A Review of Terrestrial Invertebrate Information for the Tekapo Power Scheme Resource Consents

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1. Executive Summary

The Tekapo Hydro Power Scheme (TekPS) has water consents that are due to expire in April 2025. Genesis Energy Ltd are seeking to renew consents without changing existing water use parameters. Entecol Ltd was contracted to provide a literature review of terrestrial invertebrate values found in the area, assess the impacts of continuing the TekPS on those values, and evaluate the continued efficacy of Project River Recovery in the context of mitigating the impacts identified.

Information on terrestrial invertebrate presence in the TekPS and wider area was obtained largely through Crown tenure review conservation resources reports from between 1997 and 2007, a range of science papers, and Department of Conservation reports.

Results

A range of invertebrates with known conservation significance have been recorded from the wider Lake Tekapo/Takapō and Lake Pūkaki area, with a subset of these associated with braided rivers and most likely to be affected by the TekPS. This includes spiders, stiletto and robber flies, grasshoppers, Tekapo ground weta, moths, and some true bugs.

The key impacts from the TekPS and reduced severity and frequency of flood events were increased accessibility to predators, exacerbated weed problems, fire (particularly from the added fuel load of weeds), and reduced deposition and maintenance of sandy substrates, which are key habitats for some species. However, the reduced severity of flood events is also a potential positive for the species needing more stable habitat features. The major changes to terrestrial invertebrate communities from managed flow regimes to the Tekapo/Takapō River will have already occurred over the preceding decades, and the ongoing changes to the existing communities caused by the TekPS will be relatively small.

Project River Recovery is predominantly focused on protecting braided river and wetland communities from weeds and predators, so is well targeted in terms of mitigating and compensating for the key impacts on terrestrial invertebrates that were identified for the TekPS. Project River Recovery also supports key research on braided river ecosystems and has an important advocacy role, both of which will benefit the management of terrestrial invertebrate communities in the area.

Key Findings

- In the absence of mitigation, the impacts of the continuation of the TekPS on the existing terrestrial invertebrate fauna is considered minor at worst.
- Ongoing support for the initiatives undertaken by Project River Recovery on weed and predator control is a highly appropriate mitigation/compensation for the impacts of continuing the TekPS on terrestrial invertebrates.
- Even if the TekPS were not operating, weeds and predators would still exist as major threats to terrestrial invertebrates on braided rivers, so the conservation benefits that would accrue from ongoing support of Project River Recovery will exceed any negative impact on terrestrial invertebrates from continuing the TekPS.

2. Background

The Tekapo Hydro Power Scheme (TekPS) has a number of water permits due to expire in April 2025 requiring the current owner and operator, Genesis Energy Ltd, to apply for new consents. As part of that wider reconsenting process, Genesis Energy Ltd contracted Entecol to provide a review of terrestrial invertebrates in the area to better inform its consenting application.

3. Introduction

The Mackenzie Basin is a large inland plain between the Southern Alps and the foothill ranges of South Canterbury and is the site of the Upper Waitaki hydroelectric scheme. Other significant industries in the Mackenzie Basin include farming and tourism. In generating energy from water flowing from the Southern Alps out to sea, the rivers and lakes in the Mackenzie Basin and Waitaki river have been modified with canals, dams, power stations, and man-made or raised lakes, to provide the country with renewable electricity. Lake Tekapo/Takapō became the reservoir for two hydroelectric power stations, Tekapo A and Tekapo B with the development of the Tekapo Power Scheme (TekPS) in 1951.

Lake Tekapo/Takapō has a normal operating range of 702.1 to 710.9 metres above sea level (masl), however the minimum and maximum consented operating levels vary throughout the year. Pre-1951, the natural (uncontrolled) lake level fluctuation was approximately 2.6 m, with lake levels varying between 704.4 and 707 masl under the influence of the natural inflows and outflow from the lake.

The lake is fed at its northern end mainly by the Godley River, Macauley River and Cass River, and is dammed at the head of the Tekapo/Takapō River by the Lake Tekapo Control Structure (Gate 16). Approximately 2km downstream of Gate 16 is a concrete weir that dams the Tekapo/Takapō River to form Lake George Scott. Water released from Lake Tekapo/Takapō and held in Lake George Scott can be discharged into the Tekapo Canal via Gate 17, or flow over Lake George Scott Weir and continue down the Tekapo/Takapō River to Lake Benmore. Under normal conditions the Tekapo/Takapō River channel has no or very little flow from the Lake Tekapo/Takapō outlet until it converges with Fork Stream, approximately 7km downstream of the Lake Tekapo/Takapō outlet. The 3 km reach of the Tekapo/Takapō River between Lake George Scott and the confluence with Fork Stream does have some minor groundwater inflow which results in some ponding and minor surface flow along this reach of the Tekapo/Takapō River.

The storage and diversion of water for hydroelectric schemes alters natural flow regimes and sediment transfers downstream (Caruso et al 2013, Gabbud & Lane 2015). The river systems of the TekPS are braided rivers, and braided rivers naturally undergo repeated perturbation of the riverbed. Reduced flows and flood attenuation from hydroelectric schemes can modify natural sedimentation and channel forming processes. This in turn may adversely affect downstream biota that have adapted to live in braided river environments, including terrestrial invertebrate species. The focus of this review is on describing those communities and assessing the effects of the TekPS on them.

The construction of Tekapo A commenced in 1938 before it was commissioned in 1951; the construction of the Tekapo Canal and Tekapo B was completed in the 1970s. As Genesis Energy Ltd is not proposing to change current operating conditions in the reconsenting of the TekPS, the various assets associated with the TekPS will be treated as existing features within the environment when considering impacts on terrestrial invertebrate values. This assessment does not and cannot (given the lack of historic information) consider the original impacts of the scheme on terrestrial invertebrate communities. Rather it focuses on the existing invertebrate community and considers those aspects of the ongoing operation of the TekPS that have the potential for ongoing effects on them.

Invertebrate research in terrestrial braided river environments in New Zealand is limited (O'Donnell 2016, Schori 2020, DOC ECan report), so our knowledge of the range of terrestrial invertebrate species, including those dependent on braided rivers, is certainly incomplete. We do know that invertebrate communities within the Mackenzie Basin generally have been affected by many other factors, particularly habitat loss through expanding agricultural activities such as pastoralisation and irrigation. While these threats are acknowledged in terms of the overall environmental pressures on invertebrate communities in the region, they are not directly relevant in considering the environmental effects of the TekPS itself.

In recognition of the potential adverse effects of hydroelectric schemes on braided river and wetland systems, Meridian Energy Ltd and Genesis Energy Ltd fund Project River Recovery (PRR) via an agreement with the Department of Conservation. This assessment will also evaluate the benefits of PRR activities as a mitigation or compensation for the potential impacts of the TekPS on terrestrial invertebrates.

Finally, we have also undertaken an assessment of the ecological significance of the terrestrial invertebrate habitat in respect to the criteria found within the Canterbury Regional Policy Statement (CRPS) from Environment Canterbury.

4. Objectives

- To determine what terrestrial invertebrates of conservation significance are known to, or likely to occur within, the wider Lake Tekapo/Takapō and Lake Pūkaki areas, and therefore potentially within the scope of the TekPS.
- To ascertain which of the identified invertebrates are associated with the braided river habitats and therefore potentially affected by flow management regimes associated with the operation of the TekPS.
- Identify the impacts of continuation of the TekPS on terrestrial invertebrates.

- Assess the appropriateness of Project River Recovery to mitigate/offset effects on terrestrial invertebrates and any other mitigation measures that may be appropriate.

