Republic Of The Marshall Islands Marine Resources Profiles

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PREFACE

The South Pacific Forum Fisheries Agency (FFA) was approached by the Marshall Islands Marine Resources Authority (MIMRA), to provide technical assistance in the compilation of a set of marine resources profiles. The terms of reference provided to the consultant were:

1. With assistance from national fisheries staff, examine all closed and current files pertaining to fisheries resource matters in the Marshall Islands held at the Marshall Islands Marine Resources Authority;

2. Assess, collate and compile all written matter, data, etc, which provides information relating to resource abundance, distribution, exploitation, etc, in Marshall Islands;

3. Review existing legislation controlling the exploitation of living marine resources in Marshall Islands and advise on appropriate regulations for controlling the existing fisheries for those resources currently not protected;

4 Based on the information examined, produce a comprehensive set of resource profiles for the marine resources of Marshall Islands in a similar format to the profiles that have been produced for other FFA member states.

The report was prepared during and immediately after a four week visit to the Republic of the Marshall Islands (RMI) in June, 1992. This report provides an overview of the major marine resources identified as being of importance to the commercial, artisanal and subsistence fisheries sectors in the RMI. The main purpose is to provide the basic information required to assess the current levels of exploitation, and to identify the research and management requirements for future developments.

The information for each marine resource is divided into four main areas: a brief description of the resource (the species present, their distribution, and the aspects of their biology and ecology relevant to exploitation and management); an overview of the fishery (its utilization, production levels and marketing); the status of the stocks; and management concerns (research issues, the current legislation and policies regarding exploitation, and recommended management options).

A comprehensive listing of marine resources references is available for the RMI (see Izumi, 1992). A number of the references listed in Izumi (1992) are not held anywhere in the RMI and were therefore not used for this review. Where possible these references are noted in the relevant sections of the profiles. The references cited throughout the report should be consulted for more details on specific resources.

Funding for this report was provided jointly by the Australian International Development Assistance Bureau (AIDAB) and the Pacific Islands Network (PIN) of the National Oceanic and Atmospheric Administration, USA. The assistance provided by Mr Danny Wase (Director), Mr John Bungitak (Deputy Director), Mr Mike White (Advisor), Mr Ronald Alfred (Fisheries Officer) and the other MIMRA staff members was greatly appreciated. The cooperation provided by Ms Elizabeth Harding (EPA) is greatfully acknowledged.

The consultant assumes full responsibility for the contents of this report. Opinions, where expressed, are his alone and in no way reflect the policy of FFA, MIMRA or the RMI government.

LIST OF ABBREVIATIONS & ACRONYMS

ADB - Asian Development Bank
AFD - Arno Atoll Fisheries Development Project
AIDAB - Australian International Development Assistance Bureau
CITES - Convention on the International Trade in Endangered Species
CPUE - Catch Per Unit Effort
CZ - Coastal Zone
DWFN - Distant Water Fishing Nations
EEZ - Exclusive Economic Zone
EPA - National Environmental Protection Authority
FAD - Fish Aggregating Device
FFA - Forum Fisheries Agency
FOB - Free On Board
FSM - Federated States of Micronesia
GDP - Gross Domestic Product
IUCN - International Union for Conservation of Nature & Natural Resources
JICA - Japan International Cooperation Agency
JTPA - Job Training Partnership Act
KADA - Kwajalein Atoll Development Authority
MFCA - Majuro Fishermen's Cooperative Association
MIA - Marshall Islands Aquaculture
MIAFC - Marshall Islands Aquaculture Farmers Cooperative
MIDA - Marshall Islands Development Authority
MIMRA - Marshall Islands Marine Resources Authority
MMDC - Micronesian Mariculture Demonstration Center
MOP - Mother of Pearl Shell
MSY - Maximum Sustainable Yield
NEC - North Equatorial Current
NECC - North Equatorial Counter-Current
NEP - National Environment Protection Act
OFCF - Overseas Fishery Cooperation Foundation
OPS - Office of Planning & Statistics
PFDF - Pacific Fisheries Development Foundation
PIN - Pacific Islands Network
RMI - Republic of the Marshall Islands
RRE - Robert Reimers Enterprises
RTTP - Regional Tuna Tagging Programme
SCUBA - Self Contained Underwater Breathing Apparatus
SPC - South Pacific Commission
SSAP - Skipjack Survey and Assessment Programme
TBAP - Tuna & Billfish Assessment Programme
TTPI - Trust Territory of the Pacific Islands
US - United States of America

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SUMMARY

The Republic of the Marshall Islands (RMI) consists of two island chains of 29 atolls and five low-elevation coral islands in the central Pacific. The total land area is only 70.05 square miles, with 4,506.87 square miles of lagoonal areas, and an Exclusive Economic Zone (EEZ) of over 750,000 square miles. The population level in the 1988 census was 43,380, and the average annual growth rate was 4.17 percent.

The Marshall Islands Marine Resources Authority (MIMRA) is the primary agency responsible for the exploration, exploitation, regulation and management of the living and non-living marine resources in the RMI. The National Environmental Protection Authority (EPA), Marshall Islands Development Authority (MIDA), Kwajalein Atoll Development Authority (KADA), and the local atoll governments also play significant roles in the exploitation and regulation of the marine resources sector. The resolution of jurisdictional overlaps is urgently required to avoid potential management problems.

