

CHAPTER 1

Introduction

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Throughout this publication, the Pacific islands region is generally considered to be that region encompassing Micronesia, Polynesia and Melanesia (Fig. 1). However, many issues discussed are not limited to this geographic range and topics relevant to fisheries in adjacent Asian countries such as the Philippines and Indonesia, southern Japan and Taiwan, northern and eastern Australia and Hawaii are raised in the majority of chapters. In addition, there are other aspects that are also relevant to other tropical oceans outside the Pacific.

Within these three regions of the western, central and southern Pacific Ocean, 13 independent small-island states, another, Palau, in transition, and six dependent territories are found. All the independent island nations together with Australia, Palau and New Zealand are members of the South Pacific Forum Fisheries Agency (FFA)¹. The Agency was established 13 years ago and although mainly active in legal and economic issues concerning tuna fisheries development and management within 200 mile exclusive economic zones, the member countries have recently requested increased effort be extended towards activities supporting research, development, management and conservation issues in nearshore areas.

These island nations support a population currently estimated to be 5.25 million with 67 per cent resident in Papua New Guinea. Of increasing concern is the relatively high population growth rate which averages 2.1 per cent annually for all countries and territories in the region. Although the total land area, approximately 526,000 km², is small relative to the area of the region, approximately 30 million km², Papua New Guinea accounts for 87 per cent of this land. The smallest countries in terms of land area are Nauru and Tuvalu which have a total of 21 km² and 26 km² of land respectively. However, on a global scale, the exclusive economic zones of FFA member countries are large covering about 25.2 million km², 19.8 million km² accounted for by the smaller island countries excluding Australia and New Zealand. Kiribati's zone covers almost 3.6 million km², Papua New Guinea's 3.1 million km² and Federated States of Micronesia's 2.9 million km² (see Table I).

Table I also provides an estimate of the number of islands and atolls present in each country or territory within the region. Few coasts do not support a