- Assess the significance of invertebrate habitat potentially impacted by TekPS in respect to CRPS policy 9.3.1 Protecting significant natural areas.

5. Methods

A literature review encompassing a desktop search of records, plans, unpublished reports and publications pertaining to terrestrial invertebrates in the Mackenzie Basin was carried out, focusing on mentions of species presence in the Lake Tekapo/Takapō and Lake Pūkaki area.

The Toitū Te Whenua Land Information New Zealand website was accessed for records of Crown pastoral lease tenure reviews, which contained conservation resources reports. The pastoral runs surrounding the lakes were identified using the information provided in the reports and the online topographic map hosted on NZ Topo Map. These reports contain results of specialist surveys carried out on-site on the Crown portion of the otherwise freehold pastoral runs. Relevant information of species presence and distribution were filtered out and retained, while entries lacking specifics or listing commonly found invertebrates were discarded as this level of information is not useful for current purposes.

The terrestrial invertebrates identified as potentially significant were then cross-checked against the New Zealand Threat Classification System (NZTCS) database to ascertain their current conservation statuses. The NZTCS assesses the conservation status of groups of native animals, plants, and fungi in New Zealand, and is administered by the Department of Conservation. In accordance with the Department of Conservation's definition (Townsend et al. 2008), 'Threatened' species are most in danger of extinction, whereas 'At Risk' species may become threatened species should population numbers drop further. Under the NZTCS system, 'Threatened' and 'At Risk' are umbrella categories for a range of conservation statuses, as shown in Table 1. There is also a Data Deficient category, which is given to species where there is so little information available that a proper assessment of their conservation status cannot be made. For invertebrates, these species are often known and described from just a few individuals but there is no further demographic data available.

The invertebrate habitat potentially affected by TekPS was assessed for regional significance in respect to policy 9.3.1 of the CRPS by evaluating various factors against the criteria found in Appendix 3 of the CRPS.

Table 1: Conservation status classifications under the NZTCS system.

	Umbrella Categories	
	At Risk	Threatened
Conservation Status	Declining	Nationally Critical
	Recovering	Nationally Endangered
	Relict	Nationally Vulnerable
	Naturally Uncommon	

6. Results

The data on species distribution are collated mostly from Crown pastoral lease tenure review surveys, which were carried out between 1997-2007 on stations surrounding Lakes Pūkaki and Tekapo/Takapō. The species of conservation interest are presented in tabled form in Appendix I, and other 'notable' invertebrates in Appendix II. Factors not associated with the TekPS, particularly habitat loss through expanding agricultural activities such as pastoralisation and irrigation, were found to have significant effects on invertebrate communities within the Mackenzie Basin.

A dedicated Project River Recovery terrestrial invertebrate survey on the Tasman River was carried out between 2005-2012 (Project River Recovery Report 15/01). The results to date relate to trapping undertaken from October 2005 to February 2006, which was focused on the most common vegetation habitat type in the Tasman braided river system, namely the *Raoulia haastii - R. australis* cushionfield community (Murray 2019). For that period of sampling, 152,509 specimens were obtained from the 438 trap samples collected across six sites on the Tasman River floodplain. A total of 919 unique recognisable taxonomic units (RTUs) from 21 orders and 165 families were identified. This included a range of undescribed species (new to science), although that is not unusual when conducting intensive trapping in natural habitats.

The section below provides a summary of species of conservation significance identified as present within the Mackenzie Basin, along with a brief discussion of their known biology, habitat requirements, and whether they are likely affected by the TekPS.

6.1 Species of Known Conservation Significance

Spiders (Araneae)

Two spiders of potential conservation interest were identified from the PRR survey of the Tasman River. The "naturally uncommon" wolf spider *Anoteropsis arenivaga* is quite widespread in the South Island and is associated with sandy riverbeds, lake edges and beaches (Vink 2002). It is very well camouflaged against the rocks and sand, and mostly nocturnal.

A "data deficient" Gnaphosid spider, *Matua festiva*, was the other spider of potential conservation significance collected during the PRR survey. This species was previously known only from near Lake Rubicon (which lies between Porters Pass and Waimakariri River) indicating it is probably more widespread in suitably open riverine habitats in Canterbury at least. If these spiders are also found in braided river systems downstream of the TekPS they are potentially affected by flow management, although it is difficult to guess exactly what the implications of flow changes would be as we know so little about the specific habitat needs of these spiders.

In addition to the above, *Cantuaria spp*., being trapdoor spiders that live underground in burrows for most of their lives, have been identified in grassland near Lake Ōhau but not within the TekPS area. The majority of the species live in forest environments, but there some are dryland environment specialists. The lifestyle and large size of these spiders means they are capable of eating many invertebrates that move past their burrows (even earthworms) and there is no evidence to suggest any of the species found in the Mackenzie basin will be especially dependent on braided river species. Because of their sedentary nature it is considered *Cantuaria* will have restricted distributions with some of the described species in New Zealand being considered “At Risk, Naturally Uncommon” for that reason.

The areas potentially affected by flow management have already been subject to flow management for decades, so a continuation of the TekPS without significant changes to flow are unlikely to have any additional impacts on the extant populations of spiders.

Beetles (Coleoptera)

Three beetle families with species of conservation significance are listed in Appendix I, namely a darkling beetle (Tenebrionidae), ground beetles (Carabidae) and chafer/scarab beetles (Scarabaeidae).

The “naturally uncommon” darkling beetle *Artystona lata* is recorded from a few sites within the Mackenzie Basin, mostly from rocky outcrops and rock piles. The closest record to the TekPS is at Mt John. In general, darkling beetles feed on dead organic material and live mainly in soil or in leaf litter, and under logs (Watt, 1992). They are unlikely to live in braided riverbeds and are not considered likely to be affected by water flows.

Ground beetles of the flightless genus *Holcaspis* generally tend to be found under logs and stones in fields and forests (Larochelle & Larivière 2007), and the “declining” *Holcaspis falcis* is known to live mostly in drier montane woodlands, shrublands and tussock grasslands (Larochelle & Larivière 2001). The “nationally critical” ground beetle *Holcaspis bidentella* was recorded from a range of environments in the Mackenzie Basin, from elevated ridges to rocky areas near tarns and moraines. Described by Johns in 2003, its type locality is Simons Hills. Both *Holcaspis* species are confined to the Mackenzie Basin and its surrounding mountains. Fuller et al. (2013) suggest that loss or modification of native habitats, in conjunction with predation by both native and introduced species, may be the main threats for these ground beetles. Again, they are unlikely to live in braided riverbeds and are not considered likely to be affected by the TekPS.

The "naturally uncommon" scarab beetle *Prodontria matagouriae*, is named after its association with matagouri (*Discaria toumatou*) shrubs, and has so far been found in intermontane basin grassland. This species is not considered affected by the TekPS. The "naturally uncommon" species *Prodontria minuta* was collected from grassland near a road to the east of the Mackenzie River about 3 km north of Lake Benmore in 1993. It is the smallest known *Prodontria* species. Little is known about its distribution or ecology (Emerson & Barratt 1997, Barratt 2007, Leschen et al. 2012). In general, *Prodontria* species have limited distribution ranges and are all flightless, making them vulnerable to habitat modification (Klimaszewski & Watt, 1997). However, the grid reference data on the specimen label and the "grassland" habitat mentioned, indicates that *P. minuta* is unlikely to be within the braided river system typically affected by river flows.

Stiletto Flies (Diptera: Therevidae)

The stiletto flies (Therevidae) are specialists of loose, sandy substrates e.g. on river margins, lake shores, and coastal sand dunes. New Zealand is especially rich in Therevid species, with 69 described species and the likely total fauna exceeding 100 species (Lyneborg 1992). Numerous species have been found associated with sandy deposits along river margins. The braided rivers of the Mackenzie Basin are no exception.

