REEF FISHERIES OBSERVATORY

Staff of the coastal component of the EU-funded Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C) and the Coastal Fisheries Development Programme (CoFish) conducted fieldwork in the Republic of Palau. In addition, SPC's Live Reef Fisheries Specialist was involved in several projects, including training an attachment, and analysing data collected from a marine aquarium trade fish resource survey at Funafuti Atoll, Tuvalu.

Fieldwork and surveys in Palau

Finfish, invertebrate and socioeconomic surveys were conducted in four locations in Palau (Ngarchelong, Ngatpang, Airai and Koror, see Fig. 1) from April–June 2007. The sites were selected by Palau's Bureau of Marine Resources, in consultation with CoFish staff. Palau is the 16th country/territory to be surveyed as part of the PROCFish/C and CoFish project.

The PROCFish/C and CoFish team consisted of Kim Friedman, Kalo Pakoa, Emmanuel Tardy and Ferral Lasi (invertebrates); Silvia Pinca, Pierre Boblin, Ribanataake Awira and seconded field officer from Conservation International in Alatau, Papua New Guinea, Noel Wangunu (finfish); and Mecki Kronen (socioeconomics). The PROCFish/C and CoFish team acknowledge and thank the following people who assisted and/or worked with the team at one or more locations: Theofanes Isamu, Director of Marine Resources; Evelyn 'Anna' Perez and Lora B. Demei from the Bureau of Marine Resources; Adalbert Eledui, Manager of the Koror State Rangers; Rengechel Dlutaoch and Davis Rekemesik from the Department of Conservation and Law Enforcement of Koror State; boat skippers and helpers, including Harvey Renguul, Elizer Ngotel, Lorenzo Osilek, Gerda Darrow, Takao Teriong, Wenceslao Niones, McCarthy Kotaro and Sorens Meyar; Sam's Tours Dive Shop for equipment support; Chief Marcelino Augustine, Valentino Kloulchad, Jackie Emmanuelle, Elizeder Elendui, Roger Rumong, Roy Fransiso and Cleoffas Iyan for their excellent support during the socioeconomic fieldwork; the Governors of the four States; the Youth Department of the State of Koror; Anne Kitalong and the Women's Group from Airai; and the elders, community members, fishers and people from the four survey sites for their support and cooperation.

Field logistics and the availability of vessels meant that the CoFish disciplinary teams worked independently of each other, with the invertebrate team going to and working with local counterparts at each of the four sites. As the invertebrate team finished their work, the finfish team arrived in Palau and used the same approach, with each site being surveyed in three to four days. Socioeconomic surveys were also conducted separately after the completion of invertebrate and finfish surveys. Counterpart officers were rotated during the different surveys to maximise training and skills transfer.

NGARCHELONG

Ngarchelong village is located at the extreme north-northwestern tip of the island of Babeldaob, the main island of the Palau archipelago. Ngarchelong has a com-

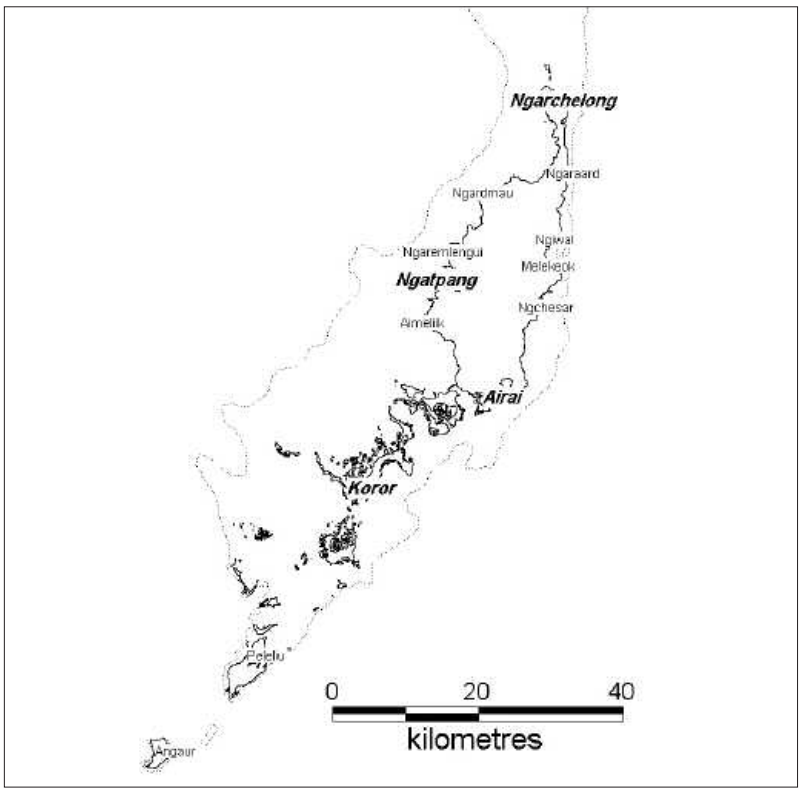

Figure 1: The four survey sites in Palau

plex reef system that extends 30 km outward (in a NE and NW direction) from the main island. The fishing area, which extends north about 13 nautical miles, is an open access area. Figure 2 shows the location of invertebrate survey dive sites.

