Pacific Regional Report On the Issues and Activities Associated with Coral Reefs and Related Ecosystems

Prepared by Andrew J. Smith
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South Pacific Regional Environment Programme (SPREP)

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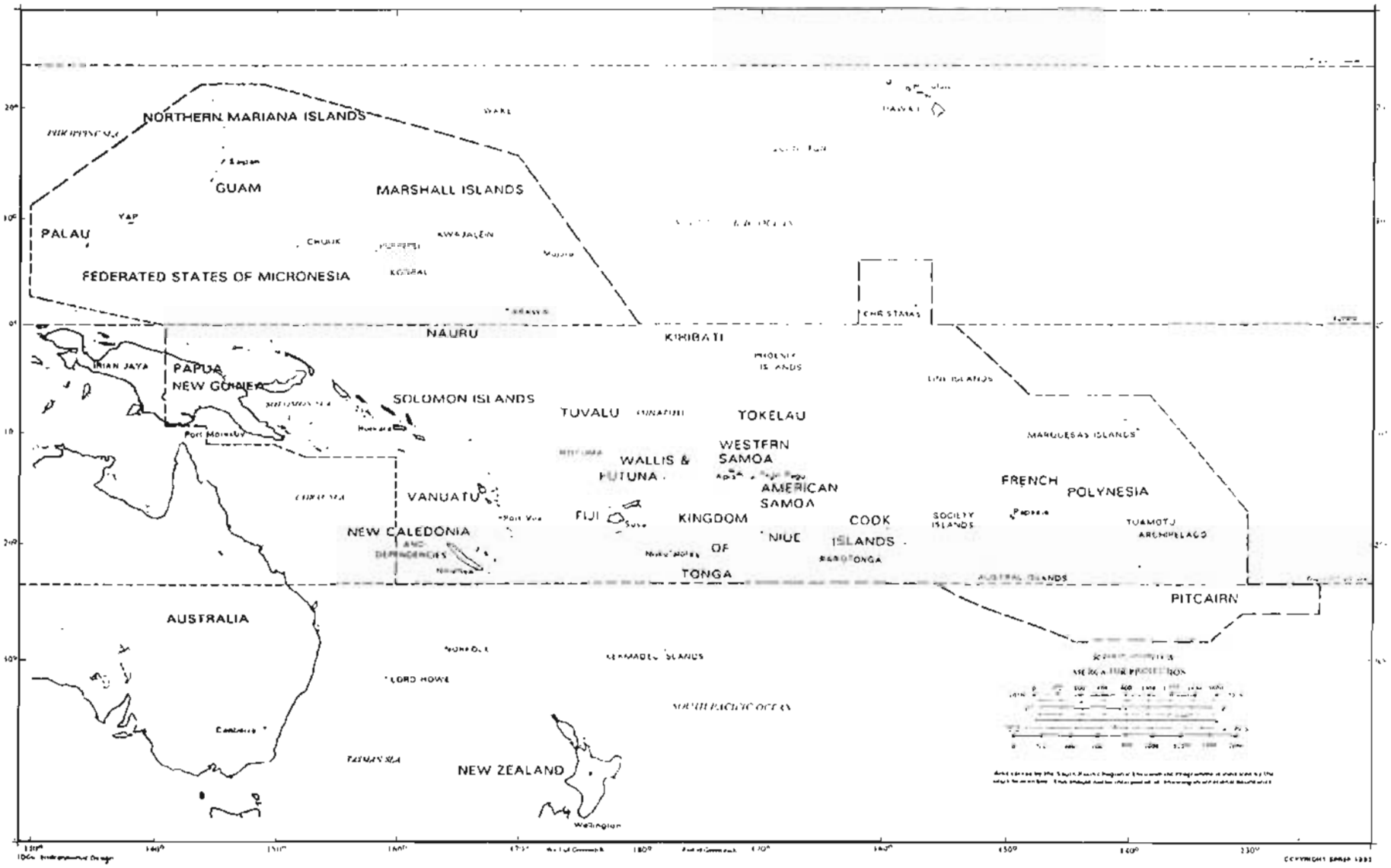

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Contents

Annexes

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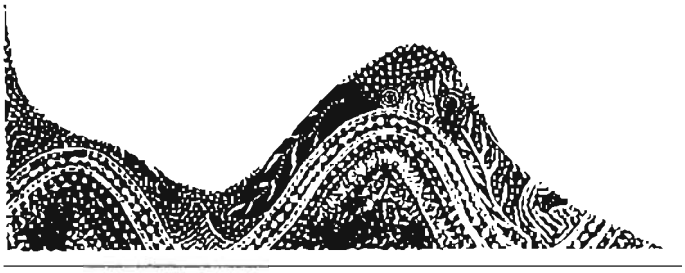
Acronyms

CLOD	Coralline Lethal Orange Disease
CNMI	Commonwealth of the Northern Mariana Islands
DEST	Department of the Environment, Sport and Territories (Australia)
EIA	Environmental Impact Assessment
EPHE	Ecole Pratique des Hautes Etudes (French Polynesia)
FFA	Forum Fisheries Agency
FSM	Federated States of Micronesia
GBR	Great Barrier Reef (Australia)
ICRI	International Coral Reef Initiative
ITSEE	Institut Territorial de la Statistique et des Etudes Economiques
IUCN	The World Conservation Union
NGO	non-government organisation
NMI	Northern Mariana Islands
NZ	New Zealand
ORSTOM	Institute Francais de Recherche Scientifique pour le Developpment en Cooperation
PBDC	Pacific Basin Development Council
PNG	Papua New Guinea
SOPAC	South Pacific Applied Geoscience Commission
SPC	South Pacific Commission
SPREP	South Pacific Regional Environment Programme
UNEP	United Nations Environment Programme
US/USA	United States of America
USP	University of the South Pacific

Executive Summary



Executive Summary

Coral reefs are one of the most important and extensive ecosystems within the Pacific region. When considered in conjunction with mangrove and seagrass systems, their importance to the well-being of the Pacific people and their island environments cannot be over-stated. They are a critical element of the complex and vulnerable tropical small island environment. The social, cultural and economic prosperity of the Pacific islands region has been, and will continue to be, directly dependent upon the health of coral reefs and associated ecosystems.

This regional report briefly outlines the major issues and priorities for coral reef conservation and management in the Pacific. The eastern Pacific coast and associated islands have been included in the regional report for the Inter-tropical Americas; Japan and China's Pacific coasts and associated islands are included in the East Asia regional report.

The Country Description section briefly describes the countries and territories of the region and the main issues affecting coral reefs and related ecosystems in those countries. An overview of the regional situation is then provided, identifying the major *regional* issues and the *regional* priorities for the next five to ten years. Annexes 1 to 6 summarise additional information for the region concerning the conservation and management of coral reefs and associated areas

The nature of the Pacific region, especially considering the number of small islands, means it is not possible to single out coral reef ecosystems, even including mangrove and seagrass systems, for separate conservation and management attention. The sectoral approach to environmental management within this region has been the predominant approach used in the past and has proven largely to be unsuccessful. Therefore, in this report, although the emphasis is on coral reefs and related ecosystems, reference is often made to the more broader environmental issues which must be taken into consideration and the essential integrated approach to their management and sustainable development.

Issues

The major issues for each country and territory are noted. The following have been identified as key issues affecting Pacific coral reefs and related ecosystems. Their importance varies throughout the region, but they exist in virtually all countries and territories to varying degrees. They are (in no particular order):

- Pollution from sewage, fertilisers, biocides, toxic wastes, oil spills, solid wastes, freshwater runoff and other land-based sources of pollution.

- Siltation due to soil erosion from inappropriately conducted land use practices (e g agriculture, forestry, mining, site clearance, road building).
- Over-exploitation of coral reef and mangrove resources (e g commercially valuable species such as beche-de-mer, giant clams, trochus, certain fish and shellfish, live coral harvesting for aquariums and tourist trade; mining coral heads for construction; subsistence fishing pressure)
- Destructive fishing and collecting methods (e g. poisons, explosives)
- Land reclamation (including mangrove and reef-flat destruction), inappropriate coastal protection works, and unsound mariculture practices
- Coastal and marine development projects (often internationally funded and driven) progressing without EIAs, or with inadequate or inaccurate EIAs
- Channel blasting and dredging activities (e.g. lagoon sand mining)
- Mining of beach and reef materials (e g beach sand)
- Coastal erosion and accretion
- Tourism activities and related developments
- Military testing, training and dumping (e.g nuclear testing, munitions disposal)
- Catastrophic events (e g tropical cyclones, volcanic eruptions, earthquakes, tsunamis, coral bleaching, crown-of-thorns starfish infestations, severe El Niño-Southern Oscillation (ENSO) events and possible climate change and sea level rise)

Priorities

The following are *regional* priorities, however, the implementation of any actions to address them will largely be at the *national* level, and the specific priorities will vary from location to location. The possibility of duplication of effort, and alternatively of leaving gaps, is always a prospect considering the number and varying capacities of governments within the region, and the range and variability of technical and financial assistance provided bilaterally and multilaterally to the region. The region does, however, have a history of being able to coordinate its activities, especially in the area of the environment.

Capacity Building

- Technical training, especially on survey and monitoring techniques, environmental impact assessment and management strategies.
- Education and awareness programmes on the benefits derived from healthy coral reefs and related ecosystems.
- Improved coordination and cooperation of activities and information exchange

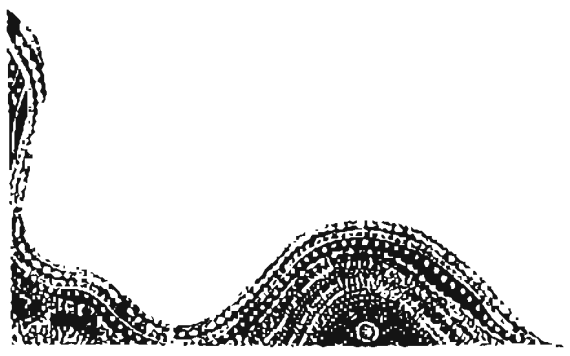
Research and Monitoring

- Acquisition of baseline information on the status of coral reefs and mangroves within the region, especially through rapid assessment techniques for remote areas.
- Monitoring of coral reefs and related ecosystems to detect disturbances due to natural and/or anthropogenic stresses; such monitoring should also include coastal stability and sediment budgets
- Adoption of basic survey and monitoring methods and standards, integrating regional monitoring activities into the Global Coral Reef Monitoring Network when it is operational
- Applied research into reef management, conservation and sustainable use options, e.g. reef fisheries management, marine protected area siting and design, local tenure and use rights.

Management

- Adoption of Integrated Coastal Management appropriate to Pacific islands circumstances.
- Adoption of Environmental Impact Assessment procedures and post-construction monitoring for all development activities.
- Establishment of effective marine conservation and protected areas.
- Control of marine pollution from land based sources

Pacific Regional Report On the Issues and Activities Associated with Coral Reefs and Related Ecosystems



Pacific Region Report on the

Issues and Activities Associated with Coral Reefs and Related Ecosystems

Introduction

The coral reef ecosystems are one of the most important and extensive found within the Pacific region. When considered in conjunction with mangrove and seagrass systems, their importance to the well-being of the Pacific people and their island environments cannot be over-stated. Without reefs, many atoll countries and most tourist beaches in the Pacific region would not exist. Coral reefs constitute the primary coastal protection structures on most tropical small islands and provide the sand for the construction of atoll islets and beaches. Perhaps of more importance is their role as sources of subsistence food resources, reservoirs of high biodiversity and environmental health indicators. The social, cultural and economic prosperity of the Pacific islands region has been, and will continue to be, directly dependent upon the health of coral reefs and associated ecosystems.

This regional report briefly outlines the major issues and priorities for coral reef conservation and management in the Pacific region (Figure 1). The eastern Pacific coast and associated islands have been included in the regional report for the Inter-tropical Americas; Japan and China's Pacific coasts and associated islands are included in the East Asia regional report.

The following section briefly describes the countries and territories of the region and the main issues affecting coral reefs and related ecosystems in those countries. This is followed by an overview of the regional situation, identifying the major *regional* issues and the *regional* priorities for the next five to ten years. Annexes 1 to 6 summarise additional information for the region concerning the conservation and management of coral reefs and associated areas.

The nature of the Pacific region (especially when one considers the number of small islands involved)[1] means it is not possible to single out coral reef ecosystems - even including mangrove and seagrass systems - for separate conservation and management attention. Predominantly the sectoral approach to environmental management has been employed within this region in the past and has proven to be unsuccessful. Therefore, in this report, even though the emphasis is on coral reefs and related ecosystems, reference is often made to the broader environmental and resource issues, and to the essential integrated approach required for their management and sustainable development.

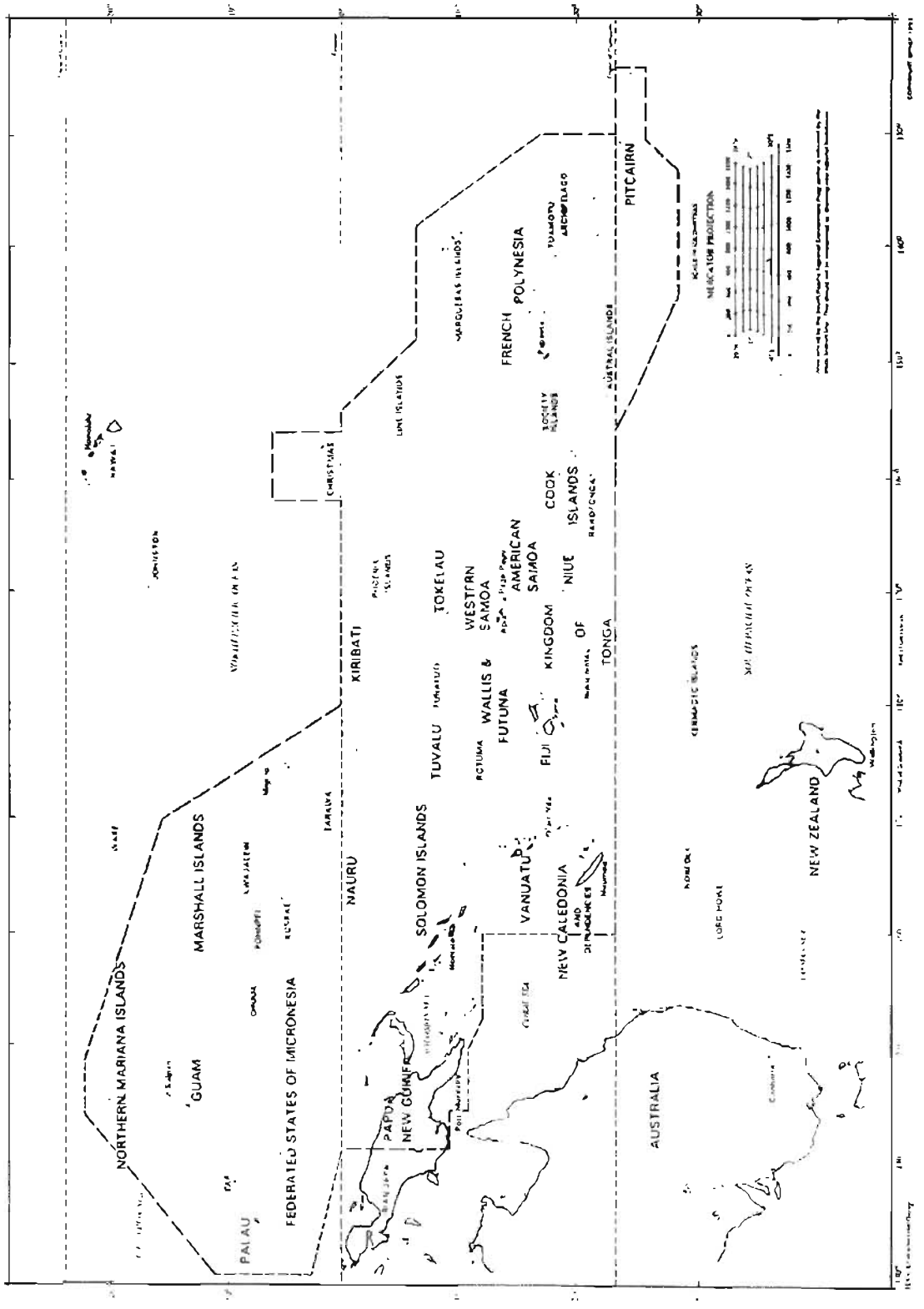
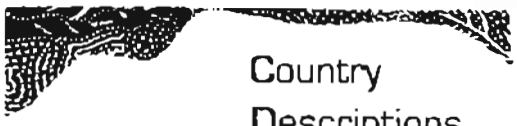


Figure 1
The Pacific Region and the Area Served by the South Pacific Regional Environment Programme



Country Descriptions

The following country and territory descriptions were compiled primarily from UNEP/IUCN (1988), Maragos and Holthus (1996), Scott (1993) and review comments on the draft presented at the ICRI Workshop. For each country or territory a brief description of the coral reef, mangrove and seagrass environments are given, followed by the key issues affecting those areas. Some *Additional references* have been included where appropriate as well as extra information summarised in Annexes 1, 2, 3 and 4.