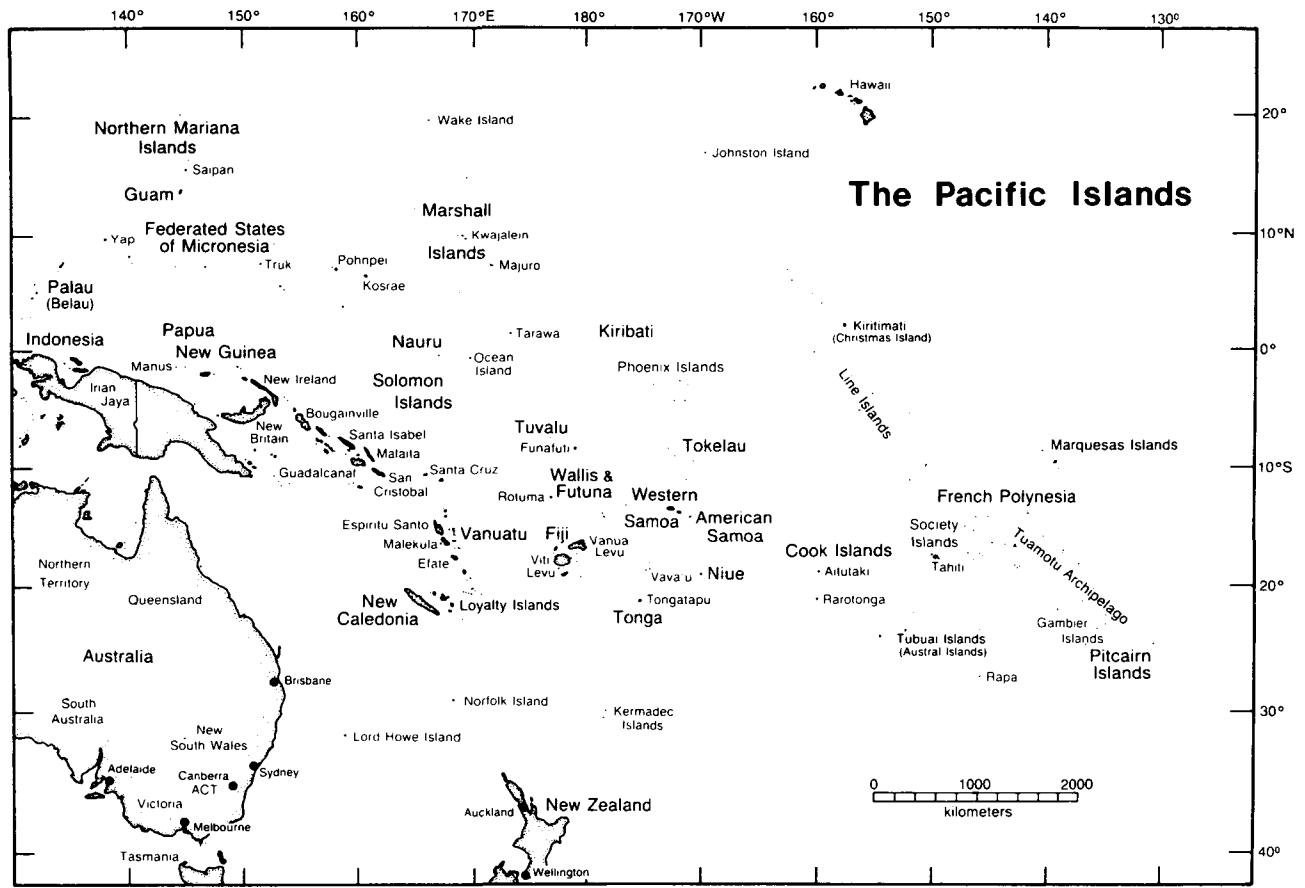


Figure 1. Map of the South Pacific region (Pacific Islands Development Program, Hawaii).

fringing or barrier reef and in fact in some areas, for example in Fiji, there are extensive barrier reef systems along the western coast and throughout the Lau Group. Similar extensive barrier or fringing reef systems are found in the Gambier Islands in French Polynesia, on the western coast of New Caledonia and the southern and northern coasts of mainland Papua New Guinea. The Great Barrier Reef, with almost 2,500 major reefs and almost as many islands, is well recognised as the world's premier barrier reef system. Recognising difficulties in attempting to measure the area of reef systems globally, Smith (1978) estimated that the area of reef in the South Pacific (including eastern Australia), is 77,000 km² or 13 per cent of world reef systems in depths less than 30 m. There have been no recent attempts to validate this estimate.

Based largely on the theory of subsidence (Darwin, 1842), coral reefs have been divided into three types: fringing reefs which either abut the shore or are isolated from it by a shallow moat, barrier reefs which are separated from the shore by lagoons which can be quite deep, and atolls. A useful classification of coral reefs for the purposes of this book is presented by UNEP/IUCN (p. xvi, 1988):

Present day reefs fall into two basic categories: shelf reefs, which form on the continental shelf of large land masses; and oceanic reefs, which develop adjacent to deep waters, often in association with oceanic islands. Within these two categories are a number of different reef types: fringing reefs which grow close to shore (i.e. most shelf reefs, although some develop around oceanic islands); patch reefs which form on irregularities on shallow parts of the sea bed; bank reefs which occur deeper than patch reefs, both on the continental shelf and in oceanic waters; barrier reefs which develop along the edge of the continental shelf or through land subsidence in deeper water and are separated from the mainland or island by a relatively deep, wide lagoon; and atolls, which are roughly circular reefs around a central lagoon and are typically found in oceanic waters, probably corresponding to the fringing reefs of long since submerged islands.

In addition to the hard, stony or hermatypic corals, many shallow water reefs are also composed of heavy encrustations of red algae which cement the reef framework and in well developed circumstances, form algal ridges. Closely associated with most coral reefs are a large number of related habitats in which most of the resources discussed in this volume spend at least part of their life. These habitats include seagrass beds and mangrove systems.

