



**Inshore Fisheries Resources of
Solomon Islands**

by
Andrew H. Richards¹, Lui J. Bell¹
and Johann D. Bell²

ICLARM contribution

FFA Report 94/01

PACIFIC ISLANDS FORUM FISHERIES AGENCY
P.O.BOX 629 HONIARA SOLOMON ISLANDS
TELEPHONE (677) 21124
FAX (677) 23995
WEB <http://www.ffa.int>

Despite the large number of islands within its Exclusive Economic Zone, Solomon Islands has a relatively limited amount of coral reef to support inshore marine fisheries. The nation's population is growing rapidly and continues to depend heavily on inshore marine resources, particularly finfish, for subsistence. In the past decade, there have been substantial exports of *bêche-de-mer* (processed sea cucumber), trochus shell, pearl oyster shell, green snail shell, turtle shell and crocodile skin. In late 1993, export of turtle shell and crocodile skin was banned in response to an obvious need for the conservation of these species. The export of pearl oyster shell was also prohibited in late 1993, to foster the development of aquaculture, by improving the supply of wild spat and by ensuring that there are sufficient numbers of wild oysters to provide broodstock for future hatcheries. Since 1986, there has been active research in Solomon Islands on the aquaculture of giant clams to improve their future export value and provide opportunities to reseed denuded reefs. Simple controls, e.g. minimum and maximum size limits, have been placed on the harvest of several non finfish species, and closed seasons have been self-imposed on sea cucumber and trochus by some communities. Increased use of self-imposed regulations by customary owners and a variety of conservative common-sense management measures would help to ensure that the stocks of the main export commodities, such as sea cucumber, trochus and green snail, provide sustainable and lucrative harvests in the future.

INTRODUCTION

Solomon Islands is situated in the south-western Pacific Ocean between 5-12° S and 152-170° E (Fig. 1). Its Main Group Archipelago (MGA) consists of a double chain of six large islands (Choiseul, Santa Isabel, New Georgia, Malaita, Guadalcanal and San Cristobal [Makira]). There are also some 30 smaller islands, and approximately 962 islets, atolls and cays spread over 600,000 km² of ocean (Fig. 2). The country has a total land area of 28,369 km² and jurisdiction over 1.34 million km² of ocean within its 200 mile Exclusive Economic Zone (EEZ). The islands have little or no continental shelf and many of them support only limited areas of relatively depauperate coral reef (UNEP/IUCN, 1988). Other islands, however, have extensive fringing and barrier reefs, enclosing some of the world's largest lagoons (Skewes, 1990).

Solomon Islanders rely heavily on marine resources and have one of the highest per capita rates of seafood consumption in the world. In 1982, the national average annual consumption of fish per person was estimated to be 25.7 kg, ranging from <10 kg in rural Guadalcanal and San Cristobal, to 54 kg in the Western Province (Cook, 1988). Another survey conducted in Honiara in 1992, found that 31 per cent of households consumed fresh fish each day and that 82.4 per cent of meals containing animal protein were based on fish. The annual per capita consumption of fish was estimated to be 45.5 kg, comprising 36.7 per cent fresh fish, 31.0 per cent frozen fish and 32.3 per cent canned fish (Crossland & Philipson, 1993).

The vast majority of fish eaten in Solomon Islands comes from the nation's EEZ, which includes some of the most productive tuna fishing grounds in the tropical Pacific. In 1991, the domestic commercial tuna fleet landed almost 50,000 mt of skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*). This fishery has accounted for 30-50 per cent of the nation's total foreign exchange earnings during the past decade (Anon., 1992a).

Foreign fishing vessels, mainly Japanese pole-and-line and longline fleets, have fished in Solomon Islands waters for more than 20 years. The pole-and-line catch peaked in 1976 at nearly 20,000 mt and annual catches by Japanese longliners have varied between 1,000-6,000 mt. Licenses sold to foreign nations for access to the EEZ also provide substantial revenue.

The domestic fishery is managed by the allocation of quotas and restrictions on the areas of operation of the pole-and-line and purse seine components of the fishing fleet. The current total quota allocation is 120,000 mt, comprising 50,000 mt allocated to pole-and-line vessels fishing within the MGA and 70,000 mt to both pole-and-line and purse seine vessels fishing outside the MGA. The quotas are based largely on the conclusion of the South Pacific Commission's (SPC) Skipjack Survey and Assessment Programme that, in the early 1980's, there was potential for greatly increased skipjack tuna catches from the waters of Solomon Islands. SPC scientists are currently of the opinion that there is considerable potential for increased tuna catches, particularly skipjack, in Solomon Islands waters (Anon., 1992a).

