

Before the Fast-track Panel

Under: Fast-track Approvals Act 2024

In the matter of: FTAA-2605-1236 – Remarkables Ski Area Upgrade and Doolans
Expansion

Statement of advice: Corinne Watts

Terrestrial Invertebrate Ecology

Independent consultant

12 October 2026



Department of
Conservation
Te Papa Atawhai

**Te Kāwanatanga
o Aotearoa**
New Zealand Government

Introduction

1. My full name is Corinne Hannah Watts.

Instruction

2. I have been requested to provide expert advice to the Director-General of Conservation (DOC/the Department) for the purposes of his comments on the Remarkables Ski Area Upgrade and Doolans Expansion Fast-track application.
3. My advice will be used to inform DOC's s51 reporting and s53 comments on the application.

Qualification and Experience

4. I am an independent Invertebrate Ecology consultant working from Hamilton. I have a Bachelor of Science in Ecology from the University of Victoria Wellington (1996), a Master of Science in Zoology from University of Victoria Wellington (1999), and a PhD in Zoology from University of Canterbury (2006). I have more than 27 years' experience at the Bioeconomy Science Institute (now a Research Associate) in research on the ecology, monitoring, restoration and management of indigenous invertebrate biodiversity across both conservation and productive landscapes.
5. I have written over 95 peer-reviewed scientific papers, reports, book chapters and other publications on invertebrate monitoring, the impact of restoration and mammal control on insect communities, the effects of climate change on New Zealand's invertebrates, particularly giant wētā, and on threatened New Zealand insects.
6. I have previously been an expert witness in Environment Court for several major infrastructure projects such as the Mt Messenger Bypass and the Hauāuru mā raki wind farm. I am currently involved in a number of Fast-track Act applications that require expert invertebrate ecology advice and information. My role in this project to date has included review of both draft and substantive application documents.

Code of conduct

7. Whilst it is acknowledged this is not an Environment Court Proceeding, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023. I have complied with the Code of Conduct in the preparation of this advice. Unless I state otherwise, this advice is within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Scope of advice and expert opinion

8. My expert advice relates to the following:
- i. Adequacy of the Applicant's assessment of terrestrial invertebrates values, noting any values not identified.
 - ii. Adequacy of the applicant's assessment of effects on terrestrial invertebrates, noting any effects not adequately addressed.
 - iii. Adequacy of the Applicant's proposed mitigation measures in relation to terrestrial invertebrates.

Material Considered

9. In preparing this advice I have reviewed the following documents as part of the substantive application:

Part A – Substantive Application

A-10 – Substantive Application Report Section 3 - Project Description updated 3 September 2026

A-13 – Substantive Application Report Section 6 - Assessment of Environmental Effects updated 3 September 2026

A-14 - Substantive Application Report Section 7 – Management and Monitoring of Actual and Potential Effects updated 3 September 2026

A-16 - Substantive Application Report Section 9 – Approvals Relating to the Resource Management Act 1991 Effects updated 3 September 2026

A-17 - Substantive Application Report Section 10 – Approvals Relating to the Conservation Act updated 3 September 2026

A-21 – Effects Management and Compensation Overview Addendum

Part B – Technical Reports

B-05 – Remarkables Ski Area Upgrade and Doolans Expansion – Carpark & Bus Hub Ecological Impact Assessment

B12 – Terrestrial Ecology Impact Assessment 26 Aug 26

B-14 – Tracks, Crossings, Stormwater Freshwater Ecological and Hydrological Impact Assessment updated 27 Aug 26

B-28 Remarkables Ski Area Upgrades and Doolans Expansion - Construction Environmental Management Plan

Part C

Project Maps and Drawings C-00 – C-11

Part F

F.02 – Remarkables Ski Area Upgrades and Doolans Expansion – Construction Environmental Management Plan

F.03 - Remarkables Ski Area Upgrade and Doolans Expansion – Terrestrial Ecology Management Plan

Part H - Proposed Conditions

H.02 - Resource Consent Conditions updated 3 September 2026

10. I have not undertaken a site visit due to the timing of my engagement on this project and the constraints associated with travelling from Hamilton prior to the onset of the first snowfall.

