Freshwater Fishes
of
Tetepare Island



Western Province
Solomon Islands

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WETLANDS INTERNATIONAL

Acknowledgements

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Executive Summary

Tetepare Island is the largest unlogged and uninhabited lowland rain-forest island in the South Pacific. In September 2006, Wetlands International-Oceania and University of the South Pacific researchers led the first survey of the freshwater fish fauna of Tetepare. Fifteen 150 m sections in four rivers and two lakes were sampled for fresh water fishes and water quality. A total of 797 individuals representing 60 species, 46 genera and 29 families of fishes were collected or observed. We consider this fauna to contain five undescribed species endemic to the Solomon Islands (*Schismatogobius sp., Sicyopterus sp., Stiphodon sp., Stenogobius sp., unknown Gobioid*). Of these country-level endemics, three species are only so far known from Tetepare Island (*Sicyopterus sp., Stiphodon sp., unknown gobioid*). The unknown gobioid is highly derived and may represent a new family of fishes, however, it appears most closely related to the families Gobiidae and Eleotridae and needs further investigation and further specimens collected to elucidate its correct taxonomic placement. We did not observe or collect any invasive species during the survey. 12 species of snails were also collected from Tetepare freshwaters including a new species of Thiarid snail from Bangatu Lake. Tetepare Island freshwater fish fauna appears remarkably diverse compared to other related island groups in the near region. 15% of the fauna are either restricted to the Melanesian archipelagoes (5%) or only known from the Solomon Islands (10%). This component of the ichthyofauna and the unique community composition *en toto* should be considered as a priority for conservation. Size structure, biomass, species composition and water quality all suggest high levels of intactness within fish communities rarely documented in the region and should be considered a benchmark for island freshwaters of the Pacific. The life history strategies of Tetepare fishes can be divided into nine distinct functional groupings with the dominant life history strategy, amphidromy, representing 25% of the fishes. Life history traits of Tetepare fishes clearly illustrate inextricable ecological links to the ocean with all species likely entering ocean or estuarine environments at periods during their lives. Specific conservation recommendations are provided, including a strong endorsement for Tetepare Island being nominated as a World Heritage site. This report has an accompanying volume entitled "*Freshwater fishes of Tetepare: a preliminary guide*" with full colour pictures of all species and diagnostic characteristics.

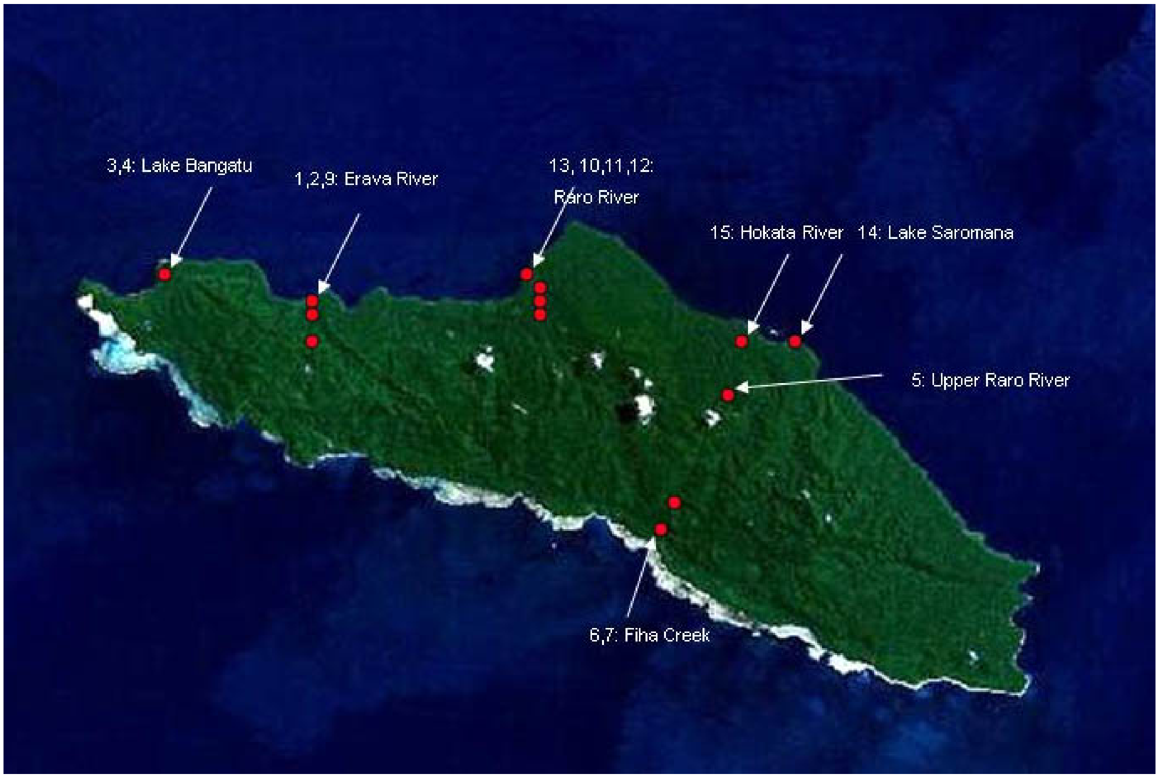
INTRODUCTION

Tetepare Island (8^o 45’ S, 157^o 32’ E) is the largest (11, 880 ha) unlogged and uninhabited lowland rainforest island in the South Pacific. The customary landowners fled the island in the mid -1800’s leaving the isolated island’s terrestrial, freshwater and adjacent marine ecosystems largely intact to this day. While a small (375 ha) coconut plantation was planted on the western tip of the island between 1907 -1918, this grove has largely been reclaimed by the rainforest. Today this island is managed by the descendants of the original inhabitants (Tetepare Descendents Association, TDA) for purposes of sensitive low-level ecotourism and conservation. A small eco-lodge on the island is managed by TDA for accommodating researchers, eco-tourists and local rangers (Read and Moseby, 2006).

While only a few biological studies have been carried out on the island (Hansell and Wall, 1976; Diamond, 1976; Dahl, 1980; Gee, 2003; Read & Moseby, 2006) it is increasingly clear to all investigators that the island is of international biological and conservation significance and should be maintained as such in perpetuity. Numerous authors (Diamond, 1976; Dahl, 1980; Lees 1990; Read & Moseby, 2006) have strongly recommended the island as crucially important to conservation and worthy of World Heritage nomination. To date, botanical (Hansell and Wall, 1976; Keppel, 2007, in preparation) and terrestrial vertebrate (Read & Moseby, 2006) surveys have been carried out showing a richly diverse lowland rainforest containing at least 25 reptile, 4 frog, 76 bird and 13 mammal species, many of which are of international conservation significance and have important refuge populations on the island.

In September (9^{th} -14^{th}) 2006, Wetlands International-Oceania and University of the South Pacific researchers led the first survey of the freshwater fish fauna of Tetepare by invitation of the Tetepare Descendants Association. This paper reports our survey results and is designed to assist the TDA and other interested stakeholders appreciate and appropriately manage the aquatic resources of this unique and increasingly valuable island wilderness.

Figure 1. Sattelite image of Tetepare island showing locations of sampling sites in red. Image courtesy of Google Earth.



SAMPLING METHODS

Fifteen 150 meter sections in the aquatic habitats of Tetepare were sampled for fresh water fishes and water quality. Aquatic habitats sampled and habitat characteristics of each site are listed in Appendix 2. A variety of techniques were used to collect fauna from the rivers, stream or lakes 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-fishing machine

A non-commercially available, backpack electro fishing machine operating at 8 Amps and 110 Volts of pulsed electricity was used. This apparatus was used extensively in shallow waters (<1m) of all habitats. A fine (5 x 5 mm) mesh net was attached to the anode and two other persons were positioned downstream with a pole seine net and hand nets to catch stunned fishes.

*Gill net (*30m x 2 m, 5 cm^2 mesh)

This monofilament gill net was weighted with lead on the bottom (lead line) and had floats on the top (float line). When stretched to full length the net was tied onto two rods at each end of the net. This net was used in Lake Bangatu and at the mouth of the Raro River.