Fisheries associated with inshore coral reefs are of major importance to coastal communities in Solomon Islands. Several species are harvested for subsistence, and by artisanal fishermen as a source of income. Traditionally, the fisheries resources associated with coral reefs have been harvested under a complex system of Customary Marine Tenure (CMT), whereby a kinship-based group exerts control over certain areas of reef and/or their associated resources (Hviding, 1988). The opportunities to earn income from coral reef species have focussed, and often strengthened, the control that kinship groups have over their traditional marine areas. Consequently, proposals to develop fisheries, or implement new measures for management, have to be approved by many groups with varying controls and demands over local marine resources (Skewes, 1990). In some areas, however, e.g. Marovo Lagoon in the Western Province, CMT is highly flexible and adaptive and can handle contemporary local issues related to subsistence and commercial use (Ruddle *et al.*, 1992).

In 1991, Solomon Islands had a population of approximately 330,000, which is forecast to double in 20 years at the current population growth rate. It is reasonable to expect that this will substantially increase the exploitation rates of inshore marine resources. The Government of

Solomon Islands is aiming for sustainable use of inshore marine resources and has recently developed strategies to reduce over-harvesting of reefs and lagoons, and to protect the habitats of reef species. It has also legislated to conserve endangered species, notably turtles and crocodiles (Anon., 1993).

In this review, we briefly describe the nature and status of the main inshore marine fisheries of Solomon Islands. In virtually all cases, quantitative data on stock sizes are lacking and so we have concentrated on outlining the size and extent of the resources, their current and projected uses and the existing controls on their exploitation.

NON FINFISH RESOURCES

Commercial activity in inshore fisheries has been dominated by non finfish species. Prior to the introduction of amendments to the *Fisheries Act 1972* in late 1993, the main non finfish marine commodities ranked in order of export value were trochus shell, bêche-de-mer, hawksbill turtle shell, black-lip and gold-lip pearl oyster shell, green snail shell, and salt-water crocodile skin. Between 1985 and 1992, the combined value of these exports, excluding the value of crocodile skin, varied from approximately SI\$0.95 to 15.5 million [\cong USD0.3 to 5.1 million] (Fig. 3). There are minor export and/or local markets for giant clams, spiny lobster, mud crabs and coconut crabs.

Trochus

The turban snail or topshell (*Trochus niloticus*), also known as trochus, is widespread in Solomon Islands. Fishing and processing is small-scale and artisanal. The shell is boiled to remove the meat, which is commonly consumed by the harvester and his family. Prior to 1990, unprocessed, cleaned and dried shell was shipped to markets in south-east Asia, principally Japan (unpub. data, Solomon Islands Fisheries Division).

Between 1985 and 1992, exports of trochus averaged around 450 mt per year and accounted for 55 per cent of the annual value of all non finfish exports (Fig. 4). Establishment of button factories and an increase in the export levy on unprocessed trochus shell from 10 to 30 per cent in early 1991 led to large sales to the factories. Export of unprocessed shell fell to 87 mt in 1991 and 50 mt in 1992. On the other hand, 243 mt of unprocessed shell was purchased by the button factories in 1991 and 270 mt in 1992 (unpub. data, Solomon Islands Fisheries Division).

Although stocks of trochus in Solomon Islands are virtually unstudied, a decrease in catches since 1991 suggests that the resource may be fully or over-exploited. The introduction of minimum (8 cm) and maximum (12 cm) size limits in 1993 is in line with current legislation in Vanuatu, Fiji and New Caledonia, currently the main trochus-producing countries of the region, but alone may not be sufficient to adequately conserve the stock. Other management measures that have been recommended by Adams *et al.* (in press) include the imposition of a Total Allowable Catch (TAC) of around 450 mt, and establishment of sanctuaries throughout the main fishing areas. However, based on the data presented in Fig.4, a TAC of somewhat less than this would seem to be more appropriate. At Ontong Java in Malaita Province, the community has imposed a harvesting policy which precludes the taking of trochus every other year (Adams, *et al.*, in press).

Bêche-de-mer

Bêche-de-mer or trepang is produced from sea cucumbers (holothurians) by boiling, cleaning, drying, and in some cases smoking, the animals. The finished product, which has a rubbery texture, is normally re-hydrated by repeated soaking or boiling prior to consumption. It is considered a delicacy and an aphrodisiac in China and south-east Asia, which are the principal markets (Preston, 1993). With the re-entry of China into world trade, there has been a large increase in demand for bêche-de-mer, especially that prepared from the lower value species of sea cucumber (Kriz, in press).

In Solomon Islands, sea cucumbers are not part of the subsistence diet. Instead, 22 species are harvested by artisanal fishermen to produce bêche-de-mer (Holland, 1994). The three species that currently fetch the highest prices worldwide are sandfish (*Holothuria scabra*), white teatfish (*H. fuscogilva*) and prickly redfish (*Thelenota ananas*). Within Solomon Islands, white teatfish is particularly abundant at Ontong Java (Holland, 1994).