The southern lagoon receives little terrigenous influence from the rivers, however, this is not the case in the northern lagoon. The coastal reefs are generally bordered by small areas of mangroves. Intermediate reefs are more abundant in the northern area. Eastern area reefs, as well as all back reefs, are very sandy. A 90 km^2 marine conservation area is located in the northwest of this area, and this reserve has been in effect since 1994.

The general status of corals was fairly good at both coastal and intermediate reefs, although it was very poor at some sites, with coral rubble covered in encrusting brown sponges, algae and turfs (Fig. 3). Better coral coverage was found at sites in front of the northern islands, where there were many table and branching corals. On the outer reef, coral coverage was fairly high in the shallows (flat reef) with many soft corals (*Lemnalia*), and branching (*Pocillopora*) and tabulate (*Acropora*) hard corals. Coral cover varied, however, with areas of barren bedrock with some rock boulders covered with turfs and encrusting algae, mixed with diverse, massive and submassive *Porites*, tabulate, encrusting and digitate corals that were abundant, especially at depths greater than 20 m.

Ngarchelong's fish biodiversity was very high, although density was rather average, and mean fish sizes were small (Fig. 4). At first sight this area appeared heavily exploited by fishermen. Fish everywhere reacted warily, including inside the reserve, suggesting that spearfishing is very common. Only rarely were large-sized species of parrotfish observed (e.g. *Scarus altipinnis*, *Chlorurus microrhinus*, *Hipposcarus longiceps*). Similarly, a total absence of large groupers

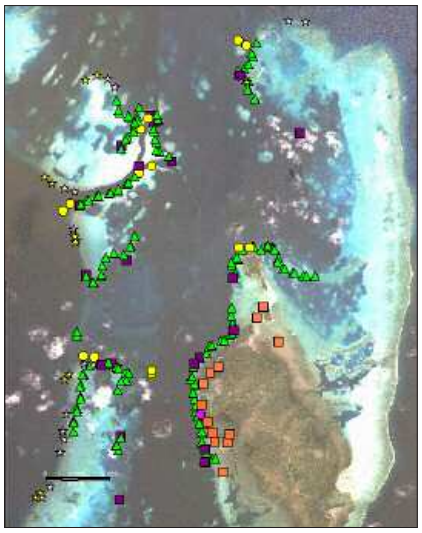

Figure 2 (top): Ngarchelong invertebrate survey locations

Figure 3 (middle): Porites coral in Ngarchelong's lagoon

Figure 4 (bottom): *Lutjanus gibbus*, *Hipposcarus longiceps*, *Naso lituratus* and *Acanthurus* spp.

and Napoleon wrasses was noted, as well as other carnivores. *Lutjanus gibbus* was present but was very wary, and *Lethrinus harak*, *L. xanthochilus*, and *L. olivaceus* (see Fig. 4) were present only in small numbers. Apex predators were extremely rare.

At Ngarchelong, seven species of Tridacnidae were recorded during broad-scale surveys (manta tows) and more targeted invertebrate assessments of reef and soft benthos. Despite the low density of the true giant clam, *Tridacna gigas* (Fig. 5), this species was more numerous at this site than at any other (this was also true for *T. derasa*). In addition, both large adults and new recruitments were recorded on the reefs. The commercial topshell, *Trochus niloticus*, was unevenly distributed across the reefs in Ngarchelong (414 individuals recorded), with the highest numbers found close to shore. The average basal shell measurement of trochus was 90.2 mm. False trochus, *Tectus pyramis*, was also recorded in low densities, while the blacklip pearl oyster, *Pinctada margaritifera*, was relatively common (32 individuals recorded).

This site had a high number of sea cucumber species (22 species), which reflected the diversity of habitats present and the level of protection given to this resource (i.e. no commercial exporting activity allowed). Seven lobster species were noted and, burrows of the banded prawn killer, *Lysiosquillina maculata*, were regularly recorded on sandy bottoms.

Socioeconomic surveys in Ngarchelong were conducted among 25 households, covering 87 people. In addition, surveys were conducted with 23 finfish fishers (16 men and 7 women) and 15 invertebrate fishers (5 men and 10 women). Around 55% of the surveyed households listed salaries as their first income source, while fisheries only accounted for around 12%. However, 24% of those surveyed listed fisheries as their second source of income. Seafood consumption in Ngarchelong was moderate at 57 kg/capita/year; finfish were consumed on average 4.3 days/week, invertebrates consumed 0.6 days/week, and canned fish 1.6 days/week.

The average household size in Ngarchelong was three people, with 1.2 fishers/household. About 48% of all men and 14% of all women surveyed targeted finfish only. No men specifically targeted invertebrates, while 10% of all women surveyed did.

About 10% of all men surveyed and 17% of all women surveyed were involved in both finfish and invertebrate fishing. Finfish catches were primarily for sale (over 80%, some of the catch was sold cooked; Fig. 6), while less than 20% was for home consumption. The vast majority of invertebrates collected were for home consumption, with only a small number sold (Fig. 6).

Figure 5 (top): *Tridacna gigas*
Figure 6 (bottom): Ngarchelong women selling cooked fish (left) and clam meat (right)

Ngatpang

The second survey site was in Ngatpang State (Fig. 7), 28 km southwest of Ngarchelong. Ngatpang is on the western side of Babeldaob Island. The fishing area, which is open access, is approximately 9.5 km long and 6 km wide. Figure 7 shows the finfish dive sites in Ngatpang. A small 1.5 km^2 reserve is located within this fishing area.