American Samoa

American Samoa with a total population in 1991 of 49,000 is an unincorporated territory of the USA, consists of five volcanic islands, together with Swains and Rose atolls (UNEP/IUCN 1988). Fringing reefs predominate on the southern coasts of Tutuila, Ofu and Olosega, the west coasts of Aunu'u and Olosega, and the northern coasts of Ta'u, only apron reefs or reef communities occur elsewhere (Maragos and Holthus 1996). With the exception of Swains Atoll and Ta'u all reefs in American Samoa were recently surveyed (Green in prep). Results indicate the reefs to be in poor condition on the main island of Tutuila, but healthy on the three islands of the Manu'a Group (Ofu, Olesega and Ta'u) and at Rose Atoll (Maragos 1994b, Maragos and Holthus 1996, Green in prep). Birkeland (pers comm 1995) reported Coralline Lethal Orange Disease (CLOD) in American Samoa during a recent survey, but was absent during previous surveys. American Samoa is the easterly limit of mangrove distribution in the Pacific (Ellison 1995). Mangrove swamps occur on Tutuila and Aunu'u.

Between 1961 and 1991 there has been a total decrease in wetlands by approximately 77 per cent, from 2.43 km^2 to 1.87 km^2 (approximately 40 per cent of the 1991 wetland figure were mangroves) (Biosystems Analysis 1992).

Additional references: corals - Dahl & Lamberts (1977), Birkeland *et al.* (1987, 1991), Birkeland & Randall (1979), Craig *et al.* (1995) and Craig (1995); mangroves - Cole *et al.* (1988).

Major issues affecting coral reefs and associated environments (Sources: PBDC 1994, Scott 1993; UNEP/IUCN 1988):

- Non-point source pollution (sedimentation, nutrient enrichment, contaminated stormwater, marine debris) affects water quality and reef health
- Chemical pollution from oil and hazardous materials spills.
- Solid waste disposal in coastal areas.
- Population growth causing stress from over-fishing and non-point source pollution (e.g. poor land use practices)
- Extensive damage to reefs from three major cyclones/hurricanes (last 3 years) and crown-of-thorns starfish infestations (late 1970s).
- Inadequate enforcement of fisheries management regulations, education against over-fishing and harmful fishing techniques, and data collection.
- Massive coral bleaching episode in 1994
- Mangrove clearing and manual collection of sand

Australia (Eastern)

The largest area of coral reefs of any nation is found in Australia which also contains the largest coral reef complex, the Great Barrier Reef (GBR), with some 2900 major

[1] See the Barbados Conference's Programme of Action for the Sustainable Development of Small Island Developing States (UN 1994)

reefs. Major areas of coral reefs are also present in Torres Strait and the Coral Sea Territories and around Lord Howe Island, Elizabeth and Middleton Reefs Extensive mangrove and seagrass beds occur along Australia's east coast and into the Torres Strait with 3,900 km^2 of mangrove and 4,300 km^2 of seagrass on the GBR.

Coral reefs are relatively well represented in the marine protected areas of Australia. There are also significant areas of protection for reefs found in other areas. however management is often restricted not only by their great size and remoteness. but also through lack of financial resources. Australia's coral reefs are relatively unaffected by human activities due to their remoteness. but elevated nutrients and sediments resulting from inland soil erosion are a threat in non-arid regions (Zann 1995)

Major issues affecting coral reefs and associated environments (Sources R. Kenchington pers. comm 1995. DEST pers comm. 1995):

General:

- Effects of sediments and nutrients.
- Effects of fishing and tourism.
- Threats of oil spills.

Specific threats:

- Elevated nutrients in the inner GBR
- Outbreaks of crown-of-thorns starfish in the outer central and northern GBR and Tasman reefs
- Damage from the passage of tropical cyclones.

Cook Islands

The Cook Islands are self-governing with a population in 1991 of 18,552, all citizens of New Zealand (Rongo 1993). consists of one high volcanic island (Rarotonga). one almost-atoll (Aitutaki), four raised islands (Mangaia, Mauke, Mitiaro, Atiu), two sand clay islands (Nassau, Takutea) and seven atolls (Suwarrow, Penrhyn, Pukapuka, Manihiki, Rakahanga, Palmerston and Manuae) (A. Tiraa-Passfield pers. comm. 1995) Mangroves and seagrasses are absent throughout the Cook Islands (UNEP/IUCN 1988).

Cook Islands reefs have been periodically affected by cyclones and crown-of-thorn starfish infestations (UNEP/IUCN 1988). With the exception of Rarotonga and parts of Aitutaki. most reefs in the Cook Islands are reported to be in good condition. although soil erosion resulting from pineapple cultivation has occurred on Mangaia and Atiu (UNEP/IUCN 1988) Reefs around Rarotonga are recorded as being in an advanced stage of degradation due to anthropogenic stresses These stresses include increased organic and nutrient levels. the deposit of acidic soil through siltation. reclamation and land fill. chemical leakages into the coastal environment. coastal construction; coral and sand mining. destructive fishing practices and over-fishing (Rongo 1993; UNEP/IUCN 1988) Coralline Lethal Orange Disease (CLOD) was observed at Rarotonga and Aitutaki (Littler & Littler 1995).

Additional references. Andrews (1987). Baronie (1995). Dahl (1980). Devaney & Randall (1973). Miller *et al* (1994). Paulay (1985. 1994) and Stoddart (1972. 1975)

Major issues affecting coral reefs and associated environments (Sources. Rongo 1993. SPREP 1993a: A Tiraa-Passfield pers comm 1995):

> Waste management - an issue common to all islands. but especially Rarotonga is liquid and solid waste disposal. such as garbage and sewage disposal. nutrients and chemicals from agriculture (fertilisers. biocides) and oil spills.

- Land use problems resulting in soil and coastal erosion.
- Coastal degradation due to mining for sand and coral aggregate
- The use of destructive fishing practices
- Damage to corals by anchoring boats.
- Deepening of harbours by dredging.
- Development of foreshore areas
- Lack of environmental awareness in general, and of coral reefs in particular
- Tropical cyclones, climate change and possible sea-level rise.

Federated States of Micronesia

The Federated States of Micronesia (FSM) with a total population in 1990 of 111,600, consists of the four states of Yap, Chuuk, Pohnpei and Kosrae. They are self-governing with a Compact of Free Association with the USA (UNEP/IUCN 1988, Maragos and Holthus 1996). FSM has four groups of volcanic islands (the population centres of Kosrae, Pohnpei, Chuuk and Yap), 31 atolls and seven coral islets (Maragos and Holthus 1996). Barrier reefs surround the high volcanic islands in Chuuk and Pohnpei lagoons, with wide fringing reefs surrounding the volcanic islands of Yap and Kosrae (Maragos and Holthus 1996). In FSM 65 per cent of the mangrove area occurs on Pohnpei (5,525 ha), with 1562 ha on Kosrae and 1171 ha on Yap (Scott 1993, in Ellison 1996). Mangrove stands also occur on the high islands in Chuuk lagoon, and some very limited stands on a few atolls (Ulithi, Elato, Pingelap) (UNEP/IUCN 1988). Seagrasses are found throughout the FSM (Gawel 1993).

Maragos and Holthus (1996) noted the main threats to coral reefs included urban pollution (sewage, garbage disposal and over fishing) which are concentrated near the state government centres, which are located on the high islands. Coastal construction projects including roadways, ports and airfields have compounded damage to many coral reefs and associated environments (Maragos 1993). Fishing with dynamite is a serious problem in Chuuk lagoon, while on the remote atoll reefs, the poaching of giant clams, reef fish, sea turtles and other desired species has been a problem (Maragos and Holthus 1996). FSM is also becoming a popular tourist and sport diver destination (Maragos and Holthus 1996) which may cause problems in the future if it is not controlled.

Additional references: corals - Eldredge *et al.* (1979), mangroves - Fosberg (1947, 1975), Falanruw *et al.* (1987a, 1987b), MacLean *et al.* (1986), Pettys *et al.* (1986); seagrasses - Tsuda *et al.* (1977).

Major issues affecting coral reefs and associated environments (Sources: Gawel 1993, SPREP 1993b; Maragos 1993)

- Clearing and filling of mangrove areas for development, commercial and subsistence uses
- Siltation and erosion from poor land use planning and practices
- Shoreline damage from sand and gravel dredging
- Land and marine based sources of pollution (solid and liquid waste disposal, hazardous waste disposal; water quality).
- Over-harvesting of marine resources around urban centres and the use of destructive fishing methods
- Lack of development controls and coordinated planning.
- Tropical cyclones, climate change and possible sea-level rise
- Short and long term effects from vessel groundings and related fuel leaks.
- Inappropriate coastal protection measures and structures

Fiji

Fiji with a population in 1991 of 760,000 (UNEP/IUCN 1988, Margos and Holthus 1996) consists of about 844 islands with the volcanic islands of Viti Levu and Vanua Levu accounting for 87 per cent of the main archipelago; other large islands include Taveuni, Kadavu and Gau (UNEP/IUCN 1988). The complex reef systems include two types of barrier reefs, fringing and platform reefs (UNEP/IUCN 1988). Maragos and Holthus (1996) noted that at least 22 barrier reef and three atoll reef systems occur within Fiji's complex reef systems. The area of mangroves in Fiji is inadequately known, but various reports estimate the area to be between 19,700 ha and 49,777 ha. At present, the widely accepted estimate is an area approximately 42,000 ha out of an original 45,000 ha (Watling & Chape 1992) Mangrove distribution is irregular, with the largest stands occurring at the mouths of the larger rivers (Watling & Chape 1992) There are reportedly a large scattering of seagrass beds occupying relatively small areas (Watling & Chape 1992). There are approximately 450 species of benthic macro-algae in Fiji, and it is estimated that less than 50 per cent of the flora has been described. Of these, approximately 40 species of reef-binding crustose coralline algae have been identified (South & Kasahara 1992). Coralline Lethal Orange Disease (CLOD) was reported from the Great Astrolabe Reef during surveys in 1993 and 1994, but was absent in 1992 (Littler & Littler 1995)

Additional references, corals - Morrison & Naqasima (1992), Ryland (1979, 1981), Zann (1994), mangroves - Watling (1985, 1986), Nedwell (1974), Lal *et al.* (1983), Pillai (1987).

Major issues affecting coral reefs and associated environments (Sources: Watling and Chape 1992; UNEP/IUCN 1988, Maragos and Holthus 1996):

- Tropical cyclones causing freshwater inundation, mud slides and mechanical damage.
- Erosion and siltation from logging and agricultural activities.
- Potential danger from the disposal of mining tailings.
- Sand and coral mining for construction materials and other dredging activities - these have also damaged or destroyed seagrass beds.
- Coral harvesting for the curio, medical and aquarium trades.
- Extraction of live coral rock for use in septic systems.
- Over-exploitation of some marine resources around urban centres.
- Use of destructive fishing methods (explosives and poisons)
- Pollution and waste disposal problems, especially in and adjacent to the expanding urban areas.
- Inappropriate coastal protection and construction (jetties, channels through reefs)
- Depletion of mangrove areas through urban growth, tourist developments and drainage schemes

French Polynesia

French Polynesia with an estimated population in 1994 of 212,000, is a territory of France consisting of five archipelagos, the Society, Tuamotu, Gambier, Marquesas and Austral islands. The territory has an internal autonomy status which permits it to deal with environmental matters (T Vallaux pers comm 1995) There are approximately 120 islands, 85 of which are atolls, the remainder are high volcanic islands (B. Salvat pers. comm. 1995).

French Polynesia has an EEZ of 5,500,000 km^2; 3,500 km^2 of land, and lagoon areas totalling 12,800 km^2 (T Vallaux pers comm 1995) The Marquesas are the only volcanic islands not surrounded by uninterrupted fringing or barrier reefs The Society archipelago (with 70 per cent of the population) is also volcanic and support well developed barrier reefs. It consists of 14 islands split into two groups the windward islands (Tahiti, Moorea, Maiao, Mehetia and Teiaroa Atoll), and the leeward islands (Hauhine, Raiatea, Tahaa, Bora-Bora, Maupiti, and four atolls, Tupai, Mopelia, Scilly and Bellinghausen) The Austral islands (high volcanic and limestone) and Gambier islands (high volcanic) support a mixture of fringing, barrier and atoll reef types (Maragos and Holthus 1996) The Tuamotu form the largest group of atolls (80) in the world, 41 of which are uninhabited Pearl oyster farming is well developed in many of the Tuamotu atoll lagoons The Tiahura reef complex in Moorea is one of the best studied in the Pacific with 25 years of research and over 300 publications, due to the presence of the EPHE Research Centre (OFAI 1995) With the exception of some introductions of mangroves to Moorea, Tahiti and other Society islands, no natural mangrove stands exist in French Polynesia

Additional references Adjeroud *et al* (1994), Aubanel & Salvat (1990), Aubanel *et al.* (1991), Bagnis (1991), Chauvet (1990), Egretaud *et al* (1995), Fagerstrom & Rougerie (1994), Gabrié (1994, 1995a), Galzin *et al.* (1993), Hutchings *et al* (1994), Jardin (1994), Marquet (1994), ORSTOM (1993), Payri *et al* (1994), Salvat (1990, 1991, 1992), Tatarata & Salvat (1995)

Major issues affecting coral reefs and associated environments (Sources: UNEP/IUCN 1988; Maragos and Holthus 1996; Hoegh-Guldberg 1994; B. Salvat pers. comm. 1995; T. Vallaux pers. comm. 1995):

- Coral bleaching episodes in 1991 and 1994
- Population pressures in the Society Islands, especially Tahiti (with one third of the total French Polynesian population), affecting reefs and reef resources
- Coral dredging, filling, and sand mining for construction, especially in the past
- Sewage and other waste disposal (domestic and industrial)
- Soil erosion from agriculture, clearing for development and other land based sources producing sedimentation on reefs and in the lagoons
- Effects from increasing recreational and tourist activities.
- Over-exploitation of some marine resources
- Intensive use of some lagoon areas for fishing, pearl farming and tourism, resulting in resource use conflicts
- Nuclear testing on Mururoa and Fangataufa atolls (Tuamotu) in the atmosphere from 1965-1974 and underground since then.
- Tropical cyclones, climate change and possible sea-level rise

Guam

Guam with a population in 1990 of 133,152 is an unincorporated territory of the USA It is the largest island in Micronesia and is composed of raised limestone and old deeply weathered volcanoes (UNEP/IUCN 1988) Most of the reefs are fringing reefs, but there are also two barrier reef lagoons (UNEP/IUCN 1988). Patch reefs and submerged reefs occur in Apra Habor and off north west Guam (R. Richmond pers. comm. 1995). Periodic bleaching has also occurred on Guam reefs (R. Richmond pers. comm.

