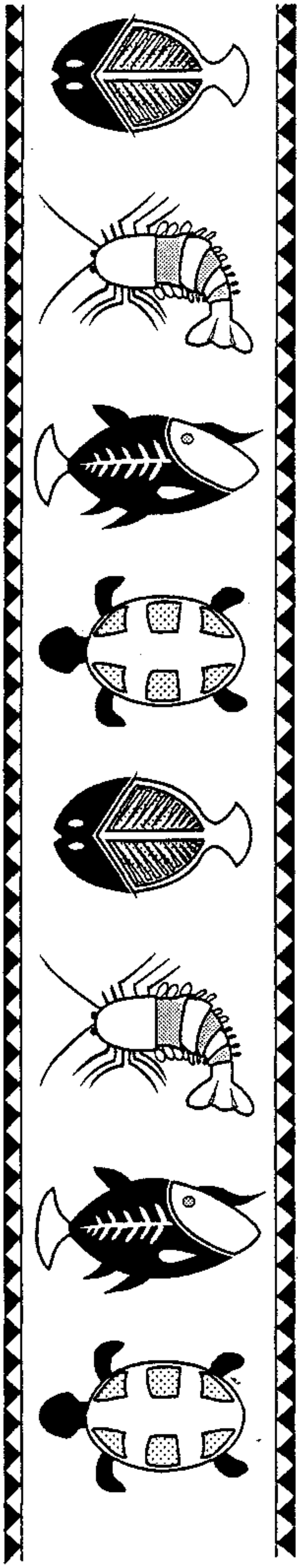


ISSN 1018-3116

Inshore Fisheries Research Project
Technical Document No. 4

FISHERIES RESOURCES AND MANAGEMENT INVESTIGATIONS IN WOLEAI ATOLL, YAP STATE FEDERATED STATES OF MICRONESIA

South Pacific Commission
Noumea, New Caledonia

Fisheries resources and management investigations in Woleai Atoll, Yap State, Federated States of Micronesia.

by

Andrew Smith[1] & P. Dalzell[2]

1. Marine Resources Management Division
Dept of Resources & Development
PO BOX 251
Colonia
Yap
Federated States of Micronesia

2. South Pacific Commission
BP D5,
Noumea
New Caledonia

a. Present address:
South Pacific Regional Environmental
Programme
PO BOX 240
Western Samoa

South Pacific Commission
Noumea, New Caledonia
1991

Original text: English

South Pacific Commission Cataloguing in publication data

Smith A
Fisheries resources and management investigations in Woleia Atoll, Yap State, Federated States of Micronesia/ by
A. Smith, P. Dalzell.
(Inshore Fisheries Research Project technical document ; no. 4)

1. Fishing-Woleai 2. Fishery resources—Woleai
3. Fishery management-Woleai I. Dalzell, P.
II. South Pacific Commission Inshore Fisheries Research Project IV. Title VI. Series

639.2099626 AACR2
ISBN 982-203-318-4

Prepared for publication and printed at
South Pacific Commission headquarters,
Noumea, New Caledonia, 1991991

SUMMARY

Four depletion fishing experiments were carried out at Woleai Atoll (Federated States of Micronesia) between May and June 1991 to estimate standing stock biomass of reef fish on the shallow reefs. Two experiments were conducted with a traditional leaf sweep method and two with group spearfishing. The dominant fishes in each instance were surgeonfish and parrotfish which formed between 60 and 90 per cent of the catch. Decline in the catch rate versus cumulative catch was observed for total, surgeonfish and parrotfish catches in each experiment and this was used to compute standing stock biomass. The standing stocks ranged from 5 to 25 t/km^2 with a mean of 12 t/km^2. The total fishable standing stock of shallow water reef fishes on the shallow reefs of Woleai lagoon was estimated to be 60 t or about 470,000 fish. Parallel underwater visual census counts were made of five fish families (Acanthuridae, Scaridae, Chaetodontidae, Lethrinidae, Lutjanidae) at the fishing sites and at adjacent control sites. No significant declines were observed in the numbers of surgeonfish and parrotfish at the fishing sites foEowing fishing activities. This was ascribed to deficiencies in the census methodology which tended to enumerate juvenile rather than adult fish. Spearfish catches contained a greater range of species and spearfishing tended to be positively biased to larger specimens of species common to both fishing methods. The results of this study were discussed with respect to the conservation and management of reef fish stocks in the remote atolls such as Woleai.

RESUME

ACKNOWLEDGEMENTS

This project was funded by the Yap State Legislature and the South Pacific Commission's Inshore Fisheries Research Project. We would like to thank the Council of Tamol and especially the Woleaian Chiefs for their co-operation and permission to conduct the project. We would like to thank all the fishermen who worked with us on the project for their patience and good humour which greatly contributed to the project's success. A special note of thanks is due to our temporary assistants: Titus Hasug, Philip Maiufil, Hosey Rechmai and Sebastian Tachibmai.

CONTENTS

TABLES

FIGURES

INTRODUCTION

The islands that comprise Yap State in the Federated States of Micronesia (FSM) consist of small closely associated high islands of Yap proper to the west and 15 smaller coral islands and atolls to the east (Figure 1). In all, the total land area of Yap State amounts to about 120 km^2, of which only 16per cent consists of the outer island land. By contrast, the total area of lagoon enclosed by reefs in Yap State amounts to about 1050 km^2, with all but three per cent of this in the outer islands (Anon. 1988). In common with people living on small coral islands and atolls in the Pacific, the Yap outer islanders have traditionally relied on the sea as a major source of food in the form of fish, invertebrates, turtles and in some instances, cetaceans. Not surprisingly, fishing and seamanship skills are highly developed amongst the Yap outer islanders.

The populations of many of the islands that comprise Yap State were seriously depleted by increased mortality from disease following European intrusion into the Pacific in the middle of the second millennium. Present annual population growth rates in the FSM are estimated to be 3.4 per cent (Connell 1984) and in Yap State about 2.3 per cent (Anon. 1988), which represents a net doubling of the population in about thirty years or approximately one generation. This rapid population growth is mitigated to some extent by emigration of people to Guam, Hawaii and the mainland United States; however, the populations of Yap State are likely to continue growing rapidly. This rapid increase in population will require an additional increase in food production from primary sources, which in the outer islands effectively means an increase in annual landings of fish.

Both reef fish and open ocean pelagic species such as tunas are targeted by fishermen in Yap State's outer islands. Reef fish are particularly important as they represent a more or less constant source of protein, while fishing for high seas pelagics is seasonal and weather-dependent. Not all the reef areas can be fished throughout the year due to rough seas from the seasonally prevailing north-easterly winds. However, the fish and invertebrate populations on the inner lagoon back reefs represent a resource that is fishable throughout most of the year and important in terms of food security for the outer islanders.

Virtually nothing is known about the catch rates, catch composition or stock sizes of inshore reef fish in Yap State. Under the Yap State Government, the investigation and management of fish stocks is the responsibility of the Marine Resources Management Division. In practical terms, however, the remoteness of the outer islands, lack of funds and trained staff has precluded acquiring information for the management of outer island reef fish stocks over the long term. Recent documentation of traditional fishing practices in the Yap outer islands (Smith in prep.) suggested that short term studies in the outer islands might yield valuable management information, particularly where community fishing methods were used.

Community fishing by men is a feature of all the Yap outer islands and is practised with traditional and introduced fishing methods. As community fishing can generate significant fishing pressure, it was recognised that these methods would lend themselves to some form of simple stock depletion experiment and hence estimation of reef fish biomass. When a stock is fished intensively over a short period, then the compensatory mechanisms of growth, recruitment and immigration can be ignored and the decline in catch rates will be proportional to the initial biomass or standing stock (Ricker 1975). Such information is extremely useful for determining potential yields from a fishery and also provides a historical record for future comparative studies.

In this report we describe a series of four fishing experiments that made use of traditional scare-line drive-in-net fishing and group spearfishing to estimate standing stocks of fishes on the inner back reefs of Woleai lagoon. Woleai Atoll was chosen as the site for an initial series of stock depletion experiments because community fishing with drive-in-nets and group spearfishing are regularly practised there. Further, the atoll is divided into a western and eastern lagoon. People live on the islands of both lagoons but two thirds of the population live around the eastern lagoon. There is a strong system of reef tenure on Woleai so that the reefs of the eastern lagoon are traditionally more heavily fished than those in the western lagoon due to the greater number of people in the east. Although annual landings of fish are not known, the population imbalance provided some comparison between stock densities under different fishing intensities. These fishing experiments also provided useful ancillary management data on species composition and size frequencies of the target species. These and the estimates of standing stock are discussed with respect to the present and future levels of production from the reefs of Woleai Atoll.

STUDY SITE

Woleai Atoll is located at 7°22'N, 143"52'E and lies about 675 km to the east-southeast of Yap proper. The atoll is shaped in the form of a figure eight (Figure 1) and covers a total area of 47.89 km^2. The total land area amounts to only 4.5 km^2, encompassing a lagoon area of 28.7 km^2. The area of shallow reef was estimated by planimetry from the most recent topographic chart to be 10.8 km^2, with 5.1 km^2 classed here as back reef. The larger of the two lagoons is the western lagoon which is about twice the area of the eastern lagoon. Depths in the centre of the eastern lagoon range from between 20 to 35 m, while the western lagoon is deeper with depths ranging from 35 to 50 m.

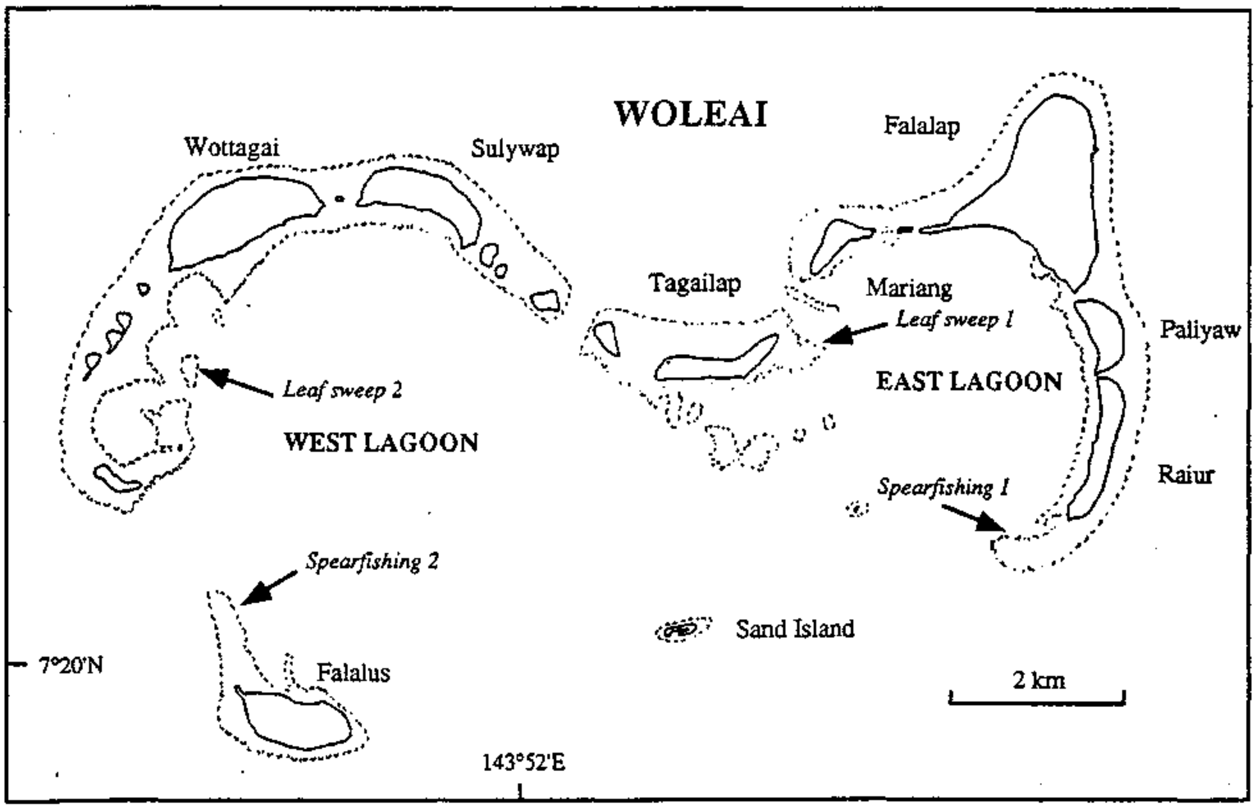


Figure 1. Map of Woleai Atoll showing places named in the text and the locations of the four fishing experiments

The climate of Yap and the outer islands is equatorial with mean monthly temperatures ranging from 27°C to 31°C through the year with an average of 28°C. Average rainfall is about 3000 mm/yr with most precipitation occurring from July to October. No hydrographic data for Woleai were found in the literature although it would be expected that annual sea water temperatures would be similar to air temperatures. The larger islands of Woleai possess substantial amounts of subterranean freshwater, however, the lack of any substantial fresh-water runoff means that salinities in the lagoon will approximate to those of the open sea and range between 35 and 36 ppt.

The population of Woleai is approximately 770, with about 500 people living on the islands of Tagailap and Falalap in the eastern lagoon. Employment opportunities are normally very limited on Woleai, but at the time of these investigations about 30 men were employed in the construction of an airfield and runway. Apart from canned meats bought at local stores, the main sources of animal protein are fish, pigs, turtles and dogs. Fish is the most common of these and communal fishing is an important activity to provide large quantities for social events such as marriages, funerals and holidays. Most fishing is carried out by the men of the atoll, although women glean the reefs at low tide for shellfish and small fish caught in baskets (see next section).

No information on the fisheries resources of Woleai are apparent in the literature. The South Pacific Commission's Regional Tuna Tagging Programme's fishing vessel, the *Te Tautai,* captured baitfish at Woleai on the morning of 9 September 1990 at 04.00 hrs. A total of 41 buckets (~ 74.0 kg) of bait were captured that comprised about equal quantities of the sprats *Sprateiloides gracilis* and *Spratelloides delicatulus.* Other species in the catch were the hardyheads *Atherinomorus lacunosus, Hypoatherina temmincki,* and the cardinal fish, *Rhabdamia cypselurus.*

TRADITIONAL FISHING ON WOLEAI

Literature

Very little has been published concerning fishing on Woleai. The only descriptions of fishing occur in the ethnographic literature. These accounts are concerned with the social aspects of fishing, mainly describing and discussing the rituals associated with fishing.

Kramer (1937) provides brief accounts of methods, equipment and ritual associated with fishing on Woleai in the early 1930s. The majority of other references come from publications by Alkire resulting from field work in the 1960s and 1970s. Alkire (1978) refers to various fishing activities among the daily activities he observed on Woleai in 1965. The method for capturing dolphins and the ritual associated with their consumption is detailed in Alkire (1968a). Other papers touch on the use of canoes and navigation (Alkire 1970) and ethno-geographical classifications (Alkire 1968b). Moore (1987) provides a very brief overview of current fishing practices and use of marine resources in the Yap outer islands. The subsistence use of turtles in the Caroline Islands, including Woleai, is discussed by McCoy (1974, 1981).

Information specifically on traditional fishing and marine management was recorded for Woleai by Smith (in prep.) as part of a survey of all of the outer islands of Yap State. A total of 54 named fishing methods was recorded. The actual number may be higher as later research on adjacent atolls extended this list to approximately 90 named methods. The actual number of methods will vary considerably with the classification system used. For example, on Woleai the various species-specific bottom-line fishing techniques are virtually identical, only the location and in some cases the timing varies. Each, however, has a distinct names.

Woleaian marine management and fishing

Before briefly outlining the fishing methods used at Woleai, an overview of the traditional management system is necessary. All customary use rights and marine tenure systems are intricately bound up in the complicated cultural and social systems. These systems are inherently dynamic and to specify one aspect as 'traditional' and another as 'non-traditional' is of little practical value. This report does not discuss marine management in its social context, however, its importance in marine resource usage and management must be recognised.

How Woleaians perceive their environment, relative to the Western system, is also of use in investigating marine resource usage. Alkire (1968b) asserts that from the Woleaians' point of view there are four main geographic features: the open sea **(metaw),** the lagoon **(lamw),** the reef **(wosh),** and the land **(faliuw).**

The lagoon area is defined as the area enclosed and sheltered by the reef, with the enclosing configuration of the reef being the most significant factor (Alkire 1968b). Woleaians recognise three lagoons: the eastern lagoon, the western lagoon, and the small enclosure between Pial and Wottagai islands. The channels **(taw)** are the openings connecting the lagoon to the sea, large enough to permit a canoe to pass. Woleaians recognise eleven such channels (Alkire 1968b).

The reef areas are significant primarily as resource areas, and secondarily as potentially dangerous areas when travelling by canoe or boat. Alkire (1968b) notes that Woleaians conceptually subdivide the reef into different 'ecological zones' which differ from western geography. Of importance are: points of sharp curvature on the reef called tegai; protruding reef segments found on the ocean sides called **mangal** (there are about 35 to 40 named sites); large coral heads protruding from the lagoon floor and separate from the reef called **moto** (Woleai has 30 named within the lagoon); reef isolates, and submerged reefs, often separate to the atoll, called **fas.**

Marine management

Tenure rights exist over all the reefs and lagoons of Woleai. These rights lie with the chiefly clans and subclans. In the Yap State outer islands the major socio-political groupings are based on the matrilineal clans. These clans are ranked upon the sequence of their arrival on different islands. The spokesperson for a land holding group is its 'chief, usually the oldest competent male of a lineage or subclan (Alkire 1989). There are various levels of 'chiefs', the lowest being the 'chief of the lineage'. Where there are several lineages of the same clan, the eldest man of the senior line is also the 'chief of the clan'; and if the clan was one of the 'founding' clans, then the clan chief will also be a 'chief of a district' (Alkire 1989).

The lagoon and reefs are divided into sections, each of which is controlled by the appropriate chief. The chief, as guardian, has the right to restrict certain kinds of fishing in the areas he controls. For example, in the case of a funeral ceremony, he can prohibit fishing altogether for a specified time. The power to close a section of reef to all fishing has been adapted in recent times to include reefs where the chief and fishing masters feel there has been too great a decline in fish numbers. This decline has usually been attributed to spearfishing.

The following passage from Alkire (1974: 49—50) elaborates on marine tenure in Woleai:

> Sections of the reef and lagoon are divided among the various chiefs of the islands, but intra-atoll political organization has resulted in a more complex division of rights. Here is a socio-political system called the '**sheolifaiumwag**' that unites the different districts and clans of islands at opposing ends of the lagoon in a reciprocal exchange system...This system can be referred to as the 'intra-atoll exchange system'. In these instances a clan from an eastern district which controls and portion of the reef shares this control with a clan from the west which is united with it in the 'intra-atoll exchange system', and vice versa.
>
> ...Because of the 'intra-atoll exchange system', Woleai clan of Falalus has a right to exploit that part of the eastern reef of the atoll that is directly under the control of the chief of 'Woleai clan' of Iur district on Falalap Island. The Iur district 'Woleai clan' chief could give sections of

the reef to some other clan if he wished, as long as he gained permission from the other senior members of his clan; but he would have to tell Falalus residents about the transfer so they could appropriately restrict their fishing.

The whole 'intra-atoll exchange system' seems intimately tied to reef and lagoon ownership. Pigul district of Wottagai is the one major district of the atoll not involved in the 'intra-atoll exchange system', and the chief of this district does not control any reef or lagoon areas. Chiefly control of a reef area not only means that the chief can pass these rights on to another clan as outlined above, but that he can restrict or prohibit fishing in these areas. Only members of the particular chiefly clan are permitted to place fish traps on the reef. Anyone, however, is free to fish the area with spears or hook and line. Net drives on the reef are also restricted since they are communal affairs initiated and organized by a chief. The chief can close the area to all types of fishing for the duration of a funeral ceremony, which may last for several months, when someone from his clan dies.

Contemporary fishing

Today only about half of the 54 named methods are still used and approximately one third used regularly. The most common methods employed by individuals today are spearfishing, trolling from outboard powered boats, and line fishing from small canoes or boats. Seasonally, fish traps are set on the lagoon bottom, and when conditions are appropriate tuna poling is conducted from sailing canoes. The main community fishing activities are leaf sweeps (roop), group spearfishing (gapiungiupiung), beach seining (yeting) (with large coconut sennit nets for capturing schools of bigeye scads, *Selar crumenophthalmus,* and occasionally tuna, and an encircling method using a rope and net to catch schools of rainbow runner *(Elagatis bipinnulatus).*

Fishing techniques on Woleai can be loosely grouped into nine categories: bottom lines; pole-and-line; trolling; spearing; traps; fish drives; nets; collecting; and miscellaneous techniques.

Bottom lines: The techniques of bottom line fishing at Woleai vary considerably. The diversity has dramatically increased since metal hooks and synthetic lines became readily available. Line fishing can be conducted anywhere within the lagoon, over the reef, and outside the reef. Deep bottom fishing is only occasionally used due to the difficulty of pulling hand lines from depths. Location is of key importance and often kept secret from other fishermen, although certain areas are well known for certain species. Line fishing is conducted both day and night. The primary bait used at Woleai is octopus. The use of any pelagic fish for bait is prohibited. Fish bait is only used after a large catch of, for example, bigeye scads with the beach seines. The use of any other bait is restricted, except for certain specific methods. For some techniques, and when sinkers are unavailable, baited lines are wrapped around small rocks and secured with a slip knot. Also wrapped to the rock by the line is some chewed-up bait. When the rock and line reach the bottom, or the desired depth, the line is tugged and the rock and chum released.

