Preliminary assessment of Waipoua stream biodiversity: a light trapping exercise for adult EPT insects

Technical report prepared by:

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for the Waipoua Ngā Awa River Restoration Programme, Department of Conservation

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Cover photos: Main photo: Kopai Stream, a third order stream in the Waipoua River catchment - Milly Farquhar, Department of Conservation. Insets of adult mayflies: top *Ichthybotus hudsoni*, middle *Coloburiscus humeralis*, bottom *Ameletopsis perscitus* - Olly Ball & Steve Pohe Collection.

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1. Introduction

In 2019 Department of Conservation (DOC) launched the 'Ngā Awa River Restoration Programme' in response to a mandate to improve the knowledge and management of native freshwater biodiversity. The Ngā Awa initiative seeks to restore freshwater biodiversity of 14 priority catchments from mountains to sea. One of the 14 priority catchments is the Waipoua River catchment. Work being undertaken there is a collaborative effort between DOC and Te Iwi O Te Roroa who hold mana whenua in the region. The Waipoua Ngā Awa project incorporates Te Roroa's unique mātauranga (traditional knowledge) to inform restoration efforts and ensure that the river's health is prioritised.

In combination with other restoration activities, river health monitoring was undertaken (2020–2023) to establish a baseline of ecological state, and a report was prepared by Cawthron Institute (see Eveleens & Kelly 2023). Part of this ecological work included surveillance monitoring of benthic freshwater macroinvertebrates, which can be used to detect changes in the aquatic environment resulting from human-induced stresses e.g. contaminants entering the waterway. Macroinvertebrates are normally abundant in streams and rivers, and are commonly used in the assessment of water quality as their diverse communities provide varied responses to changing environmental conditions (Boothroyd & Stark 2000). They are good indicators of local conditions because they tend to be limited in their in-stream movements, thus are effected by the environmental conditions over an extended period of time, unlike water quality measurements that are snapshots of the waterway at that point, at that moment. The monitoring data revealed high biodiversity values at most sites, but invertebrates, habitat and water quality were being impaired, and challenges remain, including land use practices relating to exotic forestry and pastoral activities, which have contributed to degradation in some areas. It was concluded that addressing these issues will be crucial for achieving the project's long-term goals of a healthy and thriving Waipoua Awa. In addition to the annual macroinvertebrate monitoring, a study was commissioned by DOC in 2023, comparing benthic sampling results collected in 1994 at 13 Waipoua sites (Seitzer 1994), with new samples collected by DOC in May 2023 (reported by Pohe 2023). While results were difficult to interpret due to recent large-scale flooding in the region, it was concluded that the stream health conditions were very similar to those ~30 years earlier.

DOC is charged with managing and protecting New Zealand's biodiversity, and an important component of this role is the sustained assessment of the conservation status of species'. The New Zealand freshwater invertebrate fauna is characterised by high levels of regional and national endemism. Many of the represented taxa are considerably understudied, and current assessment and sampling methods generally have a biomonitoring focus (e.g. identification to genus level for water quality assessment), rather than a biodiversity focus (identification to species level), so are likely to significantly underrepresent the actual biodiversity present. For example, a biomonitoring approach would record the mayfly genus *Zephlebia* as present, but a biodiversity assessment (in a Northland catchment) could record all eight described *Zephlebia* species in one stream. Diversity studies by their very nature require species-level identifications, which in turn often require adult specimens collected by sampling methods tailored for the task. To conserve biodiversity, understanding what species are present is probably the largest knowledge gap faced. Two other major knowledge gaps facing freshwater invertebrate conservation in New Zealand are insufficient data on taxa distributions, and a lack of autecological information (Drinan et al. 2021).

Here we report results of a research study that involved a series of light trapping surveys designed to target the adult life-stages of three numerically dominant freshwater insect orders; Ephemeroptera, Plecoptera and Trichoptera (hereafter EPT), known commonly as mayflies, stoneflies and caddisflies. As a preliminary study, seven sites in three Waipoua streams (Okawawa, Kopai, Mirowharara) were surveyed. The intent was to gain a better understanding of the species-level stream invertebrate biodiversity present, and also to start to document species of conservation interest (species listed as Threatened, At Risk, Data Deficient or new to science).