1995) CLOD infestations reported in September 1995 (C. Birkeland pers. comm. 1995) The most extensive mangrove communities are found in Apra Harbor, although the area has undergone extensive modification due to dredging and construction (UNEP/IUCN 1988). Seagrass beds occur around Guam.

Additional references: corals - Randall & Holloman (1974), Easton *et al* (1978), Randall & Eldredge (1976), Richmond (1993a & b).

Major issues affecting coral reefs and associated environments (Sources: UNEP/IUCN 1988; Maragos and Holthus 1996; PBDC 1994. R. Richmond pers comm. 1995):

- Soil erosion and sedimentation caused by military, resort and residential developments.
- Eutrophication from terrigenous runoff and sewage discharge.
- Tourism growth is increasing pressure on certain reef areas.
- Frequent and severe tropical cyclones.
- Over-harvesting and over-fishing.
- Physical damage from maritime/boating activities and military mooring activities.
- Thermal effluent from power plant discharge.

Hawaii

The Hawaiian archipelago with a population in 1990 of 1,200,000 is a State of the USA Maragos and Holthus (1996) noted that its extreme geographic isolation, marginal tropical climate, and exposure to open seas and heavy wave action from all directions, have all contributed to limit coral reef growth. Optimal coral growth are found on steep slopes in deeper water, along protected coastlines or within shallow embayments (Maragos and Holthus 1996).

Despite their low diversity, Hawaii's reefs are fairly well developed (UNEP/IUCN 1988). Mangroves are not native to Hawaii, they were intentionally introduced at the turn of the century, and are now rapidly spreading throughout the islands (Ellison 1996).

Major issues affecting coral reefs and associated environments (Sources: PBDC 1994; UNEP/IUCN 1988; Maragos and Holthus 1996):

- Stresses from high population levels in the main islands
- Siltation and erosion from land clearing, agriculture and construction
- Sewage discharge as well as non-point sources of pollution.
- Dredging, blasting, construction of piers, harbours, maintenance work and construction of outfall systems.
- Military related construction of ports, airfields, roads, navigation channels
- Over-fishing of reef areas and over-development for recreational purposes.

Kiribati

The Republic of Kiribati with a total population in 1991 of 73,500 (UNEP/IUCN 1988, Maragos and Holthus 1996), consists of all the islands of the Gilbert and Phoenix groups, eight of the eleven Line islands and Banaba Island The entire group consists of low coral islets resting on atoll and table reefs, except for Banaba which is a high limestone island (Maragos and Holthus 1996). Wilson (1994) notes that mangroves are limited in area with approximately 53 km² of mangroves colonising the shorelines of the Gilbert Group, the more extensive stands occurring on Butaritari. Seagrass beds are found on many of the islands of Kiribati (Wilson 1994). Relatively little information is available concerning the reefs, mangroves and seagrasses of Kiribati.

Additional references: corals - Bolton (1982), Chave & Kay (1974), Guinther *et al* (1992), Forbes & Hosoi (1995); mangroves - Fosberg (1975)

Major issues affecting coral reefs and associated environments (Sources: Wilson 1994, UNEP/IUCN 1988, Maragos and Holthus 1996)

- Water quality affected by sewage disposal in Tarawa
- Solid waste disposal is a major problem on all the populated islands
- Excessive crowding on south Tarawa Atoll and associated public health sanitation risks
- Toxic and hazardous chemicals usage and disposal
- Coastal erosion problems are widespread; the associated sediment movements are directly affecting coral reefs
- Causeway construction between islets within atolls has had a noticeable negative affect on mangroves, water flushing (water quality) and marine resources (fish migrations)
- Boat channel construction through reef blasting
- Beach mining and reef flat excavation of borrow pits
- Over-fishing and harvesting (turtles, giant clams)
- Past phosphate mining and associated activities on Banaba Island has affected reefs.
- Climate change and possible sea-level rise.

Marshall Islands

The Republic of the Marshall Islands with a total populationin 1991 of 48,000 consists of 29 coral atolls and five low coral islands. They are self-governing with a Compact of Free Association with the USA (UNEP/IUCN 1988, Maragos and Holthus 1996). Two-thirds of the population live on Majro (Majuro) Atoll and Ebeye Island on Kuwajleen (Kwajalein) Atoll. Mangrove vegetation has a restricted distribution, they are poorly developed with impoverished stands on some of the southern (wettest) islands, while in the northern areas they are found in "mangrove depressions" inland (Scott 1993). Seagrasses are rare in the Marshall Islands, with limited beds on Ujlan (Ujelang), Aelonlaplap (Ailinglaplap), Majro and Kuwajleen atolls (Scott 1993, SPREP 1993c).

Additional references: corals - Thomas *et al* (1989), Agegian *et al* (1987), Lamberts & Maragos (1989), Maragos (1994a); mangroves - Woodroffe (1987), other - Devaney *et al* (1987).

Major issues affecting coral reefs and associated environments (Sources: SPREP 1993c, Maragos and Holthus 1996):

- Residual damage to reefs from nuclear testing.
- Sand and rock mining from lagoons and reef flats
- Shoreline protection works, blasting, dredging and filling activities, and causeway construction
- Sewage discharges into the lagoons at the crowded urban centres on Majro and Ebeye
- Solid, toxic and hazardous waste storage and disposal
- Over-fishing around the heavily populated atolls
- Tropical cyclones, climate change and possible sea-level rise

Nauru

The Republic of Nauru with a population in 1992 of 9,919 consists of a single raised coral limestone island with a narrow but continuous fringing reef encircling the entire island (Maragos and Holthus 1996).

UNEP/IUCN (1988) notes that little or no coral growth occurs on the reef flat, although rich growth occurs in deeper water Nauru has been heavily mined for phosphate. A small patch of mangroves, probably less than 2 ha, exists on the northeast coast (Scott 1993).

Major issues affecting coral reefs and associated environments (Sources: Maragos and Holthus 1996; UNEP/IUCN 1988):

- Damage from heavy wave action due to the almost vertical reef slope.
- Filling of coastal areas for residential development.

New Caledonia

New Caledonia with a population in 1989 of 164,173 and estimated to be approximately 180,000 in 1994 (ITSEE), is a territory of France. Grande Terre is the largest island (high, volcanic) with 88 per cent of the land area (ORSTOM 1981) It is mostly encircled by a lagoon/barrier reef system second in size only to Australia's Great Barrier Reef (Maragos and Holthus 1996). The Loyalty Islands form a parallel chain to the northeast of Grande Terre, and a submerged reef and one complex of atoll-like reefs occur to the west (ORSTOM 1981, Maragos and Holthus 1996). The total area of mangroves has been estimated at 20,250 ha, mostly located on the west coast of Grande Terre (Scott 1993) A considerable amount of work has been carried out on New Caledonia's lagoon ecosystem and mangroves, particularly in the south western lagoon and around Noumea, the main urban centre

Additional references: Gabrie (1995b), Fromaget & Richier de Forges (1992); corals - Holthus (1995a), Joannot *et al.* (1983), Thomassin & Vasseur (1982); benthos - Chardy *et al.* (1987); mangroves and seagrasses - Garrigue (1987), Thollot (1987), Holthus (1995b)

Major issues affecting coral reefs and associated environments (Sources: Maragos and Holthus 1996; UNEP/IUCN 1988; R. Farman pers. comm. 1995):

- Soil erosion resulting in sedimentation.
- Nickel mine tailings discharge.
- Urban and some industrial pollution.
- In-filling of mangrove swamps and other ecosystems around Noumea for development purposes

Niue

Niue with a population in 1991 of 2,239 is an isolated small high limestone island and is a self-governing territory of New Zealand (Lane 1994, UNEP/IUCN 1988) There is no true reef and no lagoon. There is a thin discontinuous veneer of living corals in the intertidal area and a rich coral growth in the sub-tidal waters (UNEP/IUCN 1988) Little is known of Antiope and Harran's reefs and only a limited assessment has been made of Beveridge Reef, all of which are in Niue's territory (Lane 1994) Ellison (1995) lists one mangrove species for Niue No seagrasses occur on Niue

Major issues affecting coral reefs and associated environments (Sources: Lane 1994, UNEP/IUCN 1988)

- Increased potential to over-harvest inshore marine resources
- Waste oil, and toxic and hazardous chemicals disposal
- Reef blasting

Northern Mariana Islands

The Commonwealth of the Northern Mariana Islands (CNMI) had a population of 17,600 in 1981 (UNEP/IUCN 1988), and is a sovereign territory of the USA. It is comprised of 14 of the 15 Mariana islands, the separate US territory of Guam

being the other Saipan and Tinian have small barrier reefs with shallow lagoons along part of their western coasts, while some of these islands, as well as Maug and Rota, are surrounded by fringing reefs (Maragos and Holthus 1996, UNEP/IUCN 1988). The other northerly islands only support reef communities therefore structural reefs are absent (Maragos and Holthus 1996) There are a few small stands of mangroves on Saipan which may have been more extensive in the past (Scott 1993) Seagrass beds exist in the lagoon areas on the west coast of Saipan (UNEP/IUCN 1988)

Additional references include Eldredge *et al* (1977), Eldredge & Randall (1980) and Randall (1995)

Major issues affecting coral reefs and associated environments (Sources PBDC 1994 Maragos and Holthus 1996, UNEP/IUCN 1988)

- Soil erosion resulting sedimentation, especially on Saipan
- Over-harvesting and over-fishing on Saipan Tinian and Rota
- Effects of construction, dredging and filling on the urbanised islands especially related to tourist developments
- Non-point source pollution, especially related port and harbour developments
- Liquid and solid waste disposal problems
- Increased recreational and tourist activities on the reefs.

Palau

The Republic of Palau with a population in 1991 of 15,600 in 1991 (UNEP/IUCN 1988; Maragos and Holthus 1996), is self-governing with a Compact of Free Association with the USA. It consists of about 22 groups of high volcanic and limestone islands and low coral islands An extensive barrier reef partly encircles the main group of islands including two atolls and one submerged atoll reef lie to the north, and one high limestone island, one atoll, and 5 low coral islands on table reefs lie up to 600 km to the south of the main group (Maragos and Holthus 1996, Otobed & Maiava 1994) Fringing reefs occur around many islands in the lagoon as well as over 1,300 patch and pinnacle reefs (Maragos and Holthus 1996). Palau is well known for its 400 rock islands, which are small undercut, uplifted reefs, in the lagoon (Maragos and Holthus 1996) Based upon available information, Palau is considered to have possibly the richest reefs in the Pacific with the highest count of species diversity (UNEP/IUCN 1988) Extensive mangrove stands exist around Babeldaob (4,025 ha, covering all but 32 km of the island's 157 km coastline), and to a lesser extent around Koror, Peliliu and some of the smaller offshore islands, for a total of 4,708 ha (Scott 1993) Seagrasses are found throughout the islands including major beds off northeast Peliliu, the rock islands south of Koror, and most coasts of Babeldaob

Additional references Maragos & Cook (in press), Maragos *et al* 1994

Major issues affecting coral reefs and associated environments (Sources Otobed & Maiava 1994, Maragos and Holthus 1996, UNEP/IUCN 1988)

- Tourism related development and activities
- Tropical cyclones.
- Reefs around the urban centre are affected by pollution, over-fishing, sewage disposal and leachates from waste disposal
- Sedimentation from earth moving activities associated with construction.
- Dredge and filling for dock development and lagoon dredging for construction materials
- Mangrove clearing and filling

- Pollution from increased shipping (oil, waste dumping).
- Road construction on Babeldaob.
- Commercial harvest of selected food and aquarium fish species

Papua New Guinea

Papua New Guinea (PNG) with a population in 1992 (UNEP/IUCN 1988) of 3,670,000. It consists of the eastern half of the island of New Guinea and includes all the islands making up Milne Bay Province, the Bismark Archipelago and the northern part of the Solomon Island archipelago (Bouganville and Buka) Maragos and Holthus (1996) note that PNG consists of thousands of islands and reefs unstudied by marine scientists, the great majority being fringing and barrier reefs, but also supports the second largest number of atolls (over 40) in the region (after French Polynesia) PNG probably will rank near the top of the Pacific in terms of coral and reef diversity, once sufficient information becomes available (J Maragos pers comm, 1995) CLOD reported from surveys in 1994 (Littler & Littler 1995). Mangrove swamps occupy large parts of the coastal areas, with the largest areas in the south - the Gulf of Papua - has between 162,000 and 200,000 ha of mangroves (Scott 1993) There are extensive seagrass beds in PNG (UNEP/IUCN 1988).

Additional references. corals - Kojis *et al* (1984, 1985), Huber (1994); mangroves - Cragg (1987); other - Agardy & Pernetta (1993)

Major issues affecting coral reefs and associated environments (Sources, Maragos and Holthus 1996; UNEP/IUCN 1988):

- Natural stresses from tropical cyclones, earthquakes, volcanism (e.g. 1994 eruption at Rabaul), crown-of-thorns starfish and freshwater runoff
- Localised effects from soil erosion due to mining and logging, and tailings discharges
- Around urban centres pollution from sewage discharge, waste disposal, and industry.
- Over-harvesting and over-fishing around urban centres

Pitcairn Islands

The Pitcairn Islands with a population in 1993 of 53 are an dependent territory of the UK and comprises Pitcairn Island, and uninhabited Oeno, Henderson and Ducie islands (UNEP/IUCN 1988, Scott 1993) Pitcairn is a high volcanic island with lava cliffs and poorly developed reefs. Oeno and Ducie are low coral atolls, and Henderson, the largest island, is a raised limestone atoll with fringing reefs on the north, northwest and northeast sides (Scott 1993, UNEP/IUCN 1988). Corals are found from the intertidal area in pools to deeper depths (R Richmond pers comm 1995), otherwise the marine environments of the Pitcairn islands are poorly known. The main interest in the coral reefs is their isolation and location at the southeastern geographic limit of reef growth (Scott 1993) The islands are too far east for naturally occurring mangroves

Major issues affecting coral reefs and associated environments (Sources, UNEP/IUCN 1988):

- A mass mortality of corals at Ducie Atoll recorded in 1970.