Pole-and-line: There are two categories of pole-and-line fishing: one is tuna poling, and the other uses poles with light lines and small hooks in the shallows or from the beach. Tuna poling is used primarily from sailing canoes during the north-east trade wind season (November to April), and is most often done at the fas a few miles to the north of Wottagai. No boats or outboard motors are permitted at this fishing site, and no trolling is allowed. The lighter poles and lines used from the beach and shallows are often used by young boys to catch fish such'as small trevallys and jacks (Carangidae).

Trolling: Trolling for pelagic species (tunas, wahoo, etc.) from outboard powered boats is one of the more common methods in use today. When open water trolling for large pelagics such as wahoo *[Acanthocybium solandri),* barracuda *(Sphyraena* spp.), dolphinfish *(Coryphaena hippurus),* yellowfin tuna *(Thunnus albacares)* and skipjack tuna *{Katsuwonus pelamis),* the lures are dressed with young, light yellow-coloured coconut leaflets torn in such a way as to imitate the wings of flying fish. Other slower forms of trolling are also still used. These include trolling for needle fish with octopus bait from paddling canoes; and trolling for holocentrids and carangids at night over the edges of the reefs.

Spearing: Spearing with a single wire, propelled by an unattached piece of surgical rubber tubing, is the most common method in use today. This technique can be used by individuals and small or large groups. It is also used to catch octopus as bait for line fishing. Flashlight spearfishing at night has been prohibited at Woleai due to the ease with which reef fish were being caught. For a while in 1989 and 1990 all spearfishing was banned by the chiefs of Falalap. Locally made spearguns are used for catching larger fish, but are considered cumbersome and too slow to reload for general reef spearing. Also included under the category of spearing is the harpooning of turtles, predominantly greens.

Traps: There are three types of fish trap still in use. The large **uulimorouwel** was primarily used for tying to floating logs in the open ocean, into which the log-associated rudderfish (Kyphosidae) would swim when the log was towed. These traps are now largely used as capture baskets when bigeye scads are seined. The **uulibiyow** trap is used to fish in the lagoon during the NE trade wind season. The trap is placed unbaited on the lagoon floor adjacent to small coral heads or rocks, and checked every two days. There is considerable skill and knowledge used in determining the right location, orientation and making minor positional adjustments. The design of the entrance to the traps is considered of prime importance and this is secret knowledge passed on to relatives only. The third type of trap, **uulipaamw,** is used to catch small yellowstripe goatfish *(Mulloides flavolineatus)* when schools are seasonally found on the lagoon-side beaches of the islands. The traps are set in only 1 to 2 m of water and the trap is kept on the bottom by pouring a layer of sand into it to cover the base. Bait consisting of pounded landcrab mixed with loamy sand is rolled into small balls and placed inside the trap and around the entrance. The trap is lifted and the fish removed after 5 to 10 minutes in the water.

Fish drives: The two main types of fish drives are **roop** and **gapiungiupiung** which are described in detail further below. Other types of fish drives are still known but rarely used.

Nets: There is a diverse group of techniques which uses nets. The most common community method would be the beach seining of scads. Other methods include: cast nets; fish drives into capture nets; scoop nets, including flying fish fishing (rarely used now); and lift nets. If a school of tuna or rainbow runner is spotted within the lagoon, the men will rush out and try to surround the school with a rope with men positioned along it. If the school is successfully encircled, the large seine nets will be brought out and the fish hauled ashore or into the boats. This type of opportunistic fishing requires virtually all the men to participate.

Collecting: This category includes a wide variety of methods, for example, collecting tridacnid clams, hooking octopus, collecting lobsters on the reef flat at low tide during the full moon, collecting of shellfish by women and children (not very common nowadays), and collecting small fish such as triggerfish from under rocks at low tide on the reef flat.

Miscellaneous: Breadfruit leaf kite fishing for needlefish (Belonidae) is still used by some of the older men. Torch-light fishing for flying fish was last used in the 1970s, but is still considered as currently in use.

***Roop* fishing: Roop** fishing is conducted on any sloping back reef or, weather permitting, on some outer reefs. At Woleai there are specific sites used for **roop.** Calm seas and weak currents are required before **roop** can be done. The starting depth is variable, but is usually done where the bottom can be seen. The size of the initial sweep depends on the numbers of sections of **roop** scare-line and fishermen. The following account is based on field notes of the senior author and describes **roop** fishing conducted in late May 1988. This was performed for the 'opening' of the outer reef of Tagailap which had been closed to all fishing from January to May due to the death of a chiefs sister.

Our canoe house's section of **roop** (approximately 50 m long) was prepared this afternoon. Other canoe houses were doing the same...[Next day] the men from our canoe house were ready to go by about 0730. However, as Iyefang village was 'conducting' the **roop** nobody could put a boat in the water until they did. Their first boat went in the water just before 0830, immediately boats and small paddling canoes were launched by the other canoe houses.

The wind was about 5 knots from the SW, later in the day it picked up to 10 knots. Seas were flat, just a few low waves and virtually no swell. Mostly sunny; few patchy clouds. Tide high, but dropping. Eight outboard powered boats, each with one **roop** section, and 13 small paddling canoes took part. All the men and youths of Falalap and Tagailap took part. The middle school boys were given the day off to help. Estimated about 80 men and boys. All boats and canoes converged on the northern side of Tagailap's reef. Had to wait for about 30 minutes as the boat with the net was late with motor trouble, had to.be towed over; but later the engine started. I was told that the fishing master is supposed to be in the net boat which is positioned centrally. However, later told that about six men were giving directions instead of one.

First set commenced at about 0930 and took about 5 minutes to run the **roop** sections out. The net boat positioned itself centrally...in about 13 m of water. They ran their section of roop out parallel to the reef, then at either end two other boats tied their sections on and ran them out, laying the **roop** in an arc.Ropes were attached to the ends of the **roop** and walked into the breakers. Meanwhile, each boat positioned itself in the middle (or thereabouts) of their section of **roop,** and the canoes and fishermen were spread evenly between them. Weighted lines were attached to the **roop,** so the weight was about 30 cm below the middle of the **roop.** The other end of the line was attached to a boat, canoe, or float. One fisherman tended that line, adjusting its length so that the **roop** was just off the bottom. If stuck on coral heads, a diver would release it. The **roop** moved quite slowly over the bottom, speed depended on those pulling the rope ends in the breakers...As the **roop** swept into the shallower water, fishermen dived down and chased fish back that tried to escape through small surge channels.

When the rope ends were nearly joined, the net boat moved inside the roop and set the capture net in about 3.0—4.5 m of water. The opening of the V-shaped net faced the shallow water. The sections of **roop** were untied adjacent to the capture net and each end tied to the coral next to each side of the entrance of the net. The **roop** was then pulled towards the net entrance by doubling the **roop** ends back towards the net. Divers formed a barrier either side of the entrance to prevent fish escaping around the net ends. On a signal all the fishermen dived down and chased the fish into the net entrance. A trip line was pulled to close the cod--end and the wings of the net released from the coral and bundled in towards the cod-end and the whole net raised quickly to the net boat which was anchored next to the net. A second heavier net was put under the capture net to provide extra support as the catch was lifted into the boat.

...The **roop** sections were pulled into their respective boats. The first set ended at 1100. About 5 minutes later a second set was made to the west of the first...The same procedure was used as for the first set...A greater number of fish were caught. This set took about one hour. A third set was made to the east of the first set...Same procedure; same size catch as for the first set; again took about an hour. A fourth set was made to the NE of Tagailap. Here the water was shallower, but the current stronger...Same procedure; catch as for 1st and 3rd sets. Also took about one hour...The fifth and final set was made in shallow water off the eastern end of Tagailap *[Note: Just to the north of the site for leafsweep 1].* The current was strong; maximum water depth about 1.8—2.5 m. This set produced a catch about equal to the 2nd set. Fishing ended about 1500. After this, boats and some canoes took the catch to Tagailap to divide the catch.

...Fish were initially divided into piles of 'large, good fish' (these were mostly scarids, lutjanids and lethrinids) and 'small fish' (largely acanthurids)...While dividing the fish, the 'good' fish

> were being counted. After that the 'small' fish were counted, ignoring the very small fish. Total count was approximately 1500 fish...Described as not very good for the number of sets; they expected around 2000—3000 fish...The older men sat around to determine how the catch would be divided *[Note: There are specific systems for dividing these catches]...From* the large fish, 100 were set aside for the 'reef opening';..About 500 of the smaller fish were set aside for the middle school graduation tomorrow. These were divided amongst the villages and then amongst the families in the villages to cook the fish...Of the remaining fish, these were divided: 2 fish for each person on Falalap and Tagailap; the left over fish were then divided 5 for each family.

roop is used during the boreal summer months (June-August) only. It is best done as the tide drops, starting at the turn of the tide. It will only be used at most about four times per summer (per island). The chiefs are the only ones to decide when it can be done. When a decision is made to conduct **roop** fishing, all available men are supposed to assist.

Gapiungiupiung fishing;. **Gapiungiupiung** or group spearfishing can be performed at virtually any reef location, but is predominantly done on reef slopes (back reefs and especially outer reefs) adjacent to the wave break/surf zone. A minimum of ten men are needed, although usually more are required. It is conducted either by the whole community or by the men of one or two canoe houses. The method usually requires calm seas and clear water, so is done mostly during the summer, although when conditions permit it can be performed any time of year. It can be carried out during any tide phase and level. There are no restrictions on how often it can be performed, and the decision to conduct rests with the chiefs or a group of men at the canoe house. If a fish trap is set on the reef, **gapiungiupiung** cannot be used within 400 m. It cannot be done on any 'closed' reefs. Traditionally, **gapiungiupiung** could only be done on the reefs owned by the participants. Now it can be done anywhere as long as permission is requested first (this is very rarely refused).

METHODS

Fishing methods

Four fishing experiments were carried out over a four-week period commencing on the 15 May and terminating on 10 June 1991. Two fishing experiments were carried out using **roop** fishing and a further two by group spearfishing, or **gapiungiupiung.** The details and dimensions of the gear used for **roop** fishing are given in Appendix 1. The scare lines in both ***roop*** experiments were made from coconut sennit rope, traditionally manufactured by the men of Woleai. Wound on to the rope were strips of green coconut leafs (still attached to a strip of rachis), and fastened so that the leaves protruded from the rope.

The net used in both instances was a 4.5 cm mesh seine net, set in a V-shape (Figure 2) on the reef and temporarily sown part of the way along the bottom to form a cod-end. The scare lines were joined and set in a circular pattern on the reef, and sunk on the bottom by weights attached to the rope. At intervals along the rope were small lines from the weights to the surface by which the rope could be lifted over the coral heads. The net was set on the lagoon side and inside the periphery of the fishing area (Figure 2), with the mouth of the V pointing toward the centre (i.e. towards the shallower water).

The scare line initially formed an incomplete circle, the gap being on the shallowest side of the fishing area. Fishermen bridged the gap to keep fish within the periphery of the fishing area. As the scare line was pulled the two ends overlapped, while at the opposing side the scare line was parted and each end attached to the mouth of the net. The scare line was steadily pulled to drive the fish towards the net (and deeper water). The fishermen followed behind and above the line to add their efforts to driving the fish and to prevent the line from snagging on the coral. As the fish were chased into the net, some fishermen crowded into the mouth to prevent them escaping, while others succeeded in closing the mouth and secured the catch.

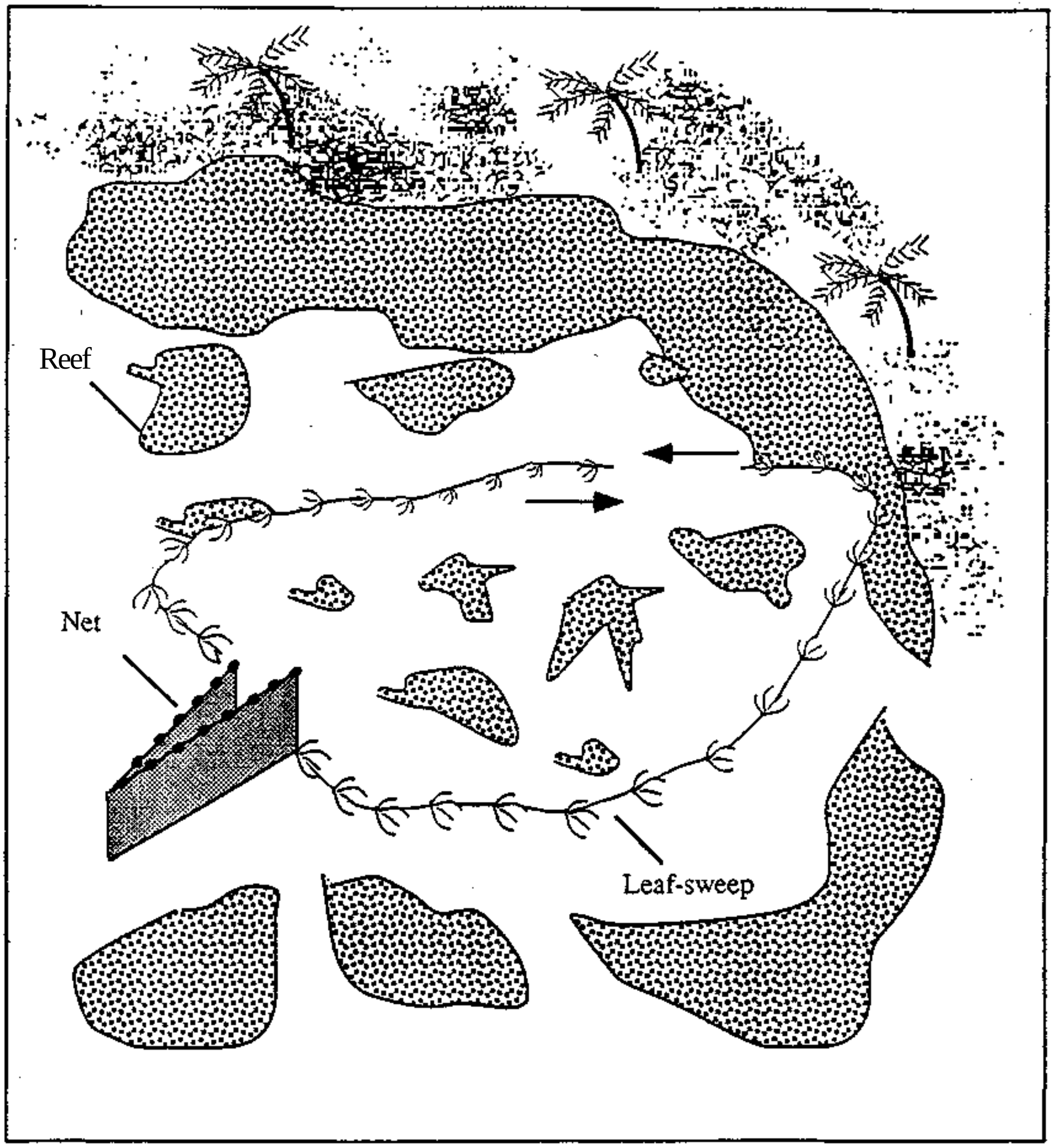


Figure 2. Sketch of the deployment of the net and leaf-sweep employed for roop fishing. The leaf sweep has been attached to the two wings of the net and is being pulled in the directions indicated by the arrows to shorten the diameter of the scare line and thus to drive the fish towards the net

On the first day of each roop fishing experiment, the scare line was laid down on the reef but was not hauled immediately. The periphery described by the scare line was marked with surveyor's tape, approximately every 10 m, so the scare line could be reset at the same location on successive days. Prior to sinking the scare lines on the first day, sightings were made at various points with a range finder to measure the diameter of the circle described by the coconut rope. In both instances the shape of the scare line was elliptical rather than strictly circular. The fishing was delayed slightly each day—approximately 45 to 60 minutes—to ensure that the fishing was done at about the same tide phase.

About 45 men were involved in roop fishing. A similar number of fishermen were employed for the gapiungiupiung fishing. The fishermen formed a circle in the water, then slowly swam to the centre, concentrating the fish which attempted to hide in amongst the interstices of the coral. The fish were speared with wire spears 1.5 to 1.8 m long. On the first day of fishing for each experiment, the fishermen paused in the water after the circle was completed and at a given signal dived to the substrate and tied pieces of surveyors' tape to the coral.

Prior to the signal for attaching the tape, sights were taken with the range finder to determine the shape and diameter of the fishing ground. Again, each day's fishing was delayed to allow the fishing to occur at the same tide phase. Unlike fishing with **roop,** each **gapiungiupiung** fishing experiment was timed to obtain the fishing effort. Fishing effort was expressed as the product of the number of men by hours fished. Fishing times varied from forty-five minutes to one hour, depending on when the fishermen began to lose interest in fishing as fish became scarce. As effort slackened, then a halt was called to that day's fishing.

A summary of the four different fishing experiments by site, dates, gear and designation used in this report is given in Table 1. The four sites were all gently sloping back reefs within the lagoon and consisted of areas of hermatypic coral interspersed with areas of sand and coral bommies. The depths fished in each instance ranged from between 1.5 and 5.0 m. The shape of the fished area in each instance was elliptical rather than strictly circular, based on a number of measurements of the diameter taken at different points on the periphery. The formula for an ellipse was used to compute the fished areas and these are also included in Table 1.

Table 1: Details of the four fishing experiments undertaken at Woleai Atoll, May-June 1991

Fishing experiment	Site	Area (ha)	Dates	Gear	Designation	Comments
1	Xagailap	1.32	15-17/5/91	Leaf sweep and stationaiy seine net	Leaf sweep 1	Fished three weeks previously by group spearfishing
2	Wottagai	2.12	21-24/5/91	Leaf sweep and stationaiy seine net	Leaf sweep 2	Fished six months previously by leaf sweep fishing
3	Raiur	2.04	28-31/5/91	Group spearfishing	Spear fishing 1	Fished two months previously by spearfishing
4	Falalas	1.12	4-7/6/91 & 10/6/91	Group spearfishing	Spear fishing 2	No fishing on this reef for over a year

Underwater visual census

Prior to and after each fishing experiment, a series of transects was laid and underwater visual census counts of five fish families made. Two or three 50 m transects were laid in each fishing site and an adjacent control site. The transects were swum by a pair of observers linked by a 5 m piece of line. Each observer counted all the parrotfish (Scaridae), surgeonfish (Acanthuridae), groupers (Serranidae), snappers (Lutjanidae), emperors (Lethrinidae) and butterflyfish (Chaetodontidae) in the 50 m transect. One observer swum along the transect line and used the position of the other observer to judge the boundary of the 5 m transect width. The other observer used the transect line as the boundary for his set of counts.

On the initial upward leg of the transect, the observers counted all parrotfish, emperors, groupers and snappers. On the return leg, the observers counted the number of surgeonfish and butterflyfish. Apart from making the counting easier by splitting up the target families, the first four families were more prone to swim away from the observers and required counting at first sighting. To minimise the effects of disturbance, a ten-minute interval was left between the time the transect was laid and observation swims begun. Three counts were made on each transect with a ten-minute gap between the rotation of different pairs of observers.

Biological data

After each day's fishing the catch was separated to species level, based on identifications in Masuda et al. (1980 1984) and Myers (1989).The lengths of fish in the catch were measured to the nearest 0.1 cm and the weights recorded to the nearest 10 g. Where a large number of a particular species was caught, only a portion of the total was processed for length and weight data, but the total numbers and weight captured were recorded. The need to process the catch quickly so that it could be divided up and eaten meant that few other biological data could be collected. Sex was recorded where coloration or shape was obviously sexually dimorphic. Further, the bellies of fish were squeezed gently to see if they were in a ripe or spawning condition through the release of eggs or sperm.

Equipment comparison

During June 1988, an inventory of all canoes, boats, outboard motors and fishing equipment located in and around the canoe houses was made for all islands within the atoll, with the exception of Tagailap. A similar count was made during this study. Only equipment always stored within the canoe houses was included in this report. Various other types of fish traps and fishing poles, as well as personal fishing equipment, were usually stored at the owner's house. Some traps were used seasonally and were constructed for that season only. Those types of trap were omitted from the comparison. Harpoons were primarily used for catching turtles.

RESULTS

Catch composition

In all, just over 100 species of fish belonging to 25 families were captured during the four fishing experiments on Woleai. The percentage composition of the catch by family taxon for each of the four fishing experiments by weight and numbers is given in Table 2. A more detailed record of the catch composition by species is included in Appendix II. The catches from these inner lagoon back reefs were comprised principally of surgeonfish (Acanthuridae) and parrotfish (Scaridae). Surgeonfish and parrotfish together comprised between 70 and 90 per cent of the catch from leaf sweep fishing, while these two families accounted for between 60 and 80 per cent of the spearfishing catch. The emperors (Lethrinidae) accounted for about 12 per cent of the catch by numbers for the first leaf sweep, most of which was a single species, *Gnathodentex aurolineatus*. A school of this species was present around one coral head within the fishing area and large numbers of this species were captured on the first and last day of fishing. Besides the surgeonfish and parrotfish, other common features of the two leaf sweep catches were the goatfish (Mullidae), butterflyfish (Chaetodontidae), wrasses (Labridae) and rabbitfish (Siganidae).

The first and second leaf sweep fishing experiments captured a total of 41 and 53 species respectively. A greater number of families (Table 2), and hence species, were captured by the two spearfishing experiments. A total of 76 species were captured in the first spearfishing experiment, while a slightly smaller number, 69 species, were taken during the second experiment. The catches of both spearfishing experiments contained significant amounts of triggerfish (Balistidae), groupers (Serranidae) and wrasses. Squirrelfish (Holocentridae) were of minor importance in the first spearfishing experiment.