Together with Fiji and Papua New Guinea, Solomon Islands is a principal source of bêche-de-mer in the Pacific (Preston, 1993). In 1985, 13 mt of processed bêche-de-mer was exported from Solomon Islands, representing 8 per cent of the value of non finfish exports. Between then and 1990, exports were in the vicinity of 100 mt per annum, but increased rapidly to 622 mt in 1991 and 715 mt in 1992 (Fig. 4). The high catches in 1991 were due mainly to increased landings of species of lower value (Holland, 1994). The 1992 catch was worth SI\$10.2 million [\cong USD3.4 million] and represented 62 per cent of all non finfish exports. Since 1992, exporters have reported a marked decrease in the total catch of sea cucumbers (David Boardman, pers. comm.).

Exploitation of bêche-de-mer is not controlled by legislation. At Ontong Java, however, the community has restricted harvesting of sea cucumbers to every other year to permit resource regeneration in inshore areas (Doulman, 1992). However, the existing management measures at Ontong Java are now considered inadequate by several of the community leaders and may be revised to further limit fishing (Johnson Kengalu MP, pers. comm.).

In addition to rehabilitating stocks on exploited reefs by using customary regulations to reduce fishing, Adams (1993) and Holland (1994) have recommended several measures for the management of bêche-de-mer in Solomon Islands. These include:

- limiting the number of export businesses, and introducing strict but viable quotas for each exporter;
- introducing minimum size limits based on the size at maturity and maximisation of yield per recruit (the largest animals fetch premium prices);
- imposing alternate closed seasons for sea cucumber and trochus;
- banning the use of SCUBA or hookah underwater breathing apparatus for harvesting; and
- establishing reserves to protect broodstock for replenishment of surrounding areas.

Adams (1993) also recommends the monitoring of size frequencies of the main species at exporter's warehouses, to determine whether management measures need to be adjusted.

Another possibility for management of bêche-de-mer fisheries is stock enhancement. Juvenile sea cucumbers produced in hatcheries, and caught as spat from the wild, are already used to enhance wild populations in Japan (Preston, 1993). The International Center for Living Aquatic Resources Management (ICLARM) is currently experimenting with methods for the propagation of tropical sea cucumbers at its Coastal Aquaculture Centre, near Honiara. If propagation proves to be cost-effective, ICLARM plans to assess the feasibility of releasing reared juveniles to restore or enhance wild populations in Solomon Islands and other tropical developing nations.

Turtles

Hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*) and Olive Ridley (*Lepidochelys olivacea*) turtles occur in Solomon Islands. However, the latter two species are rare and have never been observed nesting within the country.

There is a major rookery for hawksbill turtles on the Arnavon Islands (between Santa Isabel and Choiseul), where much of the pioneering work with turtles in Solomon Islands was carried out (Vaughan, 1981). Leary *et al.* (in prep.) have analysed variation in the average number of clutches laid in this rookery since 1979. They found no significant decrease in the average number of clutches laid per day between 1979 and 1992, although a marked decrease in 1991 led them to recommend continued monitoring to determine the degree of reproductive success. The Arnavon Islands rookery is the most significant hawksbill rookery in the Pacific, and is of world importance. Plans are well advanced to declare the rookery a reserve, along with 85 km² of surrounding marine habitat (Tanya Leary, pers. comm.). There are a number of other large hawksbill rookeries on Santa Isabel and in the Western Province, and small numbers of hawksbill turtles nest on beaches throughout Solomon Islands.

Green turtles also nest throughout Solomon Islands. Guadalcanal, Santa Isabel, Choiseul and Western Province are important nesting areas for leatherback turtles.

A substantial decrease in the Arnavon Islands nesting hawksbill turtle population in 1991 has been linked to exports of large numbers of hawksbill turtle shells, principally to Japan (Leary *et al.*, in prep.). The 3.4 mt of hawksbill turtle shell exported in 1989 represented a harvest of 3,700 adult turtles. Green turtles are important culturally, and as a source of food for many coastal people. There is also a small local trade in turtle meat.

The 1993 Fisheries Amendment Regulations ban the sale, purchase and export of any turtle or turtle products. They also ban the taking of nesting turtles or their eggs during the breeding season. Enforcement of these measures, and the total protection of the hawksbill rookery at the Arnavon Islands, should result in a gradual increase in the numbers of the three main species of turtle found in Solomon Islands.

Pearl Oysters

Three commercially important species of pearl oyster occur in Solomon Islands; the black-lip pearl oyster (*Pinctada margaritifera*), gold-lip pearl oyster (*P. maxima*) and the brown-lip pearl oyster (*Pteria penguin*). All three species are known collectively as Mother-Of-Pearl (MOP), but the value of brown-lip is lower than the other two species (Sims, 1993).

All species are widespread in Solomon Islands, with black-lip occurring predominantly in shallow water (1-2 m) and gold-lip at greater depths (10-60 m) (G. Tiroba, pers. comm.). Until recently, MOP was collected by free-diving, but hookah is now used to harvest gold-lip from previously inaccessible depths.