Solomon Islands

The Solomon Islands, with a population of 285,176 in 1986, consists of a double chain of nearly 1,000 islands to the east of PNG Most of the islands are high volcanic and raised limestone with frequent earthquake experiences. Oema, Ontong Java and Sikaiana are atolls to the north while

Rennell and Bellona are narrow raised atolls located furthest to the south (UNEP/IUCN 1988, Scott 1993, Maragos and Holthus 1996). Fringing and barrier reefs are common, with most reefs in very good condition. The Solomon Islands appear to support very high coral reef biodiversity (Maragos and Holthus 1996). There are extensive mangrove forests in the Solomon Islands, estimated at 642 km^2 in 1972 (Scott 1993) containing the greatest diversity in the Pacific islands region after Papua New Guinea (Ellison 1996). Seagrass beds occur throughout the islands, but very little scientific data are available to indicate their extent or importance (SPREP 1993d). The Arnavon Islands support the largest hawksbill turtle nesting beaches left in the insular tropical Pacific (Holthus 1993, Eckert *et al* in prep).

Additional references: corals - Weber (1973), Morton (1971), Maragos (in prep), mangroves - Hansell & Wall (1976).

Major issues affecting coral reefs and associated environments (Sources: SPREP 1993d, Scott, 1993; Maragos and Holthus 1996, UNEP/IUCN 1988).

- Majority of the population is concentrated in the coastal areas.
- Tropical cyclones and seismic activity are the primary natural threats.
- Logging and mining and its associated coastal developments have caused sedimentation problems. Logging is presently expanding.
- Use of mangrove areas near population centres for firewood and dump sites.
- Sand mining of beaches causing coastal erosion.
- Waste disposal around the urban centres.
- Over-harvest of preferred and valuable reef fish and invertebrates.

Tokelau

Tokelau with a population in 1991 (Ioane 1994), of 1,577 consists of three low atolls and is a non-self-governing territory of New Zealand. None of the three atolls have passages into the lagoons (UNEP/IUCN 1988). There have been few studies of the reefs, but they have been described as diverse but not luxuriant (UNEP/IUCN 1988). There are no mangroves.

Major issues affecting coral reefs and associated environments (Sources: Ioane 1994; UNEP/IUCN 1988).

- Tropical cyclones, climate change and possible sea-level rise.
- Over-exploitation of marine resources (giant clams, trochus, black pearl oysters, turtles, reef fish).
- Unsustainable use of beach sand resulting in beach erosion.
- Solid, liquid and hazardous waste storage and/or disposal.
- Possible channel blasting through the atoll reef rims.

Tonga

The Kingdom of Tonga, with a population of 101,000 in 1990, consists of 174 island and reef systems in four major groups: Tongatapu, Ha'apai, Vava'u and the northern islands (Maragos and Holthus 1996, UNEP/IUCN 1988, Scott 1993). The Tongatapu group consists of high limestone islands and low coral islands surrounded by mixed fringing and lagoon reefs; the Ha'apai group consists of high volcanic and high and low limestone islands surrounded by reef communities, fringing reefs and a few barrier/lagoon reefs; the Vava'u group consists mostly of high limestone with some high volcanic islands, mostly surrounded by fringing reefs; and the northern islands consist of high volcanic islands surrounded by fringing and barrier

reefs (Maragos and Holthus 1996) The total area of mangroves in Tonga has been estimated at 1,000 ha (Scott 1993) Extensive seagrass beds occur around Tongatapu. in the Vava'u group and at Nomuka in the Ha'apai group (Scott 1993).

Additional references: corals - Zann *et al.* (1984), Chesher (1985), Holthus (in press). mangroves - Whistler (1992): other - Tappin (1993).

Major issues affecting coral reefs and associated environments (Sources: Scott. 1993; Maragos and Holthus 1996; SPREP 1993e; UNEP/IUCN 1988; Tappin 1993):

- Tropical cyclones and seismic activity.
- Destructive fishing and collecting methods (reef/coral smashing. dynamite and poisons) compounding over-harvesting problems.
- Sand mining of beaches
- Extensive clearing and filling of the limited mangrove areas for housing and other development activities.
- Coastal construction and poor land-use management resulting in sedimentation
- Sewage and solid waste disposal around the urban centres. especially near the capital. Nuku'alofa. on Tongatapu

Tuvalu

Tuvalu had a population in 1987 (Maragos and Holthus 1996. Scott 1993). of 8,600. It consists of six atolls and three islands with fringing/table reefs. Small stands of mangroves occur on three of the limestone islands and two of the atolls (Scott 1993)

Additional references: corals - Buckley (1985). Kaly & Jones (1990). mangroves - Woodroffe (1985. 1987).

Major issues affecting coral reefs and associated environments (Sources: Lane 1993; Maragos and Holthus 1996; Scott 1993; UNEP/IUCN 1988):

- Tropical cyclones, climate change and possible sea level rise.
- Channel blasting affecting corals, fish and water circulation.
- Over-harvesting of marine resources, sewage and waste disposal affecting Funafuti atoll (urban centre).
- Beach rock and sand mining.

United States of America
Other Territories

These include Midway Is (atoll: population of 2,300 in 1981; military airbase since 1941). Johnston Is. (atoll. population of 1,000 in 1981. currently US defence facility for storage and destruction of nerve gas and other chemical weapons): Wake Is (atoll: population of 1,600 in 1981: administered by the US Air Force since 1972). Palmyra (atoll. original 52 small islets linked together during the war. now only 39). Kingman Reef. Jarvis Is (low coral island). Howland Is (low coral island): and Baker Is (small coral island) (UNEP/IUCN 1988. Scott 1993). A change in the legal status of seven of these islands is currently under deliberation in the US Congress with one option being assigning them to the State of Hawaii (Scott 1993. J. Maragos pers. comm 1995) No mangroves exist on any of the islands Johnston. Howland. Jarvis and Baker islands are US National Wildlife Refuges

Major issues affecting coral reefs and associated environments (Sources. UNEP/IUCN 1988):

- Extensive dredging. in-filling and construction associated with defence facilities
- Storage and destruction of chemical weapons on Johnston Atoll.
- Frequent tropical cyclones

Vanuatu

The Republic of Vanuatu, with a population in 1989, of 142,630 consists of a bifurcating chain of 42 volcanic islands with the larger (western) islands consisting of extinct volcanoes with uplifted coral reefs (Maragos and Holthus 1996, Scott 1993). Coral reefs are mostly fringing reefs with reef communities only found along the coasts of twelve of the islands. Tectonic activity and volcanism has caused many islands to emerge, preventing development of wider fringing reefs and barrier reefs (Maragos and Holthus 1996). There are estimated to be between 2,500 and 3,000 ha of mangroves, almost 2,000 ha of which occur on Malekula (Scott 1993) Seagrass beds are located throughout Vanuatu (Scott 1993).

Additional references corals - Guilcher (1974), Done & Navin (1990); mangroves - Chambers (1988), David (1985); seagrasses - Chambers *et al* (1990)

Major issues affecting coral reefs and associated environments (Sources Maragos and Holthus 1996, UNEP/IUCN 1988; Scott 1993)

- Frequent tropical cyclones and tectonic uplifting
- Over-harvesting of corals, coastal construction and sewage discharges around the urban centre of Port Vila

Wallis and Futuna

Wallis and Futuna, with a population in 1990 of 13,600 is a territory of France, consists of three islands (UNEP/IUCN 1988, Scott 1993). Uvea is a volcanic island with a barrier reef supporting 22 reef islets, collectively known as the Wallis islands Futuna and Alofi are mountainous volcanic islands, with Futuna being surrounded by a narrow fringing reef and Alofi with a small patch of fringing reef on the northwest coast (UNEP/IUCN 1988). There are no mangroves in Wallis and Futuna.

Additional references include Richard *et al.* (1981) and Richard *et al.* (1982).

Major issues affecting coral reefs and associated environments (Sources: UNEP/IUCN 1988):

- Over-harvesting of marine resources due to population pressures.
- Soil erosion is a serious problem on Futuna island but the effects on the reef are unknown

Western Samoa

Western Samoa, with a population of 161,298 in 1991, consists of two main volcanic islands (Upolu and Savai'i) and seven smaller islands and islets (Scott 1993, UNEP/IUCN 1988). The coastlines of the main islands support fringing reefs except along the northeast coasts where only reef communities and very narrow fringing reefs occur (Maragos and Holthus 1996) Western Samoa's reefs and lagoons have been described as among the most degraded in the Pacific (Taule'alo 1993). Mangroves are confined to the two main islands (Scott 1993)

Additional references corals - Andrews & Holthus (1989), Zann (1991), Lovell & Toloa (1994), mangroves - Whistler (1992), Sua (1988)

Major issues affecting coral reefs and associated environments (Sources: Taule'alo 1993, Maragos and Holthus 1996, Scott 1993, UNEP/IUCN 1988):

- Tropical cyclones, crown-of-thorn starfish and some coral bleaching have affected Western Samoa's reefs.
- Uncontrolled cutting and in-filling of mangrove areas.
- Destructive (dynamite and poison) fishing and collecting practices.
- Over-harvesting of marine resources.
- Sewage, solid waste and hazardous waste disposal.

- Poor land-use practices resulting in soil erosion and sedimentation of reefs and lagoons.

- Beach sand mining, dredging, reclamation activities and coastal construction are severely degrading the coastal areas.

Regional Issues and Priorities

Issues

Within the Pacific region the full range of coral reef problems and issues caused by both natural and anthropogenic means are found. However, the full extent of disturbances to coral reefs and related ecosystems within the region are not known. Local reef users often possess an extensive and detailed knowledge of coral reef systems and resources which are largely undocumented. Maragos and Holthus (1996) estimate that less than one percent of the reef areas in the region have been visited and assessed by reef scientists. However, this is not meant to imply that the majority of the coral reefs in the Pacific region are not affected by human activities. It is an indication of the lack of qualified reef scientists within the region, and the financial and logistical difficulties of working within the region.

One of the more important aspects of coral reefs in the region is their role as coastal protection structures, a contribution that is often overlooked (Jackson 1995). The coastal protection value of coral reefs is fundamental to the very existence of low-island communities and is enhanced by the protective role of the Mangrove stands as well. Less widely recognised is the role of coral reefs as the primary source of the carbonate sand that constitutes the majority of beach deposits within the region. These beaches also have coastal protection value in addition to the more obvious tourism values.

The major issues for each country and territory were noted in the previous section, while the major sources of anthropogenic stress on coral reef and related ecosystems are shown in Annex 3 which are also discussed in Richmond (1993a and 1994). It is important to note that the synergistic effects of human - induced chronic disturbances, when combined with natural disturbances, can severly affect a reef's capacity for recovery. The following have been identified as key issues affecting Pacific coral reefs and related ecosystems. Their importance varies throughout the region, but they exist in virtually all countries and territories to varying degrees. They include (in no particular order):

- Pollution from sewage, fertilisers, biocides, toxic wastes, oil spills, solid wastes, freshwater runoff and other land-based sources of pollution.
- Siltation due to soil erosion from inappropriately conducted land use practices (e.g. agriculture, forestry, mining, site clearance, road building).
- Over-exploitation of coral reef and mangrove resources (e.g. commercially valuable species such as beche-de-mer, giant clams, trochus, certain fish and shellfish, live coral harvesting for aquariums and tourist trade, mining coral heads for construction, subsistence fishing pressure).
- Destructive fishing and collecting methods (e.g. poisons, explosives).
- Land reclamation (including mangrove and reef-flat destruction), inappropriate coastal protection works, and unsound mariculture practices.
- Coastal and marine development projects (often internationally funded and driven) progressing without Environmental Impact Assessments (EIAs), or with inadequate or inaccurate EIAs.
- Channel blasting and dredging activities (e.g. lagoon sand mining).
- Mining of beach and reef materials (e.g. beach sand).
- Coastal erosion and accretion.
- Tourism activities and related developments.

- Military testing, training and dumping (e.g nuclear testing, munitions disposal).
- Catastrophic events (e.g. tropical cyclones, volcanic eruptions, earthquakes, tsunamis, coral bleaching, crown-of-thorns starfish infestations, severe El Niño-Southern Oscillation (ENSO) events and possible climate change and sea level rise)

Priorities

Although the following are *regional* priorities, the implementation of any actions to address them will largely be at the *national* level, and as such, specific priorities will vary from area to area. The possibility of duplication of effort, and alternatively of leaving gaps, is always a prospect considering 1) the number and varying capacities of governments within the region, 2) the difficulty of continuous communication; and 3) the range and variability of technical and financial assistance provided bilaterally and multilaterally to the region. The region does, however, have a history of being able to coordinate its activities, especially in the area of the environment.

Capacity Building

- Technical training, especially on survey and monitoring techniques, environmental impact assessment and management strategies.
- Education and awareness programmes on the benefits derived from healthy coral reefs and related ecosystems.
- Improved coordination and cooperation of activities and information exchange

There is a wide range of political, administrative and cultural systems represented in the region. These, in conjunction with the varying economic circumstances found here, have resulted in varying capacities to monitor and manage coral reefs. These range from very high capabilities to virtually non-existent, but the majority of countries tend to have low capabilities (Annex 6.1.2 provides an indication of these capabilities for each country and territory).

Technical training. Both long and short term training are required for government officers whose responsibilities involve coral reef and related ecosystems conservation and management. Two areas of immediate need are in coral reef and mangrove survey techniques (including data acquisition, storage and analysis) and in coral reef and mangrove management strategies. As many officers are insufficiently trained, or even untrained in survey work and coral reef/mangrove biology, all training should involve as much practical experience as possible and be conducted in-country wherever feasible. Training should also include representatives from local NGO and community groups. Specific training for community groups must be made part of any programme, as their involvement in monitoring and management is often vital due to customary land and marine tenure systems. A number of the regional organisations (FFA, SOPAC, SPC, SPREP) now have on-the-job training attachments for varying periods for their member government officers. It is also essential that technical training be linked to the research, monitoring and management priorities noted below. Training of government personnel should be in sectors with important implications for coral reefs and related ecosystems, for example, these could include, *inter alia*, shoreline development and construction, fisheries management, EIA, coastal management, land use planning, legislation/regulation, and upland erosion control. The development of good and appropriate resource materials needs greater emphasis.

Education: Coral reef and mangrove education programmes will be essential components for the conservation and management of these ecosystems in the

Pacific region to be successful. Assistance is required at all educational levels - elementary, secondary and tertiary. Particular support is needed at the community college level to develop appropriate courses and materials. The lack of university level institutions in the region has hampered not only the availability of education and training opportunities, but research and monitoring as well. There are only six true university centres within the Pacific insular region: Suva (University of the South Pacific), Port Moresby (University of Papua New Guinea), Tahiti (Université Française du Pacifique), Noumea (Université Française du Pacifique); Guam (University of Guam); and Honolulu (University of Hawaii, Chaminade, Brigham Young, Hawaii Pacific University). There are also a few community colleges within the region that offer marine courses relating to coral reefs and mangroves. College of Micronesia-FSM (in Pohnpei, FSM), Palau Community College (Palau), and Northern Mariana College (Saipan, NMI). Greater coordination and cooperation is required between these educational centres, as well as with the universities in Australia (James Cook University, Southern Cross University, University of Queensland, etc), and other regional research organisations that offer relevant training courses (e.g. Australian Institute of Marine Science, Ecole Practique des Hautes Etudes Research Centre in Moorea).

Awareness. Coral reef and mangrove awareness programmes will also be an essential ingredient for success in conserving and managing these ecosystems. Awareness programmes are urgently required which target decision makers (politicians, community leaders), public servants within the bureaucracies and community groups (such as women's, church and youth groups).