The four typical marine habitat types were present at this location (i.e. back reefs, inner reefs, outer reefs, and lagoon). However, the diveable back-reefs were only found in the northern part (80% of back reefs were sandy and were unable to be surveyed by the divers). The lagoon was subject to heavy terrigenous influence due to the numerous rivers that flow into this area. As a consequence of the high levels of sediment entering the water, a high number of filtrating sponges were present.

Corals were fairly diverse and healthy, especially on the coastal and back reef habitats, with many different forms present (submassive, digitate, foliose, encrusting and branching; see Fig. 8) as well as several types of soft corals (e.g. *Lemnalia* and *Dendronephtya*). On the outer reefs, coral cover was high at depths greater than 10 m, with many tabulate (Fig. 9), massive, branching, and encrusting forms, as well as some soft corals. Less coral cover was found at the intermediate reefs, especially on the reef flat.

Figure 7: Ngatpang finfish dive locations

Figure 8: Branching and submassive corals on Ngatpang's intermediate reefs

Figure 9: Tabulate *Acropora* at Ngatpang's outer reefs

In general, fish at Ngatpang were very wary and were small in size. There was no difference in the number of fish observed inside the reserve vs outside the reserve, despite the fact the reserve has been in effect since 2003. There were very few large Scaridae (*S. altipinnis*, *C. microrhinus*, *Hipposcarus longiceps*), and *Bolbometopon muricatum* was basically non-existent. Lethrinids were represented by *Lethrinus xanthochilus*, *L. obsoletus* and *Monotaxis grandoculis*. Lutjanids were represented by Lutjanus gibbus and *L. fulvus* as well as *L. biguttatus* and *L. lutjanus* (Fig. 10). Fish biodiversity was high, although apex predators were very rare.

Tridacnidae were common, with seven species recorded. The fluted giant clam, *Tridacna squamosa*, was relatively abundant (52 individuals noted). The commercial topshell, *Trochus niloticus*, was not common at this site (only 33 individuals noted) nor was the false trochus, *Tectus pyramis*, which has a relatively similar life strategy. Blacklip pearl oysters, *Pinctada margaritifera* (23 individuals) were relatively common.

Sea cucumber diversity was high (24 species), reflecting the range of habitats present and the positive affects of marine protected areas, which ban artisanal fishing activities in seagrass areas close to Ngatpang. Fishing and processing of sea cucumbers (Fig. 11) is still practiced in this area. Although specific night-time searches of reef fronts were not made, four lobsters were observed.

Socioeconomic surveys in Ngatpang were conducted among 25 households, covering 116 people. In addition, surveys were conducted with 23 finfish fishers (19 men and 4 women) and 16 invertebrate fishers (10 men and 6 women). Around 85% of the surveyed households listed salaries as their first income source, while fisheries only accounted for around 8%.

However, 20% of those surveyed listed fisheries as their second source of income. Seafood consumption in Ngatpang was moderate (62 kg/capita/year): finfish were consumed on average 4.1 days/week, invertebrates consumed 0.6 days/week, and canned fish 1.7 days/week.

The average household size in Ngatpang was four people, with 1.3 fishers/household. About 60% of all men surveyed primarily targeted finfish, while none of the women surveyed fished for finfish. Only 4% of all men surveyed specifically targeted invertebrates, while 12% of women did. Those people that were involved in both finfish and invertebrate fishing consisted of 13% men and 13% women. Finfish catches were primarily for sale (around 60%), while around 40% were for home consumption. The majority of invertebrates collected were for home consumption, with only a small number sold.

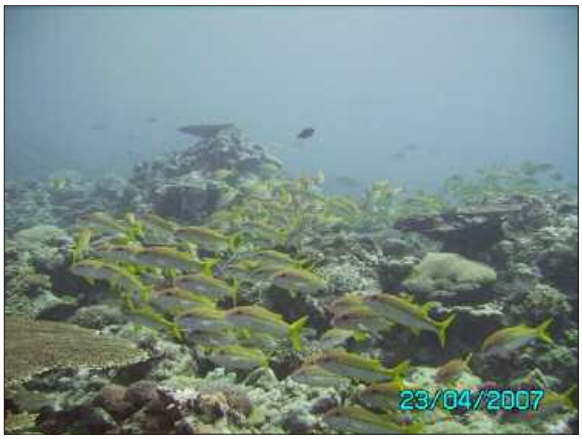

Figure 10 (top): *Lutjanus lutjanus*, outer reefs

Figure 11 (bottom): Processing sea cucumbers at Ngatpang

Airai

Airai village is in the south-southeastern side of Babeldaob Island (Fig. 1). The fishing area (Fig. 12) is delimited in the north by the southern part of Ngemelachel Pass, and in the south by an east–west line extending eastward from the southern channel of Babeldaob. There are two reserves in this area, one established in 1994 (1 km^2) and the other established in 1997 (1 km^2).

Airai has the four main marine habitats (i.e. back reefs, inner reefs, outer reefs, and lagoon). The lagoon was relatively shallow (30–40 m) with few intermediate reefs, which were mostly found in the extreme northern and southern areas. Corals were rare and unhealthy in the lagoon, but appeared more abundant and healthy on the outer reefs and in the northern back reefs, although they were limited in number and area. Often the reef, especially in the coastal area, consisted of coral slab covered in coralline algae and turf. In the intermediate habitats, the coral was covered in macroalgae (e.g. *Sargassum*, *Padina*, *Halimeda*) and seagrasses.

