The Invasive Mammal Fauna of the Nakauvadra Range, Ra Province, Fiji

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Chapter 9

Freshwater fish and water quality of two catchments in the Nakauvadra Range, Ra Province, Fiji

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SUMMARY

This survey was conducted to produce an inventory of freshwater fishes in the Vunilaci and Vuniqesa Rivers, within the Nakauvadra Range interior forests of Ra province, Fiji.

Overall a total of eight species from five different families were collected or observed. Two species were collected from the family Gobiidae (*Awaous guamnesis* and *Sicyopterus zosterophorum*) that dominated the mid and the upper catchments. Also collected were three species of freshwater eels from the family Anguillidae (*Anguilla marmorata*, *A. obscura* and *A. megastoma*). The freshwater moray, *Gymnothorax polyuranodon* (Family Muraenidae), was also observed but not collected. We did not record any introduced exotic species in the mid and upper catchments although we observed that the lower catchment of the river system was heavily populated by the introduced Mozambique Tilapia *Oreochromis mossambicus* (Family Cichlidae) and the mosquitofish, *Gambusia affinis* (Family Poeciliidae).

These two catchments appear depauperate in both diversity and abundance of fishes. There are a number of notably absent families (e.g. Kuhlidae, Eleotridae) and the sparse ichthyofauna that remains are among the hardier, ubiquitous species. No endemic or sensitive, rare fauna were observed. Although the natural riparian buffer zones on both of these upper catchments were largely still intact, the low abundance and diversity is likely due to the poor management of the lower catchments, compounded by the presence of the invasive Tilapia and mosquitofish in lower areas and the common use of *Derris* roots (Duva) as a fishing method. This was evident when sampling was carried out in the middle and upper catchments where freshly used *Derris* roots could be frequently seen. As the vast majority of fishes are migratory, their populations are effected by these lower catchment areas of poor habitat quality that they must migrate across. Managing village waste and agricultural buffer zones in the highly erodible and flood-prone lower catchments may also help improve the migration path from sea to freshwater estuaries and up into the middle and upper catchments, assisting a rehabilitation process for these inland freshwater fauna.

INTRODUCTION

This brief report documents the freshwater ichthyofauna and habitat (water) quality of the Vunilaci and Vuniqesa river systems, which flow along the edges of the Nakauvadra Range in the interior forests of Ra Province. These results are based solely on this initial biodiversity survey carried out from November 19-28, 2008. During this period, eight 150 – 200 m sections of both the Vunilaci and Vuniqesa catchments were intensively sampled for freshwater fish fauna and water quality in

the mid and the upper catchments. The results of this survey contribute to evaluating the overall conservation significance of the area. Survey results also permit direct comparison of the fish fauna with other river systems, both within and outside Fiji and will be entered into the Fiji freshwater fish database, currently maintained by Wetlands International-Oceania (WI-O). Initial observations and survey results have also helped in identifying some of the primary threats to these catchments and potential catchment management actions.

Catchment characteristics

The Vunilaci and Vuniqesa rivers are small, tertiary catchments which drain into the Wainibuka River, a major secondary tributary of the Rewa River (296,000 ha), the largest catchment in Fiji. The Wainibuka River catchment (74,567 ha) is one of five major tributaries and drains the drier northeastern part of Viti Levu. This catchment has around 64% forest cover with 47,362 ha of forest remaining intact. With relatively steep slopes and deep weathering, soil erodibility is generally high with the erodibility of grassland and grazing along the upper reaches of the Wainibuka classified as severe (Atherton et. al. 2005). Contributing to this erodibility, this secondary catchment is also notable in having the highest number of river road crossings (ie. bridges, culverts, fords) of any catchment in Fiji with a total of 1460 and the second highest length of roads in any catchment in Fiji (950 km), second only to Dreketi River with 1655 km (Atherton et. al. 2005). Both of the sampled, interior river catchments, however, do not show great erosion potential with buffer zones on the river banks are still thick with native trees. These interior catchments are characterized by steep relief with many large barriers such as waterfalls and large metamorphic boulders, making it difficult for many fish to penetrate except for the Gobiidae (gobies) and Anguillidae (freshwater eel) families.

METHODS

Field sampling

Eight 150-200 m sections of the Vunilaci and Vuniqesa catchments and tributaries were sampled for fishes and water quality (see Map 9). These sites were divided into two major catchment types, middle and upper catchments with the altitude ranging from 200 m in the mid catchments to 300 m on the upper catchments. Two upper and two mid catchment sites were sampled in each river. A variety of techniques were used to collect fauna from the river or stream, depending upon the characteristics of the site. Approximately 1 hr was spent sampling at each site. The apparatus and techniques used were as follows:

Electro-fisher (Deka 3000, 600V, 10A) was a primary sampling tool in river and stream habitats. Wearing rubber waders and never venturing deeper than 1.5 m, the anode (on a 1 m long rod) was discharged while two people (also wearing rubber waders) held a medium sized, 1 mm2 mesh net across the stream several metres upstream from the anode. When the anode reached the net, it was raised and fauna within the net were placed in a water-filled plastic bucket.

