigaust tumidicauda</i>	Native	Not assessed					2		2
		Anostomatidae	<i>Hemiandrus</i> indet.	N/A	N/A			1				1
			<i>Hemiandrus maia</i>	Native	Not Threatened		5			3		8
		Indet.	indet. indet.	N/A	N/A				1			1
		Rhaphidophoridae	<i>Pleiopectron thomsoni</i>	Native	Not Threatened		37			71		108
			<i>Setascutum pallidum</i>	Native	Not Threatened		4			3		7
			<i>Setascutum sp.1</i>	N/A	N/A		3					3
		Tettigoniidae	<i>Conocephalus bilineatus</i>	Native	Not Threatened		6			24		30
		Trigonidiidae	<i>Bobilla</i> indet.	N/A	N/A					1		1
			<i>Bobilla nigrova</i>	Native	Not Threatened		269			290		559
			<i>Phaulacridium marginale</i>	Native	Not Threatened		2					2
	Psocodea	Indet.	indet. indet.	N/A	N/A		7			2		9
	Trichoptera	Indet.	indet. indet.	N/A	N/A		103			39		142

Class	Order	Family	Genus + species	Status	Threat status	Direct Disturbance Footprint			Surrounding Landscape			Total
						Dec 2023	Feb-Apr 2024	Oct-Nov 2024	Dec 2023	Feb-Apr 2024	Oct-Nov 2024	
Malacostraca	Zygentoma	Indet.	indet. indet.	N/A	N/A		1			12		13
	Amphipoda	Indet.	indet. indet.	N/A	N/A		50					50
		Talitridae	indet. indet.	N/A	N/A					1		1
	Isopoda	Indet.	indet. indet.	N/A	N/A		20			13		33
Myriapoda		Porcellionidae	<i>Porcellio scaber</i>	Introduced	Introduced and Naturalised		1					1
	Chilopoda	Indet.	indet. indet.	N/A	N/A		5			5		10
	Diplopoda	Indet.	indet. indet.	N/A	N/A		1			1		2
	Indet.	Indet.	indet. indet.	N/A	N/A					4		4
Total						884	12043	80	1519	14774	265	29565

Appendix 3 GBIF Species Records

Table 4. List of terrestrial invertebrates from the Global Biodiversity Information Facility (GBIF) database on April 2024, from the Dunstan Mountain Ranges, along with native/introduced and New Zealand Threat Classification status. Highlighted rows indicate species that were also recorded in the BOGP terrestrial invertebrate field surveys.

Class	Order	Family	Genus + Species	Status	NZTCS Status
Arachnida	Araneae	Araneidae	<i>Backobourkia brouni</i>	Native	Not Assessed
		Pisauridae	<i>Dolomedes minor*</i>	Native	Not Threatened
Insecta	Coleoptera	Anthribidae	<i>Euciodes suturalis</i>	Introduced	N/A
		Carabidae	<i>Laemostenus complanatus</i>	Introduced	N/A
			<i>Mecodema rectolineatum</i>	Native	Not Assessed
			<i>Mecodema tibiale*</i>	Native	Not Assessed
			<i>Mecodema zonula</i>	Native	Not Assessed
			<i>Neocicindela dunedensis</i>	Native	Not Assessed
			<i>Neocicindela latecincta</i>	Native	Not Assessed
			<i>Oregus aereus*</i>	Native	Not Assessed
		Coccinellidae	<i>Adalia bipunctata*</i>	Introduced	N/A
		Curculionidae	<i>Gonipterus platensis</i>	Introduced	N/A
			<i>Otiorhynchus sulcatus</i>	Introduced	N/A
		Scarabaeidae	<i>Indet.</i>	N/A	Not Assessed
	Diptera	Calliphoridae	<i>Calliphora vicina</i>	Introduced	N/A
		Culicidae	<i>Aedes antipodeus</i>	Native	Not Assessed
		Syrphidae	<i>Helophilus hochstetteri</i>	Native	Not Assessed
	Hemiptera	Pentatomidae	<i>Hypsithocus hudsonae</i>	Native	Not Assessed
		Triozidae	<i>Trioza discariae</i>	Native	Not Assessed
	Hymenoptera	Apidae	<i>Bombus ruderatus</i>	Introduced	N/A
			<i>Bombus terrestris</i>	Introduced	N/A
		Braconidae	<i>Apanteles helespas</i>	Introduced	N/A
			<i>(blank)</i>	N/A	N/A
			<i>Shireplitis bilboi</i>	Native	Data Deficient
			<i>(blank)</i>	N/A	N/A

