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Poissons de mangrove des Samoa Occidentales
Mission d'expertise du 25/11/1992 au 05/12/1992
Rapport final

Pierre THOLLOT

Document de travail

L'INSTITUT FRANÇAIS DE RECHERCHE SCIENTIFIQUE
POUR LE DÉVELOPPEMENT EN COOPÉRATION

ORSTOM

CENTRE DE NOUMÉA

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/Thollot, P.

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ORSTOM Nouméa
REPROGRAPHIE

SUMMARY

RESUME

A la demande des autorités des Samoa Occidentales, l'ORSTOM a été pressenti pour réaliser une mission d'expertise concernant les mangroves et leurs communautés ichtyologiques. Cette mission, conduite à Apia par Pierre THOLLOT du 25 novembre au 05 décembre 1992, avait pour principaux objectifs :

- réaliser un inventaire préliminaire des poissons de mangrove;
- recueillir des informations nécessaires à la réalisation d'une base de donnée;
- définir un protocole d'échantillonnage adapté au suivi des communautés de poissons;
- familiariser aux techniques de pêche le personnel local qui sera chargé du suivi des communautés de poissons;
- fournir des conseils théoriques nécessaires à l'étude des communautés de poissons.

Cette action de coopération régionale a été réalisée avec succès. Elle a pleinement répondue aux besoins exprimés par les Samoa Occidentales en fournissant les données de base, l'expérience et les conseils nécessaires à la réalisation d'une étude des communautés de poissons par les membres de la "Division of Environment and Conservation".

EXECUTIVE SUMMARY

A preliminary survey of Western Samoa mangrove fish fauna was held in 1992, from November the 25th to December the 5th. Because of the short time available, it was not possible to undertake an exhaustive study of the fish fauna. However, field trips and samplings, using gill nets and rotenone poisonings, allowed a rapid but reasonable description of the fish communities from two mangrove areas : the first one in Vaiusu Bay, near Apia, the second one in Sa'anapu-Sataoa, on the south coast of Upolu.

The major findings are :

1) 35 species of fish, distributed among 22 families, were censused in Western Samoa mangroves;
2) the most speciose families are Gobiidae (5 spp.), Mullidae, Mugilidae and Ophichtidae (3 spp.);
3) numerically dominant species are the mullets (*Liza melinoptera* and *Valamugil engeli*), the pufferfish (*Arothron manillensis*) and the crescent perch (*Therapon jarbua*);
4) the most important species, in fresh weight, are the crescent perch, the mullets and, to a lesser extent, the goatfishes (*Mulloides flavolineatus*, *Parupeneus indicus* and *Upeneus vittatus*) and the damsellfish (*Chrysiptera notialis*);
5) Vaiusu Bay and Sa'anapu-Sataoa sampling sites show similar species richness (20 spp.), however, their species composition is very different with only 6 species common to both sites; moreover the community structure of the communities is not similar, the one from Vaiusu Bay being highly dominated by a single species, *Liza melinoptera*, which is a common feature of heavily disturbed communities probably because of the pollution of this area, while Sa'anapu-Sataoa fish fauna seems to be a quite stable assemblage;
6) gill nets and rotenone are efficient complementary methods for a qualitative assessment of the mangrove fish fauna, gill nettings enabled the collection of large fish (8 species) while rotenone poisonings caught juveniles and small species (32 species);
7) the biology of 16 spp. has been studied, 154 records of the length, weight, sex, sexual maturity and feeding habits of these species were recorded.

Using the data recorded during this survey and the informations available in the litterature, it was possible to realize a preliminary data base for further studies of mangrove fish communities. For example, 216 additional species of fish, distributed among 61 families, have a potential to be found in Western Samoa mangroves. As a consequence, global species richness of Western Samoa mangrove fish fauna would be 251 species distributed among 65 families. A questionaire, allowing the use of fishermen's knowledge, could be used. It would give numerous informations on the dependence of villagers on mangroves for fishing or other purposes, the fishing effort and the catch of the fishermen, the use of edible fish living in the mangroves, and so on. Training of DEC's staff provided during the field trips, together with theoretical advice, have given the basic knowledge for a future monitoring of the mangrove fish fauna in Vaiusu Bay and Sa'anapu-Sataoa.

FOREWORD

This document is the final report of the Western Samoa mangrove fish fauna survey undertaken in November - December 1992 by Pierre THOLLOT from ORSTOM. A preliminary report has been prepared after the completion of field work for the Division of Environment and Conservation from the Department of Land and Surveys in Apia, Western Samoa. Results and interpretations presented here are limited by time and location of sampling. As a consequence, they must be used with caution. Furthermore, as this work will be published, data, tables and figures should not be used without prior approval of the author.

BACKGROUND

In September 1989, during SPREP's intergovernmental meeting held in Noumea, ORSTOM submitted a project dealing with the mangroves of the south-west Pacific. This project has been accepted and will be completed in 1993. Joe RETI became aware of the project and asked ORSTOM to undertake a survey of the mangroves in Western Samoa in order to assess the impacts of cyclone OFA and define the role of the mangroves in fish resources. In 1990, a proposal was sent to the French Foreign Office (DCSTE) to get funding. The fund were provided in late 1991. At that time, cyclone VAL occured and we were advised that a Japanese team of scientists (JIAM/ISME) had made a survey of the vegetation after the cyclone (Nakamura, 1992; Sasaki, 1992). However, Western Samoa was still interested by an assessment of the mangroves by ORSTOM.

As a consequence, the initial project was modified. Jean-François DUPON (ORSTOM representative for Asia and the Pacific : DEPAC) and Sam SESEGA (Department of Land, Surveys and Environment, Division of Environment and Conservation : DEC) agreed that the study should focus on the fish fauna of two mangroves. The first sampling site should be located in Vaiusu Bay, which is known to be very polluted, and the other one in Sa'anapu-Sataoa, a quite undisturbed area. It was planned to get preliminary data on the fish communities living in these mangroves which will be monitored in order to define the impacts of environmental parameters.

MAIN GOALS

According to the above proposal, the main goals of the survey was to provide :

- a prelimary checklist of the fish species occurring in the mangroves;
- a taxonomical and biological data base for further investigations;
- the definition of sampling methods that could be use for the monitoring of the mangrove fish communities;
- the training of staff who will be involved in this monitoring;
- theoretical advice for the study of this fish fauna.

PRESENTATION OF THE STUDY AREA

Western Samoa is located in the Central Pacific, approximatively 172° W - 14° S. Two islands (Upolu : 1,100 km² and Savai'i : 1,820 km²) and several islets cover a total area of 2,934 km² while the extent of the exclusive economic zone (EEZ) is only 120,000 km² (Antheaume & Bonnemaison, 1988). Recently, 160,000 inhabitants have been censused in an unofficial census (Liu, 1992), population density being 54.5 inhabitant per square kilometer. Average annual temperature is 27°C, total annual rainfall ranges from 2,500 to 5,000 mm, reflecting a tropical oceanic climate. South-east trade winds blow from May to August, they are north-westerly during the wet season (December to March). Cyclones can occur from November to April (Anonyme, 1986). As most published and unpublished data on geology, geomorphology and further informations on coastal ecosystems from Western Samoa have been reviewed recently (Anonyme, 1991; Pearsall & Whistler, 1991; Richmond, 1992), they will not be detailed here.

Western Samoa is at the eastern limit of Indo-Pacific mangrove distribution. Chapman (1976) has reported *Bruguiera gymnorrhiza* and *Rhizophora* spp. with associated species such as *Heriteria littoralis*, *Exoecaria agallocha*, *Clerodendron inerme*, *Barringtonia racemosa* and *Scirpodendron costatum*. Recently, Tomlinson (1986) identified *B. gymnorrhiza* and *Rhizophora samoensis* together with *H. littoralis* and *E. agallocha*. According to this author, *R. samoensis* is very similar to *Rhizophora mangle* which occurs in America, the Caribbean and Africa. These species could be the phytogeographical link between Indo-Pacific and American mangroves (Tomlinson, 1986). Botanical surveys of Western Samoa mangroves have been undertaken by Vodonovailu (undated), Nakamura (1992) and Sasaki (1992). An exhaustive inventory of the mangal vegetation is given, detailing 45 species (**Table 1**). Nine mangrove and closely related species have been recorded, it is therefore likely that a tenth species is present : *Rhizophora* x *selala* which is an F1 hybrid of *R. samoensis* and *R. stylosa* (Tomlinson, 1986).

Table 1 : Western Samoa mangrove species and associates
Data from Vodonovailu (undated), Nakamura (1992) and Sasaki (1992).

Mangroves and associated species	**Associated species (Including epiphytes)**		
Acrostichum aureum	*Acanthus ilifolius*	*Davallia solida*	*Lycopodium phlegnaria*
Avicennia marina	*Anonaceae* sp.	*Dendrobium biflorum*	*Lycopodium trifoliatum*
Bruguiera gymnorrhiza	*Asplenium nidus*	*Dendrobium catillare*	*Ophioglossum pendulum*
Exoecaria agallocha	*Asplenium laserpitiifolium*	*Dendrobium tokai*	*Pandanus pyriformis*
Heritiera littoralis	*Asplenium polyodon*	*Drynaria rigidula*	*Paspalum distichum*
Rhizophora samoensis	*Bulbophyllum longiscapum*	*Earina* sp.	*Phreatia* sp.
Rhizophora stylosa	*Bulbophyllum* sp.	*Hibicus tiliaceus*	*Phymatosorus grossus*
Sonneratia alba	*Clerodendron inerme*	*Histiopteris incisa*	*Psilotum complanatum*
Xylocarpus granatum	*Ctenopteris* sp.	*Hoya australis*	*Pyrrosia adnascens*
	Cyatea lunulata	*Humanta banksii*	*Taeniophyllum fasciola*
	Davallia epiphylla	*Humata heterophylla*	*Thespesia populnea*
	Davallia fejeensis	*Hymenophyllum* sp.	*Vigna marina*

To our knowledge, the only estimation of the area of mangroves from Western Samoa is the one of Liu (1992). Unfortunately, the given values (15,000 - 20,000 ha) are not correct, probably because of a misprint. It is likely that his original estimation is 150 - 200 ha, in other words 1.5 - 2.0 km². A planimetry of 1:20,000 topographical maps printed in 1983 (NZMS 174) gives a slightly greater value : 2.5 km². Obviously, this value is still an underestimation of Western Samoa mangroves area because only mappable stands were taken into an account. For instance on Savai'i, the *Xylocarpus* mangrove stand censused by Pearsall & Whistler (1991) could not be located using the topographical maps. Furthermore, some areas considered as marshes on the maps have been misidentified. In fact, some of them are mangrove forests, as in Sa'anapu-Sataoa for instance. The major mangrove stands are located on **Figure 1**. Sasaki (1992) has described four major vegetal communities and their zonation in Western Samoa mangroves (**Figure 2**). Threatened mangroves, because of drainage, reclamation and pollution, have been reported (Anonyme, 1991; Nakamura, 1992)). It is likely that mangroves stands near Apia are the most disturbed ones. According to Liu (1992), approximatively 5% of mangrove area has been converted to other uses and most of the remaining stands are severely disturbed by adjacent and on-site land-use conversion, rubbish disposal and pollution.