Prior to the establishment of button factories in Honiara in 1990, MOP was sold mainly to Japan by local traders. In 1991, 44 mt of black-lip and 14 mt of gold-lip pearl oyster shells were exported (Fig. 4).

Since 1988, several surveys have been conducted in the Santa Isabel region to assess the potential resource of gold-lip pearl oysters. These surveys found that most of the gold-lip oysters found there were too large (ie. > 20 cm dorso-ventral size) to be suitable for pearl farming (Colgan, 1993). In 1993, ICLARM and the Solomon Islands Fisheries Division surveyed the abundance of black-lip pearl oysters around population centres on Guadalcanal, Malaita, Florida Islands, Russell Islands, New Georgia and Gizo. Interviews with local villagers revealed that stocks had been reduced substantially from abundance levels 10 years ago. The maximum density of adult black-lip observed during the survey was 12 oysters per diver hour, but encounter rates of 2-3 oysters per diver hour were most common. These densities are low compared with wild populations in Cook Islands (Sims, 1990) and reflect consistently high exploitation levels during the past decade.

Recent legislation has banned export of black-lip and gold-lip pearl oyster shell, except that from oyster farms (*Fisheries [Amendment] Regulations 1993*). This measure is designed to foster the development of aquaculture, by improving the supply of wild spat, and by ensuring that there are sufficient numbers of wild oysters to provide broodstock for future hatcheries.

In January 1994, ICLARM and Fisheries Division set up a large-scale sampling programme to collect black-lip spat at five widely spaced lagoonal areas within Solomon Islands where reasonable numbers of black-lip oysters remain. Spat are being collected from three sites at each area using the general methods described by Sims (1993). The spat will be grown-out at coastal villages with the aim of accumulating enough oysters to establish village-based pearl farms, similar to those in Cook Islands (Sims, 1993).

Green snail

Green snail (*Turbo marmoratus*) is fished by small-scale artisanal fishermen and the shell is exported primarily to Japan and Korea. Exports have dropped markedly since the mid 1980's (Fig. 4), despite the high price paid to divers (currently SI\$60 [≡ USD20] per kg). The taking of green

snail for the tourist trade is thought to be a major source of fishing mortality (P. Nichols, pers. comm.).

There have been no specific surveys conducted for green snail, but the indications are that the stock is currently over-exploited across its distribution in Solomon Islands. Adams *et al.* (in press) concluded that stocks are unlikely to recover unless measures are taken to assist the process. A minimum size limit of 15 cm shell aperture would bring Solomon Islands legislation into line with that of Papua New Guinea and Vanuatu. However, a complete ban on fishing green snail for several years, combined with liberation of hatchery reared juveniles, may be needed to restore this potentially valuable fishery to the point where it can be managed to provide greater, sustainable yields.

Salt-water Crocodile

The salt-water crocodile (*Crocodylus porosus*) presently occurs in Solomon Islands only as small, widely scattered populations (Messel & King, 1989). Until the end of 1993, mature crocodiles were killed for their skins whenever they were encountered, and juvenile crocodiles were held in small grow-out pens until they were large enough to be legally killed for their skins. In 1989, 7,452 inches (belly-width) of skins valued at SI\$187,438 (\cong USD62,000) were exported, mainly to Japan (Solomon Islands Statistics Office data).

The dramatic decline in crocodile numbers prompted a survey of the resource in 1989. This survey found that salt-water crocodiles were nearing local extinction (Messel & King, 1989). Recently introduced legislation bans the export of any crocodile, crocodile skin or product, except that reared in a farm (*Fisheries [Amendment] Regulations 1993*). If rigidly enforced, this measure may ensure preservation of crocodiles in Solomon Islands, especially if it is combined with the protection of special areas of suitable habitat such as brackish-water lagoons (Skewes, 1990).

Giant Clams

Six species of giant clams occur in Solomon Islands: the giant clam (*Tridacna gigas*), smooth giant clam (*T. derasa*), fluted giant clam (*T. squamosa*), rugose giant clam (*T. maxima*), boring clam (*T. crocea*) and horse's hoof clam (*Hippopus hippopus*). Apart from *T. derasa* and *H. hippopus*, which have limited distributions within the MGA (see Fig.1), all species are widespread throughout Solomon Islands (Govan *et al.*, 1988). In several nearby countries, e.g. Fiji, Vanuatu and New Caledonia, some of the species, particularly *T. gigas*, do not occur or have become locally extinct (Munro, 1993).

All species of giant clams are eaten in Solomon Islands and are a highly esteemed food for many coastal communities. Clam meat is also sold in local markets for about the same price as reef fish.