Class	Order	Family	Genus + Species	Status	NZTCS Status
		Colletidae	<i>Leioproctus fulvescens</i> *	Native	Not Assessed
			(blank)	N/A	N/A
		Dryinidae	<i>Gonatopus zealandicus</i>	Native	Not Assessed
		Halictidae	<i>Lasioglossum maunga</i>	Native	Not Assessed
		Ichneumonidae	(blank)	N/A	Not Assessed
			<i>Megarhyssa nortoni</i>	Introduced	N/A
		Tenthredinidae	<i>Pontania proxima</i>	Native	Not Assessed
		Vespidae	<i>Vespula germanica</i>	Introduced	N/A
	Lepidoptera	Crambidae	<i>Antiscopa elaphra</i>	Native	Not Assessed
			<i>Scoparia ustimacula</i>	Native	Not Assessed
		Elachistidae	<i>Elachista thallophora</i>	Native	Not Assessed
		Geometridae	<i>Arctesthes catapyrrha</i>	Native	Not Assessed
			<i>Paranotoreas fulva</i> *	Native	At Risk (Naturally Uncommon)
		Lycaenidae	<i>Lycaena boldenarum</i>	Native	Not Assessed
			<i>Zizina oxleyi</i> *	Native	Not Threatened
		Noctuidae	<i>Ichneutica arotis</i>	Native	Not Assessed
			<i>Ichneutica caraunias</i> *	Native	Not Assessed
			<i>Ichneutica lithias</i> *	Native	Not Assessed
			<i>Ichneutica moderata</i> *	Native	Not Assessed
			<i>Ichneutica mutans</i> *	Native	Not Assessed
			<i>Ichneutica nullifera</i> *	Native	Not Assessed
			Indet.	N/A	N/A
			<i>Persectania aversa</i> *	Native	Not Assessed
			<i>Physetica cucullina</i>	Native	Not Assessed
			<i>Physetica phricias</i> *	Native	Not Assessed
			<i>Physetica prionistis</i>	Native	Not Assessed
		Nymphalidae	<i>Argyrophenga antipodum</i>	Native	Not Assessed
			<i>Vanessa gonerilla</i>	Native	Not Assessed
		Pieridae	<i>Pieris rapae</i>	Native	Not Assessed
		Psychidae	<i>Orophora unicolor</i>	Native	Not Assessed
	Mantodea	Mantidae	<i>Orthodera novaezealandiae</i>	Native	Not Assessed

Class	Order	Family	Genus + Species	Status	NZTCS Status
	Neuroptera	Hemerobiidae	<i>Micromus tasmaniae</i>	Introduced	N/A
	Odonata	Corduliidae	<i>Procordulia smithii</i>	Native	Not Assessed
		Lestidae	<i>Austrolestes colenisonis</i>	Native	Not Assessed
	Orthoptera	Acrididae	<i>Phaulacridium marginale</i>	Native	Not Threatened
			<i>Sigauss australis</i>	Native	Not Threatened
		Anostomatidae	<i>Hemiandrus maia</i>	Native	Not Threatened
		Rhaphidophoridae	<i>Pharmacus senex</i>	Native	Not Threatened
			<i>Pleiopectron thomsoni</i>	Native	Not Threatened
			<i>Setascutum pallidum</i>	Native	Not Threatened