The holotype for the "data deficient" stiletto fly *Anabarhynchus albipennis* was collected from Lake Pūkaki in 1964 (Lyneborg 1992) and is known only from that one male specimen. Apart from it inhabiting inland lake shores, nothing else is known about its biology (Pawson & Emberson 2000). The "data deficient" *Anabarhynchus indistinctus* was collected during the PRR survey, this was previously known only from dry riverbeds near Arthurs Pass, so the discovery at Tasman River indicates its distribution is likely to be wider than previously recognised.

The holotype male and two paratype females of the "naturally uncommon" *Anabarhynchus harrisi* were collected on sand adjacent to Blue Stream (which flows into the Tasman River above Lake Pūkaki) in 1989 (Harris 2006) but was not collected during the PRR survey. The worm-like larvae of *A. harrisi* live in the loose sand or soil and burrow through the substrate to predate on other insect larvae. They lead a kleptoparasitic way of life, where the larvae raid nests of wasp species that are stocked up with mayflies, caddisflies as well as paralysed spiders (Lyneborg 1992). Loss of habitat and habitat modification are the most immediate threats to therevids in Canterbury (Pawson & Emberson 2000). The riverine species are adapted to the loose sandy deposits that are formed and maintained by flood events that are part of a normal dynamic river system, so are potentially vulnerable to changes in flow management regimes that are insufficient to support the ongoing formation and maintenance of vegetation-free sand areas. However, flow management regimes have been in place on the affected braided river systems for a number of decades, so we would expect any significant changes to the stiletto fly communities due to a reduced severity/frequency of flood events to have occurred already, and therefore the current stiletto fly communities should be largely unaffected by a continuation of the TekPS.

Robber Fly (Diptera: Asilidae)

A "naturally uncommon" species of robber fly (*Neoitamus smithii*) was collected during the PRR survey of the Tasman River. This species is regarded as naturally uncommon because it has only been found in association with braided rivers of the Canterbury region (Andrew et al. 2012). Adult robber flies are large, strong-flying predators that catch other insects on the wing. The adults are therefore clearly able to escape flood events. The larval stages of this species are unknown, but most robber fly larvae are found in the soil. We do not know if the larvae of *N. smithii* are found within the normal flood zones of braided rivers, but if the species is indeed associated with braided rivers, then it is clear they are adapted to survive occasional flooding events. We do not know if their larvae live in the very loose riverine sands like the larvae of stiletto flies (discussed above) so it is difficult to postulate how they might be impacted by flow management regimes.

Grasshoppers (Orthoptera: Acrididae)

The Nationally Endangered robust grasshopper (*Brachaspis robustus*) is protected under the Wildlife Act 1953 of New Zealand, one of only five orthopteran species granted protection under the Act. The flightless grasshopper is known from the stony floodplain terraces, fluvioglacial outwashes, and rocky braided river systems of the Mackenzie Basin. *B. robustus* was common around the weather station within 100 m of the Tekapo A Powerhouse in 1971-72 (White 1994). Monitoring for the species is ongoing at Patersons Terrace (Schori et al. 2020), and updated information is expected soon (Schori, personal communication).

While *B. robustus* is resilient to natural disasters such as floods and droughts, it is a poor jumper and populations are continually at risk from both indigenous predators (such as birds, spiders and skinks) and introduced predators, particularly feral cats and hedgehogs (White 1994).

Another *Brachaspis* species is also found in the wider area, and were previously referred to as *Brachaspis* "Hunter Hills" and considered "data deficient" (Trewick et al 2016). However, the most recent conservation status assessment (Trewick et al 2022) considered the "Hunter Hills" variant to be conspecific with *B. nivalis*, which they considered not threatened.

The "nationally vulnerable" *Sigaus minutus* was discovered in the Mackenzie Basin in 1928 but failed to be recorded by entomologists for nearly 50 years, before being rediscovered in 1975 at Edwards Stream (White 1994). It is also known from Lindis Pass. Variants called *Sigaus* 'blue' and *S.* 'green' recorded from the wider area are most recently considered conspecific with *S. australis* 'central arid' (Trewick et al 2022) and considered "nationally vulnerable", however there is some confusion with tag names used in the Crown pastoral tenure reviews with some referring to *S.* cf. *minutus* 'blue' and *S.* cf. *minutus* 'green' respectively. The Island, a flat alluvial outwash riverbed located below the confluence of the Macaulay River at the northern end of Lake Tekapo/Takapō, contains the northernmost reproducing population of *Sigaus* 'blue' (Crown pastoral tenure review). This location is unaffected by the TekPS.

Another short-horned grasshopper, *Phaulacridium otagoense*, has also recently had its conservation status worsened from "not threatened" to "declining" (Trewick et al 2022). Recent research (Sivyer *et al*. 2018) has shown that the future of this small grasshopper species is threatened by land use changes (especially irrigation of dryland environments) within its limited range, which has also seen the range expansion of a much more widespread congener, *P. marginale*, with which it is inter-breeding. The Mackenzie Basin is at the northern end of its range, and it has been reported from very dry areas of Camp Stream and Mid Coal River.

A shared feature of habitat preferences for these grasshoppers are open, dry stony substrates. *B. robustus* and *Sigaus* grasshoppers depend on braided river systems for their continued survival i.e., they rely on the braided river habitats for feeding, breeding, and shelter (White 1994, Jamieson 1998, O'Donnell et al. 2016). The grasshoppers are clearly adapted to cope with occasional natural flood events, and studies by White (1994) on *B. robustus* demonstrated that they would survive natural flood events on the Tekapo/Takapō River of 390 cumecs at the long-term stations he used (and 1240 cumecs on the Pūkaki River). Since the hydroelectric flow controls have been in place, neither Tekapo/Takapō River nor Pūkaki River have reached such flood levels. It is therefore very unlikely that these grasshoppers will be adversely affected by the highest flows within the TekPS, and it is possible that a flow regime that reduces the severity of maximum flood events is beneficial to the population. They are vulnerable to habitat loss, predation and weed growth, some of which is potentially exacerbated by lower flood flows.

Weta (Orthoptera: Anostostomatidae)

The long-lived Tekapo ground weta *Hemiandrus "furoviarius"* is known only from the Mackenzie Basin, and is endemic to the river margins in the area, including the Tekapo/Takapō (van Wyngaarden 1995, Johns 2001). *Hemiandrus "furoviarius"* was reclassified from "naturally uncommon" in 2012 to "nationally critical" in 2014 due to its observable decline in numbers (Trewick et al. 2016). However, this has recently had its conservation status improved to "nationally endangered" due to new information on their population (Trewick et al. 2022). The Tekapo ground weta spend most of their lives in burrows, which tend to be in places where the substrate consists mainly of fine, silty soil (van Wyngaarden 1995, Johns 2001). The availability and depth of substrate suitable to burrowing influences the distribution of *H. "furoviarius"*, with the population being highest where their soil of choice was deepest (van Wyngaarden 1995). The Tekapo ground weta is at risk of predation from native invertebrates as well as introduced predators, especially hedgehogs and cats. It is generally located in areas above normal flood levels and is unlikely to be negatively affected by flows from the TekPS. It possibly benefits through reduced severity of extreme flood events, although it is known to survive through quite sustained flood events causing deposition of considerable silt on top of their burrows (Johns 2001).

