# Chapter 9

## Freshwater fish and water quality of two catchments in the Nakorotubu Range, Ra and Tailevu Provinces, Viti Levu, Fiji.

*David Boseto*

***Team members:*** *Kinikoto Mailautoka (Wetlands International-Oceania), Joelle C.Y. Lai (University of Singapore), late Timoci Saqa (Matuku Village), Semi Gonekalou (Verevere Village), and Sosiceni Lautou (Nasau Village).*

## SUMMARY

A total of 15 species from eight families were collected and/or observed. These included the native species *Bunaka grinoides* and *Ophioeleotris* sp. (Eleotridae); *Awauous guamensis*, *A. ocellaris*, *Glossogobius* sp., *Sicyopus zosterophorum* and *Sicyopterus lagocephalus* (Gobiidae); *Microphis leiaspis* (Syngnathidae); *Kuhlia marginata* and *K. rupestris* (Kuhliidae); the freshwater eels *Anguilla marmorata* and *A. megastoma* (Anguillidae), freshwater moray eel *Gymnothorax polyuranodon* (Muraenidae); and the introduced *Oreochromis mossambicus* (Cichlidae) and *Gambusia affinis* (Poecilidae).

Surveyed streams and rivers in the Nakorotubu watershed showed low fish diversity ranging from zero to ten with an average of four species per streams surveyed. The fish species collected from Nakorotubu represented 9% of the total freshwater fish diversity of Fiji.

There was an abundance of the amphidromous goby *S. lagocephalus* in the Uloa River and the introduced mosquito fish *G. affinis* in the Uloa and Wailotua Rivers. Species from the family Eleotridae were not collected at Uloa River. A single species of *K. marginata* and *K. rupestris* each were collected at Uloa River. There was a low abundance of *K. marginata* and *K. rupestris* from Wailotua River compared to the intact forest of the Sovi Basin. There were no endemic or rare species collected or observed during this survey.

## INTRODUCTION

This report documents the freshwater ichthyofauna and habitat (water) quality of eleven sites along the upper reaches Uloa and Wailotua rivers, a small creek beside Base camp 2 and the Nalalau Creek in the Nakorotubu Range which were surveyed between 30 November and 10 December 2009. The findings from this survey will contribute to the overall conservation significance of the Nakorotubu Range. In addition, results from this survey will allow comparison of freshwater fauna with other river/ stream systems in Fiji and other Pacific islands.

### Habitat and Catchment Description

The Nakorotubu watershed is covered with well vegetated lowland and upland tropical forest. The stream-bed habitats are covered with sand, small rocks/pebbles, gravels, fused rock bottoms and rocks and boulders on the sides. Morphology of the rivers and creeks surveyed vary widely and range from shallow to deep sections. The rivers and creeks have range from very narrow to very wide. As the water flow rates depend on the river and creek shape and size, the water flow rate of the rivers and creeks are slower in the wide and deeper section of the pools, and rapid in shallow and narrow sections. There are sections within the rivers that have cascades with rock pools.

The rivers and creeks surveyed drain into the Wainibuka River which then flows into the Rewa River. The Wainibuka River catchment is one of the major tributaries of the Rewa River. The geomorphology of the Nakorotubu Range has rugged, mountainous steep slopes and deep weathering, highly erodible grassland soil, farmland and grazing along the mid- upper reaches of the Uloa and Wailotua rivers. There are feral cattle in the forest and along the edge of the Uloa and Wailotua rivers. This survey was undertaken during the dry period of the year, therefore the

water level was low and the water flow very slow. A thick layer of sediments and dense green and brown algae cover were found on the substrate of the Uloa River and creek beside Base camp 2 and Nalalau Creek. Uloa River and the two creeks are at high altitude with many large metamorphic boulders. The Wailotua River is also at high altitude but has a large flood plain area that passes through Nasau Village, cattle ranches and subsistence farm land. There are no major barriers observed in the river, therefore the fish population can move freely between the Wailotua and Wainibuka rivers.