The second five-year development plan (1991/92 to 1995/96) identifies the fisheries sector as one of the key areas for development. A considerable portion of that effort is being directed towards developing the pelagic fisheries sector (primarily tunas), through infrastructure development (such as shore facilities) and establishment of a locally based longline fishery. This is initially occurring through joint venture agreements between the government and foreign companies. Additional assistance in establishing a local longline fishery is being received through the Asian Development Bank funded Fisheries Development Project. This project will provide shore facilities and fishing vessels, as well as institutional strengthening and training.

From the limited information available, it does not appear that the deep-slope fish resources of the RMI would be sufficient to sustain a commercial fishery.

With the exceptions of Majuro, Arno and Kwajalein atolls, virtually all of the inshore fisheries are subsistence based. The Japanese Overseas Fishery Cooperation Foundation (OFCF) has been developing has been developing small scale lagoon, bottom and trolling fisheries at Arno Atoll since August 1989. All fish is marketed at Majuro. The project has involved considerable infrastructure development at Arno. It has yet to prove economically viable and self sustaining. The concept, with certain significant modifications, is soon to be expanded to three other atolls by the government, with assistance from OFCF. The main objective of the project is to provide the outer atoll residents a means of augmenting their income, currently limited to copra production, and to reduce migration to the urban centers. The fish will be marketed at Kwajalein, where demand for fresh, salted and dried fish is high.

As with other Pacific countries, the RMI is looking to aquaculture/mariculture to provide employment and income opportunities in the outer atolls. To date this sector has concentrated on clam farming (grow-out), with one private hatchery operating. MIMRA is in the process of expanding its clam facility at Likiep, with the aim of developing it into a mariculture center. Trochus harvesting occurs on some atolls; a small commercial black-pearl oyster farm is being developed at Namodrik; and the feasibility of seaweed farming is being assessed.

Legislation relating to RMI's marine resources requires review and revision in a number of areas. Of importance is the resolution of the legislative overlaps, especially between MIMRA and EPA. New and/or updated legislation will be needed to address the developing commercial exploitation (especially export) of some marine resources, for example, coral and aquarium fish collection. The lack of an overall marine resources and coastal zone management plan is serious. The considerable effort being expended in fisheries and other development activities, if not coordinated and managed through appropriate planning, is likely to produce adverse environmental problems. MIMRA and EPA, in conjunction with the local governments, need to address this deficiency without delay.

A. BACKGROUND

A.1 THE COUNTRY

The Republic of the Marshall Islands (RMI) consists of two archipelagos of 29 atolls and five low-elevation coral islands in the central Pacific. The two island chains, the eastern *Ratak* ("Sunrise") and western *Ralik* ("Sunset") are located about 129 miles (208 km) apart and lie in a north-west to south-east direction between 4^{o} 34'N to 14^{o} 43'N latitude and from 160^{o} 48'E to 172^{o} 10'E longitude. Mean height above sea level is about 8 to 10 feet (2.5 m), with the highest point in the RMI only 33 feet (10 m). The total land area is 70.05 square miles, with 4,506.87 square miles of lagoon area, and an Exclusive Economic Zone (EEZ) of over 750,000 square miles (see Table 1). Nineteen atolls and four islands are inhabited.

The climate of the RMI is tropical (hot and humid), with relatively uniform temperatures throughout the year (average 81^{o} F or 27.2^{o}C) and a mean humidity (in Majuro) of 81.3 percent. Rainfall varies greatly from north to south, with the northern most atolls receiving 40 to 70 inches per year, and the southern ones 130 to 200 inches per year. Majuro, the capital and a southern atoll, receives an average annual rainfall of 132 inches, but with distinct seasonal variation. October and November are the wettest months and December to April (when the northeast trade winds prevail) are the driest.

A.2 THE PEOPLE

The people of the Marshall Islands are of Micronesian descent. Their cultural heritage remains strong and is reflected in the social, political and economic life of the country. The society is organized according to a complex class structure. Traditional extended family and clan systems are still prominent. The society is matrilineal with land and property rights descending from the mother's clan. Since the late 1800s the Marshall Islands have been under the successive controls of Germany, Japan and the US. After World War II the Marshall Islands was included as part of the United Nations' Trust Territory of the Pacific Islands (TTPI) administered by the US. The RMI became an independent nation in late 1986, and was adopted into the United Nations in 1991. Under a Compact of Free Association with the United States, the RMI is responsible for its own internal and foreign affairs, while the US has been delegated the responsibility for defence and providing economic assistance (US$715 million) over a 15 year interim period.

Table 1: Geography and population of the Republic of the Marshall Islands.