2. Methods

2.1 Insect sampling and processing

Biodiversity surveys with light traps were used to sample adult aquatic insects belonging to the orders Ephemeroptera, Plecoptera and Trichoptera (EPT) by the authors at seven sites beside three Waipoua streams (Okawawa, Kopai, Mirowharara) (Table 1; Figures 1, 2; Appendix 1). Light traps fitted with two 8-Watt ultraviolet fluorescent tubes were set during warm stable weather on 29th February 2024 (set to activate with a timer at dusk and deactivate three hours later). The following morning traps were cleared (Figure 3) and specimens placed into plastic containers with strong ethanol (~90%). For more details of sampling protocols and equipment used see Pohe et al. (2023).

In the laboratory, all samples were pre-sorted to taxonomic order and tentative family under a 3-Diopter magnifying light (22W). Identification to genera or species was done by microscopic examination with a Leica M205C dissecting microscope (3.9–160x magnification) following relevant identification keys and original species descriptions.

Table 1. Sampling sites, stream names and coordinates of the seven sampling sites.

Sampling site	Stream	Latitude
Site 1	Kopai Stream (bottom)	-35.655699; 173.577255
Site 2	Kopai Stream (top)	-35.655219; 173.577196
Site 3	Mirowharara Stream (bottom)	-35.660752; 173.573733
Site 4	Mirowharara Stream (middle)	-35.661186; 173.573869
Site 5	Mirowharara Stream (top)	-35.661665; 173.573747
Site 6	Okawawa Stream (bottom)	-35.655617; 173.576738
Site 7	Okawawa Stream (top)	-35.655919; 173.577023

Figure 1. Light trap set beside the Kopai Stream (bottom site), with two 8W ultraviolet fluorescent tubes.

Figure 2. Light trap set beside a pool in the Mirowharara Stream (top site), with a small catch present.

Figure 3. Steve Pohe and Dave West picking aquatic insects from a light trap set beside the Mirowharara Stream (middle site), with the inset photo showing a close up of the catch.

2.2 Data analyses

Full count data (including sex and life-stage metadata) of all seven light trap catches is presented in a Microsoft Excel spreadsheet provided to DOC with this report (*Waipoua River adult insect biodiversity results 2024.xlsx*). The Microsoft Excel worksheets were used to keep track of species presence, and calculate and graph summary data (counts, means, etc.). For completeness, summarised species lists are also recorded in Appendix 2 of this report. For all species obtained, their conservation threat status was checked and recorded (following Grainger et al. 2018).

Because benthic macroinvertebrate samples were collected at the same sampling sites by DOC the previous year (see Pohe 2023) we took the opportunity to investigate any differences between sampling methods using ordination analysis. Thus, presence data derived from the light trap samples, as well as presence data obtained from the benthic data, were entered into Microsoft Excel. Because the two methods being examined differ in the fauna they collect (light traps only collect adult winged insects and benthic samples are more limited in the resolution of their identification), a measure of standardisation was employed for the ordination data whereby the dataset was degenerated to a common point (non-EPT taxa were removed and taxa not able to be identified to species in benthic samples e.g. *Deleatidium* were pooled at the genus-level for both methods).

From the combined light trapping and benthic sampling dataset, a principal coordinates analysis (PCoA) ordination based on the Sørensen (Bray–Curtis) distance measure was used to examine similarities and differences in the sampling results based on their invertebrate communities, with convex hulls used to aid visualisation of the different datasets. Raw data expressed as presence–absence were used in the ordination; no data transformations or rare species removals were done before analysis. A joint plot was incorporated to display the correlation between sites in invertebrate community space and recorded taxonomic richness. The multi-response permutation procedure (MRPP) was used to test whether invertebrate stream communities from the two sampling methods were significantly different.

3. Results and Discussion

3.1 EPT biodiversity

Biodiversity surveys for adult EPT insects using ultraviolet light trapping at seven Waipoua stream sites recorded 48 species (Figure 4, Appendix 2). Trap catches for most sites (1–5, 7) caught on average 241 target individuals per trap (range: 176–356) with an average species richness of 27.5 per trap (range: 25–29). Site 6 on the Okawawa Stream recorded considerably more individuals (2718) representing 65% of the overall catch and comprising 41 species. However, 80% of the individuals from Site 6 were two common caddisfly species, *Oxyethira albiceps* (50%) and *Hydropsyche colonica* (30%). Overall, caddisflies represented much of the catch, which also include a small proportion of mayflies, but no stoneflies. Generally speaking, survey results were modest in their catch volume and diversity, and while these results are comparable to catches in other places around New Zealand, there were many species missing from these surveys. This was expected due to sampling being conducted late in the insect flight season (but for more see comments in the Conclusion).