As a result of the prevalence of reef habitats throughout the South Pacific and the fact that most coastal people have access to reef environments supporting resources which in addition to daily subsistence requirements, are increasingly harvested for export to international markets, this book is almost entirely

Country	High islands	Low islands	Atolls islands, and cays	Land Area (km ²)	EEZ Area ('000) (km ²)	1990 Popn. ('000) (km ²)
American Samoa	5	-	1	200	390	46.8
Cook Islands	6	>200	9	237	1,830	16.9
Palau	18	>350	-	488	629	15.2
Federated States of Micronesia	16	>250	36	701	2,978	101.2
Fiji	113	>350	12	18,272	1,290	725.0
French Polynesia	26	>100	82	3,521	5,030	196.3
Guam	1	-	-	541	218	133.4
Kiribati	-	>100	23	690	3,550	71.8
Marshall Islands	-	>50	29	181	2,131	46.2
Nauru	-	1	-	21	320	9.3
New Caledonia	4	18	11	19,103	1,740	167.6
Niue	-	1	-	259	390	2.2
Northern Mariana Islands	16	4	-	471	1,823	44.2
Papua New Guinea	83	>350	47	462,243	3,120	3,528.5
Solomon Islands	37	65	2	27,556	1,340	324.0
Tokelau	-	124	3	10	290	0.2
Tonga	16	>150	-	747	700	96.3
Tuvalu	-	4	5	26	900	10.2
Vanuatu	25	43	-	12,190	680	146.4
Wallis and Futuna	1	22	-	255	300	13.7
Western Samoa	3	2	-	2,935	120	157.7

Table I. Land and sea area details and recent population estimates of the island countries and territories of the South Pacific region, excluding Australia and New Zealand.²

dedicated to marine resources found in association with reef community systems. Although the mangrove crab, *Scylla serrata* is normally found in extensive estuary systems it is also found on coral coasts subject to high freshwater runoff from adjacent land areas where mangroves have become established in sheltered bays. The deepwater finfish and shrimp resources are confined to deeper waters on the reef slope extending to 600m and coconut crabs spend the majority of their lives out of water. Nevertheless they are island resources whose lives are intimately linked with coral reef ecosystems.

The contribution of tropical oceans to global fisheries production is almost impossible to estimate accurately. Longhurst and Pauly (p. 1, 1987) noted that "the tropical ocean accounts for almost 50 per cent of the total area of all open water and 30 per cent of the total area of continental shelf, but produces only about 16 per cent of global fish production". They further noted that fisheries of coral reefs account for only 5 per cent of total estimated fish production in the tropics. However, the South Pacific does not generally reflect this global generalisation. Even with the exclusion of subsistence fishing, which constitutes a sizeable annual harvest in itself, reef and lagoon fish may constitute 29 per cent of the commercialised local fishery in the region (Salvat, 1980). In addition, the commonly termed "miscellaneous marine products" which include green snail, trochus, bêche-de-mer, spiny lobster and pearl oyster have also been subject to significant fishing effort for export markets spanning decades in the case of shell fisheries and more than a century for bêche-de-mer.

Throughout this volume, the point that reef-associated fisheries in the South Pacific region are extremely difficult to monitor is made many times. In most countries in the region, limited research funds within government fisheries administrations constrain most sampling activities to short term, creel census-type exercises. Only a few countries, for example Kiribati, Papua New Guinea and Fiji, have maintained programmes on a multi-year basis in the past. Few of those programs are currently operational either because funds are limited or because staff with the capability to design and implement monitoring programmes, analyse results and disseminate the findings are either not available in country, are working elsewhere or are working for the government fisheries agency but are fully occupied with a multitude of other programmes within their office (Shepard *et al.*, 1989). In addition to difficulties in attracting the appropriate recognition for research as an integral component of any initiative to formulate fishery development and management advice for fisheries generally within the region, there are a large number of other difficulties inherent in collecting data from reef-associated fisheries (Lewis, 1990).