No quantitative surveys of giant clam abundances have been made in Solomon Islands, but it is evident that stock densities vary widely among the various islands. Abundances of *T. gigas* have been drastically reduced in areas close to main population centres due to persistent subsistence fishing, and at several outlying areas through licensed fishing, and poaching by crews of foreign fishing vessels (see Govan *et al.*, 1988 for details).

Giant clams are locally abundant in some remote areas, e.g. Shortland Islands, and at two other spatial scales. The first of these are the extensive areas under customary marine tenure of members of the Seventh Day Adventist Church, who do not eat marine invertebrates. At a smaller scale, many coastal villagers throughout Solomon Islands establish "clam gardens" on reefs in front of their houses. Some households keep the clams until they are large enough to eat, but in many cases they are never killed. In areas of low clam abundance, the practice of keeping clam gardens may increase spawning success of giant clams.

In mid-1992, *T. gigas* and *H. hippopus* died *en masse* at Makira, Guadalcanal and Florida Islands, and to a lesser extent at Russell Islands and Santa Cruz Islands, due to an unknown cause. None of the known pathogens of giant clams were implicated, nor were there any obvious sources of biological toxins (e.g. algal blooms). The mortalities happened during a pronounced "El Niño" event with tidal levels 20 cm below predictions, abnormally strong currents and water temperatures 2-3^o C below average (Anon., 1992b).

Since 1986, ICLARM's Coastal Aquaculture Centre has been developing village-based farming methods for those species of giant clam found in Solomon Islands (Usher & Munro, 1988; Govan, 1993; Bell, 1993). Standard methods of culture are now in use in over 20 villages. Initially, the farming techniques were aimed at producing clams for the traditional market for adductor muscle in Taiwan, based on large clams, particularly adult *T. gigas*. However, the emphasis is now on producing live juveniles of all species except *H. hippopus*, for the aquarium trade in the U.S.A. and Europe. Future research will identify optimum husbandry methods for supplying giant clams in the size range of 12-18 cm to the live seafood trade in Japan and Asia.

The high prices paid for clams in the aquarium trade raises the concern that wild clams, particularly *T. crocea*, could be sold to the trade. All species of giant clams are currently listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix II includes all species which although not necessarily now threatened with extinction, may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilisation incompatible with their survival. Solomon Islands is considering acceding to CITES, and the Ministry for Natural Resources proposes to introduce interim legislation to prevent export of live wild clams, or clam products.

Village-based farming of cultured giant clams will facilitate an increased and sustainable production of these species for the export market. However, harvests of wild clams for local consumption will have to be managed in order to ensure that viable spawning populations are maintained. The operation of a giant clam hatchery by ICLARM provides the opportunity to use cultured juveniles to restore areas denuded of giant clams. Protocols to ensure that reseeded giant clams to denuded areas does not introduce pathogens have been developed by several research institutions in the Pacific, including ICLARM. These protocols are described by Calumpong (1992).

Coconut Crab

The coconut or robber crab (*Birgus latro*) forms part of the traditional diet of Solomon Islanders. There is commercial exploitation on a small-scale, artisanal basis for local markets and the restaurant trade. No stock assessment work on coconut crabs has been done in Solomon Islands, but until recently they were considered abundant. Approximately 15,000 live coconut crabs, weighing 3 mt, were exported under special permits in 1990 (Anon., 1990). The 1993 amendments to the *Fisheries Act 1972* prohibit export of coconut crabs, except for scientific purposes. The amendments also ban the sale or purchase of any coconut crab which is less than 9 cm carapace length, or any coconut crab which is carrying eggs or from which the eggs have been removed.

Spiny Lobsters

The principal lobster species taken is *Panulirus penicillatus*, although *P. versicolor* and *P. longipes femoristriga* are also caught in limited numbers. A survey of spiny lobster stocks conducted in the late 1970's concluded that the resource was exploitable but small (Prescott, 1980 in Skewes, 1990).

Factors such as rough weather, the cryptic nature of spiny lobsters during the bright phases of the moon and their aversion to entering traps have precluded large commercial operations. There is, however, a growing interest in exporting spiny lobsters. A small-scale, artisanal fishery supplies local markets and restaurants. Recently amended fisheries legislation bans the sale or purchase of spiny lobsters with a carapace length < 8 cm, and any female carrying eggs externally or from which the eggs have been removed.

FINFISH RESOURCES

Shallow-water Reef Fish

Approximately 180 species of reef fish from 30 families are caught from shallow-water by the domestic fishery. Catches are dominated by the families Lutjanidae (snappers), Serranidae (groupers and rock cods), Lethrinidae (emperors), Scombridae (mackerels) and Carangidae (trevallies). Most species are associated with coral reefs, although the Scombridae and Carangidae are less closely linked to reefs than the other families (Skewes, 1990).