Table 2: Summary of the catch composition of the leaf-sweep and group spearfishing experiments at Woleai Atoll

Family	Leaf sweep 1		Leaf sweep 2		Spearfishing 1		Spearfishing 2	
	% no	% Wt	% no	% Wt	% no	% Wt	% no	% Wt
Acanthuridae	48.49	35.10	62.92	4631	42.62	38.00	56.48	37.86
Scaridae	27.01	32.11	29.22	46.21	14.24	21.62	21.08	39.98
Lethrinidae	12.08	13.13	0.46	0.68	1.18	2.38		
Mullidae	2.52	236	1.14	0.7	132	2.02		
Cheatodontidae	235	130	3.03	1.63	1.72	0.87	2.62	1.01
Labridae	134	1.14	1.26	1.26	3.82	3.89	3.41	432
Siganidae	4.7	11.21	0.34	1.44	1.98	4.81	0.42	0.95
Monocanthidae	0.50	0.40	1.2	0.78	0.79	0.64	1.85	2.18
Lutjanidae	0.34	0.87	0.06	0.05	0.66	1.10	0.14	0.20
Zanclidae	034	0.43	0.11	0.12	0.53	0.35	1.14	0.71
Balistidae	0.17	0.13	0.11	0.09	11.08	9.60	7.12	5.12
Malacanthidae					0.13	0.29		
Pomacanthidae			0.06	0.06	0.13	0.11	0.14	0.12
Diodontidae			0.06	0.44	033	1.61		
Holocentridae					6.86	236	0.14	0.12
Serranidae					9.76	6.21	4.7	5.66
Grammistidae					0.13	0.003		
Cirrhitidae					0.13	0.13	036	0.10
Ostraciidae			0.06	0.03	0.79	0.26		
Synodontidae					0.26	0.02		
Bothidae					0.66	0.97	0.21	023
Belonidae					0.13	0.04		
Fistularidae					0.13	0.27		
Tetraodontidae					0.13	031		
Carangidae	0.17	1.82			0.26	2.03	0.14	1.47

Catch and fishing effort

The catch, fishing effort and catch per unit of effort (CPUE) in weight and numbers for the four fishing experiments are summarised in Tables 3—10. As the surgeonfish and parrotfish were the most important catch components, catches of these fishes were extracted from the raw data and are included in the tables. For the leaf sweeps, catch and catch rate are equivalent, while with spearfishing the CPUE was expressed as the catch divided by the product of the time spent fishing and number of spearfishermen.

Catch rates of leaf sweep fishing ranged between 12.8 and 38.6 kg/set in the first experiment and 8.1 and 129.4 kg/set in the second. The CPUE of spearfishing ranged from 0.55 kg/spear hour and 1.8 kg/spear hour in the first experiment and 0.6 kg/spear hour and 2.04 kg/spear hour in the second. Catch rates declined appreciably for the total catch and for the surgeonfish and parrotfish in all four of the fishing experiments.

Table 3: Summary of the catch (weight) and fishing effort data for the first leaf-sweep fishing experiment

Day	Effort (sets)	Catch (kg)			Catch rates (kg/set)			Cumulative catch (kg)		
		Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae
1	1	38.63	15.99	16.91	38.63	15.99	16.91	38.63	15.99	16.91
2	1	14.3	1.37	4.91	143	1.37	4.91	52.93	1737	21.82
3	1	12.8	155	4.88	12.8	1.55	4.88	65.73	18.92	26.70

Table 4: Summary of the catch (weight) and fishing effort data for the second leaf-sweep fishing experiment

Day	Effort (sets)	Catch (kg)			Catch rates (kg/set)			Cumulative catch (kg)		
		Total	Acanthuridae	Scaridae	Tout	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae
1	1	129.42	54.47	68.01	129.42	54.47	68.01	129.42	54.47	68.01
2	1	77.74	.3126	37.74	77.74	37.26	37.74	207.16	91.73	105.75
3	1	17.96	9.17	7.83	17.96	9.17	7.83	225.12	100.90	113.58
4	1	8.09	3.02	3.93	8.09	3.02	3.93	233.21	103.92	117.51

Table 5: Summary of the catch (weight) and fishing effort data from the first group spearfishing experiment

Day	Effort (spear hours)	Catch (kg)			Catch rates (kg/spear hour)			Cumulative catch (kg)		
		Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae
1	30.75	55.39	18.44	16.32	1.80	0.60	053	55.40	18.44	16.32
2	23.92	35.55	12.73	859	1.49	0.53	036	90.89	31.17	24.91
3	2450	24.30	8.61	4.04	0.99	035	0.17	115.19	39.78	28.95
4	25.08	13.78	8.04	0.7	055	0.32	0.03	128.97	47.8	29.65

Table 6: Summary of catch (weight) and fishing effort data for the second group spearfishing experiment

Day	Effort (spear hours)	Catch (kg)			Catch rates (kg/spear hour)			Cumulative catch (kg)		
		Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae
1	3225	50.85	25.67	18.92	1.58	0.80	059	50.85	25.67	18.92
2	33.75	68.87	2426	31.73	2.04	0.72	0.94	119.72	49.93	50.65
3	33.75	44.44	14.74	22.19	131	0.44	0.66	164.16	64.67	72.84
4	39.42	43.28	14.30	17.51	1.09	0.36	0.44	207.44	78.77	90.35
5	38.00	22.98	10.11	5.36	0.60	027	0.14	230.42	88.88	95.71

Table 7: Summary of the catch (numbers) and fishing effort data for the first leaf-sweep fishing experiment

Day	Effort (sets)	Catch (no)			Catch rates (no/set)			Cumulative catch (no)		
		Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae
1	1	419	252	115	419	252	115	419	252	115
2.	1	67	19	23	67	19	23	486	271	138
3	1	101	21	23	101	21	23	587	292	161

Table 8: Summary of the catch (numbers) and fishing effort data for the second leaf sweep fishing experiment

Day	Effort (sets)	Catch (no)			Catch rates (no/set)			Cumulative catch (no)		
		Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae
1	1	923	543	293	923	543	293	923	543	293
2	1	593	397	149	593	397	149	1516	940	442
3	1	168	118	38	168	118	38	1684	1058	480
4	1	67	42	22	67	42	22	1751	1100	502

Table 9: Summary of the catch (numbers) and fishing effort data from the first group spearfishing experiment

Day	Effort (spear hours)	Catch (no)			Catch rates (no/spear hour)			Cumulative catch (no)		
		Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae
1	30.75	292	117	51	950	3.80	1.66	292	117	51
2	23.92	221	82	35	9.24	3.43	1.46	513	199	86
3	2450	157	67	18	6.41	2.73	0.73	670	266	104
4	25.08	111	61	5	4.43	2.43	020	781	327	109

Table 10: Summary of catch (numbers) and fishing effort data for the second group spear fishing experiment

Day	Effort (spear hours)	Catch (no)			Catch rates (no/spear hour)			Cumulative catch (no)		
		Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae	Total	Acanthuridae	Scaridae
1	3225	353	224	65	10.95	6.95	2.02	353	224	65
2	33.75	354	214	88	10.49	634	2.61	707	438	153
3	33.75	262	131	67	7.76	3.88	1.99	969	569	220
4	39.42	276	141	70	7.00	3.58	1.78	1245	710	290
5	38.00	164	87	16	4.32	229	0.42	1409	797	306

Biomass estimates

Where time series of catch and effort data were short and the effects of growth, mortality and recruitment negligible, this decline in catch rate is proportional to the initial biomass or standing stock (B_o). The depletion model of Leslie (in Ricker 1975) can be used with such catch and effort data to estimate B_o and the model takes the form:

$$C_t = qf_t (B_o - Kt$$

where C_t is catch at time t, f is fishing effort, Kt is the cumulative catch and q is the catchability coefficient. In terms of CPUE the model can be rearranged such that:

$$C_t/f_t = qB_0 - qKt$$

and is a linear equation with a slope equal to q and an abscissal intercept equal to B_o.

The results of fitting the Leslie model to the catch data in weight and numbers from each of the four experiments are given in Tables 11 and 12 and the lines are shown fitted to the scatters of CPUE versus cumulative catch by weight in Figures 3 and 4. The data for the first and second days' fishing for the second group spearfishing experiment at Falalus were combined into a single data pair. The first day's fishing was carried out following a storm, and, as such, catch rates were depressed due to rough seas and rather strong currents.

Table 11: Summary of the regression coefficients and the fishable biomass estimates, by weight, from the application of the Leslie model to four stock reduction experiments at Woleai Atoll

Fishing experiment	Catch component	Regression values			Estimated biomass (kg)	Biomass per unit area (t/km^2)
		a	b	r^2		
Leaf-sweep 1	Total catch	72.64	-0.970	0.82	74.88	5.63
	Acanthuridae	90.60	-4.84	0.71	18.73	1.43
	Scaridae	35.70	-1.23	0.753	29.02	2.15
Leaf-sweep 2	Total catch	280.58	-1.12	0.88	252.88	11.92
	Acanthuridae	11030	-0.97	0.89	113.71	533
	Scaridae	155.82	-1.25	0.90	124.76	5.88
Spearfishing 1	Total catch	2.81	-0.0164	0.93	17134	839
	Acanthuridae	0.81	-0.0104	0.92	77.60	3.80
	Scaridae	1.11	-0.0335	0.88	33.1	1.62
Spearfishing 2	Total catch	3.41	-0.0119	0.95	286.16	25.47
	Acanthuridae	1301	-0.0120	0.913	108.51	9.66
	Scaridae	1.499	-0.0122	0.813	118.77	10.58

Table 12: Summary of the regression coefficients and the fishable biomass estimates, by number, from the application of the Leslie model to four stock reduction experiments at Woleai Atoll

Fishing experiment	Catch component	Regression values a	b	r^2	Estimated biomass (no)	Biomass per unit area (no/km^2)
Leaf-sweep 1	Total catch	10483	-1.715	0.56	6113	46,310.6
	Acanthuridae	16383	-5.672	0.72	288.8	21,878.9
	Scaridae	329.7	-2.000	0.75	164.8	12,484.8
Leaf-sweep 2	Total catch	1886.0	-0.986	0.88	1912.4	90,207.5
	Acanthuridae	1037.7	-0.838	0.82	1238.5	58,419.8
	Scaridae	682.2	-1.297	0.95	526.0	24,8113
Spearfishing 1	Total catch	1330	-0.011	0.84	12693	62,220.6
	Acanthuridae	4.659	-0.007	0.97	678.1	33,240.2
	Scaridae	2.976	-0.022	0.77	132.6	6,500
Spearfishing 2	Total catch	1635	-0.008	0.93	1988.8	177,571.4
	Acanthuridae	-10.87	-0.011	0.89	1003.1	89,562.5
	Scaridae	3.903	-0.009	0.63	4153	37,080.4

The slopes of the line from the various regressions (b) are equivalent to the catchability coefficient. Biomass in the fishing site was estimated from the regression parameters then converted to weight and numbers per square kilometre of reef. The total biomass of all fish ranged from 5.63 t/km^2 at Tagailap to 25.47 t/km^2 at Falalus, or 46,310 fish/km^2 to 177,570 fish/km^2.

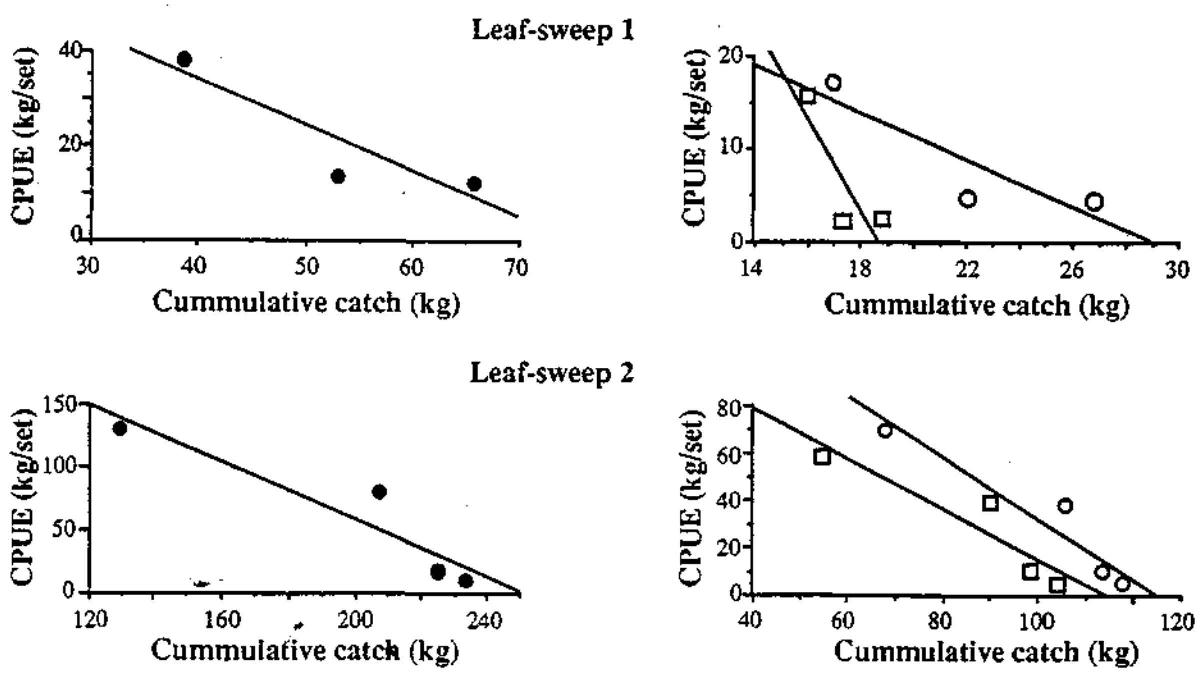


Figure 3. Catch rate versus cumulative catch of all fish (●), surgeonfish (□) and parrot fish (○) in the two leaf-sweep fishing experiments

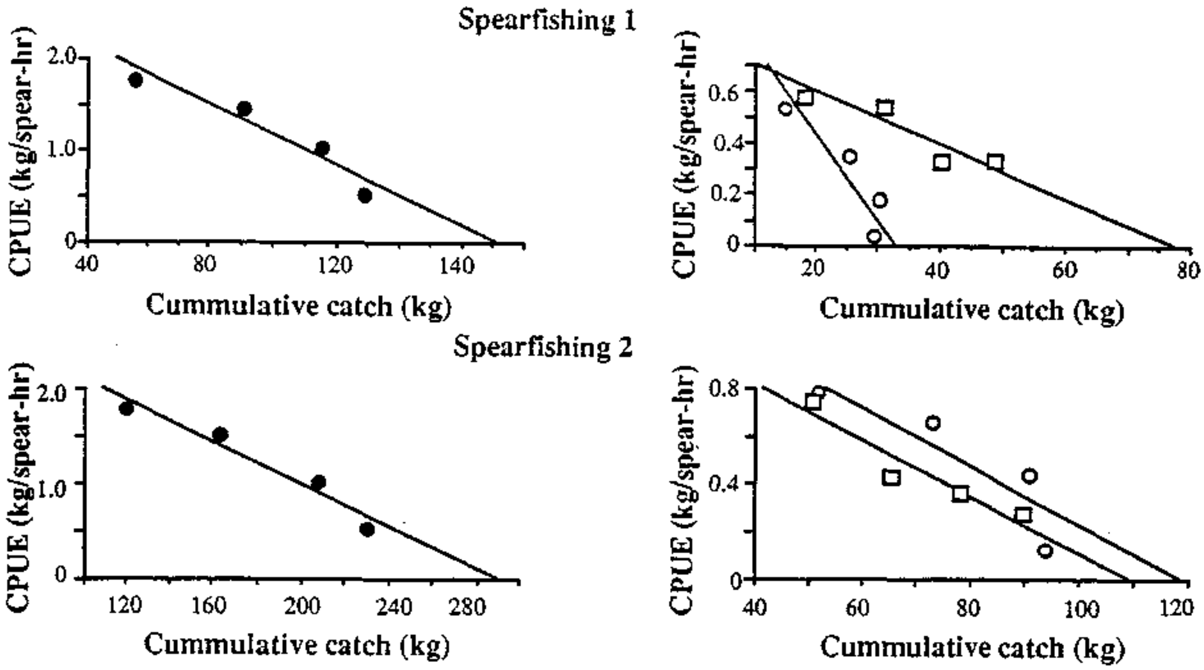


Figure 4. Catch rate versus cumulative catch of all fish (●), surgeonfish (□) and parrot fish (o) in the two spearfishing experiments

Figure 4. Catch rate versus cumulative catch of all fish (•), surgeonfish (•) and parrot fish (**o**) in the two spearfishing experiments

Underwater visual census

A complete summary of the results of visual census observations at three of the four fishing sites is given in Appendix III. Emperors and snappers were rarely observed during the counts and the most common fishes with in the transects were parrotfish and surgeonfish. Although butterflyfish and groupers were less common, they were present in each transect site. Simple t tests were performed on the fishing and control site counts before and after each fishing experiment to see if there were demonstrable changes in densities from fishing.

A summary of the results of the t tests is given in Tables 13 and 14 for the fishing and control sites separately. In most instances there was no significant change in the means from before and after fishing. The mean density of butterflyfish increased after the first leaf sweep, while there was a significant decline in the densities of emperors and groupers after the first spearfishing experiment. Amongst the data from the control sites there was a single instance of a significant change in mean density, where butterflyfish numbers increased after the first spearfishing experiment.

Table 13: Summary of t tests between means of transect counts for six fish families in fishing sites before and after fishing experiments

Family	**Leaf sweep 1**		**Leaf sweep 2**		**Spear fishing 1**	
	t	Significance	t	Significance	t	Significance
Lethrinidae	0.45	ns	0	0	6.210	s -ve
Lutjanidae	1.14	ns	0	0	1.069	ns
Serranidae	0.91	ns	3.410	ns	13.2	s -ve
Scaridae	0.55	ns	1.150	ns	0.950	ns
Acanthuridae	1.66	ns	0.087	ns	0.753	ns
Chaetodontidae	2.61	s +ve	1.659	ns	0.438	ns

Table 14: Summary of t tests between means of transect counts for six fish families in control sites before and after fishing experiments

Family	Leaf sweep 1		Leaf sweep 2		Spear fishing 1	
	t	Significance	t	Significance	t	Significance
Lethrinidae	0	**0**	0	**0**	0	**0**
Lutjanidae	0	**0**	0	**0**	0	**0**
Serranidae	1.415	**ns**	0.832	**ns**	1.026	**ns**
Scaridae	1.449	**ns**	0.903	**ns**	1.421	**ns**
Acanthuridae	1.711	**ns**	1.525	**ns**	1.491	**ns**
Chaetodontidae	0.711	**ns**	0.077-	**ns**	3.739	**s + ve**

The proportions of the six families within the fishing and control sites before and after fishing was tested using the χ^2 distribution. A summary of these results is given in Table 15. The critical value of χ^2 for $p < 0.05$ at five degrees of freedom is 11.07, thus no significant changes in the composition of observations were observed after the fishing experiments, although in two instances (leaf sweep 1, fishing site; leaf sweep 2; control site) the result was near the borderline.

A series of x^2 tests were run between the ratios of densities observed between the different fishing sites and the control sites before fishing took place but there were no significant differences between the composition of the proportions of the different families.

Table 15: Summary of results of χ^2 analyses between ratios of visual counts of six fish families at fishing and control sites before and after fishing

Fishing experiment	Fishing **site**		**Control site**	
	X^2	**P**	X^2	**P**
Leaf sweep 1	10.966	0.1-0.05	4.664	0.5-0.1
Leaf sweep 2	1.115	>0.5	10.926	0.1-0.05
Spearfishing 1	1.404	>0.5	0.742	>0.9

Equipment comparison

Table 16 shows the counts of vessels and fishing gear during 1988 and 1991, for the western and eastern lagoons of Woleai. The number of commercially manufactured dinghies increased at Woleai, from 25 to 49 vessels during this three year period. The number of outboard motors increased from 19 in 1988 to 29 in 1991.

The number of different fishing gears declined between 1988 and 1991, apart from the harpoons and fishing poles which-increased in number by about 60 per cent. The large increase in the number of vessels and gears during the three year period was due to an influx of money for war reparations for WWII. These were one-off payments from the US Government and thus future increases in gears and vessels are likely to be more modest.

Table 16: Comparison of the changes in the numbers of selected vessel types and fishing equipment between 1988 and 1991 at Woleai Atoll

Vessels & **gear**	**Eastern lagoon**			**Western lagoon**			**Total**		
	1988	**1989**	**diff**	**1988**	**1989**	**diff**	**1988**	**1989**	**diff**
Canoes - small	**27**	**31**	4	**30**	**30**	**0**	**57**	**61**	**4**
Canoes - large	5	5	0	**9**	**7**	**-2**	**14**	**12**	**-2**
boats	12	**26**	14	**13**	**23**	**10**	**25**	**49**	**24**
o/boards < 25 hp	1	**4**	3	**8**	**11**	**3**	**9**	**15**	**6**
o/boards>=25 hp	5	15	10	5	**9**	**4**	**10**	**24**	**14**
nets - monofilamnet, nylon bait	**0**	0	0	**6**	5	**-1**	**6**	5	**-1**
nets - seine, large	**12**	**16**	4	**19**	**14**	-5	**31**	**30**	**-1**
nets - seine, small	**6**	6	0	**7**	**7**	**0**	**13**	**13**	0
nets - other	**2**	**1**	-1	3	**4**	**1**	5	5	0
traps - uulimorouwel	**17**	**12**	-5	**12**	**9**	**-3**	**29**	**21**	**-8**
pole - harpoons	**8**	**14**	**6**	5	7	**2**	**13**	**21**	8

Biological observations

Length-weight equations and condition factors

The relationship between fish weight (W) and length (L) is normally exponential and can be fitted by a function of the form:

$$W = aL^b$$

where a and b are constants of the equation. Where growth in fish is isometric, ie equal in all directions then b ~ 3. Conversely when growth is allometric then b <> 3. Weight and length can also be related by the condition factor (CF) which takes the form:

$$CF = L^3/W$$

Sufficient data was available to compute the length weight coefficients and the condition factors for 26 species, and these are given in Table 17.