Research and Monitoring

- Acquisition of baseline information on the status of coral reefs and mangroves within the region, especially through rapid assessment techniques for remote areas.
- Monitoring of coral reefs and related ecosystems to detect disturbances due to natural and/or anthropogenic stresses; such monitoring should also include coastal stability and sediment budgets.
- Adoption of basic survey and monitoring methods and standards, integrating regional monitoring activities into the Global Coral Reef Monitoring Network when it is operational.
- Applied research into reef management, conservation and sustainable use options, e.g. reef fisheries management, marine protected area siting and design, local tenure and use rights.

Surveys, inventories and monitoring. Few Pacific islands have adequate information concerning their coral reef and mangrove areas. Appropriate baseline information is a key ingredient for successful coral reef and mangrove resource management. The technical capacity to undertake the necessary data collection and monitoring programmes is now available at the regional level. This expertise exists within the regional universities and the regional organisations. All surveys and inventories need to be done through, or in conjunction with, the appropriate island government agencies. Surveys conducted by outside agencies and personnel must include training components for island government staff. Technology and skills transfer should be a key aspect of any such surveys or inventories, as this will allow long-term monitoring to be conducted by in-country personnel. Other key limitations to in-country surveying and monitoring are the lack of equipment and appropriate facilities. The adoption of basic survey standards for the region are needed, such standards need to be practical and basic enough for non-specialists to acquire data, yet able to be built upon by researchers

with greater experience and knowledge. The Marine Ecosystem Classification System recently developed by SPREP and The Nature Conservancy for the tropical islands provides a regionally developed framework for systematically inventorying and evaluating coral reefs and related ecosystems. This will also facilitate the exchange of information within and outside the region. In addition, specific data are required on the levels at which pollutants become toxic to coral reef organisms and affect reproductive recruitment processes. The linkage between data collection and its use in management (i.e. why data and information needs to be collected) requires greater emphasis and visibility.

Management

- Adoption of Integrated Coastal Management appropriate to Pacific islands circumstances.
- Adoption of Environmental Impact Assessment procedures and post-construction monitoring for all development activities.
- Establishment of effective marine conservation and protected areas.
- Control of marine pollution from land based sources.

The majority of Pacific islands are now tending to move away from the sectoral approach to environmental conservation and management towards a more coordinated or integrated approach. Therefore priorities for coral reef and related ecosystems conservation and management will need to be considered in relation to each country or territory's individual environmental conservation and management priorities.

Management strategies. The development of coral reef and mangrove resource management strategies *appropriate to Pacific island circumstances* are urgently required. Such strategies will be required not only to be technically relevant, but also to be culturally and socially sensitive (many traditional or customary strategies already exist and this infrastructure should be built upon where appropriate). Management strategies will need to address enforcement and regulatory issues in situations where enforcement agencies are under-staffed or non-existent. Most island government officers are usually responsible for a broad range of duties, of which coral reef and mangrove issues may form only a limited part. The interrelated nature of Pacific environments will need to be taken into consideration via the adoption of an integrated approach to the management of coral reef and related ecosystems. Appropriate Integrated Coastal Management (ICM) will provide the most effective means of managing these ecosystems within the region. The adoption and implementation of appropriate ICM will assist in reducing the causes of land based sources of pollution.

Protected areas. Efforts to identify and develop *effective* marine conservation and protected areas within the region need to be increased. The emphasis should be directed towards establishing appropriate and effective community management of such areas.

References

* References cited but not seen

Adjeroud, M., Y. Chancerelle & B. Salvat 1994. A new bleaching event in French Polynesia during early 1994. Int. Soc. Reef Studies (ISRS), 2nd European Regional Meeting, Luxembourg, September 1994. Abstract volume pp 27. *

Agardy, M.T., & J. Pernetta 1993. A preliminary assessment of biodiversity and conservation for coastal and marine ecosystems in Papua New Guinea. *In:* B. Beehler (ed) Papua New Guinea conservation

assessment, Biodiversity Support Program. pp 381-421 *

Agegian, C.R., K.E Chave, R Lauritzen, E. Ratigan, A Suzumoto & G. Tribble 1987. Marine environmental assessment for the rehabilitation and resettlement of Bikini Atoll. Status report prepared under Bikini Atoll Rehabilitation Committee (BARC) contract. Appendix C, BARC Suppl. Doc. No. 2, Part 2. *

Andrews, G.J 1987. Marine Ecological Survey of Pukapuka Atoll. Final Report, November 1987 Commonwealth Science Council. Australian Institute of Marine Science, Townsville. *

Andrews, G.A. & P.F. Holthus 1989. Marine Environment Survey: Proposed Aleipata Islands National Park. Western Samoa *SPREP Reports and Studies* No 43 South Pacific Regional Environment Programme. Noumea. New Caledonia

Aubanel, A. & B. Salvat 1990 French Polynesia government and research institution in coral reef environmental studies during the last 20 years Int Soc Reef Studies (ISRS). Annual Meeting. Noumea. New Caledonia. Nov 1990 pp 9-16 *

Aubanel, A . J Bonvallot & L Loubersac 1991 Evolution du trait de côte du littoral corallien d'une île tropicale en voie de développement (Moorea, Polynésie française). Colloque sur "Le littoral. ses contraintes environnementales et ses conflits d'utilisation". Juillet 1991. Union des Océanographes de France. Société française d'Ecologie. Université de Nantes: 35-38 *

Bagnis. R 1991 Dégradation et nuissances *In:* Écosystemes de lagons de la Polynésie Fraçaise. *SPREP Rep. Etud.* 51. *

Baronie, F. 1995. A Report on the State of Reef Fish Populations, Community Fishing Practices and Tourist Attitudes to Lagoon Issues in Aitutaki. On behalf of the Cook Islands Conservation Service, January-February 1995. A Tourism Master Plan Project. Cook Islands Conservation Service, Rarotonga. *

Biosystems Analysis 1992 A Comprehensive Wetlands Management Plan for the Islands of Tutuila and Aunu'u, American Samoa Prepared for Economic Development Planning Office, American Samoan Government. Biosystems Analysis, Inc , Tiburon, California

Birkeland, C , S Amesbury & R H. Randall 1991. Coral and reef-fish assessment of the Fagatele Bay National Marine Sanctuary. Report to NOAA. US Dept of Commerce, University of Guam Marine Lab., *NOAA Tech. Memorandum Series* Mangilao. Guam *

Birkeland. C & R.H Randall 1979. Report on the *Acanthaster planci* (Alamea) studies on Tutuila, American Samoa. Prep by University of Guam Marine Lab for Director. Office of Marine Resources. Government of American Samoa *

Birkeland. C E , R H Randall, R.C Wass, B Smith & S Wilkins 1987. Biological resource assessment of the Fagatele Bay National Marine Sanctuary *NOAA Tech Memorandum*, No 5. MEMO 3. US Dept of Commerce. Washington DC. *

Bolton. L A 1982. The intertidal fauna of southern Tarawa Atoll lagoon, Republic of Kiribati. Institute of Marine Resources, Univ. S. Pacific. *

Buckley. R 1985 Environmental survey of Funafuti Atoll. Proc. 5th Int. Coral Reef Congr., Tahiti 6:305-310.*

Buddemeier, R.W. 1993. Corals, climate and conservation. *In:* R.H. Richmond (ed) Proceedings of the 7th International Coral Reef Symposium, Guam, 22-27 June

1992. University of Guam Press, Mangilao. Vol. 1, pp 3-10.

Chambers, M.R. 1988. The Mangroves of Vanuatu. Information Note for the Working Group Meeting for the Rational Use of Mangroves in the Pacific Islands Region, Apia, Western Samoa, February 1988 *

Chambers, M.R., F. Nguyen & K.F Navin 1990. Seagrass Communities *In* Done, T.J & K F Navin (eds) Vanuatu Marine Resources. Report of a biological survey 92-103 Australian Institute of Marine Science, Townsville, Australia *

Chardy, P., C. Clavier, P. Gerard, P. Laboute, A. Martin & B. Richier de Forges 1987. Etude quantitative des finds meubles du lagon sud-ouest de Novelle-Calédonie liste taxonomique, densités et biomass Nouméa: ORSTOM Rapp Sci Tech : Sci Mer . Biol mar . 44:81p *

Chauvet C. 1990. Etude des activités halieutiques côtières en Polynésie française, première phase réalisation d'une banque de donnees biologiques, économiques et sociales à Raiatea-Tahaa 66p.*

Chave, K.E. & E.A. Kay (eds) 1974. Fanning Island Expedition July-Aug 1972. *Hawaii Inst of Geophysics Rep* HIG-73-13. *

Chesher, R.H 1985. Practical problems in coral reef utilization and management: A Tongan case study Proc. 5th Int Coral Reef Cong., Tahiti 4:213-217. *

Cole, T.G., C.D Whitesell, W.A. Whistler, N. McKay & A.H. Ambacher 1988. Vegetation survey and forest inventory, American Samoa. PSW-25. Pacific Southwest Forest and Range Experiment Station, Forest Service, US Department of Agriculture. Berkeley, California. *

Coles, R. & J. Kuo (1995) Seagrasses. *In:* J.E. Maragos, M.N.A. Peterson, L.G. Eldredge, J.E. Bardach & H.F. Takeuchi (eds) Marine and Coastal Biodiversity in the Tropical Island Pacific Region, Vol. 1: Species Systematics and Information Management Priorities. East-West Center, Honolulu; Pacific Forum/CSIS, Honolulu; Pacific Science Foundation, Honoulu pp 39-57

Coles, R & W. Lee Long (1996). Seagrasses *In:* Marine and Coastal Biodiversity in the Tropical Island Pacific Region Volume 2: Population, Development and Conservation Priorities East-West Center, Honolulu

Cragg, S 1987 Papua New Guinea *In.* Umali, R M *et al* (eds) Mangroves of Asia and the Pacific: Status and Management 299-309. Natural Resources Management Center and National Mangrove Committee, Ministry of Natural Resources, Manila *

Craig, P (ed) 1995. American Samoa: Natural history and conservation topics, vol. 2 *Biol Rep Ser, Rep 67**

Craig, P , A. Green & S Saucerman 1995. Coral reef troubles in American Samoa. *SPC Fisheries Newsletter* 72:33-34.

Dahl, A.L. 1980 Regional ecosystems survey of the South Pacific Area. *SPC/IUCN Technical Paper* 179, South Pacific Commission, Noumea, New Caledonia

Dahl, A.L. & A.E. Lamberts 1977. Environmental impact on a Samoan coral reef: A resurvey of Mayor's 1917 transect *Pacific Science* 31(3): 309-319. *

David, G. 1985. Subsistence fishing and natural environment: the mangroves of Vanuatu and their significance with respect to fishing. *Notes and Documents on Oceanography* No. 13. ORSTOM, Port Vila, Vanuatu. *

Devaney, D.M. & J.E. Randall 1973. Investigations of *Acanthaster planci* in south-eastern Polynesia during 1970-71. *Atoll Res. Bull.* 169: 35 pp. *

Devaney, D.M. *et al.* 1987. The natural history of Enewetak Atoll, 2 vol. US Department of Energy, Office of Scientific and Technological Information. *

Done, T.J. & K.F Navin (eds) 1990 Vanuatu Marine Resources, Report of a biological survey. Australian Institute of Marine Science, Townsville, Australia *

Easton, W.H., T L. Tu & R H. Randall 1978 Recent reefs and shore lines of Guam. *Micronesica* 14(1) 1-11 *

Eckert, S. *et al.* in prep Draft recovery plans for endangered and threatened sea turtles in the Pacific National Marine Fisheries Service Hubbs Sea World, San Diego. *

Egretaud, C., C. Jardin & B. Jouvin 1995 Etude préalable de conception et d'aménagement des sites du parc marin de Bora-Bora Phase I et II 112 p *

Eldredge, L G., R T Tsuda, P Moore, M Chernin & S Neudecker 1977 Natural history of Maug, Northern Mariana Islands *Univ. Guam Mar Lab Tech Rept* 43. *

Eldredge, L G., B R Best, M I Chernin, R K Kropp, R F Myers & T L Smalley 1979 Marine environmental survey of Okat, Kosrae *Univ. Guam Mar Lab Tech Rept.* 63 *

Eldredge, L.G & R.H. Randall 1980 Atlas of the reefs and beaches of Saipan, Tinian and Rota Coastal Resources Management, Saipan, CNMI *

Ellison, J C (1995) Systematics and distributions of Pacific Island Mangroves *In.* J.E Maragos, M N A Peterson, L.G Eldredge, J.E. Bardach & H F. Takeuchi (eds) Marine and Coastal Biodiversity in the Tropical Island Pacific Region, Vol. 1: Species Systematics and Information Management Priorities. East-West Center, Honolulu; Pacific Forum/CSIS, Honolulu; Pacific Science Foundation, Honoulu. pp 59-74.

Ellison, J.C. (1996) Mangroves. *In:* Marine and Coastal Biodiversity in the Tropical Island Pacific Region Volume 2: Population, Development and Conservation Priorities. East-West Center, Honolulu.

Fagerstrom, J.A. & F. Rougerie 1994. 1994 coral bleaching event, Society Islands, French Polynesia. *Marine Pollution Bulletin* 29(1-3):34-35. *

Falanruw, M., T. Cole, A. Ambacher, K. McDuffie & J. Maka 1987a. Vegetation Survey of Moen, Dublon, Fefan and Eten, State of Truk, Federated States of Micronesia. *Resour. Bull.* PSW-20. Pacific Forest and Range Experiment Station. Forest Service, US Department of Agriculture Berkeley, California *

Falanruw, M., C Whitesell, T Cole, C. MacLean & A Ambacher 1987b Vegetation Survey of Yap, Federated States of Micronesia *Resour Bull* PSW-21 Pacific Forest and Range Experiment Station, Forest Service, US Department of Agriculture Berkeley, California *

Forbes, D L & Y Hosoi 1995 Coastal erosion in South Tarawa, Kiribati. *SOPAC Technical Report* 225. *

Fosberg, F R 1947. Micronesian mangroves *New York Bot. Gard. Jour* 48.128-138 *

Fosberg, F R 1975 Phytogeography of Micronesian mangroves. *Proc. International Symposium on Biological Management of Mangroves* 1:23-42. *

Fromaget M. & B. Richier de Forges 1992. Catalogue bibliographique indexé du milieu marin de Nouvelle-Calédonie. 2nd édition. ORSTOM Cat.: Sci. Mer 274 pp *

Gabrié, C 1994. Termes de références pour l'élaboration d'un schéma d'aménagement et de gestion intégrée des zones maritimes et côtières de Polynésie française. *

Gabrié, C. 1995a. L'état de l'environnement dans les Territoires Français du Pacifique Sud (La

Polynésie française, Mars 1995) Ministere de l'Environnement, IFEN. *

Gabrié, C 1995b. L'état de l'environnement dans les Territoires Français du Pacifique Sud: la Nouvelle-Calédonie. Ministere de l'Environnement. *

Galzin, R., J.P. Marfin & B. Salvat 1993. Long term coral reef monitoring program: Heterogeneity of the Tiahura barrier reef (Moorea, French Polynesia). *Galaxea* 11:73-91. *

Garrigue, C. 1987. Les macrophytes benthiques du lagon sud-ouest de la Nouvelle-Calédonie carte des principaux groupements. Nouméa. ORSTOM. Rapp. Sci Tech Sci Mer.: Biol Mar., 46 122p *

Gawel, M.J. 1993 The Federated States of Micronesia: State of the Environment Report South Pacific Regional Environment Programme, Apia, Western Samoa.