Of the 48 species, 40 were confidently identified to species-level. Six others were unique species, likely belonging to described species, but which differed from published taxonomic literature, thus were given the qualifier cf. (= closest form) and require further investigation. One species (*Paroxyethira* sp.) was represented by two female individuals, and could only be named to genus-level. Finally, one male *Hydrobiosis* individual from Site 7 (Okawawa Stream, top site) could not be placed within the known fauna, and is either a regional variant or an undescribed species, so also requires further investigation.

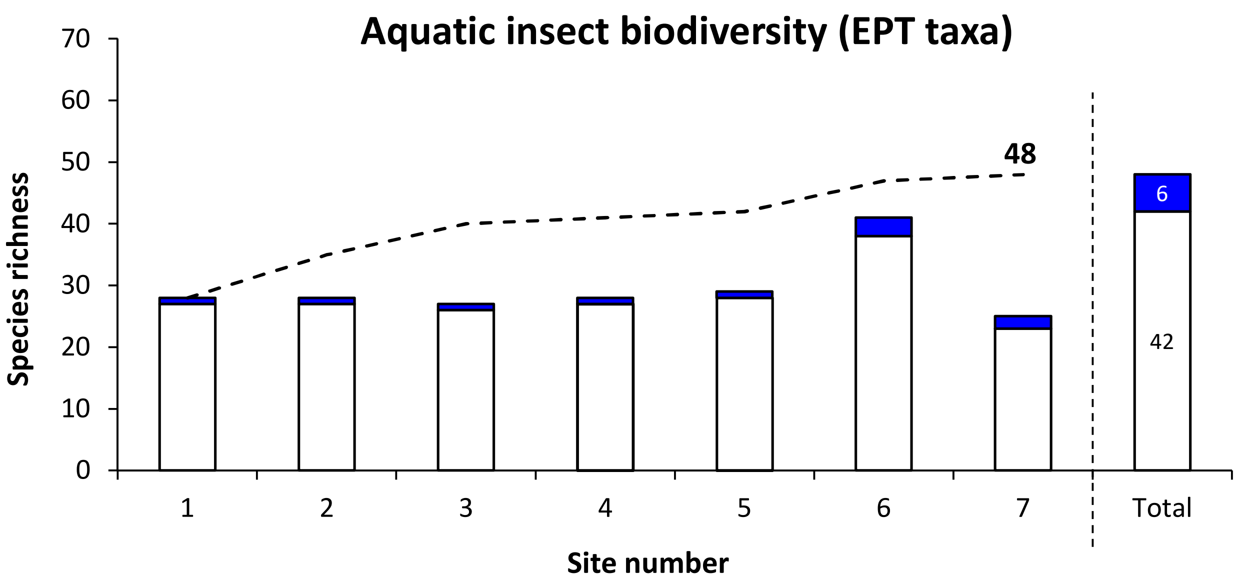

Figure 4. Species richness of aquatic insects found in Waipoua streams (Sites 1–7). Bars indicate the number of species recorded at each survey site (alpha diversity), and at all sites combined (gamma diversity). The blue portion of the bars indicates the number of species that were of conservation interest. The dashed line represents the cumulative frequency of species as new sites are added.

From the light trapping results, the 40 species that were confidently identified all have a conservation threat status of Not Threatened. Two others (*Paroxyethira* sp. and *Pycnocentrodes* cf. *aureolus*), while not identified to species-level are also expected to be common species that are Not Threatened. The remaining six, being either odd forms or of uncertain identity, warrant further investigation, and are presented here as taxa of conservation interest (Table 2).

Table 2. Taxa recorded of interest to conservation and freshwater management, requiring further investigation.