Factors affecting the ability of biologists to monitor coral reef fisheries in the region include the dispersed nature of fishing operations and landing sites, the use of a variety of gears during fishing expeditions and the associated difficulty of assigning portions of the catch by gear type, taxonomic difficulties with

respect to accurate identification of an extremely diverse catch, the intermittent involvement of many participants, and difficulty in measuring effort (for example see Stevenson and Marshall, 1974; Wright and Richards, 1985; Bellwood, 1988; Russ, 1991).

In addition, fish poisoning or ciguatera poses particular problems for researchers in the South Pacific. In many areas of Micronesia and Polynesia in particular, the presence of ciguatoxic fish is a major factor influencing fishing activity in terms of both locations fished and the composition of the catch retained and returned to the landing site (*e.g.* see Anderson and Lobel, 1987; Randall, 1980). In theory, the harvest of the invertebrate resources, such as *bêche-de-mer*, trochus, green snail and deepwater corals, should be much easier to monitor as they are usually produced for export markets and therefore must leave the country of origin through a port registered to handle international transactions. However, at present in the South Pacific linkages between national customs services and fisheries administrations are not optimally exploited to gather useful information relating to the harvest of these resources.

In order to gain a reasonably accurate understanding of reef-associated fisheries in the Pacific, it is important to monitor subsistence fisheries in conjunction with the artisanal fishery. This does not only concern finfish but also relates to *bêche-de-mer*, spiny lobster and shell fisheries. In fact, throughout the Melanesian region there are large volumes of shell harvested and traded on domestic markets as traditional currency for which little or no harvest information exists. Similarly elsewhere in the region, large local harvest of octopus and the urchin *Tripneustes gratilla*, are basically unmonitored.

In many situations the catch monitored from the artisanal fishery is confined to that portion of the catch presented for sale. Often a portion of the catch, mostly consisting of smaller fishes, is retained for home consumption and is not presented at a market point. It is therefore not often recorded in catch sampling exercises. Although total annual harvests are difficult to measure accurately, many Pacific islands countries rank among the highest in the world for the per capita consumption of fish with some atoll nations consuming up to 250 kg per year. Even the relatively urbanised and agricultural islands such as Fiji consume 45 kg per head annually.

Although these issues are introduced in the two chapters by John Munro and Semisi Fakahau following this introduction, they are topics that are revisited by the majority of contributors in subsequent chapters. These two chapters are concerned with research and monitoring programme design and implementation and the transfer of the results of these programmes to fisheries development personnel and resource managers. The introductory chapters lay the basis for the following chapters which are each dedicated to specific resource groups. As such, these chapters need little introduction. Each is presented in a similar format with sections reserved for discussion on the taxonomy of the resource,

its distribution, biology, including growth, trophic relations, reproductive biology and recruitment. Many chapters also discuss estimated current harvest levels throughout the region together with issues in resource management. The majority of chapters conclude with discussion of future research requirements and issues facing management and resource conservation.

Chapters 4 to 9 are devoted to finfish resources, with Chapter 9 dedicated to sharks, a resource largely neglected in discussions concerning fisheries research and management in the region. Chapter 4 compiled by Robert Moffit concentrates on the limited number of species of snappers and groupers which dominate the deepwater demersal fish catches around Pacific islands. These species have not been important in traditional, subsistence fisheries, but do show potential for tourist and export markets due to their high quality flesh.

Chapter 5 by Paul Dalzell reviews the biology and fisheries for small pelagic fishes in the South Pacific. Most existing information concerns the fisheries for small clupeoid species taken by supportive bait fisheries for pole-and-line tuna fishing. He notes the life spans of small pelagic fishes are typically short but can be grouped into those that live for less than one year, those that survive into a second year of life and those that live beyond two years of age. Recruitment of small pelagic fishes is also poorly understood but in some species appears related to environmental parameters such as rainfall.