Green, A.L (in prep) A quantitative assessment of the status of coral reef fishes and their habitat in American Samoa *

Guilcher, A. 1974. Coral reefs of the New Hebrides, Melanesia, with particular reference to open-sea, not fringing reefs. *Proc 2nd Int. Coral Reef Symp., Brisbane* 2 523-535 *

Guinther, E.B., J.E. Maragos & R.R Thaman 1992 National Biodiversity Overview: Republic of Kiribati (draft). Prepared by The Nature Conservancy, USP, and Aecos Inc., Honolulu, Hawaii, for the Government of Kiribati *

Hansell, J.R.F. & J.R.D Wall 1976 Land resources of the Solomon Islands. Volume 1: Introduction and Recommendations Land Resources Study 18, Land Resources Division, Ministry of Overseas Development, Surrey, England. *

Hoegh-Guldberg, O 1994. Mass-bleaching of coral reefs in French Polynesia A report prepared for Greenpeace International.

Holthus, P.F 1993. Coastal and marine habitat survey: Proposed Arnavon Islands Protected Area, Solomon Islands Ministry of Natural Resources, and the landowners of the Arnavon Islands.*

Holthus, P.F. 1995a. Rapid Ecological Assessment of the Coral Reefs and Shoreline of Greater Noumea and the Reserves of the Parc du Lagon Sud. Report prepared for the Service de la Mer, Province Sud, Nouvelle Caledonie. *

Holthus, P.F 1995b Coastal Zone Management for Greater Noumea, New Caledonia. Report prepared for the Service de la Mer, Province Sud, Nouvelle Caledonie

Holthus, P.F (in press) Rapid Assessment of the coral reefs of Vava'u, Tonga. *SPREP Reports and Studies Series* South Pacific Regional Environment Programme, Apia, Western Samoa.

Holthus, P.F. & J.E. Maragos 1992 Marine biological diversity conservation in the Central/South Pacific Marine Region (IUCN CNPPA Marine Region 10). Prepared for IUCN CNPPA Marine Realm. Unpubl.

Huber, M 1994 An assessment of the status of the coral reefs of Papua New Guinea *Marine Pollution Bulletin* 29(1-3):69-73. *

Hutchings, P., C Payri & C. Gabrie 1994. The current status of coral reef management in French Polynesia. *Marine Pollution Bulletin* 29(1-3):26-33.

Ioane, M.K 1994 Tokelau: State of the Environment Report 1994. South Pacific Regional Environment Programme, Apia, Western Samoa

Jackson, J.B.C. 1995. The role of science in coral reef conservation and management *In:* Partnership building and framework development. Final report of the ICRI Workshop, Dumaguete City, Philippines, 29 May-2 June 1995. ICRI Secretariat, Washington DC. pp 5-9.

Jardin, C. 1994. Biologie de la reproduction de quelques coraux scléractiniaires en Polynésie française Application à la restauration d'un site lagonaire degrade. *

Joannot, P , B.A Thomassin & Y. Magnier 1983 Coral banks in muddy environment in the SW lagoon of New Caledonia Int Coral Reef Studies ann meet *

Kaly, U L & G.P. Jones 1990. The construction of boat channels across coral reefs: An assessment of ecological impact Report 4 (final) Prep for New Zealand Ministry of External Relations and Trade Department of Zoology. University of Auckland. New Zealand

Kojis, B L., N J Quinn, M R Claereboudt & W Y Tseng 1984 Coral reefs of the Huon Gulf and Hansa Bay Papua New Guinea. Paper presented at the joint meeting of the Atlantic Reef Committee and International Society for Reef Studies. Advances in Reef Science. Miami, Florida, October 1984 *

Kojis, B L., N J Quinn & M R Claereboudt 1985 Living coral reefs of northeast New-Guinea. *Proc 5th Int Coral Reef Cong Tahiti* 6:323-328 *

Lal, P N., K Swamy & P Singh 1983 Mangroves and secondary productivity: Fishes associated with mangroves in Wairiki Creek, Fiji *In* Lal, P N (ed) Proceedings of an Interdepartmental Workshop, February 1983, Suva, Fiji *Fisheries Division Technical Report* 5 Ministry of Agriculture and Fisheries, Fiji. *

Lamberts, A.E. & J.E. Maragos 1989 Observations on the reefs and stony corals of Majro Atoll, Republic of the Marshall Islands *In*: Majro Coastal Resource Inventory. Prepared by University of Hawaii Sea Grant Extension Service and the US Army Corps of Engineers, Pacific Ocean Division, Honolulu, in press *

Lane, J. 1993 Tuvalu: State of the Environment Report 1993 South Pacific Regional Environment Programme, Apia, Western Samoa.

Lane, J. 1994. Niue: State of the Environment Report 1993. South Pacific Regional Environment Programme, Apia, Western Samoa.

Littler, M.M & D S Littler 1995. Impact of CLOD pathogens on Pacific reefs. *Science* 267 1356-1360. *

Lovell, E R & F Toloa 1994 Palolo Deep National Marine Reserve: A Survey, Inventory and Information Report *SPREP Reports and Studies Series* No 84. South Pacific Regional Environment Programme, Apia, Western Samoa

MacLean, C , T Cole, C Whitesell, M Falanruw, & A Ambacher 1986. Vegetation Survey of Pohnpei, Federated States of Micronesia. *Resour Bull* PSW-18 Pacific Forest and Range Experiment Station, Forest Service, US Department of Agriculture Berkeley, California *

Maragos, J E 1993. Impact of coastal construction on coral reefs in the U S.-affiliated Pacific islands *Coastal Management* 21:235-269

Maragos, J E 1994a Description of reefs and corals for the 1988 protected areas survey of the northern Marshall Islands. *Atoll Res. Bull* 419 1-88, A-1 to A-14, B-1, C-1, D-1. *

Maragos, J.E 1994b Reef and coral observations on the impact of the grounding of the longliner Jin Shiang Fa at Rose Atoll, American Samoa. Unpub Review Draft. *

Maragos, J.E. (in prep) A preliminary checklist of the shallow water stony corals from the Solomon Islands. *

Maragos, J E & C W Cook, Jr (in press) The 1991-1992 rapid ecological assessment of Palau's coral reefs. *Coral Reefs* in press. *

Maragos, J.E. & P.F. Holthus (1996) A preliminary status report on the coral reefs of the insular tropical Pacific. *In:* Marine and Coastal Biodiversity in the Tropical Island Pacific Region Volume 2: Population, Development and Conservation Priorities. East-West Center, Honolulu.

Maragos, J.E., C. Birkeland, C. Cook, K. Des Rochers, R Di Rosa, T J Donaldson, S.H. Geermans, M Guilbeaux, H. Hirsh, L Honigman, N. Idechong, P.S Lobel, E Matthews, K McDermid, K Z Meier, R Myers, D Otobed, R H Richmond, B. Smith & R. Smith 1994. Marine and coastal survey of the main Palau islands Part 2 Rapid ecological assessment synthesis report. CORIAL and The Nature Conservancy, Honolulu

Marquet, N. 1994. La ligne de rivage des Iles-Sous-le-Vent (Archipel de la Societe, Polynésie française) Categorisation et quantification, taux d'anthropisation. Diplôme d'Etudes Approfondies "Cannaissances et Gestion des milieux corallıens littoraux et océaniques" Université Française du Pacifique, Papeete, Tahiti.*

Miller, I., A Thompson & M. Loo 1994. Report on Baseline Surveys for Monitoring the Fringing Reef of Rarotonga, Cook Islands. Australian Institute of Marine Science, Townsville

Morrison, R.J & M.R Naqasima (eds) 1992. Fiji's Great Astrolabe Reef and Lagoon. A Baseline Study Institute of Natural Resources, University of the South Pacific, Suva.

Morton, J.E. 1974 The coral reefs of the British Solomon Islands: A comparative study of their composition and ecology. *Proc Second Internat. Coral Reef Sympos.* 2: 31-53. *

Nedwell, D.B 1974 Sewage treatment and discharge into tropical coastal waters. Search 5(5) 187-190.*

OFAI n°11 1995. Bulletin du CROIBE-EPHE de Moorea, Bilan annuel 1994. *

ORSTOM 1993. Atlas de la Polynésie française, Editions de l'ORSTOM, Paris. *

ORSTOM 1981. Atlas de la Nouvelle-Caledonie. *

Otobed, D.O & I.A Maiava 1994. Republic of Palau: State of the Environment Report 1994. South Pacific Regional Environment Programme, Apia, Western Samoa

Paulay, G 1985 The biogeography of the Cook Islands coral fauna. *Proceedings 5th International Coral Reef Congress, Tahiti* 4: 89-94 *

Paulay, G 1994 The State of the Reef: Aitutaki Surveys, 1994 Marine Laboratory, University of Guam, Guam *

PBDC 1994. Draft American Pacific Islands Coral Reef Initiative Management Program Planning Meeting Summary Report Pacific Basin Development Council

Pettys, E. S. Peter, R Rugg & T Cole 1986 Timber Volumes in the Mangrove Forests of Pohnpei, Federated States of Micronesia Resour. Bull PSW-19. Pacific Forest and Range Experiment Station, Forest Service, US Department of Agriculture, Berkeley, California. *

Pillai, G. 1987. Mangroves of Fiji, their uses and management. *In.* Field, C.D & A.J Dartnall (eds) Mangrove Ecosystems of Asia and the Pacific: Status, exploitation and management: 150-160. Proc Research for Development Seminar, Townsville, Australia, May 1985 Australian Institute of Marine Science. *

Payri, C.E, C. Gabrié & Y Vernaudon 1994 Vers lamenagement et la gestion de l'environnement littoral et lagonaire d'un système insulaire polynésien: Etude du cas de Bora-Bora, îles de la Société, Polynésie française, Tahiti, I 17-71. *

Randall, R.H. 1995. Biogeography of reef-building corals in the Mariana and Palau Islands in relation to back-arc rifting and the formation of the Eastern Philippine Sea. *Nat. Hist Res.* 3(2):193-210. *

Randall, R.H. & L.G. Eldredge 1976. Atlas of Reefs and Beaches of Guam Coastal Zone Mgmt Sect., Bur. Planning, Guam *

Randall, R.H. & J Holloman 1974. Coastal survey of Guam *Univ Guam Mar Lab Tech Rept* 14 *

Richard, G., R. Bagnis, J Bennet, M Denizot, R. Galzin, M. Ricard & B Salvat 1981 Geomorphology, ecology and socio-economy of the Futuna marine ecosystems (Horn Archipelago - Polynesia) *Proc Fourth Int Coral Reef Symp., Manila* 1:269-274 *

Richard, G., R Galzin, G Salvat, R Bagnis, J. Bennett, M Denizot & M Ricard 1982. Wallis et Futuna. Etude de l'environment lagunaire et récifal des iles Wallis et Futuna (Polynésie Occidentale) Ecole Pratique des Hautes Etudes. Antenne de Tahiti *

Richmond, R H 1993a. Coral reefs Present problems and future concerns resulting from anthropogenic disturbance *American Zoologist* 33:524-536

Richmond, R H 1993b Effects of coastal runoff on coral reproduction *In* Ginsberg, R N (compiler) Proceedings of the Colloqium on Global Aspects of Coral Reefs: Health, Hazards and History, 10-11 June 1993, Miami University of Miami pp 360-364

Richmond, R.H 1994. Coral reef resources Pollution's impacts *Forum for Applied Research and Public Policy*, Spring, 9(1):54-57

Rongo, T. 1993. Cook Islands State of the Environment Report South Pacific Regional Environment Programme, Apia, Western Samoa.

Ryland, J.S. 1979. Introduction to the coral reefs of Fiji. *In:* Proc. Seminar Workshop on Utilisation and Management of Inshore Marine Ecosystems of the Tropical Islands, November 24-30, 1979. University of the South Pacific. pp 13-22. *

Ryland, J.S. 1981. Reefs of south-west Viti Levu and their tourism potential. *Proc. 4th Int. Coral Reef Symp., Manila* 1: 293-298. *

Salvat, B. 1990. The South Pacific towards 2000: Major environmental problems and monitoring networks. Int. Soc Reef Studies (ISRS) Annual Meeting, Noumea, New Caledonia, Nov 1990 pp 203-210 *

Salvat, B 1991 World coral reef network project A long term global plan to monitor coral reefs of natural and anthropogenic change XVII Pacific Science Congress, Honolulu, Hawaii. Abstract volume p 118 and *Pacific Science* 1992 46:380 *

Salvat, B 1992 Blanchissement et mortalité des scléractiniaires sur les récifs de Moorea (Archipel de la Société) en 1991 *C R Acad Sci. Paris, France* 314(II) 105-111 *

Scott, D A (ed) 1993 A Directory of Wetlands in Oceania IWRB, Slimbridge, UK and AWB, Kuala Lumpur, Malaysia

South, G R & H Kasahara 1992. A preliminary checklist of the benthic marine algae of the Fiji Islands, South Pacific *Micronesica* 25(1) 41-70

SPC 1995 Pacific Islands Social and Human Development. South Pacific Commission, Noumea, New Caledonia

SPREP 1993a. Cook Islands: National Environmental Management Strategies. South Pacific Regional Environment Programme, Apia, Western Samoa

SPREP 1993b. The Federated States of Micronesia: Nationwide Environmental Management Strategies. South Pacific Regional Environment Programme, Apia, Western Samoa.

SPREP 1993c. Republic of the Marshall Islands National Environmental Management Strategy: Part A State of the Environment Report 1992. South Pacific Regional Environment Programme, Apia, Western Samoa

SPREP 1993d. Solomon Islands: National Environmental Management Strategy. South Pacific Regional Environment Programme. Apia. Western Samoa

SPREP 1993e. The Kingdom of Tonga Action Strategy for Managing the Environment South Pacific Regional Environment Programme. Apia. Western Samoa.

Stoddart. D R 1972 Reef islands of Rarotonga *Atoll Res Bull* 160 1-7 *

Stoddart. D.R. 1975. Almost-atoll of Aitutaki. Geomorphology of reefs and islands *Atoll Res Bull* 190: 31-57 *

Sua. T S 1988 Information Note on the Mangroves of Western Samoa Report presented at the Working Group Meeting for the Regional Use of Mangroves in the Pacific Island Region. Apia, Western Samoa. *

Tappin, D R 1993. Beach-sand resources of Tonga. *British Geological Survey, Technical Report* WC/93/31.

Tatarata, M. & B. Salvat 1995. Bilan du réseau territorial d'observation du lagon de Tahiti (RTO). Propositions de poursuite du réseau. Délégation à l'Environnement (Tahiti) et CRIOBE-EPHE (Moorea). *

Taule'alo, T. 1993. Western Samoa: State of the Environment Report. South Pacific Regional Environment Programme, Apia, Western Samoa.

Thollot, P 1987. Importance de la mangrove pour l'ichthyofaune du lagon de Nouvelle-Caledonie Diplome d'etude affronfondie en Oceanologie. Centre d'Oceanologie de Marseille. ORSTOM, Noumea, New Caledonia. *

Thomas, P.E.J., F.R. Fosberg, L.S. Hamilton, D.R. Herbest, J.O. Juvik, J E Maragos. J.J Naughton & C.F. Streck 1989 Report of the Northern Marshall Islands natural diversity and protected areas survey 7-24 September 1988 South Pacific Regional Environment Programme. Noumea. New Caledonia and East-West Center. Honolulu

Thomassin. B A & P Vasseur 1982 The coral reef complexes of the SW coast of New Caledonia: Building and geomorphology Proc 4th Int. Reef Symp. Manila. 18-22 May 1981. 1 596 *

Tsuda. R T. F.R Fosberg & M H. Sachet 1977 Distribution of seagrasses in Micronesia. *Micronesica* 13(2):191-198 *

UN 1994 Programme of Action for the Sustainable Development of Small Island Developing States. New York

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, UK/UNEP, Nairobi, Kenya.