Length-frequency distributions

The length frequency distributions of the dominant species from each fishing experiment are given in Appendix IV and shown in Figure 5. Only two species, *Acanthurus nigrofuscus* and *Ctenochaetus striatus*, were caught in sufficient quantities in all four fishing experiments to permit comparison between the four sites and the two fishing methods.

The lengths of *A.nigrofuscus* captured by the leaf sweep at Tagailap were unimodal with a peak at 10.0 cm while those of the same species taken by the same method at Wottagai were bimodal with peaks at 10.0 cm and 15.0 cm). The modal peak at 10.0 cm in both instances is likely to be the result of mesh selection, with incomplete retention of all sizes smaller than 10.0 cm. Indeed underwater observation on the catches in the seine net showed that small *A.nigrofuscus* were able to pass through the mesh. The modal peak at 15.0 cm in the length data from Wottagai is possibly due to separation of different year class or cohort in the length data. The length frequencies of the same species captured by spearfishing at Raiur and Falalus have modal peaks at 15.0 and 16.0 cm, with some evidence for minor peaks at 10.0 cm. The structure of the length data from spearfishing probably reflects the selection by the spear fishermen for larger sized fish, while the true population size frequency is more likely to be that observed in the leaf sweep catch.

Table 17: Length-weight coefficients and condition factors for selected reef fishes captured during experimental fishing at Woleai Atoll

Species	Regression coefficients		Condition {actor	r^2
	a	b		
Acantkuna lineatus	0.0192	3.072	Z339	0:977
Acanthunisnigricans	0.0670	2.669	2.755	0.905
Acanthurusnigrofitscus	0.0440	2.812	2.726	0.994
Acanthunis olivaceous	0.0070	3398	2.098	0.947
Acanthurustriostegus	0.0164	3.137	2312	0.972
Calotomuscarolinus	0.0122	3.167	2.000	0.997
Cantherines dumaili	0.0406	2.792	2.191	0.961
Ctenochaetusstriatus	0.0210	3.040	2384	0.976
Epinephelus spilotoceps	0.0041	3.346	1.161	0.979
Gnathod&uexaurolineatus	0.0090	3.285	2.172	0.951
Melichthysvidua	0.0058.	3.554	2.876	0.958
Monotaas grandoculis	0.0360	Z851	Z316	0.992
Naso lituratus	0.0497	2.839	2.076	0.984
Naso uniconus	0.0228	2.922	1.179	0.956
Rhinecanthusacuieatus	0.1790	3.100	2394	0.953
Rhinecanthus reaangulus	0.0355	2.875	2.4%	0.940
Sargocentrwn microstoma	0.0018	3.851	2.986	0.989
Scants psittacus	0.0114	3.163	L847	0.990
Scarusaltipinnis	0.0233	2.980	1980	0.993
Scarusgibbus	0.0133	3.132	2.121	0.989
Scarus rubrioviolaceous	0.1360	3.109	1.917	0.994
Scarus sordidus	0.0127	3.141	1.940	0.995
Sigcaws argentus	0.0250	2.883	1.727	0.987
Sufflamen chrysopetra	0.0153	3.152	2.191	0.961
Zancuius comutus	1.7190	1323	3.171	0.907
Zebrasoma scopas	0.1290	3 3 3	Z735	0.985

Catches of the tang, *Cstriatus,* by leaf sweep fishing were unimodal but with distinctly different peaks at 16.0 cm (Tagailap) and 17.0 -18.0 cm (Wottagai). The length distributions of *Cstriatus* captured by spearfishing were similar with unimodal peaks between 16.0—17.0 cm. Comparisons of size frequencies captured by spearfishing and leaf sweep fishing between two or three locations were possible for *Acanthurus lineatus, Acanthurus nigricans, Acanthurus olivaceous, Naso lituratus,* and *Scarus sordidus* females. The size frequency of *A.olivaceous,* captured by leaf sweep fishing was clearly unimodal with a peak at 18.0 cm. Specimens captured by spearfishing at Raiur also have a peak at 18.0 cm but there were several small specimens captured from this location also, but without a defined modal peak. The specimens captured by spearfishing at Falalus were mostly larger individuals with two modes at 19.0 and 21.0 cm.

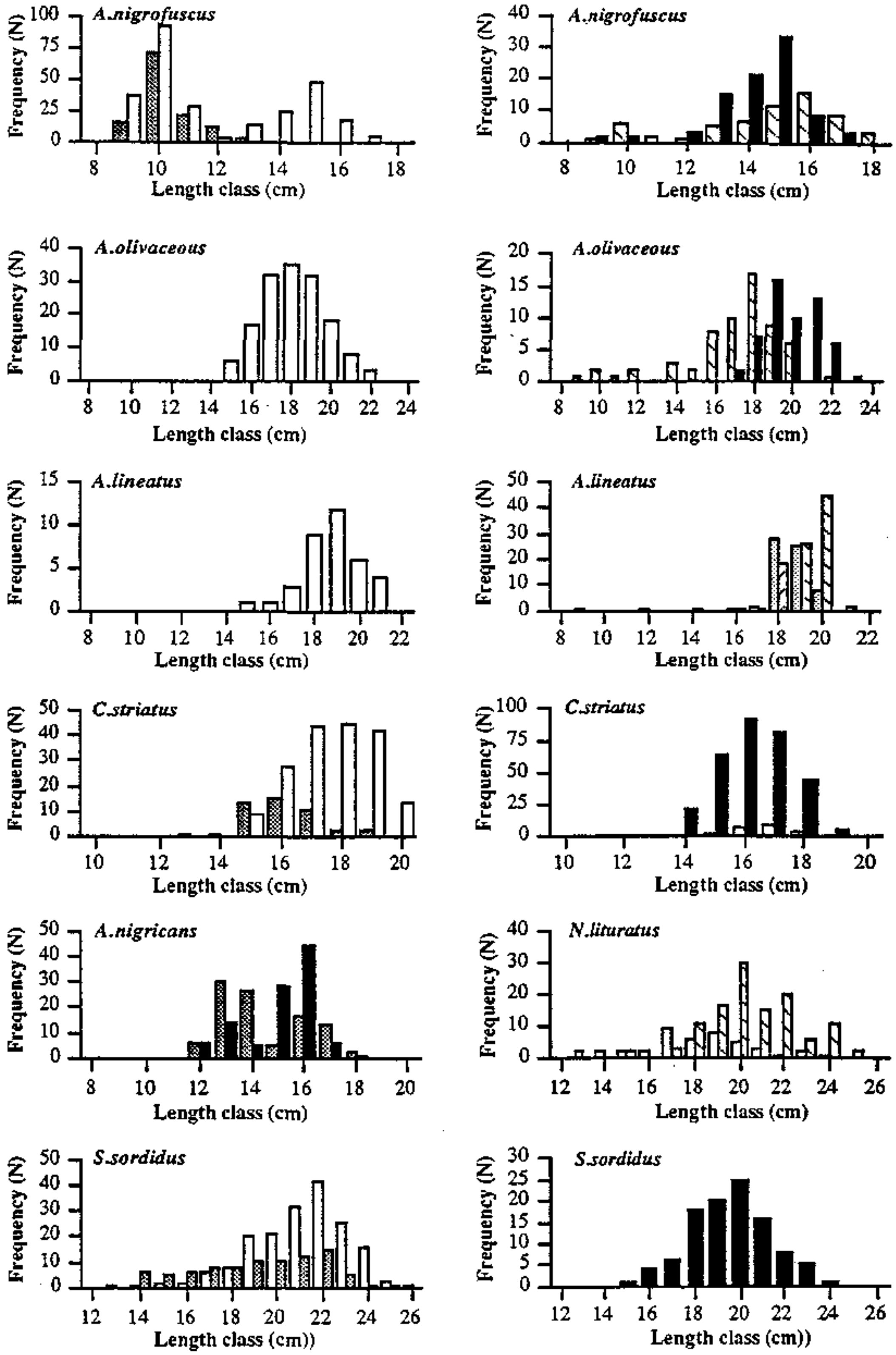


Figure 5. Length frequency distributions of the principal species in the four depletion fishing experiments. Key: ▩ Leaf-sweep 1, □ Leaf sweep 2, ◪ Spearfishing 1, ■ Spearfishing 2.

The surgeonfish, *Acanthurus lineatus,* was captured at one leaf sweep site and one spearfishing site. Subsistence fishing on the outer reef slope by group spearfishing provided another sample not shown) which was compared with the fish obtained in the depletion fishing. The size frequency of specimens captured by leaf sweep fishing was unimodal with a peak at 19 cm. The sample from spearfishing at Falalus was also unimodal with a peak at 18 cm, although two juvenile specimens, (9.0 & 12.0 cm) were also captured. The specimens of *A.lineatus* captured by spearfishing on the outer reef slope were larger than those from the inner lagoon and had a modal length of 20 cm.

The length distributions of *A.nigricans* from leaf sweep and spearfishing were bimodal with peaks at 13.0 and 16.0 cm. As with *A.nigrofuscus,* the larger modal peak was much more pronounced in the spearfish catch. The data for *N.lituratus* were similarly from single examples of leaf sweep fishing and spearfishing, and show that fish caught by spearing tend on average to be larger than those captured by the leaf sweep seine net. This may be due to the active -selection of larger fish by the fishermen, but real differences in population size frequencies cannot be discounted.

The female morph of the parrotfish, *Scarus sordidus,* was captured in large quantities in the two leaf sweep experiments and during spearfishing at Falalus. The shapes of the two length frequencies from leaf sweep fishing were somewhat similar with strong negative kurtosis and modal lengths at 21.0 cm. The distribution of specimens from spearfishing did not demonstrate a similar skew and the modal length was at 20 cm.

It was thought initially that the two peaks in the length frequency distributions of the two small surgeonfishes, *A. nigrofuscus* and *A. nigricans,* were seperate year classes and that this would permit the computation of growth parameters for these two species. Few growth studies have been made of the surgeonfishes and no published estimates of the growth of these two species were found in the literature. Fishelson et al (1987) tagged several hundred A *nigrofuscus* during a study on the biology and ecology of this species in the Red Sea. Although no growth studies were made on this species, tagged fish were observed for at least four years and some individuals with scars or markings for longer (L. Fishelson, Tel Aviv University, pers. comm.). More recently ageing of *A. nigrofuscus* from the Great Barrier Reef in Australia by reading marks on the otoliths suggest that this species can live well in excess of 15 years and that there may be many year classes contained in a single one centimeter length interval (T. Hart, pers. comm.). Given the probable longevity of this species, it is likely that the two modal peaks in the length data from Woleai may not represent year classes, and growth parameters should not be based on length data without supportive evidence from tagging or otolith studies. The same also applies to *A. nigricans.*

DISCUSSION

The principle objectives of this study were to collect quantitative information on the catches by two community fishing methods, and to assess the potential for using such fishing techniques for stock assessment in a remote atoll where long term records of catch and biological data were not available. On Woleai we were able to assess the effects of both leaf sweep fishing with a fixed seine net and group spearfishing. Further, the selection of fishing sites permitted observations on reefs that had been fished as recently as a few weeks before our operations to being left unfished for over a year. Clear reductions in CPUE were evident in all instances following periods of sustained fishing pressure and these were then used to estimate standing stocks on the fished reefs. However, a number of questions remain to be answered from this work namely:

1. Are the estimates of standing stocks generated by leaf sweep fishing and spearfishing comparable, given the differences in fishing methods, selection effects and catchabilities?

2. How can the lack of change in visually estimated abundance at the fishing sites be explained with respect to the decline in CPUE in successive catches?

A definitive answer to the first of these questions is not possible from the data collected here and would need a further series of fishing experiments to provide conclusive answers to this topic. Standing stocks, as estimated from the two methods, ranged from 5.6 to 25.5 t/km^2 or 46,300 to 177,500 fish/km^2 respectively. Standing stocks were highest in the western lagoon where human populations are lowest and the reefs are fished less often than in the western lagoon. Although all catches were dominated by surgeonfish and parrotfish, the composition of the combined catches from spearfishing and from leaf sweep fishing were significantly different ($x^2 = 599$, $p < 0.001$, 24 df.). Most of this difference was ascribable to the sizeable contribution of groupers and triggerfish to the spearfishing catch and the complete or virtual absence of these families from the leaf sweep catch.

It is important to note here that our estimate of fish standing stock refers specifically to demersal species, mainly algal herbivores closely associated with the reef substrate. Further, both fishing methods are size selective, although this is mostly a function of mesh size with the leaf sweep, as opposed to the selection of larger sizes with spearfishing. Many of the small fishes found amongst the coral such as damsel fish (Pomacentridae) and fairy basslets (Serranidae, sub. fam. Antheinae) were not taken by the two gears employed. Further, evidence from the Philippines (Alcala & Gomez 1985; Dalzell et al. 1990) and the Great Barrier Reef (Williams & Hatcher 1983) suggest that the fusiliers (Caesionidae) comprise a major component of the biomass on coral reefs. No fusiliers were caught in any of the four fishing experiments, and small pelagic species in general, such as small carangids, scombrids and clupeoids, were mostly absent from the catches.

It is concluded from the present data that the two different methods probably provide reasonable estimates of the standing stocks of surgeonfish and parrotfish, but that leaf sweep fishing misses those fish that are particularly adept at hiding in the holes within the coral, such as trigger fish and groupers. Clearly, these conclusions would be strengthened by carrying out further such studies in other atolls. It may, therefore, be more realistic to term our population estimates the fishable biomass or fishable standing stock, to distinguish this from the true density of fish on the reefs. For the purposes of an overall fishable biomass estimate for the back reefs of Woleai the means of the four fishing experiments were used to estimate average densities of 12.6 t/km^2 or 94,000 fish km^2. The back reefs of Woleai lagoon cover an area of about 5.0 km^2 which gives an estimate of total standing stock of 60 t or 470,000 fish.

Goldman & Talbot (1976) present some estimates of reef fish standing stocks which range from 17.5 to 195.0 t/km^2, from reefs in the Red Sea, Caribbean, Bermuda, Caroline Islands and Great Barrier Reef. The lower limit of this range of 17.5 t/km^2 was for the upper reef slope of an island on the Great Barrier Reef and is comparable to the figures obtained for the back reefs at Woleai. Williams & Hatcher (1983) recorded reef fish standing stocks on inshore, mid-shelf and outer shelf reefs of 92 t/km^2, 156 t/km^2 and 237.3 t/km^2 respectively. The average of our four estimates of standing stock is 12.9 t/km^2, composed mainly of surgeonfish and parrotfish.

The results of the analyses on the visual census data suggest that the stock reduction fishing had no visible effect on the populations of fish observed in the fishing sites. Most of the fish seen within the transect sites comprised almost exclusively juvenile surgeonfish and parrotfish. The larger adult specimens were often observed during the transects swimming away outside the transect area and hence were not counted. Juvenile surgeonfish would usually exhibit little concern about the presence of swimmers passing overhead and continue feeding. If a flight response was evident the fish would only move a small, distance/and could be easily counted. Juvenile parrotfish were often more wary but could be readily counted in the same manner. The wariness of the adult fishes was ascribed to the prevalence of spearfishing on Woleai which has conditioned adult fishes to swim away from swimmers and seek shelter in coral. Such avoidance behaviour has been noted on reefs elsewhere in the Pacific where spearfishing is prevalent (Russ in press). Future work of this kind will need to adapt some method where fish densities can be accurately assessed, despite the wariness of the larger adult size classes.

No other studies of this type, where traditional community fishing techniques have been employed to generate biomass data, have been reported in the literature from the atolls of Micronesia or indeed from the Pacific region. Effects on densities and community structure of shallow reef fish assemblages in the Philippines have been studied by Russ & Alcala (1989) who recorded the changes on a marine reserve following 18 months of intensive fishing. These authors noted large declines in the abundance of predator species (groupers, emperors and snappers) and increases in density some of the wrasses and parrotfish. Beinssen (1988) observed the densities of coral trout *(P. leopardus)* on a marine reserve, before and after a moratorium on line fishing was rescinded and noted that about 25 per cent of the standing stock of coral trout were caught within the first 14 days of fishing. Similarly, the fishing experiments on Woleai demonstrate how effectively a reef can be fished out in a short time, with catch rates declining in some instances by one order of magnitude and with between 75 and 90 per cent of the fishable biomass forming the catch.

MANAGEMENT AND CONSERVATION OF OUTER ISLAND REEF FISH STOCKS

All fish landed on Woleai are caught for subsistence purposes. Although demand for reef fish has stimulated export markets in other parts of Micronesia, such fisheries are unlikely to develop in the Yap outer islands due to their remoteness and poor communications and transport. The principle factors determining fisheries production on Woleai are human population size and the availability of other animal proteins for consumption. The population of Woleai increased between 1967 and 1987 from 550 people to 770 people, or an annual growth rate of 1.5 per cent (Anon. 1988). The population in 1990 was estimated from this to be about 810 people. Dalzell (1991) has suggested that census figures can be combined with nutritional data to provide an empirical estimate of subsistence fisheries production. Unfortunately, there are no direct estimates of per capita fish consumption for Woleaians or other outer islanders. Instead a range of 50 to 100 kg/person was used here, based on observations from other South Pacific islands. Present total annual fish landings on Woleai are thus thought to lie within the range of 40 to 80 t.

As the population of Woleai continues to grow there will be an increasing demand for fresh fish. This will almost certainly mean that greater volumes of fish will be captured from the lagoon inner reefs. Further, influxes of money into Woleaian society is likely to be spent on boats and outboard motors thus increasing the range and fishing power of fishermen. A conventional approach to fisheries management is to try to predict the optimum or sustainable catch from a fishery, the maximum sustainable yield (MSY), and structure development and management strategies around this figure. Management of a fishery usually takes the form of formally legislated regulation of fishing seasons, size Limits, gears and catch quotas. Where a fish population is unfished then estimates of MSY can be expressed as a function of the virgin biomass and the natural mortality rate (see Garcia et al. 1989 for a review of methods). This single species approach has been adapted for multispecies stocks such as caught here. However, as implied above, the biomass estimates determined here are not from virgin populations, indeed the shallow reef fish stocks of Woleai have been exploited for centuries. Modifications to estimates of MSY from biomass estimates where catch is known have been suggested (see Garcia *et al* 1989) but as discussed earlier, no catch figures are available for Woleai and the back reef fish stocks are only part of a range of marine fish exploited by Woleaian fishermen.

Hilborn & Siebert (1988) have questioned the concept of MSY in the fisheries of developing countries and suggest instead the formulation of flexible monitoring and management strategies that account for the large degree of variation often* found in fisheries yields. Their remarks were addressed principally to commercial fisheries but are applicable here since the Woleai fishery is purely for subsistence purposes and yields are a function of human population density. The conventional approach to fisheries management is thus inappropriate in a traditional Micronesian society such as Woleai, where catches are not weighed and recorded and legislation formulated by the government in Yap proper often has little relevance to the subsistence situation. The value of the present study is that for the first time a quantitative assessment has been made of catch rates, catch composition, size frequencies and biomass for these reefs, based on traditional fishing practices, and which will act as a reference point for the future.

The production from the coral reefs at Woleai is regulated to some extent by the traditional tenure system and the selective banning of fishing on some reefs due to perceived declines in abundance. Such bans have been enforced in previous years where pressure from spearfishing has been sufficient to cause the perceived decreases in standing stocks. A further regulatory mechanism is the natural seasons of the year when certain species become more abundant and form the focus of fishing activity. Goatfish are seasonally more abundant between the months of April and May and are selectively targeted by fishing with portable traps. Similar seasonality is evident for catching large pelagic species such as skipjack tuna *(Katsuwonas pelamis),* yellowfin tuna *(Thunnus albacares)* and wahoo *(Acanthocybium solandri),* which are more abundant during the boreal summer.

These fishing experiments may give some indication of the rate of recovery from such types of community fishing, where a large fraction of the biomass is captured. The intervals between our fishing operations and the most recent community fishing by the Woleaians ranged from three weeks to a year. Figure 6 shows that there is a linear relationship between the fishable biomass estimate in weight and numbers (Tables 11 & 12) and interval between periods of community fishing (Table 1).