Workshops

11. I attended the NZ Ski meeting where they presented their approach to the effects management hierarchy and compensation (15 September 2026) and I have viewed

the recordings of the Feedback on Terrestrial Ecology meeting (7 August 2026) and the Lizard Discussion meeting (21 August 2026) facilitated by the applicant.

Executive Summary

12. This advice reports on the invertebrate values present within the project area for the Remarkables Ski Area Upgrade and Doolans Expansion Fast-track application.
13. The applicant engaged ecological consultant e3 Scientific, to carry out an invertebrate survey and desktop review of invertebrates within the area proposed for expanding the existing Remarkables Ski Area into the adjacent Doolans Basin.
14. The Applicant's assessment does not adequately characterise the invertebrate values or fully assess potential effects. Limitations in seasonal sampling, abundance data, and information on the distribution and ecological requirements of some taxa reduce confidence in the assessment.
15. The proposed activities may cause habitat loss and degradation, direct mortality and disturbance, snow and soil compaction, altered snow duration and soil conditions, and erosion and sedimentation. Effects may extend beyond the development footprint through altered snowmelt, runoff, and sediment movement.
16. Snowmaking and grooming are of particular concern because changes in snow density, persistence and insulation can alter soil temperature, moisture, aeration and biological processes, affecting soil and litter habitat and associated invertebrates. Increasing reliance on snowmaking as climate conditions change could increase these effects.
17. The proposed management measures do not yet provide sufficient confidence that effects on Threatened, At Risk, Data Deficient and poorly known taxa will be adequately avoided or managed. Greater emphasis is needed on avoidance, species-specific assessment, and robust monitoring. Overall, adverse effects remain insufficiently addressed, particularly in Doolans, and there is insufficient basis to conclude that the proposed mitigation, offsetting and compensation will adequately address residual effects.

Invertebrate fauna of the Remarkables Range

18. The Remarkables Ecological District (ED) supports a diverse and distinctive alpine invertebrate fauna, although it remains incompletely documented. The most detailed published survey (Patrick et al. 1992), of the Rastus Burn Basin, recorded 186 Lepidoptera species, including rare and poorly known species and four taxa that were potentially new to science. Coleoptera, Trichoptera, Hemiptera, Orthoptera, Plecoptera and Neuroptera were also recorded. The authors considered the fauna to have high conservation value, with a mixture of Central Otago and western alpine elements (Patrick et al. 1992). Research on less conspicuous alpine fauna, the soil micro-invertebrates, has subsequently demonstrated a substantial diversity. Sampling occurred at high elevations in the Remarkables recording 29 Collembola and 50 Oribatida taxa, with numerous taxa across the wider study area being previously undescribed (Minor et al. 2017). In addition, the Department of Conservation's Kawarau/Remarkables Ecological Values Report (2020) similarly identifies a large invertebrate fauna, recording 320 moth species and highlighting giant weevils, large diurnal chafer beetles, alpine cicadas, wētā and grasshoppers. Overall, evidence indicates high alpine invertebrate diversity, specialised habitat associations, and a significant component of rare, poorly known, and potentially undescribed fauna. The fauna is particularly associated with specialised alpine habitats such as cushionfields, snowbanks, fellfield, wetlands, and alpine soils. The absence of records from particular parts of the range should therefore be treated cautiously, given the lack of comprehensive multi-taxon sampling.

