

## 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 recent fieldwork in Fiji Islands and the Republic of the Marshall Islands. In addition, database assistance was provided to the Vanuatu Fisheries Department and a socioeconomic technical manual was finalised.

### Fieldwork in Fiji Islands

Socioeconomic surveys were conducted at four sites in Fiji Islands in June/July 2007. These were followup surveys to those conducted by the DemEcoFish and PROCFish/C project in 2002, when different methodologies were used. The followup surveys now use the agreed on methodologies of the PROCFish/C project. The four sites surveyed, Muaivuso and Dromuna on Viti Levu and Mali and Lakeba on Vanua Levu (Fig. 1), were the same sites as previously surveyed. The surveys were undertaken by Aliti Vunisea from PROCFish/C, with assistance from Ratu Nemani Cavuilati, Senior Fisheries Officer at the Fiji Fisheries Department's central office; Apisai Sesewa, Senior Fisheries Officer northern office; and Tavenisa Vereivalu, Research and Aquaculture Officer, northern division. PROCFish/C acknowledges the assistance of the Fiji Fisheries Department, the Provincial Office Northern and the village headmen of Muaivuso, Dromuna, Nakawaga and Lakeba.

#### MUAIVUSO

In Muaivuso, 28 out of 60 households were surveyed, and an additional 25 fishers were interviewed. Fishing is a way of life for the community, with 86% of all surveyed households actively involved in reef fisheries. Although the community is in close proximity to Suva, people here live a subsistence lifestyle, with both men and women involved in semi-subsistence fishing activities. Men dominate finfish fishing activities, while women are mainly

involved in invertebrate fishing. Nearly half of the surveyed households (49%) relied on fisheries as their primary income source, with 72% of surveyed households relying on fisheries as both primary and secondary income sources. Thus, households in Muaivuso relied significantly on fisheries resources for their social and economic livelihoods. Fish consumption was very high at 107 kg/year with fresh fish consumed an average of four times per week. Invertebrate consumption was low and this was also the case for the consumption of canned fish. All households surveyed consumed fresh fish, and about 86% of households consumed invertebrates, mainly caught by household members.

The main fishing methods used were gillnetting, diving and handlining, with women mainly involved in handlining in the shallower areas of the coastal

reefs and lagoon areas. The main distribution outlets for fisheries resources were the Suva and the Lami markets, where women sold finfish and invertebrates weekly. Sea cucumbers, both fresh and processed, were sold directly to exporters, while other invertebrates, such as octopus, sea urchins and spider conch shells were sold at the Suva market weekly. In the last few years, Muaivuso has been the target of fisheries management initiatives with the University of the South Pacific, the association of non-governmental organisations (e.g. the Fiji Locally Managed Marine Area — FLMMA), government departments involved in marine resource management, and the Fiji Fisheries Department, working together with local communities to set up reef reserves in the area. Most of these no-take zones are currently monitored by local communities with the assistance of outside partners. With portions of coastal reef

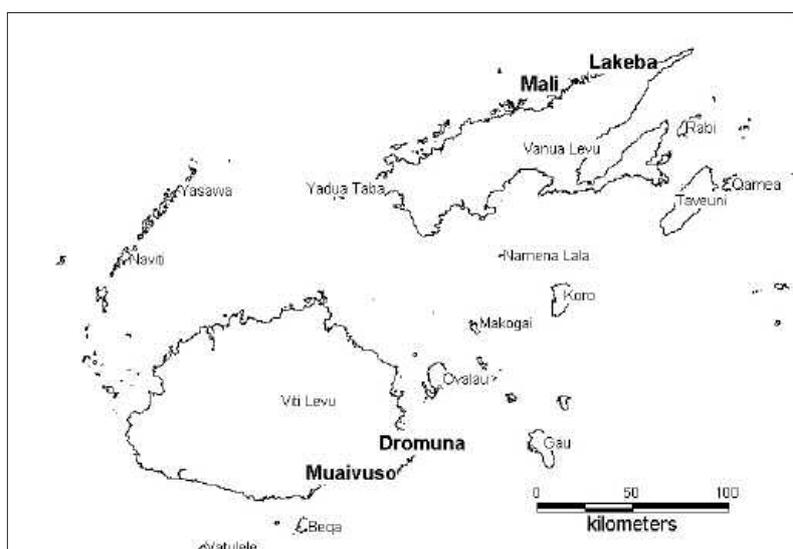


Figure 1: The four survey sites in Fiji Islands.

areas as reserves, people go farther out to fish. Respondents, however, perceived positive changes to fisheries resources, both in availability, sizes and distribution of certain finfish and invertebrate resources since the implementation of management interventions.

#### DROMUNA

In Dromuna, 24 out of 60 households were surveyed, and an additional 15 fishers were interviewed. Dromuna community, which is about 30 minutes by boat from the nearest marketing centre, is one of the main suppliers of both finfish and invertebrates to the Nausori and Suva urban centres. Men dominated the finfish fishery while women were largely involved in invertebrate collection. Women were involved in finfish fishing for commercial purposes generally when they went out on family fishing ventures. Men's participation in the invertebrate fishery was more sporadic, collecting whatever species they came across while finfish fishing. Both men and women collected certain invertebrate species for the commercial market, including species of sea cucumbers and lobsters.