Large seine net (2 m x 7 m, 0.4 cm^2 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 minimise 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, 1mm^2 mesh)

This was used in a variety of ways. Firstly, it was held firmly downstream as people kick and dislodge 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. This net was particularly useful for narrow streams.

Small hand nets (15cm x 10cm + 10 cm x 8 cm , 1mm^2 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 enough and the water was clear, a mask and snorkel were used to observe the benthos and fisheries resources that were not being caught by the nets.

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 University of the South Pacific

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 hand held 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

Diversity of fishes

A total of 797 individuals representing 60 species, 46 genera and 29 families of fishes were collected or observed in Tetepare freshwater habitats (Table 1). At least 14 of these species are new records for the Solomon Islands. Currently we consider this fauna to contain 5 undescribed species endemic to the Solomon Islands (*Schismatogobius sp., Sicyopterus sp., Stiphodon sp., Stenogobius sp., unknown Gobioid*). Of these country-level endemics, three species are only so far known from Tetepare Island (*Sicyopterus sp., Stiphodon sp., unknown gobioid*) although they may be more widespread upon further survey work given the assumed pelagic larval dispersal phase of these taxa. The unknown gobioid is highly derived and may represent a new family of fishes, however, it is seemingly most closely related to the families Gobiidae and Eleotridae and needs further investigation and further specimens collected to elucidate its correct taxonomic placement. It is a new genus and a new species of fish thus far only known from Tetepare Island. Only one third of the water bodies of Tetepare were sampled and we were only able to get to the head waters of the Raro river. Further surveys are likely to yield additional species particularly climbing gobies of the genera *Lentipes* and *Sicyopterus*.

Table 1. Fishes collected and observed in Tetepare island aquatic habitat sampling sites.

FAMILY	SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ambassidae	*Ambassis interruptus*			12							12					
	Ambassis miops	8	6							3						
Anguillidae	*Anguilla marmorata*						1		2	5			3			2
	Anguilla megastoma		1			2	2									
Apogonidae	*Apogon hyalosoma*										2					
	Apogon sp.										8					
Carangidae	*Caranx papuensis*													4		
	Decapterus sp.													1		
	Scomberoides commersonianus													1		
Chanidae	*Chanos chanos*				16											
Eleotridae	*Belobranchus cf belobranchus*									5			6			7
	Bunaka gyrinoides			3			1	2				2				
	Butis butis		5								1					
	Butis amboinensis	3								4			2			
	Eleotris fusca	10		27	1		7	1	10			10	6		7	4
	Eleotris melanosoma	7	6	4												
	Giuris magaritaceous	2						2					1		3	3
	Giurus sp.						8									
	Hyseleotris guentheri												5			
	Ophiocara porocephala		2												4	2
Gobiidae	*Awaous ocellaris*	2	2							1		2				
	Glossogobius sp	10	2							6	2	2	3			2
	Mugilogobius fusculus														36	
	Periopthalmus argentilineatus	1														
	Redigobius cf chrysosoma	2										2				
	Redigobius cf bikolanus		1	16	13										1	
	Schismatogobius sp									6		1	1			3
	Sicyopterus lagocephalus		3							1			5			6
	Sicyopterus longifilis															4

	Sicyopterus n.sp.	3										9	45			10
	Stenogobius sp.	2		1												
	Stiphodon rutilaureus	3	2									13				
	Stiphodon n. sp	2										15				
Hemiramphidae	*Zenarchopterus sp.*										2			4		
Kuhliidae	*Kuhlia marginata*	6	13					12		12		6	6			12
	Kuhlia rupestris		2	2				2					3			5
Leiognathidae	*Leiognathus equulus*									1				1		
Lutjanidae	*Lutjanus argentimaculatus*	4	3							3		3				
	Lutjanus fulvus		2									2				
	Lutjanus fuscesens		4										5			5
Megalopidae	*Megalops cyprinoides*				1											
Monodactylidae	*Monodactylus argenteus*		1							1	2					
Moringuidae	*Moringua cf ferruginea*											1				
Mugilidae	*Crenimugil crenilabris*									1	8			9		
	Liza vaigiensis			2	1					2						3
Muraenidae	*Gymnothorax polyuranodon*		2									1				1
Ophichthidae	*Lamnostoma kampeni*	1	5							12		19	6			13
Polynemidae	*Polydactylus sexifilis*													9		
Pomacentridae	*Neopomacentrus aquadulcis*										8					
Rhyacichthyidae	*Rhyacichthys cf aspro*									5						8
Scatophagidae	*Scatophagus argus*									1						
Scorpaenidae	*Tetraroge barbata*									5			3			2
Serranidae	*Epinephalus polystigma*	1										2				
Syngnathidae	*Microphis cf brachyurus*									1						
Terapontidae	*Mesopristes argenteus*	2	3							3			5			5
	Mesopristes cancellatus									3			4			4
	Terapon jarbua										3					
Toxotidae	*Toxotes jaculatrix*										1					
Unknown Gobioformes	*New gen. n.sp.*															1
Unknown Rajiformes		1														

Like many Indo-Pacific high islands, the fauna is dominated by gobioid fishes, mainly members of Gobiidae and Eleotridae, with a single representative of the family Rhyacichthidae and the unknown gobioid. This gobioid group is represented by 27 species or 45% of the entire fauna. Cling gobies of the sub-family Sicydiinae (containing genera *Lentipes, Sicyopterus, Sicyopus* and *Stiphodon*) are particularly prominent and in abundance in Tetepare streams as they are in most clear rocky streams in the islands of the region. These fishes are called cling gobies because of their “sucking disk” a peculiar morphology that is formed by fused pelvic fins and allows these fishes to “cling” to rocks in rapid stream flow. *En masse* migration of oceanic pelagic larvae of these fishes into the streams is characteristic of the group and no doubt plays a crucial role in the ecology of these water bodies (Keith, 2003). A common practice throughout many Indo-Pacific islands is to harvest these “white-bait” as they migrate into river mouths. It is highly recommended that to preserve the integrity of these systems that this practice is banned from Tetepare Island.

Most of the non-gobioid fishes are estuarine and marine forms that will inhabit the lower to mid reaches of streams and are usually prevented from inland dispersal by the first large waterfall. These fishes are a combination of juvenile forms and adult forms that will spend periods in fresh water for feeding and breeding as well as migrate between habitats. The life history patterns of all Tetepare fishes are discussed below.

It appears that Tetepare Island, with at least 60 species inhabiting freshwater, has a remarkably diverse fauna compared to other related island groups in the near region. For example the following locations have yielded these results (species numbers in parentheses): Milne Bay Islands, Papua New Guinea (56), Yapen Island, Papua Province (48), and Raja Ampat Islands, Papua province (57) (G. Allen, personal communication). This high diversity on Tetepare is likely a consequence of the pristine nature of the catchments, including the presence of large tracts of largely unaltered lowland rainforest and the obvious lack of sustained human harvest of the resources for around a century (also see section on Abundance and Biomass). Many of the Sicydiine gobies are particularly sensitive to catchment alteration and, with the exception of hardy species such as *Sicyopterus lagocephalus*, will often be absent or sparse in catchments altered by logging, tree farming, mining and other deleterious activities (Jenkins, 2007; Argent & Carline, 2004; Keith, 2003).

We did not observe or collect any invasive species during the survey. It is absolutely vital that no invasive species are allowed on to the island. Species such as Tilapia (*Oreochromis mossambicus*) and Mosquitofish (*Gambusia spp*.) are already present in the Solomon Islands in locations such as Honiara and the lakes on Rennel Island (G. Allen, personal communication). These species can drastically change stream ecology and cause native species to decline in numbers and potentially become locally extinct (Allen, 1991). An explicit ban on introduction of exotic species of fishes (or any other taxa) should be enforced for Tetepare Island.