Chapter 6 also concentrates on the small-size finfish component of the reef community, in particular those popular as ornamental marine fishes in aquariums. Richard Pyle notes that the vast majority of fishes entering the aquarium trade are wild-caught, and originate from tropical coral reefs in the Atlantic, Pacific, and Indian Oceans. Most coastal waters of tropical Pacific islands offer rich sources of fishes for the marine aquarium industry. In general, on a Pacific-wide scale, this fishery remains underdeveloped. This chapter includes a description of the marine aquarium fish collection and export industry in the Pacific, specifically with respect to member countries of the FFA. Information is provided concerning the ecology of the fishes involved, mechanics of the industry, environmental impact of collecting, management techniques, and possible avenues of research. Live marine invertebrates (such as corals, anemones, crustaceans, and others), although also in demand, do not presently form a substantial portion of the industry in the Pacific, and are discussed briefly in a section at the end of this chapter.

Robert Gillett and James Ianelli review the fisheries and biology of flyingfish in Chapter 7. Relatively little research on flyingfish has been carried out in the Pacific and as a result their contribution includes information from other areas. Based on current knowledge of the biology of the fish and geographical comparisons within the Pacific islands and between other areas of the world, they conclude that there is potential for the development of flyingfish fisheries in the Pacific islands. They note that flyingfish fisheries appear particularly

suited for small-scale fishermen because of the relatively low technology required and, in many cases, the proximity and apparent abundance of the resource.

The following chapter by Andrew Wright brings together many of the topics relating to tropical finfish biology presented in the preceding four chapters concentrating on the finfish species-groups that traditionally form the basis of subsistence fisheries in island communities. These groups of finfish now also form the target resource for developing commercial fisheries for local distribution and export; thus, in addition to promoting sustainable resource use strategies in general, competing interests in accessing these resources are becoming an increasingly important issue for resource managers. The chapter includes discussion of nearshore demersal species that move between coral-algae reef systems and adjacent seagrass and mangrove habitats, others that spend the majority of their life within the reef community and other groups considered more neritic pelagic in nature but which are regularly found in association with coral reef systems. In addition to methods that can be applied to the study of tropical finfish resources and discussion of various biological parameters, this chapter presents information on current estimates for fish harvests from reefs in the South Pacific region and issues that concern the development of appropriate approaches to management of this important resource.

Although of considerable economic importance, world catch statistics for sharks are generally patchy, and certainly incomplete. Available data presented in Chapter 9 by Paul Nichols indicate that the South Pacific area accounts for around 12 per cent of total recorded catches. Major commercial shark fisheries exist in Australia, New Zealand, West Coast of USA and to a lesser extent Papua New Guinea. Although there are few commercial fisheries that specifically target sharks in the Pacific islands countries, sharks are of considerable importance to subsistence fishermen in the Pacific islands both as a source of food and for the generation of cash income, principally through the sale of dried shark fins. Sharks also have an important role in the cultures and customs of many Pacific islands people. If current plans to commence transshipment operations of shark products from Asian longliners targeting tuna in the South Pacific are implemented, the oceanic shark resources in the region will be subject to increased fishing pressure in future years.

Harold Hirth provides a comprehensive discussion of the biology, distribution, exploitation and management considerations for six species and one subspecies of marine turtles in the South Pacific in Chapter 10. He recommends increased attention be paid to the value of education in programmes assisting the recovery of threatened marine turtle populations and the promotion of sustainable resource use practices.

Chapter 11 is the first of 10 chapters that discuss what have become known as "miscellaneous marine products" in the South Pacific region. Garry Preston

discusses the importance of *bêche-de-mer* in Pacific island economies noting that its use dates to at least the early days of European contact. Historical accounts describe visits to Northern Australia and Western Pacific locations by Malay vessels in search of *bêche-de-mer* in the late 1700s. The eastward expansion of the trade began in the first years of the nineteenth century. Although by European standards it was an insignificant industry conducted by a small number of ships, the *bêche-de-mer* trade in conjunction with whaling expeditions had enormous influence on the lives of Pacific Islanders in the first half of the nineteenth century. Garry notes that the quantity of *bêche-de-mer* produced in the Pacific, although not known with any accuracy, has probably never comprised a major part of world production. Nevertheless, in the last decade fishing operations targeting the *bêche-de-mer* resource have increased dramatically in the South Pacific region, raising concern that in many areas the resource has been exploited beyond sustainable levels.