Large seine net (2 m x 7 m, 0.4 cm2 mesh) This net was pulled in a rough circle, with the bottom edge down as close as possible to the substrate and forward of the top floating edge of the net. This technique was executed before anyone could set foot in the water body to minimize the number of fleeing fishes. This was generally used only in minor tributaries and slow moving or still waters.

Medium pole seine net (1.2 m x 0.8 m, 1mm2 mesh) This 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 waterbodies. This net was particularly useful for narrow streams.

Small hand nets (15 cm x 10 cm and 10 cm x 8 cm, 1mm2 mesh) These were used to "scoop" the underside of overhanging rocks and in small crevices in the smaller streams and also to collect fishes when in still water bodies.

Observations (mask and snorkel) In areas that were shallow and the water was clear enough, a mask and snorkel were used to observe the benthos and fisheries resources that were not being caught by the nets.

Specimen preservation

Voucher specimens were collected, fixed in a 10% formalin solution and transferred to 70% ethanol solution after 5 days of fixation. Some specimens were stored directly in 70% ethanol for DNA analysis. As color loss is rapid, accurate preservation of color patterns was recorded by photography. Fresh specimens were placed in a portable aquarium with some local aquatic vegetation and benthos to enhance the photography. Voucher specimens were deposited at the Marine Studies collection of University of the South Pacific in Suva (USPS).

Water quality and habitat characteristics

Current speed was measured by floating a plastic lid a measured distance, timing it with a stopwatch and dividing distance (m) by time(s). pH, temperature, conductivity and salinity were measured using a TPS handheld meter. Turbidity was measured using a turbidity tube and given in Nephthalometric Turbidity Units. Location was taken with a Garmin 8 handheld GPS. Depth, width and length of reach sampled were measured with a waterproof, fiberglass measuring tape. Approximately 1 hr was spent sampling at each site.

RESULTS AND DISCUSSION

Species richness and abundance

Overall a total of eight species from five different families were collected or observed (Table 9.1). Two species were collected from the family Gobiidae (*Awaous guamnesis* and *Sicyopterus zosterophorum*, Plate 19) that dominated the mid and the upper catchments. Also collected were three species of freshwater eels from the family Anguillidae (*Anguilla marmorata*, *Anguilla obscura* and *Anguilla megastoma*). The freshwater moray, *Gymnothorax polyuranodon* (Family Muraenidae), was also observed and photographed but not collected. We did not record any introduced exotic species in the mid and upper catchments of Vunilaci and Vuniqesa Rivers although we did observe that in the lower catchment, where the rivers join near Vunisea village, was heavily populated by the introduced Mozambique Tilapia *Oreochromis mossambicus* (Family Cichlidae) and the mosquitofish, *Gambusia affinis* (Family Poeciliidae).

Headwaters

In Table 9.1, most of the sites sampled ranged from 200-300 m a.s.l. Although we divided the sites up into mid and upper catchments, the diversity and life forms of the fishes sampled reflect largely the common families of an Indo-West Pacific island upper catchment fauna. All species found in these head waters are highly migratory native fauna that are the hardy, ubiquitous species found in both degraded and intact catchments (Jenkins et al. 2005). They are morphologically capable of surmounting large barriers such as waterfalls. The fish diversity and abundance was poor however, and this could be partially caused by overfishing, as people commonly travel across this catchment and use the highly destructive *Derris* root for fishing (Plate 20). This could also reflect the poor quality and highly interrupted state of the lower catchments including the Wainibuka. The major headwater fauna observed are Anguillidae (Freshwater eels) which have an obligate catadromous life history pattern. This means that the adult eels must migrate out to sea where they breed and die. The larval eels then re-enter freshwater were they will migrate upwards feeding and growing until they must return to sea to breed. The other family present is Gobiidae from the sub-family Sycidiinae. These species are amphidromous, meaning that they spawn in freshwater, the hatched larvae pass to sea and the juveniles return to freshwater as post-larval fishes where they will migrate upwards and grow (Keith 2003).

Mid-reaches

The middle reaches of these catchments were also at quite a high elevation for a tropical high island scenario (around 200 m) and again predominantly yielded the common families associated with higher elevations (Anguillidae, Gobiidae). However, in addition to the fauna found in the headwater sites, two other species of eels were found. First was another species of Anguillidae, *Anguilla obscura*, generally more common in swampy, low flow areas. Secondly was the freshwater moray, *Gymnothorax polyuranodon* (Family Muraenidae). Both of these species are obligate catadromous species which must migrate to sea to breed and die, before the larval eels re-enter the freshwater for growth and the bulk of the remainder of their lives.