Species	Insect type	Reason for conservation interest
Costachorema cf. xanthopterum	Caddisfly	Odd form
Hydrobiosis unknown TBA	Caddisfly	Likely new species
Oxyethira cf. waipoua	Caddisfly	Data Deficient
Pycnocentrodes cf. aeris / modesta	Caddisfly	Data Deficient
Zephlebia cf. spectabilis	Mayfly	Odd form
Zephlebia cf. versicolor	Mayfly	Odd form

3.2 Comparison of sampling methods - light trapping vs benthic sampling

Because benthic samples were collected at the same sampling sites by DOC the previous year (see Pohe 2023) we took the opportunity to do a cursory investigation of what differences might occur between the two sampling methods. A principal coordinates analysis (PCoA) was used to ordinate sites sampled by the two methods in invertebrate species space. The ordination generated two axes that explained 74.2% of the variation in the data (Figure 5), which revealed clear differences in invertebrate communities sampled with the two collection methods. Survey sites sampled by light trapping plotted to the left of Axis 1, strongly correlated with high taxonomic richness. In contrast, survey sites recorded by benthic sampling plotted to the right side of Axis 1. Analysis of the benthic data, regarding separation of Waipoua 1–3, are covered in more detail (and with higher resolution data) by Pohe (2023), but relate to low biotic index values at those three sites. MRPP analysis indicated the differences in the invertebrate communities between the light trapping and benthic sampling were highly significant (T = -12.04, A = 0.48, $P < 0.001$).

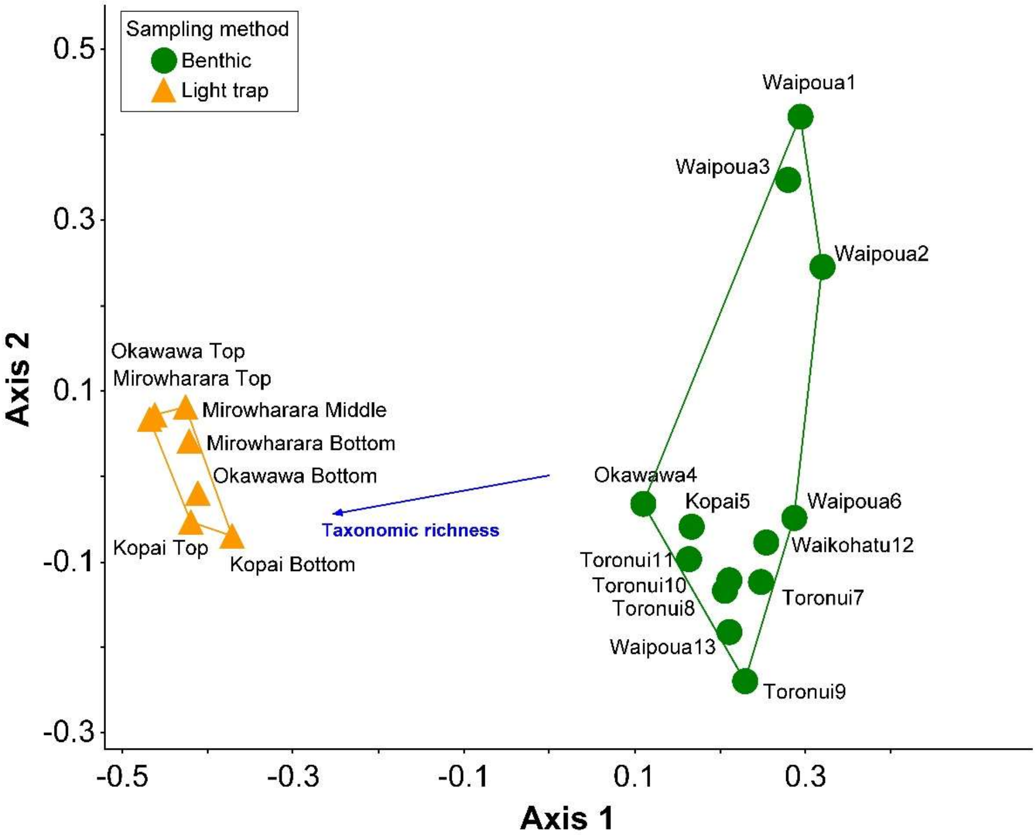

Figure 5. Principal coordinates analysis (PCoA) ordination of the Waipoua sampling sites for benthic sampling and light trapping methods showing the relationship between the ordination scores of sites in macroinvertebrate community species space (Axis 1 = 58.3%; Axis 2 = 15.9%). The blue vector indicates the strength and direction of correlation between taxonomic richness values and ordination axes scores (Pearson's $r^2 = 0.70$ with Axis 1).

4. Conclusions

Biodiversity surveys for adult EPT insects using ultraviolet light trapping at seven Waipoua stream sites recorded 48 species. Most were common species but several were Data Deficient, and several others were of interest as they differed from taxonomic literature. One was likely a new species.