All households in the village were involved in reef fisheries, with 74% of all surveyed households depending on fisheries as their primary source of income, and another 10% of households relying on fisheries as their secondary income source. This indicates the community's high dependence on fisheries resources for their social and economic livelihoods. Per capita consumption of fresh fish was 105 kg/year, while invertebrate and canned fish consumption was very low.

The main fishing methods used were gillnetting and diving in the lagoon and coastal reef areas, while outer reef fishing mostly involved the use of han-

dlines. Most fishers sold their catch to the various distribution outlets, and this included selling to the Fisheries Department Centre, middle sellers, the Nausori and Suva markets, and other smaller outlets. Sea cucumbers, one of the main marine resources collected and sold by both men and women, were sold directly to exporters in Suva. While there was no community level fisheries management initiative in place, respondents were interested in implementing some form of fisheries management, given the community's high rate of dependence on marine resources, high harvest rates, and high incidences of poaching or illegal fishing by outsiders.

#### MALI

In Nakawaga village on the island of Mali, 16 out of 50 households were surveyed, and an additional 18 fishers were interviewed. Mali, which is only 20 minutes by boat from the Labasa market, is one of the major suppliers of seafood, with village fishermen selling fish almost daily to the market and other distribution outlets. Most of the fishers interviewed were involved in both finfish and invertebrate fisheries. There was a very high dependence on fisheries resources for food and income, with 84% of surveyed households relying on fisheries resources as their primary source of income, with another 10% relying on fisheries as their secondary income source. Fishing was an everyday activity, with 94% of surveyed households actively involved in reef fishing. Per capita consumption of finfish was high at 78 kg/year, but low for invertebrates and canned fish. Men dominated finfish fishing activities, with women mostly involved in invertebrate collection. Men were, however, more involved in the harvesting of invertebrates for commercial purposes, and this included

species such as sea cucumbers and lobsters, which were mainly sold to buyers from the Labasa urban centre.

The main fishing methods used were gillnetting within the lagoon and coastal reef areas, diving using spearguns, and handlining, which was mostly done at night in outer reef areas. Women mostly fished within the immediate inshore areas using handlines or accompanying their husbands on fishing trips to outer reef areas.

Management initiatives have been introduced at the provincial level, thus, a major portion of coastal reef areas was under a five-year fishing ban. The community-based management initiatives in place were developed and implemented with the assistance of several international NGOs in collaboration with the Fiji Fisheries Department and communities.

#### LAKEBA

In Lakeba, 25 out of 90 households were surveyed, with an additional 18 fishers interviewed. Lakeba is almost six hours by road to Labasa, the nearest urban centre; therefore, selling finfish and invertebrates to the market is conducted on a weekly basis. Most fishers interviewed were involved in both finfish and invertebrate fisheries. Despite transportation and marketing difficulties, fisheries resources were the primary source of income for the community, with 96% of households stating that fisheries resources were their primary and secondary income sources. Fishing was an everyday activity, with all households actively involved in reef fishing. Men dominated finfish fishing activities, while women were mostly involved in invertebrate collection. Women contributed significantly to household incomes through their regular weekly

sales of invertebrates to the Labasa market. Distribution of finfish was either to middle-sellers that frequented the village, or to the Fisheries Department fish buying centre close to the village.

Fishing was a daily activity with fresh fish consumed on average four times per week. Per capita consumption of fresh

fish was 70 kg/year, while consumption of invertebrates was much lower. The main fishing methods used were gillnetting, handlining and spearfishing within the lagoons, coastal and outer reef areas.

Management was initiated and implemented through the assistance of international NGOs in collaboration with FLMMA, the

Fisheries Department and communities. A five-year fishing ban in certain reef areas had been implemented at the provincial level and had been in existence for two years. Perceptions from respondents focused largely on the positive changes in finfish and invertebrate sizes, availability and abundance in coastal fishing areas.



## Fieldwork and surveys in the Republic of the Marshall Islands

Finfish, invertebrate and socio-economic surveys were conducted in four locations around the Republic of the Marshall Islands (RMI): Likiep, Ailuk, Arno and Majuro atolls (Fig. 2) during August/September 2007. The sites were selected by staff of the Marshall Islands Marine Resources Authority (MIMRA) in consultation with staff of the CoFish programme. RMI was the 17th 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 and Ribanataake Awira (finfish); and Aliti Vunisea (socioeconomics). The PROCFish/C and CoFish team acknowledges and thanks the following MIMRA staff who assisted and/or worked with the team at one or more locations: Glen Joseph, Director; Florence Edwards, Chief, Coastal fisheries Division; Albon Ishoda, Deputy Chief, Coastal Fisheries Division; Melba White, Emma Kabua, Candis Guavis, and Clyde James, the main CoFish attachments/counterparts for the fieldwork; and Nakamura Reimers and Lee Polin, the skippers, and Boston Levai and Laneo Jacklick the crew, of MIMRA vessels M/V *Laintok* and M/V *Jolok*. Sincere thanks also go to the local governments

and communities, represented by Mayor Capelle and the fisheries committee in Likiep; the Honourable Mayor of Ailuk, Madam Cradle Alfred; Junior De Brum, Likiep Fishbase Manager; Joe and Yumiko De Brum on Likiep; Tempo Alfred and Ken Alfred on Ailuk; and boat skippers and helpers Alik Lokeijak, Hermon John, Jackie Jacklick, Jokna Myjena, Caleb Hitchfield, Rice Snight, Aimbi Snight, Junior Alfred, Ricky Ritok, Baiwod Snight, and Jomi Bunglick. The team also acknowledges the assistance rendered by other organisations including the College of the Marshall Islands (CMI) for pro-

viding air compressors and lodging facilities; and the National Research Authority (NRAS) for lending their medical kits.