## METHODS

### Field sampling

Eleven 150 - 200 m sections of the aquatic habitat of the Nakorotubu watershed were sampled. Site details and habitat descriptions are in Appendix 8. Approximately two hours was spent sampling at each site and the equipment used are as follows:

**Pole Seine Net** (2.0 m x 1.5 m, 2 cm2 mesh) (Plate 34).
The net was used in a variety of ways. Firstly, it was held firmly downstream as people kicked and dislodged rubble upstream. This was a useful method for collecting small, bottom dwelling fish. On vegetated banks the net was thrust under submerged vegetation and the vegetation was disturbed on the bank, dislodging fishes into the net. Also, this net was used to "scoop" (bottom edge held forward, run along substrate for a few seconds then lifted from any accessible shallow body of water. The pole seine net was particularly useful for narrow streams.

**Small Hand Net** (1m x 10 cm, 2cm2 mesh)
This net was used to scoop the underside of overhanging vegetation in the smaller streams and also to collect fishes in slow flowing and still water bodies.

**Aquarium Net** (19 cm x 15 cm, 2mm2 mesh)
This net was used to scoop the underside of rocks and in small crevices on small creeks. It was also used to scrape embedded rock walls and waterfalls for climbing gobies.

**Fijian Hand Sling Spear Gun** (Plate 35)
The Fijian Sling Spear Gun is made of a long thin iron rod (spear) and an elastic rubber. The thin iron rod was placed on a loop at end of the elastic and another loop was made of the other end where the diver put his thumb to pull and stretch the elastic and took aim at the fish and let go of the spear. It was very useful in collecting fast moving fish and those hiding under tree roots or under big rocks in a pool. The spear gun was used while swimming with mask and snorkel.

**Observations and underwater photography (mask and snorkel)** (Plate 36)

Underwater observations were made in deep pools with a mask and snorkel, and in areas that were shallow and the water clear. Approximately an hour was used to observe, record, collect, and photograph the observed fauna.

### Fish photography

Fish photographs were taken in situ when fish were collected with a pole seine net, or caught with a spear and during underwater observation of the surveyed sites. A Canon powershot SD1100 digital camera was used to take fish photographs.

### Fish fixation

Fish specimens collected were fixed in 10% formalin solution and transferred to 75% ethanol solution after five days of fixation. Most of the fish voucher specimens are currently with the author but will be deposited at the Marine Collection at the University of the South Pacific (USP) in Suva, Fiji.

The tissues or clipped fins for genetic studies were preserved in 95% ethanol. For each representative sample for genetic studies, the right pectoral fin or a piece of flesh from the right side of the caudal peduncle were taken and preserved in 95% ethanol. Vouchers of these specimens will also be deposited in the Marine Collection at USP.

### Fish identification

Fish were identified to family level using the Gestalt Method (Shape/location). Taxonomic keys by Allen (1991) and Marquet et al. (2003) were used to identify specimens to the genus and species levels.

### Water quality and habitat characteristics

A 360 YSI meter was used to measure the water quality parameters including water temperature, conductivity, ph and salinity (Plate 33). A Garmin 8 hand-held Global Positioning System (GPS) was used for recording the sampling site locations. Depth, width and length of the sampled areas were measured with a fiberglass measuring tape. Water flow rate (m/s) was measured by using a tree leaf flowing downstream over 2 m and was timed with a stop watch. Personal observation was used to determine the estimation of the water clarity.

## RESULTS AND DISCUSSION

### Species richness and abundance

A total of fifteen species from twelve genera and eight families were recorded from eleven sites during this survey (Table 9.1). Five species were collected from the family Gobiidae [*Awaous guamnesis* (Plate 45), *A. ocellaris* (Plate 46), *Glossogobius* sp. (Plate 48), *Sicyopterus lagocephalus* and *Sicyopus zosterophorum*]. *S. lagocephalus* (Plate 51) dominated the mid and the upper catchments. *S. zosterophorum* was observed from a pool in Site 8. There were no fish observed