Remarkables ski field expansion invertebrate community values assessment

19. Ski NZ Ltd engaged independent ecology consultant, e3 Scientific, to carry out a survey and desktop review of invertebrates within the area proposed for expanding the existing Remarkables Ski Area into the adjacent Doolans Basin. Invertebrate sampling was undertaken using three sampling techniques during mid- to late summer; pitfall trapping, manual sampling, and light trapping. A diverse invertebrate assemblage of ground dwelling and flying invertebrates was recorded with a total of 120 distinct taxa from 15 Orders and 64 Families identified. Common species found were: *Celatoblatta quinque maculata* (Otago alpine

cockroach), *Anoteropsis hilaris* (Garden wolf spider), *Sigaus australis* (Alpine grasshopper), *Hemideina maori* (Mountain stone wētā), *Hemiandrus focalis* (Ground wētā), and *Mecodema politanum* (Ground beetle). In total, 25 (not 24 as written in Remarkables Ski Field Expansion Project Terrestrial Ecological Impact Assessment report, hereafter referred to as the TEIA report) ‘notable’ invertebrate species (including 8 taxa identified from the desktop review as potentially present and given a ‘Likelihood of Occurrence’ rating) were either unclassified or classified as Data Deficient, At Risk, or Threatened (Table 1).

Table 1. The 25 ‘notable’* invertebrate species sampled from the Remarkables Ski Field Expansion Project area or identified from the desktop review as potentially present within the project area.

Data extracted from Table 7 in ‘Remarkables Ski Field Expansion Project TEIA’ report.

Species	NZTCS Conservation Status	Likelihood of Occurrence	Type of Invertebrate
Invertebrates sampled:			
<i>Dasyuris partheniata</i>	At Risk – Declining	Present (observed)	Moth
<i>Plutella</i> sp.1 (CO)	At Risk – Declining	Present (observed)	Moth
<i>Sigaus campestris</i>	At Risk – Declining	Present (observed)	Grasshopper
<i>Dasyuris micropolis</i>	At Risk – Declining	Present (observed)	Moth
<i>Nivetica nervosa</i>	At Risk – Declining	Present (observed)	Moth
<i>Hypsithocus hudsonae</i>	At Risk – Naturally Uncommon	Present (observed)	Shield bug
<i>Neoramia alta</i>	At Risk – Naturally Uncommon	Present (observed)	Spider
<i>Mamoea montana</i>	Data Deficient	Present (observed)	Spider
<i>Rorea otagoensis</i>	Data Deficient	Present (observed)	Spider
<i>Subantarctia centralis</i>	Data Deficient	Present (observed)	Spider
<i>Anagotus latirostris</i>	Unclassified ¹	Present (observed)	Weevil
<i>Inophloeus inuus</i>	Unclassified ²	Present (observed)	Weevil
<i>Huttonia</i> sp.	Unclassified	Present (observed)	Spider
<i>Scoparia panopla</i>	Unclassified ²	Present (observed)	Moth
<i>Scoparia niphospora</i>	Unclassified ²	Present (observed)	Moth
<i>Pasiphila eratica</i>	Unclassified ¹	Present (observed)	Moth
<i>Pasiphila</i> sp.n	Unclassified ²	Present (observed)	Moth
Desktop review:			
<i>Asaphodes stinaria</i>	Threatened – Nationally Critical	Very Low	Moth
<i>Xanthorhoe bulbulata</i>	Threatened – Nationally Critical	Very Low	Moth
<i>Xanthorhoe frigida</i>	Threatened – Nationally Vulnerable	High	Moth
<i>Pyrausta comastis</i>	Threatened – Nationally Vulnerable	Moderate	Moth
<i>Taenarthrus capito</i>	Unclassified ²	Moderate	Beetle
<i>Duvaliomimus walkeri</i>	Unclassified ¹	Moderate	Beetle
<i>Protodendrophagus</i> sp. 1	Unclassified ²	Low	Beetle
<i>Peripatus</i> sp. Remarkables	Unclassified ²	Moderate	Peripatus

*Notable species are defined within the TEIA as ‘rare species, as assessed by the Department of Conservation’s Threat Classification system and/or have not been formally assessed but based on expert judgement, could potentially have a threat classification greater than Not Threatened if assessed’.

¹ Tentatively assigned the classification of At Risk – Naturally Uncommon by the TEIA given it is largely range restricted to montane to alpine environments, with limited land modification or disturbance within its recorded elevation range.