As with the other two sites, fish were wary of divers, indicating that spearfishing was one of the main fishing methods. Fish biodiversity as well as abundance appeared to be less than at the other sites, and fish sizes were generally small. Very few scarids were recorded, and *Bolbometopon muricatum* and *Cheilinus undulatus* (Fig. 13) were represented only by small juvenile individuals. Carnivores (lethrinids and lutjanids) were rare and apex predators very rare. Most transects were dominated by herbivorous *Ctenochaetus striatus* and *Chlorurus sordidus*.

All endemic Tridacnidae were recorded at Airai (seven species noted), although the total number in records was moderate compared with other sites. The commercial topshell, *Trochus niloticus*, was common at this site (604 individuals noted) as were false trochus, *Tectus pyramis* (134 individuals noted). The average basal shell measurement of trochus was 96.4 mm. Blacklip pearl oysters, *Pinctada margaritifera*, were less evident at both of the southern sites of Airai and Koror (17 individuals).

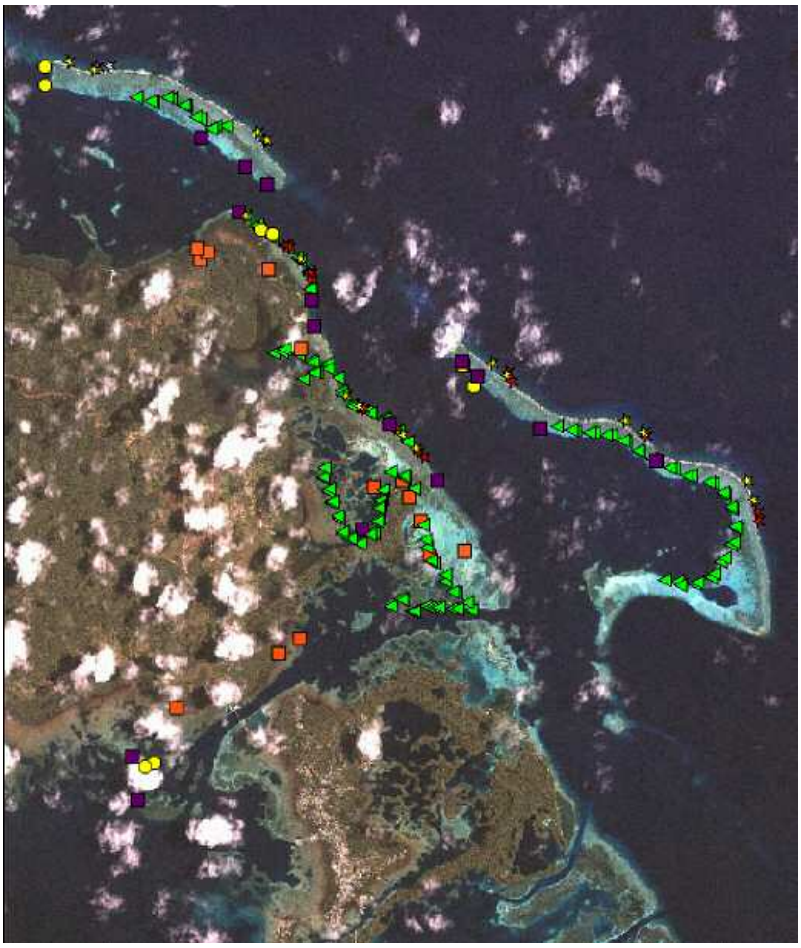

Figure 12 (top): Airai invertebrate survey locations

Figure 13 (bottom): Juvenile *Bolbometopon muricatum*

Sea cucumber diversity was high (23 species; see Fig. 14), reflecting the range of habitats, from inshore seagrass beds, to the oceanic-influenced barrier reef. Despite not conducting specific night-time searches of reef fronts, 14 lobsters were observed.

Socioeconomic surveys in Airai were conducted among 27 households, covering 134 people (Fig. 15). In addition, surveys were conducted with 25 finfish fishers (17 men and 8 women) and 14 invertebrate fishers (5 men and 9 women). Around 52% of surveyed households listed salaries as their first income source, while fisheries only accounted for around 14%. Another 15% of those surveyed listed fisheries as their second source of income. Seafood consumption in Airai was high at around 70 kg/capita/year; finfish was consumed on average 4.0 days/week, invertebrates consumed 0.9 days/week, and canned fish 2.1 days/week.

The average household size in Airai was four people, with 1.3 fishers/household. About 45% of all men surveyed primarily target finfish, while only 3% of women target finfish only. No men specifically targeted invertebrates, while 8% of women did. Those people that were involved in both finfish and invertebrate fishing consisted of 20% men and 23% women. Finfish catches were primarily for sale (around 80%), while around 20% were for home consumption. The majority of invertebrates collected were for home consumption, with only a small number sold.

Figure 14 (top, middle): A range of sea cucumber species in seagrass areas at Airai

Figure 15 (bottom): Survey in Airai

Koror

Koror Island is the capital of Palau and is located south of Babeldaob Island (Fig. 1). The general fishing grounds extend from Koror in the north to Peleliu Island in the south, although specific areas were requested and identified by the Conservation and Law Enforcement Department of Koror State to be surveyed for fish (Fig. 16). The Koror area has a range of reserves and protected areas.