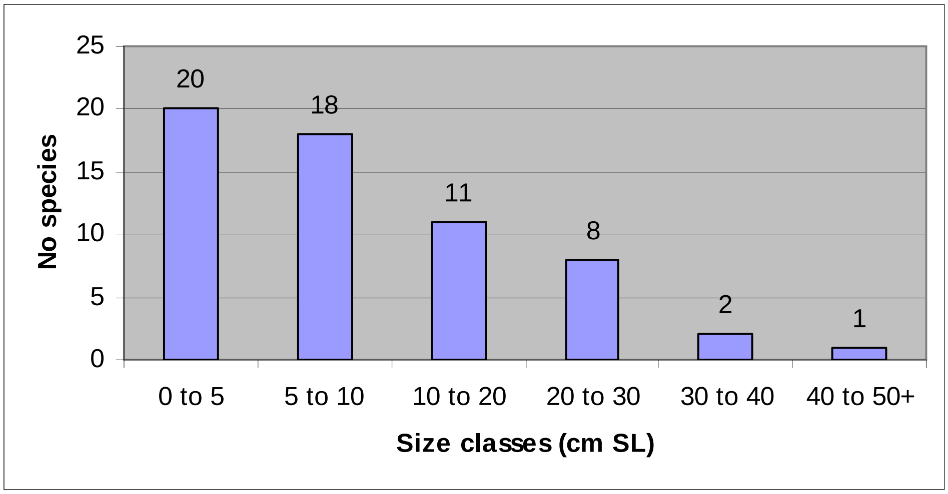
Note on freshwater snail diversity

Freshwater snails were also collected during the survey although not systematically. Dr. Alison Haynes (University of the South Pacific) identified 12 species of snails from Tetepare freshwaters including a new species of Thiarid snail from Bangatu Lake. The list of species collected by waterway are listed in Appendix 4.

Size structure

Eleven fish species exist in Tetepare freshwaters that were encountered between 20 – 50 + cm in length and are a suite of major food fishes from freshwaters and estuaries of the Solomons and the wider region. In descending average size encountered, these species are (mean size cm SL in parentheses): *Anguilla megastoma* (54.4), *Chanos chanos* (33.7), *Caranx papuensis* (30), *Scomberoides commersonianus* (30), *Polydactylus sexifilis* (29), *Anguilla marmorata* (28), *Lutjanus fuscescens* (26.4), *Terapon jarbua* (25), *Crenimugil crenilabrus* (24.8), *Decapterus cf macarellus* (23) and *Gymnothorax polyuranodon* (20.5). In the 10 -20 cm size class there are mainly gudgeons (Eleotridae) and sub adult forms of other common food fishes including snappers *Lutjanus argentimaculatus* (14.9), *L. fulvus* (17.5) and grunters *Mesopristes argenteus* (12.2) and *M. cancellatus* (17.9). Within the smaller size classes are a variety of forms dominated in diversity by the family Gobiidae. This size class structure appears to be significant because Indo-Pacific island streams that are regularly fished or in degraded catchments tend to have around only 2 or 3 species encountered in the top three size classes (Jenkins et al 2006, Jenkins, 2005) generally *Anguilla sp., Liza sp.* and *Caranx sp.*

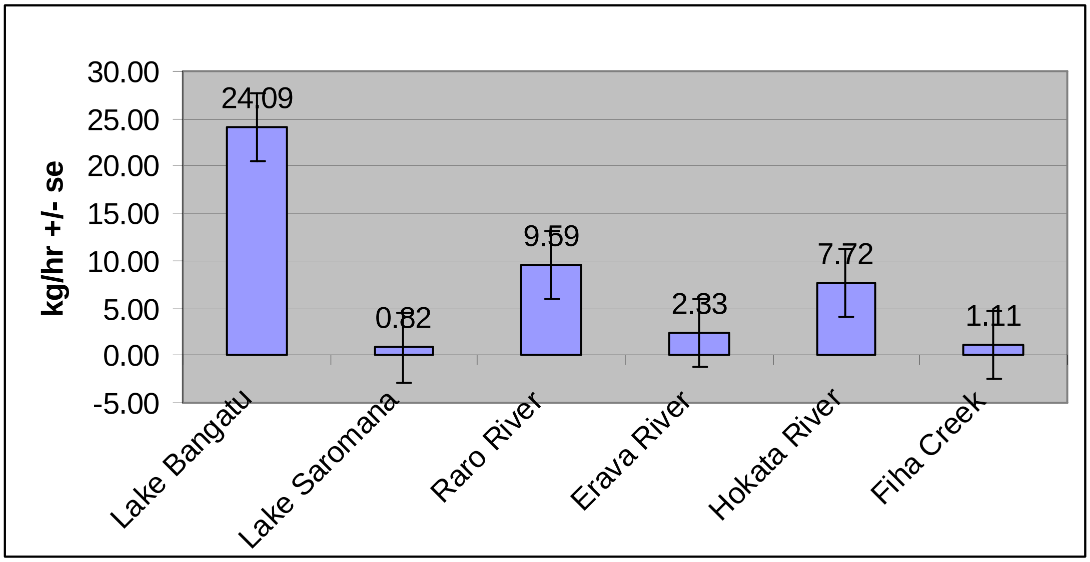
Figure 2. Species richness within six mean size classes



Biomass and abundance

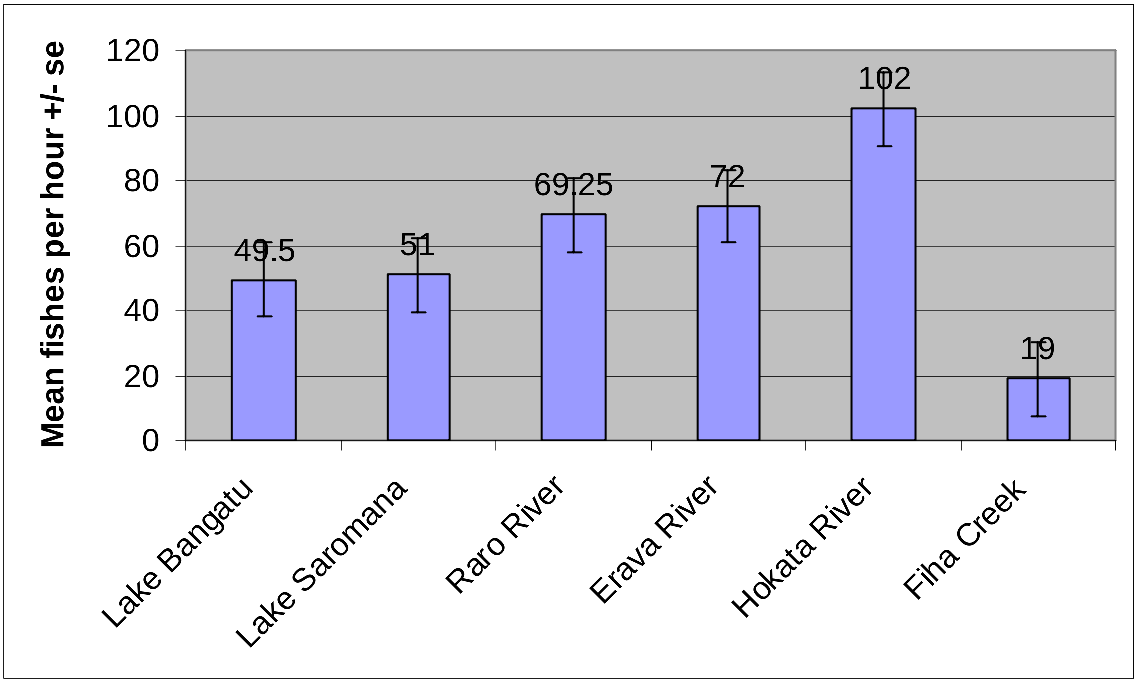
The sites that appear to have the highest biomass of fishes are Lake Bangatu (24 kg/hr), which is dominated by Milkfish (*Chanos chanos*) and Indo-Pacific Tarpon (*Megalops cyprinoides*) and the mouth of the Raro River (22.7 kg/hr) which is dominated by migrating Trevally (Carangidae) and Mullet (*Crenimugil crenilabrus*) (Appendix 3).
In terms of catch per unit effort, Lake Bangatu is clearly the most productive waterbody for fish, yielding over twice the catch of the nearest river, the Raro River (Figure 3). The Raro River is the largest on the island and has a deep river mouth and a variety of deep pools similar to the Hokata River which is the next most productive.