Survey results overall were modest in their catch volume and diversity, and while these catch results are comparable to other places around New Zealand, there were many species missing, suggesting Waipoua streams are particularly diverse, but that full diversity was not recorded on this occasion. This is not surprising as sustained effort with multiple events and methods are needed to build an accurate biodiversity record. In this sampling event, surveys were done in late summer due to busy workloads of the authors, reducing the effectiveness of the surveys. It was also noted that river levels were exceptionally low for that time of the year. As water levels drop and rivers warm, stressed insects tend to emerge earlier to avoid unfavourable conditions. In addition, the surveys in this event sampled third and fourth order streams, which tend to produce larger volumes of common species.

Notwithstanding the above comments, these preliminary surveys have started to document the diverse array of fauna in the middle reaches of the Waipoua river system. Further sampling in the lower reaches, but particularly in the headwaters of the upper catchment, targeting seeps, trickles, cascades and waterfalls, will certainly document many more rare and new species. Given the changing climate and warm and dry conditions we are now experiencing each summer, future surveys would be best earlier in the insect flight season (i.e. December/January rather than February/March which has historically been the best trapping period).

5. References

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6. Acknowledgements

We acknowledge Te Iwi O Te Roroa, who are kaitiaki of the awa, ngahere and whenua of Waipoua, for the work they are doing to protect the taonga within their rohe.