Fieldwork in RMI was conducted in several stages. First, two SPC finfish divers trained two MIMRA divers/counterparts in finfish survey methodologies and fish identification. These four divers then assessed/surveyed the finfish resources in Likiep and Ailuk atolls. The invertebrate team and socioeconomist, along with their counterparts, conducted their work on the atolls at the same time. At the conclusion of this work, there was a changeover of

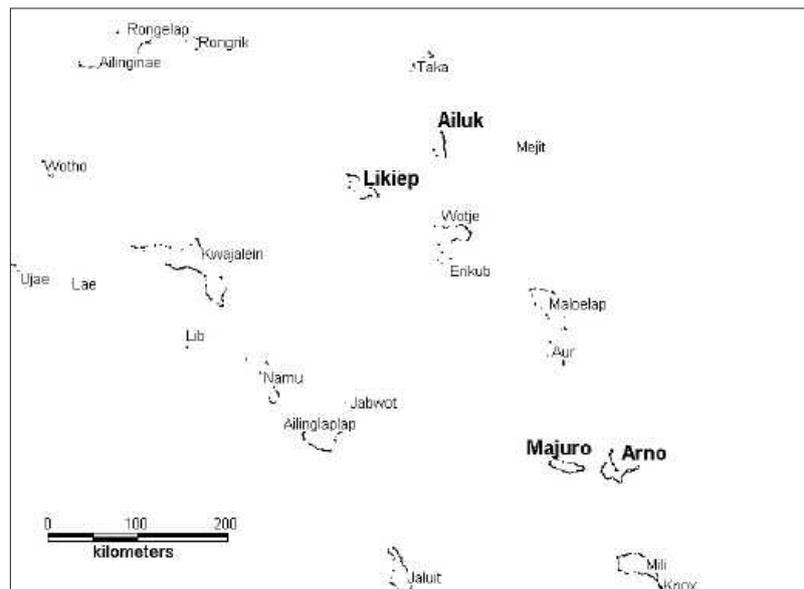


Figure 2: The four survey sites in the Republic of the Marshall Islands.

CoFish staff, with the arrival of a second team. The same two MIMRA finfish counterparts worked with one CoFish finfish diver to conduct finfish surveys at Arno and Majuro atolls, with the invertebrate team and socioeconomist, along with their counterparts, conducting their work at the same time.

### LIKIEP ATOLL

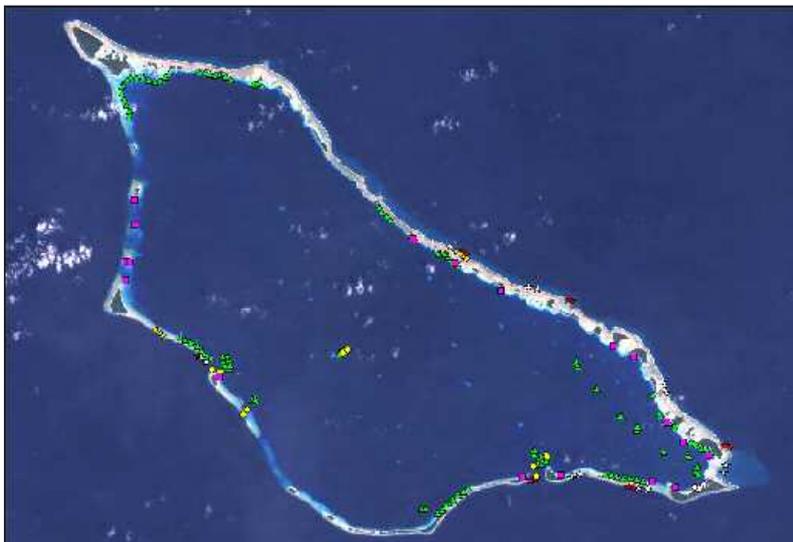
Likiep is a large atoll (Fig. 3) located at 9°54'N and 169°08'E. It is 45 km long and 15 km wide, and is oriented along a north-west-southeast axis. Passes are present only in the south. Motus

(islets) are scattered along almost all of the barrier reef with fewer found in the northwest. The two main communities live in the southern islands. Three typical habitats, as described by the CoFish finfish protocol (outer reef, back reef and intermediate or lagoon reef), are clearly present at this atoll. The fourth coastal habitat (coastal reef) is missing because the atoll lacks any terrigenous influence. Twenty finfish dive sites were made at Likiep in three of the typical habitats: outer reef, back reef and intermediate reef.

The outer reef habitat was generally very healthy. The eastern reef could not be sampled due to a lack of passes and rough weather (predominantly coming from the northeast). No exceptional densities or sizes of finfish species were recorded. No *Bolbometopon muricatum* were observed and only very few, small-sized *Cheilinus undulatus* were found in the outer reef area. Back reefs were mainly found in the northern part of the atoll and were very rare anywhere else, and these were, in general, completely covered in sand or detritus. Those that had some living corals had numerous large-sized fish (Fig. 4). The intermediate reefs were essentially represented by large pinnacles with high coral cover (Fig. 5), but their surface area was limited. Fish were quite fearful of divers and were more abundant in the extreme northwestern part of the atoll, far from the main village.