Name	Type	Approx. # Islets	Area (sq. mi.) Lagoon	Land	Population - 1988 (Av.Growth Rate %)
Ratak Chain					
Taongi	atoll	10	30.13	1.25	-
Bikar	atoll	7	14.44	0.19	-
Utirik	atoll	10	22.29	0.94	409 (+2.41)
Taka	atoll	6	35.96	0.22	-
Mejit	island	1	-	0.72	445 (+3.86)
Ailuk	atoll	55	68.47	2.07	488 (+2.05)
Jemo	island	1	-	0.06	-
Likiep	atoll	65	163.71	3.96	482 (+0.03)
Wotje	atoll	75	241.06	3.16	646 (+2.31)
Erikub	atoll	16	88.92	0.59	-
Maloelap	atoll	75	375.57	3.79	796 (+3.19)
Aur	atoll	43	92.58	2.17	438 (-0.17)
Majuro	atoll	64	113.92	3.75	19,664 (+6.28)
Arno	atoll	103	130.77	5.00	1,656 (+1.32)
Mili	atoll	92	294.70	6.15	854 (+1.38)
Knox	atoll	18	-	-	-
Ralik Chain					
Enewetak	atoll	44	387.99	2.26	715 (+3.40)
Ujelang	atoll	30	25.47	0.67	0
Bikini	atoll	36	229.40	2.32	10
Rongerik	atoll	14	55.38	0.65	-
Rongelap	atoll	61	387.77	3.07	0
Ailininae	atoll	25	40.91	1.08	-
Wotho	atoll	18	36.65	1.67	90 (+0.70)
Ujae	atoll	15	71.79	0.72	448 (+4.56)
Lae	atoll	20	6.82	0.56	319 (+3.65)
Kwajalein	atoll	93	839.30	6.33	9,311 (+4.18)
Lib	island	1	-	0.36	115 (+1.96)
Namu	atoll	54	153.53	2.42	801 (+2.49)
Jabat	island	1	-	0.22	112 (+5.42)
Ailinglaplap	atoll	56	289.69	5.67	1,715 (+2.62)
Jaluit	atoll	91	266.31	4.38	1,709 (+2.02)
Kili	island	1	-	0.36	602 (+2.55)
Namodrik	atoll	2	3.25	1.07	814 (+3.40)
Ebon	atoll	22	40.09	2.22	741 (-2.21)
Total:		1,225	4,506.87	70.05	43,380 (+4.17)

Source: Statistical Abstracts 1989/1990, Office of Planning & Statistics.

The government of the RMI consists of a bi-cameral legislature, an executive (President and Cabinet), a judiciary and a public service. The two legislative bodies consist of the Council of Iroij (upper house with 12 members) and the Nitijela (lower house with 33 members). The Council of Iroij

are traditional leaders and review legislative matters affecting customary law, traditional practices, or land tenure legislation as adopted by the Nitijela. The President is a member of, and elected by a simple majority of the Nitijela and is authorized to nominate between six and ten members of the Nitijela to serve as members of his cabinet. The judiciary consists of a Supreme Court, a High Court and a Traditional Rights Court. The public service is headed by a Chief Secretary and assists the cabinet in exercising its executive authority. There are 24 local governments. Typically each local government consists of an elected council, a mayor, appointed local officials and a local police force.

The RMI government is dependent on four major sources of revenue (all from the US) and two minor sources. The US provides funding through: the lease of Kwajalein Atoll for military purposes; the Compact of Free Association; US Federal grants for education, health and social services; and compensation for contamination of atolls from atomic testing during the 1950s. Monies are also generated from import taxes, philatelic sales, and assistance in the form of capital, goods and services from various foreign nations. The RMI has some limited natural resource generated income which mainly comprises compensation for fishing rights and agricultural production (based on copra production).

The census in 1988 indicated a population of 43,380 for the RMI. The intercensal (1980 to 1988) average annual growth rate was 4.17 percent (see Table 1), and the average annual increase between 1958 and 1988 was 3.8 percent. The population estimate for 1995 is 56,216. In 1988, 51 percent of the population was under 15 years of age. Almost half the population lives on Majuro Atoll, while another 19 percent live on Ebeye Island in Kwajalein Atoll. Migration from outer atolls to urban areas is high. In 1988, 20,512 people out of 43,380 lived on another atoll prior to moving to the atoll where they were enumerated. Urban movement is also indicated by Majuro's very high annual average growth rate of 6.28 percent. Urbanization has also been accompanied by a profound westernization of lifestyle.

A.3 INSTITUTIONS/AGENCIES

Marshall Islands Marine Resources Authority (MIMRA)

MIMRA is the primary agency responsible for the exploration, exploitation, regulation and management of living and non-living marine resources in the RMI. It was created by the Nitijela in 1988 as an independent statutory authority responsible to a five-member Board of Directors, of which the Minister of Resources and Development is chairman.

Prior to the establishment of MIMRA, marine resources activities were the responsibility of the Marine Resources Division (Ministry of Resources and Development) and the

Marshall Islands Maritime Authority. All of their responsibilities were transferred to MIMRA.

The Director of MIMRA is responsible for its management and administration. Some of the powers and duties of MIMRA include:

-the conservation, management and control of the exploration and exploitation of all living and non-living resources in the fishery waters,[1] seabed, and subsoil;

-the establishment and implementation of the EEZ management program;

-the issuing of fishing licenses;

-the issuing of licenses for the exploration and exploitation of the seabed and subsoil of the fishery waters;

-the negotiation and, with the approval of Cabinet, conclusion of foreign fishing agreements;

-participation in the planning and execution of programs related to fisheries or fishing, or the exploration or exploitation of the non-living resources of the fishery waters, seabed or subsoil.