As mentioned above, shallow-water reef fish form a significant part of the diet of Solomon Islanders and the major use of the resource is by the subsistence fishery. Leqata *et al.* (1990) provided information relating to the subsistence fishing activities of rural communities in Solomon Islands, collected by means of a household survey. Small amounts of reef fish, surplus to subsistence requirements, are sold through local markets in main population centres. Droplining and handlining are the most common fishing methods, followed by trolling and spearfishing. Gillnetting is common, but is probably the most seasonal of all techniques used. Gillnets are sometimes used together with a poison from a plant known locally as "buna".

The total annual domestic catch of reef fish is unknown, though a total annual production of 5,500 mt of fresh fish for local consumption has been estimated, using Honiara urban area consumption data reported in Crossland & Philipson (1993) and the size of the human population of Solomon Islands, currently estimated to be 350,000. There have been no estimates of standing stocks or equilibrium yields. The government is concerned about probable over-harvesting of reef fish at both the subsistence and commercial levels near the centres of high population (Anon., 1993), but there is currently no national legislation on the exploitation of reef fish. Blaber *et al.* (1990) concluded that the bait-fishery, which supplies the commercial pole-and-line tuna industry, had a negligible impact on reef fish, except for the less reef-associated, neritic pelagic species.

Deep-water Fin-Fish

Information on the species composition, relative abundance, catches and catch rates of deep-water finfish in Solomon Islands is summarised by Wata (1988). This resource is dominated by snappers of the Sub-families Etelinae and Apsilinae.

Commercial catches of deep-water fin-fish species are increasing steadily. There is a project operating in north Malaita, with financial and technical assistance from the Government of Japan, which produces 12 mt of deep-bottom snappers and groupers per year. A project funded by the European Commission (EC) produces approximately 30 mt per year for export and local sale. Deep-bottom fishing is concentrated around Florida Islands, Santa Isabel and Russell Islands (Michael Batty, pers.comm.). The EC-funded project has successfully conducted trial exports of chilled, whole, deep-water snappers and groupers to markets in Hawaii.

There is no national legislation on the exploitation of deep-water fish. Government policy is to promote the fishery in rural areas using small-scale local fishing operations, in an attempt to divert fishing effort away from more heavily exploited reef and lagoon finfish resources (Skewes, 1990).

Sharks

Sharks of the genus *Carcharhinus* are caught by subsistence and small-scale artisanal fishermen, often as a by-catch while fishing for reef and deep-water fish. Shark fins are sun-dried for sale to traders while subsistence fishermen may retain the meat for domestic consumption. Of greater importance is the catch of sharks by the domestic purse seine fleet. Purse-seine vessel crewmen sell the dried fins to obtain extra income (Paul Nichols, pers. comm.). Approximately 7 mt of dried shark fins were exported from Solomon Islands in 1992 (unpub. data, Fisheries Division).

Nichols (1993) summarises information on commercial shark fishing ventures in Solomon Islands from the early 1980's until the present. During 1984-1985, 190 mt of mainly carcharhinid sharks were taken by pelagic longlining throughout Solomon Islands. The catch was primarily utilised for the production of 2,000 hides and 2 mt of fins, which were exported. An experimental arrangement whereby local fishermen were encouraged to catch sharks in customary-owned reef areas for sale to a mother-ship, was unsuccessful.

From 1987 until 1992, a commercial fishing venture targeted deep-water gulper sharks, mainly *Centrophorus* spp., using bottom-set deep-water longlines. The livers from the catch were utilised for the production of shark liver oil, which is reported to have a high squalene content. The oil produced was exported exclusively to Japan, with exports rising from 2.9 mt in 1989 to 7.7 mt in 1992 (Toshiro Maeda, pers. comm.). The recent global over-supply of shark liver oil to the Japanese market, and a subsequent weakening of prices, may have contributed to the cessation of this fishery in 1993.

No stock assessment work on sharks has been carried out and there is no national legislation relating to shark exploitation. Skewes (1990) considered that the fishery was not under significant pressure.

CONCLUSIONS

Despite the large number of islands, and the size of the EEZ, there is a relatively limited amount of coral reef to support inshore marine fisheries in Solomon Islands (UNEP/IUCN, 1988). The high consumption rates of fish, the rapidly growing population, and the existence of lucrative export markets have placed considerable pressure on inshore fisheries resources. In the absence of data from quantitative surveys of abundance, growth and mortality, the declines in export volumes indicate that stocks of most non finfish species may have been fully or over-exploited in recent years. More accurate records of the source, volume, and size-frequency of exports are required to identify the management needs of non finfish species.

Management of inshore fisheries is possible through the *Fisheries Act 1972*, which empowers the Minister for Natural Resources to regulate fishing by such measures as conservation and protection of species, establishment of closed seasons, limiting the catch of any species, prohibiting fishing in particular areas, restricting methods of fishing and regulating fish exports. The declines in export volumes, the apparent need for conservation and the desire to encourage aquaculture, have already led the government to ban the export of several species, notably turtles, crocodiles and pearl oysters, and to introduce size limits for trochus, coconut crabs and spiny lobsters. Aquaculture has been embraced as a means of maintaining and improving the future export value of pearl oysters and giant clams.