Watling, D. 1985. A Mangrove Management Plan for Fiji, Phase I. Government Press, Suva, Fiji

Watling, D. 1986. A Mangrove Management Plan for Fiji, Phase II. Government Press, Suva, Fiji

Watling, D. and S.P. Chape (eds) 1992. Environment Fiji - The National State of the Environment Report IUCN, Gland, Switzerland.

Weber, J.W. 1973. Generic diversity of scleractinian reef corals in the Central Solomon Islands. *Pacific Science* 27(4):391-398. *

Whistler. W.A. 1992. Vegetation of Tonga and Samoa *Pacific Science* 46(2):159-178 *

Wilkinson, C R. 1993. Coral reefs of the world are facing widespread devastation: Can we prevent this through sustainable management practices? *In*: R Richmond (ed) Proceedings of the 7th International Coral Reef Symposium, Guam, 22-27 June 1992. University of Guam Press, Mangilao. Vol. 1, pp 11-21.

Wilson, C. 1994 Kiribati. State of the Environment Report. South Pacific Regional Environment Programme, Apia, Western Samoa.

Woodroffe, C.D 1985 Vegetation and flora of Nui Atoll, Tuvalu. *Atoll Res. Bull.* 283 1-18. *

Woodroffe, C.D. 1987 Pacific island mangroves: Distribution and environmental settings. *Pacific Science* 41(1-4). 166-185. *

Zann, L. 1991. Inshore Resources of Upolu, Western Samoa. Coastal Inventory and Fisheries Database. FAO/UNDP SAM/89/002 Field Report No 5.

Zann, L.P. 1994. The status of coral reefs in south western Pacific islands. *Marine Pollution Bulletin* 29(1-3):52-61.

Zann, L. (ed) 1995 Our sea, our future: Major findings of the State of the Marine Environment Report for Australia. Ocean Rescue 2000 Program, GBRMPA, Townsville.

Zann, L P., W.J Kimmerer & R.E. Brock 1984 The ecology of Fanga'utu Lagoon, Tongatapu, Tonga. Univ. Hawaii, UNIHI-SEAGRANT-CR 84-04. *

Annex 1
Pacific Region Summary Information

Country or Territory	Marine Jurisdiction (km^2) [1]	Total No. of Island Systems [1,6]	Total Land Area (km^2) [1]	Population (year) [1,2,5,6]	Number of Recognisable Reef Systems [1,6,7]				No. of Mangroves Species Recorded (introduced) [2,3,4]	No. of Seagrass Species Recorded [2,3,4]
					Reef Communities [8] or Submerged Reefs [9]	Fringing	Barrier or Lagoon	Atoll		
American Samoa	390,000	7	197	49,000 ('91)	2	5	1	2	3	2
Australia (east)[10]	9,000,000	>900 [11]	7,682,300	18,000,500 ( )	571	795	1,603	542	✓	✓
Cook Islands	1,830,000	15	241	18,552 ('91)	0	7	1	7	×	×
FSM	2,978,000	69	701	111,600 ('90)	1	27	2	31	14	6
Fiji	1,290,000	844	18,272	760,000 ('91)	0	13	22	3	9	4
French Polynesia	5,030,000	118	3,265	212,000 ('94)	0	12	22	85	× (1)	1
Guam	218,000	2	541	133,152 ('90)	1	1	2	0	11	4
Hawaii	?	27	10,434	1,200,000 ('90)	14	11	2	5	× (2)	1
Kiribati	3,550,000	36	810	73,500 ('91)	3	15	0	18	4	1
Marshall Islands	2,131,000	34	181	48,000 ('91)	0	5	0	29	5	1
Nauru	320,000	1	21	9,919 ('92)	0	1	0	0	2	?
New Caledonia	1,740,000	?	19,103	164,173 ('89)	4	5	4	5	16	10
Niue	390,000	1	259	2,239 ('91)	0	1	0	0	1	×
Northern Marianas	1,823,000	15	471	17,600 ('81)	11	11	2	0	3	4
Palau	629,000	23	441	15,600 ('91)	2	19	1	3	13	10
PNG	3,120,000	> 1000 [9]	462,841	3,670,000 ('92)	5	24	15	41	35	10
Pitcairn Islands	800,000	4	43	53 ('93)	2	1	0	2	×	×
Solomon Islands	1,340,000	> 900	27,556	285,176 ('86)	1	16	10	3	22	✓
Tokelau	290,000	3	10	1,577 ('91)	0	0	0	3	×	×
Tonga	700,000	174	699	101,000 ('90)	7	37	6	0	8	2
Tuvalu	900,000	9	26	8,600 ('87)	1	3	0	4	2	✓
US - territories	!	7	28.2	4,900 ('81)	0	3	0	4	×	?
Vanuatu	710,000	47	12,190	142,630 ('89)	12	42	0	1	14	11
Wallis & Futuna	300,000	3	177	13,600 ('90)	2	3	1	0	×	✓
Western Samoa	120,000	9	2,935	161,298 ('91)	5	7	0	0	3	2

1. Modified from Maragos & Holthus (1996). 'system' means a group of interrelated individual islands or reefs ✓ = present × = absent, ? = no information. 2. Scott (1993). 3. UNEP/IUCN (1988). 4. Coles & Kuo (1995), Ellison (1995) 5. SPC (1995). 6. Review submissions 7. Data for Australia not complete for reefs in the Coral Sea. Information was available for Lihou and Mermaid reefs only (DEST pers. comm. 1995) 8. 'Reef communities' = where structural coral reefs are absent 9. 'Submerged reefs' = reefs lacking islands or permanent land. 10. Figures for marine jurisdiction, land area and population are for all of Australia, not just the east coast. 11. A precise figure is not available There are over 618 continental islands and 300 coral cays in the Great Barrier Reef Marine Park alone (DEST pers. comm. 1995).

Annex 2

Pacific Region - Research and Management Capacity

COUNTRY OR TERRITORY	EXTENT OF REEF SURVEY	PROTECTED AREAS [1]	MANAGEMENT CAPABILITIES			HIGHER EDUCATIONAL & RESEARCH FACILITIES WITH RELEVANT MARINE COURSES
			CAPACITY	RESEARCH & MONITORING	MANAGEMENT	
American Samoa	moderate	✓	moderate / high	moderate	moderate	American Samoa Community College
Australia (eastern)	moderate / high	✓	high	high	high	range of universities and institutes
Cook Islands	moderate	✓	moderate	low / moderate	moderate	none
FSM	low	×	low	low	low	College of Micronesia (FSM)
Fiji	low / moderate	(✓)	low / moderate	moderate	low / moderate	University of the South Pacific *[nb: regional]*
French Polynesia	moderate	✓	high	moderate / high	moderate / high	Université Française du Pacifique & EPHE-CRIOBE Moorea
Guam	high	✓	high	high	moderate / high	University of Guam
Hawaii	high	✓	high	high	high	University of Hawaii; Hawaii Pac. Univ.
Kiribati	low	(✓)	low	low	low	USP Atoll Research Programme
Marshall Islands	low	×	low	low	low	College of Marshall Islands(?)
Nauru	moderate	×	low	low	low	none
New Caledonia	moderate	✓	moderate / high	high	high	Université Française du Pacifique
Niue	low / moderate	×	low	low	low	none
Northern Marianas	low / moderate	(✓)	moderate	moderate	moderate	Northern Marianas College
Palau	moderate	✓	low	low / moderate	low / moderate	Palau Community College
PNG	low	✓	low / moderate	low	low	University of PNG; Univ. of Tech.(?)
Pitcairn Islands	low / moderate	×	low	low	low	none
Solomon Islands	low	(✓)	low	low	low	Solomon Islands College of Higher Education
Tokelau	low	×	low	low	low	none
Tonga	low	✓	low	low	low	none
Tuvalu	low	×	low	low	low	none
US - territories	moderate	✓	high	moderate / high	high	none
Vanuatu	low	✓	low	low	low	none
Wallis & Futuna	low	×	low	unknown	unknown	none
Western Samoa	low - moderate	✓	low	low	low	none

1. ✓ = includes reef areas, (✓) = adjacent, but excludes reef areas, × = none. Modified from UNEP/IUCN (1988) & Holthus & Maragos (1992) cited in Maragos & Holthus (1996). See also Annex 6.

Annex 3

Sources of Anthropogenic Stress on Coral Reef and Related Ecosystems in the Pacific Region

(Modified from Maragos & Holthus 1996)

COUNTRY OR TERRITORY	EXTENT OF REEF SURVEY	PROTECTED AREAS [1]	MANAGEMENT CAPABILITIES			HIGHER EDUCATIONAL & RESEARCH FACILITIES WITH RELEVANT MARINE COURSES
			CAPACITY	RESEARCH & MONITORING	MANAGEMENT	
American Samoa	moderate	✓	moderate / high	moderate	moderate	American Samoa Community College
Australia (eastern)	moderate / high	✓	high	high	high	range of universities and institutes
Cook Islands	moderate	✓	moderate	low / moderate	moderate	none
FSM	low	×	low	low	low	College of Micronesia (FSM)
Fiji	low / moderate	(✓)	low / moderate	moderate	low / moderate	University of the South Pacific *[nb: regional]*
French Polynesia	moderate	✓	high	moderate / high	moderate / high	Université Française du Pacifique & EPHE-CRIOBE Moorea
Guam	high	✓	high	high	moderate / high	University of Guam
Hawaii	high	✓	high	high	high	University of Hawaii; Hawaii Pac. Univ.
Kiribati	low	(✓)	low	low	low	USP Atoll Research Programme
Marshall Islands	low	×	low	low	low	College of Marshall Islands(?)
Nauru	moderate	×	low	low	low	none
New Caledonia	moderate	✓	moderate / high	high	high	Université Française du Pacifique
Niue	low / moderate	×	low	low	low	none
Northern Marianas	low / moderate	(✓)	moderate	moderate	moderate	Northern Marianas College
Palau	moderate	✓	low	low / moderate	low / moderate	Palau Community College
PNG	low	✓	low / moderate	low	low	University of PNG, Univ. of Tech.(?)
Pitcairn Islands	low / moderate	×	low	low	low	none
Solomon Islands	low	(✓)	low	low	low	Solomon Islands College of Higher Education
Tokelau	low	×	low	low	low	none
Tonga	low	✓	low	low	low	none
Tuvalu	low	×	low	low	low	none
US - territories	moderate	✓	high	moderate / high	high	none
Vanuatu	low	✓	low	low	low	none
Wallis & Futuna	low	×	low	unknown	unknown	none
Western Samoa	low / moderate	✓	low	low	low	none

1 ✓ = includes reef areas, (✓) = adjacent, but excludes reef areas, × = none. Modified from UNEP/IUCN (1988) & Holthus & Maragos (1992) cited in Maragos & Holthus (1996). See also Annex 6

Annex 4
Major Regional Programmes Concerning Coral Reefs and Related Ecosystems

(Note: This table is based upon responses received to requests for information and is therefore not a complete indication of all existing programmes)

ORGANISATION / INSTITUTION	ACTIVITY	DURATION (END DATE)	FUNDING SOURCE	AMOUNT (US$)	COUNTRIES INVOLVED
SPREP	Surveying; training; workshops; management plans. Coastal habitat surveys; mangrove management Conservation area establishment & management. EIA programme ICRI workshops (Philippines & Fiji)	5 yrs (Dec '95) 1 yr (Dec. 95) 5 yrs (Apr. '98) on-going 6 mth (Dec 95)	CIDA AusAID & US GEF via UNDP AusAID AusAID, CIDA, UNESCO/IOC, IUCN	~ 400,000 ~ 95,000 10m ~ 120,000	All 22 Pacific island SPREP members
SOPAC	Coastal aggregate resource surveys Coastal monitoring & process studies Coastal mapping & remote sensing Training, workshops & scholarships Regional data centre	1 yr ('96) 1 yr ('96) 1 yr ('96) 1 yr ('96) 1 yr ('96)	AusAID & EU CIDA, China, EU, CFTC France EU, CIDA, AusAID, CFTC, NZ EU	~ 211,000 ~ 470,000 ~ 267,000 ~ 338,000 ~ 120,000	All 15 Pacific island SOPAC members
South Pacific Commission	Inshore fisheries assessment, management advice & attachment training Integrated Coastal Fisheries Management Project	on-going Sept 94-Aug 97	UK ODA, UNDP, ACIAR, FAO	 1.5m	All 22 Pacific island SPC members
University of the South Pacific	Marine studies programme (pre-degree; certificates, diplomas, bachelor's & post-graduate); continuing education, marine public education programme.	on-going	various	?	USP's 12 member countries (Cook Is., Fiji, Kiribati, Marshall Is., Nauru, Niue, Solomon Is., Tokelau, Tonga, Tuvalu, Vanuatu, W Samoa)
East-West Center	Rapid ecological assessment; marine monitoring; EIA training; risk assessment; protected areas planning; funding graduate degree fellowships for Pacific Islanders	1989-1995	Variable MacArthur, ADB, National Park Service, SPREP, TNC EWC, Ocean Policy Institute	?	American Samoa, FSM Palau, Marshall Is, Hawaii and other Pacific island countries

ORGANISATION / INSTITUTION	ACTIVITY	DURATION (END DATE)	FUNDING SOURCE	AMOUNT (US$)	COUNTRIES INVOLVED
International Ocean Institute - South Pacific	Training courses: management & development of coastal fisheries; coastal management with reference to small islands; management issues in resource & environmental economics; fisheries economics & management; practical taxonomy & identification of tropical Indo-Pacific non-geniculate coralline algae	on-going	UNDP, Comm. Sec., Sasakawa Foundation, etc.	150,000 (annual)	All Pacific countries
The Nature Conservancy	Rapid ecological assessments; marine protected areas; community based marine resource management	on-going	Various: US, Japan & other private & government sources	?	PNG, Solomon Islands, Palau
Pacific Island Network	Extension; technical assistance; training; marine & coastal project support	?	US Govt.	?	American Samoa, FSM, Marshall Is, Palau, NMI, Hawaii
University of Guam Marine Laboratory	Coral reef research; regional technical support and training; BS and MS degree programmes; community education	on-going	Government of Guam; grants & contracts		Guam, Palau, FSM, Marshall Is., US, Asia

Annex 5
Key Institutions in the Region Involved with Regional Coral Reef and Related Ecosystems Activities

South Pacific Regional Environment Programme (SPREP)

Address: P.O. Box 240, Apia, Western Samoa Tel: (685) 21929; Fax: (685) 20231

Type: Regional inter-governmental organisation
Area: Environment
Countries: 22 Pacific island member governments
Relevant Programs: Coastal Management & Planning; Conservation of Biological Diversity; Climate Change; Environmental Education & Training, Prevention & Management of Pollution; Environmental Management & Planning, Environmental Information; Capacity 21.
Key Activities: Integrated coastal management; management plan development; coastal habitat surveying; training; information; development of conservation areas; species conservation; EIA

South Pacific Applied Geoscience Commission (SOPAC)

Address: Private Mail Bag, GPO, Suva, Fiji Tel: (679) 381139; Fax (679) 370040

Type: Regional inter-governmental organisation
Area: Geoscience
Countries: 15 Pacific island member governments
Relevant Programs: Coastal, Training, Information
Key Activities: coastal mapping; coastal management (geoscience), training courses & scholarships, geoscience information

South Pacific Commission (SPC)

Address: B.P. D5, Noumea Cedex, New Caledonia Tel: (687) 262000; Fax (687) 263818

Type: Regional inter-governmental organisation
Area: Fisheries, Agriculture Demography, Rural Technology Economic Statistics Community Health
Countries: 22 Pacific island member governments
Relevant Programs: Coastal Fisheries
Key Activities: Inshore resource assessment & management, fisheries information

Forum Fisheries Agency (FFA)

Address: P.O. Box 629, Honiara, Solomon Islands Tel: (677) 21124 Fax (677) 23995

Type: Regional inter-governmental organisation
Area: Fisheries
Countries: 14 Pacific island member governments
Relevant Programs:
Key Activities: Fisheries assessment and management

The University of the South Pacific (USP)

Address: P.O. Box 1168, Suva, Fiji Tel: (679) 305272, Fax (679) 301490

Type: University
Area: Education, research & consulting
Countries: 12 Pacific island country members
Relevant Programs: Marine Studies Programme, Ocean Resources Management Programme, Atoll Research Programme (Tarawa, Kiribati), Institute of Marine Resources (Honiara, Solomon Is.); Pacific Islands Marine Resources Information System (PIMRIS); Marine Public Education Programme (Institute of Education).
Key Activities: Certificate, diploma and degree courses on campus & by extension

University of Papua New Guinea (UPNG)

Address: P.O. Box 320, Waigani, PNG Tel: (675) 253900, Fax: (675) 267187.