The enforcement and surveillance division has recently been moved from MIMRA's oversight, to the Attorney Generals Office. With the Fisheries Development Project funded through the Asian Development Bank, MIMRA proposes to reorganize and expand its staffing levels.

National Environmental Protection Authority (EPA)

EPA was established as an independent authority in 1984, and is funded directly by the Nitijela. The Authority consists of a Chairman and four other members. EPA activities are run by a General Manager who oversees a staff of twelve, who in turn are responsible for numerous activities including: public education, laboratory analyses, pollution control, nature preservation, and regulatory oversight of solid wastes, earth-moving, water quality, toilet facilities, and pesticide use.

The responsibilities of EPA are diverse: study the impacts of human activities on the environment; restore and maintain environmental quality; promote the beneficial human-environment interaction; coordinate governmental plans and functions as they relate to the environment; regulate human activities; and, preserve important cultural, historical and natural environmental resources.

[1] "Fishery waters" are the waters of the territorial sea, EEZ and internal waters, including lagoons and any other waters.

The EPA has been given the power to enforce its policies by use of cease and desist orders, civil penalties, civil proceedings and criminal penalties.

Marshall Islands Development Authority (MIDA)

MIDA was created by the "Marshall Islands Development Authority Act 1984" as the business arm of the RMI government. It is an independent statutory authority whose primary function is to investigate, study, develop and implement social and economic development programs and projects.

Kwajalein Atoll Development Authority (KADA)

KADA was created by the "Kwajalein Atoll Development Authority Act 1985" for the social and economic development of Kwajalein Atoll. Its primary functions are to investigate, study, develop, implement and aid in the financing of social and economic development programs and projects, including fisheries activities, in Kwajalein Atoll, especially Ebeye islet.

Local Government (RMI Constitution, Article IX)

The jurisdiction of the local governments extend to the sea and the seabed of the internal waters of the atoll or island and to the surrounding sea and seabed to a distance of five miles from the baselines from which the territorial sea is measured. These local governments may make ordinances for their areas of jurisdiction, provided that they are not inconsistent with any Act, legislative instrument (other than a municipal ordinance), or any executive instrument.

A.4 MARINE RESOURCE LEGISLATION

This section provides a brief overview of current RMI legislation relevant to marine resources exploitation and management. The details relating to specific resources are included in the relevant profiles. A detailed review of RMI's environmental legislation has been prepared by the legal counsel to the RMI Environmental Protection Authority (see Harding, 1992).

Marine Zones (Declaration) Act 1984 (Title 33, Chapter 2)

This Act defines the internal waters, the archipelagic waters, the territorial sea, the exclusive economic zone, and the contiguous zone of the Republic.

Internal waters: are all waters on the landward side of the baseline[2] or, as declared by Cabinet, to landward of physical

[2] The "baseline" is defined as the low water line of the seaward side of the reef fringing the coast of any part of the

features marked on official charts or geographical coordinates between which lines are drawn to determine the outer limits of the internal waters in the case of the entrances to lagoons.

Archipelagic waters: comprise all areas of sea contained within the baselines established by the Cabinet with the Nitijela's approval, by reference to physical features marked on official charts or geographical coordinates between which straight baselines are drawn to determine the outer limits of the archipelagic waters and the inner limits of the territorial sea.

Territorial sea: is the sea within twelve nautical miles from the baseline of the Marshall Islands, or from the archipelagic baseline if outside the limits of the internal waters.

Exclusive economic zone: the seas of which the inner limit is the outer limit of the territorial seas, and their outer limits a line drawn 200 nautical miles seaward from the baselines from which the territorial sea is measured.

Contiguous zone: that part of the sea within twenty-four nautical miles from the baseline from which the territorial sea is measured.

The sovereignty of the RMI extends over the internal, archipelagic and territorial seas, the air space over them and seabed and subsoil under them, and the resources contained therein. Within the EEZ the RMI has sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources. All relevant laws of the RMI extended to the contiguous zone, and has all rights necessary to prevent infringement of its customs, fiscal, immigration and health laws.

Public Lands and Resources Act (Title 9, Chapter 1, Section 3)

This Act states that all marine areas below the ordinary high water mark belong to the government, with the following exceptions: (a) the rights to erect, use and control fish weirs or traps as were recognized by local customary law at the time the Japanese administration abolished them; (b) such fishing rights on and in waters over reefs where the general depth of water does not exceed four feet at mean low water as recognized by customary law at the time such rights were abolished by the Japanese administration. These exceptions create no right to misuse, abuse, destroy, carry away or damage mangrove trees or the land abutting the ocean or lagoon.

RMI or bounding any lagoon waters adjacent to any part of the coast, or, where a reef is not present, the low water line of the coast itself.

Marshall Islands Marine Resources Authority Act 1988 (Title 33, Chapter 4)

This Act establishes the Marshall Islands Marine Resources Authority (MIMRA) and provides for the exploration, exploitation, regulation, corporation and management of marine resources and related matters.

In addition to the powers and duties listed for MIMRA above, it also has the power to make regulations concerning:

-the conservation, management and protection of fish and other aquatic organisms in the fishery waters;

-the catching, loading, landing, handling, transporting, possession and disposal of fish;

-the use of fishing gear and equipment;

-the issue, suspension and cancellation of licenses;

-the pollution of the fishery waters;

-the export of fish from the RMI;

-the licensing and control of fish aggregating devices.