However, for centralised management to be effective, adequate enforcement measures will be required, with a consequent drain on the fragile financial and human resources of the national and provincial governments. A more effective method of management could be that used at the community level, where outside enforcement measures are minimal. The community-based management of trochus and bêche-de-mer at Ontong Java provides a practical example of what may be achieved without government intervention. Similar initiatives in other inshore areas of Solomon Islands are worthy of government support. Other measures that could be applied to effectively manage the inshore marine resources of Solomon Islands include enhancement of wild stocks with juveniles reared in hatcheries and the use of strategically located marine protected areas to increase recruitment.

ACKNOWLEDGMENTS

We thank Michael Batty, Tanya Leary, John Munro, Paul Nichols and Gideon Tiroba for providing information about various fisheries and/or commenting on the draft manuscript.

REFERENCES

- Adams, T.J.H. (1993). Management of bêche-de-mer (sea cucumber) fisheries. *South Pacific Commission Bêche-de-mer Information Bulletin* 5, 15-21.
- Adams, T.J.H., Leqata, J., Ramohia, P., Amos, M. & Lokani, P. (1994). Pilot survey of the status of trochus and bêche-de-mer resources in the Western Province of Solomon Islands, with options for management. South Pacific Commission, Noumea, New Caledonia. *SPC Technical Report* (in press).
- Anon. (1990). Coconut crab ban useless. *LINK* 18, 4. Solomon Islands Development Trust, Honiara, Solomon Islands.
- Anon. (1992a). *Solomon Islands Country Report 1992*. Tuna and Billfish Assessment Programme, South Pacific Commission, Noumea, New Caledonia. 81p.
- Anon. (1992b). *Annual Report for 1992*. ICLARM Coastal Aquaculture Centre, Honiara, Solomon Islands. 24p.
- Anon. (1993). *Solomon Islands National Environmental Management Strategy*. South Pacific Regional Environmental Programme, Apia, Western Samoa. 160p.

- Bell, J. (1993). Growth and survival of *Tridacna gigas* during village grow-out trials in Solomon Islands. *Clamlines* 12, 3. ICLARM Coastal Aquaculture Centre, Honiara, Solomon Islands.
- Blaber, S.J.M., Milton, D.A., Rawlinson, N.J.F., Tiroba, G. & Nichols, P.V. (1990). Reef fish and fisheries in Solomon Islands and Maldives and their interactions with tuna baitfisheries. In *Tuna baitfish in the Indo-Pacific Region: proceedings of a workshop*. 1990 Honiara, Solomon Islands, 11-13 December 1989. ACIAR Proceedings No.30 (S.J.M.Blaber & J.W.Copland J.W. eds) pp. 169-178. Australian Council for International Agricultural Research, Canberra, Australia.
- Calumpong, H.P. ed. (1992). *The giant clam: an ocean culture manual*. ACIAR Monograph No. 16. 68p.
- Colgan, K. (1993). Survey of *Pinctada maxima*, gold-lip pearl oysters, in the Wagina region, Solomon Islands. FFA Report No. 93/46. South Pacific Forum Fisheries Agency, Honiara, Solomon Islands. 26p. plus appendices.
- Cook, J.R. (1988). *Review of Solomon Islands Fisheries Statistics Program*. Fisheries Technical Bulletin No. 1. Ministry of Natural Resources, Fisheries Division, Honiara, Solomon Islands. 30p. plus appendices.
- Crossland, J. & Philipson, P.W. (1993). *The Rural Fishing Enterprise Project in Solomon Islands: Fish Market and Marketing Study*. Report prepared for the Delegation of the Commission of the European Communities in Solomon Islands, Honiara, Solomon Islands. 136p.
- Doulman, D. J. (1992). Community-based fishery management: towards the restoration of traditional practices in the South Pacific. In FAO/Japan expert consultation on the development of community-based coastal fishery management systems for Asia and the Pacific. Kobe, Japan, 8-12 June 1992. 18p.
- Fisheries Act 1972 (No. 13 of 1972). (L.N.68/72) (Solomon Islands).
- Fisheries (Amendment) Regulations 1993. (L.N.43/93) (Solomon Islands).
- Govan, H. (1993). Participatory research in giant clam farming. *NAGA, the ICLARM Quarterly* 16(1), 8-10.
- Govan, H., Nichols, P.V. & Tafea, H. (1988). Giant clam resource investigations in Solomon Islands. In *Giant clams in Asia and the Pacific* (J.W.Copland & J.S.Lucas, eds), pp. 54-57. ACIAR Monograph No. 9, Canberra, Australia.
- Holland, A. 1994. The bêche-de-mer industry in Solomon Islands: recent trends and suggestions for management. *South Pacific Commission Bêche-de-mer Information Bulletin* 6. (in review).
- Hviding, E. 1988. Marine tenure and resource development in Marovo Lagoon, Solomon Islands. FFA Report No. 88/35. South Pacific Forum Fisheries Agency, Honiara, Solomon Islands. 110p.
- Kriz, A. (1994). *Marketing of South Pacific Seafood: A case study on sea cucumber*. FFA Report No. 94/11. South Pacific Forum Fisheries Agency, Honiara, Solomon Islands (in press).
- Leary, T., Ramohia, P., Pita, J., Aujare I., Leqata, J. & Laumani, M. (1994). Ecological aspects and conservation status of the hawksbill turtle (*Eretmochelys imbricata*) rookery in the Arnavon Island Group, Solomon Islands. *Aust. Wildl. Res.* (in prep.).
- Leqata, J.L., Rawlinson, N.J.F., Nichols, P.V. & Tiroba, G. (1990). Subsistence fishing in Solomon Islands and the possible conflict with commercial baitfishing. In *Tuna baitfish in the Indo-Pacific Region: proceedings of a workshop*. 1990 Honiara, Solomon Islands, 11-13 December 1989. ACIAR Proceedings No.30 (S.J.M.Blaber & J.W.Copland J.W. eds) pp. 169-178. Australian Council for International Agricultural Research, Canberra, Australia.
- Messel, H. & King, W. (1989). Report on the CITES and Solomon Islands Government national survey of the crocodile populations of the Solomon Islands: 20 July-8 September, 1989. S. I. Fish. Div. Misc. Rep. 89/1. Ministry of Natural Resources, Honiara, Solomon Islands. 54p.
- Munro, J.L. (1993). Giant Clams. In *Nearshore Marine Resources of the South Pacific* (A. Wright & L. Hill, eds), pp. 433-452. Forum Fisheries Agency/Institute of Pacific Studies.