Figure 3. Mean biomass of fishes sampled per hour in Tetepare water bodies.



The top ten fishes contributing most to the biomass of Tetepare streams are (total kg collected or observed across all sites in parentheses): *Chanos chanos* (10.7) which was in very high abundance in Lake Bangatu and not found elsewhere, *Lutjanus fuscescens* (8.5), *Crenimugil crenilabrus* (7.2), *Kuhlia rupestris* (6.2), *Polydactylus sexifilis* (3.6), *Anguilla megastoma* (2.2), Unidentified Stingray(2.1), *Caranx papuensis* (2.0), *Mesopristes cancellatus* (1.9) and *Megalops cyprinoides* (1.3). Full data on estimated biomass for all species by site is available in Appendix

Figure 4. Mean number of fishes caught per hour in Tetepare freshwater bodies.

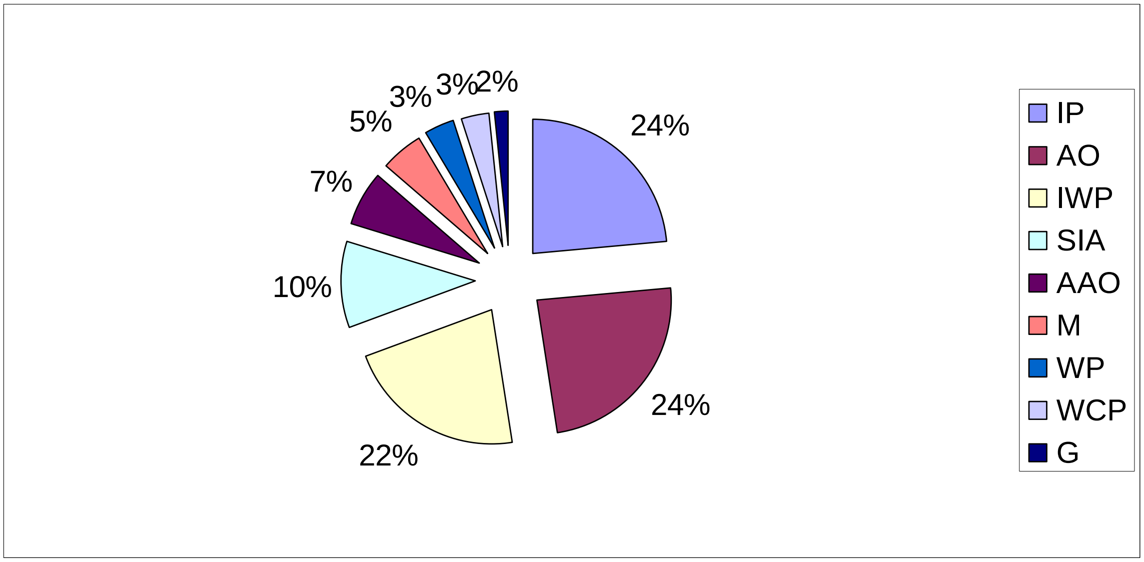


If we examine numerical abundance of individual fishes caught over an hour (Figure 4) then the picture emerges with Hokata river as the highest abundance (102 /hr) followed by the Erava River (72/hr). In this case, it appears that the Hokata and Erava rivers have a higher availability of micro-habitats (eg. Petrified coral heads, instream-logs) compared to the other water bodies, allowing for greater numbers of small fishes (particularly gobies) to thrive. Three of the top five fishes in terms of abundance collected overall are gobiids (*Eleotris fusca*, *Sicyopterus n. sp.*, *R.bikolanus*) and the others are the snake-eel (*Lamnostoma kampeni*) and the flagtail (*Kuhlia marginata*).

The species that were most commonly encountered during the survey are generally widespread forms seen throughout the region. The top seven species in order of ubiquity (% of sites encountered in parentheses) are: *Eleotris fusca* (67), *Glossogobius sp.* (47), *Lamnostoma kampeni* (40), *Kuhlia marginata* (40), *K.rupestris* (33.3), *Giurus margaritaceus* (33.3) and *Anguilla marmorata* (33.3).

Zoogeography

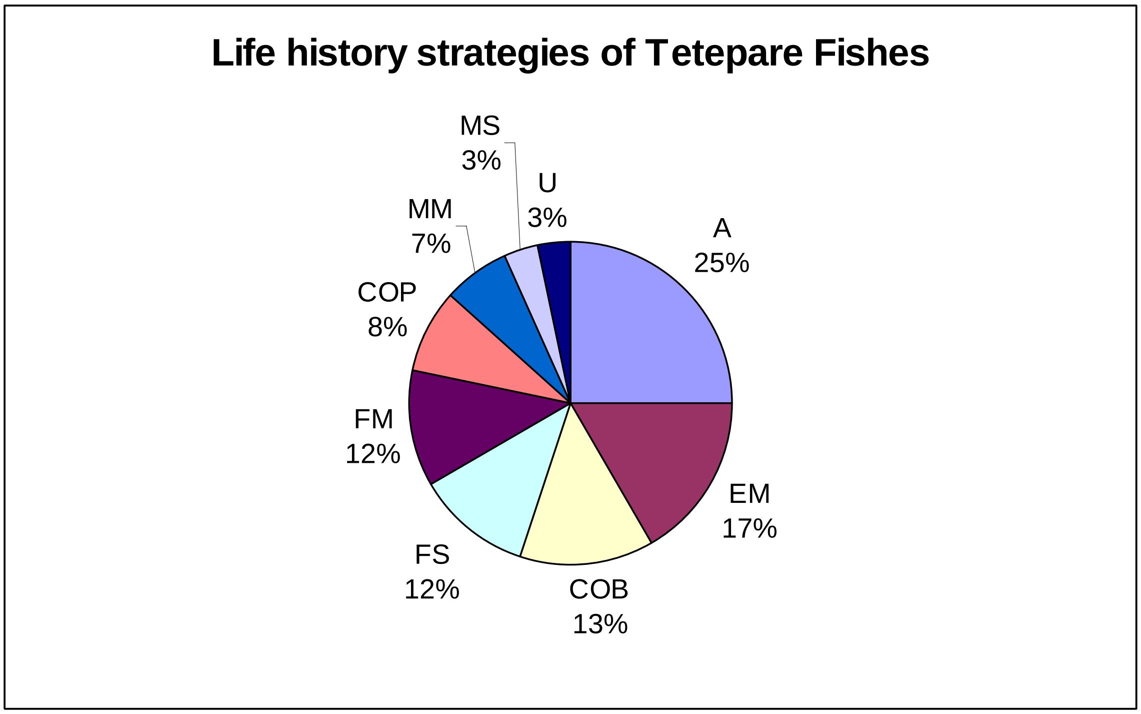
Figure 5. Geographical ranges of freshwater fishes of Tetepare. Key: IP – Indo-Pacific; AO – Asia, Oceania; IWP – Indo-West Pacific; SIA – Solomon Islands Archipelago; AAO – Africa, Asia, Oceania; M – Melanesian Archipelagoes; WP – Western Pacific; WCP – West and Central Pacific; G – Cicumglobal



Unlike fishes in continental or mainland freshwaters that typically spend their entire life cycle in freshwater, Tetepare fishes, like most Pacific Island fishes, mainly have an oceanic, pelagic larval phase (see Life history traits section) and therefore are widely dispersed. The freshwater fishes of Tetepare are, broadly speaking, a complex containing mainly fishes ranging across Asia and the Oceanic Indo-Pacific. Specifically, almost a quarter (24%) of the fauna range over the Indo-Pacific, a further 24% range over Asia and Oceania and 22% range over Indonesia and the Western Pacific. Small components of the fauna are confined to either Western Pacific (3%) or West and Central Pacific (3%). Other small components of the fauna are very widely dispersed across Africa, Asia and Oceania (7%) or occur circumglobally (2%). This leaves 15% of the fauna that are either restricted to the majority of Melanesian archipelagoes (5%) or only known from the Solomon Islands (10%). These components of the fauna are important to highlight for conservation as they are unique components of the Melanesian region. Another consideration is that the island has its own unique mix of species that may rarely be seen elsewhere. It is this unique community composition *en toto* that should be considered a priority for conservation.

