Preliminary Baseline Survey of the Avifauna of the Nakauvadra Range, Ra Province, Fiji

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Source: A Rapid Biodiversity Assessment of the Nakauvadra Range, Ra Province, Fiji: 52

Published By: Conservation International

URL: https://doi.org/10.1896/054.057.0108

Chapter 7

Freshwater Macroinvertebrates of the Nakauvadra Range, Ra Province, Fiji

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SUMMARY

The total species richness of macroinvertebrates found in the four sites sampled was 35 species. Mayfly abundance and caddisfly larval diversity were high. These results are indicative of relatively "healthy" streams and are as expected for upper catchment streams surrounded by a relatively "undisturbed" catchment area. The streams also appeared to be in good condition primarily because the stream bank vegetation (riparian vegetation) is intact; the streams are well-shaded with high levels of organic debris such as leaf litter. Special efforts should be made to keep the natural vegetation intact and undisturbed along all stream banks since the overall health of the waterways is likely to be reliant on the organic matter inputs from the surrounding forest.

No obvious invasive freshwater macroinvertebrates or any cane toad tadpoles were found during sampling. There were however, obvious signs of invasive weeds in the stream beds particularly in the lower Volivoli sites sampled. This is of concern as any similar accidental introductions of non-native freshwater invertebrate species in the future, such as viviparid gastropods, may displace the native fauna and introduce species capable of acting as vectors for human-related illnesses.

INTRODUCTION

Freshwater macroinvertebrates are a fundamental component of freshwater ecosystems being essential for ecosystem function. The assemblages vary depending on environmental variables - natural and human induced. It is therefore important to note that this survey was conducted during "dry" conditions at the very end of the dry season before expected wet season rains began.

Several freshwater macroinvertebrate surveys have been previously carried out in different parts of Fiji (e.g., Cowie 1980, Haynes 1994, 1999, Haynes and Whippy 1997, Boseto 2006, Jenkins et al. 2006). Previous freshwater invertebrate surveys have been also carried out by NIWA (New Zealand) in the Nakauvadra Range, as part of a Fiji-wide 160 site survey, but data from that exercise is not readily available. This latter data has however been used to create freshwater invertebrate tools for Fiji (see Suren, in press a, b).

METHODS

Field sampling followed methodology adapted from Suren (in press a, b) in combination with United States Department of Agriculture Stream visual assessment protocols (USDA 1998).

Field methods

Study sites

Four study sites were sampled (Map 7). Sites 1, 3 and 4 were sampled along a 100 m length whereas Site 2 was only sampled along a 50 m length because of limited accessibility to the water course.

Environmental parameters

At each sample site the following parameters were recorded; GPS location, altitude, flow rate, shade cover, water temperature, time of day, pH, water clarity, stream width, stream depth, bank vegetation type, bank condition, organic material present, substrate type. The first eight parameters were recorded once per site while the latter seven were recorded every 10 m and then "averaged".

Table 7.1. Comparative summary of environmental parameters recorded at each study site.

Parameter	Stream Site 1 Volivoli A	Stream Site 2 Volivoli B	Stream Site 3 Natoluwalu	Stream Site 4 Nabiya
Grid Position	S17°27'34.5; E178°06'015	S17°27'35.7; E178°06'03 65	S17°27'16.5; E178°05'59 6	S17°27'19.59; E178°05'49 55
Altitude (m)	278	229	289	331
Flow rate (m/s)	0.25	2.33	0.62	0.14
Shade coverage (%)	70	80-85	85	90
Water temperature (C°)	22.0	22.2	22.8	24.0
Time of day	Morning	Afternoon	Morning	Afternoon
pH	8.07	8.29	7.55	7.38
Water Clarity	100%	100%	100%	100%
Stream width (average active channel)	2.8 m	3.1 m	3.24 m	2.2 m
Stream width (av. stream bed)	16.5 m	12.7 m	13.6 m	12.8 m
Stream depth (average)	Medium (< 0.8 m)	Medium (< 0.8 m)	Very low (< 0.2 m)	Low (< 0.5 m)
Bank vegetation	Tall trees, native forest	Ferns & weeds	Large trees left bank, ferns on other side	Weeds and native vegetation
Bank Condition	Stable - rocky but weeds present	Stable either solid rock or stones	Relatively stable vegetated/soil. Stones and tree roots.	Relatively stable - 6 metre straight bank on right, gentle slope on left
Organic Material Present	A lot of dead leaves	Some green "film" algae	Dead leaves, some green "film" algae	Dead leaves, some brown "film" algae
Dominant substrate type*	Gravel, medium rocks	Medium rocks, large boulders	Gravel, small to medium rocks	Small to medium rocks

* small rock = < 15 cm, medium rock = < 50 cm, large rock = > 50 cm, boulder = > 1 m

Invertebrate sampling

Invertebrate fauna was sampled within the water (riffles, runs and pools) by selecting 10 liftable sized rocks and vigorously brushing the surface of each with a soft brush while a fine- mesh net was held down stream. Additional samples were also taken in pools; from the water surface using a hand held fine-mesh sweep net, and from the sides of larger boulders by hand. Within each site the samples from all habitats were combined into one sample. Some additional invertebrates were also collected opportunistically outside of the site areas (= "others" column in Table 7.2). All samples were preserved in 80% ethanol for transport back to the laboratory.

Laboratory sorting and identification

Invertebrate field samples were examined and sorted under a dissecting microscope in the laboratory at the University of the South Pacific Laucala Campus. Identifications were made using the following references: Choy (1984), Haynes (in progress, 2001), Short (2004), Suren (in press b) and Hawking (2007).