² Tentatively assigned the classification of At Risk – Data Deficient by the TEIA due to the lack of recorded biological information. However, specimens have been recorded across a wide range of habitat and ecological regions.

20. No invertebrate abundance data were presented in the report. I therefore reviewed Appendix D of the TEIA and counted the individuals recorded for each species on each sampling date, obtaining an approximate total of 1,200 individuals. In my opinion, the underlying abundance data should have been reported explicitly. Abundance data are fundamental to the calculation of a range of invertebrate community indices and provide an important basis for assessing differences in community composition and relative abundance among vegetation types. This is particularly relevant in the context of the proposed project, as different vegetation types may support distinct invertebrate communities and may be affected to different degrees by the proposed activities. The absence of readily accessible abundance data therefore limits the extent to which the reported sampling results can be independently evaluated and used to assess potential effects across the project area.
21. Where complete taxonomic identification was not possible, the TEIA used the term “indeterminate” (indet.). I note that the TEIA does not refer to “recognisable taxonomic units” (RTUs), which is a commonly used term for taxa that cannot be identified to a formal taxonomic level but can nevertheless be consistently distinguished as separate units for the purposes of ecological assessment. While the use of the term RTU is not essential, its absence is notable given that this terminology provides a standardised means of describing and reporting such taxa.
22. I acknowledge the applicant’s practical constraints associated with alpine sampling of invertebrates, including the limited availability of suitable weather windows and the use of desktop information to supplement field surveys. I also accept that February–March sampling will detect a substantial component of the active alpine invertebrate fauna and that desktop review can provide useful

information on taxa that may not be readily detected during field surveys.

Nevertheless, I remain concerned that the absence of sampling during early to mid-summer represents a limitation to the field-based baseline. Alpine invertebrate activity and detectability can vary substantially through the season, and some taxa may be active or more readily detectable during spring and early to mid-summer but less so during February–March. Consequently, I consider that reliance on late-summer field sampling, supplemented by desktop information, may not fully characterise the invertebrate communities present within the project area or their relative abundance and distribution among vegetation types. The desktop review provides an important supplementary source of information, but it does not provide equivalent evidence of the presence, abundance, or site-specific distribution of taxa within the project area. I therefore consider seasonal sampling coverage to remain a limitation when interpreting the field survey results and assessing the potential effects of the proposed ski field expansion on alpine invertebrate values.

23. The Doolans Basin warrants specific consideration because, unlike the already modified Rastus Burn ski-field environment, it is described in the application as “almost entirely unmodified and natural.” This provides a more intact invertebrate baseline, with comparatively continuous alpine habitats and specialised microhabitats that support potentially diverse and poorly known fauna. The effects of the proposed expansion should therefore be distinguished from those occurring within the existing ski-field footprint, particularly given the acknowledged limitations of the invertebrate survey and the potential for direct habitat loss, fragmentation, microclimate change and loss of refugia in Doolans. The comparatively intact condition of Doolans is a crucial factor when assessing the magnitude and significance of these effects.

Ecological effect of habitat loss of the proposed Remarkables ski field expansion on invertebrates

24. I broadly agree with the assessment that habitat loss would result in a ‘Moderate to High’ level of effect on invertebrates, and with the assessment of varying effects on the 24 invertebrate taxa classified as Unclassified, Data Deficient, At Risk, or Threatened (see Table 15 in the TEIA). The magnitude of the effect will depend on

the extent, nature and quality of habitat affected, the scale at which the effect is considered, and the ecological requirements, distribution, abundance, and mobility of the taxa concerned. For example, complete loss of a discrete habitat such as a tarn may represent a high magnitude of effect for invertebrates dependent on that habitat, even where the area affected is small at the landscape scale. In addition, the loss or modification of habitats supporting restricted-range or habitat-specialist taxa has the potential to result in disproportionately greater effects than the loss of more widespread or less specialised habitat.