Life history traits and faunal connectivity

Figure 6. Life history strategies of Tetepare Fishes. Key: A-Amphidromous; EM – Estuarine migrant; COB – Catadromous obligate; COP – Catadromous opportunist; FS – Freshwater straggler; FM – Freshwater migrant; MM – marine migrant; MS – Marine straggler; U-unknown



The life history strategies of Tetepare fishes can be divided into nine distinct functional groupings that, in general, are similar proportionately to most high islands of Melanesia (Jenkins, 2007 SCB). The dominant life history strategy is amphidromy representing 25% of the fishes. Amphidromous fishes spawn in freshwater, the hatched larvae pass to sea and juveniles return to freshwater often *en masse*. This life history trait is functionally distinct to anadromy where mature adults return to freshwater (eg. Salmon) (McDowell, 2004). The species in Tetepare that are amphidromous include gobiids from the genera *Awaous, Eleotris, Glossogobius, Schismatogobius, Rhyacichthys, Sicyopterus, Stiphodon*, the Terapontid genera *Mesopristes* and the Ophichthid eel *Lamnostoma.*

The next largest functional grouping is the estuarine migrants (17%) which are estuarine spawners with a marine larval phase and/or migration between the estuary and adjacent aquatic habitats**.** This group of fishes includes the gobiid genera *Periopthalmus, Butis*, cardinalfishes of the genus *Apogon*, ponyfishes of the genus *Leiognathus*, the moonfish genus *Monodactylus* and the grouper *Epinephelus polystigma.* The next largest grouping are the catadromous obligates (13%) which spawn at sea and juveniles and/or sub-adults must access freshwater. This group contains freshwater eels of the genus *Anguilla*, the freshwater moray *Gymnothorax polyuranodon*, the milkfish *Chanos chanos*, flagtails of the genus *Kuhlia* and gobies of the genus *Redigobius*. The next grouping (12%) are freshwater stragglers that spawn in freshwater and enter estuaries only briefly if conditions favourable (eg. calm, low salinity conditions). This grouping contains the gobiid genera *Mugilogobius, Belobranchus, Giurus*, the pipefish genus *Microphis* and the Damselfish *Neopomacentrus aquadulcis*. The next grouping is the freshwater migrants (12%) that spawn in freshwater and are present in freshwater and estuaries throughout the year. This group contains the eleotrid genera *Bunaka, Ophiocara*, the glass perchlets of the genus *Ambassis*, the snapper *Lutjanus fuscescens,* the scat *Scatophagus argus* and the scorpianfish *Tetraroge barbata*.

The following group are catadromous opportunists (8%) which exhibit facultative catadromy. This group are sea spawners, the juveniles and/or sub-adults access freshwater when available with only a proportion developing in freshwater and the remainder developing in an estuarine environment. This group contains the snappers *Lutjanus argentimaculatus, Lutjanus fulvus*, the Indo pacific tarpon*, Megalops cyprinoids,* the grunter *Terapon jarbua* and the mullet, *Liza vaigiensis*. The smallest two groups are marine migrants (7%) and marine stragglers (3%). Marine migrants are euryhaline, spawn at sea, occur in high numbers and extensively use the estuary as juveniles and/or adults. This group contains jacks, *Caranx papuensis*, *Scomberoides commersonianus, Decapterus sp*. and the mullet *Crenimugil crenilabrus*. Marine stragglers are also euryhaline, spawn at sea, occur in small numbers and usually only in lower reaches of rivers or estuaries. This group includes the worm eel *Moringua cf ferruginea* and the threadfin *Polydactylus sexifilis*. In the final grouping we are unsure of the life history strategy and this is represented by the unknown gobiid family.

If we consider collectively, life history strategy, physiological and morphological limitations and occurrence records of the Tetepare fishes we can divide them into functional groups based on the range of habitats they could potentially occur across (ie. Cross-system connectivity). If we assume that many of the amphidromous fishes can reach headwaters if no major waterfalls are present (we didn't observe any over a few meters in height) then we can divide the fishes into five range groups: 32 % of the fauna will range between the ocean and the lower tidal reaches of streams, 29% will be able to range from the ocean up to the headwaters, 22 % will range from the ocean to the mid reaches, 18% will range from estuary to mid reaches and 16% will range only between the estuarine habitat and lower reaches of streams. This clearly illustrates inextricable ecological links to the ocean with all species likely entering ocean or estuarine environments at periods during their lives. It also points to the fact that around 30% of the fauna can potentially range the full length of the catchments and out to sea across different life stages. This, again, illustrates the high level of cross system connectivity within this fish fauna.

Much of the invertebrate fauna also observed were freshwater prawns (*Macrobrachium sp*), shrimp species (*Palaemon sp., Caridina sp.*) freshwater snails (Neritidae, Thiaridae) and freshwater crabs (*Varuna sp*.), all of which are amphidromous, highly migratory species and can traverse the expanse of the catchment during their lives. If we were to look at percentages of *all* aquatic fauna with a high degree of connectivity across a range of habitats, then the level of inter-habitat connectivity will be even higher than for fishes alone.

Degree of Intactness

Tetepare Island rivers, streams and lakes are remarkably intact in terms of size structure, density of fishes, catch per unit effort, species composition and water quality. For anecdotal comparison, we can compare results of this study to three previous studies done using the same methodology in heavily utilized rivers and streams of the Fijian archipelago and a Papua New Guinean saline lake (Jenkins, 2005; Jenkins et. al, 2006, WI, unpublished data). Firstly, it is salient that the freshwater bodies of Tetepare have high numbers of large, food-sized, fishes. In the Kubuna River in Viti Levu, Fiji (which has undergone catchment alteration from pine plantations, sugar cane farming and heavy resource utilization by 3 villages) fishes in the 30 – 50 cm size class were entirely absent and only two species (2 individuals) were found within the 20 -30 cm size class (Jenkins, 2005). In comparison, Tetepare's Raro River, of roughly equivalent size, yielded 19 fishes (3 species) in the 30 – 50 cm size class and 28 fishes (8 species) in the 20 -30 cm size class. Approximately 23 times as many larger (20 – 50 cm), food-sized, fishes were collected in the Raro than the Kubuna with almost identical fishing effort. This is one clear anecdotal illustration of the unharvested nature of Tetepare water bodies.

Also, if we examine density of fishes, the Kubuna River has a mean of 4.4 fishes/ 100 m^2 whereas the Raro River has a mean of 10.2 fishes/ 100 m^2. There is approximately 2.3 times higher density of fishes in the Raro than in the Kubuna River. In another study of five rivers in Macuata, Fiji (Jenkins et. al. 2006) the large Dreketi catchment, also impacted by logging, sugar cane farming and heavy village utilization, yielded only 1988 g/hr in river mouth samples versus 22678 g/hr in the mouth of the Raro in Tetepare. This represents an 11.4 times greater catch per unit effort in the Raro River compared to the degraded Fijian river. If we examine the results from a gillnet survey in a peri-urban, heavily utilized, saline lake in Madang, Papua New Guinea (Kranket Lake), the catch per unit effort is approximately 818 g/hr (unpublished data) whereas the result from an equivalent effort and gear type in the un-fished Lake Bangatu in Tetepare is 24087 g/hr. This result indicates a 29 times greater catch per unit effort for the lake in Tetepare.

Species composition can also reflect the degree to which catchments have been degraded. In Indo-Pacific islands, in particular, many of the smaller gobies from the sub-family Sicydiinae are sensitive to catchment alteration and will be in severely reduced numbers or absent from degraded catchments (Keith, 2003; Jenkins, 2007). Again, using the comparison of the Kubuna River to the Raro River, the Kubuna River had only 2 species (*Sicyopterus lagocephalus* and *Sicyopus zosterophorum*) (4 individuals) only observed in the faster moving side tributaries. The Raro River possessed 5 species (*S.lagocephalus*, *S.longifilis*, *S.n.sp*, *Stiphodon rutilaureus*, *S.n.sp*) (87 individuals) for an equivalent sampling effort.