Part III of the Act concerns foreign fishing, in particular: foreign fishing licenses - application, revocation, suspension, variation and period of validity; and foreign and regional fishing agreements.

Part IV of the Act concerns activities other than foreign fishing, such as: the development of local fisheries; issuing of licenses to local fishing vessels; issuing of licenses for non-commercial fishing; issuing of licenses for fish processing; and the issuing of licenses for non-living resources.

The Act states that it is illegal for foreign fishing vessels to fish the fishery waters without the appropriate license. Additionally, it is illegal for anybody to use, or permit to be used, explosives, poisons or other noxious substances for the purpose of killing, stunning, disabling or catching fish.

Marshall Islands Marine Resources Authority (Amendment) Act 1989

This Act[3] prohibits the use of drift nets. A drift net is defined as a gillnet or other net which is more than 2.5 kilometers in length, entangles fish or other marine life, and

[3] A copy of this Act was not seen by the consultant. This paragraph was based on Harding (1992).

is left to drift in the water without attachment to any point of land or the seabed. This Act was passed in concert with the Nitijela's approval of the Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific. The Convention and its Protocols was adopted in Wellington, New Zealand in November, 1989.

Marine Resources Act (Title 33, Chapter 1)

This Act regulates fishing and protects endangered species in the RMI. Specifically:

Section 2 - Fishing with explosives, poisons, chemicals, etc.: It is illegal to knowingly catch fish or other marine life by means of explosives, poisons, chemicals or other substances which kill fish or marine life, nor shall any person possess or sell any fish or any other marine life caught by those means. The Minister in charge may grant written permission under specific circumstances. Exclusion is made for the catching of any fish or other marine life by the use of local roots, nuts, or plants which have the effect of stupefying but which do not kill fish or other marine life.

Penalties shall be a fine of not less than US$100 or more than US$2,000, or imprisonment for not less than six months or more than two years, or both.

Section 3 - Limitations on taking turtles: See turtle profile for details and comment.

Section 4 - Control of sponges: No sponges artificially planted or cultivated shall be taken or molested, except by permission of Cabinet. See sponge profile for comments.

Section 5 - Control of Pinctada margaritifera (black-lip mother-of-pearl oyster shell): See pearl oyster profile for details and comment.

Marine Resources (Trochus) Act 1983 (Title 33, Chapter 3)

This Act is to regulate the harvesting of trochus. It encompasses the regulation of harvesting of trochus; permitted taking of trochus during an open season; and removal for replanting. Details are discussed in the trochus profile.

Endangered Species Act 1975 (Title 8, Chapter 5)

This Act provides for the protection of endangered[4] species of

[4] An "endangered species" is defined as any species which is in danger of extinction throughout all or a significant portion of its range. "Threatened species" are any species which are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

fish, shellfish and game in the RMI. The RMI government policy is that the indigenous plants and animals of the RMI are of aesthetic, ecological, historical, recreational, scientific, and economic value and will foster the well-being of these plants and animals by whatever means necessary to prevent the extinction of any species or subspecies from the islands of the RMI or the water surrounding them. The Nitijela has determined that certain species of plants and animals are threatened with or in danger of becoming extinct in the Republic.

The Act allows for a number of exemptions, including: permitted take for scientific purposes; species raised in commercial quantities under controlled conditions of aquaculture, mariculture; where subsistence take for old traditional uses does not further endanger the species involved, provided that there is no commercial or export activity involved.

The endangered species listed on the former TTPI Territorial Register (Vol.2, No.1, page 436) are still valid for the RMI (Harding, pers. comm., 1992). Those species are: blue whale (*Balaenoptera musculus*); sperm whale (*Physeter catadon*); Ratak Micronesian pigeon (*Ducula oceanica ratakensis*); hawksbill turtle (*Eretmochelys imbricata*); and leatherback turtle (*Dermochelys coriacea*).

National Environment Protection Act 1984 (Title 35, Chapter 1)

This Act provides for the establishment of a National Environmental Protection Authority for the protection and management of the environment. In relation to marine resources Sections 29, 30 and 32 are especially relevant:

Section 29 - Natural resources: The EPA, in conjunction with the Council and with the assistance of the Ministry of Resources and Development, recommend to the Minister the basic policy on the management and conservation of the country's natural resources in order to obtain the optimum benefits and to preserve them for future generations.

Section 30 - Fisheries: The EPA shall, in consultation with the Council and with the assistance of the Ministry in charge of the subject of fisheries, recommend to the Minister a system of rational exploitation of fisheries and of the aquatic resources within the territorial waters and the EEZ, and shall encourage citizen participation to maintain and enhance the optimum and continuous productivity of the waters. Measures for the rational exploitation of fisheries and other aquatic resources may include the regulation of the harvesting and marketing of threatened species of fish or other aquatic life.

Section 32 - Studies, research, etc: The EPA may undertake and promote continuing studies and research programs on

environmental management and shall from time to time determine priority areas of environmental research.

Coast Conservation Act 1988 (Title 33, Chapter 5)

This Act makes provision for a survey of the coastal zone[5] and the preparation of a coastal zone management plan; to regulate and control development activities within the coastal zone; and to make provisions for the formulation and execution of schemes for coast conservation.