RESULTS

Environmental parameters

A comparative summary of the environmental parameters recorded for each site is shown in Table 7.1. All sites were relatively similar in respect to water temperature, pH, shading and substrate type. However the sites differed substantially in respect to flow rate and water depth. The higher altitude sites, i.e., Sites 3 and 4, had less flow and less available water. The higher flow rate in Site 2 was the result of several additional water sources (each seemingly small on the land surface) entering the main stream downstream of Site 1.

Table 7.2. Summary of invertebrate taxa and abundance found

	Taxa	Site 1 Volivoli A	Site 2 Volivoli B	Site 3 Natoluwalu	Site 4 Nabiya	Other	Total
Insecta	Ephemeroptera	157	572	2	5	-	735
	Coleoptera	-	-	2	-	2	4
	Hemiptera	6	7	-	-	-	13
	Odonata	53	8	21	6	-	88
	Lepidoptera	10	5	10	1	-	26
	Orphoptera	-	-	-	-	1	1
	Trichoptera	19	100	33	48	-	200
	Diptera	1	12	1	32	-	46
	Unknown	4	-	1	1	-	6
Mollusca	Gastropod	11	32	23	29	5	100
Crustacea		7	2	8	1	-	18
Platyhelminthes		22	1	18	3	-	44
Nematomorpha		-	-	-	-	1	1
Arachnida		-	3	1	-	-	4
Annelida		-	13	11	4	-	28
Total		**290**	**755**	**130**	**133**	**10**	**1318**

Invertebrates

Abundance

A total of 1318 individual invertebrates from 35 different species were found at all sites (Table 7.2, Appendix 5). These were divided by higher taxon as follows: Insecta (84.8%), Mollusca (7.6%), Crustacea (1.7%), Nematomorpha (0.08%), Platyhelminthes (3.4%), Arachnida (0.3%), Annelidia (2.1%). The most abundant taxa were larvae of the mayfly *Psuedocloeon* sp. followed by the damselfly *Nesobasis* spp.

There was a strong difference among sites in that several taxa, particularly mayflies, increased in abundance where stream flow rate was higher and where the stream contained more water (i.e., greater average depth).

Species richness

Of the 35 species found 27 (65.7%) were insects. The most species-rich order of insects was the caddisflies (Order Trichoptera) with eight different species. The damselfly genus *Nesobasis* (insect Order Odonata) probably contains several species but these are not easily separated.

Functional feeding groups

Overall, the macroinvertebrates identified were a relatively even mixture of the four broad categories of macroinvertebrate feeding group; grazers, shredders, filter feeders and predators (Table 7.2).

DISCUSSION

Stream health

Generally the fauna found, particularly the high abundance of mayfly and high species richness of caddisfly larvae, is indicative of relatively "healthy" streams (Hawking 2007). The lower numbers of these taxa at the higher altitude sites i.e., Site 3 (Natoluwalu Stream) and Site 4 (Nabiya Stream) are most likely the result of there being less water above ground at the end of the dry season. The forested streams sampled are likely to be heterotrophic, that is they reply on debris from the surrounding forest as their energy base (see Cowie 1980).

Human food species

The abundance of the freshwater long-arm prawn species *Macrobrachium cf. latidactylus* (Thallwitz 1891) [ura] was not adequately sampled by the methods employed in this survey however, our opportunistic sampling suggests that the species is relatively abundant.

Non-human food species

Although the majority of faunal biodiversity found in this survey consists of very small animals, their feeding habits and functional diversity means that they are a very important part of the overall food web. For example these macroinvertebrates may be essential bird, fish or prawn food and play a vital role in the break down of organic materials (e.g. leaf litter). The macroinvertebrates grazers also have a significant influence on algal biomass. In short, the presence of these non-food species is vital for healthy streams and overall ecosystem function (Suren, in press a, b).

Comparison to previous macroinvertebrate studies in Fiji

The total species richness of 35 species is similar to the 38 species found by Haynes (1999) in the unlogged Wainikovu Creek. However, the study by Haynes extended over a 3 year period and separated out six individual damselfly species of the genus *Nesobasis*. The macroinvertebrate biodiversity of the current study (35 species) is considerably higher than the macroinvertebrate biodiversity (four crustacean species) recorded by Boseto (2006) in the Sovi Basin. This is because of a different focus and sampling methodology.

Invasives and human health

No obvious invasive freshwater macroinvertebrates or any cane toad tadpoles were found during sampling however there were obvious signs of invasive weeds in the stream beds particularly in the Volivoli sites below the base camp. This is of concern as similar accidental introductions of invasive invertebrates such as viviparid gastropods may introduce species capable of acting as vectors for human-related illnesses.
The opportunistic discovery of a large freshwater nematomorphan horsehair worm [**wa-lutu-mai-lagi**] was unexpected however, the fact that it has a local name indicates it is not uncommon. The larvae of this species are parasitic but are not known to infect

humans, the normal host being insects (Ruppert et al. 2004).

CONCLUSIONS AND RECOMMENDATIONS

The macroinvertebrate biodiversity ratios found (i.e. high mayfly and caddisfly larvae) are as expected for upper catchment streams surrounded by native forest with a relatively "undisturbed" catchment area. However, there is evidence of invasive weed species along the stream beds which implies there is strong potential for similar introductions of invasive freshwater fauna.

Efforts should be made to reduce pathways for introduction and spread including:

- Restricting horse access
- Keeping the use of camp streams and access tracks to a minimum
- Controlling the entry of human related waste e.g. chemicals or rubbish, into streams

The streams sampled appeared to be in good condition primarily because the stream bank vegetation (riparian vegetation) is intact and the streams are well-shaded with high levels of organic debris such as leaf litter. Special efforts should be made to keep the natural vegetation intact and undisturbed along all stream banks since the overall health of the waterways is likely to be reliant on organic matter inputs from the surrounding forest.

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