7. Appendix 1

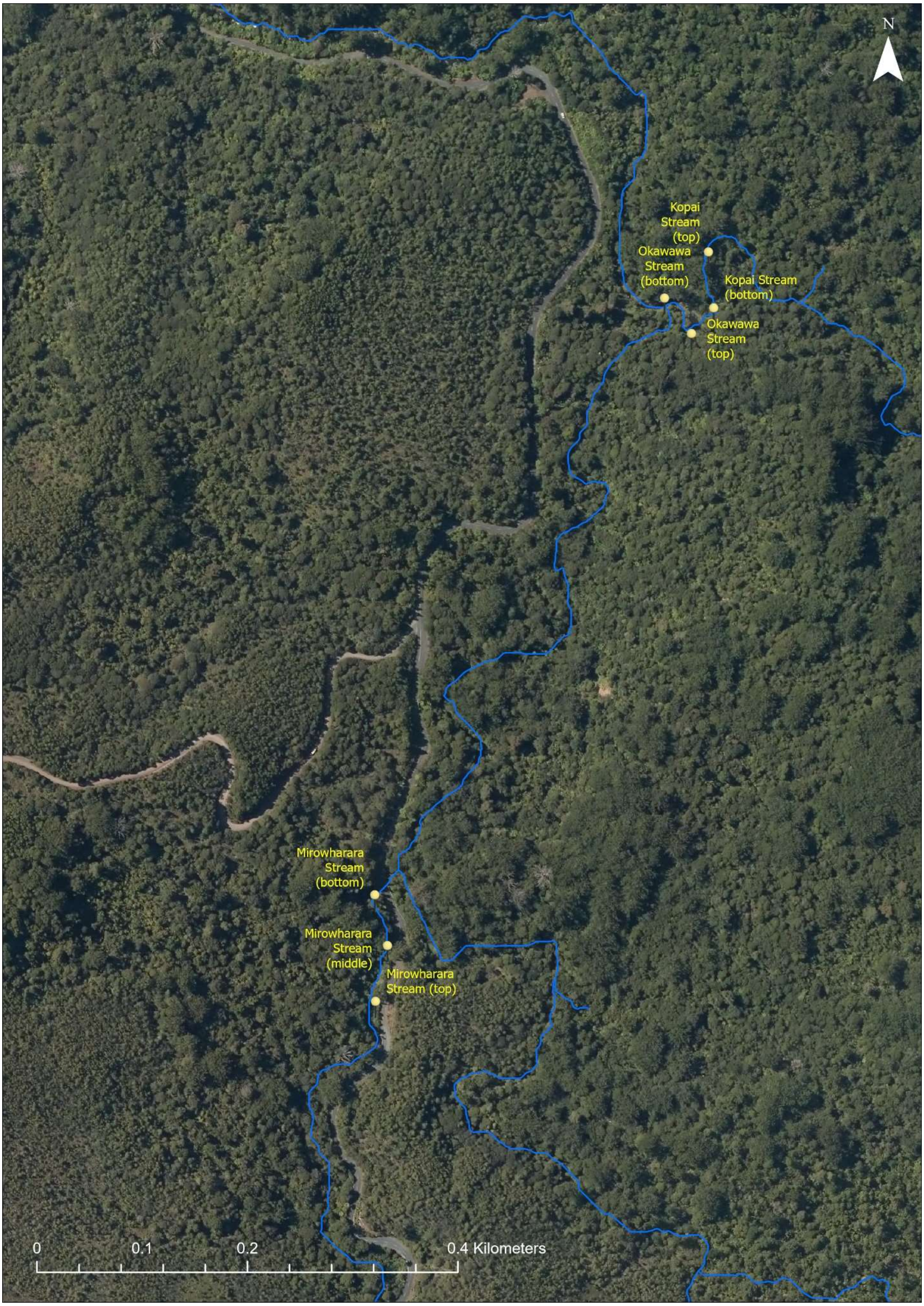

Figure A1. Map of light trapping sites within the Waipoua Forest, Northland.

8. Appendix 2

Table A2. Lists of species sampled per stream by overnight light trapping on 29th February 2024 within the Waipoua River catchment.