Hemideina maori, the mountain stone weta, was found under rocks on the old riverbeds two to three kilometres below Tekapo A Power Station in November 2020 (Graham Ussher pers. comm.). The species is not threatened, but is mentioned here as earlier literature does not mention its presence despite *H. maori* being a characteristic element of dry riverbeds in the Canterbury high country. The PRR survey found a similar pattern in that orthopterans were uncommon in trap samples, but where there were specimens collected, they tended to be *H. maori*, or crickets.

Moths (Lepidoptera)

There are several threatened moth species within the Mackenzie Basin that are very limited in distribution and numbers, and habitat loss appears to be the main challenge to their survival. For a long time, the "nationally endangered" lichen tuft moth (*Izatha psychra*), was known solely from the type specimen collected at Porter's Pass in 1882, before being rediscovered in 2001 at Pūkaki Scientific Reserve, near Lake Pūkaki. Despite extensive sampling in the one shrubland site where they are known to occur, as well as sampling in similar shrubland in the southern South Island, they are still currently only known to exist in the one site, and their female and larval forms remain unknown (Hoare 2010). This location is outside of the TekPS.

The Museum of New Zealand and Canterbury Museum each hold a specimen of the "nationally critical" carpet moth (*Xanthorhoe bulbulata*), which were collected from Lake Pūkaki and Lake Tekapo/Takapō sometime in the 1890s to 1920s. This was once a common and widespread species found in dry, open grassy areas ranging from coastal to low alpine zones (Pawson & Emberson 2000, Patrick 2000a, Hoare et al. 2017). Since 1940, only two specimens have been recorded (both from Otago). It may still exist within the Mackenzie Basin, but given its grassland habitat is likely to be outside of the riverbeds, this species is unlikely to be affected by the TekPS.

The "nationally endangered" plains jumper moth, *Kiwaia* 'plains jumper', was found on floodplains and terraces during surveys for the Crown pastoral land tenure review of Mary Burn Station, and was inferred to also be present at Balmoral Station (Crown pastoral tenure review). The adults of *Kiwaia* 'plains jumper' are diurnal and do not fly. They jump around on shingly or sandy ground where mosses, sorrel, and cushion plants (*Raoulia* spp.) grow. They inhabit open river terraces, old foredunes and riverbed relics, and are known from a few other sites in Kaitorete Spit, McLeans Island and Rakaia Island, which is a large in-river island in the Rakaia River (Pawson & Emberson 2000, Patrick & Dugdale 2000; Patrick & Grove 2014). Habitat modification by urbanisation or development of pastures was identified as the main threat facing *Kiwaia* 'plains jumper' (Pawson & Emberson 2000). The known distribution and habitats of this species indicate it is adapted to the open riverine habitats and its populations will be tolerant to at least some degree of flooding. The flow regimes under the TekPS reduce the severity of flood events in the Tekapo/Takapō River, so this is potentially a positive situation for a moth that prefers the rarely-flooded *Raoulia* cushionfields.

The "nationally critical" Grays River grass moth *Orocrambus fugitivellus* is a diurnal endemic known only from the Grays River wetlands in the Mackenzie Basin plains, where its grassland habitat is seasonally flooded. The holotype specimen was collected in 1939 from the Mackenzie Basin and identified in 1950 by George Hudson, and the species is known only from its type locality (Patrick & Dugdale 2000). Its habitat consists of native and exotic grasses and sedges (Patrick 2004). The males can fly but the females are rendered flightless by their very small wings, thus limiting their dispersal ability (Patrick & Dugdale 2000). The wetland locality where this species is found is fed from catchments to the west of Lake Tekapo/Takapō and is therefore not impacted by the TekPS.

Orocrambus "Mackenzie basin" is a taxonomically indeterminate moth that is considered threatened due to it having a very localised distribution. There is little known about this species apart from being found in stony tussock country on flat dry moraines. There is no evidence or information to indicate that this species will be affected by the TekPS.

The "naturally uncommon" *Eurythecta robusta* was collected during the PRR survey of the Tasman River. It also has flightless females, making the species vulnerable to disturbance due to its poor dispersal capabilities. This species was once common and widespread through Canterbury grasslands but does not survive in cultivated pastures and urbanised areas, so is now much more local in its distribution (Patrick & Heenan 2019). While it will occur in dry riverbed habitats, it is not restricted to regularly flooded areas, so the impact of TekPS is likely to be minor for the species. However, the reduced severity of flood events due to flow management is possibly a positive for some of the sites where this moth might occur. Urban sprawl and lifestyle block conversions were identified as the main threat to this species (Pawson & Emberson 2000).

The "relict" diurnal looper moth *Paranotoreas fulva* was sampled on glacial outwash terraces immediately south of Lake Tekapo/Takapō. It was once associated only with the Central Otago saltpans, and this was the first record of *P. fulva* in the Mackenzie Country (Patrick 1992). It has now been found at a range of locations in Otago and appears generally restricted to dry inland areas with low-stature vegetation (Patrick 2004). While the vegetated parts of river flats include suitable habitat for *P. fulva*, it is unlikely that the continuation of the TekPS will have a negative impact on this species, and the reduced severity of flood events is possibly a benefit to it at some sites.

Both the "data deficient" *Graphania tetrachoa* and the "nationally vulnerable" *Pasiphila* sp. 'Olearia' were both found during a survey of the Tekapo Military Training Area (unpublished Wildlands TMTA survey) and have an association with *Olearia* species, as the larvae feed only on the foliage of *Olearia* shrubs and trees. *Graphania tetrachoa* is known to have a distribution ranging from the centre of the North Island to Southland (Patrick 2000b). These species are in shrubland and not affected by the TekPS.

Seed bugs (Hemiptera: Lygaeidae)

The holotype female for the "data deficient" seed bug *Lepiorsillus tekapoensis* was collected from "Lake Tekapo" in 1929. It was the sole specimen ever collected, with no others of this genus known, and it was remarked that "the type locality may now be permanently flooded" (Malipatil 1979). The species has not been collected since and nothing is known of its specific habitat requirements, so it is difficult to draw any conclusions as to whether it will be affected by the ongoing operation the TekPS or, in fact, whether it continues to survive in the area at all. However, other locally occurring Lygaeid seed bugs in the same subfamily (Orsillinae) are often associated with low stature vegetation (e,g, *Raoulia* cushions, tussocks, etc) so it is certainly possible that *L. tekapoensis* does survive somewhere on the Tekapo/Takapō River flood plains. It is also most likely to have an association with a particular species or family of native plants, so the current threats to any residual population are more likely to be habitat loss via conversion to pasture, introduced herbivores, weed spread, and vehicle damage rather than ongoing operation of the TekPS.

The PRR survey yielded the "data deficient" *Rhypodes triangulus* and the "naturally uncommon" *Nysius liliputanus*. Both of these are in the same subfamily as *L. tekapoensis* discussed above. Lariviere & Larochelle (2004) note that *R. triangulus* is probably hosted by *Raoulia*, while *N. liliputanus* has been "[c]ollected in moss on glacial moraines; on *Ozothamnus*-tussock associations; in dry riverbeds; also on ferns (at night)." The habitat types listed indicate that these species may also be present around the Tekapo/Takapō River. Both *R. triangulus* and *N. liliputanus* are probably capable of flight, and therefore the adults may escape flood-prone areas. Nevertheless, they may gain some benefit from the reduced severity of flood events due to the TekPS flow controls.