References

- Ball, O.J.P, Fitzgerald, B.M., Pohe, S.R. and Whaley, P.T. (2022). Effect of plant composition on epigeal spider communities in northern New Zealand forest remnants. *New Zealand Journal of Ecology*, 46(2), 3480.
- Barratt, B.I.P. (1983). Distribution survey of soil insects at Millers Flat, Central Otago, New Zealand. *Journal of Experimental Agriculture*, 11(1), 83–87.
- Barratt, B.I.P. and Campbell, R.A. (1982). Biology of the striped chafer, *Odontria striata* (Coleoptera: Scarabaeidae) I. The adult, flight and ground surface activity, female reproductive maturation, and food-plant selection. *New Zealand Journal of Zoology*, 9(2), 249–266.
- Barratt B.I. and Patrick B.H. (1987). Insects of snow tussock grassland on the East Otago Plateau. *New Zealand Entomologist*, 10(1), 69-98.
- Bates, D., Mächler, M., Bolker, B. and Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1), 1–48.
- Bertoia, A., Murray, T., Robertson, B. C., and Monks, J. M. (2023a). Pitfall trapping outperforms other methods for surveying ground-dwelling large-bodied alpine invertebrates. *Journal of Insect Conservation*, 27: 679–692
- Bertoia, A., Murray, T., Robertson, B. C., and Monks, J. M. (2023b). Time-lapse cameras improve our understanding of invertebrate activity in the alpine zone. *New Zealand Journal of Ecology* 47(1), 3551.
- Bioresearches (2024). Invertebrate Survey & Assessment: Macraes Phase 4 Project. Technical report prepared for Oceanagold (New Zealand) Ltd. 65pp.
- Bowie, M. H. and Frampton, C. M. (2004). A practical technique for non-destructive monitoring of soil surface invertebrates for ecological restoration programmes. *Ecological Management & Restoration*, 5 (1).
- Bowie, M., Stokvis, E., Barber, K., Marris, J. and Hodge, S. (2018). Identification of potential invertebrate bioindicators of restoration trajectory at a quarry site in Hunua, Auckland, New Zealand. *New Zealand Journal of Ecology*, 43(1), 3360.
- Bray, J.R. and Curtis, J.T. (1957). An Ordination of the Upland Forest Communities of Southern Wisconsin. *Ecological Monographs*, 27(4), 325–349.
- Brown, G. R., & Matthews, I. M. (2016). A review of extensive variation in the design of pitfall traps and a proposal for a standard pitfall trap design for monitoring ground-active arthropod biodiversity. *Ecology and Evolution*, 6(12), 3953-3964.
- Chapman, R.F. (1987). The relationship between diet and size of the midgut caeca in grasshoppers (Insecta: Orthoptera: Acridoidea). *Zoological Journal of the Linnean Society*, 994, 319–338.
- Chinn, W. (2017). Invertebrates: sorting invertebrate samples Version 1.0. Department of Conservation, New Zealand.
- Derraik, J. G. B., Barratt, B. I. P., Sirvid, P., Macfarlane, R. P., Patrick, B. H., Early, J., Closs, G. P. (2001). Invertebrate survey of a modified native shrubland, Brookdale Covenant, Rock and Pillar Range, Otago, New Zealand. *New Zealand Journal of Zoology*, 28(3), 273–290.