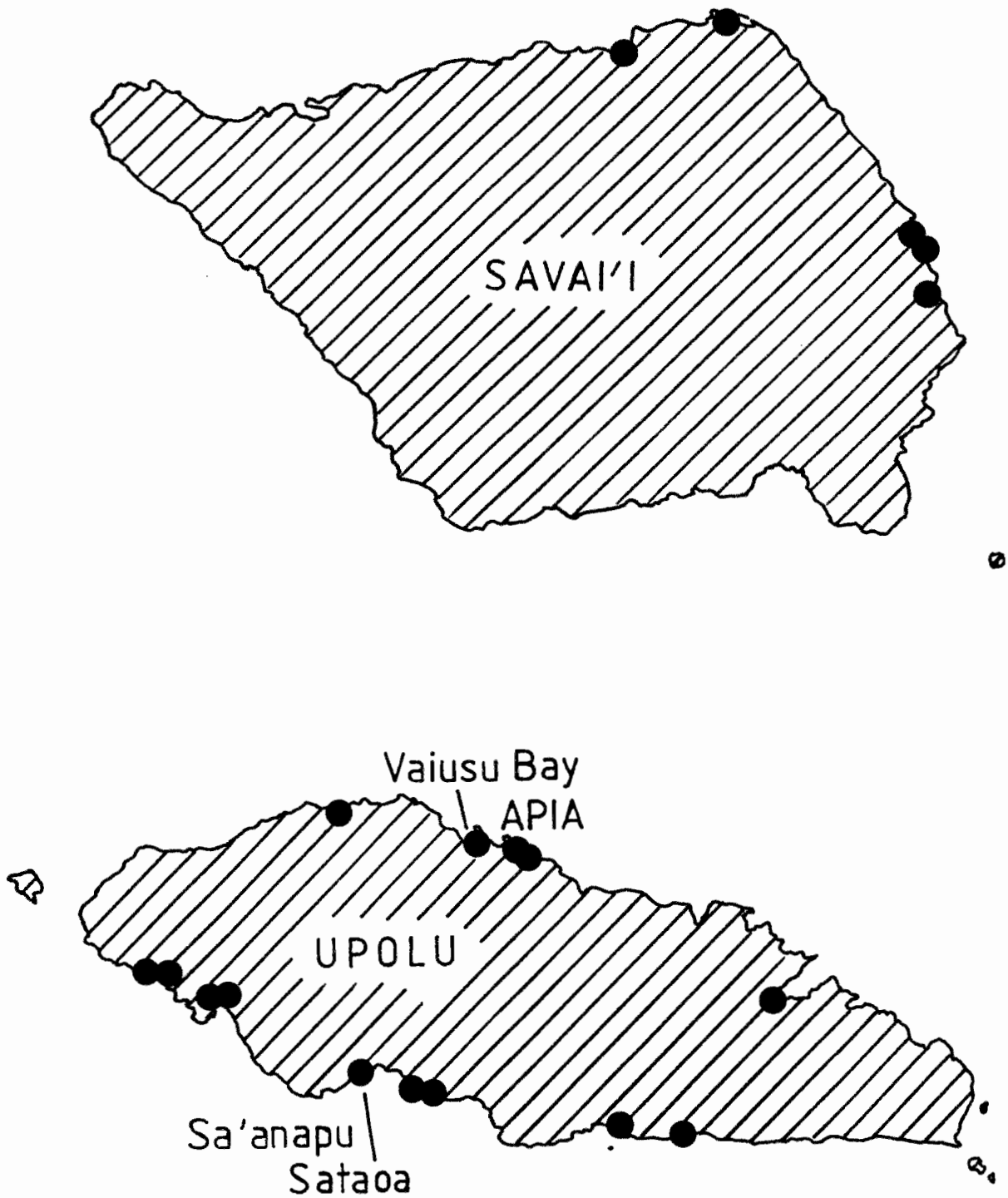
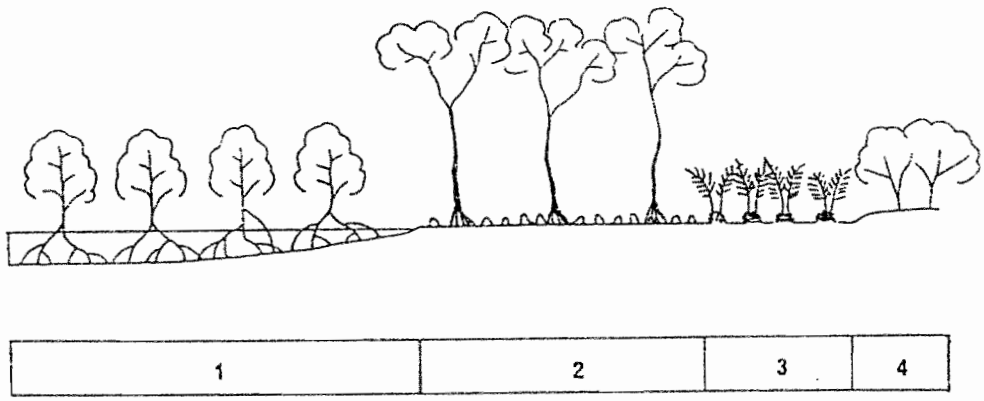


Figure 1 : Major mangrove stands from Western Samoa (black dots)



1 : *Rhizophora samoensis* community
2 : *Bruguiera gymnorrhiza* community
3 : *Acrostichum aureum* community
4 : *Hibicus tiliaceus* community

Figure 2 : Typical mangrove zonation in Western Samoa, from Sasaki (1992)

MATERIAL AND METHODS

Survey completion

The survey of Western Samoa mangrove fish fauna took place in 1992, from November the 25th to December the 5th (Table 2).

Table 2 : Schedule of Western Samoa mangrove fish survey

DATE	TIME	ACTION
25/11/1992	4.00 PM	Arrival from Nandi
26/11/1992	AM	Meeting with Cedric SCHUSTER (DEC) for details on the survey
	AM	Meeting with Fisheries Department
	AM-PM	Collect of the sampling equipment sent to SPREP
27/11/1992	AM	Sampling and field trip preparation
	PM	Visit to Vaiusu Bay sampling stations
28/11/1992	AM-PM	Sa'anapu-Sataoa samplings with gill nets (11 AM - 04 PM / 02 PM - 03 PM)
29/11/1992		No Work on Sunday
30/11/1992	AM	Meeting with Cedric SCHUSTER for theoretical advice
	PM	Vaiusu Bay sampling with rotenone (2.30 PM - 04 PM)
01/12/1992	AM-PM	Sa'anapu-Sataoa sampling with rotenone (10.30 AM - 01.30 PM)
02/12/1992	12.00 AM	Presentation of the survey to DEC
03/12/1992	AM	Redaction of the preliminary report
	PM	Vaiusu Bay sampling with gill nets (12 AM - 01 PM)
	16.00 PM	Preparation of the equipment
04/12/1992	AM	Final meeting with DEC's staff
	PM	Equipment sent to SPREP for forward freight to New Caledonia
05/12/1992	7.00 PM	Departure to Nandi

Sampling equipment

Two sampling techniques were used : gill-netting and rotenone poisoning (Table 2).

Three gill nets, 75m long and 3 m high, with stretched meshes of 40 mm, 60 mm and 80 mm, were set at the edge of the mangrove and in front of the main channels. These fishing gears enable the collection of small to large mobile species getting in and out of the mangrove.

Rotenone kills fishes by prevention of oxygen fixation on their gills. In a low energy zone surrounded by a small mesh gill net, the poison, mixed with soap and sea water in order to avoid sinking, was released. Fish were collected at the water surface by hand and with small landing nets. Sunk specimen were caught by snorkelling. Juveniles and small species, usually too small to be collected with gill nets, and sedentary species can be collected using rotenone poisoning.

Sampling stations

According to the survey proposal, the first sampling station is located in Vaiusu Bay (171°46'5 W - 13°49'5 S), a 76.2 ha mangrove stand in Apia (Figure 1 & 3). Sampling took place in the major mangrove area (52 ha), which lies between the old rubbish dump and petrol tanks. This place is known to be very polluted. Trees are small, less than 5 m high, *Rhizophora samoensis* and *Rhizophora stylosa* being the main components of the vegetal community.

The other sampling station is a quite undisturbed area in Sa'anapu-Sataoa (171°52' W - 13°58'7 S), on the south coast of Upolu (Figure 1 & 4). The vegetal community is larger (71.9 ha) and much more mature and healthy than the one from Vaiusu Bay. Large *Bruguiera gymnorrhiza* with numerous epiphytic species grow up to 15 m high in the inner side of the mangrove while a narrow fringe of *Rhizophora* spp. is located at the seashore. On each sampling site, at least one gill netting and one rotenone poisoning were performed, see Table 2 for date and duration.