Mirid bug (Hemiptera: Miridae)

PRR sampling in December 2005 yielded two "nationally critical" adult specimens of *Pimeleocoris roseus* from two upper Tasman River sites. This species was previously known only from one site on the Waiho River Flats in South Westland (Murray, T.J. 2019). The fact this new site is on the other side of the dividing range is unusual and indicates that *P. roseus* may well have a considerably wider distribution than previously thought, but only more dedicated sampling of host plants will determine this. Lariviere & Larochelle (2004) note that *P. roseus* is probably capable of flight and both the adult and nymph of this species can be found on its host plant *Pimelea*. This plant was not recorded in the margins of the Tekapo River during a recent botanical survey (Gary Bramley, pers. comm.) but will occur in areas of the wider flood plain. Given their known habitats, *P. roseus* populations are likely adapted to cope with some level of occasional flooding, but like other species discussed in this section, it possibly benefits from the reduced severity of flood events due to TekPS flow controls.

Other Information

A list of the invertebrates of the Mackenzie area (Wakelin *et al*. 2023) was published after the work described in this report was undertaken. That list provides a summary of the state of the environment with regards to invertebrates in the area. The publication provides a list of 3052 invertebrate taxa of the Mackenzie area compiled from published surveys, museum catalogues and other sources, many of which were referred to in preparing this assessment. The published list does not alter the conclusions reached in this report.

7. Impacts on Terrestrial Invertebrates

7.1 Overview

The application for consent being considered does not involve any construction or significant modifications to the TekPS as it exists now.

The canal system is entirely man made and, while offering habitat to aquatic organisms, the banks of the canals do not attempt to emulate a natural river system and offer no valuable habitat to terrestrial invertebrates that are naturally adapted to the braided rivers of the area. As this situation is part of the current environment, we consider it neutral in terms of impacts on terrestrial invertebrate values.

The terrestrial invertebrate values that are most likely to be affected by flows from the TekPS are those specifically associated with braided rivers and lake margins. These invertebrates are naturally adapted to live with variable water flows, sporadic high-discharge events and shifting river channels. They may also have specific host plant needs (e.g. *Raoulia* cushions), larval habitats (loose sand), or have a camouflage perfectly matched to the rock and sand substrates. Species such as the robust grasshopper, alpine grasshopper, stiletto flies, and *Kiwaia* 'plains jumper' moth will spend most of their life cycle on floodplains, shorelines or lake and river margins in the wider Tekapo/Takapō and Pūkaki area, while others, like the Tekapo ground weta, will have specific substrate requirements to survive and thrive. We therefore predict that these sorts of species are the ones most likely affected by changes to the braided river system.

The PRR survey of the Tasman River is the most intensive collection of braided river invertebrates ever undertaken in New Zealand and has, as expected, greatly increased the list of species known from the Mackenzie Basin. This includes species of conservation interest, such as 2 seed bugs, a robber fly, 2 spiders, another moth, and a nationally critical mirid bug. While these species are now known on the Tasman River, which is outside the scope of the TekPS, the habitats they utilise are also found within the areas potentially affected by the TekPS and therefore we should consider they may also be present there, because there simply hasn't been the sort of intensive survey needed to say with confidence that they are not present.

Braided river systems are in themselves naturally uncommon ecosystems in New Zealand (NIWA website, Wiser et al. 2012), and they are characterized by wide gravel beds, high flow variability, and multiple shifting channels interspersed with gravel terraces across floodplains. Braided rivers carry high sediment load and can migrate across the landscape as the ongoing erosion and deposition of sediment in the networks of braids are reshaped by frequent flood-induced disturbances. This results in mosaics of bare ground devoid of vegetation or litter cover, creating a dynamic environment that provides habitat for specialist floral and faunal communities (DOC Education Resource 2010, ECan website 2019, Singers & Rogers 2014, O'Donnell 2016).

Habitat degradation and introduced predatory mammals are the key potential threats to the persistence of endemic terrestrial invertebrates in braided river landscapes (O'Donnell 2016, White 1994, Hoare et al, Schori et al 2019, Pawson & Emberson, 2000, DOC ECan report).

Water-flow changes in the Mackenzie Basin have altered the physical functioning of sections of the braided river systems, affecting the way the braid channels erode and reform, and the reduced number and severity of flooding events within the system has enabled the increased spread of invasive vegetation over gravel plains and islands (O'Donnell 2016, Caruso et al 2013). The reduction in size and number of river braids allows introduced mammalian predators such as cats, hedgehogs and mustelids easier entry to riverbed islands and greater access to the native species that inhabit these spaces. Increased vegetation levels are also likely to provide increased cover for these predators during the day.

Climate change is also predicted to have an impact on terrestrial invertebrate communities in braided river habitats, although the exact nature of those changes is difficult to predict due to the complex interactions between individual species, climate, resource availability, habitat requirements and a species phenotypic plasticity (e.g. Bulgarella et al 2013, Chinn & Chinn 2020, McGlone & Walker 2011). However, one likely impact of climate change in New Zealand is an increase in the number of invasive species that can establish here and a significant range expansion of invasive species that are already established here, both of which are serious threats to invertebrate biodiversity values in natural ecosystems (e.g. Harris & Barker 2007, Kean et al 2015).

While the primary direct impact of the TekPS is in the form of controlled flow (with typically no flow) to the Tekapo/Takapō River, there are a range of impacts that are specifically related to that and these are discussed below.

7.2 Predators

As identified above, one of the identified impacts of reduced flows is increased access by predators, which in turn becomes an increased threat to invertebrates. The New Zealand fauna did not evolve with land mammals, and consequently lack suitable defense strategies for avoiding mammalian predation. For example, both the robust grasshopper, *Brachaspis robustus*, and the alpine grasshopper *Sigaus minutus* prefer the open, rocky habitats of the braided river system (White 1994, Jamieson 1998, Trewick 2001). Both grasshoppers rely on their cryptic colouration as camouflage to escape detection by predators, and *B. robustus*, being a poor jumper as well as being flightless, relies heavily on staying stationary as its method of escaping predation. This makes it highly susceptible to mammalian predators that hunt by smell rather than sight (White 1994; Schori 2020).

Cats and hedgehogs are highlighted as the predators of concern for ground dwelling invertebrates in the Mackenzie Basin, while mustelids and rodents are considered a smaller threat due to their lower numbers in the area (van Wyngaarden 1995, Schori 2020). Hedgehogs feed mainly on invertebrates, and their gut contents have revealed that they consume *Hemiandrus* weta. Hedgehogs can consume large numbers of insects in a night should they encounter rich food patches, posing a serious threat to invertebrates that aggregate loosely in scattered patches in the Mackenzie Basin (van Wyngaarden 1995; Jones et al 2005; Schori 2020).

While invertebrates are not the primary food source for cats, cats are known to be able to "prey-switch" to smaller prey when their main food sources become scarcer. Grasshoppers have been predated by cats, as revealed by cat scat analyses in the Mackenzie Basin and around New Zealand (Schori et al. 2018). Mustelids, such as stoats and ferrets, are also capable of prey-switching should their main source of food (rabbits/hares) run low (Ragg 1998, Smith 2010, Cliff et al. 2020), putting the less mobile invertebrates such as the robust grasshopper at increased risk. Young mustelids and cats can also subsist on invertebrates and lizards until they are skilled enough to catch rabbits (van Wyngaarden 1995).

7.3 Invasive Weeds

The reduced severity and frequency of flood events allows weed species to become established more easily. The stabilising effect of invasive plant species, such as crack willow, pasture grasses, broom, gorse, sweet brier and Russell lupins, increase channelisation, thus changing the essential character of braided rivers. The capacity of rivers to shift sediment and form new sand areas is likewise altered, leading to a decreasing availability of open, unvegetated habitat preferred by specialist braided river species (Sinclair thesis 1995, Wiser et al. 2012, Schori 2020).