25. I consider that the assessment appropriately recognises that habitat loss is not simply a measure of the area of vegetation or habitat removed. The ecological consequences will also depend on the degree to which habitat loss reduces the availability and connectivity of suitable habitat, fragments populations, alters habitat condition at retained habitat margins, and affects resources such as host plants, litter, soil structure and other microhabitat features required by invertebrates. These effects may extend beyond the footprint of direct habitat clearance and may persist where the recovery of suitable habitat is slow or uncertain.
26. For the 24 taxa identified in Table 15 in the TEIA report, I therefore support the recognition of differing levels of effect rather than applying a uniform effect magnitude across all taxa. The potential consequences for individual taxa should be considered in relation to their known or likely distribution within the project area, the amount and quality of suitable habitat to be lost or modified, and the availability and connectivity of suitable habitat within the wider landscape. Where information on the distribution, dispersal ability, or ecological requirements of a taxon is limited, the degree of uncertainty should also be recognised when determining the level of effect and the appropriate mitigation response.

Other significant effects of the proposed Remarkables ski field expansion on invertebrates

27. The proposed ski-field activities have the potential to affect alpine invertebrates through direct mortality or disturbance and, indirectly, through modification of soil, litter, vegetation and aquatic habitats. The magnitude of effects will depend on the extent, frequency and location of disturbance, the degree of habitat

modification, and the sensitivity, distribution, and ability of the invertebrate taxa present to disperse or relocate to suitable habitat.

28. The proposed ski-field activities have the potential to affect alpine invertebrates through direct mortality or disturbance and, indirectly, through modification of soil, litter, vegetation and aquatic habitats. The magnitude of effects will depend on the extent, frequency and location of disturbance, the degree of habitat modification, and the sensitivity, distribution, and ability of the invertebrate taxa present to disperse or relocate to suitable habitat.
29. In my view, the assessment of effects presented in both the TEIA report does not adequately identify or assess a number of important effects of the proposed project on the Doolans Basin. In particular, several effects on terrestrial invertebrates (and ecosystems generally) are either omitted from the assessments or, in my view, substantially underestimated. These include the effects associated with:
 - i. snowmaking and grooming
 - ii. skiing and associated on-mountain activity;
 - iii. visitor use and associated activities during summer; and
 - iv. roading and associated infrastructure.
30. These activities have the potential to result in effects on terrestrial ecological values that are additional to, or materially different from, those addressed in the Applicant's assessments. In my view, a robust assessment of the project's ecological effects should consider these activities explicitly and assess their effects both individually and in combination with the other components of the proposal.

Snowmaking

31. Snowmaking has the potential to alter the physical and chemical conditions of alpine soils and associated invertebrate habitat.
32. Snow and soil compaction: Artificial snow is denser than natural snow and, in combination with grooming and skiing, can increase snow compaction. Compaction can alter soil porosity, permeability, moisture and temperature, potentially reducing the suitability of soil and litter habitat for invertebrates and

affecting associated microbial and decomposition processes (Rixen et al., 2003). The Fahey et al. (1999) review of ski-field effects identified changes in snow compaction, frost penetration, soil moisture and soil biological processes as important pathways of effect.

33. Delayed snowmelt and altered seasonality: Artificial snow can persist beyond natural snow cover and delay snowmelt and soil warming. A field study of a groomed ski slope with artificial snow recorded a four-week delay in snowmelt and soil warming (Keller et al. 2004). Such changes have the potential to shorten or shift the period suitable for activity, feeding and reproduction of some alpine invertebrates and to alter the seasonal availability of food resources.
34. Altered soil chemistry: Snowmaking increases the amount of water and associated dissolved ions deposited on the receiving environment. Where these inputs differ from natural precipitation in quantity or timing, repeated application has the potential to alter soil conditions and vegetation, with consequent indirect effects on invertebrate habitat and food resources (Rixen et al., 2003). Effects may extend beyond the snowmaking area through drainage and runoff.
35. Altered runoff and erosion: Increased or delayed meltwater, particularly where soils are compacted, may increase surface runoff, waterlogging and localised erosion. This has the potential to remove or redistribute litter, organic soil and associated invertebrate habitat and to transport sediment into downslope wetlands and waterways.
36. The effects of snowmaking are therefore expected to be predominantly indirect, through modification of the physical and chemical characteristics of invertebrate habitat, although direct disturbance or mortality may also occur where snowmaking affects occupied surface or soil habitat.