The invertebrate team worked both within the lagoon and on both sides of the barrier reef. Abundance of most invertebrate species was relatively low at Likiep, predominantly due to the poor nutrient profile and exposed nature of the environment, although, fishing activities also had a noticeable effect. In the southern part of the atoll, the exterior reef slope was steeper, and coral life forms were more complex, supporting a wider range of invertebrates in the relatively protected (less exposed) reef.

Giant clams were a commonly harvested fishery resource, and *Tridacna maxima* was the most common species recorded. Stocks were relatively healthy, especially those on reefs close to passages where water exchange and movement was greatest. Fishing pressure was noted on reefs near Likiep Island. The fluted clam (*T. squamosa*) and horsehoof clam (*Hippopus hippopus*), were also recorded. Abundance



**Figure 3 (top):** Likiep Atoll, showing some of the survey sites.

**Figure 4 (middle):** *Caranx sexfasciatus* in a back reef habitat.

**Figure 5 (bottom):** High coral cover in an intermediate reef habitat.

of *T. squamosa* was moderate to low, whereas *H. hippopus* was relatively common. In addition, there was a batch of *T. derasa* at MIMRA's aquaculture facility at Likiep. About 5000 juvenile *T. derasa* were introduced 16 years ago (1–2 cm shell length), and now, 150 remain (35–40 cm shell length). *T. derasa* was not recorded outside the nursery during the survey, although the local fisheries officer reported sightings of *T. derasa* juveniles (possibly new recruitments) on reefs to the west of the nursery. The MIMRA Likiep facility produces clams (*T. derasa*, *T. maxima* and *T. squamosa*, Fig. 6) for the aquarium market. The clams are sent to Majuro to be sold to international buyers.

A relic of a much larger population of *T. gigas* still exists at Likiep Atoll. The Likiep survey observed a few medium to large sized individuals around reefs, typically in the west of the atoll, away from the main habitable islands. It is promising to see this giant bivalve present in Likiep, as natural populations are endangered around the Pacific. Some management attention is needed for all clam species at Likiep, especially for rebuilding remnant stocks of *T. gigas*.

The pearl oyster *Pinctada margaritifera* was recorded sporadically at Likiep, and a spat collection trial is underway as part of a study to look at pearl farming prospects in the country. Unfortunately, the commercial top-shell "trochus" (*Trochus niloticus*) is not endemic to the Marshall Islands, and they were not introduced to Likiep in the 1930s. According to local reports, an attempt was made some years ago to seed reefs at Likiep, but this was unsuccessful (Junior De Brum, Likiep Fish-

eries Officer, pers. comm. 2007). A resurvey of areas where the introductions were made was completed, but these were found to be a non-optimal locations for trochus and none were recorded.

Socioeconomic surveys at Likiep covered 20 out of 80 households, and an additional 22 fishers were interviewed. Community activities were organised around fishing activities, with people still using

knowledge of the moon phases, tides and winds when fishing. More than 95% of the surveyed households were actively involved in reef fisheries. Men dominated both finfish fishing and invertebrate collection activities, with women only minimally participating in both activities. Likiep is an isolated atoll, and thus distribution potential for the commercial market is very limited. A fish buying centre was set up on the



**Figure 6: *T. derasa* (top) and *T. squamosa* (bottom) broodstock at the MIMRA clam nursery at Likiep.**

atoll by MIMRA, however, difficulties and costs of transporting fresh fish to the urban areas of Majuro and Ebeye have made this activity sporadic. Handicraft sales were the primary income source for 35% of households; these sales were the primary responsibility of women. Fisheries resources were second in terms their importance as an income source, being the primary income source for 20% of households; 40% of households rely on fisheries as their secondary income source. The higher reliance on fisheries resources as a secondary income source mainly involved local selling of dried fish.

Per capita fish consumption was very high at 144 kg/year, with fresh fish consumed around four times per week. Invertebrate consumption was almost negligible, and this was because gleaning and collecting shellfish and other invertebrates was only done during periods of very low tides. Other invertebrates, such as lobsters and coconut crabs, were occasionally harvested and sent by plane to relatives on Majuro or Ebeye. All surveyed households consumed fresh fish and invertebrates, and there was very low consumption of canned fish. This was associated with both the low purchasing power of residents, and their preference for fresh fish.

The main fishing methods practiced included deep-bottom fishing, diving and handlining, with women mainly involved in handlining in lagoon areas. Both fish and fish catches were large, reflecting the abundance of finfish resources. Although some management initiatives exist, they have not been implemented at sites that have been identified as needing some form of protection. With transportation problems and a lack of markets, local fish consumption is high and fishing is done primarily for subsistence purposes.

#### AILUK ATOLL

Ailuk is an elongated shaped atoll (Fig. 7) that is 30 km long, 13 km wide, and oriented in a north-south direction. It is located at 10°20'N and 169°56'E. The deepest part of the lagoon is about 40 m. Nearly all of the motus are on the eastern side of the atoll. The southernmost motu is inhabited by a community of fishermen who still use sailing or paddling outrigger canoes. The western part of the reef is more submerged and presents four passes, one of which is very wide. Nineteen finfish sites were assessed around the atoll (Fig. 7), covering three of the main habitat types: outer reef, back reef and intermediate reef.