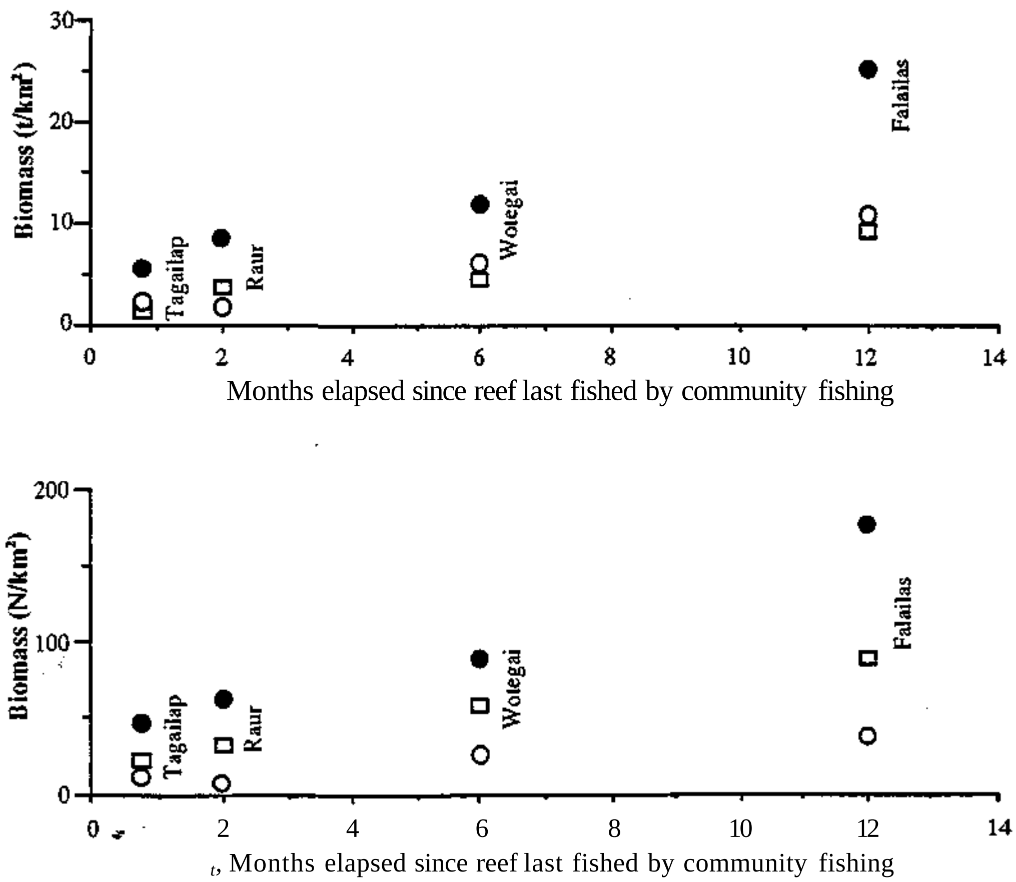


Figure 6. Estimated fishable biomass by weight (top) and numbers (bottom) of all fish (•), surgeonfish (•) and parrotfish (o)

The data suggest that following community fishing when the reef fish population is depleted, the biomass might increase by about 20 t/km^2 over a period of about 12 months. Some caution must be exercised, however, with interpretation of these results. First, the linear trend of the points may be misleading since it is likely that increase in biomass with interval between fishing will tend towards an asymptote as the fish population approaches the equilibrium biomass. Second no account was taken of fishing by individuals on some or all of these reefs between the periods of community fishing. Third, there was no information available on the amount of fishing effort expended on these reefs during the initial period of fishing. Certainly, it is not the common practice to fish one area of reef continuously, but to fish several times at different locations on the reef, so as to maximise catches and avoid poor catches from depleted areas. However, the results form an initial basis for setting moratoriums on fishing particular reefs, and give an indication of the expected increase in population size at least after a one year interval.

The management and conservation of reef fish stocks on the other outer islands of Yap State are also likely to be mainly influenced by the rate of human population growth. As with Woleai, no records have been kept of current levels of catch or catch rates, and only anecdotal accounts from the islanders are available from which to formulate conclusions on the status of stocks. Not all the outer islands have lagoons and pressure on reef fish stocks is likely to be most apparent where reef area is limited and population density high, such as Satawal. Studies of the type described here may not be appropriate or practicable on these other islands, but information on fishing practices and contemporary catch rates need to be collected. Detailed records of traditional fishing and management in the outer islands have been made by Smith (in prep.), but more information on catch rates and catch composition need to be recorded to provide a reference for future management investigations such as reported here.

During the field work we were asked by the Woleai chiefs to provide some recommendations for managing Woleai's reef fish resources. The following are management suggestions based not only on the project results, but also on our personal observations (for one of us [A.S.] those observations were made over a four-year period).

First, it must be clearly understood that Woleai's subsistence fishery has been strictly managed for centuries. Until about the late 1940s the regulations governing marine resources exploitation were very severe. These restrictions were related to the ritual and tabus associated with fishing, fishermen and fish, but their justification was cultural maintenance rather than resource management *per se*. However, those rituals, coupled with the reef tenure and use rights systems and the low technology equipment, combined to indirectly ensure reef resources management.

In recent times some, but by no means all, of the restrictions have been eased or in some cases eliminated altogether. Today it would be socially impossible to re-impose all those old restrictions. However, there still remains a need for some control over fishing. Where traditional methods are still used, even in a modified form, and there is a willingness by the chiefs and fishermen to use customary controls, then we encourage that practice.

For the reasons previously mentioned in this report, it is not possible to provide specific recommendations for management based solely on the results of this study. The following suggestions are provided for consideration by the chiefs and fishermen of Woleai, but may also be relevant to the other outer islands as well.

The first suggestions relate directly to the two fishing methods used in this study, the latter suggestions are more general. All suggestions have the aim of allowing the reef fish stocks to recover as quickly as possible after exploitation.

1. Roop:

- It would be advisable to maintain a minimum mesh size for the capture net no smaller than currently used (4.5 cm). This will permit the smaller species and some juveniles to escape, which will assist with stock recovery.

- Spearfishing immediately after driving the fish during **roop** (to catch those fish that have avoided the sweep by hiding amongst the coral) should be avoided.

- The number of times that **roop** fishing is repeated at the same or adjacent locations during one summer be kept to an absolute minimum. The repetitive **roop** fishing in this study demonstrated that it was possible to quickly reduce the fish stocks in a short time. Also, Figures 19 & 20 indicate that there might be a linear relationship between the fishable biomass estimates and the interval between periods of community fishing.

2. Group Spearfishing:

- The destruction of the coral habitat while spearfishing should be minimised. We noticed habitat damage sometimes occurred during **gapiungiupiung** fishing as fishermen tried to locate, spear and remove fish from their hiding places. Much of the coral that was broken during the process is extremely slow growing and the reduction in the amount of habitat available to the fish may limit the reef fish stocks recovery in the area.

- The spearing of very small fish should be avoided.

- The interval between conducting group spearfishing in an area should be as long as possible. Group spearfishing is a very efficient way to fish an area. The more intensively an area is fished then the longer the recovery will take.

3. General:

- The custom of closing reef areas to all fishing after the deaths of certain people should be retained. Similar closures are encouraged for areas where the **taufita** (fishing masters) consider reef fish stocks have been reduced too much. The length of closure should be for a long as is feasible.

- The customary system of using different fishing methods during specific seasons to target different species in a number of areas should be encouraged. The recent trend to use only a few of the relatively easy methods (e.g. spearfishing) most of the time, means that the same species will be targeted all year in most areas, possibly resulting in overfishing if fishing intensity is high enough. The more seasonal rotation in methods used and areas fished the better.

- The use of new methods and/or equipment should be allowed, but the effects of any introductions should be carefully evaluated, and if considered unsuitable either socially or too damaging to reef fish stocks, then steps should be taken to prohibit or regulate them. To some extent this has already occurred with flashlight spearfishing and monofilament gillnets. The Marine Resources Management Division could provide assistance in such matters.

REFERENCES

Alkire, W.H. 1968a. Porpoises and taro. Ethnology, 7(3):280-289.

Alkire, W.H. 1968b. An atoll environment and ethnogeography. Geographica, 4:54—59.

Alkire, W.H. .1970. Systems of measurement on Woleai Atoll, Caroline Islands. Anthropos, 65:1—73.

Alkire, W.H. 1974. Land tenure in the Woleai. In: H.P. Lundsgaarde (ed.) Land tenure in Oceania. University Press of Hawaii: Honolulu, pp. 39—69.

Alkire, W.H. 1978. Coral Islanders. AHM Publishing: Illinois. 164 pp.

Alcala, A.C. & E.D. Gomez. 1985. Fish yields of coral reefs in the Philippines. Proc. Vth Coral Reef Congress, vol. 5, 521-524.

Anon. 1988. Yap State Statistical Bulletin, 1987. Office of Planning & Budget, Colonia, Yap, 155 pp.

Beinssen, K. 1988. Boult reef revisited. Reeflections 21, 8-9.

Connell, J. 1984. Islands under pressure—population growth and urbanisation. Ambio 13 (526), 306-312.

Dalzell, P. 1991. The value of nutritional surveys for fisheries workers. South Pacific Commission Fisheries Newsletter 56, 27—28.

Dalzell, P., P. Corpuz, F. Arce & R. Ganaden. 1990. Philippine small pelagic fisheries and their management. Aquacult. Fish. Mgmt., 21, 77—94.

Fishelson, L. W.L. Montgomery & A.A. Myrberg 1987 Biology of surgeonfish *Acanthurus nigrofuscus* with emphasis on changeover in diet and annual gonadal cycles. Mar. Ecol. Prog. Ser. 39,37-47.

Garcia, S., P. Sparre & J. Csirke. 1989. Estimating surplus production and maximum sustainable yield from biomass data when catch and effort time series are not available. Fisheries Research 8, 13-23.

Goldman, B. & F.H. Talbot. 1976. Aspects of the ecology of coral reef fishes. In, OA. Jones & R. Endean (eds), Biology and geology of coral reef fishes, vol. IV, Biology 2, Academic Press, New York, 125-154.

Hilborn, R. & J. Siebert. 1988. Adaptive management of developing fisheries. Marine Policy 12 (2), 112-121.

Kramer, A. 1937. Zentralkarolinen. In: G. Thilenius (ed) Ergebnisse der Sudsee-Expedition 1908-1910. II B, 10/1. Hamburg.

Masuda, H., K. Amaoka, C. Araga, T. Uyeno & T. Yoshino. 1984. The fishes of the Japanese archipelago Tokai University Press, Tokyo, Japan. 437 pp.

Masuda, H., C. Araga & T. Yoshiro. 1980. Coastal fishes of southern Japan. Tokai University Press, Tokyo, Japan. 382 pp.

McCoy, M.A. 1974. Man and turtle in the Central Carolines. Micronesica, 10(2):207-221.

McCoy, MA. 1981. Subsistence hunting of turtles in the Western Pacific: the Caroline Islands. In: KA. Bjorndal (ed) Biology and conservation of sea turtles. Smithsonian Institute Press: Washington DC. 275-280.

Moore, J.D. 1987. Current fishing practices and use of marine resources in the outer islands of Yap State, Federated States of Micronesia. Yap Fishing Authority report, Yap, FSM.

Myers, R. F. 1989. Micronesian reef fishes. Coral Graphics, Guam, 298 pp.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd. Canada 191, 382 pp.

Russ, G.R. 1991. Coral reef fisheries: effects and yields. In, P.F. Sale (ed) The ecology of fishes on coral reefs. Academic Press, New York, 601—637.

Russ, G.R. & A.C. Alcala. 1989. Effects of intensive fishing pressure on an assemblage of coral reef fishes. Mar. Ecol. Prog. Ser. 56, 13-27.

Smith, A. J. (in prep.) Yap State Traditional Fisheries Project: Outer Islands Report. Yap Institute of Natural Science, Yap, Micronesia.

Williams, D. M. & A. I. Hatcher. 1983. Structure of fish communities on outer slopes of inshore, midshelf and outer shelf reefs of the Great Barrier Reef. Mar. Ecol. Prog. Ser. 10, 239-250.

APPENDICES

Appendix I

DIMENSIONS OF THE LEAF-SWEEP AND SEINE NET USED FOR EXPERIMENTAL ROOP FISHING ON WOLEAI ATOLL

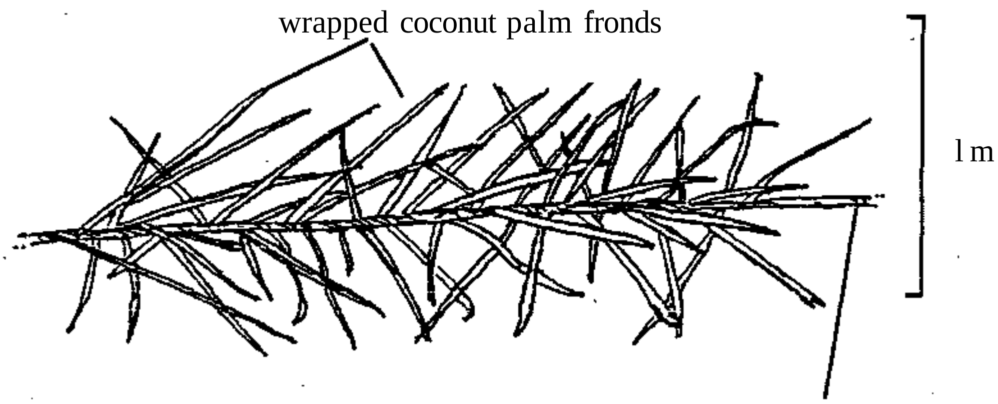
Roop dimensions

Dimensions	Roop 1	Roop 2
Roop length(m)	184	264
Rope length (m)	157	123
Gap (m)	67	141
Ellipse diameters (m)	120 x 140	150 x 180
Area fished (m^2)	13,195	21,206

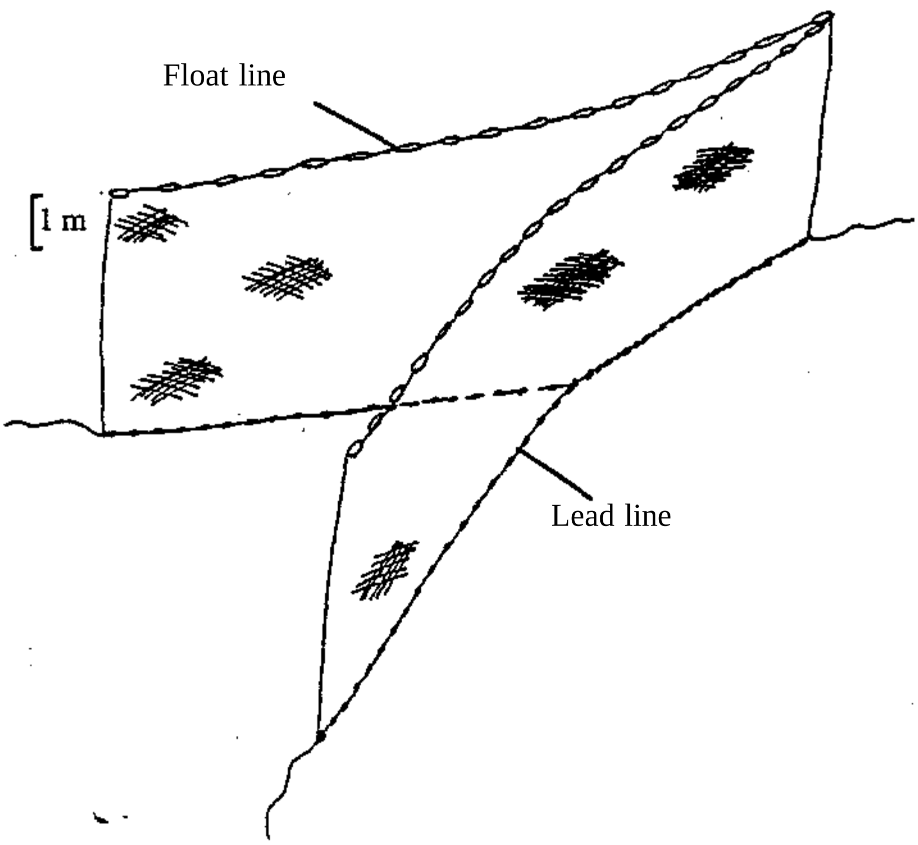
Net dimensions

Dimensions	Roop 1	Roop 2
Mesh size (cm)	4.5	4.5
Wing length (m)	12.7	16.8
Drop (m)	~4	~4
Mouth width (m)	~6	~7

Appendix 1 contd.



Details of construction of leaf sweep for roop fishing



Details of the seine net deployed for roop fishing

Appendix II

FAMILY AND SPECIES COMPOSITION FROM ALL EXPERIMENTAL FISHING OPERATIONS AT WOLEAI ATOLL

Family and species	Leaf-sweep 1		Leaf-sweep 2		Spearfishing 1		Spearfishing 2	
	%no	%wt	%no	%wt	%no	%wt	%no	%wt
ACANTHURIDAE	48.49	35.10	62.92	46.51	42.62	38.00	56.48	37.86
Acanthurus leucopareius					0.13	027		
Acanthurus lineatus	0.17	0.36	2.05	2.72	0.13	0.02	4.99	4.41
Acanthurus maculiceps			0.06	0.13			028	0.41
Acanthurus nigricans	16.28	17.54			0.13	0.02	7.19	421
Acanthurus nigricauda			0.17	034	1.19	2.18	036	0.38
Acanthurus nigrofuscus	22.65	8.94	29.38	10.89	726	3.96	7.69	3.37
Acanthurus olivaceous	0.34	0.38	11.92	12.12	6.73	4.99	5,41	5.29
Acanthurus pyroferus			0.06	0.06				
Acanthurus triostegus			0.17	0.03	4.49	1.37		
Ctenochaetus binotatus	0.17	0.03						
Ctenochaetus striatus	7.89	6.79	12.89	14.16	3.03	1.83	28.85	17.49
Naso lituratus	1.01	1.06	2.45	2.4	12.14	13.15	157	1.87
Naso tuberosus			0.06	0.96	0.13	1.79		0.43
Naso unicomis			0.06	0.15	726	8.42	0.14	0
Naso vlamingi			0.06	0.05				
Zebrasoma scopas			359	2.5				
BALISTIDAE	0.17	0.13	0.11	0.09	11.08	9.6	7.12	5.12
Balistapus undulatus					1.45	L06	057	0.5
Balistoides viridescens					0.13	0.43		
Melichthys niger							0.07	0.05
Melichthys vidua					4.22	3.81	328	2.59
Bhinecanthus aculeatus					1.64	2.94		
Rhinecanthus rectangulus					1.19	0.85	1.92	1.47
Sufflamen chrysoptera	0.17	0.13	0.11	0.09	1.45	0.51	128	0.51
BELONIDAE					0.13	0.04		
Piatybeione argalus platyura					0.13	0.04		
BOTHIDAE					0.66	0.97	021	023
Bothus mancus					0.66	0.97	021	023
CARANGIDAE	0.17	1.82			026	2.03	014	1.47
Caranx melampygus	0.17	1.82			0.13	1.79	0.07	0.95
Caranx sp.					0.13	024		
Scomberoides lysan							0.07	052
CHAETODONTIDAE	235	130	3.03	1.63	1.72	0.87	2.62	1.01
Chaetodon auriga			029	0.17	0.4	035	0.07	0.03
Chaetodon citrinellus	0.17	0.03					0.14	0.01
Chaetodon ephippium	0.17	0.16	034	030	0.4	020	0.21	0.15
Chaetodon lunula			0.46	0.40			0.07	0.05
Chaetodon meyeri	0.17	0.71	0.06	0.03				
Chaetodon ornatissimus			0.11	0.07				
Chaetodon reticulatus	1.17	0.71	1.08	0.42	0.79	028	1.92	0.72
Chaetodon trifascialis	0.17	0.06	023	0.06			0.14	0.03
Chaetodon unimaculatus			0.17	0.09				
Chaetodon vagabundus	0.17	0.08			0.13	0.04	0.07	0.02
Forcipiger flavissimus	0.34	0.13	029	0.09				

Family and species	Leaf-sweep 1		Leaf-sweep 2		Spearfishing 1		Spearfishing 2	
	%no	%wt	%no	%wt	%no	%wt	%no	%wt
CIRRHITIDAE								
Paracirrhites fosteri					0.13	0.04	0.36	0.1
DIODONTIDAE			0.06	0.44	0.53	1.61		
Diodon hystrix			0.06	0.44	0.40	1.51		
Diodon liturosus					0.13	0.10		
FISTULARIIDAE					0.13	0.27		
Fistularia commersoni					0.13	0.27		
GRAMMISTIDAE					0.13	0.003		
Grammistes sexlineatus					0.13	0.003		
HOLOCENTRIDAE					6.86	2.56	0.14	0.12
Mypristi berndti							0.07	0.06
Sargocentron caudimaculatum					1.85	0.96		
Sargocentron diadema					1.45	0.42		
Sargocentron microstoma					3.3	0.97		
Sargocentron tiere					0.26	0.21	0.07	0.06
LABRIDAE	1.34	1.14	1.26	1.26	3.82	3.89	3.41	4.32
Anampses caeruleopunctatus			0.51	0.32			0.07	0.06
Anampses geographicus			0.06	0.07	0.40	0.41		
Cheilinus diagrammus	0.17	0.16			0.13	0.12		
Cheilinus sp.	0.67	0.62						
Cheilinus trilobatus			0.11	0.24	0.92	0.89	1.21	2.36
Cheilinus unifasciatus	0.17	0.17	0.29	0.30	0.13	0.08	0.43	0.33
Cheilo inermis							0.07	0.02
Coris aygula							0.07	0.22
Coris gaimard			0.17	0.19				
Epibulus insidiator							0.21	0.25
Gomphosus varius	0.17	0.1						
Halichores hortulanus	0.17	0.1	0.06	0.07	0.66	0.26	0.64	0.17
Halichoeres margaritaceus					0.13	0.08		
Hemigymus fasciatus			0.06	0.07			0.14	0.19
Hologymnus annulatus							0.07	0.09
Macropharynodon meleagris					0.13	0.01		
Novaculichthys taenioutus					0.92	0.80	0.36	0.45
Thalassoma purpureum					0.4	1.17	0.14	0.18
LETHRINIDAE	12.08	13.13	0.46	0.68	1.18	2.38		
Gnathodentex aurolineatus	10.40	10.26						
Lethrinus elongatus					0.13	0.74		
Lethrinus ramak					0.26	0.55		
Monotaxis grandoculis	1.68	2.87	0.46	0.68	0.79	1.09		
LUTJANIDAE	0.34	0.87	0.06	0.05	0.66	1.10	0.14	0.2
Aphareus furca	0.34	0.87			0.13	0.21	0.14	0.2
Lutjanus gibbus			0.06	0.05	0.53	0.89		
MALACANTHIDAE					0.13	0.29		
Malacanthus latovittatus					0.13	0.29		
MONOCANTHIDAE	0.50	0.40	1.2	0.78	0.79	0.64	1.85	2.18
Amanses scopas							0.07	0.04
Cantherines dumerilii	0.50	0.40	0.06	0.09	0.79	0.64	1.78	2.14