Some of the water quality characteristics also shed light on the degree of intactness of the Tetepare water bodies with respect to habitat for fishes. The most telling characteristic is the very high levels of dissolved oxygen in Tetepare rivers with a mean of 8.2 mg/l across all sites. Again, comparing to the degraded Kubuna River in Fiji which averaged around 3.3 mg/l (Jenkins, 2005) or to the five catchments in Macuata, Fiji (Jenkins et.al, 2006) (mean 5.1), the dissolved oxygen is exceptionally high. Also, if we examine turbidity, the mean of Tetepare rivers is well below 10 NTUs on average compared to the Kubuna and Macuata rivers with means of 13 and 17 NTUs respectively. All of the other water quality parameters measured for Tetepare are well within the range to support a high diversity and abundance of freshwater fish life.

These measurements and comparisons provide some anecdotal evidence of the level of intactness of Tetepare freshwater bodies. The size structure, density, species composition and catch per unit effort of fishes in Tetepare reflects both the lack of harvesting and the high quality of the water habitat, in turn a function of the unaltered nature of the catchments.

CONSERVATION AND FURTHER STUDY RECOMMENDATIONS

- In terms of representative catchment intactness, unique species composition, high species diversity, endemism and abundance of fishes, Tetepare is of international and regional significance and should be seriously considered for World Heritage and/or Ramsar nomination.

- The high level of aquatic faunal connectivity between freshwaters and nearby marine areas demonstrates the need to approach conservation of Tetepare from a holistic, ecosystem – based management framework.
- No exotic species of fishes are currently present in Tetepare. An explicit ban on introduction of exotic species of fishes (or any other taxa) should be enforced for Tetepare Island.
- The intactness of Tetepare is a benchmark for freshwater systems on tropical islands of the Indo-Pacific. This benchmark status should be promoted and further understood through longer term ecological studies on the island. Elements of ecosystem function (eg. Species, migratory routes) now lost from related island ecosystems could potentially be restored if understood in an intact form.
- Preservation of a high degree of intactness will require catchments to remain undeveloped and uninhabited and that harvest of river fishes be entirely restricted or, at very least, very carefully managed with clearly articulated size limits, bag limits and gear restrictions (eg. Derris root fishing should be entirely banned, harvest of "white-bait" migrations into rivers should be entirely banned).
- In stream, three dimensional structure created by fallen trees, hanging vegetation and other natural processes should not be removed.
- Current monitoring on Tetepare of coral reef health and turtle nesting could be augmented with stream monitoring of water quality and in-stream faunal abundance.
- Further study is needed of the remaining water bodies of Tetepare, in particular the headwaters which will likely yield additional fish species.
- Systematic surveys of freshwater invertebrate species will likely yield new unique species and further highlight the conservation importance of Tetepare Island.

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Appendix 1. Select images of Tetepare aquatic habitat collecting sites

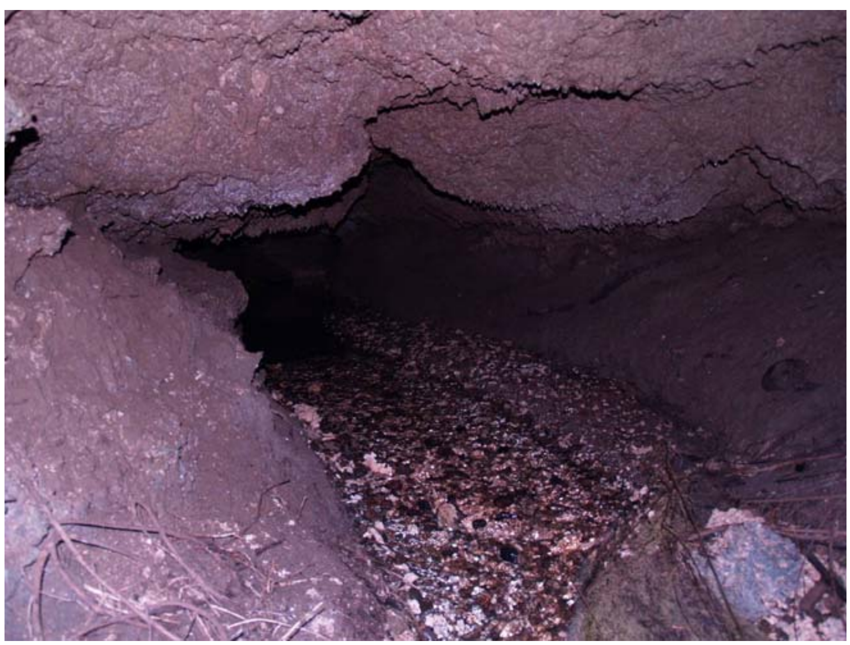
Mid Erava River

Mid Hokata River

Mid Fiha Creek

Lake Bangatu (Crocodile Lake)

Lower Raro River



Entrance to Cave Creek

Appendix 2. Sampling sites and water quality characteristics of freshwater/estuarine water bodies of Tetepare Island, Western Province, Solomon Islands.

Site **1.** Lower-mid Erava River (9/9/06); **2.** Mid-Erava River (9/9/06); **3.** Outlet of Lake Bangatu (10/9/06); **4.**Lake Bangatu (10/9/06); **5.** Upper Raro River (11/9/06); **6.** Upper-mid Fiha Creek (11/9/06); **7.**Mid- Fiha Creek (11/9/06); **8.** Namba 3 cave creek (12/9/06); **9.** Upper-mid Erava River (12/9/06); **10.** Lower-mid Raro River (13/9/06); **11.** Mid-Raro River (13/9/06); **12.**Upper-mid Raro River (13/9/06); **13.** Mouth of Raro River (13/9/06); **14.** Lake Saromana (14/9/06); **15.** Mid- Hokata River (14/9/06).

site	GPS Co-ordinates	Current Speed (m/s)	Depth (m)	Width (m)	Conductivity (µS)	Turbidity (NTU)	DO (mg/L)	Salinity (ppt)	pH	Temp (°C)
1	S 08°42.50.27 E157°28.57.92	0.2	1	9	195.9	<10	8.1	0.0	7.0	25.8
2	S 08°42.30.31 E157°29.01.23	0.3	1	10	222.4	<10	8.2	0.0	7.2	26.6
3	S 08°42.03.52 E157°27.00.19	1.5	0.3	1.5	505.0	<10	7.9	0.2	7.88	29.9
4	S 08°42.13.58 E157°26.58.52	0.0	NA	30	551.0	<10	9.7	0.2	8.00	31.1
5	S 08°43.12.46 E157°35.12.35	0.3	0.1	2.8	58.1	<10	8.7	0.0	7.51	25.0
6	S 08°45.29.94 E157°83.44.21	0.03	0.2	0.9	241.1	<10	7.0	0.0	NA	25.5
7	S 08°45.52.37 E157°33.53.09	0.3	0.4	7.4	341.3	<10	8.1	0.2	7.20	25.5
8	NA	0.3	0.03	1	456.3	<10	5.6	0.2	7.10	26.0
9	S 08°45.52.35 E157°33.53.12	0.5	0.3	4	254.7	<10	8.1	0.0	7.10	26.6
10	S 08°42.19.95 E157°32.10.80	0.2	0.5	21	377.0	<10	8.5	0.2	9.03	25.9
11	S 08°42.22.49 E157°32.14.63	0.5	1.5	15	300.4	<10	8.1	0.1	8.00	26.0
12	S 08°42.22.15 E157°32.14.63	0.4	0.8	20	295.2	<10	8.2	0.1	7.77	25.7
13	S 08°43.12.46 E157°35.12.35	1.5	2.0	22	420.1	15.0	7.8	0.2	7.71	26.2
14	S 08°42.19.13 E157°36.00.50	0.0	NA	18	356.9	12.0	5.1	0.1	7.76	28.8
15	S 08°43.12.46 E157°35.12.35	1.5	0.4	13	6.4	<10	8.0	0.0	7.75	26.0

APPENDIX 3. Diversity, abundance and catch per unit effort by reach in six Tetepare Island freshwater habitats. GN-Gill Net; EF-Electrofisher; SN-Seine Net