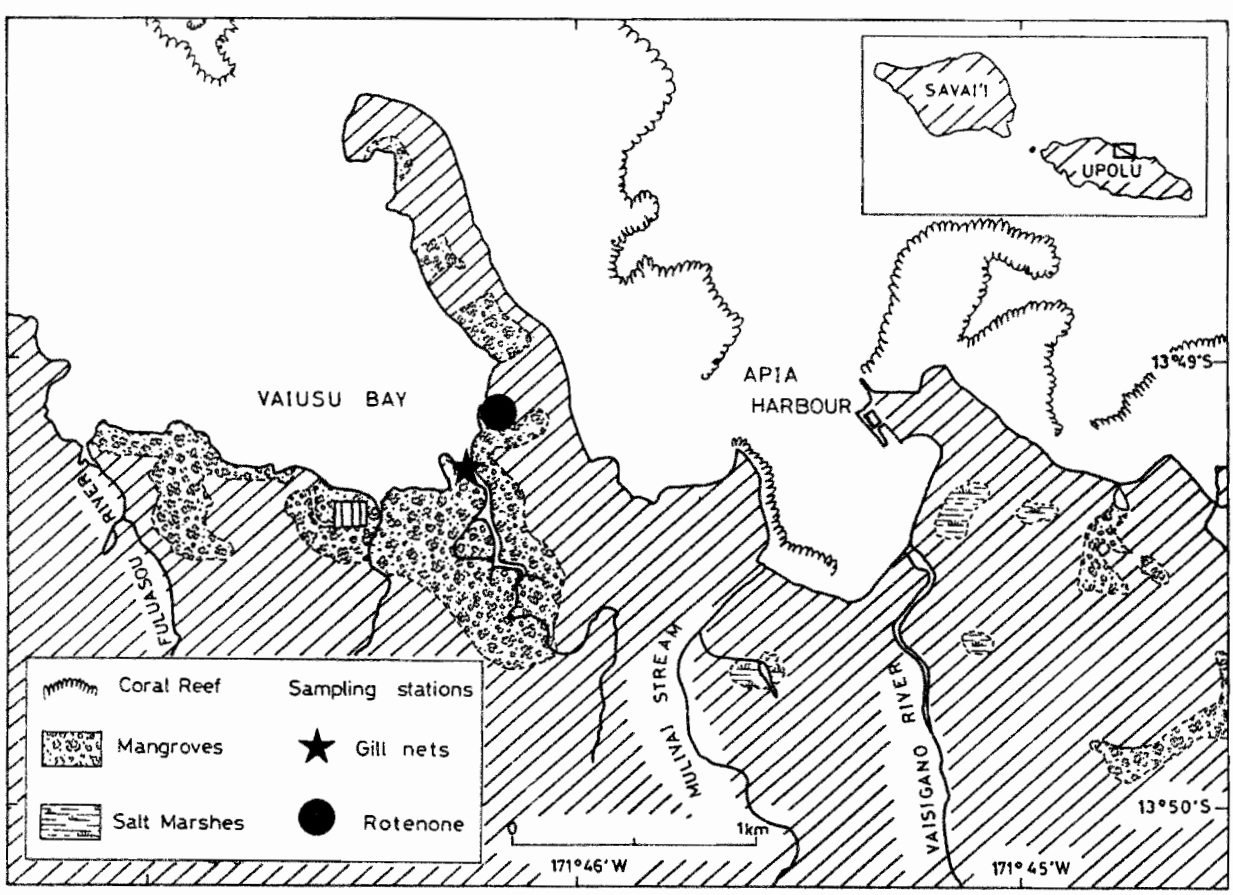


Figure 3 : Location of Vaiusu Bay sampling stations

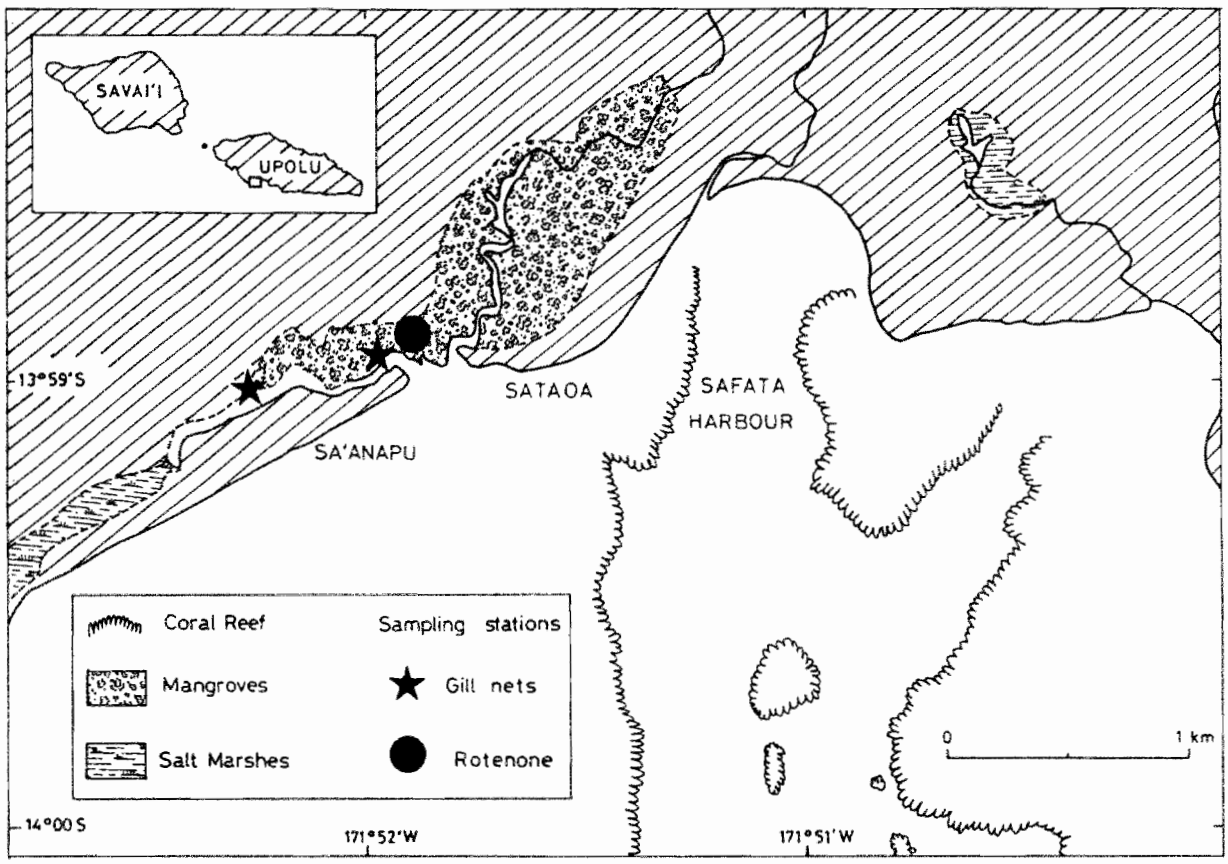


Figure 4 : Location of Sa'anu-Sataoa sampling stations

Biological data

For each fish collected, biological observations were recorded in order to assess basic informations necessary to the study of their biology, biometry and population dynamics.

Fork length was measured at the lower half centimeter. It should be noticed that in some instances the total length (eel-like species) or the disk width (rays) was recorded.

The fish were weighted at the lower gramme, as soon as possible after their collection.

Sex (immature, male and female) and sexual maturity were recorded as defined in **Table 3**.

Feeding habits were defined by macroscopical stomach content analysis. Various food items, such as fish, crabs, prawns, bivalves, worms, plankton, algae, and so on, were recorded with their volumic importance (as a percentage) in the stomach content.

Table 3 : Macroscopic definition of sexual maturity

Maturation index	Male	Female
0	Thin gonad	Thin gonad
1	Thin and elongated gonad	Vascular gonad
2	Gonad does not bleed after section	Opaque ovary, eggs not visible
3	Gonad bleeds a little after section	Granular ovary
4	Gonad bleeds after section	Eggs start to come loose
5	Gonad bleeds by pressure	Eggs come out of the ovary by pressure

RESULTS AND DISCUSSION

Preliminary checklist of the mangrove fish fauna

Thirty-five species distributed among 22 families were recorded during the survey (Table 4). The most speciose families are the Gobiidae (5 spp.), the Mullidae, the Mugilidae and Ophichthidae (3 spp.), the Carangidae and the Pomacentridae (2 spp.). Of course, further samples are needed before considering this checklist complete. Such samples have to be undertaken within the monitoring of the fish communities in Vaiusu Bay and Sa'anapu Sataoa mangroves. Such monitoring requires sampling at regular intervals, on, at least, a yearly basis. Further samples should also concern other mangrove areas in Upolu but also in Savai'i where there is a *Xylocarpus* mangrove stand, the rarest Western Samoa's ecosystem (Pearsall & Whistler, 1991). Data from these places could yield very interesting informations. Additional data can also be collected through enquiries to fishermen and villagers. This latter point will be developped in a further section.

Table 4 : Preliminary checklist of the mangrove fish from Western Samoa
Qualitative compilation of all samples and methods. Scientific names can be submitted to changes as some specimens were sent to taxonomists for confirmation of identification.
Samoan names are those from Anonyme (1991). Bold printing is given when used for several species or the whole family.