Ectotherms, such as grasshoppers, require open spaces free from dense vegetation to bask in the sun and thermoregulate. External heat sources are integral to their fitness and survival (Harris et al. 2015; Köhler & Schielzeth 2020).

It is well known that invasive weeds also change the community structure of the areas they invade, often to the disadvantage of native invertebrate communities (Vilà et al 2011). This will be particularly true if areas with very short, sparse, native vegetation is replaced by a taller, denser, weed community.

7.4 Fires

A flow-on effect of increased weed cover is the potential for increased fire risk due to the increasing fuel availability. With climate change, rainfall gradients will also change. Drought potential is projected to increase across the Canterbury region and inland areas are likely to have more hot days, which may lead to increased fire risks (NIWA projection). Fires can destroy existing limited habitats, as was seen in the 2020 Pūkaki Downs fire that led to extensive damage in the Pūkaki Scientific Reserve - home to the nationally endangered moth *Izatha psychra*. Fires also have the capacity to drive changes in plant communities as well as lead to changes in soil properties (van Wyngaarden 1995, Gagnon et al. 2015, Santín & Doerr 2016, Stavi 2019), further degrading the quality and availability of habitats for native invertebrates.

7.5 Substrate Quality

Another effect of controlled river flows are changes to substrate quality, both as a result of changes to natural deposition processes and also from other factors, particularly increased weediness and vegetation stability generally.

The larvae of stiletto flies are found in loose sandy substrate, and overseas research has shown that the individual species of this family can have very specific niche requirements within dynamic sandy systems (Holston 2005). Substantial loss or modification of sandy substrates can therefore hold serious implications for these species. The soil-binding effect of weed growth and reduced frequency of flood events creating new areas of loose sand are some of the potential threats posed to such species.

The nationally endangered weta, *Hemiandrus "furoviarius"*, is endemic to the river margins of the Tekapo/Takapō as well as nearby rivers (Johns 2001). This weta shelters and oviposits in burrows in the silty soils of river margins and are also thought to rear their young in these burrows (van Wyngaarden 1995). The burrows have only been found where the substrate was predominantly fine and friable silt, so changes to those soils through time and reduced deposition of new silt areas are potentially damaging over the long term.

7.6 Summary of Impacts on Terrestrial Invertebrates

In assessing the impact of the TekPS on the braided river invertebrates it is important to remember that Tekapo A was commissioned 70 years ago and the Tekapo Canal and Tekapo B more that 40 years ago, so controlled water flows have been in place for decades. Invertebrates typically have much shorter generation times than vertebrates, and invertebrate communities respond to perturbations quite rapidly, so the most significant changes in invertebrate communities due to the impacts of reduced flows will already have occurred.

This means that the invertebrate communities have already had several decades to adjust to managed flow regimes and there are no proposals within the reconsenting application to make significant changes to these flow regimes. There are ongoing risks to native invertebrate communities with respect to things such as weed invasion or from both indigenous predators and introduced predators as well as natural catastrophic events that cause changes to river flows. These risks arise from a variety of human and natural influences and are not limited only to effects of the existence of the TekPS. Further monitoring may detect subtle changes in invertebrate communities; however, attributing those changes to any particular cause would be impracticable and would likely occur even in the absence of the TekPS.

While the impacts of both predators and weeds is considered exacerbated by the flow regimes, it is also important to acknowledge that both weeds and predators would still pose a threat to terrestrial invertebrates in the Tekapo/Takapō River even if the TekPS was not operating. However, the reduced frequency and severity of flooding allows increased opportunity for weed growth and vegetation stability over the affected reach of the Tekapo/Takapō River, and this has potential to affect the community structure of those habitats over the long-term, unless managed. In contrast to this, and as noted for several species in section 6.1 above, the reduced severity of natural flood events can also have a potentially positive effect for some of the species that benefit from a more stable habitat.

Terrestrial riverine invertebrate communities have adapted over thousands of years to cope with occasional flood events but remain vulnerable to extreme flooding events that scour out the areas of habitat they have been living amongst. Likewise, within the TekPS, the existing environment has been established over many years and comprises and environment where a typically dry riverbed is subject to intermittent inundation as a result of releases from Lake Takapō. The ability of individual species to recover from such events will depend on a multitude of factors, but one of these is that there is sufficient intact adjacent habitat that populations survive in. The number of invertebrate species likely to be present within the areas affected by the scheme will number in the thousands, and the potential responses of these species to any given level and timing of flooding will be equally variable. The resource consents sought for the TekPS will not change the situation that presently exists in the Takapō River.

Taking the potential for both negative and positive impacts into account and given the known distribution of the species of conservation interest in the wider Mackenzie Basin, we consider that the continuation of the TekPS is largely neutral, to minor, in terms of its impact on the terrestrial invertebrate values of braided river habitats.

The literature review identified other invertebrates of conservation concern that are present in the Mackenzie Basin, but our analyses indicated these are not specifically associated with braided river environments and are unaffected by the TekPS. We also acknowledge that there may be other invertebrates of interest in wetlands adjacent to Lake Tekapo/Takapō. While some of the wetlands surrounding Lake Tekapo/Takapō can be influenced by lake level fluctuations from TekPS operations, the current pattern of interaction between wetlands and Lake Tekapo/Takapō are unlikely to be impacted by continuation of the TekPS as there will be no significant changes to the lake's existing operating levels (Veendrick, Nicol & Scouller 2025). Invertebrates that are adapted to utilise lake shores and wetlands for part of their lifecycle are, by necessity, able to cope with fluctuating water levels, so are unlikely to be affected by continuation of the TekPS.

8. Mitigation and Project River Recovery

Project River Recovery (PRR) was established in 1990 by way of an agreement between Electricity Corporation of New Zealand Ltd (ECNZ) and Department of Conservation in recognition of the impacts of hydroelectric development on braided rivers and wetlands in the upper Waitaki Basin. Meridian Energy Ltd took over responsibility for this agreement from ECNZ in 1999 and Genesis Energy Ltd became a contributing party to the agreement in 2011, when it acquired Tekapo A and B power stations. The project is administered by the Department of Conservation and aims *to maintain and enhance river and wetland habitat, ecological communities and populations of indigenous animals and plants that use these habitats in the upper Waitaki Basin* (DOC website). The Genesis Energy Ltd contribution to PRR is linked to the consents to take and use water, so are due to end in 2025.

PRR undertakes large-scale invasive weed and predator control, with a particular focus on braided river habitats. While the pest animal and weed control components of PRR were initially set up to improve breeding success for braided river bird species, these control measures ultimately benefit many aspects of the native fauna, including terrestrial invertebrates. The main threats to terrestrial invertebrates on braided rivers are not dissimilar to the challenges faced by braided river birds. The impacts of predators and weeds (and subsequently fire) on terrestrial invertebrates are outlined in section 8 above, so it is clear that support for PRR is a well-targeted environmental compensation for the TekPS.

While the primary areas of focus for PRR have been above the hydro lakes, they are also conducting projects in the Tekapo/Takapō River environs below Lake Tekapo/Takapō, so any weed and pest control in these areas would be considered a direct mitigation of impacts. However, even those PRR operations undertaken away from areas directly affected by TekPS will have mitigating benefits in terms of reducing weed and predator loads and enhancing populations of many of the same species.

Gaining maximum conservation benefit for braided rivers and wetlands is one of the key aspects that DOC considers in terms of deciding where to undertake PRR operations. The PRR activities are not limited to weed and pest control. They also support fundamental research to better understand the braided river and wetland ecosystems in the area, which includes terrestrial invertebrate research. As one example, the invertebrate survey undertaken on the Tasman River has greatly increased our knowledge of invertebrates associated with braided rivers. PRR also has an important advocacy role in terms of education around the values of braided river and wetland habitats and the importance of protecting them.