Corals were in poor condition, either broken, diseased or attacked by crown-of-thorns starfish, especially in intermediate and back reef habitats. Most inner coral reefs still showed evidence of recent bleaching events. Outer reef corals were in better condition with good cover at German Channel (Fig. 17).

Only three habitat types were surveyed here: back reef, intermediate reef and outer reef. Although these habitat types are normally abundant in fish, this survey found fish at this site to be small and in low to moderate densities. No surveys of reserve areas were allowed, so we were unable to make comparisons of fished and non-fished areas. The survey site with the most abundant and diverse fish species was at German Channel, which is a well known dive site for tourists.

All species of Tridacnidae were recorded at Koror (seven species noted), including large numbers of mature sized *T. maxima* (1020 individuals noted) and the endemic *Hippopus porcellanus*, which has a restricted range in the Pacific (Fig. 18). The commercial topshell, *Trochus niloticus*, was common (720 individuals noted) as were false trochus, *Tectus pyramis* (165 individuals noted). The average basal shell measurement of trochus was the same as at Airai, at 96.4 mm.

Sea cucumber diversity was high (21 species), reflecting the

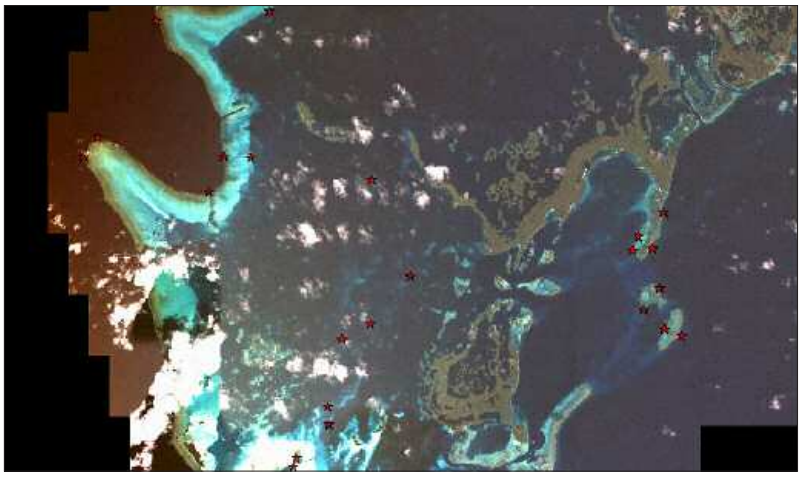

Figure 16 (top): Finfish survey locations
Figure 17 (middle): Corals at German Channel
Figure 18 (bottom): First PROCFish/C record of *Hippopus porcellanus*

scale and range of habitats present and the protection afforded to the fishery, although generally, density was not as high as at northern survey sites. Despite not conducting specific night-time searches of reef fronts, 24 lobsters were observed.

Socioeconomic surveys in Koror were conducted with 51 households (25 from Meyuns and 26 from Ngermid), covering 244 people (Fig. 19). In addition, surveys were conducted with 30 finfish fishers (24 men and 6 women) and 15 invertebrate fishers (6 men and 9 women). Around 72% of surveyed households listed salaries as their first income source, while fisheries only accounted for around 5%. Another 5% of those surveyed listed fisheries as their second source of income. Seafood consumption in Koror was the highest, at around 75 kg/capita/year; finfish were consumed on average 4.5 days/week, invertebrates consumed 0.8 days/week, and canned fish 2.2 days/week.

The average household size in Koror was four people, with 0.9 fishers/household. About 58% of all men surveyed, primarily targeted finfish, while only 2% of surveyed women targeted finfish only. No men specifically targeted invertebrates, while only 5% of women did. Those people who were involved in both finfish and invertebrate fishing consisted of 19% men and 13% women. About 70% of finfish catches were primarily for sale, while the remaining 30% were for home consumption. The majority of invertebrates collected were for home consumption, with only a small number sold.

Figure 19: Local counterpart Harvey Renguul conducting a finfish survey

The Live Reef Fisheries Trade (LRFT) Initiative

Results from Funafuti Atoll's marine aquarium resource survey

A survey of Funafuti's marine aquarium resources was conducted in 2005, with Mr Tupulanga Poulasi from Tuvalu's Fisheries Department, attached to SPC (see SPC *Fisheries Newsletter* #120) in March/April 2007 to complete data analysis. The results were presented to the Government of Tuvalu in a technical report.

Overall, 74 species from 12 families — recorded during a survey of both lagoon reefs and outer reefs — were found to have potential for the marine aquarium trade. On the outer reef, the pomacentrids (damselfishes) were very well represented with *Pomacentrus vaiuli* being the most common species with an average density of 48 individuals/1000 m^2 of reef. Other pomacentrids with significant densities included *Pomacentrus pavo* (38 ind/1000 m^2), *Chromis iomelas* (23 ind/1000 m^2), *Chromis margaritifer* (22 ind/1000 m^2) and *Plectroglyphidodon johnstonianus* (15 ind/1000 m^2). Among the pomacanthids (angelfish), two species were quite common, *Centropyge flavissimus*, known more commonly in the aquarium trade as the lemon peel had an average density of 17 ind/1000 m^2 of reef and *C. loriculus*, flame angel, had an average density of 8 ind/1000 m^2 of reef.