or collected from Site 7. Two species of sleeper's family *Eleotridae* [*Bunaka grinoides* (Plate 47) and *Ophioeleotris* sp.] were collected from the mid reaches of the Wailotua River. Two species of jungle perch family Kuhliidae [*Kuhlia marginata* (Plate 50) and *K. rupestris*] were collected from Uloa and Wailotua rivers. Two species of freshwater eels family *Anguillidae* [*Anguilla marmorata* (Plate 43) and *A. megastoma* (Plate 44)] were collected from the upper reaches of the Uloa River. The freshwater moray eel, *Gymnothorax polyuranodon* (Plate 49) (Family *Muraenidae*), was also observed and photographed from Sites 6 and 11. A species from the family Syngnathidae (*Microphis leiaspis*) was collected from mid reaches of the Wailotua River. The introduced, exotic species were observed and recorded in theUloa and Wailotua rivers. Both rivers were heavily populated by the introduced Mozambique Tilapia *Oreochromis mossambicus* (Plate 53) (Family Cichlidae) and the mosquito fish, *Gambusia affinis* (Plate 52) (Family Poeciliidae).

**Table 9.1:** Species distribution and abundance of freshwater fish in the Nakorotubu Watershed. The numbers in the column below sites indicates the number of fish collected from each site. Sites 1-6 are different sections of the Uloa River. Site 7 is the creek beside Base camp 2, Site 8 is Nalalau Creek, Sites 9- 11 are different sections of the Wailotua River. Abbreviation Abu = Abundant (>100).

| No. | Verbatim species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anguillidae | *Anguilla marmorata* | | | | | | | | | | | |
| | | | | | 2 | | | | | | | |
| | *Anguilla megastoma* | | | | | 1 | | | | | | |
| Ciclidae | *Oreochromis mossambicus* | 5 | | | | | 3 | | | Abu | Abu | |
| Eleotridae | *Bunaka grinoides* | | | | | | | | | 1 | 1 | |
| | *Ophioeleotris* sp | | | | | | | | | 2 | | |
| Gobiidae | *Awaous guamensis* | | 3 | 2 | | | 2 | | | 1 | 1 | 1 |
| | *Awaous ocellaris* | | | | | | | | | 1 | 1 | 1 |
| | *Glossogobius* sp. *1* | | | | | | | | | 2 | 1 | 1 |
| | *Sicyopterus lagocephalus* | Abu | Abu | Abu | Abu | Abu | Abu | | 2 | 2 | 1 | |
| | *Sicyopus zosterophorum* | | | | | | | | 2 | | | |
| Kuhliidae | *Kuhlia marginata* | | | | | | 1 | | | 5 | 3 | 2 |
| | *Kuhlia rupestris* | | | | | | 1 | | | | 2 | |
| Muraenidae | *Gymnothorax polyuranodon* | | | | | | 1 | | | | | 1 |
| Poeciliidae | *Gambusia affinis* | Abu | Abu | | | | Abu | | | Abu | Abu | Abu |
| Syngnathidae | *Microphis leiaspis* | | | | | | | | | 1 | | |

### Headwaters

*Sicyopterus lagocephalus* and *Sicyopus zosterophorum* from the subfamily *Sicydiinae* of the family *Gobiidae* were recorded from the upper reaches (Table 9.1). They are known as *amphidromous* fish - characterized by adults living and breeding in freshwater (McDowall 2004, 2008). Their larvae are transported into the ocean where they grow into post-larval (juvenile fish) before returning to the rivers to complete their life cycle (Keith 2003, 2010). The pattern of such distribution is common amongst amphidromous fish throughout the tropical Pacific freshwater system (Ryan 1991). These fish can navigate through barriers like waterfalls and can also survive in degraded areas where green and brown algae dominate (Plate 42). *S. lagocephalus* is herbivorous and feeds on the algae.

### Mid-reaches

The elevation of the middle reaches of the Nakorotubu catchment ranges from 150- 180 m. Species from the Anguillidae, Gobiidae and Poecilidae families were collected from the middle reaches. The species from Anguillidae were *Anguilla marmorata* and *A. megastoma*. The species from the family *Gobiidae* were *Awauous guamensis* and *Sicyopterus lagocephalus* and the introduced *Gambusia affinis* from the family Poecilidae. Sicyopterus lagocephalus and Gambusia affinis were the common species that dominated the middle

reaches. Freshwater eels (Anguillidae) are known as catadromous fishes. They live in freshwater as adults, migrate to the ocean to breed and juveniles return to freshwater to complete their life.