Family	(English name)	Scientific name	Samoan name
Muraenidae	(Moray eels)	*Uropterygius concolor*	**Pusi**
Ophichthidae	(Snake eels)	*Cirrimuraena tapeinopterus*	**Gatauli**
		Muraenichthys macropterus	
		Yirrkala lumbricoides	
Chanidae	(Milkfish)	*Chanos chanos*	Ava; Avali'i
Hemiramphidae	(Halfbeaks)	*Zenarchopterus dispar*	
Kuhliidae	(Mountain basses)	*Kuhlia marginata*	Lalele
Teraponidae	(Crescent perch)	*Therapon jarbua*	Ava'ava
Apogonidae	(Cardinalfishes)	*Apogon lateralis*	**Fo**
Carangidae	(Trevallies)	*Caranx melampygus*	Malauli apamoana
		Caranx papuensis	Malauli sinasama
Leiognathidae	(Ponyfishes)	*Leiognathus equulus*	Mumu
Lutjanidae	(Snappers)	*Lutjanus fulvus*	Tamala (toau)
Lethrinidae	(Emperors)	*Lethrinus harak*	Filoa-vai
Gerreidae	(Mojarras)	*Gerres macrosoma*	**Matu**
		Gerres oyena	Matu-Iua
Mullidae	(Goatfishes)	*Mulloidichthys flavolineatus*	Pasina (<10 cm), Vete
		Parupeneus indicus	Ta'uleia
		Upeneus vittatus	**Ula'oa**
Monodactylidae	(Monos)	*Monodactylus argenteus*	
Cichlidae	(Tilapia)	*Oreochromis mossambica*	Tilapia
Poecilidae	(Livebearers)	*Poecilia* sp. cf. *mexicana*	
Pomacentridae	(Damselfishes)	*Abudefduf septemfasciatus*	Mutu
		Chrysiptera notialis	**Tu'u'u**
Mugilidae	(Mullets)	*Liza melinoptera*	**Moi (<5 cm), Poi (5-8 cm),**
		Valamugil engeli	**Aua (8-12 cm), Fuafua (12-15 cm)**
		Valamugil seheli	**Popoto (15-20 cm), Anae (>20 cm)**
Eleotrididae	(Sleepers)	*Ophiocara porocephala*	
Gobiidae	(Gobies)	*Glossogobius biocellatus*	**Mano'o**
		Oxyurichthys ophthalmonema	
		Periophthalmus cantonensis novae-guineaensis	
		Taenioides jacksoni	
		Yongeichthys nebulosus	
Acanthuridae	(Surgeonfishes)	*Acanthurus xanthopterus*	**Pone (<15 cm), Palagi (>15 cm)**
Tetraodontidae	(Pufferfishes)	*Arothron manillensis*	**Sue**

Yamasaki *et al.* (1985) and Knudsen (1991) reported respectively 13 and 70 species in American Samoa mangroves. Although methods and duration of the samplings are not similar (one day beach seining for Yamasaki *et al.* (1985) and for Knudsen (1991) 6 months with unknown methods), the number of species recorded during in this survey can be considered as a good starting point for further investigations.

Mangrove fish studies have been held in the region (American Samoa, Fiji, New Caledonia, Vanuatu) and elsewhere in the Indo-Pacific. The relevant inventories have been compiled and compared with the checklists of the fishes from Samoa (Wass, 1984; Andrews & Holthus, 1989; Anonyme, 1991). A list of all fish which can potentially use the mangrove during a part of their life is given (**Appendix I**). A total of 216 species distributed amongst 61 families have a potential to be found in mangroves from Western Samoa. Most speciose families would be Carangidae (14 spp.), Apogonidae (11 spp.), Gobiidae (10 spp.) and Clupeidae (9 spp.). As gobies are usually a main component of the mangrove fish fauna (Thollot, 1992), the number of Gobiidae species could probably be much greater (about 30 to 40 species). If the species recorded in Vaiusu Bay and Sa'anapu-Sataoa were taken into account, global richness of the fish fauna would be 251 species and 65 families. Of course, some species are more likely to occur in samoan mangroves, because they have already been censused in American Samoa (44 spp.), than others recorded only in mangroves from remote countries (59 spp., coded + in appendix I). Furthermore, seven species have also a high probability in belonging to samoan mangroves, even if they have not been collected yet in Western Samoa nor American Samoa. These species have a wide distribution and occur both in mangroves from Fiji, New Caledonia, Vanuatu and other Indo-Pacific places. Such species are *Hemiramphus far*, *Lutjanus argentimaculatus*, *Lutjanus fulviflamma*, *Plectorhinchus gibbosus*, *Platax orbicularis*, *Chaetodon auriga* and *Mugil cephalus* (**Appendix I**).

Comparison of Sa'anapu-Sataoa and Vaiusu Bay sampling stations

Both areas show similar species richness. Twenty species have been recorded in both Sa'anapu-Sataoa and Vaiusu Bay. However, the two fish communities do not have the same species composition, qualitatively and quantitatively (**Table 5**). They share only 6 species. Most of these species are known to live in extremely diverse habitats, from clear to brackish polluted waters : *Chanos chanos*, *Therapon jarbua*, *Caranx papuensis*, *Upeneus vittatus* and *Liza melinoptera*.

Table 5 : Comparison of the catch composition according to the sampling stations.
N = Number of fish - W = Fresh weight (g) - AW = Average Weight (g).
ST = Sampling Technique (R:Rotenone, G:Gill nets) - Species followed by * were collected on both sampling stations.

Catch composition in Vaiusu Bay					Catch composition in Sa'anau-Sataoa				
Species	N	W	AW	ST	Species	N	W	AW	ST
Uropterygius concolor	3	41	13.67	R	*Chanos chanos* *	2	460	230.00	G
Cirrimura tapeinotus	5	80	16.00	R	*Zenarchopterus dispar*	6	53	8.83	R
Muraenichthys macropterus	6	15	2.50	R	*Therapon jarbua* *	48	5710	118.96	R
Yirrkala lumbricoides	1	5	5.00	R	*Kuhlia marginata*	10	220	22.00	R
Chanos chanos *	1	41	41.00	G	*Apogon lateralis*	2	14	7.00	R
Therapon jarbua *	68	635	9.34	R	*Caranx melampygus*	6	71	11.83	G+R
Caranx papuensis *	5	28	5.60	R	*Caranx papuensis* *	4	137	34.25	G+R
Leiognathus equulus	15	9	0.60	R	*Lutjanus fulvus*	4	125	31.25	R
Gerres macrosoma	3	4	1.33	R	*Gerres ovatus*	3	175	58.33	R
Upeneus vittatus *	3	19	6.33	R	*Lethrinus harak*	5	270	54.00	R
Oreochromis mossambica	1	48	48.00	R	*Mulloides flavolineatus*	4	405	101.25	R
Poecilia sp. cf. *mexicana*	1	5	5.00	R	*Parupeneus indicus*	1	640	640.00	R
Liza melinoptera *	705	1810	2.57	R+G	*Upeneus vittatus* *	1	165	165.00	R
Ophiocara porocephala	2	6	3.00	R	*Monodactylus argenteus*	1	65	65.00	F
Glossogobius biocellatus	2	6	3.00	R	*Abudefduf septemfasciatus*	1	135	135.00	F
Oxyurichthys ophthalmonema	16	18	1.12	R	*Chrysiptera notialis*	22	692	31.45	R
Periophthalmus cantonensis	1	1	1.00	R	*Liza melinoptera* *	31	3000	96.77	R
Taenioides jacksoni	2	1	0.50	R	*Valamugil engeli*	69	1391	20.16	G+R
Yongeichthys nebulosus	19	50	2.63	R	*Valamugil seheli*	3	420	140.00	R
Arothron manillensis	172	82	0.48	R	*Acanthurus xanthopterus*	2	335	167.50	R
Total	1031	2904	-	-	Total	225	14483	-	-

The fish fauna from Vaiusu Bay and Sa'anapu-Sataoa do not have the same community structure. In Vaiusu Bay, one species highly dominates the catch : *Liza melinoptera*. This species contributes from 69% (rotenone) to 94% (gill nets) of the sample. As a consequence, diversity indexes are low (Table 6). This latter observation is very significant of disturbed communities, probably because of the pollution of the area. In Sa'anapu-Sataoa, the most important species do not make more than 31% of abundance and 43% of weight. Diversity index values are greater than those of Vaiusu Bay, eveness values being close to 0.8 which suggests that the community is quite stable (Table 6).

Table 6 : Ecological characteristics of Vaiusu Bay and Sa'anapu-Sataoa mangrove fish fauna.
SR = Species Richness - H' = Diversity index - E = Eveness - the indexes (n and w).

	Gill nets					Rotenone				
Sampling station	SR	H'_n	E_n	H'_w	E_w	SR	H'_n	E_n	H'_w	E_w
Vaiusu Bay	2	0.310	0.310	0.281	0.281	19	1.654	0.389	2.174	0.512
Sa'anapu-Sataoa	7	2.524	0.899	2.299	0.819	17	2.998	0.734	2.702	0.661

The composition of the fish communities is closely related to the nature of the substrate, and to a lesser extent to other biological and ecological parameters (Thollot, 1992). In this study, it is obvious that there are many differences in the nature of the substrate between Sa'anapu-Sataoa (sandy to muddy sediment with large volcanic rocks suitable for algae and invertebrates) and Vaiusu Bay (heavily silted sediment with trapping of organic matter). As underlined previously, another factor has to be taken into account : the pollution of Vaiusu Bay (chemical analysis not performed).

Comparison of the sampling methods

Gill nets (70 m x 3 m, stretched mesh 40, 70 and 80 mm) and rotenone (a chemical ichthyocide) have been used. The most successfull method is undoubtly rotenone poisoning (cf. **Table 5 and 6**). Using rotenone 32 species were collected 17 species in Sa'anapu-Sataoa and 19 species in Vaiusu Bay, while only 8 species were netted, 7 species in Sa'anapu-Sataoa and 2 species in Vaiusu Bay (**Table 7**). The efficiency of the sampling methods to collect complementary components of the fish communities appears clearly. Gill nets catch few but large fishes (average weight from 6.0 to 167.0 g per fish). On the opposite, rotenone poisonings enable the collection of very small specimen, usually represented by large number of individuals, such as juveniles of *Liza melinoptera* and *Arothron manillensis*. The average weight of the fish sampled with rotenone ranges from less than 1.0 g to 640.0 g. About half of the species (46.9%) have an average weight less than 10.0 g. The collection of large specimen (*Parupeneus indicus* and some *Therapon jarbua*) is probably linked to the use of Sa'anapu-Sataoa area by inshore species foraging in mangrove chanels for food.

Thus, the rotenone has been the best method during this survey (**Table 7**). If the checklist of the mangrove fish fauna from Western Samoa needs to be completed in the future, this sampling technique cannot be omitted. This method is widely used in all exhaustive ichthyofauna study. However, in Western Samoa, traditionnal rules exist in some villages banning the use of chemical substances for fishing. This is supported by most Samoan governmental agencies. It is then difficult to imagine the Department of Environment and Conservation (DEC) using such substance. Furthermore, as rotenone is quite expensive (about 20 US $ per litre), it is doubtfull that DEC could afford the cost of an extensive survey using this substance.