Snow grooming

37. Snow grooming can produce some effects similar to snowmaking, but without the additional water and associated ion inputs from snowmaking. Grooming also changes the physical properties and insulating capacity of the snowpack.
38. Altered soil temperature: Increased snow density and altered snow insulation can affect heat transfer between the atmosphere and underlying soil. Where snow

cover is relatively shallow, this may increase frost penetration and affect overwintering invertebrates and soil biological processes. However, the magnitude and direction of this effect are site-dependent.

39. Soil compaction and waterlogging: Repeated grooming can contribute to snow and soil compaction and alter soil porosity and permeability. During snowmelt this may increase soil saturation and reduce the suitability of soil and litter habitat for some invertebrates. Fahey et al. (1999) reviewed evidence from overseas of reduced soil-fauna abundance associated with snow grooming and reported reductions of up to approximately 70% in some studies. This evidence should be regarded as indicative of the potential magnitude of the effect rather than as evidence of a comparable reduction at the Remarkables.
40. Delayed snowmelt: Dense groomed snow can persist beyond natural snow cover, delaying soil warming and the onset of biological activity. This may alter the timing and duration of activity and resource availability for some alpine invertebrates.
41. Runoff and erosion: Concentrated or delayed meltwater from groomed areas may increase localised runoff and erosion, potentially resulting in loss or redistribution of surface organic matter and associated invertebrate habitat.

Skiing

42. Skiing has the potential to compound the physical effects of snow compaction and grooming.
43. Direct disturbance and mortality: Skiing may directly disturb or kill surface-active invertebrates and affect shallow soil and litter habitat, particularly where snow cover is thin or discontinuous. The potential for direct effects is greatest during periods of shallow snow cover, when skis or associated equipment may contact underlying vegetation and soil (Fahey et al. 1999).
44. Compaction: Repeated ski traffic can increase snow compaction and, where snow is shallow, contribute to disturbance of underlying vegetation, litter and soil. This may reduce the quality of habitat available to surface and soil fauna (Fahey et al. 1999).

45. Pollution: Skiing and associated recreational activity may introduce litter and other contaminants to the alpine environment. Such inputs have the potential to produce localised effects on invertebrates and their food resources, although the magnitude of this pathway will depend on the nature and quantity of contaminants entering the environment.
46. Effects are likely to be concentrated in areas receiving repeated or intensive ski traffic and where snow cover is insufficient to protect underlying soil and litter habitats.

Summer visitor activity

47. Summer recreational use has the potential to affect invertebrates primarily through physical disturbance and degradation of their habitat.
48. Trampling: Off-track walking and other recreational activity can directly disturb or kill surface-active invertebrates and damage vegetation, litter and shallow soil habitat.
49. Soil compaction and erosion: Repeated foot traffic can compact surface soils and create informal tracks, reducing soil porosity and increasing runoff and erosion. Loss of litter and organic soil can reduce habitat availability for soil- and litter-associated invertebrates.
50. Habitat fragmentation and disturbance: Repeated disturbance can reduce the continuity and quality of suitable habitat, potentially affecting less mobile or habitat-specialist taxa.
51. Effects are likely to be concentrated around access routes, facilities and areas receiving repeated visitor use. The significance of these effects will depend on the level and spatial distribution of summer use and whether visitor activity extends into areas supporting sensitive or locally restricted invertebrate habitat.

Roading and vehicle activity

52. Road construction and vehicle use have the potential to affect invertebrates through direct habitat loss, physical disturbance and changes to adjacent soil and vegetation.