The impact of TekPS on substrate quality, particularly the creation and maintenance of loose sands used by species such as stiletto flies, is more difficult to mitigate other than through allowing a greater severity and frequency of flood events. However, there are no data for the Mackenzie Basin to determine the flow regimes required to support any particular species of terrestrial invertebrate, and while any change may benefit one group of invertebrates, it may also be to the detriment of others. An alternative, more tangible, mitigation is provided by weed control to prevent older areas of friable substrate from becoming bound with roots. PRR is also undertaking weed control on sections of braided rivers that are not affected by hydro schemes, so these areas have both the natural formation of sands and the benefits of weed suppression.

Our assessment for the ongoing impacts of TekPS on terrestrial invertebrates is that they are minor at worst (see 7.6 above), and we are satisfied that these impacts would be compensated by Genesis Energy Ltd continuing to support the PRR initiative beyond the current consent period. Threats posed by predators and weeds will remain even if the TekPS was discontinued, so we consider the conservation benefits that accrue to terrestrial invertebrates through PRR are greater than the impacts from a continuation of the TekPS and therefore presents a very good mitigation and compensation strategy.

9. Ecological Significance for Canterbury Regional Policy Statement

The Canterbury Regional Policy Statement (CRPS) 9.3.1 provides a basis for assessing the significance of areas and habitats in respect to their ecosystems and indigenous biodiversity. Terrestrial invertebrate communities are an important component of ecosystems and biodiversity, so need to be assessed following the criteria provided in Appendix 3 of the CRPS. Those criteria include an assessment in respect to their (a) representativeness, (b) rarity/distinctiveness, (c) diversity and pattern; and (d) ecological context. Our assessment is as follows.

9.1 Representativeness

Braided Rivers are a characteristic element of the entire Mackenzie Basin (including the headwaters to the three main lakes). As discussed previously, the terrestrial invertebrate communities most impacted by TekPS are those found in braided river communities on the Tekapo River below Tekapo B, which largely falls within the Pukaki Ecological District. The Pukaki E.D. wraps around the Tekapo, Pukaki and Ohau Rivers, and all three of these rivers are heavily modified.

In relation to the first criterion, although modified, the invertebrate communities present in the affected area of the Tekapo River are "some of the best remaining examples" of such communities.

In relation to the second criterion, the Tekapo braided river invertebrate community is, by its very nature, a characteristic and large example of a modified braided river invertebrate community within the Pukaki E.D. It therefore meets point 2 of the CRPS assessment.

Overall, while the habitat is heavily modified, we consider the invertebrate communities in the Tekapo River must be considered significant under points 1 and 2 of the Representativeness criteria found in Appendix 3 of the CRPS.

9.2 Rarity/Distinctiveness

Despite the heavy modification, a number of terrestrial invertebrates have been identified from the area of the TekPS that are nationally uncommon or threatened, including the robust grasshopper, the Tekapo ground weta, several rare moth species, and several Lygaeid seed bugs. For this reason, we consider the habitat of these species must be considered significant under point 4 of the Rarity/Distinctiveness criteria found in Appendix 3 of the CRPS. For completeness, we do not consider that the other points in this category apply.

9.3 Diversity and Pattern

While there will be micro-diversity of habitat and changes in faunal composition within the braided river ecosystem impacted by TekPS, we are of the opinion that this probably does not meet the intention behind the Diversity and Pattern criterion found in point 7 of Appendix 3 of the CRPS, because such micro-diversity of invertebrate habitats is a feature of virtually all habitat types. Therefore, we do not consider it to be significant in that regard.

9.4 Ecological Context

As they have evolved in relation to their environment, many of the terrestrial invertebrate species associated with braided river habitats are critically dependent on those habitats for either part of, or the entirety of, their life cycles. This includes aspects such as the substrates they breed in, the plant communities they feed on, and the rocks they sun on and shelter under.

For these reasons, while heavily modified, we consider the extent of the braided river habitat potentially affected by TekPS to be significant for invertebrates under point 10 of the Ecological Context criteria found in Appendix 3 of the CRPS. For completeness, we do not consider that the other points in this category apply.

10. Conclusions

- Terrestrial invertebrates of known conservation significance are potentially present within areas affected by TekPS, including spiders, flies, true bugs, grasshoppers, ground weta, and moths.
- The major perturbations to terrestrial invertebrate communities as a result of managed water flows to the Tekapo/Takapō River will have already occurred, as flows have been managed for decades.
- The main ongoing threats as a result of managed flows to braided river habitats are from increased predator access, exacerbated weed establishment, and reduced deposition/maintenance of loose sandy substrates.
- There is also potential for positive impacts for some species in the form of reduced severity of flooding.
- In the absence of mitigation, the impacts of the continuation of the TekPS on the existing terrestrial invertebrate fauna are considered, at most, to be minor.
- Ongoing support for the initiatives undertaken by Project River Recovery on weed and predator control is a highly appropriate mitigation/compensation for the impacts of the TekPS on terrestrial invertebrates.
- Even if the TekPS were not operating, weeds and predators would still exist as major threats to terrestrial invertebrates on braided rivers, so the conservation benefits that would accrue from ongoing support of Project River Recovery will exceed any negative impact on terrestrial invertebrates from continuing the TekPS.
- The terrestrial invertebrate habitat found along the Tekapo/Takapō River does meet several criteria for significance in Appendix 3 of the Canterbury Regional Policy Statement, and we therefore consider it to by significant under CRPS policy 9.3.1.

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13. Appendices

13.1 Appendix I: Invertebrates of conservation significance

Order/Family	Common Name	Scientific Name	NZTCS Umbrella Category	NZTCS Conservation Status	Location(s)	References
Araneae: Lycosidae	Wolf spider	*Anoteropsis arenivaga*	At Risk	Naturally Uncommon	Tasman River flood plain	Murray, T.J., 2019
Araneae: Gnaphosidae	Ground spider	*Matua festiva*		Data Deficient	Tasman River flood plain	Murray, T.J., 2019
Coleoptera: Tenebrionidae	Darkling beetle	*Artystona lata*	At Risk	Naturally Uncommon	Mt John (holotype); At 1270m altitude, in a rock pile to the south of Mt Gerald Creek	Watt, 1992 Mt Gerald CRR
Coleoptera: Carabidae	Ground beetle	*Holcaspis bidentella*	Threatened	Nationally Critical	Under rocks near tarn in Lake Block; terminal moraine beside SH8; Irishman Creek; Simons Hill	Simons Pass CRR Balmoral CRR
	Ground beetle	*Holcaspis falcis*	At Risk	Declining	Mackenzie Basin	Irishman Creek CRR
Coleoptera: Scarabaeidae	Chafer beetle	*Prodontria matagouriae*	At Risk	Naturally Uncommon	Mackenzie Basin	Barratt, 2007 Leschen et al, 2012
	Chafer beetle	*Prodontria minuta*	At Risk	Naturally Uncommon	Mackenzie Basin	Barratt, 2007