At first glance, the failure of the gill nets can easily be explained. First, tidal range is low in Western Samoa, less or equal to one metre. As there is less water entering the mangroves with the incoming tide, it is not easy for large and numerous species to invade the mangrove and be captured by the nets. Second, stratification of the water (fresh water above and salt water below) has been observed. Large pools and channels can provide temporary habitat to most fish. In Sa'anapu-Sataoa, the fish could hide among the stems of *Brugueira gymnorrhiza* roots, but also in crevices and under volcanic rocks. Second, the average size of the fish observed during the survey seems to be low. As the mesh used were quite large (40 mm and more), most fish were seen going through the net. Large fish also jumped over the floating line. Gill netting in Vaiusu Bay has been undertaken under bad weather conditions, this may explain the low species richness recorded (2 species, in fact 3 species because a specimen of *Therapon jarbua* has been lost). A main difficulty for the use of these nets is the amount of rubbish in the water (plastic bags, empty cans, and so on).

Table 7 : Comparison of the catch composition according to the sampling techniques.
N = Number of fish - W = Fresh weight (g) - AW = Average Weight (g).
SS = Sampling Station (S:Sa'anapu-Sataoa, V:Vaiusu Bay) - Species followed by * were caught using both techniques.

Catch composition of gill nettings					Catch composition of rotenone poisonings				
Species	**N**	**W**	**AW**	**SS**	**Species**	**N**	**W**	**AW**	**SS**
Chanos chanos	3	501	167.00	S+V	*Uropterygius concolor*	3	41	13.67	V
Caranx melampygus *	1	6	6.00	S	*Cirrimuraena tapeinotus*	5	80	16.00	V
Caranx papuensis *	2	89	44.50	S	*Muraenichthys macropterus*	6	15	2.50	V
Monodactylus argenteus	1	65	65.00	S	*Yirrkala lumbricoides*	1	5	5.00	V
Abudefduf septemfasciatus	1	135	135.00	S	*Zenarchopterus dispar*	6	53	8.83	S
Chrysiptera notialis	4	132	33.00	S	*Therapon jarbua*	116	6345	54.70	S+V
Liza melinoptera	17	800	47.06	V	*Kuhlia marginata*	10	220	22.00	S
Valamugil engeli	5	231	46.20	S	*Apogon lateralis*	2	14	7.00	S
					Caranx melampygus *	5	65	13.00	S
					Caranx papuensis *	7	76	10.86	S+V
					Leiognathus equulus	15	9	0.60	V
					Lutjanus fulvus	4	125	31.25	S
					Gerres macrosoma	3	4	1.33	V
					Gerres ovatus	3	175	58.33	S
					Lethrinus harak	5	270	54.00	S
					Mulloides flavolineatus	4	405	101.25	S
					Parupeneus indicus	1	640	640.00	S
					Upeneus vittatus	4	184	46.00	S+V
					Oreochromis mossambica	1	48	48.00	V
					Poecilia sp. cf. *mexicana*	1	5	5.00	V
					Chrysiptera notialis *	18	560	31.11	S
					*Liza melinoptera**	719	4010	5.58	S+V
					Valamugil engeli *	64	1160	18.12	S
					Valamugil seheli	3	420	140.00	S
					Ophiocara porocephala	2	6	3.00	V
					Glossogobius biocellatus	2	6	3.00	V
					Oxyurichthys ophthalmonema	16	18	1.12	V
					Periophthalmus cantonensis	1	1	1.00	V
					Taenioides jacksoni	2	1	0.50	V
					Yongeichthys nebulosus	19	50	2.63	V
					Acanthurus xanthopterus	2	335	167.50	S
					Arothron manillensis	172	82	0.48	V
Total	34	1959	-	-	**Total**	1222	15428	-	-

The choice of an adequate sampling method is of primary importance for the monitoring of the fish communities which will be undertaken in the future. Using the knowledge from this field trip, some conclusions can be made and new perspectives arise. Gill nets should not be used unless with caracteristics different from those which were used in this survey, specially smaller mesh size. Rotenone cannot be employed too often at the same place, because it changes the community structure. Alternative fishing methods are needed. Fish traps which are too selective should not be used. Fyke nets and cast nets could be used, if available in Western Samoa.

Last but not the least, fishermen's knowledge should be used. A questionnaire has been settled. The enquiry should provide additional possibilities for DEC's staff to undertake environmental education focused on mangroves and their protection. The questionnaire is presented in **Appendix II** with recommendations and details on its fulfillment. It could give numerous qualitative and quantitative informations on various topics :

- the dependence of villagers on mangroves for fishing or other purposes;
- the fishing effort intensity;
- the catch of the fishermen;
- the use of edible fish.

Biological data

Biological data (fork or total length, fresh weight, sex with maturation, stomach content) were recorded for most of the species censused. It provides a data base for further investigation in order to assess the use of the mangrove by the fish fauna during different parts of their life-cycle (**Appendix III**). More than 150 records (154) have been collected for 16 species (**Table 8**). As most of the work is macroscopical analysis, all the fish collected with gill nets were dissected (34 fish) while only 10% of the rotenone catch was analysed (120 fish). Most of the observations deal with length and weight measurements, data on the sexual maturity of 10 species were also recorded, the feeding habits of only 5 species being investigated (**Table 8**).

Table 8 : Abstract of the biological data base.
n = number of fish observed, detailed for sex and feeding habits analysis.
I = Immature - F = Female - M = Male.
Percentages of food items are volumic percentages.

Species	n	Length (mm)		Weight (g)		Sex and Sexual maturity		Food and Feeding habits	
		min	max	min	max	n	Data	n	Data
Chanos chanos	3	135	275	41	385	3	3 I	1	Algae (100%)
Zenarchopterus dispar	5	155	170	80	110				
Therapon jarbua	47	120	290	28	435	20	20 F 2-4		
Kuhlia marginata	10	85	140	10	45				
Caranx melampygus	1	85		6					
Caranx papuensis	2	140	150	42	47				
Mulloides flavolineatus	3	165	200	80	140	3	M 3 / 2 F 4-5	3	Crabs (75%), Bivalves (12.5%), Worms (10%), Algae (2.5%)
Parupeneus indicus	1	305		640		1	M 2	1	Crabs (50%), Bivalves (50%)
Upeneus vittatus	1	205		165		1	F 2	1	Crabs (100%)
Monodactylus argenteus	1	135		65					
Abudefduf septemfasciatus	1	145		135		1	F 4		
Chrysiptera notialis	21	100	115	26	47	17	8 M 1-3 / 9 F 3-4	2	Algae (100%)
Liza melinoptera	48	135	250	35	210	25	I / 16 M 1-3 / 8 F 1-4		
Valamugil engeli	5	150	170	41	53				
Valamugil seheli	3	181	230	95	165	3	I		
Acanthurus xanthopterus	2	185	190	155	180	2	I		

Such biological data base is needed if one wants to define the nature and importance of the mangroves in terms of nursery areas for juveniles, breeding sites and feeding grounds for adults. The structure and the functionning of mangrove fish communities will be available. This information is of primary importance for a rational use of mangroves by decision makers. Furthermore, many biological data are necessary for the management of fisheries : biometry of commercial species, their population dynamics and definition of stock protection measures (minimal length, breeding periods, and so on).

THEORETICAL ADVICE

There is a wealth of documentation dealing with the characterization of biological communities. Synthetic indices exist, they can be very usefull in comparing sets of samples and, above all, monitoring fish communities. Three simple, easy to compute and to understand indices were selected :

- species richness, SR :

  SR = number of species;

- species diversity, H', from Shannon's information theory (Shannon & Weaver, 1949) expressed in bit ("binary digit") :

$$H' = -\sum_{i=1}^{SR} p_i (\log_2 p_i)$$

where p_i is the proportion of the i^{th} species in the community of which species richness is SR, p_i is estimated by the ratio q_i/Q, the relative frequency of the i^{th} species in the sample, with :

q_i = abundance or weight of the i^{th} species,

Q = total abundance or total weight in the sample;

- eveness, E, Pielou's index (Pielou, 1969), its calculation is derived from H' :

$$E = H'/H'_{max} = H'/\log_2 SR$$

E ranges from 0 (one unique species in the sample) to 1 (equal distribution of the species). Thus, eveness values describe if the sample is heterogeneous. Usually, values below 0.80 are the expression of unbalanced communities.

These indices can be used in space or time comparisons using ANOVA, Student's *t* test or Wilcoxon-Mann-Whitney's *w* test. All informations relevant to these classical statistical tests are available in Sokal & Rohlf (1981) and Siegel & Castellan (1988). A brief example of the use of these indices has been given in **Table 6.**

Sheets for data collection, both catch composition and biological analysis, are provided in **Appendix IV.**

CONCLUSION

The Western Samoa mangrove fish survey has been realized and most proposed applications have been successfully performed. Thirty-five species have been censused and biological data were recorded. These informations enabled the realisation of a preliminary data base. Field trips, sampling technique experiments and theoretical advice have provided training for DEC's staff and will give the basic knowledge for a future monitoring of the mangrove fish fauna in Vaiusu Bay and Sa'anapu-Sataoa.

Further studies on mangroves from Western Samoa should be undertaken. This place is located at the eastern limit of distribution of indo-pacific mangroves. As *Rhizophora samoensis* is very close from *Rhizophora mangle*, it may represent a phytogeographical link between american and indo-pacific mangroves. Furthermore, attention should be focussed on the fish communities in Western Samoa. As mangroves and reefs are not extensive, the description of these fish fauna would be very helpful in understanding the functionning of the communities. Such findings would give major informations for the study of more complex tropical coastal ecosystems.

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Appendix I : Putative checklist of Western Samoa mangrove fish.

This list has been prepared by comparing Wass (1984), Andrews & Holthus (1989) and Anonyme (1991) checklists of samoan fishes to those from mangroves in American Samoa (Yamasaki *et al.*, 1985; Knudsen, 1991), Fiji (Lal *et al.*, 1984), New Caledonia (Thollot, 1992), Vanuatu (David, 1985) and various countries from the Indo-Pacific (data from Thollot (1992)).

Samoan names are those from Anonyme (1991). Bold words are family or multi-species names.

The last column (Indo-Pacific) tells in which country the species has been recorded : AS = American Samoa, F = Fiji, NC = New Caledonia, V = Vanuatu, + = various countries from the Indo-Pacific.