Family and species	Leaf-sweep 1		Leaf-sweep 2		Spearfishing 1		Spearfishing 2	
	%no	%wt	%no	%wt	%no	%wt	%no	%wt
Cantherines pardalis								
MULLIDAE	2.52	2.36	1.14	0.70	1.32	2.02		
Parupeneus barberinus			0.11	0.11	0.66	0.80		
Parupeneus bifasciatus	1.34	1.28						
Parupeneus cyclostomus	0.67	0.67			0.40	1.09		
Parupeneus multifasciatus	0.50	0.41	1.03	0.59	0.26	0.13		
OSTARCIIDAE			0.06	0.03	0.79	0.26		
Ostracion meleagris			0.06	0.03	0.79	0.26		
POMACANTHIDAE			0.06	0.06	0.13	0.11	0.14	0.12
Apolemichthys trimaculatus					0.13	0.11	0.07	0.04
Pomacanthus imperator							0.07	0.08
Pygloptes diacanthus			0.06	0.06				
SCARIDAE	27.01	32.11	29.22	46.21	14.24	21.62	21.08	39.98
Calotomus carolinus	1.01	1.43	3.48	3.52	3.03	4.25	1.28	1.41
Cetoscarus bicolor							0.14	0.59
Hipposcarus longiceps							0.07	0.43
Scarus altipinnis	2.35	2.35			1.06	3.82		
Scarus dimidiatus					0.13	0.14	0.07	0.18
Scarus festivus			0.23	0.68	0.26	1.01	0.14	0.45
Scarus forsteni			2.00	3.93			2.85	5.36
Scarus frenatus			1.43	3.55			0.28	0.6
Scarus gibbus	0.34	1.08	0.06	0.21	0.4	1.55	1.99	10.55
Scarus globiceps							0.07	0.09
Scarus japonensis	1.34	2.46					0.07	0.05
Scarus niger			1.20	2.61			0.36	0.76
Scarus oviceps	0.17	1.01	0.06	0.26				
Scarus prasiognathus							0.29	1.8
Scarus psittacus					3.43	3.01	0.36	0.43
Scarus quoyi	0.17	0.35	0.23	0.82				
Scarus rubrioviolaceous	3.02	7.04	4.96	11.22	4.22	6.52	1.78	4.25
Scarus scaber	0.67	1.19						
Scarus schlegeli	2.01	3.84	0.68	0.63			0.93	1.41
Scarus sordidus	15.77	11.13	14.72	18.69	0.13	0.24	10.33	11.56
Scarus sp.	0.17	0.24			0.13	0.27		
Scarus spinus			0.17	0.09	1.45	0.81	0.07	0.06
SERRANIDAE					9.76	6.21	4.7	5.66
Cephalopholis argus					0.26	0.21	0.07	0.11
Cephalopholis urodeta					0.79	0.50	0.5	0.18
Epinephelus hexagonatus					1.98	0.41	1.35	0.33
Epinephelus merra					1.19	0.46		
Epinephelus spilotoceps					4.75	2.62	2.07	1.99
Epinephelus tauvina					0.66	1.08	0.5	1.77
Variola louti					0.13	0.93	0.21	1.28
SIGANIDAE	4.70	11.21	0.34	1.44	1.98	4.81	0.42	0.95
Siganus argenteus	4.70	11.21	0.34	1.44	1.98	4.81	0.28	0.49
Siganus punctatus							0.14	0.46
SYNODONTIDAE					0.26	0.02		
Synodus sp					0.13	0.01		
Synodus variegatus					0.13	0.01		

Family and species	Leaf-sweep 1		Leaf-sweep 2		Spearfishing 1		Spearfishing 2	
	%no	%wt	%no	%wt	%no	%wt	%no	%wt
TETRAODONTIDAE					0.13	0.31		
Arothron meleagris					0.13	0.31		
ZANCLIDAE	0.34	0.43	0.11	0.12	0.53	0.35	1.14	0.71
Zanclus cornutus	0.34	0.43	0.11	0.12	0.53	0.35	1.14	0.71

Appendix III

SUMMARY OF THE COUNTS OF SIX FISH FAMILIES FROM UNDERWATER VISUAL CENSUS COUNTS AT FISHING AND CONTROL SITES, BEFORE AND AFTER THREE FISHING EXPERIMENTS

LEAF SWEEP 1 FISHING SITE, BEFORE FISHING

Observer	Emperors	Snappers	Groupers	Parrotflsh	Surgeon fish	Butterflyflsh
			TRANSECT 1, DEPTH 4-5.5 M			
PD	11	1	0	3	49	5
AS	18	0	0	2	56	3
ST	5	2	2	6	23	7
HR	5	0	0	4	46	0
TH	50	30	1	30	23	4
PI	57	2	0	6	48	2
			TRANSECT 2, DEPTH 2-3 M			
HR	0	0	1	6	25	1
ST	0	0	1	9	28	1
TH	0	0	0	3	7	2
PI	0	0	1	6	14	2
PD	0	0	0	8	13	0
AS	0	0	2	20	22	1
			TRANSECT 3, DEPTH 4.5 M			
PD	0	0	0	10	28	1
AS	0	0	1	2	30	5
ST	1	0	3	10	34	2
TH	0	0	1	7	10	2
Mean	9.19	2.19	0.81	8.25	32.3	Z38
s.e.	4.52	1.86	0.23	1.82	4.99	0.49

LEAF SWEEP 1 CONTROL SITE, BEFORE FISHING

Observer	Emperors	Snappers	Groupers	Parrotflsh	Surgeon flsh	Butterflyflsh
			TRANSECT 1, DEPTH 4-5.5 M			
PI	0	0	3	14	15	4
ST	0	0	3	13	21	3
AS	0	0	3	15	28	4
PD	0	0	0	27	25	4
PM	0	0	1	12	22	1
TH	0	0	1	5	15	0
			TRANSECT 2, DEPTH 2-3 M			
TH	0	0	1	10	9	2
PM	0	0	1	5	15	2
HR	0	0	4	26	11	0
ST	0	0	6	27	18	4
AS	0	0	2	44	29	1
PD	0	0	1	28	18	3
Mean	0	0	2.17	18.83	18.83	2.33
s.e.	0	0	0.49	3.35	1.83	0.45

Appendix III contd.

Observer	Emperors	Snappers	Groupers	Parrotflsh	Surgeon fish	Butterflyilsh
			LEAF SWEEP 1 FISHING SITE, AFTER FISHING			
			TRANSECT 1			
PD	0	0	0	31	40	4
AS	0	0	1	28	37	5
PM	0	0	1	6	25	7
PI	0	0	1	6	16	6
ST	0	0	2	0	23	5
TH	0	0	0	0	10	2
			LEAF SWEEP 1 TRANSECT 2			
HR	a	0	2	3	34	3
ST	0	0	1	3	22	1
PD	0	0	1	66	50	5
AS	0	0	0	33	37	9
PI	0	0	0	0	24	4
PM	0	0	0	0	18	2
PD	0	0	3	3	15	0
AS	0	0	3	3	18	1
TH	0	1	0	4	11	2
HR	0	0	1	2	10	2
PI	0	0	2	3	8	5
PM	0	0	2	2	10	6
Mean	0	0.055	1.11	10.72	22.66	3.83
s.e.	0	0.059	026	4.40	3.08	0.59

Observer	Emperors	Snappers	Groupers	Parrotfish	Surgeon fish	Butterflyfish
			LEAF SWEEP 1 CONTROL SITE, AFTER FISHING			
			TRANSECT 1 DEPTH 1.5-2 M			
PD	0	0	2	7	19	0
AS	0	0	3	7	21	2
HR	0	0	2	1	6	1
ST	0	0	4	5	13	2
TH	0	0	5	3	8	0
PI	0	0	2	4	8	1
			TRANSECT 2 DEPTH 2-3 M			
ST	0	0	6	13	73	4
HR	0	0	3	6	49	8
PD	0	0	1	22	35	6
AS	0	0	4	46	49	10
TH	0	0	2	15	30	0
PM	0	0	3	12	45	2
Mean	0	0	3.08	11.8	26.3	3.0
s.e.	0	0	0.42	3.55	5.4	0.96

Appendix III contd.

Observer	Emperors	Snappers	Groupers	Parrotfish	Surgeon fish	Butterflyflsh
LEAF SWEEP 2 FISHING SITE, BEFORE FISHING						
TRANSECT 1, DEPTH 2-3 M						
PD	0	0	2	3	21	2
AS	0	0	3	3	28	0
TH	0	0	5	9	3	3
ST	a	a	3	14	7	5
PI	0	0	3	5	6	4
HR	0	0	2	10	5	2
TRANSECT 2, DEPTH 2-3 M						
PI	0	a	1	9	16	1
PM	0	0	1	8	15	1
PD	0	a	2	4	52	2
AS	0	a	3	4	54	3
TH	0	a	0	5	30	2
ST	0	0	1	6	47	7
TRANSECT 3, DEPTH 2-3 M						
ST	0	0	4	1	21	6
TH	0	0	2	1	9	5
HR	0	0	2	1	12	0
PM	0	a	1	0	13	2
PD	0	a	2	0	30	3
AS	0	0	4	1	29	2
Mean	0	0	*23*	4.7	22.1	2.8
s.e.	0	0	0.3	0.94	3.8	0.46

Observer	Emperors	Snappers	Groupers	Parrotfish	Surgeon fish	Butterflyfish
LEAF SWEEP 2 CONTROL SITE, BEFORE FISHING						
TRANSECT 1, DEPTH 1.5-2 M						
PM	0	0	3	2	15	3
HR	0	0	1	2	21	0
TH	0	0	1	1	6	0
ST	0	0	3	4	28	2
PD	0	0	3	5	20	2
AS	0	0	3	4	24	8
TRANSECT 2, DEPTH 2-3 M						
ST	0	0	5	8	39	2
TH	0	0	2	6	20	3
AS	0	0	3	2	22	2
PD	0	0	4	0	14	2
HR	0	0	0	1	16	4
PI	0	0	0	3	13	4
TRANSECT 3, DEPTH 4-5 M						
AS	0	0	0	0	37	5
PD	0	0	0	0	23	6
PI	0	0	0	0	10	4
PM	0	0	0	0	14	4
TH	0	0	0	2	11	5
ST	0	0	1	3	34	7
Mean	0	0	1.6	2.4	20.4	3.5
s.e.	0	0	O.39	0.54	2.20	0.51

Appendix III contd.

			LEAF SWEEP *2* FISHING SITE, AFTER FISHING			
Observer	**Emperors**	**Snappers**	**Groupers**	**Parrotfish**	**Surgeon fish**	**Butterflyfish**
			TRANSECT 1, DEPTH 2-3 M			
PD	0	0	2	25	17	2
AS	0	0	3	18	18	2
HR	0	0	3	12	8	2
TH	0	0	3	10	8	5
HR	0	0	2	4	5	2
PI	0	0	5	6	11	7
			TRANSECT 2, DEPTH 2-3 M			
TH	0	0	0	10	15	8
PI	0	0	0	12	15	6
PD	0	0	2	IS	30	5
AS	0	0	2	13	45	4
PD	0	0	2	11	39	2
AS	0	0	2	11	30	6
			TRANSECT 3, DEPTH 1-2M			
AS	0	0	0	0	25	2
HR	0	0	0	0	16	1
PD	0	0	1	2	23	3
PI	0	0	1	2	17	2
TH	0	0	0	3	20	4
ST	0	0	1	2	24	1
Mean	0	0	1.6	8.7	20.3	3.6
s.e.	0	0	0.32	1.61	*2.5*	*05*

			LEAF SWEEP *2* CONTROL SITE, AFTER FISHING			
Observer	**Emperors**	**Snappers**	**Groupers**	**Parrotfish**	**Surgeon lisà**	**Butterflyfish**
			TRANSECT 1, DEPTH 3-4 M			
PD	0	0	2	3	17	4
AS	0	0	1	1	22	5
PI	0	0	3	11	14	3
ST	0	0	2	10	12	3
TH	0	0	3	5	20	7
HR	0	0	0	6	24	4
			TRANSECT 2, DEPTH 2-3 M			
HR	0	0	1	7	23	2
TH	0	0	2	7	30	6
PD	0	0	0	6	24	0
AS	0	0	1	3	20	0
PI	0	0	3	5	30	5
ST	0	0	2	7	44	5
			TRANSECT 3, DEPTH 1-2 M			
PI	0	0	0	1	21	3
ST	0	0	1	2	22	2
TH	0	0	0	2	32	3
HR	0	0	0	0	25	0
AS	0	0	1	7	33	7
PD	0	0	1	9	32	5
Mean	0	0	1.3	5.1	24.7	3.6
s.e.	0	0	025	0.76	1.82	0.52

Appendix III contd.

Observer	Emperors	Snappers	Groupers	Parrotfish	Surgeon fish	Butterflyfisb
			SPEARFISHING 1 FISHING SITE, BEFORE FISHING			
			TRANSECT 1, DEPTH 2 M			
TH	0	0	1	2	4	1
ST	0	0	2	2	8	2
PD	0	0	0	2	8	0
AS	0	0	1	2	7	0
HR	0	0	2	0	6	3
PM	0	0	2	0	5	4
			TRANSECT 2, DEPTH 2 M			
PM	0	0	1	0	12	2
HR	0	0	0	1	12	3
TH	4	0	1	2	6	0
ST	5	0	2	1	12	1
PD	1	0	0	3	13	0
AS	1	0	0	6	19	2
			TRANSECT 3, DEPTH 1.5-2 M			
PD	0	0	0	2	20	0
AS	1	0	0	0	33	0
HR	0	0	1	3	11	0
PM	0	0	3	2	13	0
TH	1	0	0	5	2	2
ST	0	0	0	9	14	2
Mean	0.72	0	0.89	2.33	11.39	1.22
s.e.	0.34	0	0.23	0.55	1.71	0.31

Observer	Emperors	Snappers	Groupers	Parrotfish	Surgeon fish	Butterflyfish
			SPEARFISHING 1 CONTROL SITE, BEFORE FISHING			
			TRANSECT 1, DEPTH 4-5 M0			
PD	0	0	4	11	14	0
AS	0	0	5	12	9	0
ST	0	0	9	6	24	0
TH	0	0	6	5	11	0
HR	0	0	2	0	11	0
PM	0	0	5	2	S	0
			TRANSECT 2, DEPTH 2 M			
TH	0	0	1	2	4	1
ST	0	0	2	2	8	2
PD	0	0	0	2	g	0
AS	0	0	1	2	7	0
HR	0	0	2	0	6	3
PM	0	0	2	0	5	4
			TRANSECT 3, DEPTH 1-2 M			
PD	0	0	4	11	14	0
AS	0	0	5	12	9	0
ST	0	0	9	6	24	0
TH	0	0	6	5	11	0
HR	0	0	2	0	11	0
PM	0	0	5	2	8	0
Mean	0	0	3.9	4.44	10.7	0.56
s.e.	0	0	0.62	1.02	1.31	0.28

Appendix III contd.

SPEARFISHING 1 FISHING SITE, AFTER FISHING						
Observer	Emperors	Snappers	Groupers	Parrotfish	Surgeon fish	Butterflyflsh
TRANSECT 1, DEPTH 1 M						
AS	0	0	0	2	6	4
PD	0	0	1	0	9	2
TH	0	0	0	2	14	2
ST	0	0	0	2	9	2
PI	0	0	0	4	18	2
PM	0	0	0	5	13	2
TRANSECT 2, DEPTH 1-1.5 M						
PM	0	0	0	2	9	2
PI	0	0	0	2	8	2
PD	0	0	1	1	10	1
AS	0	0	0	1	8	5
ST	0	1	0	0	7	0
TH	0	1	0	0	5	0
TRANSECT 3, DEPTH 2-3 M						
TH	0	0	0	0	6	0
ST	0	0	0	1	6	0
PM	0	0	0	8	2	2
PI	0	0	0	10	1	2
PD	0	0	0	11	12	1
AS	0	0	0	9	6	0
Mean	0	0.11	0.11	3033	8.29	1.61
s.e.	0	0.08	0.08	0.87	0.98	0.33

SPEARFISHING 1 CONTROL SITE, AFTER FISHING						
Observer	Emperors	Snappers	Groupers	Parrotfish	Surgeon fish	Butterflyfish
TRANSECT 1, DEPTH 1 M						
PD	0	0	0	7	30	1
AS	0	0	1	6	27	1
PI	0	0	3	13	16	2
PM	0	0	3	11	20	2
PH	0	0	2	10	30	4
ST	0	0	0	7	24	4
TRANSECT 2, DEPTH 1-1.5 M						
PM	0	0	6	20	23	0
PI	0	0	5	If	23	0
ST	0	0	5	0	57	0
TH	0	0	6	0	50	0
AS	0	0	0	14	47	0
PD	0	0	1	26	36	0
TRANSECT 3, DEPTH 4-5 M						
TH	0	0	3	3	10	0
ST	0	0	7	5	16	0
PD	0	0	5	24	25	2
AS	0	0	4	23	36	2
PI	0	0	4	6	13	1
PM	0	0	3	9	15	1
Mean	0	0	3-22	11.06	27.67	1.11
s.e.	0	0	0.52	1.88	3.11	031

Appendix IV

LENGTH FREQUENCY DISTRIBUTIONS OF THE PRINCIPAL SPECIES CAPTURED DURING THE FIRST LEAF-SWEEP FISHING EXPERIMENT

Length class (cm)	*Acanthurus nigrofuscus*	*Acanthurus nigricans*	*Ctenochaetus striatus*	*Scarus sordidus* ♀
8				
9	16			
10	71			
11	21			
12	11	6		
13	3	30	1	
14		27	1	6
15		5	13	5
16		17	15	6
17		3	11	8
18			3	8
19			3	11
20				11
21				12
22				15
23				1
24				1

Appendix IV contd.

LENGTH FREQUENCY DISTRIBUTIONS OF THE PRINCD7AL SURGEONFISH SPECIES CAPTURED DURING THE SECOND LEAF-SWEEP FISHING EXPERIMENT

Length class (cm)	*Acanthurus nigrofuscus*	*Acanthurus olivaceous*	*Ctenochaetus striatus*	*Naso lituratus*	*Acanthurus lineatus*	*Zebrasoma scopas*
8						
9	36					
10	92					
11	27					
12	2					
13	13			2		5
14	24			2		17
15	47	6	9	2	1	16
16	17	17	28	2	1	20
17	4	32	44	9	3	4
18		35	45	6	9	
19		32	42	8	12	
20		18	13	5	6	
21		8		3	4	
22		3		1		
23				2		
24				1		

Appendix IV contd.

LENGTH FREQUENCY DISTRIBUTIONS OF THE PRINCIPAL PARROTFISH SPECIES CAPTURED DURING THE SECOND LEAF-SWEEP FISHING EXPERIMENT

Length class (cm)	*Calotomus carolinus*	*Scarus sordidus*		*Scarus rubrioviolaceous*	*Scarus lepidus*	*Scarus frenatus*
		♀	♂			
8						
9						
10						
11						
12	1					
13	2	1				
14	3	1		6	1	
15	8	2		3	1	
16	7	2		4		
17	5	6		4		
18	8	8		10	2	
19	5	20		7		
20	9	21		2	3	
21	2	32		4	5	3
22	1	42		6	4	1
23	2	26	1	4	13	1
24	2	16	2	3	1	4
25		3	3	4	3	4
26		1	1	3		1
27			2	4		3
28			5	6		1
29			4	4		
30			3	2		
31			1	1		
32						
33						
34						
35						
36				1		

Appendix IV contd.

LENGTH FREQUENCY DISTRIBUTIONS OF THE PRINCIPAL
FISH SPECIES CAPTURED DURING THE FIRST
SPEARFISHING EXPERIMENT

Length class (cm)	*Acanthurus nigrofuscus*	*Acanthurus olivaceus*	*Acanthurus triostegus*	*Ctenochaetus striatus*	*Naso lituratus*	*Naso unicornis*	*Calotomus carolinus*	*Scarus globiceps*
8								
9	1	1						
10	6	2	1	1				
11	2	1	5					
12	1	2	9					
13	5		8					
14	7	3	5	1				
15	12	2	6	2	2			1
16	16	8		7			1	2
17	9	10		10	3	1		
18	3	17		4	11			2
19		9		1	16	1	1	7
20		6			30	5	3	4
21					15	9	3	6
22		1			20	20	6	2

Appendix IV contd.