The administration, control, custody and management of the coastal zone (CZ) is vested in the EPA. Part III of the Act concerns coastal zone management. Section 6 directs that as soon as practical a survey of the coastal zone be conducted and a report prepared which includes:

-an inventory of all structures, roads, excavations, harbors, outfalls, dumping sites and other works located in the CZ;

-an inventory of all coral reefs found within the CZ;

-an inventory of all commercially exploitable mineral deposits, both proven and suspected, located within the CZ;

-an inventory of all areas within the CZ of religious significance or unique scenic value or of value for recreational purposes, including those areas most suitable for recreational bathing;

-an inventory of all estuarine or wetland areas within the CZ with an indication of their significance as fisheries or wildlife habitat;

-an inventory of all areas within the CZ of special value for research regarding coastal phenomena, including fisheries and shell fisheries, sea erosion, littoral movements and related subjects;

-an inventory of all areas within the CZ from which coral, sand, sea shells or other substances are regularly removed for commercial or industrial purposes;

-an assessment of the impact of sea erosion on the CZ including a quantified indication, by geographical location, of the amount of land lost thereby, an estimate of the economic cost of such loss and the extent to which

[5] The "coastal zone" is defined in the Act as the area laying within a limit of twenty-five feet landwards of the mean high water line and a limit of two hundred feet seawards of the mean low water line.

human activity has contributed to such a loss;

-an estimate of the quantities of sand, coral, sea shells and other substances being removed from the CZ, together with an estimate of the extent to which such quantities can be supplied from other sources or other materials and an analysis of the economic practicability of doing so; and

-a census, classified by geographical areas, and by activity, of all workers currently engaged on a regular basis in the removal of coral, sand, sea shells or other substances from the CZ and a census of the dependents of such workers and estimate of the per capita income obtained from these activities.

Section 7 directs the EPA to prepare a comprehensive Coastal Zone Management Plan within three years from the date of operation of the Act. The plan is to include:

-the guidelines to be used in determining the suitability of particular development activities in the CZ;

-proposals which deal with the following subjects within the CZ:
-land use;
-transport facilities;
-preservation and management of the scenic and other natural resources;
-recreation and tourism;
-public works and facilities, including waste disposal facilities, harbors and power plants;
-mineral extraction;
- living resources;
- human settlements;
-agriculture;
-industry;

-proposals for the reservation of land or water in the CZ for certain uses, or for the prohibition of certain activities in certain areas of the CZ;

-a comprehensive program for the utilization of manpower displaced as a direct result of more effective CZ regulation; and

-recommendations for strengthening Governmental policies and powers and the conduct of research for the purposes of coast conservation.

Upon acceptance of the Coastal Zone Management Plan, any development activity within the CZ, except for activities exempted by EPA, will require a permit.

Marine Mammal Protection Act 1990

This Act provides for the protection of dolphins and other marine mammals captured in the course of commercial fishing operations in the eastern tropical Pacific Ocean by flag vessels of the RMI.

A.5 MANAGEMENT OF MARINE RESOURCES

There is an overlap of responsibilities for marine resource matters between MIMRA, EPA and the local governments. MIMRA has the complex task of developing, managing and conserving all marine (living and non-living) resources. EPA, in part, is responsible for providing recommendations on the exploitation and management of fisheries resources, to recommend basic policy on natural resource management and conservation, and to conduct environmental management research programs. Additionally, it has responsibility for coastal zone management. Local governments have the power to regulate their own marine resource usage.

With current staffing levels (and staff qualifications and expertise), neither MIMRA nor EPA are able to fully execute their legislated responsibilities. To some extent institutional strengthening will occur in the near future through separate ADB funded projects, however, this will not resolve the potential problems of the jurisdictional overlaps.

What is urgently needed is a meeting between MIMRA and EPA to arrive at an understanding as to which agency should take primary responsibility for specific areas. One positive aspect of jurisdictional overlaps is that it provides a "check and balance" system, which is desirable when you have one agency charged with both encouraging exploitation as well as management and conservation.

The following are suggestions for possible areas of primary responsibility for each agency:

MIMRA: should concentrate on commercial fisheries development and its regulation and management, and all associated responsibilities (licensing, agreement negotiations, export control, etc); fisheries data collection; and aquaculture development.

EPA: in relation to marine resources, it should concentrate on conservation of protected species; development of reserve or sanctuary areas; environmental and biological baseline surveys and inventories; coastal zone[6] management planning; and the

[6] The extent of the "coastal zone", as defined in the Coast Conservation Act, is unrealistic. In atolls, **all** land areas should be included within the coastal zone, as every activity on land will have a direct impact on the marine areas. To try and separate the "coastal zone" from the rest of the land will create a planning and bureaucratic nightmare, and will not permit environmentally sound coastal management. I realize that

development and implementation of environmental education programs (which include marine resources).

What is urgently required is an overall marine resources management plan, which includes government policies for marine development, management and conservation, and has appropriate review guidelines incorporated. It will need to be jointly developed by MIMRA and EPA, in close association with the local governments. However, as mentioned above, the main limitation will be obtaining appropriate staff at MIMRA and EPA.