Family	(English name)	Scientific name	Samoan name	Indo-Pacific
Carcharhinidae	(Grey sharks)	*Carcharhinus leucas*	**Malie**	NC +
		Carcharhinus limbatus		NC +
		Carcharhinus melanopterus	Apeape	NC
		Negaprion acutidens		NC +
		Trianodon obesus	Malu	F
Sphyrnidae	(Hammerhead sharks)	*Sphyrna lewini*	Mata'italiga	NC
Rhynobatidae	(Guitarfishes)	*Rhynchobatus djiddensis*		+
Dasyatidae	(Stingrays)	*Dasyatis kuhlii*	Fai-tala, Fai-malie	F NC +
Myliobatididae	(Eagle ray)	*Aetobatus narinari*	Fai-pe-a, Fai-manu	V
Megalopidae	(Tarpons)	*Megalops cyprinoides*	Ana analagi, fa	F NC +
Albulidae	(Bonefishes)	*Albula vulpes*	Ava	V +
Anguillidae	(Freshwater eels)	*Anguilla australis*	Tuna	+
Muraenidae	(Moray eels)	*Echidna nebulosa*	**Pusi**	+
		Echidna polyzona		+
		Gymnothorax meleagris	Pauali'i, Ai'iivai	V
		Gymnothorax thyrsoideus		NC
		Gymnothorax undulatus	Pusi-pulepule	NC
		Muraenichthys laticaudatus		+
		Siderea picta		NC
Ophichthidae	(Snake eels)	*Cirrhimuraena playfairi*	**Gatauli**	AS
		Leiuranus semicinctus		NC
		Myrophis uropterus		NC
Congridae	(Conger eels)	*Conger cinereus*	I'aui	AS NC
Clupeidae	(Herrings)	*Amblygaster clupeoides*	**Pelupelu**	AS
		Amblygaster sirm		NC
		Herklotsichthys quadrimaculatus	Pelupelu	AS NC +
		Sardinella albella	Pelupelu	+
		Sardinella fimbriata		+
		Sardinella gibbosa		+
		Sardinella melanura		+
		Spratelloides delicatulus	Poi, Nefu	NC +
		Spratelloides gracilis	Poi, Nefu	NC
Engraulidae	(Anchovies)	*Stolephorus indicus*	Nefu	AS NC +
		Thryssa baelama	Nefu	NC +
Plotosidae	(Eel catfishes)	*Plotosus lineatus*	Apoa	AS F NC V +
Synodontidae	(Lizardfishes)	*Saurida gracilis*		F NC +
		Saurida nebulosa		AS NC +
		Synodus variegatus		+
Antennariidae	(Frogfishes)	*Antennarius commersoni*	**Ia'otale, nofu**	NC +
		Antennarius nummifer		F
Hemiramphidae	(Halfbeaks)	*Hemiramphus archipelagicus*		AS
		Hemiramphus far		F NC V +

Family	(English name)	Scientific name	Samoan name	Indo-Pacific
Hemiramphidae	(Halfbeaks)	*Hyporhampus affinis*		+
		Hyporhampus dussumieri		NC +
Belonidae	(Needlefishes)	*Strongylura incisa*		F NC +
		Tylosurus crocodilus		NC +
Atherinidae	(Silversides)	*Atherinomorus lacunosus*		NC +
		Atherion elymus		V
		Hypoathrina ovalaua		+
		Hypoatherina temmincki		+
Holocentridae	(Squirrel fishes)	*Myripristis adjusta*	Malau	AS
		Myripristis murdjan		AS
		Myripristis pralinia	Malau va'ava'a	AS
		Neoniphon argenteus		NC
		Neoniphon samarra	Malau tui	AS NC
		Sargocentron rubrum		NC
		Sargocentron tiereoides		AS
Fistulariidae	(Cornetfishes)	*Fistularia commersonii*	Taoto-ama, Taotao	F +
		Fistularia petimba		+
Syngnathidae	(Pipefishes, Seahorses)	*Corytoichthys amplexus*		NC
		Doryramphus excisus		NC
		Hippichthys spicifer		+
		Hippocampus kuda		+
		Syngnathoides biaculeatus		NC +
Dactylopteridae	(Flying Gurnards)	*Dactyloptena orientalis*		F +
Scorpaenidae	(Scorpionfishes)	*Pterois volitans*	Ia'otale (< 8cm)	F V +
		Scorpaenodes guamensis	nofu,	+
		Scorpaenodes kelloggi	i'aotale (> 8cm)	AS
		Scorpaenopsis macrochir		AS
Synanceiidae	(Stonefishes)	*Synanceia verrucosa*	Ia'otale	V +
Centropomidae	(Perchlets)	*Ambassis miops*		NC +
Serranidae	(Groupers)	*Anyperodon leucogrammicus*	[1]	NC +
		Cephalopholis argus	Gatala uli, Loi	+
		Epinephelus fuscoguttatus		F
		Epinephelus lanceolatus	Ata'ata -uli	NC +
		Epinephelus maculatus	Gatala-pule-ule	NC
		Epinephelus merra	Gatala pulepule	NC V
		Epinephelus microdon	Gatala nifoli'i	NC
		Epinephelus tauvina		F NC +
Grammistidae	(Soapfishes)	*Grammistes sexlineatus*		V
		Pogonoperca punctata		V
Plesiopidae	(Roundheads)	*Plesiops coeruleolineatus*		V
Kuhliidae	(Mountain Basses)	*Kuhlia mugil*	Safole	+
		Kuhlia rupestris	Sesele, inato	AS F NC +
Priacanthidae	(Bigeyes)	*Priacanthus hamrur*		F
Apogonidae	(Cardinalfishes)	*Apogon exostigma*	Fo	V
		Apogon fraenatus		V +
		Apogon fragilis		NC
		Apogon guamensis		NC
		Apogon leptacanthus		NC +
		Apogon novemfasciatus		AS
		Cheilodipterus quinquelineatus		NC V +
		Fowleria aurita		+
		Fowleria marmorata		+
		Fowleria variegata		NC
		Pseudamia polystigma		+

[1] **Gatala** (<30 cm), **'Ata'ata** (30-90 cm), **Vaolo** (>90 cm).

Family	(English name)	Scientific name	Samoan name	Indo-Pacific
Echeneidae	(Remoras)	*Echeneis naucrates*	Talitaliuli	+
Carangidae	(Trevallies)	*Alectis ciliaris*	[2]	+
		Atule mate		+
		Carangoides caeruleopinnatus	Filu (Lalafulu)	+
		Carangoides dinema		+
		Carangoides ferdau		+
		Caranx hedlandensis		+
		Caranx ignobilis	Sapo'anae	AS F NC +
		Caranx lugubris	Tafauli	AS NC
		Caranx sexfasciatus	Malauli matalapo'a	AS F NC +
		Gnathanodon speciosus		F NC +
		Megalapsis cordyla		+
		Scomberoides lysan	Lai (lai)	AS F NC +
		Trachinotus baillonii		+
		Trachinotus blochii		F V +
Leiognathidae	(Ponyfishes)	*Gazza minuta*	Mumu	F NC +
		Leiognathus equulus	Mumu	AS F NC +
		Leiognathus fasciatus	Mumu	F NC +
Lutjanidae	(Snappers)	*Lutjanus argentimaculatus*	Mu, Palu	F NC V +
		Lutjanus biguttatus		+
		Lutjanus bohar	Mu	NC V
		Lutjanus fulviflamma		F NC V +
		Lutjanus kasmira	Savane (Ta'ape)	+
		Lutjanus monostigma	Taiva	F V +
		Lutjanus rivulatus		F +
Gerreidae	(Mojarras)	*Gerres argyreus*	Matu	AS +
		Gerres kapas		+
		Gerres oblongus	Matu-lua	+
Haemulidae	(Grunts)	*Plectorhinchus chaetodonoides*	Misimisi	V
		Plectorhinchus gibbosus		F NC V +
		Plectorhinchus orientalis	Mutumutu	V
Lethrinidae	(Emperors)	*Gymnocranius lethrinoides*	Filoa-mu	NC
		Lethrinus nebulosus	Ulusa'o, mulogo [3]	NC +
		Lethrinus olivaceus		F NC
		Lethrinus ramak	Lauloa	AS NC
		Lethrinus rubrioperculatus	Filoa pa'o'omumu	NC
		Lethrinus variegatus		+
Nemipteridae	(Monocle breams)	*Pentapodus caninus*	Tivao-sugale	+
		Scolopsis trilineatus	Tivao	AS NC
Mullidae	(Goatfishes)	*Parupeneus barberinus*	Tusia	AS NC
		Parupeneus multifasciatus		AS
		Upeneus tragula		NC V +
Kyphosidae	(Rudderfishes)	*Kyphosus bigibbus*	Nanue	AS +
		Kyphosus cinerascens		AS
		Kyphosus vaigiensis	Nanue	F
Ephippididae	(Spadefishes, Batfishes)	*Drepane punctata*		NC +
		Platax orbicularis		F NC V +
Chaetodontidae	(Butterflyfishes)	*Chaetodon auriga*	Si'u, Si'usamasama	F NC V +
		Chaetodon ephippium	Tifitifi-tuauli	F
		Chaetodon kleinii		+
		Chaetodon lunula	Tifitifi-laumela	+
		Chaetodon mertensii	Tifitifi-sega'ula	+
		Chaetodon vagabundus	Tifitifi-matapua'a	F V +

2 **Lupo** (<8 cm), **Lupota** (8-20 cm), **Malauli** (20-50 cm), **Ulua** (50-80 cm), **Sapo'anae** (>80 cm).

3 **Mata'eleele** (<15 cm), **Ulamalosi** (15-30 cm), **Flioa** (>30 cm).