Kopai Stream (bottom)	Kopai Stream (top)	Mirowharara Stream (bottom)	Mirowharara Stream (middle)	Mirowharara Stream (top)	Okawawa Stream (bottom)	Okawawa Stream (top)
Ephemeroptera	Ephemeroptera	Ephemeroptera	Ephemeroptera	Ephemeroptera	Ephemeroptera	Ephemeroptera
Coloburiscus humeralis	*Ameletopsis perscitus*	*Ameletopsis perscitus*	*Coloburiscus humeralis*	*Ameletopsis perscitus*	*Acanthophlebia cruentata*	*Ameletopsis perscitus*
Ichthybotus hudsoni	*Coloburiscus humeralis*	*Coloburiscus humeralis*	*Nesameletus ornatus*	*Arachnocolus phillipsi*	*Ameletopsis perscitus*	*Ichthybotus hudsoni*
Mauiulus luma	*Ichthybotus hudsoni*	*Nesameletus ornatus*	*Zephlebia borealis*	*Coloburiscus humeralis*	*Coloburiscus humeralis*	*Nesameletus ornatus*
Nesameletus ornatus	*Nesameletus ornatus*	*Zephlebia borealis*	*Zephlebia dentata*	*Zephlebia borealis*	*Ichthybotus hudsoni*	*Zephlebia borealis*
Zephlebia cf. spectabilis	*Zephlebia cf. versicolor*	*Zephlebia spectabilis*		*Zephlebia dentata*	*Mauiulus luma*	*Zephlebia dentata*
Zephlebia dentata	*Zephlebia spectabilis*		Trichoptera		*Nesameletus ornatus*	*Zephlebia spectabilis*
		Trichoptera	*Beraeoptera roria*	Trichoptera	*Zephlebia borealis*	
Trichoptera	Trichoptera	*Costachorema hecton*	*Helicopsyche (S.) albescens*	*Costachorema hecton*	*Zephlebia dentata*	Trichoptera
Beraeoptera roria	*Costachorema hecton*	*Helicopsyche (S.) albescens*	*Helicopsyche (S.) zealandica*	*Helicopsyche (S.) albescens*	*Zephlebia spectabilis*	*Hudsonema amabile*
Costachorema hecton	*Helicopsyche (S.) zealandica*	*Helicopsyche (S.) zealandica*	*Hudsonema amabile*	*Helicopsyche (S.) zealandica*		*Hydrobiosella mixta*
Helicopsyche (S.) zealandica	*Hudsonema amabile*	*Hudsonema amabile*	*Hydrobiosella mixta*	*Hudsonema amabile*	Trichoptera	*Hydrobiosis budgei*
Hudsonema amabile	*Hydrobiosella mixta*	*Hydrobiosella mixta*	*Hydrobiosis budgei*	*Hydrobiosella mixta*	*Beraeoptera roria*	*Hydrobiosis parumbripennis*
Hydrobiosella mixta	*Hydrobiosis budgei*	*Hydrobiosis gollanis*	*Hydrobiosis gollanis*	*Hydrobiosis budgei*	*Costachorema cf. xanthopterum*	*Hydrobiosis soror*
Hydrobiosis budgei	*Hydrobiosis gollanis*	*Hydrobiosis parumbripennis*	*Hydrobiosis parumbripennis*	*Hydrobiosis gollanis*	*Costachorema hecton*	*Hydrobiosis spatulata*
Hydrobiosis parumbripennis	*Hydrobiosis parumbripennis*	*Hydrobiosis spatulata*	*Hydrobiosis soror*	*Hydrobiosis parumbripennis*	*Helicopsyche (S.) albescens*	*Hydrobiosis* unknown TBA
Hydrobiosis soror	*Hydrobiosis soror*	*Hydropsyche colonica*	*Hydropsyche colonica*	*Hydrobiosis soror*	*Helicopsyche (S.) zealandica*	*Hydropsyche colonica*
Hydropsyche colonica	*Hydrobiosis spatulata*	*Hydropsyche fimbriata*	*Hydropsyche fimbriata*	*Hydrobiosis spatulata*	*Hudsonema amabile*	*Hydropsyche raruraru*
Hydropsyche fimbriata	*Hydropsyche colonica*	*Hydropsyche raruraru*	*Neurochorema confusum*	*Hydropsyche colonica*	*Hydrobiosella mixta*	*Neurochorema confusum*
Hydropsyche raruraru	*Hydropsyche fimbriata*	*Neurochorema confusum*	*Oeconesus maori*	*Hydropsyche fimbriata*	*Hydrobiosis budgei*	*Oeconesus maori*
Neurochorema confusum	*Neurochorema confusum*	*Oeconesus maori*	*Olinga feredayi*	*Neurochorema confusum*	*Hydrobiosis gollanis*	*Olinga feredayi*
Oeconesus maori	*Oeconesus maori*	*Olinga feredayi*	*Oxyethira (T.) albiceps*	*Oeconesus maori*	*Hydrobiosis parumbripennis*	*Oxyethira (T.) albiceps*
Olinga feredayi	*Olinga feredayi*	*Oxyethira (T.) albiceps*	*Paroxyethira* sp.	*Olinga feredayi*	*Hydrobiosis soror*	*Polyplectropus altera*
Olinga jeanae	*Oxyethira (T.) albiceps*	*Paroxyethira* sp.	*Plectrocnemia maclachlani*	*Oxyethira (T.) albiceps*	*Hydropsyche colonica*	*Psilochorema donaldsoni*
Oxyethira (T.) albiceps	*Plectrocnemia maclachlani*	*Plectrocnemia maclachlani*	*Polyplectropus altera*	*Polyplectropus altera*	*Hydropsyche fimbriata*	*Pycnocentria evecta*
Polyplectropus altera	*Polyplectropus altera*	*Psilochorema mimicum*	*Polyplectropus aurifusca*	*Psilochorema mimicum*	*Hydropsyche raruraru*	*Pycnocentrodes cf. aeris*
Pycnocentria evecta	*Psilochorema mimicum*	*Pycnocentria evecta*	*Pycnocentria evecta*	*Pycnocentria evecta*	*Neurochorema confusum*	*Pycnocentrodes cf. aureolus*
Pycnocentria gunni	*Pycnocentria evecta*	*Pycnocentrodes cf. aeris*	*Pycnocentria gunni*	*Pycnocentria gunni*	*Oeconesus maori*	*Triplectides obsoletus*
Pycnocentrodes cf. aureolus	*Pycnocentrodes cf. aureolus*	*Pycnocentrodes cf. aureolus*	*Pycnocentrodes cf. aeris*	*Pycnocentrodes cf. aeris*	*Olinga feredayi*	
Triplectides obsoletus	*Triplectides obsoletus*	*Triplectides dolichos*	*Pycnocentrodes cf. aureolus*	*Pycnocentrodes cf. aureolus*	*Oxyethira (T.) albiceps*	
Zelandoptila moselyi	*Zelandoptila moselyi*		*Triplectides dolichos*	*Triplectides dolichos*	*Oxyethira (T.)* sp. TBA	
				Triplectides obsoletus	*Plectrocnemia maclachlani*	
					Polyplectropus altera	
					Polyplectropus aurifusca	
					Psilochorema donaldsoni	
					Psilochorema macroharpax	
					Psilochorema mimicum	
					Pycnocentria evecta	
					Pycnocentria gunni	
					Pycnocentrodes cf. aeris	
					Pycnocentrodes cf. aureolus	
					Triplectides dolichos	
					Triplectides obsoletus	
					Zelandoptila moselyi	