Among the three represented habitats, the outer reefs were by far the most diverse. Outer reefs on the atoll's eastern side

could not be surveyed due to bad weather. In general, the outer reef types in the southern and western part were vertical walls. Therefore, the living coral surface area is reduced, although it is very rich and diverse. Fish were quite large and their densities rather high.



**Figure 7 (top):** Ailuk Atoll, showing some of the survey sites.

**Figure 8 (bottom):** *Carcharhinus amblyrhynchos* on outer reef.

However, the team did not record any *Bolbometopon muricatum*, and found few *Cheilinus undulatus* and sharks (Fig. 8).

Back reefs were rather detritic or sandy but surprisingly rich where more corals were present. Corals were alive and healthy even those very close to the surface. Fish were very wary and were of average sizes and densities. Intermediate reefs were generally represented by small patches or pinnacles and were not very abundant. Some were very well built and quite alive (Fig. 9), others are detritic or sandy, and covered in algae (especially *Microdyction*). There were abundant planktophagous

fish of good size but in general fish are scared of divers.

Giant clams were a commonly harvested fishery resource. *T. maxima* and the larger clams, *T. squamosa* and *H. hippopus* were recorded, with *H. hippopus* relatively common across the site. *T. gigas* were recorded as dead shells only, especially on the tops of patch reefs.

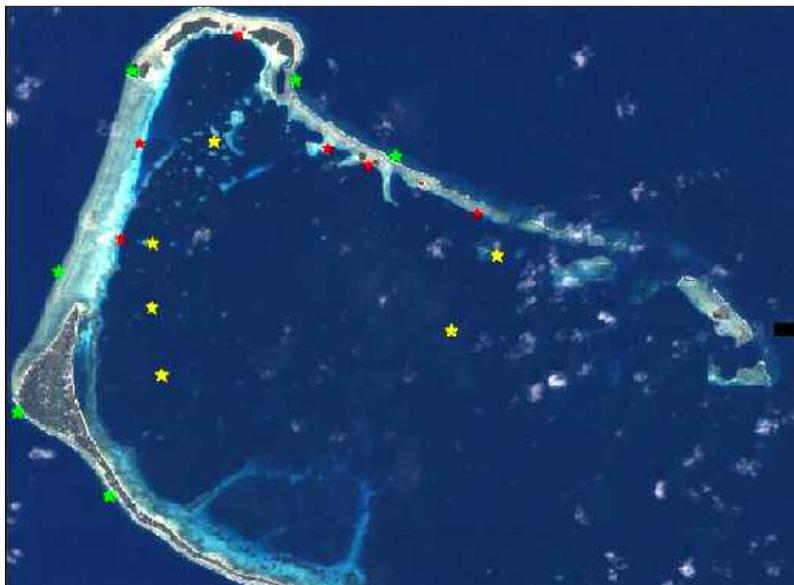
Sea cucumber resources at Ailuk were generally poor. Commercial species included *Bohadschia argus*, *Holothuria atra*, *H. edulis*, *Thelenota anax* and *T. ananas*. Leopardfish, *B. argus*, found during the surveys had an unusual pattern and colour, with little of the normal spotting that is characteristic for this species (samples have been sent for identification confirmation).

Infaunal species were of little importance at Ailuk, with no extensive shell beds (e.g. *Anadara* or *Strombus luhuanus*) found.

Lobsters, which are not generally targeted in CoFish and PROCFish/C in-water surveys, were uncommon. In surveys targeting other species, lobsters were rarely noted, despite there being an active fishery.

Topshells (or trochus, *Trochus niloticus*) are not endemic to Ailuk, although introductions may have potential because the western reefs are very complex and potentially suitable for supporting this gastropod (with adjacent back reefs suitable for juvenile trochus).

Socioeconomic surveys at Ailuk covered 19 out of 60 households, and an additional 29 fishers were interviewed. Fishing is a way of life for the community, with all surveyed households (100%) actively involved in reef fisheries. Men dominated both finfish fishing and invertebrate collection activities. An outstanding feature of Ailuk was the high use of traditional canoes for fishing and transportation within the lagoon, and the lack of motorised boats.



**Figure 9 (top):** MIMRA trainees Melba White and Emma Kabua on a rich intermediate reef.

**Figure 10 (bottom):** Finfish dive stations in Laura, western part of Majuro Atoll,

Handicraft sales were the primary source of income for households because of transportation difficulties and a lack of markets for selling seafood products. Only 10% of households relied on fisheries resources as their primary income source, and another 10% relied on fisheries as their secondary income source. Households, therefore, relied significantly on fisheries resources for basic food needs. Per capita fresh fish consumption was very high at 144 kg/year with fresh fish consumed on average 5.5 times per week. Invertebrate and canned fish consumption was low. All surveyed households consumed fresh fish and invertebrates. Invertebrates such as lobsters, giant clams and coconut crabs were often harvested and sent to relatives by plane.

The main fishing methods used were bottom fishing, diving and handlining, with women occasionally participating in handlining within the shallower areas of the lagoon. Fish were large and abundant in nearshore areas, and the lack of regular commercial fishing activities may explain this. Management interventions have been developed in the community through the assistance of international NGOs and the College of the Marshall Islands in collaboration with MIMRA. Several fishing areas have been identified for consideration for management by the community.