Family	(English name)	Scientific name	Samoan name	Indo-Pacific
Chaetodontidae	(Butterflyfishes)	*Heniochus acuminatus*	Laulaufau-laumea	NC +
Pomacentridae	(Damselfishes)	*Abudefduf sexfasciatus*	Mamo	AS +
		Abudefduf sordidus	Mutu	+
		Abudefduf vaigiensis	Mamo	+
		Chrysiptera biocellata	Tu'u'u-mo'o	NC
		Dascyllus trimaculatus	Tu'u'u-pulelua	+
		Plectroglyphidodon lacrimatus		AS
		Pomacentrus pavo	Tu'u'u-segasega	AS
		Stegastes nigricans	Tu'u'u-moi	V
Mugilidae	(Mullets)	*Liza macrolepis*	Anae	NC V +
		Liza melinoptera		AS NC +
		Liza subviridis	Anae	F +
		Liza vaigiensis	Fuitogo, afa, anaeafa	AS F NC V +
		Mugil cephalus	Anae	F NC V +
Sphyraenidae	(Barracudas)	*Sphyraena barracuda*	Saosao	AS F NC V +
		Sphyraena flavicauda	Sapatu	NC +
		Sphyraena forsteri	Sapatu	F NC
		Sphyraena qenie		AS +
Polynemidae	(Threadfins)	*Polynemus plebeius*		F +
		Polynemus sexfilis		AS +
Labridae	(Wrasses)	*Cheilinus chlororous*	Lalafi-matapua'a	AS
		Cheilo inermis	Sugale	+
		Halichoeres biocellatus		NC
		Halichoeres trimaculatus		NC
		Hemigymnus melapterus		NC
		Labroides dimidiatus	Sugale-mo'otai	+
		Stethojulis strigiventer		AS NC
Scaridae	(Parrotfishes)	*Leptoscarus vaigiensis*	[4]	+
		Scarus ghobban	Fuga-alova	NC +
Blenniidae	(Blennies)	*Istiblennius edentulus*	Mano'o	NC +
		Petroscirtes mitratus		NC
Eleotrididae	(Sleepers)	*Bostrychus sinensis*		V +
		Eleotris fusca		NC V +
		Eleotris melanosoma		+
Gobiidae	(Gobbies)	*Amblygobius nocturnus*	Mano'o	NC
		Amblygobius phalaena		NC +
		Asterropteryx semipunctatus		NC
		Bathygobius fuscus		+
		Cryptocentrus lutheri		NC
		Exyrias puntang		NC +
		Istigobius ornatus		NC +
		Oplopomus oploplomus		NC
		Periophthalmus koelreuteri		+
		Ptereleotris microlepis		NC
Acanthuridae	(Surgeonfishes, Unicornfishes)	*Acanthurus mata*	[5]	NC +
		Acanthurus triostegus	Manini	AS +
		Naso unicornis	Ume-isu	NC
Siganidae	(Rabbitfishes)	*Siganus argenteus*	Loloa,Ofe'ofe,Malava	+
		Siganus fuscescens	Lo	AS V +
		Siganus spinus	Anefe, pa'ulu	AS F V +
		Siganus vermiculatus		F +
Scombridae	(Mackerels)	*Rastrelliger brachysoma*	Ga	F +
		Rastrelliger kanagurta		AS V +

4 **Fuga**, **Fugamea** (reddish species), **Fugausi** (greenish species), **Laea** (20-50 cm), **Galo** (>50 cm).

5 **Pone** (<15 cm), **Palagi** (>15 cm).

Family	(English name)	Scientific name	Samoan name	Indo-Pacific
Bothidae	(Lefteye flounders)	*Bothus mancus*		AS
		Bothus pantherinus		F NC +
Balistidae	(Triggerfishes)	*Aluterus scriptus*	Ume-aleva, falala	+
		Cantherines pardalis	Pa'umalo	+
		Monacanthus chinensis		+
		Rhinecanthus aculeatus	Sumu-uo-uo	+
Ostraciidae	(Trunkfishes)	*Lactoria cornuta*	Moamoa-ulutao	+
		Ostracion cubicus	Moamoa	+
Tetraodontidae	(Puffers)	*Arothron hispidus*	Sue-vaolo	NC V +
		Arothron immaculatus	Sue-va'a	F +
		Arothron nigropunctatus	Sue-uli, Sue-lega	+
		Arothron stellatus	Sue-gatala, sue-va'a	+
		Canthigaster valentini	Sue	+
Diodontidae	(Porcupinefishes)	*Diodon hystrix*	Tauta	NC

Sheet number : . . . . . .

TRADITIONAL USE OF MANGROVES / FISHING ACTIVITIES QUESTIONAIRE
Department of Land, Surveys and Environment - Division of Environment and Conservation

Date : . . . . . .
Location : . . . . . .
Questioner : . . . . . .
Respondent : . . . . . .

Fishing in mangroves ? Yes ☐ No ☐ Where : . . . . . .

Number of daily hours fishing In mangroves : . . On reefs : . . . . Elsewhere : . . . . Location : . . . . . .

Access to mangroves : on foot ☐ by boat ☐ Alone ? Yes ☐ No ☐ Number of people : . . . .

Equipment used ? Spears ☐ Nets ☐ Lines ☐ Traps ☐ Chemical ☐ Other : . . . . . .

Number of day fishing per week : . . . . .

Number of hour fishing per day : . . . . . .

Number of species collected daily : . . . .

Number of fish collected daily : . . . . . .

Weight of fish collected daily : . . . . . .

Average daily catch : English (Samoan)	Juveniles	Sub-Adults	Adults	Total (Nb)
Mullet (Anae)				
Milkfish (Ava)				
Mountain Bass (Lalele/Salele)				
Trevallies (Lai/Malauli/Sapo'anae)				
Snappers (Tamala)				
Emperors (Filoa/Ulusa'o)				
Mojarras (Matu)				
Goatfishes (Pasina/Tusia/Ta'uleia)				
Others				

Locally eaten ☐ Sold ☐ Bartered ☐

Other use of mangroves : Fuelwood ☐ Mud Crabs ☐ Bivalves ☐ Dumping ☐ Sewage ☐ Medecine ☐ Tanin ☐ Honey ☐
Other : . . . . . .

Fulfill this sheet with available information
☐ Tick for a positive answer
. . . . . Complete field accurately
Use only data from the fisherman

Additional notes : . . . . . .
. . . . . .
. . . . . .
. . . . . .

Caution about the enquiry

The above questionaire have to be fulfilled, with caution and accuracy. The value of the data collected is closely related to this critical point. As the questionaire is quite long (6 topics : 25 questions), it is suggested that the respondent must be in a very receptive condition. In other words, the people undertaking the questionaire have to win the fisherman's trust. Of course, the questionaire will be DEC's property and DEC has to assure the fisherman that the use of the data is stricly restricted to fishery and environmental purposes. I do not think that DEC can undertake a long term enquiry and come back regularly in a given place to submit the questionaire. As a consequence, quantitative data on fishing effort and catch analysis should be likely estimations. The questioner must collect average values which take into account long term variations. Furthermore, in order to establish the checklist of mangrove fish, this questionaire includes a catch composition table which is very incomplete (still usefull to assess the distribution of juveniles, sud-adults and adults). It may be more clever to focus attention on one renowned fisherman, or more, for each village, to talk with him and to show him pictures of fishes and the potential checklist which has been provided (251 species).

Sheet content and fulfillement of the questionnaire

The questonaire can de divided in 6 main topics :
- Questionaire identification (1 question);
- General information (4 questions);
- Fishing effort (11 questions);
- Catch analysis (4 questions);
- Use of the finfish resource (3 questions);
- Miscellanous and additional informations (2 questions).

Some questions are very simple, other are much more difficult to answer. In such case, it needs all questioner's skills. Two kinds of questions are submitted :
- those which are answered by YES or NO (qualitative data);
- those which are answered by an information (qualitative or quantitative data).

Two kinds of answers are proposed :
- a tick in the appropriate box (qualitative data);
- a sentence (qualitative data) or a number, be sure to use the correct unity (quantitative data)

<u>Questionaire identification</u>

1) *Sheet number* : Each sheet must have a specific number, which can be numerical or alphanumerical, in order to make the computing of the data, the checking of errors, and so on, easier. The choice of the encoding has to be made by DEC in relation with its computer system.

<u>General information</u>

2) *Date* : Date of submitting the questionaire. Use dd/mm/yy, as usual.
3) *Location* : Name of the place or village where the fisherman lives. It can be usefull to mention the name of the island and if the village is part of a district or whatever.
4) *Questioner* : Name of the people from DEC asking the questionaire to the fisherman.
5) *Respondent* : Name of the fisherman responding to the questionaire and eventually his social status and usual work (not mandatory).

<u>Fishing effort</u>

6) *Fishing in mangroves ?* : The answer must be YES or NO. Tick the appropriate case. If the answer is NO go to *Other use of mangroves* section (24). If the answer is YES go to the next question.
7) *Where ?* Indicate the name of the mangrove stand where the fisherman uses to go fishing.

8) *Number of daily hours fishing in mangroves, on reefs, elsewhere ?* Give average values. At this step of the questionaire, it is very important to help the fisherman to estimate this quantitative information. It is stated that usually reefs are the main fishing places.

9) *Location* : If a fishing activity is detected elsewhere than mangroves or reefs, indicate in which kind of ecosystem (outer reef slopes, seagrass beds, and so on).

10)*Access to mangroves* : Tick the appropriate answer on foot or by boat. If it is a powered boat get the power of the engine.
11)*Alone ?* According to the number of people fishing, check YES or NO.
12)*Number of people* : Indicate the relevant information.

13)*Equipment used* : Tick the appropriate answer. The use of chemicals for fishing is usually prohibited. However, it is possible that in some places they are still in use. Dynamite fishing, which is a very destructive method, should not be usual in mangroves.
14)*Other* : Indicate the name of the fishing gear (cast net, fyke net, tangle net, dynamite, and so on).

15)*Number of day fishing per week* : Give an average value on a yearly basis.
16)*Number of hour fishing per day* : Give an average value on a weekly basis.

Catch analysis
17)*Number of species collected daily* : Give an average value on a daily basis.
18)*Number of fish collected daily* : Give an average value on a daily basis.
19)*Weight of fish collected daily* : Give an average value on a daily basis.