Type: University
Area: Education, research & consulting
Countries: PNG
Relevant Programs: Biology; Motopure Is Research Station
Key Activities: Coastal management, ecology

University of Guam (UOG)

Address: Marine Laboratory, UOG Station, Mangilao 96923, USA. Tel: (671) 734 9510; Fax: (671) 734 6767.

Type: University
Area: Education, research & technical assistance
Countries: Guam, Micronesia
Relevant Programs: Marine Laboratory
Key Activities: coral reef research; MS degree programme; technical assistance; research experiences for undergraduate and high school students, particularly Pacific islanders; regional training

Université Française du Pacifique

Address: B.P. 4635, Papeete, Tahiti, French Polynesia Tel: (689) 421680 Fax: (689) 410131.
B.P. 4477, Noumea, New Caledonia Tel: (687) 254955; Fax: (687) 254829.

Type: University
Area: Education, research & consulting
Countries: French Pacific Territories
Relevant Programs:
Key Activities: Coral research, anthropogenic impacts on corals & lagoons, monitoring (bleaching); training

University of Hawaii (various depts)

Address: University of Hawaii at Manoa, Honolulu, HI 96822, USA Tel (information): (808) 956 8111 Fax

Type: University
Area: Education, research & consulting.
Countries: Pacific region, Japan, Korea, China
Relevant Programs & Key Activities: Dept of Botany - algae & invertebrates Dept of Zoology - reef fish, Hawaii Institute of Marine Biology - coral reefs, Oceanography - deep sea, palaeoecology, coastal geomorphology, Geography; Pacific Biomedical Research Center - genetic research coral reefs; Sea Grant Program - Pacific Island Network, extension, applied research; Pacific Island Studies; Urban & Regional Planning - CZM, planning, Social Science Research Institute

James Cook University of North Queensland (JCUNQ)

Address: Post Office, James Cook University, Townsville, Qld 4811, Australia. Tel: (61-7) 7814111; Fax: (61-7) 7251570

Type: University
Area: Education, research & consulting.
Countries: Australia, Asia, Pacific
Relevant Programs: School of Biological Studies; Environmental Studies
Key Activities: coral reef and mangrove research [need to obtain more information]

East-West Center

Address: 1777 East-West Rd, Honolulu, HI 96848 USA. Tel. (info): (808) 944 7111; Tel.(coastal, EIA): (808) 944 7271; Fax (envirn.): (808) 944 7298

Type: US federally funded international center for technical and cultural interchange between the East (Asia-Pacific) and West (USA).
Area: Research, education, monitoring, management.
Countries: Mainland USA, Hawaii, tropical island Pacific, East-Asia, SE Asia, South Asia to Red Sea (excludes Africa & rest of Americas)
Relevant Programs: Environment, Pacific Islands Development Program (PIDP)
Key Activities: Environment: Coastal management, EIA, protected areas rapid assessment, risk assessment, training, monitoring

Great Barrier Reef Marine Park Authority (GBRMPA)

Address: P.O. Box 1379, Townsville, Qld 4810, Australia. Tel: (61-77) 818811; Fax: (61-77) 726093

Type: Government authority
Area: Management, planning, research, monitoring & consulting.
Countries: Australia, Asia, Pacific
Relevant Programs:
Key Activities: Management of the Great Barrier Reef Marine Park; [need to obtain more information]

Australian Institute of Marine Science (AIMS)

Address: PMB No 3, Townsville, Qld 4810, Australia. Tel: (61-77) 534211. Fax: (61-77) 725852

Type: Research institute
Area: Research, monitoring, consulting & training.
Countries: Australia, Asia, Pacific
Relevant Programs:
Key Activities: coral reef and mangrove research and monitoring; [need to obtain more information]

Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER)

Address: B.P 2059, Noumea. Tel (687) 285171; Fax: (687) 277122. B.P. 7004, Taravao, Tahiti. Tel: (689) 571274; Fax (689) 572477

Type: French Government
Area: Research
Countries: French Pacific Territories
Relevant Programs:
Key Activities: Coral research, coastal management, surveys, training

Institut Français de Recherche Scientifique pour le Développment en Coopération (ORSTOM)

Address: Centre ORSTOM - Tahiti, BP 529, Papeete, French Polynesia. Tel: (689) 439887; Fax: (689) 429555

Type: French international research institutional network
Area: Research, monitoring
Countries: French Pacific territories
Relevant Programs:
Key Activities: Anthropogenic impacts on coral reefs, remote sensing mariculture, ecological studies on coral reefs; coral bleaching, training.

Ecole Pratique des Hautes Etudes (EPHE-CRIOBE)

Address: B.P 1013, Papetoai, Moorea, Polynesie française Tel: (689) 561345, Fax. (689) 562815.

Type: French research institution
Area: Research, monitoring, education, consulting.
Countries: French Polynesia
Relevant Programs:
Key Activities. Stability of reefs, carbon budgets, anthropogenic pollution & natural events, socio-economy of reefs & resources, EIA monitoring, biodiversity, coastal management; training, remote sensing, conservation & protected areas

Sea Grant Extension Service Pacific Island Network (PIN)

Address: University of Hawaii Sea Grant Extension Service, MS 226, Honolulu, Hawaii 96822, USA Tel: (808) 9569875, Fax: (808) 956 2858

Type: US Government
Area: Extension
Countries: US-Affiliated islands (except Guam)
Relevant Programs: In-country extension agents
Key Activities: Extension; technical assistance; training, marine & coastal project support

Pacific Science Association (PSA)

Address: P.O Box 17801, Honolulu, Hawaii 96817, USA. Tel: (808) 848 4139; Fax: (808) 841 8968

Type: Association
Area: Information exchange
Countries: Pacific region
Relevant Programs: Pacific Science Congresses, Scientific Task Forces & Committees; Publications
Key Activities: Information exchange, meetings

International Center for Living Aquatic Resources Management Coastal Aquaculture Center (ICLARM CAC)

Address: PO Box 438, Honiara, Solomon Islands. Tel: (677) 20255; Fax: (677) 22130.

Type: NGO
Area: Research, monitoring, management
Countries: Solomon Islands
Relevant Programs: Clams, reefs
Key Activities: clam research, reef research

International Ocean Institute Operational Centre (IOI-South Pacific)

Address: c/- USP, P.O. Box 1168, Suva, Fiji. Tel: (679) 305446, Fax: (679) 305559

Type: NGO
Area: Education, training
Countries: Pacific region
Relevant Programs: UN/DOALOS TRAIN-SEA-COAST; Curriculum Development Unit
Key Activities: Training courses; leadership seminars; curriculum development in ocean policy, fisheries management and development, & coastal management; networking, quarterly newsletter PASIFIKA, Ocean year book, PACEM IN MARIBUS annual conference

The Nature Conservancy (TNC)

Address: Pacific Region, 1116 Smith Street, Honolulu, Hawaii 96817, USA. Tel: (808) 537 4508. Fax: (808) 545 2019.

Type: NGO
Area: Biodiversity conservation
Countries: PNG, Solomon Is, Palau, some Pacific region
Relevant Programs: Research, management, monitoring
Key Activities: Rapid ecological assessments; marine protected areas regional biodiversity conservation, community based marine area & resources management; marine ecosystem classification system, traid marine tenure & use rights' destructive fishing practices

Greenpeace Pacific Campaign

Address: (1) 14 MacGregor Rd, Suva, Fiji. Private Mail Bag Suva, Fiji Tel: (679) 312861; Fax (679) 312784
(2) Private Bag, Wellesley St, Auckland, NZ. Tel. (64 9) 377 6128
(3) 139 Townsend St, San Francisco, CA 94107, USA. Tel: (415) 512 9025.

Type: NGO
Area: Research, public awareness, monitoring.
Countries: Pacific region
Relevant Programs: Coral reef coastal management
Key Activities: Research (coral bleaching); information exchange, awareness, community based sustainability; direct action.

World Wide Fund for Nature South Pacific Office (WWF)

Address: 4 Ma'afu Street, Suva, Fiji; c/- Private Mail Bag, Suva, Fiji. Tel: (679) 315533, Fax. (679) 315410

Type: NGO
Area: Research, public awareness, monitoring, management.
Countries: Pacific region
Relevant Programs: Coastal management
Key Activities:

Annex 6
Existing Protected Areas for Coral Reef and/or Adjacent Island Environments in the Pacific Region.

(Modified from Maragos & Holthus 1996 (Table 20) based on UNEP/IUCN 1988 and Holthus & Maragos 1992; and review submissions).

American Samoa

Rose Atoll National Wildlife Refuge
Fagatele Bay National Marine Sanctuary
Ofu Territorial Marine Park
American Samoa National Park (Tutuila & Ofu)

Australian Islands

(2 within insular tropical Pacific, excluding 4 more associated with Great Barrier Reef)

Lord Howe Island Permanent Park Reserve
Elizabeth and Middleton Reefs Marine National Nature Reserve
Plus a large number of Queensland State Marine Parks, Fishery Reserves and other reserves

Cooks

Suwarrow Atoll National Park
Avatiu Foreshore Reserve (excludes reef areas)
Aitutaki Trochus Reserve
Pukapuka village reserves (seasonal closures)

Federated States of Micronesia

none

Fiji

(all exclude reef areas)

Viti Levu
- Vuo Island
- Draunibota Island
- Labiko Island

Makogai lagoon (by agreement between Tui Levuka & the Minister for Primary Industries)

French Polynesia

Marquesas (all exclude reef areas)
- Hatuta'a
- Eiao
- Mohotani
- Motu One

Society Is. - Manuae
Tuamotus - W.A. Robinson Integral Reserve

Guam

Anao Conservation Reserve
Andersen Airforce Base Ecological Reserve
Haputo Ecological Reserve Area
Orote Peninsula Ecological Reserve Area
Pati Point Natural Area
War in the Pacific National Historic Park
Luminao Barrier Reef
Guam National Wildlife Refuge

Hawaii & Other U.S. Islands

Hawaii Island
- Kealakekua Bay Marine Life Conservation District (MLCD)
- Lapakahi State Historical Park MLCD
- Wailea Bay MLCD
- Hilo Bay Marine Fisheries Management Area (MFMA)
- Kailua Bay MFMA

Kaho'olawe
- Humpback Whale National Marine Sanctuary

Kauai
- Waimea Bay & Recreational Pier MFMA
- Hanamaula Bay & Ahukini Recreational Pier MFMA
- Mililii Reef State Park
- Nualolo-Kai Reef State Park

Lanai
- Hulopoe Bay - Palawai-Manele Bay - Kamao MLCD
- Manele Boat Harbor MFMA

Maui
- Honolua & Mokuleia Bay MLCD
- Kahului Harbor MFMA
- Cape Kinau, Ahihi & La Perouse Bays State Natural Area Reserve
- Molokini Islet MLCD

Kure MFMA
Northwest Hawaiian Islands (except Kure & Midway)
- National Wildlife Refuge (NWR)

Oahu
- Hanauma Bay MLCD
- Pupukea Beach Park MLCD
- Waikiki - Diamond Head MLCD
- Coconut Island Marine Refuge

Baker Island NWR
Howland Island NWR
Jarvis Island NWR
Johnston Atoll NWR

Japan

Okinawa
- Kaigan Quasi National Park
- Iriomote National Park

Ishigaki
- Kabira Bay Marine Sanctuary
- Nagura Bay Marine Sanctuary

Kiribati

(all exclude adjacent reef areas)

Kiritimati Wildlife Sanctuary
Malden Wildlife Sanctuary
Starbuck Wildlife Sanctuary
Rawaki Wildlife Sanctuary
McKean Wildlife Sanctuary
Vostok Wildlife Sanctuary
Birnie Wildlife Sanctuary

Marshall Islands

none

Nauru

none

New Caledonia

New Caledonia shoreline protected zone
Parc du Lagon Sud
Maitre Islet Nature Reserve
Amedee Islet Nature Reserve
Great Reef Rotating Reserve
Yves Merlet Marine Reserve

New Zealand

(Kermadecs, Tokelau)

none

Niue

none

Northern Mariana Islands

(all exclude reef areas)

Guguan
Maug
Farallon de Pajaros
Asuncion
Saipan
Managaha Island

Palau

Ngerukuid Islands Wildlife Preserve
Ngerumkaoul Channel Fisheries Reserve
Ikedelukes Reef Trochus Reserve
Ngederrak Reef Fisheries Reserve

Papua New Guinea

New Britain
- Talele Island Nature Reserve
- Nanuk Island Provincial Park
- Garu Wildlife Management Area (WMA)

Manus
- Lou Island WMA
- Ndrolowa WMA

Milne Bay (New Guinea)
- Sawataetae Wildlife Management Bay
- Baniara Island Protected Area

Madang
- Ranba (Long) Island WMA
- Macclay Park

Karkar
- Bagiai WMA

Western Province
- Maza WMA

Solomon Islands

(all exclude reef areas)
- Tulagi
- Oema
- Mandoleana
- Dalakalau
- Dalakalonga

Tonga

Nuku'alofa
- Fanga'uta & Fangakakau Lagoon Reserve

Ha'atafu Beach Reserve

Hakaumama'o Reef Reserve

Malinoa Island Park and Reef Reserve

Monuafe Island Park and Reef Reserve

Pangaimotu Reef Reserve

Tuvalu

none

Vanuatu

Espiritu Santo
- President Coolidge and Million Dollar Point Marine Reserve

Efate
- White Sands Recreational Reserve

Aore
- Bukaro Recreational Reserve
- unnamed Recreational Reserve

Malo
- Naomebaravu Recreational Reserve

Wallis & Futuna

none

Western Samoa

Upolu

Palolo Deep Marine Reserve

Saanapu/Sataoa Mangrove Forest Conservation Area

Aleipata District Conservation Area