LENGTH FREQUENCY DISTRIBUTIONS OF THE PRINCIPAL
FISH SPECIES CAPTURED DURING THE SECOND
SPEARFISHING EXPERIMENT

Length class (cm)	*Acanthurus nigrofuscus*	*Acanthurus nigricans*	*Acanthurus olivaceous*	*Acanthurus lineatus*	*Ctenochaetus striatus*	*Scarus sordidus*	
8						♀	♂
9	2			1			
10	2						
11							
12	3	6		1			
13	15	14					
14	22	5			22		
15	34	28			63	1	
16	9	44		1	92	4	
17	3	6	2	2	81	6	
18		1	7	28	45	18	
19			16	25	6	20	
20			10	8	1	25	1
21			13			16	2
22			6			8	2
23			1			5	10
24						1	7
25							10
26							10
27							2

Appendix V

CATCH DATA AND SPECIES COMPOSITION FOR FISHING ACTIVITIES ON WOLEAI NOT ASSOCIATED WITH THE FOUR STOCK REDUCTION EXPERIMENTS

CATCH AND FISHING EFFORT

Fishing method	Catch		Fishing effort		CPUE (line hrs)		CPUE (spear hrs)	
	kg	no	Line hours	Spear hours	kg/line hr	no/line hr	kg/spear hr	no/spear hr
Hand line fishing in lagoon passage	6.88	aa.	20		0.844			
Hand line fishing in lagoon passage	15.2	31	10		1.52	3.1		
Spearfishing on outer reef	37.53	196		14			2.68	14.0

SPECIES COMPOSITION

Family & species	Handline fishing in lagoon passage		Handline fishing in lagoon passage		Spearfishing on outer reef	
	No	Wt (kg)	No	Wt (kg)	No	Wt (kg)
ACANTHURIDAE					60	22.2
Acanthurus lineatus					28	17.0
Acanthurus nigricans					4	0.43
Acanthurus nigricauda					1	0.33
Acanthurus olivaceous					1	0.13
Ctenochaetus striatus					15	2.06
Naso lituratus					11	2.25
ZANCLIDAE					4	0.45
Zanclus cornutus					4	0.45
SCARIDAE					18	6.34
Scarus fasciatus					2	0.43
Scarus frenatus					1	0.35
Scarus gibbus					1	0.58
Scarus oviceps					6	3.45
Scarus sordidus ♀					5	0.85
Scarus sordidus ♂					3	0.68
LABRIDAE					1	0.4
Cheilinus trilobatus					1	0.4
MULLIDAE					1	0.28
Parupeneus cyclostomus					1	0.28
SERRANIDAE			6	1.88	11	1.96
Cephalopholis argus					1	0.38
Cephalopholis urodelus					5	0.11
Epinephelus fasciatus			3	0.14		
Epinephelus hexagonatus					3	0.09
Epinephelus tauvina			2	0.56	2	1.38
Variola louti			1	1.18		

Family & species	Handline fishing in lagoon passage		Handline fishing in lagoon passage		Spearfishing on outer reef	
	No	Wt (kg)	No	Wt (kg)	No	Wt (kg)
LUTJANIDAE	n.a.	11.58	10	3.30	5	1.55
Aprion virescens	n.a.	3.4				
Lutjanus bohar	n.a.	1.3	1	0.14		
Lutjanus gibbus	n.a.	6.88	5	2.74	5	1.55
Lutjanus kasmira			4	0.42		
BALISTIDAE					21	2.41
Balistapus undulatus					2	0.45
Melichthys niger					1	0.18
Melichthys vidua					17	1.63
Rhinecanthus rectangulus					1	0.15
MONOCANTHIDAE					3	0.88
Cantherhines dumerili					3	0.88
CARANGIDAE	n.a	1.35			1	0.55
Carangoides orthogrammus					1	0.55
HOLOCENTRIDAE	n.a.	6.88	3	0.90	9	0.80
Adioryx spiniferum			1	0.67		
Sargocentrum tiere			2	0.23	9	0.80
LETHRINIDAE		0.55	12	3.21		
Gymnocranius aureolineatus			1	0.07		
Gymnocranius lethrinoides			1	1.76		
Lethrinus ramak			3	0.78		
Lethrinus rubrioperculatus			1	0.60		
Monotaxis grandoculis	n.a.	0.55	6	5.50		

Appendix VI

WOLEAIAN FISH NAMES[1] (FAMILIES, AND GENERA WITHIN FAMILIES, ARE LISTED IN ALPHBETICAL ORDER)

ACANTHOCYBIIDAE

Acanthocybium solandri (wahoo)
ngal - ngalibeol(lg)

ACANTHURIDAE

Acanthurus bariene (bariene surgeonfish)
yefal (mwoch)

Acanthurus bleekeri (surgeonfish)
mwochelilal (mwoch)

Acanthurus dussumieri (eye-stripe surgeonfish)
gamashuwag (mwoch)

Acanthurus guttatus (whitespotted surgeonfish)
parepar

Acanthurus leucopareius (whitebar surgeonfish)
yefal (mwoch)

Acanthurus lineatus (bluebanded surgeonfish)
filaang

Acanthurus maculiceps (white-freckled surgeonfish)
gamashuwag (mwoch)

Acanthurus mata (elongate surgeonfish)
yefal (mwoch)

Acanthurus nigricans (whitecheek surgeonfish)
mwochonageiy (mwoch)

Acanthurus nigricauda (epaulette surgeonfish)
yefal (mwoch)

Acanthurus nigrofuscus (brown surgeonfish)
mwochepag (mwoch)

Acanthurus olivaceus (orangeband surgeonfish)
mwarafash (mwoch)

Acanthurus pyroferus (chocolate surgeonfish)
gashengal (mwoch)

Acanthurus thompsoni (thompson's surgeonfish)
yefal (mwoch)

Acanthurus triostegus t. (convict tang)
ligeolaw/limeon

Acanthurus xanthopterus (yellowfin surgeonfish)
gamashuwag (mwoch)

Ctenochaetus binotatus (twospot bristletooth)
metechou (mwoch)

Ctenochaetus striatus (striped bristletooth)
mwoch (mwoch)

Naso annulatus (whitemargin unicornfish)
igefalefal

Naso brachycentron (humpback unicornfish)
gium

Naso brevirostris (spotted unicornfish)
felamwe

Naso hexacanthus (blacktongue unicornfish)
melango

Naso lituratus (orangespine unicornfish)
bulagaaley

Naso lopezi (lopez' unicornfish)
melango

Naso thynnoides * (unicornfish)
beiutiut

Naso tuberosus (humpnose unicornfish)
igefalefal

Naso unicomis (bluespine unicornfish)
gium

Naso vlamingii (bignose unicornfish)
mwiliy

Paracanthurus hepatus (palette surgeonfish)
masiyes

---

[1] This is a preliminary list of Woleaian fish names. The spellings have yet to be finalized due to the recent adoption of a new spelling system by the Education Department for the outer islands of Yap State. The first name is the one most commonly used; if there are two alternative names they are separated by a slash (/). The Woleaian name in parentheses () is the 'generic' or 'family' name. If different names refer to different sizes they are listed next followed by one of the following (sml), (med), (lg) or (xlg). If a name is used under special circumstances it is listed followed by (spcl).

The names were collected by two means: 1) by showing the pictures in Masuda, *et al* (1984); and 2) by Geld identification (approximately half have to be positively identified. The scientific nomenclature used in Myers (1989) was followed. Those marked with * were not listed in Myers.

Zebrasoma flavescens (yellow tang)
ligapwarig

Zebrasoma scopas (brown tang)
ligapwarig

Zebrasoma veliferum (sailfin tang)
ligapwarig

APOGONIDAE

Apogon lineatus * (cardinalfish)
tiper

Apogon spp (cardinalfish)
ligoch (ligoch)

Cheilodipterus lineatus (lined cardinalfish)
ligoch

Cheilodipterus macrodon (large-toothed cardinalfish)
ligoch

Cheilodipterus quinquelineata (five-lined cardinalfish)
ligoch

AULOSTOMEDAE

Aulostomus chinensis (trumpetfish)
gasiufetiul

BALISTIDAE

Abalistes stellatus (starry triggerfish)
buub (buub)

Balistapus undulatus (orangestriped triggerfish)
bbulefalemegisho (buub)

Balistoides conspicillum (clown triggerfish)
bbutelitel (buub)

Balistoides viridescens (mustache triggerfish)
liuwesho (liuweliu)

Canthidermis maculatus (spotted oceanic triggerfish)
buubul gapeipei (buub)

Melichthys niger (black triggerfish)
bbupel (buub)

Melichthys vidua (pinktail triggerfish)
pashemach. (buub)

Odonus niger (redtooth triggetfish)
bbugesaf (butib) *

Pseudobalistes flavimarginatus (yellowmargin triggerfish)
liuwegelaw (liuweliu)

Pseudobalistes fuscus (blue triggerfish)
buub (buub)

Rhinecanthus aculeatus (picassofish)
bbubesh (buub)

Rhinecanthus rectangulus (wedge picassofish)
bbubuwelimai (buub)

Rhinecanthus verrucosa (blackbelly picassofish)
bbuyoaro (buub)

Sufflamen bursa (scythe triggerfish)
bbugesh (buub)

Sufflamen chiysoptera (halfmoon triggerfish)
bbugesh (buub)

Sufflamen freanatus (bridle triggerfish)
bbugesh (buub)

Xanthichthys auromarginatus (bluechin guilded triggerfish) buubul nipom (buub)

Xanthichthys careuleolineatus (bluelined triggerfish)
buubul nipom (buub)

Xanthichthys lineopunctatus * (triggerfish)
buubul nipom (buub)

Xanthichthys mento (Crosshatch triggerfish)
buubul nipom (buub)

BELONIDAE

Ablennes hians (needlefish)
tagiuteor (taag)

Platybelone argalus platyura (keeled needlefish)
maag

Stonngylura incisa (reef needlefish)
tagiulifalipiy (taag)

Tylosurus acus melanotus * (needlefish)
tomotom/tagiulimetaw (taag)

Tylosurus crocodilis c. (crocodile needlefish)
tagiuliwosh (taag)

BOTHIDAE

Asterorhombus intermedius (intermediate flounder)
lippar - lippar(sml), mesapaliy(lg)

Bothus mancus (peacock flounder)
lippar - lippar(sml), mesapaliy(lg)

Pseudorhombus arsius * (flounder)
lippar - lippar(sml), mesapahy(lg)

CAESIONIDAE

Caesio cutting (fusilier)
limmeriyoang

Caesio lunaris (lunar fusilier)
sapegiuw

Caesio teres (yellowback fusilier)
limmeriyoang

Caesio tile * (fusilier)
tilibu - tilimeol(sml)

Pterocaesio marri (twin stripe fusilier)
tilibu

CARANGIDAE

Alectis ciliaris (threadfin pompano)
yappu - sileliyeo(sml)

Alectis indicus (indian threadfin)
yappu - sileliyeo(sml)

Carangoides ferdau (bar jack)
sarish - chep(sml), shepel sarish(lg)

Carangoides fulvoguttatus (yellow-dotted trevally)
sarish - chep(sml), shepel sarish(lg)

Carangoides hedlandensis * (jack)
igelefalimaailap - chep(sml)

Carangoides orthogrammus (yellow-sported trevally)
sarish - chep(sml), shepel sarish(lg)

Caranx ignobilis (giant trevally)
yetam - gaigumaw(sml)

Caranx lugubris (black jack)
yarong - chep(sml), shepeliyarong(lg)

Caranx melampygus (bluefin trevally)
langiuw - chep(sml)

Caranx papuensis (brassy trevally)
langiuw - chep(sml)

Caranx sexfasciatus (bigeye trevally)
yetam - chepop(sml)

Caranx tille * (trevally)
yetam - chgpop(sml)

Decapterus macarellus (mackeral scad)
mamoshig

Decapterus macrosoma (slender scad)
mamoshig

Decapterus russelli * (scad)
mamoshig

Decapterus tabl * (scad)
mamoshig

Elagatis bipinnulatus (rainbow runner)
foafoa

Gnathonodon speciosus (golden trevally)
urupiig - chep(sml)

Scomberoides lysan (leatherback lae)
tettal

Selar crumenophthalmus (bigeye scad atulai)
pati

Seriola dumerili (greater amberjack)
fatugerauw

Seriola rivoliana (almaco jack)
meseiug

Trachinotus bailloni (small spotted pompano)
yengang

CARCHARHIDAE

Galeocerdo cuvieri (tiger shark)
meraurau (pagow)

CARCHARHINIDAE

Carcharhinus albimarginata (silvertip shark)
mwoashog (pagow)

Carcharhinus longimanus (oceanic whitetip shark)
yeshalifes (pagow)

Carcharhinus melanopterus (reef blacktip shark)
woshaalang (pagow)

Carcharhinus obscurus * (shark)
metel (pagow)

Prionace glauca * (shark)
yeshabel (pagow)

CHAETODONTIDAE

Chaetodon auriga (threadfin butterflyfish)
(ligeriger)

Chaetodon citrinellus (speckled butteflyfish)
(ligeriger)

Chaetodon ephippium (saddled butterflyfish)
(ligeriger)

Chaetodon lunula (racoon butterflyfish)
(ligeriger)

Chaetodon meyeri (Meyer's butterflyfish)
(ligeriger)

Chaetodon omatissimus (ornate butterflyfish)
(ligeriger)

Chaetodon punctatofasciatus (spot banded butterflyfish)
ligeriger

Chaetodon reticulatus (reticulated butterflyfish)
ligeribateo (ligeriger)

Chaetodon trifascialis (chevroned butterflyfish)
ligeriger

Chaetodon trifasciatus (redfin butterflyfish)
(ligeriger)

Chaetodon unimaculatus (teardrop butterflyfish)
(liegeriger)

Chaetodon vagabundus (vagabond butterflyfish)
(ligeriger)

Chaetodon spp (butterflyfish)
ligeriger (ligeriger)

Forcipiger flavissimus (big long-nosed butterflyfish)
(ligeriger)

Heniochus chtysostomus (pennant bannerfish)
meimei (ligeriger)

CHANIDAE

Chanos chanos (milkfish)
yauta

CIRRHITIDAE

Cirrhitus pinnulatus (stocky hawkfish)
liuliulau

Paracirrhites arcatus (arc-eye hawkfish)
galiyechimweliyal

Paracirrhites forsteri (freckled hawkfish)
galiyechimweliyal

Paracirrhites hemistictus (whitespot hawkfish)
galiyechimweliyal

CLUPEIDAE

Spmtelloides delicatulus (blue sprat)
(unknown)

Spmtelloides gracilis (silver sprat)
(unknown)

CONGRIDAE

Conger cinereus cinereus (moustache conger eel)
weor (labut)

CORYPHAENIDAE

Coryphaena hippurus * (dolphin fish)
tepoar

DASYATIDIDAE

Dasyatus kuhlii (blue spotted stingray)
faiyemeet (faaiy)

Taeniura melanospilos (black-spotted stingray)
faiyenecheoligilifeo (faaiy)

DIODONTIDAE

Chilomycterus affinis * (porcupinefish)
taius - wushuga(sml)

Diodon holocanthus * (porcupinefish)
taius - wushuga(sml)

Diodon hystrix (porcupinefish)
taius - wushuga(sml)

Diodon liturosus (shortspine porcupinefish)
taius - wushuga(sml)

ECHENEIDIDAE

Echeneis naucrates (sharksucker)
tamwilemwil

Remora remora (remora)
tamwilemwil

EPHIPPIDAE

Platax orbicularis (circular spadefish batfish)
mwul - meimeiy(sml)

Platax pinnatus (pinnate spadefish)
mwul - meimeiy(sml)

Platax teira (longfin spadefish)
mwul - meimeiy(sml)

EXOCOETIDAE

Cypselurus spp * (flying fish)
mengar (mengar) - shiyow(sml), saulap(lg)

FISTULARIDAE

Fistularia commersonii (cornetfish smooth flutemouth)
lipaapa - sageopa(sml)

GEMPYLmAE

Ruvettus pretiosus *
sinimengar

GERREIDAE

Gerres filamentosus (filamentous mojarra)
liyemwit

Gerres oblongus (oblong mojarra)
liyemwit

Gerres oyena (oyena mojarra)
liyemwit

Pentaprion longimanus * (mojarras)
liyemwit

GOBIIDAE

Valenciennea strigatus (blue-streak goby)
unknown

HAEMULIDAE

Plectorhinchus chaetodonoides (harlequin sweetlips)
gafiul

Plectorhinchus gaterinoides (lined sweetlips)
laamwar

Plectorhinchus gibbosus (gibbus sweetlips)
gafiul

Plectorhinchus goldmanni (goldman's sweetlips)
laamwar

Plectorhinchus orientalis (oriental sweetlips)
laamwar

Plectorhinchus picus-(spotted sweetlips)
gafiul

Plectorhinchus schotaf * (sweetlips) *
gafiul

HEMIGALEIDAE

Triaenodon obesus (reef whitetip shark)
mweshar (pagow)

HEMIRHAMPHIDAE

Euleptorhamphus viridis ((flying) halfbeak)
mwaag

Hemimramphus far (spotted halfbeak)
fela

Hyporhamphus dussumieri (Dussumier's halfbeak)
fela

Hyporhamphus quoyi * (halfbeak)
fela

Hyporhamphus yuri * (halfbeak)
fela

HOLOCENTRIDAE

Myripristis adusta (bronze soldierfish)
mweliutemush (mwel)

Myripristis berndti (bigscale soldierfish)
mweliuseram (mwel)

Myripristis hexagona (doubletooth soldierfish)
mweliuseram (mwel)

Myripristis kuntee (pearly soldierfish)
mweliuseram (mwel)

Myripristis melaonstictus * (soldierfish)
mweliuseram (mwel)

Myripristis murdjan (red soldierfish)
mweliuseram (mwel)

Myripristis pralinia (soldierfish)
mweliuseram (mwel)

Myripristis randalli * (soldierfish)
mweliuseram (mwel)

Myripristis violacea (violet soldierfish)
mweliutemush (mwel)

Neoniphon argenteus (clearfin squirrelfish)
giuchitei (giuch)

Neoniphon opercularis (blackfin squirrelfish)
giuchiyator (giuch)

Neoniphon sammara (bloodspot squirrelfish)
giuchitei (giuch)

Sargocentron caudimaculatum (tailspot squirrelfish)
sapekang (giuch)

Sargocentron diadema (crown squirrelfish)
giuch yelus (giuch)

Sargocentron dorsomaculatum (spotfin squirrelfish)
let (giuch)

Sargocentron furcatum * (squirrelfish)
giuch yelus (giuch)

Sargocentron ittodai (samurai squirrelfish)
giuch yelus (giuch)

Sargocentron microstoma (finelined squirrelfish)
giuch yelus (giuch)

Sargocentron praslin (dark-striped squirrelfish)
giuchimwel (giuch)

Sargocentron punctatissimum (speckled squirrelfish)
giuchifaaiy (giuch)

Sargocentron spinifenon (long-jawed squirrelfish)
sera (giuch)

Sargocentron tiere (blue-lined squirrelfish)
let (giuch)

Sargocentron violaceum (violet squirrelfish)
sapekang (giuch)

ISTIOPHORIDAE

Istiophorus platypterus * (sailfish)
mwaralasho

Makaira indica * (black marlin)
taguraar

Makaira mazara * (blue marlin)
taguraar

Tetrapturus audax * (striped marlin)
taguraar

KUHLIIDAE

Kuhlia marginata (dark-margined flagtail)
paleyaw

Kuhlia mugil (barred flagtail)
paleyaw

KYPHOSIDAE

Kyphosus bigibbus (insular rudderfish)
umuleo (rel) - renigiiy (at logs)(spcl)

Kyphosus cinerascens (highfin rudderfish)
relison (rel) - renigiiy (at logs)(spcl)

Kyphosus vaigiensis (lowfin rudderfish)
umuleo (rel) - renigiiy (at logs)(spcl)

LABRIDAE

Anampses caeruleopunctatus (blue-spotted wrasse)
gaaguluug

Anampses geographicus (geographic wrasse)
giutiuw

Bodianus bilunulatus (hogfish)
ngishif

Bodianus perditio * (hogfish)
ngishif

Cheilinus chlorourus (floral wrasse)
poros

Cheilinus digrammus (bandcheek wrasse)
libbaig

Cheilinus fasciatus (red-breasted wrasse)
sifes

Cheilinus trilobatus (tripletail wrasse)
poros

Cheilinus undulatus (humphead wrasse)
mamiliporos

Cheilinus unifasciatus (ringtail wrasse)
libbaig

Cheilio inermis (cigar wrasse)
gjlal

Coris aygula (clown coris)
giutiuw

Coris gaimard (yellowtail coris)
lisheolifaliyap

Epibulus insidiator (slingjaw wrasse)
rewes

Epibulus insidiator (var.) (slingjaw wrasse)
yauwesei

Gomphosus varius (bird wrasse)
geosaap

Halichoeres hortulanus (checkerboard wrasse)
liugiugeo

Halichoeres margaritaceus (weedy surge wrasse)
(unknown)

Halichoeres trimaculatus (three-spot wrasse)
goshal (gashileo)

Hemigymnus fasciatus (barred thicklip wrasse)
ngiuwel

Hemigymnus melapterus (half-and-half wrasse)
ngiuwel

Hologymnosus annulatus (ring wrasse)
faishifuis

Labroides dimidiatus (bluestreak cleaner wrasse)
(unknown)

Ptereleotris evidens (blackfin dartfish)
(unknown)

Macrophcoyngodon meleagris (leopard wrasse)
(unknown)

Novaculichthys taeniourus (dragon wrasse)
lisheileil

Thalassoma hardwickii (sixbar wrasse)
tangalangal (gashileo)