RARO RIVER

REACH	# SPECIES	# FISHES	CPUE (g/hr)	GEAR TYPE
lower	7	29	22678.01	GN
low-mid	12	49	6517.7	EF, SN
midreach	16	90	1026.2	EF, SN
mid-upper	17	109	8134.5	EF, SN
headwater	1	2	269.31	EF, SN
TOTAL SP.	43			
ENDEMICS	4			

ERAVA RIVER

REACH	# SPECIES	# FISHES	CPUE (g/hr)	GEAR TYPE
low-mid	19	70	2952.02	EF, SN
midreach	19	65	1026.2	EF, SN
mid-upper	21	81	8134.5	EF, SN
TOTAL SP.	40			
ENDEMICS	5			

HOKATA RIVER

REACH	# SPECIES	# FISHES	CPUE (g/hr)	GEAR TYPE
midreach	21	102	7722.0	EF,SN
ENDEMICS	4			

FIHA CREEK

REACH	# SPECIES	# FISHES	CPUE (g/hr)	GEAR TYPE
Upper-mid	5	19	892.49	EF,SN
midreach	5	19	1332.17	EF,SN
TOTAL SP.	8			
ENDEMICS	0			

LAKE BANGATU

REACH	# SPECIES	# FISHES	CPUE (g/hr)	GEAR TYPE
midlake	5	32	24087.1	GN
outlet creek	8	67	1065.7	EF,SN
TOTAL SP.	10			
ENDEMICS	1			

LAKE SAROMANA

REACH	# SPECIES	# FISHES	CPUE (g/hr)	GEAR TYPE
lake edge	5	51	816.48	EF
ENDEMICS	0			

Appendix 4. Aquatic snails collected on Tetepare Island (numbers collected in parentheses)

Mid Raro

1. *Melanoides plicaria* (2)
2. *Septaria porcellana* (2)
3. *Neritina pulligera* (2)
4. *Clithon corena* (5)
5. *Clithon bicolour* (2)
6. *Clithon cancellata* (2)

Upper Raro River

1. *Neritodryas subsulcata* (3)

Saromana Lake & mid Hokata River

1. *Melanoides punctata* (5)
2. *Clithon francoisi* (2)
3. *Septaria porcellana* (2)
4. *Thiara cancellata (1)*

Bangatu Lake

1. *Thiara scabra* (11)
2. *Melanoides punctata* (9)
3. ***Unknown Thiarid* (1)**

Erava River

1. *Clithon olivacens* (1)

Appendix 5. Mean lengths of fishes by site (cm SL).

FAMILY	SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ambassidae	*Ambassis interruptus*	0.00	0.00	3.12	0.00	0.00	0.00	0.00	0.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00
	Ambassis miops	3.39	3.02	0.00	0.00	0.00	0.00	0.00	0.00	3.32	0.00	0.00	0.00	0.00	0.00	0.00
Anguillidae	*Anguilla marmorata*	0.00	0.00	0.00	0.00	0.00	62.60	0.00	18.70	17.72	0.00	0.00	14.65	0.00	0.00	26.88
	Anguilla megastoma	0.00	90.00	0.00	0.00	38.34	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apogonidae	*Apogon hyalosoma*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00
	Apogon lateralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.43	0.00	0.00	0.00	0.00	0.00
Carangidae	*Caranx papuensis*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00	0.00	0.00
	Decapterus cf macarellus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.00	0.00	0.00
	Scomberoides commersonianus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00	0.00	0.00
Chanidae	*Chanos chanos*	0.00	0.00	0.00	33.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eleotridae	*Belobranchus belobranchus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.27	0.00	0.00	7.27	0.00	0.00	7.85
	Bunaka gyrinoides	0.00	0.00	2.45	0.00	0.00	2.60	2.22	0.00	0.00	0.00	2.57	0.00	0.00	0.00	0.00
	Butis butis	0.00	3.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.02	0.00	0.00	0.00	0.00	0.00
	Butis amboinensis	4.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.47	0.00	0.00	6.37	0.00	0.00	0.00
	Eleotris fusca	1.95	0.00	3.55	2.12	0.00	6.04	2.24	9.61	0.00	0.00	8.10	7.21	0.00	6.00	4.22
	Eleotris melanosoma	2.02	5.07	4.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Giuris magaritaceous	13.95	0.00	0.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	11.71	0.00	15.00	12.00
	Giurus hoedti	0.00	0.00	0.00	0.00	0.00	9.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hyseleotris guentheri	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.69	0.00	0.00	0.00

	Ophiocara porocephala	0.00	17.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.50	5.16
Gobiidae	*Awaous ocellaris*	5.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	12.00	0.00	0.00	0.00	0.00
	Glossogobius sp	4.81	8.17	0.00	0.00	0.00	0.00	0.00	0.00	5.41	5.24	4.56	5.02	0.00	0.00	6.63
	Mugilogobius fusculus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83	0.00
	Periopthalmus argentilineatus	5.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Redigobius cf chrysosoma	2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.00
	Redigobius bikolanus	0.00	2.09	2.12	2.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00
	Schismatogobius sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.62	0.00	3.92	3.41	0.00	0.00	3.21
	Sicyopterus lagocephalus	0.00	3.01	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	0.00	3.70	0.00	0.00	5.56
	Sicyopterus longifilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.73
	Sicyopterus n.sp.	2.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.27	2.19	0.00	0.00	2.32
	Stenogobius sp.	3.78	0.00	3.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Stiphodon rutilaureus	2.23	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.25	0.00	0.00	0.00	0.00
	Stiphodon n. sp	3.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.22	0.00	0.00	0.00	0.00
Hemiramphidae	*Zenarchopterus sp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00	0.00	0.00	12.00	0.00	0.00
Kuhliidae	*Kuhlia marginata*	12.20	10.00	0.00	0.00	0.00	0.00	6.20	0.00	7.00	0.00	6.00	6.50	0.00	0.00	6.60
	Kuhlia rupestris	0.00	21.00	24.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00	35.00	0.00	0.00	31.00
Leiognathidae	*Leiognathus equulus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00	0.00	0.00	0.00	19.00	0.00	0.00
Lutjanidae	*Lutjanus argentimaculatus*	15.00	13.20	0.00	0.00	0.00	0.00	0.00	0.00	16.00	0.00	15.40	0.00	0.00	0.00	0.00
	Lutjanus fulvus	0.00	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00

	Lutjanus fuscesens	0.00	9.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.00	0.00	0.00	35.00
Megalopidae	*Megalops cyprinoides*	0.00	0.00	0.00	45.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monodactylidae	*Monodactylus argenteus*	0.00	1.18	0.00	0.00	0.00	0.00	0.00	0.00	4.22	4.62	0.00	0.00	0.00	0.00	0.00
Moringuidae	*Moringua cf ferruginea*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00	0.00	0.00	0.00	0.00
Mugilidae	*Crenimugil crenilabris*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.17	23.10	0.00	0.00	30.00	0.00	0.00
	Liza vaigiensis	0.00	0.00	6.50	7.20	0.00	0.00	0.00	0.00	6.20	0.00	0.00	0.00	0.00	0.00	6.60
Muraenidae	*Gymnothorax polyuranodon*	0.00	29.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.64	0.00	0.00	0.00	18.56
Ophichthidae	*Lamnostoma kampeni*	21.00	22.00	0.00	0.00	0.00	0.00	0.00	0.00	21.00	0.00	18.41	19.42	0.00	0.00	13.05
Polynemidae	*Polydactylus sexifilis*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.00	0.00	0.00
Pomacentridae	*Neopomacentrus aquadulcis*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.51	0.00	0.00	0.00	0.00	0.00
Rhyacichthyidae	*Rhyacichthys cf aspro*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.82	0.00	0.00	0.00	0.00	0.00	8.39
Scatophagidae	*Scatophagus argus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.52	0.00	0.00	0.00	0.00	0.00	0.00
Scorpaenidae	*Tetraroge sp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.83	0.00	0.00	5.41	0.00	0.00	2.54
Serranidae	*Epinephalus polystigma*	14.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.20	0.00	0.00	0.00	0.00
Syngnathidae	*Microphis sp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.36	0.00	0.00	0.00	0.00	0.00	0.00
Terapontidae	*Mesopristes argenteus*	18.50	17.70	0.00	0.00	0.00	0.00	0.00	0.00	6.25	0.00	0.00	9.55	0.00	0.00	9.23
	Mesopristes cancellatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.20	0.00	0.00	26.00	0.00	0.00	17.50
	Terapon jarbua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00	0.00
Toxotidae	*Toxotes jaculatrix*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00
Unknown family	*New gen. n.sp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.11