On the lagoon reefs, the pomacentrids were very well represented but this time with *Chrysiptera cyanea* being the most abundant species with an average density of 166 ind/1000 m² of reef. *Pomacentrus pavo* was also very common with an average density of 117 ind/1000 m² of reef. The most common chaetodonid (butterflyfish) in the lagoon was *Chaetodon trifascialis* with an average density of 19 ind/1000 m² of reef, and the most common pomacanthid was *Centropyge flavissimus* with an average density of 15 ind/1000 m² of reef.

Using the mean densities of the different species from the survey, it was possible to estimate the stock of each fish species in the two different reef habitats (i.e. the lagoon reefs and the outer reefs), by multiplying the density of each fish species for each habitat per 1000 m² by the total area of lagoon reefs and outer reefs, respectively.

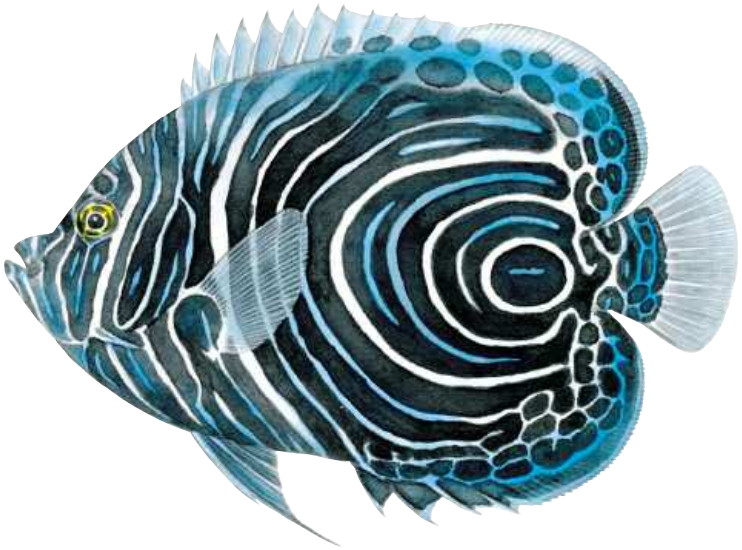

Figure 20: *Pomacanthus imperator*, emperor angel

Table 1: Stock estimates by fish family (all reef habitats) in Funafuti

Family	No. Species	Stock Estimate	StdErr_Stock
Acanthuridae	4	568,680	330,857
Balistidae	4	141,360	87,892
Blenniidae	1	111,067	79,366
Chaetodontidae	21	2,451,440	960,941
Cirrhitidae	1	67,253	51,902
Gobiidae	1	59,120	47,279
Labridae	20	1,929,267	1,134,216
Microdesmidae	1	34,267	27,898
Mullidae	1	154,013	108,141
Pomacanthidae	5	2,204,493	772,692
Pomacentridae	13	23,998,943	14,042,804
Zanclidae	1	57,293	27,892
Total	**73**		

Table 2. Stock estimates of Funafuti's 10 most important marine aquarium trade species

Species	Stock Estimates	StdErr_Stock	10% of stock
Pomacanthus imperator	3,427	3,427	343
Centropyge loriculus	235,480	83,484	23,548
Centropyge flavissimus	1,177,200	303,229	117,720
Labroides bicolor	450,800	229,890	45,080
Nemateleotris magnifica	30,840	24,471	3,084
Ctenochaetus strigosus	396,253	182,765	39,625
Gomphosus varius	231,640	102,644	23,164
Pomacentrus vaiuli	3,278,533	1,144,037	327,853
Plagiotremus laudandus	111,067	79,366	11,107
Thalassoma lunare	225,560	135,070	22,556

Looking at the stock estimates by fish family and number of species (Table 1), the four most abundant groups included pomacentrids — the most dominant group — with a total stock of about 24 million individuals, followed by chaetodontids with 2.5 million, pomacanthids with 2.2 million, and labrids with 1.9 million.

Of the 10 most valuable species recorded, Pomacanthus imperator (Fig. *20)*, with the highest potential value, has the smallest standing stock of about 3400 individuals. There were good stocks of *Centropyge loriculus* and *C. flavissimus*, two very popular species in the marine aquarium trade (235,000 individuals and 1.2 million individuals, respectively). *Pomacentrus vaiuli*, with its very high abundance of 3.3 million individuals, could also become an important species for the marine aquarium trade.

A calculation of sustainable yields will require good catch and effort data, which is not available as this is a new fishery under consideration. For such an unexploited fishery, the rule of thumb for harvesting is 10% of the calculated stock estimates per year, which is considered conservative enough as a start to allow the different fish species to be exploited in a sustainable manner. Table 2 presents the estimated stock harvest numbers for the top 10 species.

The results of the survey indicated that in Funafuti, there are at least 74 species that have potential for the marine aquarium trade. Given that no marine aquarium trade operations have existed there in the past, the stock estimate from the survey will provide an initial baseline of the standing stock of the different species. Stocks of some species, especially *Pomacentrus vaiuli* and *Chrysiptera cyanea*, are very abundant. The chaetodontids, pomacanthids and labrids are also quite abundant.

Given the current stock levels of the 10 most valuable species found in the survey, harvesting 10% of these stocks every year should support some marine aquarium trade operations. The 10% harvestable stock should be spread out over the year to dilute fishing pressure on the resources, and a limit should be set on the number of exporting companies. These two restrictions should be included in the development of a management policy and plan, which is necessary before any operations are allowed to start.