Order/Family	Common Name	Scientific Name	NZTCS Umbrella Category	NZTCS Conservation Status	Location(s)	References
Diptera: Asilidae	Inland common robber fly	*Neoitamus smithii*	At Risk	Naturally Uncommon	Tasman River flood plain	Murray, T.J., 2019
Diptera: Therevidae	Stiletto fly	*Anabarhynchus albipennis*		Data Deficient	Lake Pūkaki	Harris, 2006 Lyneborg, 1992
	Stiletto fly	*Anabarhynchus indistinctus*		Data Deficient	Tasman River flood plain	Murray, T.J., 2019
	Stiletto fly	*Anabarhynchus harrisi*	At Risk	Naturally Uncommon	Blue Stream	Harris, 2006 Lyneborg, 1992
Orthoptera: Acrididae	Robust grasshopper	*Brachaspis robustus*	Threatened	Nationally Endangered	Terraces above the Tekapo/Takapō River floodplain; lower Tekapo/Takapō River Terraces; Terrace north of Tekapo Canal; Patersons Terrace (true right of Tekapo/Takapō River); Fork Stream riverbed.	Maryburn CRR The Wolds CRR Balmoral CRR Simons Pass CRR Richmond CRR
	Short-horned grasshopper	*Phaulacridium otagoense*	At Risk	Declining	Dry area of Camp Stream and Mid Coal River	Richmond CRR
	Central arid alpine grasshopper	*Sigaus australis* "central arid"	Threatened	Nationally Vulnerable	Glenmore Tarns Moraine; The Island; Cass River delta	The Wolds CRR Mt Gerald CRR Glenmore CRR

Order/Family	Common Name	Scientific Name	NZTCS Umbrella Category	NZTCS Conservation Status	Location(s)	References
	Minute grasshopper	*Sigaus minutus*	Threatened	Nationally Vulnerable	Within 500m of the Pūkaki riverbed; Pūkaki river terraces; Lower Coal River & Washout; Tekapo/Takapō River Terraces	Maryburn CRR Richmond CRR Simons Pass CRR Glenmore CRR Godley Peaks CRR The Wolds CRR
	Tekapo ground weta	*Hemiandrus* "furoviarius"	Threatened	Nationally Endangered	Irishman Creek, Tekapo/Takapō riverbeds	Irishman Creek CRR
Orthoptera: Anostostomatidae	Owlet moth	*Graphania tetrachoa* (syn. *Meterana tetrachoa)*		Data Deficient	Tekapo Military Training Area	Wildlands TMTA survey
Lepidoptera: Noctuidae	Lichen tuft moth	*Izatha psychra*	Threatened	Nationally Endangered	Shrubland near Lake Pūkaki (Pūkaki Scientific Reserve)	Hoare et al. 2012 Hoare, 2010 Gale, 2021
Lepidoptera: Xyloríctidae	Plains jumper moth	*Kiwaia* 'plains jumper'	Threatened	Nationally Endangered	Natural floodplains and terraces of Mary Burn Station, Balmoral Station	Maryburn CRR Balmoral CRR
Lepidoptera: Gelechiidae	Snout moth/ Grays River grass moth	*Orocrambus fugitivellus*	Threatened	Nationally Critical	Grays River Flats, Old Haldon Road area, east Mackenzie plains	Balmoral CRR

Order/Family	Common Name	Scientific Name	NZTCS Umbrella Category	NZTCS Conservation Status	Location(s)	References
Lepidoptera: Crambidae	Looper moth	*Paranotoreas fulva*	At Risk	Relict	Tekapo/Takapō Terraces/ Flats Edwards Stream	Balmoral CRR Gale, 2021
Lepidoptera: Geometridae	Olearia pug moth	*Pasiphila sp.* 'Olearia'	Threatened	Nationally Vulnerable	Tekapo Military Training Area	Wildlands TMTA survey
	Carpet moth	*Xanthorhoe bulbulata*	Threatened	Nationally Critical	Lakes Pūkaki & Tekapo/Takapō	Patrick, 2000
	Seed bug	*Lepiorsillus tekapoensis*		Data Deficient	Lake Tekapo/Takapō	Malipatil, 1979
Hemiptera: Lygaeidae		*Nysius liliputanus*	At Risk	Naturally Uncommon	Tasman River flood plain	Murray, T.J., 2019
		Rhypodes triangulus		Data Deficient	Tasman River flood plain	Murray, T.J., 2019
	Pimelea bug	*Pimeleocoris roseus*	Threatened	Nationally Critical	Tasman River flood plain	Murray, T.J., 2019
Hemiptera: Miridae						

13.2 Appendix II. Other invertebrates noted from the Tekapo Power Scheme area

Order/Family	Common name	Latin name	Location(s)	References
Coleoptera: Anobiidae	Borer beetle	*Australanobium inaequale*	Rockland west of Mary Range	The Wolds CRR
Coleoptera: Carabidae	Ground beetle	*Bembidion* undescribed	Cass River Bed	Glenmore CRR
	Ground beetle	*Demetrida lateralis*	Irishman Creek	Balmoral CRR
	Ground beetle	*Megadromus alternus*	Northeast of Mary Burn wetland	The Wolds CRR
	Ground beetle	*Metaglymma aberrans (tersatum)*	Upper Waitaki Basin - Lake Pūkaki terminal moraine, Footslopes of Mary Range, Lake Tekapo/Takapō	Simons Pass CRR The Wolds CRR Jones et al, 2005
Coleoptera: Curculionidae	Weevil	*Inophloeus* spp.	Joseph Ridge	Glenmore CRR
	Hutton's Speargrass weevil	*Lyperobius huttoni*	Near Mistake Peak	Godley Peaks CRR
	Speargrass Weevil	*Lyperobius spedenii*	Gammack Range	Glenmore CRR
Coleoptera: Byrrhidae	Moss beetle	*Microchaetes* sp.	Terrace north of Tekapo Canal	The Wlds CRR
Coleoptera: Tenebrionidae	Darkling beetle	*Mimopeus convexus*	Mary Burn Station	Maryburn CRR
	Darkling beetle	*Mimopeus impressifrons*	Simons Pass Station - footslopes of Mary Range	Simons Pass CRR Glenmore CRR The Wolds CRR
Coleoptera: Scarabaeidae	Small manuka beetle	*Pyronota* nr. *festiva*	Terrace north of Tekapo Canal	The Wolds CRR
Coleoptera: Belidae	Weevil	*Rhicnobelus aenescens*	Cass Valley lower slopes	Glenmore CRR
Diptera: Muscidae	Muscid fly	*Spilogona* spp.	Irishman Creek Station	Irishman Creek CRR
Orthoptera: Anostostomatidae	Mountain stone weta	*Hemideina maori*	Old riverbeds, Tekapo/Takapō River 2-3 kms downstream of	pers. comm. Graham Ussher, 2020

Order/Family	Common name	Latin name	Location(s)	References
			Tekapo A Power Station	
Orthoptera: Acrididae	Snow grasshopper	*Brachaspis nivalis*	Gamack Range; Cass Valley; Fork Valley; possibly also Rankin Stream	Godley Peaks CRR Glenmore CRR
	Short-horned grasshopper	*Sigaus* sp. A	Moraine west of the Mary Range	The Wolds CRR
	Short-horned grasshopper	*Sigaus campestris*	Mary Burn Station	Maryburn CRR
Lepidoptera: Oecophoridae	Concealer moth	*Cremnogenes honesta* (syn. *Borkhausenia honesta)*	Lake Tekapo/Takapō, Lake Pūkaki scrub	Simons Pass CRR
Lepidoptera: Tortricidae	Leafroller moth	*Ericotenes pukakiense*	Lake Pūkaki scrub	Simons Pass CRR
Lepidoptera: Gelechiidae	Twirler moth	*Gelechia lenis (*syn. *Kiwaia lenis)*	Lake Pūkaki scrub	Simons Pass CRR
Araneae: Gnaphosidae	Ground spider	*Matua valida*	Balmoral Station	Balmoral CRR
	Ground spider	*Taieria erebus*	Lake Pūkaki terminal moraine	Simons Pass