- Fabian, S.T., Sondhi, Y., Allen, P.E., Theobald, J. C., and Ti Lin, H. (2024). Why flying insects gather at artificial light. *Nature Communications*, 15, 689. <https://doi.org/10.1038/s41467-024-44785-3>
- Harris, J. W. E., Collis, D. G., and Magar, K. M. (1972). Evaluation Of The Tree-Beating Method For Sampling Defoliating Forest Insects. *The Canadian Entomologist*, 104(5), 723–729.
- Hegg, D., Morgan-Richards, M., and Trewick, S. A. (2019). Diversity and distribution of Pleioplectron Hutton cave wētā (Orthoptera: Rhaphidophoridae: Macropathinae), with the synonymy of Weta Chopard and the description of seven new species. *European Journal of Taxonomy*, 577.
- Hegg, D., Morgan-Richards, M., & Trewick, S. A. (2022). High alpine sorcerers: revision of the cave wētā genus *Pharmacus* Pictet & de Saussure (Orthoptera: Rhaphidophoridae: Macropathinae), with the description of six new species and three new subspecies. *European Journal of Taxonomy*, 808(1), 1–58.
- Hill, M.O. (1973). Diversity and evenness: a unifying notation and its consequences. *Ecology*, 54, 427–432.
- Hoare, R.J.B. (2019). Noctuidae (Insecta: Lepidoptera: Noctuidae). Part 2, Nivetica, Ichneutica. *Fauna of New Zealand*, 80, 1–455.
- Hoare, R.J.B. and Patrick, B.H. (2022) Four threatened endemic pyraloid moths (Lepidoptera: Pyraloidea) of short turf habitats of southern New Zealand: assessment of current status, notes on systematics, habitat and threats, and recommendations for future work. Unpublished report for Department of Conservation.
- Hoare, R.J.B., Dugdale, J.S., Edwards, E.D., Gibbs, G.W., Patrick, B.H., Hitchmough, R.A., and Rolfe, J.R. (2017). Conservation status of New Zealand butterflies and moths (Lepidoptera), 2015. New Zealand Threat Classification Series 20. Department of Conservation, Wellington. 13 p.
- IPBES (2016). The assessment report on pollinators, pollination and food production. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.
- Jarvie, S. (2025). Regionally endemic species in Otago. Otago Regional Council, Otago Biodiversity Series, 2025/1
- Jonason, D., Franze'n, M. and Ranius T. (2014). Surveying Moths Using Light Traps: Effects of Weather and Time of Year. *PloS ONE*. 9(3): e92453.
- Kashian, D.R., Zuellig, R.E., Mitchell, K.A. and Clements, W.H. (2007). The cost of tolerance: sensitivity of stream benthic communities to UV-B and metals. *Ecological Applications*, 17, 365–375.
- Kruskal, W.H. and Wallis, W.A. (1952). Use of ranks in one-criterion variance analysis. *Journal of the American Statistical Association*, 47(260), 583–621.
- Lousey J.E and Vaughan M. (2006). The Economic Value of Ecological Services Provided by Insects. *BioScience*, 56, 311–323.
- Lamont, S.M., Vink, C.J., Seldon, D.S. and Holwell, G.I. (2017). Spider diversity and community composition in native broadleaf–podocarp forest fragments of northern Hawke's Bay, New Zealand. *New Zealand Journal of Zoology*, 44(2), 129–143.
- Magurran, A.E. (2004). Measuring biological diversity. Oxford, Blackwell Publishing. 215 p.

- Marples, B.J., and Marples, M.J. (1972) Observations on *Cantuaria toddi* and other trapdoor spiders (Aranea: Mygalomorpha) in Central Otago, New Zealand. *Journal of the Royal Society of New Zealand*, 2(2), 179–185.
- McGeachie, W.J. (1989). The effects of moonlight illuminance, temperature and wind speed on light-trap catches of moths. *Bulletin of Entomological Research*. 79(2):185-192.
- Montgomery, G. A., Belitz, M. W., Guralnick, R. P., & Tingley, M. W. (2021). Standards and best practices for monitoring and benchmarking insects. *Frontiers in ecology and evolution*, 8, 579193.
- Oksanen J, Simpson G, Blanchet F, Kindt R, Legendre P, Minchin P, O'Hara R, Solymos P, Stevens M, Szoecs E, Wagner H, Barbour M, Bedward M, Bolker B, Borcard D, Carvalho G, Chirico M, De Caceres M, Durand S, Evangelista H, FitzJohn R, Friendly M, Furneaux B, Hannigan G, Hill M, Lahti L, McGlinn D, Ouellette M, Ribeiro Cunha E, Smith T, Stier A, Ter Braak C, Weedon J (2024). *Vegan: Community Ecology Package*. R package version 2.6-6.1.
- Patrick, B. (1994). Hawkdun Ecological District Invertebrate Survey. Department of Conservation, Wellington. 17 p.
- Patrick, B. (1994). The importance of invertebrate biodiversity: an Otago Conservatory review. Conservatory Advisory Science Notes No 53. Department of Conservation, Wellington. 13p.
- Patrick, B. (2000). Lepidoptera of small-leaved divaricating *Olearia* in New Zealand and their conservation priority. *Science for Conservation* 168. Department of Conservation, Wellington. 26 p.
- Patrick, B., (2016). DOCCM-286730 Invertebrates: Light trapping v1.0. Department of Conservation, Wellington.
- Patrick, B., and Dugdale, J.S. (2000). Conservation status of the New Zealand Lepidoptera. *Science for Conservation* 136. Department of Conservation, Wellington. 22 p.
- R Core Team (2024). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.
- RMA Ecology Ltd. February 2025a. Bendigo-Ophir Gold Project: Vegetation Values Assessment. Report prepared for Matakanui Gold Ltd.
- RMA Ecology Ltd. February 2025b. Bendigo-Ophir Gold Project: Wetland Values Assessment. Report prepared for Matakanui Gold Ltd.
- Michel, P., Rolfe, J. and Hitchmough, R. (2022). New Zealand Threat Classification System manual 2022 – Part 1. Department of Conservation, Wellington. 45 p.
- Sandanayaka, M., Nielsen, M., Davis, V. and Butler, R. (2017). Do spittlebugs feed on grape? Assessing transmission potential for *Xylella fastidiosa*. *New Zealand Plant Protection*, 70, 31–37.
- Schauff, M. E. (Ed.). (2001). *Collecting and preserving insects and mites: techniques and tools*. U.S. Department of Agriculture, Systematic Entomology Laboratory.
- Sheikh, A. H., Thomas, M., Bhandari, R. and Bunkar K. (2016). Light Trap and Insect Sampling: an overview. *International Journal of Current Research*. 8(11): 40868-40873.
- Sherley, G. and Evans, A. (2016). Invertebrates: search and extraction methods v1.0. Department of Conservation, New Zealand.
- Sherley, G. and Stringer, I. (2016). DOCCM-248862 Invertebrates: pitfall trapping v1.0 2. Department of Conservation, Wellington.