Unknown Rajiformes	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 6. Estimated total weight (grams) of fishes by site using length/weight relationship $W = a L^b$ x total individuals

FAMILY	SPECIES	a	b	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ambassidae	*Ambassis interruptus*	0.0328	2.793	0.00	0.00	9.45	0.00	0.00	0.00	0.00	0.00	0.00	12.51	0.00	0.00	0.00	0.00	0.00
	Ambassis miops	0.0328	2.793	7.95	4.31	0.00	0.00	0.00	0.00	0.00	0.00	2.82	0.00	0.00	0.00	0.00	0.00	0.00
Anguillidae	*Anguilla marmorata*	0.00257	2.98	0.00	0.00	0.00	0.00	0.00	580.40	0.00	31.69	67.50	0.00	0.00	22.95	0.00	0.00	93.44
	Anguilla megastoma	0.00257	2.98	0.00	1712.28	0.00	0.00	269.31	205.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apogonidae	*Apogon hyalosoma*	0.0092	3.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	160.22	0.00	0.00	0.00	0.00	0.00
	Apogon lateralis	0.00917	3.347	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.69	0.00	0.00	0.00	0.00	0.00
Carangidae	*Caranx papuensis*	0.0249	2.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1980.08	0.00	0.00
	Decapterus cf macarellus	0.01	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	194.73	0.00	0.00
	Scomberoides commersonianus	0.0295	2.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	417.38	0.00	0.00
Chanidae	*Chanos chanos*	0.0073	3.25	0.00	0.00	0.00	10770.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eleotridae	*Belobranchus belobranchus*	0.01678	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.65	0.00	0.00	38.65	0.00	0.00	56.73
	Bunaka gyrinoides	0.01678	3	0.00	0.00	0.74	0.00	0.00	0.29	0.37	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00
	Butis butis	0.01053	3	0.00	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00
	Butis amboinensis	0.01053	3	2.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.76	0.00	0.00	5.44	0.00	0.00	0.00
	Eleotris fusca	0.016	3	1.19	0.00	19.33	0.15	0.00	24.63	0.18	142.18	0.00	0.00	85.03	35.98	0.00	24.19	4.79

	Eleotris melanosoma	0.016	3	0.92	12.48	5.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Giuris magaritaceous	0.0105	3	57.06	0.00	0.00	0.00	0.00	0.00	70.88	0.00	0.00	0.00	0.00	16.86	0.00	106.31	54.43
	Giurus hoedti	0.0105	3	0.00	0.00	0.00	0.00	0.00	81.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hyseleotris guentheri	0.00835	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	0.00	0.00	0.00
	Ophiocara porocephala	0.0105	3	0.00	112.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	265.93	2.89
Gobiidae	*Awaous ocellaris*	0.0131	3.1	3.85	10.92	0.00	0.00	0.00	0.00	0.00	0.00	16.49	0.00	58.04	0.00	0.00	0.00	0.00
	Glossogobius sp	0.0134	3.045	16.03	16.03	0.00	0.00	0.00	0.00	0.00	0.00	13.75	4.15	2.72	5.48	0.00	0.00	8.50
	Mugilogobius fusculus	0.01437	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.71	0.00
	Periopthalmus argentilineatus	0.0096	3.34	3.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Redigobius cf chrysosoma	0.01437	3	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00
	Redigobius bikolanus	0.01437	3	0.00	0.13	2.19	2.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00
	Schismatogobius sp	0.01169	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.32	0.00	0.70	0.46	0.00	0.00	1.16
	Sicyopterus lagocephalus	0.01169	3	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	1.70	0.00	0.00	2.97	0.00	0.00	12.06
	Sicyopterus longifilis	0.01169	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.60
	Sicyopterus n.sp.	0.01169	3	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.23	5.53	0.00	0.00	1.46
	Stenogobius sp.	0.0131	3.1	1.61	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Stiphodon rutilaureus	0.01169	3	0.39	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.73	0.00	0.00	0.00	0.00
	Stiphodon n. sp	0.01169	3	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.85	0.00	0.00	0.00	0.00
Hemiramphidae	*Zenarchopterus sp.*	0.00388	3.132	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.17	0.00	0.00	37.23	0.00	0.00

Kuhliidae	*Kuhlia marginata*	0.0134	3.121	197.60	230.17	0.00	0.00	0.00	0.00	47.79	0.00	69.80	0.00	21.57	27.69	0.00	0.00	58.09
	Kuhlia rupestris	0.0175	3	0.00	324.14	483.84	0.00	0.00	0.00	546.88	0.00	0.00	0.00	0.00	2250.94	0.00	0.00	2606.71
Leiognathidae	*Leiognathus equulus*	0.0296	2.944	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	146.83	0.00	0.00	0.00	172.16	0.00	0.00
Lutjanidae	*Lutjanus argentimaculatus*	0.0336	2.79	256.86	134.85	0.00	0.00	0.00	0.00	0.00	0.00	230.65	0.00	207.32	0.00	0.00	0.00	0.00
	Lutjanus fulvus	0.0243	2.93	0.00	135.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	315.25	0.00	0.00	0.00	0.00
	Lutjanus fuscesens	0.017	3.04	0.00	58.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4201.32	0.00	0.00	4201.32
Megalopidae	*Megalops cyprinoides*	0.0136	3.005	0.00	0.00	0.00	1263.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monodactylidae	*Monodactylus argenteus*	0.033	2.921	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	2.21	5.77	0.00	0.00	0.00	0.00	0.00
Moringuidae	*Moringua cf ferruginea*	0.001	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.74	0.00	0.00	0.00	0.00
Mugilidae	*Crenimugil crenilabris*	0.0205	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	194.58	2021.53	0.00	0.00	4981.50	0.00	0.00
	Liza vaigiensis	0.0205	3	0.00	0.00	11.26	7.65	0.00	0.00	0.00	0.00	9.77	0.00	0.00	0.00	0.00	0.00	17.68
Muraenidae	*Gymnothorax polyuranodon*	0.0011	2.57	0.00	13.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.00	0.00	0.00	2.00
Ophichthidae	*Lamnostoma kampeni*	0.0011	2.57	2.75	15.50	0.00	0.00	0.00	0.00	0.00	0.00	33.01	0.00	37.29	13.50	0.00	0.00	10.53
Polynemidae	*Polydactylus sexifilis*	0.0162	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3555.92	0.00	0.00
Pomacentridae	*Neopomacentrus aquadulcis*	0.0297	2.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.73	0.00	0.00	0.00	0.00	0.00
Rhyacichthyidae	*Rhyacichthys cf aspro*	0.0163	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.03	0.00	0.00	0.00	0.00	0.00	77.01
Scatophagidae	*Scatophagus argus*	0.0377	2.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.53	0.00	0.00	0.00	0.00	0.00	0.00
Scorpaenidae	*Tetraroge sp.*	0.0205	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.51	0.00	0.00	9.73	0.00	0.00	0.67
Serranidae	*Epinephalus polystigma*	0.0173	3	53.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	285.10	0.00	0.00	0.00	0.00
Syngnathidae	*Microphis sp.*	0.00056	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00

Terapontidae	*Mesopristes argenteus*	0.0154	3.082	247.73	324.26	0.00	0.00	0.00	0.00	0.00	0.00	13.11	0.00	0.00	80.70	0.00	0.00	72.65
	Mesopristes cancellatus	0.0154	3.082	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.31	0.00	0.00	1414.26	0.00	0.00	417.47
	Terapon jarbua	0.0154	3.082	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	939.92	0.00	0.00	0.00	0.00	0.00
Toxotidae	*Toxotes jaculatrix*	0.0154	3.082	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.90	0.00	0.00	0.00	0.00	0.00
Unknown family	*New gen. n.sp.*	0.016	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11
Unknown Rajiformes		0.034	2.99	2097.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00