- Nichols, P.V. (1993). Sharks. In *Nearshore Marine Resources of the South Pacific* (A. Wright & L. Hill, eds), pp. 285-328. Forum Fisheries Agency/Institute of Pacific Studies.
- Preston, G.L. (1993). Bêche-de-mer. In *Nearshore Marine Resources of the South Pacific* (A. Wright & L. Hill, eds), pp. 373-410. Forum Fisheries Agency/Institute of Pacific Studies.
- Ruddle, K., Hviding, E. & Johannes, R.E. (1992). Marine resources management in the context of customary tenure. *Marine Resource Economics* 7, 249-273.
- Sims, N.A. (1990). The black-lip pearl oyster, *P. margaritifera*, in the Cook Islands. *M.Sc.* thesis. University of New South Wales, Kensington, Australia.
- Sims, N.A. (1993). Pearl Oysters. In *Nearshore Marine Resources of the South Pacific* (A. Wright & L. Hill, eds), pp.411-432. Forum Fisheries Agency/Institute of Pacific Studies.
- Skewes, T. (1990). *Marine Resource Profiles: Solomon Islands*. FFA Report No. 90/61. South Pacific Forum Fisheries Agency, Honiara, Solomon Islands. 52p.
- UNEP/IUCN (1988). *Coral Reefs of the World. Volume 3: Central and Western Pacific*. UNEP Regional Seas Directories and Bibliographies. IUCN, Gland, Switzerland and Cambridge, U.K./UNEP, Nairobi, Kenya, 329p.
- Usher, G.F. & Munro, J.L. (1988). ICLARM Coastal Aquaculture Center: current facilities and progress. In *Giant clams in Asia and the Pacific* (J.W.Copland & J.S.Lucas, eds), pp.106-109. ACIAR Monograph No. 9. Australian Council for International Agricultural Research, Canberra, Australia.
- Vaughan, P. (1981). Marine turtles: a review of their status and management in the Solomon Islands. S. I. Fish. Div. Misc. Rep. 81/1. Ministry of Natural Resources, Honiara, Solomon Islands. 12p.
- Wata, A. (1988). Assessment of deep-bottom fishes of Solomon Islands. In Proceedings of the SPC Workshop on Pacific Inshore Fishery Resources, Noumea, New Caledonia: 14 March 1988. South Pacific Commission, Noumea, New Caledonia. 24p.

FIGURE CAPTIONS

Fig. 1. Location of Solomon Islands in the Pacific Ocean and the extent of its Exclusive Economic Zone.

Fig. 2. Main islands of Solomon Islands indicating location of the nine provinces.

Fig. 3. Total weight and value of non fin-fish exports from Solomon Islands between 1985 and 1992, excluding crocodile skin (Source: Statistics Office, Ministry of Finance, Solomon Islands).

Fig. 4. Weight and value (as a percentage of all non fin-fish exports) of the main non fin-fish species harvested from Solomon Islands between 1985 and 1992 (Source: Statistics Office, Ministry of Finance, Solomon Islands).