- Sirvid, P.J., Vink, C.J., Fitzgerald, B.M., Wakelin, M.D., Rolfe, J., and Michel, P. (2020). Conservation status of New Zealand Araneae (spiders), 2020. New Zealand Threat Classification Series 34. Department of Conservation, Wellington. 33 p.
- Sivyer, L., Morgan-Richards, M., Koot, E. and Trewick, S.A. (2018). Anthropogenic cause of range shifts and gene flow between two grasshopper species revealed by environmental modelling, geometric morphometrics and population genetics. *Insect Conservation and Diversity*, 11, 415– 434.
- Thompson, V., Harkin, C., Stewart, A.J.A. (2023). The most polyphagous insect herbivore? Host plant associations of the Meadow spittlebug, *Philaenus spumarius* (L.). *PLoS ONE*, 18(10), e0291734.
- Trewick, S., Hegg, D., Morgan-Richards, M., Murray, T., Watts, C., Johns, P., and Michel, P. (2022). Conservation status of Orthoptera (wētā, crickets and grasshoppers) in Aotearoa New Zealand, 2022. New Zealand Threat Classification Series 39. Department of Conservation, Wellington. 28 p.
- Ward, D.F., New, T.R. & Yen, A.L. Effects of Pitfall Trap Spacing on the Abundance, Richness and Composition of Invertebrate Catches. *Journal of Insect Conservation*, 5, 47–53 (2001).
- Ward, D.F., Young, M., Booth, K.A.M. and Beggs, J.R. (2014). Patterns of beetle diversity in Kauri forest. *New Zealand Entomologist*, 37(2), 75–82.
- Watson, R.N. (1970). The feeding behaviour of alpine grasshoppers (Acrididae: Orthoptera), in the Craigieburn range, Canterbury, New Zealand. Unpublished Master of Agricultural Science thesis. Canterbury University, Christchurch, New Zealand.
- Westerman, M. and Ritchie, J.M. (1984). The taxonomy, distribution and origins of two species of *Phaulacridium* (Orthoptera: Acrididae) in the South Island of New Zealand, *Biological Journal of the Linnean Society*, Volume 21, Issue 3, 283–298.
- White, E.G. (1991). The Changing Abundance of Moths in a Tussock Grassland, 1962-1989, and 50- to 70-year trends. *New Zealand Journal of Ecology*, 15(1), 5–22.
- White, E.G. (2002). New Zealand Tussock Grassland Moths, a taxonomic and ecological handbook. Lincoln. Manaaki Whenua Press. 362 pp.; 3 pl.
- Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, LD., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, TL., Miller, E., Bache, SM., Müller, K., Ooms, J., Robinson, D., Seidel, DP., Spinu, V., Takahashi, K., Vaughan, D., Wilke, C., Woo, K. and Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43), 1686.