53. Habitat loss: Construction of roads and associated infrastructure directly removes vegetation, litter and soil habitat and may permanently reduce the area of suitable habitat available to terrestrial invertebrates.
54. Dust: Vehicle movements, particularly on unsealed roads, can generate dust that is deposited on adjacent vegetation, litter and soil. Dust deposition has the potential to alter surface microhabitat conditions and food resources for invertebrates and may cause localised effects adjacent to roads. The magnitude of this pathway is expected to decline with distance from the road and will depend on traffic volume, road surface and weather conditions.
55. Soil compaction, drainage and sedimentation: Road construction and vehicle use can compact road margins and alter natural drainage patterns. Runoff may transport sediment into adjacent terrestrial, wetland and stream habitats, potentially reducing habitat quality for terrestrial, aquatic and semi-aquatic invertebrates.
56. Direct mortality and contaminants: Vehicle movements may cause direct mortality of ground-active invertebrates crossing roads or tracks. Fuel, lubricants and other vehicle-associated contaminants provide an additional potential source of localised effects.
57. The evidence of Dr Walker is relevant to the matters discussed in the section above.

Climate change and snowmaking

58. Climate change can alter terrestrial invertebrate phenology and behaviour (e.g., emergence, reproduction, feeding, and growth) by changing temperature and the timing and duration of snow cover. This may be particularly challenging for flightless alpine invertebrates with limited ability to track changing conditions through dispersal. Some New Zealand alpine invertebrates have already shifted upslope with changing snowlines, but their capacity to continue adapting spatially may be limited (Chinn & Chinn 2020).
59. Climate change has the potential to interact with the effects of snowmaking over the life of the project. The issue is not simply whether snowmaking is required

under current conditions, but whether changing snow conditions may result in greater reliance on artificial snow to maintain the intended ski operation.

60. Increased artificial snow production could result in longer periods of artificial snow cover, greater snow accumulation and compaction, altered timing of snowmelt and soil warming, and greater volumes of meltwater entering the receiving environment. Changes in snow duration can compress the short growing season and create mismatches with food resources or other species, while limited dispersal may constrain the ability of specialised alpine taxa to track suitable conditions. Where snowmaking overlaps with sensitive alpine soils, cushionfield, fellfield, snowbank or other specialised invertebrate habitat, these effects could become more significant over time.
61. The potential future increase in reliance on snowmaking is therefore an uncertainty that should be recognised in determining the overall effects of the proposal. The absence of an assessment of how snowmaking requirements may change under foreseeable future climate conditions limits confidence in the assessment of the project's long-term effects on terrestrial invertebrate values.

Terrestrial Ecology Management Plan (TEMP) relating to Invertebrates

62. I consider that the proposed management framework is not specific enough to provide confidence that effects on conservation-significant and poorly known invertebrate taxa will be adequately avoided or detected.
63. In particular, the TEMP should provide greater species-specific information on Threatened, At Risk, Data Deficient and otherwise poorly known taxa identified in Appendix 2, including their known distributions, habitat requirements and potential project effects. The current “Significant / Threatened Invertebrates” provisions are largely generic.
64. The proposed reliance on salvage and reinstatement of microhabitats requires greater justification. Avoidance of important habitat should be prioritised and the TEMP does not adequately demonstrate that relocated or reinstated cushionfield, turf, moss, rock refugia and associated soil/litter complexes will retain their ecological function for invertebrates.

65. The proposed BACI monitoring is appropriate in principle, but insufficient detail is provided regarding replication, control-site selection, sampling effort, seasonality, detection probability and statistical power. Consequently, it is unclear whether the proposed monitoring would reliably detect Project-related effects on invertebrates.
66. I also consider the proposed 15–20% and 20% decline thresholds insufficiently justified. The TEMP does not demonstrate that these thresholds are distinguishable from natural variability or sampling uncertainty, or that they are appropriate for individual conservation-significant taxa. Higher thresholds may also allow substantial declines in individual taxa to occur before a management response is triggered, which may be inappropriate for rare or localised taxa with limited capacity for recovery or recolonisation.
67. The provisions relating to host plants require further consideration. Translocation of host plants, including *Cardamine* and *Aciphylla* species, should not be assumed to maintain associated invertebrate populations without consideration of their life stages and the wider plant, soil, litter and microhabitat requirements.
68. There is no discussion of vegetation direct transfer methods for invertebrate communities (or notable TAR species). I recommend considering this (as briefly outlined in the Appendix 3 of the TEMP) in addition to host plant relocation. Transfer of topsoil, litter, schist debris or intact habitat blocks may improve salvage of eggs, larvae, pupae and less mobile species that are unlikely to be detected using conventional salvage methods. (Note: uncertainty of ‘success’). In addition, provide greater justification for relocation site selection, including how recipient sites will maintain long-term habitat quality, host plants and ecological processes beyond simple habitat similarity.
69. Overall, I consider that the invertebrate provisions within the TEMP should be strengthened through species-specific assessment, greater emphasis on avoidance, a more robust monitoring design, and clearly justified performance criteria and adaptive-management triggers.
70. Until these matters are addressed, I consider there is insufficient information to demonstrate that the proposed management measures will adequately address