Chapter 12 by Neil Sims is the first of four chapters dealing with molluscan resources in the region. Neil recognises their value to Pacific communities who traditionally applied shell to a range of uses including fishing lures, tools, currency and ornaments. More recently commercial fisheries first targeting the shell itself and more recently for the culture of pearls have developed across the region from Palau to French Polynesia. This chapter reviews the biology of the oysters mainly used for the production of pearls, *Pinctada margaritifera* and *P. maxima*. It reviews production estimates for a number of Pacific islands but concentrates mainly on farming issues in the husbandry of live shell for the production of pearls noting that with limited other resources on which to support economic development in the Pacific, given a suitable lagoon environment, pearl culture offers considerable development potential.

John Munro reviews the rapidly expanding literature on the eight species of giant clams in Chapter 13 drawing attention to the potential of giant clams to form the basis of successful village-based economic development initiatives. The biology of this animal, including physiology, pathology, genetics and the symbiotic relationship with the same algal species found in most reef-building corals, continues to attract considerable research attention. John reviews recent research and suggests areas that would benefit from further investigation.

Although trochus has been harvested since time immemorial for subsistence purposes, it is only since early this century that this tropical marine snail has been harvested commercially. In Chapter 14, Warwick Nash notes the susceptibility of trochus stocks to over-fishing. He suggests a number of reasons for this susceptibility including the narrow habitat preference of adults and juveniles on the seaward margin of coral reefs and the relative vulnerability of adult populations to simple fishing methods. Warwick reviews those aspects of the biology of trochus and other issues that are relevant to fishery management. He appraises the effectiveness of the various management measures (size limits,

total allowable catches, etc.) that may be used to ensure that trochus fisheries are sustained.

In the following chapter, Masashi Yamaguchi discusses a resource, which like trochus, is largely harvested for shell inlay in furniture or the production of buttons. The green snail is not an abundant resource in the South Pacific. However, despite its relative scarcity, increasing demand for pearl shell and the relative value of green snail compared with other pearl shell species for inlay work have resulted in green snail having the premium price. Masashi notes that until recently relatively little was understood about the biology and ecology of green snail. With success in rearing other molluscs such as trochus and giant clams in hatchery systems, researchers commenced aquaria-based investigations of the biology and ecology of green snail in the mid-1980s. As a result, scientists today have reasonable knowledge of the life history of this mollusc although information concerning growth, recruitment and mortality remains poorly documented. This chapter reviews available information concerning the biology, distribution and ecology of green snail. It includes an overview of the development of fisheries for green snail in the South Pacific and elsewhere and provides information on the volume and value of current exports of this shell from the region. Appropriate research strategies that could be developed to monitor fisheries for green snail in the South Pacific and possible management options that could ensure long term sustainable exploitation of the resource are discussed.

Chapter 16 by Michael King is the first of four chapters dealing with crustacean resources. Deepwater caridean shrimps have been caught in surveys using baited traps in depths between 200 m and 800 m off many tropical Pacific islands countries where the presence of shrimps belonging to the genus *Heterocarpus* has encouraged some interest in commercial exploitation. In addition to discussing available information on the biology of these animals, Michael notes that where fishing has been intensive, catch rates have dropped dramatically over short periods suggesting that deepwater shrimps may be particularly vulnerable to even moderate trapping, and that potential fisheries are likely to be small.