It is also very important for the Government of Tuvalu to note that, even though a resource might be available, it does not mean that a marine aquarium trade will be feasible to develop. An important consideration is the infrastructure and transport required to support such an export industry. The most obvious factor is the availability of airline connections from Funafuti to the market, including air cargo space available per flight, the number of transits and connecting times between flights, and freight costs. The availability of oxygen and packing materials, a reliable source of electricity for land facilities, and costs in general, are also important considerations. To fully understand the extent of these problems, the Government of Tuvalu should consider conducting an export trial.

Kiritimati Island bonefish management update: Outcomes of the bonefish management consultation workshop

As part of the new plan of action (see *Fisheries Newsletter #120*) for the completion of the bonefish management plan, a public consultation workshop was coordinated and conducted by SPC's Live Reef Fisheries Specialist in association with Kiritimati's Ministry of Fisheries and Marine Resources Development (MFMRD) in mid-March 2007. Funding was provided by the Government of Kiribati.

The aims of the workshop were to identify major stakeholder issues and concerns, and to discuss these issues with regards to available technical and economic information, in order to develop the most appropriate and effective consensual management regime. The information would then be integrated into a bonefish management plan and regulations, where necessary.

The workshop was organised into three sessions. The first session included presentations by key speakers. The second session identified major issues and concerns, introduced and explained the Ecosystems Approach to Fisheries Management (EAFM) concept, and applied the approach for developing a management system for the bonefish fishery. The third session examined regulatory measures to address the major issues of concern.

Following the presentations of socioeconomic and biological information relevant to the bonefish fishery in Kiritimati, the EAFM concept was used to define the scope of the management plan, identify main issues and prioritise them using risk analysis, and develop a management system and framework from the results. Figure 21 presents the results of this exercise.

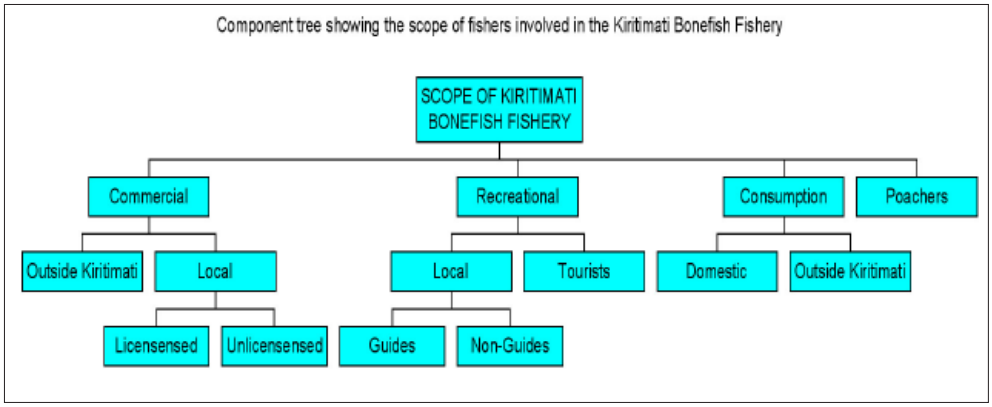

Figure 21: Fishers involved in Kiritimati bonefish fishery

Scope of the management system

A. ***Fishers involved***: There are four main categories of fishers involved in the bonefish fishery. This includes commercial fishers who fish in order to sell their bonefish catch; recreational fishers who catch and release bonefish; fishers who catch for their own consumption only; and poachers who fish illegally in closed fishing areas.

B. ***Fishing methods***: flyfishing rods, spinning and conventional casting rods (baited hook and line), gillnets – drive in nets and set nets, throw net, '**te ororo**' – very destructive form of gillnetting and hook and handline.

C. ***Fish species caught***: bonefish, milkfish, mullet, goatfish, trevally and pufferfish.

D. ***Management agencies and authorities***: Ministry of Line and Phoenix Group (LINNIX) for general administration of Kiritimati Island. The Fisheries subdivision, MFMRD for fishing licenses, permits, and enforcement of fisheries regulations under the Fisheries Act, the Wildlife Division, Ministry of Environment, Land and Agriculture (MELAD) for surveillance and enforcement of Designated Closed Areas (bird nesting grounds), under Wildlife Ordinance, the Kiritimati Island Council for local business licenses and enforcement of by-laws under the Local Government Act, the Attorney General's Office for legislation of new management initiatives, the Tourism (MCTTD) Subdivision, Ministry of Communications, Transport and Tourism for the regulation of tourists, tour packages, tourist fees, the police department for the enforcement of law and prosecution of law breakers.

E. ***The area to be covered by the management system***: Whole of Kiritimati lagoon, specific ocean reefs, especially important spawning sites, conservations areas in the lagoon, and fisheries closed pond areas.

Six main issues of concern were identified and prioritised using risk analysis in relation to three factors. These three factors include:

1. Sustainability: keeping biomass levels above Bmsy;

2. Tourism and economy: maintain catch rates at a level that keeps tourists coming (source of employment and income);

3. Food source: maintain stocks for food

The six main issues of concern are listed below.

1. ***Justification***: Gillnets are very effective in catching bonefish in great numbers and are therefore often used by commercial fishers. Research has confirmed that bonefish caught in gillnets have no chance of surviving if they are released. Gillnets can easily result in overfishing of bonefish stocks in Kiritimati's lagoon.