A.6 DEVELOPMENT PLAN

The long term socio-economic development objectives which are to be pursued by the government during the period of the second five year plan (1991/92 to 1995/96) are (source: OPS, 1992):

-ensure a continued increase in the real incomes of the Marshallese people through promoting self-sustaining growth of the economy;

-increase employment opportunities for a rapidly growing labor force;

-improve the quality of life of the people;

-promote balanced development among urban and rural areas, and equitable income distribution;

-promote national identity and unity through the preservation and promotion of common cultural heritage.

At present a substantial proportion of the RMI's Gross Domestic Product (GDP) is derived from the public sector expenditures and the US Army at Kwajalein Atoll. Close to three fourths of the public sector expenditure is funded from overseas grants. Less than a fifth of the GDP comes from production activities using domestic resources.

The fisheries sector has been identified as one of the key development areas for the government during the second five year planning period. The objectives for the marine resources sector are:

-raise the domestic fish production to a level where local demand can be satisfied, food imports be reduced and export revenues increased;

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to change the definition of the "coastal zone" will be legislatively and politically difficult, but it needs reviewing at least.

-have in place a commercially viable marine resource sector, based on:
    - small scale coastal fishing
    - large scale pelagic fishing
    - fish transshipment and processing
    - aquaculture

-establish Majuro as a canning base for domestic and foreign tuna vessels;

-have in place the human resources, able to plan, implement, maintain, administer and coordinate development in the marine resource sector;

-improve the Republic's capacity to protect its Exclusive Economic Zone in a cost effective manner;

-establish a system, able to collect, analyze and disseminate data on all aspects related to the marine resource sector.

-to provide the outer islands with a viable alternative/supplement for copra production, by establishing the necessary infrastructure, facilitating marine resource activities.

The following targets are to be achieved by the end of the planning period (OPS, 1992):

-most of the outer islands will have their own small scale fishing project, providing a permanent source of employment and income and increased levels of skills and knowledge;

-domestic fish production will have been increased to a level where local demand can be satisfied and surplus be exported;

-more joint-ventures will have been established in the marine resource sector;

-Majuro will have a tuna canning facility;

-domestic reared giant clams, trochus, blacklip oysters, etc, will be available for all outer islands interested in starting aquaculture;

-patrolling will be optimized in terms of cost-benefits;

-information regarding marine resource statistics will be available in a comprehensive way on a monthly basis.

The following programs and projects are planned for implementation or continuation during the Plan period:

-Coastal Fisheries Development Program (expanding the Arno Fisheries project to other outer atolls);
-Sashimi Tuna Fish Agency (Joint Venture);
-Tuna cannery project (based at Majuro);
-Ika-shibi fishing;
-Fish aggregating devices;
-Ebeye fisheries pilot project (ADB funded project);
-Mariculture development center (expansion of MIMRA's Likiep clam hatchery facility);
-Clam reseeding phase II;
-Arno fisheries pilot project;
-Majuro fisheries training center (ADB funded project);
-Longline fishing and training project;
-Project management unit (ADB technical assistance);

B. MARINE RESOURCES PROFILES

1. CRUSTACEANS

1.1 COCONUT CRAB

1.1.1 The Resource

Species Present: The coconut crab, *Birgus latro*.

Distribution: Coconut crabs have a wide Indo-Pacific distribution, from the Seychelles to Tuamoto Archipelago in the eastern Pacific. In the RMI they are found on a number of atolls.

Biology & Ecology: Coconut crabs are omnivorous scavengers. The species is the largest and least marine dependent of the land crabs. Growth is very slow and heavily influenced by environmental factors, which is a key reason why the species cannot be commercially cultured. Large adults may attain 8.8 pounds (4 kg) weight (Brown & Fielder, 1988). Reese (1971) estimated that size at maturity is around three to five inches (7.6 - 12.7 cm) carapace width for crabs on Enewetak, at an age of four to eight years. Fletcher (1988), working in Vanuatu, estimated a 1.3 pound (600 gm) crab to be 12 to 15 years old. Molting takes about a month and is carried out in a shallow hole plugged with earth forming a visible hump on the surface. Mating occurs in summer months (May to September), with a peak in July to August (Reese, 1971). The female carries the eggs under her abdomen attached to hairs. After about one month the female moves to the shore and releases the eggs into the sea. After hatching, the larvae remain planktonic for around four to five weeks before settling, developing a shell and becoming amphibious. The young crab will carry a shell for around nine months, becoming increasingly terrigenous (Brown & Fielder, 1988). As they grow they move further inland away from the coast.

Fletcher (1988) found recruitment to be low and highly variable. Replenishment of heavily exploited populations is therefore slow.

1.1.2 The Fishery

Utilization: Coconut crabs are collected and eaten as a delicacy throughout Micronesia (Reese, 1971). Collection is primarily for subsistence purposes, but there is a high commercial demand for them in the urban centers (Majuro and Ebeye).

Coconut crabs are caught at night with coconut meat baits laid in the bush, or by searching for burrows with pointed sticks during either day or night. Coconut crabs can be kept alive, with their claws and legs bound, for days if undamaged and kept cool. Whether for local consumption, domestic or export

markets, by keeping the crab alive the need for ice or freezing is eliminated.