Roland Pitcher's chapter on spiny lobster notes two species of spiny lobster support significant fisheries in the tropical south-western Pacific. The double-spined lobster, *Panulirus penicillatus*, is the most widespread and most commonly fished lobster in the region and supports an annual harvest of about 150 to 300 t whole weight. The ornate spiny lobster, *Panulirus ornatus*, is found mainly on continental shelf areas of the larger islands and continents, particularly in north-eastern Australia and south-western Papua New Guinea, where annual harvests range from 450 to 1,100 t whole weight. Although discussion in Chapter 17 concentrates on these two species, the importance of other species is also noted. As mentioned previously, the lack of catch statistics limits the

production of an accurate estimate for the actual catch of spiny lobsters in the South Pacific. However, Roland estimates that the total Pacific catch comprises only about 7 per cent of the world lobster catch. In addition to reviewing available information relating to the biology of panulirid lobsters, Roland undertakes some re-analysis of previously published information and presents his conclusions in Chapter 17.

Chapter 18 is dedicated to mangrove crabs (Family Portunidae, Genus *Scylla*) which occur throughout the tropical to warm-temperate Indo-Pacific. Ian Brown estimates that within this region they form the basis of localised fisheries with a combined annual production of around 11,000 t. In addition to the uncertain taxonomic status of the *Scylla* complex, Ian discusses reproduction, feeding, and larval biology and growth. He notes that little work has been done on the population dynamics of mangrove crabs and that no information exists for the relationship between spawning stock size and recruitment, but it is commonly assumed that at typical exploitation rates environmental variability has a greater effect than egg production on recruitment. The chapter concludes with discussion of management measures generally applied with the objective of conserving the spawning stock (through minimum legal sizes and effort restriction), although it is noted that increasing emphasis is being given to conserving the species' habitat, in particular the estuarine mangrove forests.

Chapter 19 by Warwick Fletcher presents detailed information on the biology of the coconut crab *Birgus latro*, the largest land dwelling crustacean, which is distributed throughout the tropical Indo-Pacific region from Mauritius in the western Indian Ocean to the Tuamotu Archipelago in the eastern Pacific Ocean. Warwick notes that although the crabs are only common on island habitats and are generally found within a few kilometres of the coast in dense forest regions, their range within this area is reported to have declined significantly during this century due presumably to overexploitation. Of particular importance as far as management of exploitation of the resource is concerned are the relatively slow growth rate and late maturity of the crabs. Warwick estimates it takes 10 or more years for the crabs to reach a marketable size and their longevity may be in excess of 50 years. He notes that capture of the crabs is easy and their population density can be reduced very quickly and so recommends that a quota-based plan, allowing the harvest of 5 per cent per year of the current standing stock in a given area, be used to control the rate of exploitation, therefore reducing the chances of local extinction.

The final chapter by Robin South is concerned with an overview of the seaweeds and seaweed resources in the tropical Pacific region. He notes that the seaweed resources within this region are not well understood and their potential as a resource has been scarcely exploited despite the fact that human consumption of seaweeds within the region is widespread. The region's extensive coral reefs and lagoons characterized by slow to moderate currents, clear water, and

sandy or coralline bottoms provide ideal habitats for seaweed farming. Robin presents available information on the current activities aimed at promoting seaweed cultivation within each country in the region and briefly summarises global aspects of seaweed production with respect to production and markets.

NOTES

- 1 Member countries of the Forum Fisheries Agency are: Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, Vanuatu, and Western Samoa
- 2 Information collated from *South Pacific Economies: Pocket Statistical Summaries 1992*. South Pacific Commission, Noumea, New Caledonia; 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. 329 pp. and Doulman, D.J. (1987). Distant-water fleet operations and regional fisheries cooperation. In *The Development of the Tuna Industry in the Pacific Islands Region: An Analysis of Options*, (D.J. Doulman, ed.), pp.33-52. East-West Center, Honolulu, Hawaii. The areas estimated for the exclusive economic zones are currently being reviewed under the auspices of the Boundary Delimitation Project at FFA. The Project is revising previous estimates to provide accurate information for 200 mile, archipelagic and territorial sea boundaries. Negotiations and assistance with the development of legislation between countries with contiguous zones is also supported at FFA.

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