Thalassoma janseni (jansen's wrasse)
gashileo (gashileo)

Thalassoma lunare (crescent wrasse)
gashileo (gashileo)

Thalassoma lutescens (sunset wrasse)
gashileo (gashileo)

Thalassoma purpureum (surge wrasse)
shaalau (gashileo)

Thalassoma quinquevittatum (five-stripe surge wrasse)
taaleyal (gashileo)

Thalassoma trilobatum (christmas wrasse)
shaalau (gashileo)

Xyrichtys aneitensis (yellowblotch razorfish)
poot (poot)

Xyrichtys melanopus * (razorfish)
poot (poot)

Xyrichtys pavo (indianfish blue razorfish)
pootibau (poot)

Xyrichtys twistii * (razorfish)
poot (poot)

LETHRINIDAE

Gnathodentex aurolineatus (yellowspot emperor)
tagiuriwash

Gymnocranius elongatus * (emperor)
liyemwit

Gymnocranius griseus (gray emperor)
igeneoi

Gymnocranius japonicus (japan sea bream)
igeneoi

Gymnocranius lethrinoides (stout emperor)
igeneoi

Lethrinus amamianus * (emperor)
metiil (roagorog)

Lethrinus amboinensis (ambon emperor)
loot (roagorog) - roagorog(sml), gatig(lg)

Lethrinus elongatus (longnose emperor)
gatigeligutag (roagorog)

Lethrinus harak (blackspot emperor)
uul (roagorog)

Lethrinus kallopterus (orange emperor)
worobil

Lethrinus lentjan (redspot emperor)
sagiuripiy (roagorog)

Lethrinus mahsenoides (yellowbrow emperor)
metiil (roagorog)

Lethrinus microdon (smalltooth emperor)
loot (roagorog) - roagorog(sml), gatig(lg)

Lethrinus nematacanthus (longspine emperor)
sagiuripiy (roagorog)

Lethrinus omatus (ornate emperor)
metiil (roagorog)

Lethrinus ramak (yellowstripe emperor)
sagiuripiy (roagorog)

Lethrinus rubrioperculatus (redgill emperor)
loot (roagorog) - roagorog(sml), gatig(lg)

Lethrinus semicinctus (reef flat emperor)
loot (roagorog) - roagorog(sml), gatig(lg)

Lethrinus xanthochilus (yellowlip emperor)
loot (roagorog) - roagorog(sml), gatig(lg)

Monotaxis grandoculus (bigeye emperor)
shaalaut - fetalipes(sml), gangiba(lg)

LUTJANIDAE

Aphareus furca (blue smalltooth jobfish)
meraab

Aphareus rutilans * (jobfish)
meraab

Aprion virescens (jobfish)
yaiuyeiu

Etelis carbunculus * (snapper)
falag

Etelis coruscans * (snapper)
falag

Lutjanus argentimaculatus (river snapper)
litetifash

Lutjanus bohar (red snapper)
mos

Lutjanus fulviflamma * (snapper)
litetifash

Lutjanus fulvus (flametail snapper)
liserefash

Lutjanus gibbus (humpback snapper)
metecha - tepabung(sml)

Lutjanus kasmira (bluelined snapper)
taat

Lutjanus monostigmus (onespot snapper)
litetifash

Lutjanus spilurus * (bluelined snapper)
taat

Macolor niger (black snapper)
wolalum - gryegimos(sml)

Pristipomoides auricilla * (snapper)
falagal meraab

Pristipomoides filamentosus * (snapper)
falagal meraab

Pristipomoides flavipinnis * (snapper)
falagal meraab

Pristipomoides multidens * (snapper)
falagal meraab

Pristipomoides sieboldii * (snapper)
falagal meraab

Pristipomoides typus * (snapper)
falagal meraab

Tropidinius amoenus * (snapper)
falagal tagiuriwash

MALACANTHIDAE

Malacanthus latovittatus (striped blanquillo)
gumwashel

MOBULIDAE

Manta alfredi (manta ray)
fairiyap/mwura (faaiy)

MONACANTHIDAE

Acreichthys hajam * (filefish)
pariutet

Acreichthys tomentosus (seagrass filefish)
pariutet

Aluterus scriptus (scribbled filefish)
paal

Amanses scopas (broom filefish)
pariutet

Cantherhines dumerilii (barred filefish)
liyooma/sampan (Jap.)

Cantherhines fronticinctus (specktacled filefish)
pariutet

Cantherhines multilineatus * (filefish)
pariutet

Cantherhines pardalis (wire-net filefish)
pariutet

Paramonacanthus japonicus (filefish)
pariutet

Pervagor melanocephalus (blackheaded filefish)
pariutet

Pervagor sp * (filefish)
pariutet

MUGILIDAE

Crenimugil crenilabis (fringelip mullet)
yaiuw (yaiuw) - yaiuwach(sml), yaiuwetam(lg)

Crenimugil heterocheilos * (mullet)
yaiuw (yaiuw) - yaiuwach(sml), yaiuwetam(lg)

Liza macrolepis * (mullet)
yaiuw (yaiuw) - yaiuwach(sml), yaiuwetam(lg)

Liza vaigiensis (yellowtail mullet)
geraf (yaiuw)

Oedalechilus labiosus (foldlip mullet)
yaiuw (yaiuw) - yaiuwach(sml), yaiuwetam(lg)

Valamugil buchanani * (mullet)
yaiuw (yaiuw) - yaiuwach(sml), yaiuwetam(lg)

Valamugil seheli (bluespot mullet)
yaiuw (yaiuw) - yaiuwach(sml), yaiuwetam(lg)

MULLIDAE

Mulloides flavolineatus (yellowstripe goatfish)
uweshig-uweshig(sml), mwatug(med), souw(lg)

Mulloides pflugeri (orange goatfish)
wailam

Mulloides vanicolensis (yellowfin goatfish)
woomey - tabutob(sml)

Parupeneus barberinoides (half-and-half goatfish)
sungong

Parupeneus barberinus (dash-and-dot goatfish)
failigiy

Parupeneus bifasciatus (two-barred goatfish)
semaiuribong

Parupeneus chrysopleuron * (goatfish)
mepiung

Parupeneus ciliatus (white-lined goatfish)
semaiuribong

Parupeneus cydostomus (yellowsaddle goatfish)
souwenal (sagiuwach)

Parupeneus cydostomus (var.) (yellowsaddle goatfish)
sauwarang (sagiuwach)

Parupeneus forsskali * (goatfish)
failigiy

Parupeneus indicus (indian goatfish)
semaiuribong

Parupeneus multifastiatus (multibarred goatfish)
sungong

Parupeneus pleurostigma (sidespot goatfish)
sagilat

Parupeneus spilurus * (goatfish)
sagilat

Upeneus subvittatus * (goatfish)
merab

Upeneus taeniopterus (band-tailed goatfish)
merab

Upeneus vittatus (yellowbanded goatfish)
merab

MURAENIDAE

Gymnothorax pious * (moray eel)
sauwefang (labut) - saufeliuw(lg)

MYLIOBATIDAE

Aetobatis narinari (spotted eagle ray)
faaiy getaf (faaiy)

NEMIPTERIDAE

Scolopsis bilineatus (twoline spinecheek) .
galengaay

Scolopsis lineatus (black-and-white spinecheek)
galengaay

OPHICHTHIDAE

Myrichthys colubrinus (banded snake eel)
limwaremwarebuul (labut)

ORECTOLOBIDAE

Nebrius concolor (nurse shark)
paab (pagow)

Stegastoma varium (zebra shark leopard shark)
wolaaliy (pagow)

OSTRACHDAE

Lactoria comuta (longhorn cowfish)
ssab

Lactoria diaphana (spiny cowfish)
ssab

Lactoria fomasini (thornback cowfish)
ssab

Ostracion cubicus (cube trunkfish)
ssab

Ostracion meleagris m. (spotted trunkfish)
ssab

PEMPHERIDIDAE

Parapriacanthus ransonneti (pigmy sweeper)
igelilanibaiu

Pempheris oualensis (bronze sweeper)
igelilanibaiu

PLESIOPIDAE

Plesiops caeruleolineatus (red-tipped longfin)
ligos

PLOTOSIDAE

Plotosus lineatus (striped eel catfish)
laiulgafiiy

POLYNEMIDAE

Polydactylus plebejus * (threadfin)
reshapagow

POMACANTHIDAE

Apolemichthys trimaculatus (three spot angelfish)
(ligeriger)

Pomacanthus imperator (emperor angelfish)
ngiungiu

Pygoplites diacanthus (regal angelfish)
rishing

POMACENTRIDAE

Abudefduf bengalensis * (sergeant)
limoulaang

Abudefduf saxatilis (sergeant-major)
limoulaang

Abudefduf septemfasciatus (banded sergeant)
sen

Abudefduf sexfasciatus (scissor-tail sergeant)
limoulaang

Abudefduf sordidus (black-spot sergeant)
sen

Amblyglyphidodon aureus (golden damsel)
limoulaang

Amblyglyphidodon curacao (staghom damsel)
limoulaang

Amblyglyphidodon tematensis (ternate damsel)
limoulaang

Chromis margaritifer (bicolor'chromis)
lisheog

Chrysiptera biocellata (two-spot demoiselle)
nimmis

Chrysiptera caeruleolineata (blue-line demoiselle)
nimmis

Chrysiptera cyanea (blue devil)
nimmis

Chrysiptera glauca (gray demoiselle)
nimmis

Chrysiptera hemicyanea * (demoiselle)
nimmis

Chrysiptera leucopoma (surge demoiselle)
nimmis

Chrysiptera rex (king demoiselle)
nimmis

Chrysiptera starcki * (demoiselle)
nimmis

Chrysiptera tricincta * (demoiselle)
nimmis

Chrysiptera unimaculata (one-spot demoiselle)
nimmis

Dascyllus trimaculatus (three-spot dascyllus)
lisheog

Dischistodus melanotus (black-vent damsel)
lisheog

Hemiglyphidodon plagiometopon (giant fanner fish)
lisheog

Paraglyphidodon melas (royal damsel black damsel)
lisheog

Plectroglyphidodon dickii (dick's damsel)
lisheog

Plectmglyphidodon lacrymatus (jewel damsel)
lisheog

Plectroglyphidodon leucozonus l. (white-band damsel)
lisheog

Plectroglyphidodon phoenixensis (phoenix islands damsel)
lisheog

Pomacentrus alexanderae * (damsel)
lisheog

Pomacentrus amboinensis (ambon damsel)
lisheog

Pomacentrus bankanensis (speckled damsel)
lisheog

Pomacentrus chrysurus (white-tail damsel)
lisheog

Pomacentrus moluccensis (lemon damsel)
lisheog

Pomacentrus nigromarginatus * (damsel)
lisheog

Pomacentrus philippinus (philippine damsel)
lisheog

Pomacentrus taeniometopon * (dusky damsel)
lisheog

Pomacentrus vaiuli (princess damsel)
lisheog

Stegastes albifasciatus (white-bar gregory)
lisheog

Stegastes fasciolatus (pacific gregory)
lisheog

Stegastes lividus (blunt snout gregory)
lisheog

Stegastes nigricans (dusky farmerfish)
lisheog

PRIACANTHIDAE

Heteropriacantkus cruentatus (glasseye)
lipauw

Priacanthus hamrur (goggle-eye)
lipauw

SCAREDAE

Bolbometopon muricatum (humphead parrotfish)
mamiligemasegul (igeliwosh)

Calotomus japonicus * (parrotfish)
Byepop (igeliwosh)

Calotomus carolinus (m) (bucktooth or stareye parrotfish)
tibulangir (m) (igeliwosh)

Calotomus carolinus (f) (bucktooth or stareye parrotfish)
limesifelang (f) (igeliwosh)

Cetoscarus bicolor (bicolor parrotfish)
gishigish (m) (igeliwosh)

Cetoscarus bicolor (f) (bicolor parrotfish)
yaregulung*(f) (igeliwosh)

Leptoscarus vaigiensis (seagrass parrotfish)
bushuga (igeliwosh)

Scarus altipinnis (filament-finned parrot fish)
gaabuhoel (i.p.) gaabush (t.p.) (igeliwosh)

Scarus atropectoralis (red parrotfish)
mausera (igeliwosh)

Scarus bowersi (bower's parrotfish)
mogoweim (igeliwosh)

Scarus dimidiatus (turquoise-capped parrotfish)
gasiyerang (igeliwosh)

Scarus festivus (festive parrotfish)
umash (igeliwosh)

Scarus forsteni (m) (Forsten's parrotfish)
wail (igeliwosh)

Scams forsteni (f) (forsten's parrotfish)
gasiyarou (igeliwosh)

Scams frenatus (vermiculate parrotfish)
uutap (m) (igeliwosh)

Scarus frontalis (tan-faced parrotfish)
usha (igeliwosh)

Scarus gibbus (gibbus parrotfish)
gamasegul (igeliwosh)

Scarus gibbus (var.) (gibbus parrotfish)
rouw (igeliwosh)

Scarus globiceps (roundhead parrotfish)
mangushingush (igeliwosh)

Scarus japonensis (Japanese parrotfish)
faaragimogoweim (m) faaragingiicha (f) igeliwosh

Scarus longiceps (f) * (parrotfish)
yaari (f) (igeliwosh)

Scarus longiceps * (parrotfish)
yiulef (m) (igeliwosh)

Scams niger (black parrotfish)
gaab (igeliwosh)

Scarus oviceps (dark-capped parrotfish)
uutap (igeliwosh)

Scarus prasiognathos (greenthroat parrotfish)
gaab (igeliwosh)

Scarus psittacus (palenose parrotfish)
shogeyal (igeliwosh)

Scarus quoyi (quoy"s parrotfish)
mogoweim (igeliwosh)

Scarus rivulatus (rivulated parrotfish)
mogoweim (igeliwosh)

Scarus mbmviolaceus (redlip parrotfish)
gawegaw (m) (igeliwosh)

Scarus rubroviolaceus (f) (redlip parrotfish)
fasiulimat (f) (igeliwosh)

Scarus schlegeli (yellowband parrotfish)
tabolobol (m) (igeliwosh)

Scarus schlegeli (f) (yellowband parrotfish)
ngimelif (f) (igeliwosh)

Scarus sordidus (bullethead parrotfish)
mogoweim (m) (igeliwosh)

Scarus sordidus (f) (bullethead parrotfish)
ngiicha (f) (igeliwosh)

Scarus sp (parrotfish)
yoyo (igeliwosh)

Scarus spinus (pygmy parrotfish)
surufuruf (igeliwosh)

SCOMBRIDAE

AUTOS rochei * (mackerel tuna)
yasiuneiu - yauma(sml)

Auxis thazard * (mackerel tuna)
yasiuneiu - yauma(sml)

Euthynnus affinis * (mackerel tuna)
yasiuneiu - yauma(sml)

Grammatorcynos bilineatus (double-lined mackerel)
gaboiu

Gymnosarda unicolor (dogtooth tuna)
yaiul - toalaliyal(sml), yaiuluifal(lg)

Katsuwonus pelamis * (skipjack tuna)
garengaap - garengaap(sml),
ligaasimwai(med), liyaubesh(lg)

Rastrelliger kanagurta (striped mackeral)
tettal

Thunnus alalunga * (albacore)
taguw (taguw) - taguw(sml),
taguw peras(med), taguw tangir(lg)

Thunnus albacares * (yellowfin tuna)
taguw (taguw) - taguw(sml),
taguw peras(med), taguw tangir(lg)

Thunnus obesus * (big-eyed tuna)
taguw (taguw) - taguw(sml),
taguw peras(med), taguw tangir(lg)

SCORPAENIDAE

Dendrochirus zebra (zebra lionfish)
laaligere

Parapterois heterurus * (lionfish)
laaligere

Pterois antennata (spotfin lionfish)
laagigere

Pterois lunulata * (lionfish)
laaligere

Pterois radiata (clearfin lionfish)
laaligere

Pterois volitans (lionfish)
laaligere

Rhinopias frondosa (weedy scorpionfish)
loou (loou)

Scorpaenopsis diabolus (devil scorpionfish)
loou (loou)

Scorpaenopsis oxycephala (tassled scorpionfish)
loou (loou)

Synanceia verrucosa (stonefish)
loufash (loou)

SERRANIDAE

Anyperodon leucogrammicus (white-lined grouper)
georochang

Cephalopholis argus (blue-spotted grouper)
galiuyeliuy

Cephalopholis boenack (brownbarred grouper)
iugiushaap

Cephalopholis leopardus (leopard grouper)
iugiushaap

Cephalopholis miniata (coral grouper)
iugiushaap

Cephalopholis obtusaurus * (grouper)
iugiushaap

Cephalopholis polleni (harlequin grouper)
iugiushaap

Cephalopholis sexmaculata (six-banded grouper)
iugiushaap

Cephalopholis sonnerati (tomato grouper)
iugiushaap

Cephalopholis spiloparaea (orange-red pigmy grouper)
iugiushaap

Cephalopholis urodeta (flagtail grouper)
gamashiyor

Epinephelus areolatus * (grouper)
galiyeshal (galiy)

Epinephelus chlorostigma (brown-spotted grouper)
maleog (galiy)

Epinephelus dictyophorus * (grouper)
maleog (galiy)

Epinephelus fasciatus (black-tipped grouper)
metail (galiy)

Epinephelus fuscoguttatus (blotchy grouper)
maleog (galiy)

Epinephelus hexagonatus (hexagon grouper)
galiyel lecholiyong (galiy)

Epinephelus lanceolatus (giant grouper)
liuliulaw (taiyaaw) - taiyaaw maleog(lg)

Epinephelus macrospilos (black-spotted grouper)
iuliuloa (galiy)

Epinephelus maculatus (highfin grouper)
galiyelinipom (galiy)

Epinephelus malabaricus (malabar grouper)
maleog (taiyaaw) - taiyaaw maleog(lg)

Epinephelus melanostigma (blackspot honeycomb grouper)
galiy mwera (galiy)

Epinephelus merra (honeycomb grouper)
galiyeshoal (galiy)

Epinephelus microdon (marbled grouper)
maleog (galiy)

Epinephelus moara * (grouper)
maleog (galiy)

Epinephelus rhyncholepis * (grouper)
metail (galiy)

Epinephelus spiloticeps (four-saddle grouper)
gaily mwera

Epinephelus tauvina (greasy grouper)
galiyechosh (galiy)

Epinephelus truncatus * (grouper)
metail (galiy)

Epinephelus tukula * (grouper)
maleog (galiy)

Plectropomus areolatus (squaretail grouper)
taiyaawal galiyeliy (Aiyaaw)

Plectropomus laevis (saddleback giant coral trout)
sheosheol taiyaaw (taiyaaw)

Plectropomus leopardus (leopard coral trout)
sheosheol taiyaaw (taiyaaw)

Variola albimarginata (whitemargin lyretail grouper)
bela

Variola louti (lyretail grouper)
bela

SIGANIDAE

Siganus argenteus (forktail rabbitfish)
neg - neg(sml), negifetiul(lg)

Siganus canaliculatus (seagrass rabbitfish)
neg - neg(sml), negifetiul(lg)

Siganus corallinus (coral rabbitfish)
geramey - geramey(sml), igesheosheo(lg)

Siganus doliatus (pencil-streaked rabbitfish)
geramey - geramey(sml), igesheosheo(lg)

Siganus fuscescens (fuscescens rabbitfish)
neg - neg(sml), negifetiul(lg)

Siganus guttatus (golden rabbitfish)
geramey - geramey(sml), igesheosheo(lg)

Siganus puellus (masked rabbitfish)
geramey - geramey(sml), igesheosheo(lg)

Siganus punctatus (gold-spotted rabbitfish)
geramey - geramey(sml), igesheosheo(lg)

Siganus spinus (scribbled rabbitfish)
neg - neg(sml), negifetiul(lg)

Siganus sutor * (rabbitfish)
geramey - geramey(sml), igesheosheo(lg)

Siganus vermiculatus (vermiculated rabbitfish)
geramey - geramey(sml), igesheosheo(lg)

SPHYRAENIDAE

Sphyraena barracuda (great barracuda)
seraw

Sphyraena forsteri (blackspot barracuda)
baiur

Sphyraena putnamiae * (barracuda)
baiur

SPHYRNIDAE

Sphyma lewini (scalloped hammerhead shark)
matefaaib (pagow)

Sphyma mokorran (great hammerhead shark)
matefaaib (pagow)

SYNODONTIDAE

Synodus sp * (lizardfish)
metouw

Synodus variegatus (variegated lizardfish)
tarawai

TETRAODONTIDAE

Arothron diadematus * (puffer fish)
lesh

Arothron hispidus (whitespotted puffer)
lesh

Arothron manilensis (narrow-lined puffer)
lesh

Arothron mappa (map puffer)
lesh

Arothron meleagris (guineafowl puffer)
lesh

Arothron nigropunctatus (blackspotted puffer)
lesh

Arothron reticularis * (puffer fish)
lesh

Arothron stellatus (star puffer)
lesh

Canthigaster amboinensis (ambon sharpnose puffer)
lesh

Canthigaster compressa (fingerprint sharpnose puffer)
lesh

Canthigaster coronata (crowned sharpnose puffer)
lesh

Canthigaster epilampra (sharpnose puffer)
lesh

Canthigaster janthinoptera (sharpnose puffer)
lesh

Canthigaster solandri (spotted sharpnose puffer)
lesh

Canthigaster valentini (yalentinni's shajpnose puffer)
lesh

ZANCLIDAE

Zanclus comutus (moorish idol)
liwaseola/lipeibaar (said by men only)