Table 9.1. Numbers of fishes collected or observed in the upper and middle sampling sites in the Vunilaci and Vuniqesa catchments. Sites 1 & 2 (mid), 3 & 4 (upper) Vunilaci River; sites 5 & 6 (mid), 7 (upper) Vuniqesa River. * Fishes observed near Vunisea village. University of the South Pacific (USPS) catalogue accession numbers are given in the final column.

Family	Genus	Species	1	2	3	4	5	6	7	*	USPS
Anguillidae	*Anguilla*	*marmorata*			2			2			5797
	Anguilla	*obscura*					1	3			observed
	Anguilla	*megastoma*			1						observed
Muraenidae	*Gymnothorax*	*polyuranodon*	1								observed
Gobiidae	*Sicyopus*	*zosterophorum*			4						5792
	Awaous	*guamensis*	7	6	2	3	2	2			5794,579 6,5798
Cichlidae	*Oreochromis*	*mossambicus*								>10	observed
Poeciliidae	*Gambusia*	*affinis*								>10	observed

Lower reaches

While we did not spend much time sampling in the lower reaches, we did make some observations by mask and snorkel near Vunisea village. These lower reaches were clearly heavily invaded by the two most common invasive fishes in the Pacific Islands, the Mozambique Tilapia (*Oreochromis mossambicus*) and the Mosquitofish (*Gambusia affinis*). Globally, introduced invasive species are second only to habitat destruction as the major factor driving extinction of native species (e.g. Canonico et al. 2005). Our research in Fiji has demonstrated that those high island catchments with Tilapia present have, on average, seven less fish species then those without and those native species lost are often the common inland food fishes (Eleotridae) and endemic species (Sicydiinae) (Jenkins et. al. pers. obs.). This observation also supports the fact that none of the major indigenous food fishes (e.g. Kuhliidae, Eleotridae) or endemics were seen during this survey.

Water quality and habitat characteristics

Overall, the quality of water in the two upper catchment areas appears to be high and reflects both the high level of remaining forest cover and the steeper topography of both the catchments (Appendix 7). With altitudes ranging from 200- 280 m a.s.l., the headwaters of both these catchments are in generally excellent condition to support aquatic life with mainly intact native riparian vegetation, shading waters to a cool 23-24°C, good average water flow of around 0.35m/s, generally over 70% dissolved oxygen and very little turbidity.

Threats

- One of the major threats which the survey team observed was the common usage of *Derris* roots as means of catching fish. The use of these poisonous plants can change the quality of water by depleting oxygen and asphyxiating all aquatic life. Although it is not really effective in free flowing, highly oxygenated waters, life forms in ponds and slower flowing waters are severely affected. It is indiscriminate and will also kill all juveniles, thus removing future potential populations;
- Introduced fish species at the lower catchment of the two rivers are also a major threat. These can also be a reason for the poor fish abundance and diversity observed. The introduced species *Oreochromis mossambicus* and *Gambusia affinis* will feed on the larvae of the migratory species which must use the river as their migration path. The team was greeted with a bundle of Mozambique Tilapia (*O. mossabicus*) upon our arrival at the village (Plate 21).
- The other primary threat noted was the algae bloom on the lower catchment of the river (Plate 22). This is indicative of a high level of nutrient

input which is likely a result of livestock, piggeries and drain outs from nearby plantations. This is also harmful to freshwater biodiversity by reducing the quality of the water by affecting levels of dissolved oxygen, water temperature and pH.

CONCLUSIONS AND RECOMMENDATIONS

- These two river systems in the Nakauvadra Range are in relatively poor condition in terms of ecological functioning and do not support healthy populations of native fishes. Sensitive endemic species are absent. Both of the upper catchment areas, however, retain quite good water quality because of intact forest and steeper, undeveloped topography. The general poor status of fishes in these rivers is due to poorly managed subsistence agriculture in the lower catchments, human settlement waste, overfishing and destructive fishing practices. Catchment level management and rehabilitation should be undertaken especially in the lower catchments in order to restore some of the ecosystem function of these rivers and in turn increase the migratory capacity to the upper catchments. Some potential options for assisting in catchment rehabilitation are:
  - ➢ community-based replanting of buffer zones particularly in mid-catchment areas adjacent to subsistence agriculture and road crossing areas;
  - ➢ village level waste and water management plans (e.g. construction of ecological or compost toilets, livestock waste areas, minimize livestock traversing waterways).

- Forests in the upper catchments of the two rivers, Vunilaci and Vuniqesa should be retained as protected areas. Generally, high water quality within the area is indicative of the remaining tract of native forest. This type of forested upper catchment is increasingly rare in Fiji and the Pacific and would serve the area well as a repository of potable water and unique terrestrial biodiversity.
- A concerted effort should be made to prevent the introduction of any exotic aquatic fauna to the upper sections these rivers. Any introduction will likely further erode the ecological function of these waterways. Stocking of native species (e.g. Gudgeons) could be considered as well as integrated irrigation/aquaculture of prawns (*Macrobrachium* sp).

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