#### MAJURO ATOLL – LAURA VILLAGE

Majuro Atoll (Fig. 10) is about 40 km long and 15 km wide, and is located at 7°10'N and 171°15'E. The deepest part of the lagoon is about 70 m. The atoll's southern part consists of a series of motus (64 in total), with one main bridge over a pass in the reef to connect the main urban areas. Given Majuro Atoll's size, the Laura area to the west was chosen for survey work, with 18 finfish dive stations covering the three habitat types found there: outer reef, back reef and intermediate reef.

The outer reefs had a high diversity of coral species with coverage ranging from 80–100%. Tabulate coral coverage was very high at the second dive station in the north, close to Rongrong Island (Fig. 11). For the remaining stations the massive and sub-massive corals were dominant with patches of digitate, foliose and branching corals.

Finfish resources in the outer reef system around Laura were dominated by *Chlorurus microrhinos* and *Acanthurus blochii* which were observed in large schools. Large *Cheilinus undulatus* (70–80 cm in length) were also observed at some of the survey stations.

The back reef system around Laura mostly consisted of rubble and sand with little coral coverage (20–30%), and mostly dominated by submassive and massive corals. Finfish populations were mostly dominated by rubble- and sand-associated fish species, such as lethinids (emperors), mullids (goatfish) and to a lesser extent scarids. Size ranges of fish observed were quite small (15–25 cm). Schools of *Mulloidichthys vani-*

*colensis* were observed in almost all stations along with schools of *Gnathodentex aurolineatus*. Larger fish were quite wary of divers in Laura's back reef system, which might indicate that spearfishing and human disturbances were frequent occurrences.

Intermediate reefs showed greater coral coverage (40–60%) compared with back reefs, and were dominated by digitate, submassive, tabulate and



**Figure 11 (top):** Tabulate corals dominating one site in the outer reef, with counterpart diver Emma Kabua recording data.

**Figure 12 (bottom):** Dead tabulate coral covered with algae.



**Figure 13 (left): *Epinephelus polyphekadion* in the intermediate reef off Laura.**



**Figure 14 (right): A species of *Bohadschia* awaiting identification confirmation**

branching corals. At a station opposite the main pass, dead table corals covered with algae were observed (Fig. 12), indicating that either a massive bleaching of table corals had occurred, or there had been a heavy storm in the area several years back. Schools of snappers (*Lutjanus gibbus* 20–25 cm) and *L. bohar* (25–30 cm) were observed in great numbers along with juvenile coral trout (*Plectropomus laevis* and *P. areolatus*). A few groupers (*Epinephelus polyphekadion*) were observed at some of the stations (Fig. 13).

Giant clams were a common fishery resource, and *T. maxima*, *T. squamosa* and *H. hippopus* were observed. *H. hippopus* and *T. squamosa* were typically average to large in size, while *T. maxima* tended to be smaller than the mean found in any of the PROCFISH/C countries visited so far. *T. maxima* densities were moderate to low, while *H. hippopus* densities were surprisingly high.

Sea cucumber resources at Laura were generally poor, with only seven commercial species recorded (*Actinopyga mauritiana*, *Bohadschia argus*, *Holothuria atra*, *H. edulis*, *H. nobilis*, *Thelenota ananas* and *T. anax*). Densities of *H. atra* were relatively high, while those of *T. anax* were moderate. All other species

were recorded at low to very low densities. Like the northern sites, the leopardfish (*B. argus*) recorded during the surveys had an unusual pattern and colour (Fig. 14), with samples taken and sent for identification confirmation).

Spider shells (*Lambis* spp.), which were commonly harvested, were sporadically found in medium to low densities. Lobsters, which are not generally targeted in CoFish and PROCFish/C in-water surveys, were uncommon, with only one *Panulirus penicillatus* and two *P. versicolor* recorded.

*Trochus niloticus* were introduced to the Marshall Islands, including Majuro, in the 1930s and were regularly recorded in surveys at Laura, although only in low densities. Nonetheless, several juvenile specimens were recorded in a back reef nursery site, indicating that spawning and recruitment were ongoing.

The survey team were unable to check the windward reef slope of the outer reef. At Majuro, trochus was found in high densities (Clyde James, Aquaculture Specialist with MIMRA, pers comm 2007) on the outer reef of the Amata Kabua international airport, although this area is distant from Laura and outside the CoFish study area. The bivalve

*Pinctada margaritifera* was recorded sporadically throughout the site in low densities.

Socioeconomic surveys at Laura covered 24 out of 180 households, with an additional 25 fishers interviewed. Fishing is central to the lifestyle of the people, with 96% of the surveyed households actively involved in reef fisheries. Laura is about one and half hours by road to Majuro's urban centre, thus the community has access to fish distribution outlets in both Laura and Majuro. Because of the community's easy access to Majuro, the main source of income was from paid employment, although a large proportion of the population relied on fisheries resources for their primary and secondary income sources (58%). Men dominated finfish fishing activities, while women were mainly involved in invertebrate collection.

Women's involvement in handicraft production for income generation was similar to the situation in the outer islands. Invertebrate collection was done on very low tides, or during specific seasons, winds and moon phases. Thus, households relied significantly on fisheries resources for their social and economic livelihoods. Per capita fresh fish consumption was very high at 132 kg/year, with fresh fish consumed on average four times per week. All households surveyed consumed fresh fish, while about 83% of households consumed invertebrates. Difficulty in accessing invertebrates and their decreasing numbers were the main reasons given by respondents for why invertebrates were not consumed as frequently as finfish.