the potential effects of the Project on terrestrial invertebrate values, particularly Threatened, At Risk, Data Deficient and poorly known taxa.

Assessment of Invertebrate Effects Management

71. The application identifies a diverse alpine invertebrate assemblage, including taxa of conservation interest, and acknowledges adverse effects including habitat loss and construction noise. However, the information provided does not give a sufficiently robust basis to determine whether the proposed effects-management response is commensurate with the values at risk.
72. In particular, the effects-management response for invertebrates does not, in my view, adequately demonstrate the application of the effects-management hierarchy. There is insufficient demonstrated avoidance of areas supporting significant or potentially irreplaceable invertebrate values; the extent to which effects can genuinely be minimised or remedied is uncertain; and there is insufficient information to establish that the proposed offsetting and compensation measures would address the residual adverse effects on invertebrate values in a manner that is ecologically commensurate.
73. This is particularly important in an alpine environment, where invertebrate assemblages are closely associated with specialised habitats and microhabitats, and where the loss or modification of particular habitat features may not be readily reversible or replaceable. The issue is therefore not simply the area of habitat affected, but whether the particular ecological functions, habitat attributes and invertebrate populations being lost can be restored elsewhere or recreated within a meaningful timeframe.
74. The Doolans Basin is of particular concern. Where significant invertebrate habitat or populations occur within the proposed disturbance footprint, avoidance should be the primary response particularly for vulnerable or irreplaceable values. This should include consideration of whether infrastructure and associated ground disturbance, such as water storage facilities and access tracks, can be located to avoid these values. Where effects cannot reasonably be avoided, including effects associated with snowmaking over habitat, the Panel would need to be satisfied

that any residual effects are capable of being addressed through demonstrably effective and ecologically commensurate measures.

75. On the information available, I therefore consider that the adverse effects on invertebrates remain insufficiently addressed, and there is presently no adequate basis for concluding that the proposed effects-management measures will address the residual effects. The evidence of Dr Maseyk and Dr Walker is relevant to these matters, particularly in relation to the significance and vulnerability of the terrestrial ecological values, the limits of restoration and the circumstances in which offsetting or compensation can appropriately address residual effects.

Persistence of Threatened Species per the Otago Conservation Management Strategy

76. Of the invertebrate species listed in Appendix 5 in the Otago Conservation Management Strategy 2016 (CMS), 3 taxa are relevant to the Remarkables ski field expansion. These are: *Huttonia* sp. (may represent *Huttonia palpimanoides*; a spider) has been recorded within the Project area, while *Xanthorhoe frigida* and *Duvaliomimus walkeri* (both moths) have high and moderate likelihoods of occurrence, respectively. Two other threatened species were identified in the desktop review: *Asaphodes stinaria* and *Xanthorhoe bulbulata*, both moths with a ‘Very Low’ likelihood of occurrence. The proposed habitat loss and modification within the ski field expansion, together with limited information on the distribution, population size and ecological requirements of these taxa, means that it is difficult to determine with confidence whether CMS-defined persistence ‘where there is a 95% probability of a species surviving over the next 50 years or three generations (whichever is longer)’ would be achieved.

References

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