### Lower reaches

Fiver lower reaches sites within the Nakorotubu watershed were surveyed. These sites were dominated by two common invasive species Mozambicus Tilapia (*Oreochromis mossambicus*) and the Mosquitofish (*Gambusia affinis*). However, there were species from the families Eleotridae, Gobiidae, Kuhliidae, Muraenidae and Syngnathidae also recorded from the lower reaches (Table 9.1, Appendix 8). It is evident from this survey that there is low freshwater fish biodiversity and species abundance in the lower reaches but high abundance of the two introduced species that are widely distributed in Fiji and the South Pacific. The number of native species is usually lower in places where the introduced Mosquitofish and Mozambicus tilapia dominate (Canonico et al. 2005, Boseto, 2006a,b, Jenkins et al. 2010). Observations made during this survey support the theory that species from the family Kuhliidae are dwindling while endemic species from the subfamily Sicydiinae were absent.

### Water quality and habitat characteristics

The water quality in rivers and streams in the Nakorotubu watershed area is still very much pristine as it flows through an intact forest system in the upper and mid reaches. However, in the lower reaches it flows through disturbed areas where agricultural activities and human habitation associated activities take place. The water and habitat conditions exhibit suitable conditions to sustain aquatic life: intact forest cover in the upper and mid reaches, the overhanging riparian plants, water temperature of 22-26°C, average water flow rate of 0.27m/s, over 70 % dissolved oxygen and very little turbidity.

### Threats to the fish fauna

The major threats observed were the use of Derris roots, weedicides and pesticides as means of harvesting fish resources from the rivers. The use of these poisonous plants and chemicals can change water quality by depleting oxygen and changing pH thereby providing an unsuitable environment for all aquatic life. The slow water flow, sediment deposits on the substrate and the presence of thick algae in the water are of concern as they will also alter the water chemistry.

The presence of introduced fish species in the lower and middle reaches of the Nakorotubu Range is a major threat. The introduced species *Oreochromis mossambicus* and *Gambusia affinis* are known to feed on the fish larvae of the native species thus their occurrence here in large numbers can be account for the poor fish abundance and diversity of native species.

The other concern was the algal bloom in the lower catchment of the Uloa and Wailotua rivers. This is indicative of high levels of nutrient input which are likely a result of livestock, weedicides, pesticides and agricultural activities. Algae can be very harmful to freshwater biodiversity by altering the physical water parameters and reducing the quality of the water by affecting levels of dissolved oxygen, water temperature and pH.

## CONCLUSIONS AND CONSERVATION RECOMMENDATIONS

The Nakorotubu Range watershed is a pristine and intact system in the mid and upper reaches but is disturbed in the lower reaches. In the lower reaches the substrate is covered with green and brown algae. The thick deposit of the algae is due to the use of Derris roots, weedicides and pesticides to harvest fish. In addition, the combination of cattle farming and agricultural waste are affecting the water quality and habitat for the fish. Overfishing and destructive fishing practices also affect the fish biodiversity and abundance. Furthermore, the abundance of the introduced species *Oreochromis mossambicus* and *Gambusia affinis* greatly contributes to the poor diversity and abundance of native species and the complete absence of any endemic species.

Therefore, watershed management and rehabilitation mitigations should be put in place to restore the freshwater ecosystem function and its rich resources. Plans to rehabilitate the Nakorotubu Range watershed should involve the whole system from upper to lower reaches as the fish population needs the entire water system to complete their life cycle.

Below are some potential suggestions for watershed rehabilitation:

1. encourage replanting of buffer zones particularly in areas that are adjacent to human habitation, subsistence agriculture and cattle farms,
2. form a village environment committee to plan monitoring of waste levels and water management (e.g. the committee will be responsible for construction of ecological or livestock waste areas, harvesting of the fish resources, and monitor the introduction of alien species).

The forests in the upper reaches of the Nakorotubu Range should be maintained as a protected area. The concern here is that the logging currently taking place on the northwest end of the mountain range may affect water quality during wet season with the sediment transported into the river. The headwaters forest should be given management priority to prevent destructive development.

Aquaculture of native species should be encouraged and introduction of any exotic aquatic fauna should be closely managed and monitored.

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