2. ***Operational objective***: To ensure the bonefish stock is sustainable and able to maintain catch rates at a level that will keep tourists coming, as well as to provide a protected portion of the bonefish population that will provide a source of recruits.

3. ***Indicators***: Catch rates from tourists inside the lagoon and from local fishers outside the lagoon, number of tourists per flight, the level of return visits by tourist fishers, the size of bonefish and the results of fisheries household surveys every few years.

4. ***Performance measure limits***: Decline in catch rates, decline in bonefish size, increase in fishing effort by tourist fishers and local fishers, and declining trends from fisheries surveys.

5. ***Evaluation***: Monitoring catch rates of tourists and catch sizes, and conducting regular fisheries household surveys every two years.

6. ***Management response***: There is currently no management response, but in the future this would include at a minimum, a restriction on or banning the use of gillnets in the lagoon, banning the sale of bonefish, banning the export of bonefish from Kiritimati, limiting the number of tour guides, and restricting fishing effort in the spawning areas three days before and three days after a full moon.

If performance limits are exceeded, drastic regulatory measures would then be added. These might include a seasonal ban on using gillnets outside the lagoon, and a total fishing closure of selected parts of the outer reef areas where bonefish are known to occur.

To oversee and implement the management plan, a management body that included the main stakeholders based in Kiritimati, was proposed (Fig. 22).

The responsibilities of the management body would be to oversee the management plan administration and implementation including reviews, management of funds for management activities, and the coordination of monitoring and enforcement efforts through relevant authorities such as the Fisheries Department, Wildlife Division, police and the bonefish guides.

Various issues that were raised during the workshop in setting

up the bonefish management system included:

- Financial support for the management plan and enforcement should come from the license permits and fees collected from bonefish tourists and other bonefish related revenues (e.g. fines and penalties). The government's agreement to allocate these funds exclusively for supporting the management of bonefish in Kiritimati is needed.

- A Bonefish Management Authority should be established. This could be empowered through the Fisheries Act or through the bonefish management plan. A full-time manager, accountant, secretary, and two bonefish wardens would form the core staff of the Management Authority. Hoteliers indicated their willingness to provide funding support for one warden for at least one year, in the initial implementation.

- There is a strong need to undertake a major public awareness campaign to properly inform people on the importance of the bonefish fisheries and the need for regulations. The Chairman of the US-based 'Friends of Kiritimati Island' stated that they can provide the financial support for the production of public awareness materials such as posters, pamphlets, T-shirts, hats etc.

- Bonefish guides are out on the sand flats everyday with their tourists and, therefore, could be used to assist enforcement at no cost.

- Although the aim is to for the Bonefish Management Authority to self-finance its management activities through bonefish fishing permits, guide licenses, and fines, some initial funding may be necessary for building an office, buying office equipment and supplies, purchasing a boat and engine, and producing awareness materials.

The outcome from the workshop will form the basis for the bonefish management plan that is being developed.

AusAID approves funding to set up the SPC regional live reef fisheries (LRF) Integrated database

After years of grant seeking, AusAID has kindly agreed to provide funding for a regional LRF database. The LRF database will provide member countries and territories the support they need for monitoring their live reef fisheries (both food fish and marine aquarium fish). The required database framework for data entry and storage as well as the integrated analytical tools, will allow instant analysis of data, which will provide the required information for making management decisions to support sustainable live reef fish trade operations.

Work on developing the database has begun with assistance and advice currently being provided by the PROCFish Reef Fisheries Information Manager. A short-term database specialist will, however, be hired to work on the development of the required portal and the LRF database. The hired database specialist will work in close association with the Reef Fisheries Information Manager to ensure a link to and use of the existing Reef Fisheries Observatory Database as the basis.

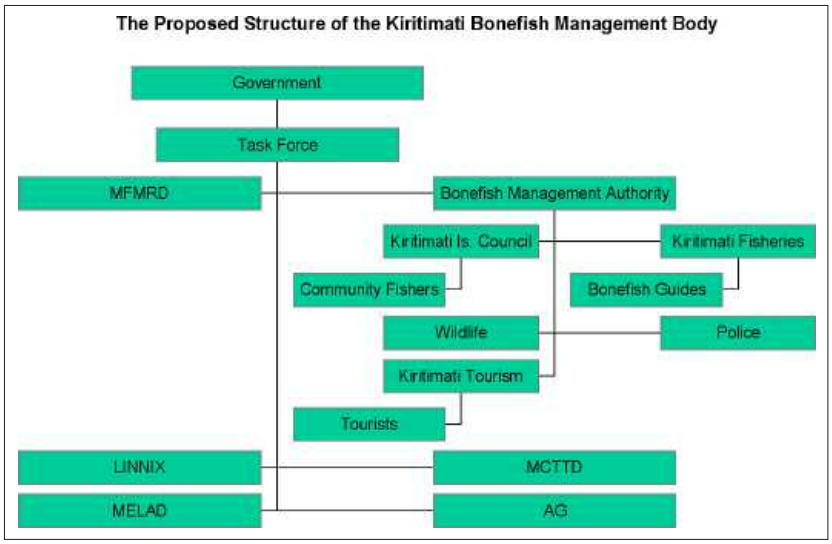

Figure 22: Proposed structure of the Kiritimati Bonefish Management Body