The main fishing methods used were gillnetting, diving, bottom fishing and handlining, with women mainly involved in handlining within the shallower areas of the combined coastal

and lagoon areas. Night fishing was more frequent — and more fishing trips were made on a regular basis — at Laura than at of the other survey sites, and this was mostly fishing specifically for commercial purposes. There were no community-based management initiatives in Laura and the open access to the fishing grounds within the Laura area could be the reason for this.

**ARNO ATOLL**

Arno Atoll (Fig. 15) — located at 7°05'N and 171°44'E — is a 30-minute boat ride from Majuro. It is L-shaped, and unlike most other atolls, it encloses three different lagoons, a large central one, and two smaller ones to the north and east. The finfish dive stations were selected based on the area targeted by local fishermen. Three main habitat types were covered (outer reef, back reef and intermediate reef), with 6 dive stations for each habitat for a total of 18 transect dives. Invertebrate dive stations were also located in the same areas (Fig. 15).

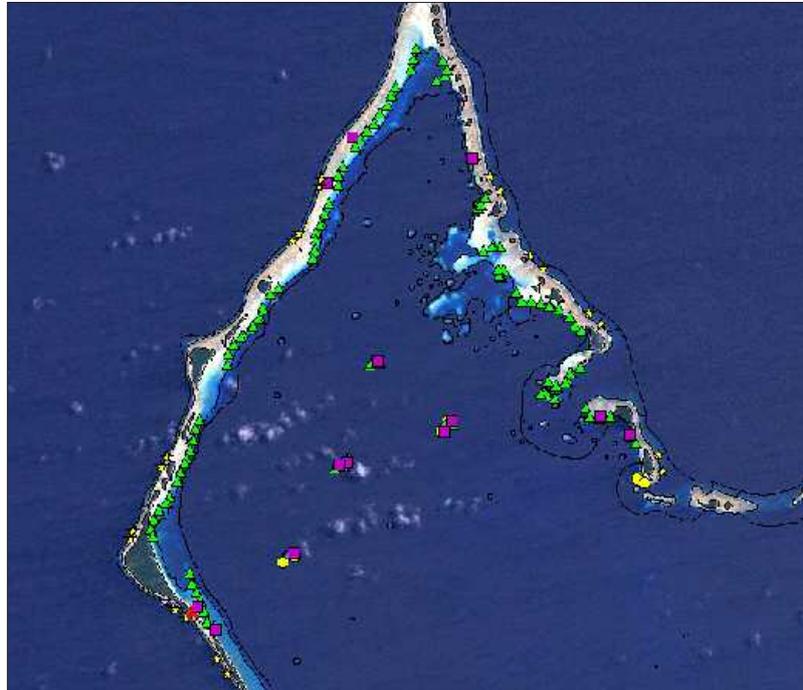
Coral coverage at the outer reef was very diverse (Fig. 16), with submassive and massive corals dominating all six stations. Coral coverage was high, ranging from 70–80% with patches of branching, tabulate and foliose corals. Fish assemblages were dominated by typical semi-pelagic species, such as rainbow runners (*Elegatis bipinnulata*, Fig. 17), *Chlorurus microrhinos*, *Acanthurus olivaceus* and *Macolor macularis*. Large species of *Cheilinus undulatus* and *Plectropomus laevis* were also observed in high numbers.

Arno's back reefs were mostly covered by rubble, sand and

patches of massive, submassive and digitate corals. Fish assemblages were dominated by *Chlorurus microrhinos* (Fig. 18) and *Naso brevirostris*. White tip reef sharks were a common sight

at almost all back reef stations on the northeast side of the atoll.

In the lagoon, almost all intermediate reef patches were quite healthy, with coral coverage



**Fig 15 (top): Invertebrate dive stations in Arno**  
**Figure 16 (middle): Corals covering Arno's outer reef.**  
**Figure 17 (bottom): School of *Elegatis bipinnulata* at Arno's outer reef.**

ranging from 30–80% and dominated by submassive, massive, digitate and tabulate corals. In some areas, coral coverage was low and the substrate was dominated by turfs and other algae types. The highlight of this habitat were the large schools of *Naso hexacanthus* and *Acanthurus mata* observed (Fig. 19) at nearly every station. Large *Plectropomus laevis* (>70 cm) were also observed at two stations, and juvenile *Cheilinus undulatus* (40–50 cm) were sighted at nearly every station.

At Arno, densities of *Tridacna maxima* were found to be moderate to high in the outer part of the western ocean-facing reefs, but densities were low elsewhere. *Hippopus hippopus* was recorded in moderate densities on the inner part of the northern reef, while elsewhere densities were low to moderate. *T. squamosa* were recorded on only a few occasions.



Sea cucumber resources at Arno were poor, especially in the shallow parts of the lagoon. Only one species, *Thelenota anax* was recorded in good densities during the sea cucumber day survey stations. Six commercial species were recorded (*Actinopyga mauritiana*, *Bohadschia argus*, *Holothuria atra*, *H. fuscogilva*, *Thelenota ananas* and *T. anax*), and mostly in very low densities. Anecdotal reports suggest that sea cucumbers were harvested at Arno in the recent past, and *Stichopus chloronotus* was among the reported species harvested, although our survey did not record a single specimen of this usually common species.

Spider shells, especially *Lambis chiragra*, were found in healthy densities, while other gastropods harvested by local fishermen (e.g. *Turbo argyrostomus*, *Strombus luhuanus* and *Thais* spp.) were found in low densities. No lobsters were recorded anywhere at Arno.