20)*Catch composition table* : A part of the table asks for qualitative data, the other one for quantitative data. The first column is the average daily catch composition, names of the species are given in english and saoman.
Qualitative data : The questioner must try to know for each species, or group of species, if juveniles, sub-adults or adults are caught by the fisherman. Indicate the relevant information by any symbol in columns 2-4, "+" or "x" are suggested.
Quantitative data : Try to estimate the average numerical composition of the catch, on a daily basis (last column).
Others : Get both qualitative and quantitative informations if an additional fish species is caught by the fisherman. Write the name of the species in the *Additional notes* section (25). If there are different additional species (more than one), only quantitative data must be collected. Eventually, explicit juveniles, sub-adults or adults for each additional species in the *Additional notes* section (25).

Use of the finfish resource
21)*Locally eaten* Tick for a positive answer.
22)*Sold* Tick for a positive answer.
23)*Bartered* Tick for a positive answer.

Miscellanous and additional informations
24)*Other use of the mangroves* : Tick the appropriate answer and explicit which different use is made.

25)*Additional notes* : All relevant additional data can be writen in this section.
Write the name and the life-stage (juveniles, sub-adults, adults) of the species caught in the mangroves which are not in the table from the catch analysis (20).
Other informations, like the sale price, the exchange value of the fish bartered and the proportion of the fish eaten, sold and bartered must be estimated within the use of the resource sections (21-23).
If other uses of the mangroves are performed (any positive answer from section 24), try to know whether it is only in a subsistence way, in the other case, be as explicit as possible.
Finally, the questioner is supposed to make an evaluation of the quality of the answers from the respondent : a credibility rate. This point requires some experience, that is one of the reasons why it is suggested that the number of questioners should be limited. Such evaluation must be made as soon as possible after each talk.

NOTE : It is likely that average estimations will not be available from the fishermen. It is then necessary to collect the information from the day before the questionaire. In such case, questions # 6 - 20 have to be modified : *Fishing in mangrove yesterday ?* and so on.

Appendix III : Biological data base of Western Samoa mangrove fishes.
Modified from ORSTOM biological data base (> 39,000 entries)

Legend :
DATE = Date of the sampling
HB = Time at the begining of the sampling
HE = Time at the end of the sampling
LONG = Longitude
LAT = Latitude
Z = Depth (m)
S = Sampling (G=Gill net, R=Rotenone)
SPECIES = Species
L = Fork length (mm)
W = Fresh weight (g)
S = Sex (M=male, F=Female, I=Immature)
M = Sexual maturity index (cf. Table 3)
GW = Fresh weight of the gonads (g)
F1 = First food item
% = Volumic percentage of the first food item
F2 = Second food item
% = Volumic percentage of the second food item
F3 = Third food item
% = Volumic percentage of the third food item
F4 = Fourth food item
% = Volumic percentage of the fourth food item

DATE	HB	HE	LONG	LAT	Z	S	Species	L	W	S	M	GW	F1	%	F2	%	F3	%	F4	%
Sa'anapu-Sataoa Gill Nets																				
28 11 92	1100	1600	171520	13590	2	G	*Chanos chanos*	275	385	I			Alg	99						
28 11 92	1100	1600	171520	13590	2	G	*Chanos chanos*	170	75	I										
28 11 92	1100	1600	171520	13590	2	G	*Valamugil engeli*	170	53											
28 11 92	1100	1600	171520	13590	2	G	*Valamugil engeli*	150	41											
28 11 92	1100	1600	171520	13590	2	G	*Valamugil engeli*	165	51											
28 11 92	1100	1600	171520	13590	2	G	*Valamugil engeli*	150	44											
28 11 92	1100	1600	171520	13590	2	G	*Valamugil engeli*	160	42											
28 11 92	1100	1600	171520	13590	2	G	*Caranx melampygus*	85	6											
28 11 92	1100	1600	171520	13590	2	G	*Abudef. septemfasciatus*	145	135	F	4									
Sa'anapu-Sataoa Gill Nets																				
28 11 92	1400	1500	171515	13590	2	G	*Monodactylus argenteus*	135	65											
28 11 92	1400	1500	171515	13590	2	G	*Caranx papuensis*	150	47											
28 11 92	1400	1500	171515	13590	2	G	*Caranx papuensis*	140	42											
28 11 92	1400	1500	171515	13590	2	G	*Chrysiptera notialis*	120	41											
28 11 92	1400	1500	171515	13590	2	G	*Chrysiptera notialis*	110	30											
28 11 92	1400	1500	171515	13590	2	G	*Chrysiptera notialis*	110	34											
28 11 92	1400	1500	171515	13590	2	G	*Chrysiptera notialis*	110	27											
Sa'anapu-Sataoa Rotenone																				
1 12 92	1030	1330	171522	13590	2	R	*Parupeneus indicus*	305	640	M	2		Cra	50	Biv	50				
1 12 92	1030	1330	171522	13590	2	R	*Upeneus vittatus*	205	165	F	2		Cra	99						
1 12 92	1030	1330	171522	13590	2	R	*Mulloides flavolineatus*	200	140	F	4		Cra	99						
1 12 92	1030	1330	171522	13590	2	R	*Mulloides flavolineatus*	195	115	F	5		Alg	10	Biv	50	Wo	40		
1 12 92	1030	1330	171522	13590	2	R	*Mulloides flavolineatus*	165	80	M	3		Cra	99						
1 12 92	1030	1330	171522	13590	2	R	*Acanthurus xanthopterus*	190	180	I										
1 12 92	1030	1330	171522	13590	2	R	*Acanthurus xanthopterus*	185	155	I										
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	130	32											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	140	45											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	120	25											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	120	26											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	85	10											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	90	11											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	100	16											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	105	16											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	110	20											
1 12 92	1030	1330	171522	13590	2	R	*Kuhlia marginata*	105	16											
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	32	M	3		Alg	99						
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	115	47	F	4									
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	115	36	M	1									
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	100	27	M	2		Alg	99						
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	30	F	4									
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	28	F	3									
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	110	33	F	4									

DATE	HB	HE	LONG	LAT	Z	S	Species	L	W	S	M	GW	F1 %	F2 %	F3 %	F4 %
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	110	30	M	2					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	28	M	2					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	28	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	27	M	1					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	30	M	1					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	29	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	115	42	F	4					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	26	F	4					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	110	33	M	2					
1 12 92	1030	1330	171522	13590	2	R	*Chrysiptera notialis*	105	30	F	4					
1 12 92	1030	1330	171522	13590	2	R	*Valamugil seheli*	230	165	I						
1 12 92	1030	1330	171522	13590	2	R	*Valamugil seheli*	225	160	I						
1 12 92	1030	1330	171522	13590	2	R	*Valamugil seheli*	185	95	I						
1 12 92	1030	1330	171522	13590	2	R	*Zenarchopterus dispar*	155	80							
1 12 92	1030	1330	171522	13590	2	R	*Zenarchopterus dispar*	170	100							
1 12 92	1030	1330	171522	13590	2	R	*Zenarchopterus dispar*	165	90							
1 12 92	1030	1330	171522	13590	2	R	*Zenarchopterus dispar*	170	110							
1 12 92	1030	1330	171522	13590	2	R	*Zenarchopterus dispar*	170	100							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	220	175	F	4					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	235	205	F	2					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	200	155							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	205	145							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	200	150							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	175	89							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	160	72							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	165	73							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	115	26							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	175	83							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	125	36							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	140	44							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	140	46							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	140	47							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	200	145							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	185	105							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	185	115							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	195	130							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	195	125							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	190	130							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	120	28							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	160	75							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	290	435	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	230	325	F	4					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	225	195	F	2					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	225	205	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	195	135	F	2					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	215	165	F	4					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	200	150	F	4					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	190	115	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	175	100	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	180	96	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	170	84	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	140	46							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	120	30							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	180	105	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	220	195	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	215	160	F	2					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	200	135	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	230	200	F	4					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	200	125	F	3					
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	195	170							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	165	88							
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	155	63							

DATE	HB	HE	LONG	LAT	Z	S	Species	L	W	S	M	GW	F1	%	F2	%	F3	%	F4	%
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	170	93											
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	150	56											
1 12 92	1030	1330	171522	13590	2	R	*Therapon jarbua*	130	41											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	215	140	M	3									
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	225	165	F	4									
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	250	210	F	3									
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	225	150											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	210	130	M	2									
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	210	135	F	4									
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	190	100											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	190	110											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	200	115	M	3									
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	190	115	F	2									
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	200	125	M	3									
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	190	105											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	180	78											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	165	58											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	175	71											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	180	89											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	155	89											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	165	58											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	175	69											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	170	64											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	160	55											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	155	46											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	185	84											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	200	100											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	180	79											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	185	84											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	175	68											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	180	78											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	180	80											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	185	82											
1 12 92	1030	1330	171522	13590	2	R	*Liza melinoptera*	180	76											
Vaiusu Bay Gill Nets																				
3 12 92	1200	1300	171463	13494	2	G	*Chanos chanos*	135	41	I										
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	160	72	F	3									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	155	52	F	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	155	50	I										
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	155	51	M	2									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	140	42	M	2									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	145	42	M	2									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	145	39	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	165	69	F	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	160	56	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	150	49	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	150	49	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	135	37	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	140	38	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	140	41	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	140	35	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	140	40	M	1									
3 12 92	1200	1300	171463	13494	2	G	*Liza melinoptera*	135	37	F	1									

Appendix IV : Proposed models for data collection sheets.
Each sheet should be be in a A4 format.

Catch composition sheet model

DATE : BEGINING HOUR : ENDING HOUR : DURATION :

LONGITUDE : LATITUDE : DEPTH : FISHING GEAR :

NB OF SPECIES : NB OF FISH : TOTAL WEIGHT :

Species	Code	Number	Weight (g)	Notes

Biological analysis sheet model

DATE : BEGINING HOUR : ENDING HOUR :

LONGITUDE : LATITUDE : DEPTH :

FISHING GEAR :

Species	Code	L (mm)	W (g)	S	SM	GW	F1	%	F2	%	F3	%	F4	%

Where : Species can be coded;
L is fork lenght in mm;
W is fresh weight in g;
S is sex (male, female or immature)
SM is sexual maturity index as defined in table 3;
GW is the weight of the gonad;
F1 is the first food item;
% is the volumic percentage of the first food item;
F2 is the second food item;
% is the volumic percentage of the second food item;
F3 is the third food item;
% is the volumic percentage of the third food item;
F4 is the fourth food item;
% is the volumic percentage of the fourth food item.

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