After initial attempts at introduction in the 1930s, the commercial topshell, *T. niloticus* was again introduced at Arno in 1990, with 200 adult specimens collected from Majuro Atoll. The animals were



**Figure 18 (top): School of *Chlorurus microrhinos* at Arno's back reef.**

**Figure 19: Schools of *Naso hexacanthus* (bottom left) and *Acanthurus mata* (bottom right) taking on a dark colour while in schooling mode at an intermediate reef in Arno.**

transplanted onto the reef in front of the Arno fishbase jetty (south coast). During this survey, we found only low densities around the reefs adjacent to the fishbase and their distribution range seemed to be limited to the inner lagoon and western reefs. The northern reefs, however, seem to be a promising site for any future attempt of seeding. A few specimens of the bivalve *Pinctada margaritifera* were also recorded.

Socioeconomic surveys at Arno covered 16 out of 60 households, with an additional 18 fishers interviewed. There is a fish selling centre at Arno, thus there is a ready outlet for commercial fishing activities. Even though they live quite close to Majuro, the people at Arno live a semi-subsistence lifestyle, with a regular commercial fishing venture providing the main means of income generation. About 96% of households were involved in reef fisheries, either for food or for income. Fisheries resources provided 48% of surveyed households with their primary and secondary income sources. Men dominated both finfish and invertebrate collection activities, with women occasionally participating in some fishing and invertebrate collection. Invertebrates were mostly targeted during special seasons, very low tides and special moon phases, and so were not regularly harvested by many of the surveyed households. Per capita fresh fish consumption was 120 kg/year, with fish consumed five times per week. Per capita invertebrate consumption was nearly negligible, with canned fish consumption also low.

The main fishing methods used at Arno were bottom fishing, gillnetting, diving and handlining, with women mainly handlining within the shallower coastal and lagoon areas. The main distribution outlet for fisheries resources was the fish cen-

tre at Arno, although many fishers chose to market their own

catch in Majuro. Some management work had been initiated at

Arno, with some areas identified for marine resource protection.



### Database assistance to Vanuatu

In an effort to help national fisheries authorities make use of data collected within countries from markets, logbooks and other sources of information, SPC's Marine Resources Division develops standardised database and software that are distributed in the region. In addition to the standard collection systems, cus-

tom databases have been developed by the fisheries authorities to meet their specific needs.

In August, the PROCFish/C's Information and Database Manager, Franck Magron, travelled to Vanuatu to assist the staff of the Fisheries Department to standardise their coastal fish-

eries access database, by restructuring the tables and writing a set of queries to produce yearly statistics. He also demonstrated from that geolocated data could be plotted on top of bathymetric charts showing the fish catch and effort around seamounts.



### Technical manual for socioeconomic surveys

The English version of a technical manual produced by the PROCFish/C and CoFish project titled "Socioeconomic fisheries surveys in Pacific Islands: A manual for the collection of a minimum dataset" by Meeki Kronen, Natasha Stacey, Paula Holland, Franck Magron and Mary Power (Fig. 20) went to the printers in September. This manual was designed in response to the most urgent issues voiced by the fisheries services in the Pacific Island countries and territories covered by the project. The manual targets staff from governmental and non-governmental organisations interested in providing the much needed data baseline, which decision-makers and managers require for the rational management of coastal reef and lagoon resources to ensure their sustainable use for food security, livelihood and economic development.

The manual will be introduced to the region through a series of sub-regional workshops. A workshop announcement has gone out to all 17 participating ACP countries and OCT territories for the nomination of a PROCFish/C-funded participant to one of three training courses. The first two training courses, in English, are sched-

uled to be held in Noumea, New Caledonia, December 2007 and January 2008. A third training workshop, in French for participants from OCT territories, will also be held in early 2008.

Each workshop will address the following major issues: rationale of socioeconomic fisheries surveys and understanding of a minimum dataset; introduction and familiarisation with the manual, the methods and software; data entry, retrieval and interpretation; discussion of questionnaire surveys, accompanying tools and additional information needed to successfully accomplish a fisheries sur-

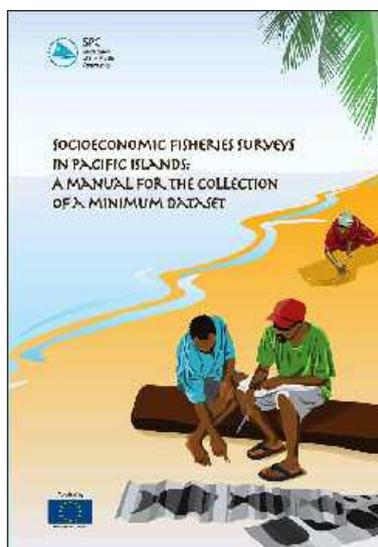
vey; and extraction of data for further and individual use.

The software package developed by the project's Information and Database Manager will be installed on participants' computers. The training workshop aims at maximising hands-on familiarisation with the method and software developed.

Participants will work on a limited project sample and will also use case studies for presentation and group discussions. The English version of the manual can be downloaded from the project webpage:

<http://www.spc.int/coastfish/sections/reef/publications.htm>

The French version of the manual should be available by the end of the year.



**Figure 20: The manual "Socioeconomic fisheries surveys in Pacific Islands: A manual for the collection of a minimum dataset".**