Production & Marketing: The level of subsistence harvest of coconut crabs is not known, nor is the amount entering the domestic markets.

Thomas (1989) notes that up to 500 coconut crabs are taken per annum by Wotho islanders, with foraging trips taking place almost every week for the few months of the year when fuel supplies are available.

1.1.3 Status Of The Stocks

Current coconut crab stock status is not known for any area of the RMI.

Thomas (1989) recorded the presence of coconut crabs during a northern atoll survey. For Wotho Atoll he noted that very few large crabs remain on the atoll, with Kabben islet possessing the main crab population.

On Rongerik Atoll, Thomas (1989) found that the coconut plantation on Rongerik islet provided the most favorable habitat and with large crabs (probably around 7 - 10 lbs; 3 - 5 kg or more), indicating that the crab population has been left virtually undisturbed since the Bikinians departure in 1947.

Despite advice that Erikub islet (Erikub Atoll) was renowned for its large coconut crab population, Thomas (1989) notes that only one large coconut crab was observed along with many large empty burrows. A number of small crabs were sighted which suggested that over-exploitation of the crab population had occurred and tighter controls over future harvesting were needed (Thomas, 1989).

1.1.4 Management

Current Legislation/Policy Regarding Exploitation: No legislation or regulation could be found specifically relating to coconut crabs.

Recommended Legislation/Policy Regarding Exploitation: Until there is some coconut crab stock assessment information available for the RMI, all domestic sales should be severely restricted, and any export prevented. Coconut crab biology (low and highly variable recruitment and slow growth) does not lend to commercial exploitation of this species.

Reese (1971) suggested a three step plan to manage and control coconut crab exploitation in Palau, Yap, Saipan and Guam. Thomas (1989) also provided recommendations for coconut crab management. The following combines, and slightly modifies, both sets of recommendations. These recommendations could form

the basis of regulations at either the national level (MIMRA or Marine Resources Acts), at the local government level, or both.

-The export and local sale of coconut crabs be prohibited by law. Coconut crabs cannot sustain commercial harvesting;

-where coconut crabs have been heavily depleted, a ban be imposed on their collection until such time as it is assessed that the population has recovered sufficiently to allow limited harvesting on a sustained yield basis;

-where coconut crabs are present on a number of islets within an atoll, and if land tenure/resource ownership permits, a series of rotating protected areas should be considered. This would involve only allowing harvesting of a limited number of crabs from one islet for a set period of time (preferably measured in years), then rotating the islet to be harvested every few years.

-that collection of crabs with a carapace length smaller than 3.5 inches (9 cm) (the median size of female reproductive activity) be prohibited;

-that the collection of crabs from beaches two days before and 6 days after a new moon be prohibited to allow females to deposit their eggs in the sea undisturbed.

-that education programs be developed (and perhaps combined with other resource issues) explaining the vulnerability of coconut crabs to over-exploitation due to their life history characteristics.

1.2 LAND CRAB

1.2.1 The Resource

Species Present: *Cardiosoma* species. No references to the exact species present could be found.

Distribution: Land crabs are found throughout RMI.

Biology & Ecology: Adult land crabs live in the inland areas of islands amongst the ground cover vegetation, and come out at night to feed. Several days before the full moon, especially during the summer months (May-June), they undertake mass migrations to the sea. The crabs emerge at dusk, around two days before the full moon and make their way to the shore. The larvae are released from the eggs into the waves by vigorous flapping of the abdomen. Release of larvae at spring tides presumably maximizes dispersal along the coast (Nichols, 1991).

1.2.2 The Fishery

Utilization: Land crabs are used primarily for subsistence purposes, and are mainly consumed as a change of diet. They are caught alive by hand at night, especially during their spawning migrations. There have been some local sales of crabs.

Production & Marketing: There are no data available on land crab production or marketing in the RMI.

1.2.3 Status Of The Stocks

No data is available for stock estimates anywhere in the RMI.

1.2.4 Management

Current Legislation/Policy Regarding Exploitation: There is currently no legislation or regulations concerning land crabs.

Recommended Legislation/Policy Regarding Exploitation: Until more information is collected concerning exploitation and some estimates of stocks are available, it will be difficult to recommend any legislation or policy.

1.3 LOBSTER

1.3.1 The Resource

Species Present: The two species of rock lobster with commercial value in the RMI are *Panulirus penicillatus* and *Panulirus versicolor*. A less abundant species of low commercial value, *Panulirus longipes femoristriga*, is also present.

The slipper lobsters, *Parribacus antarcticus* and *Palinurellus wieneckii* have been recorded from Enewetak (Devaney, *et al*, 1987b), and *Scylarides spp.* may also be present.

Distribution: All species are believed to be distributed throughout the RMI. Devaney, *et al* (1987b), however, notes that *P. versicolor* has been recorded from Arno Atoll, but not from Enewetak Atoll.

Biology & Ecology: Ebert and Ford (1986) evaluates the population ecology and fishery potential of *Panulirus penicillatus* at Enewetak Atoll. MacDonald (1971, 1979, 1988) provides a comprehensive study of the Micronesian rock lobsters, but concentrates on Palau.

P. penicillatus is the most abundant and largest species (up to 5 lbs), but occupies a limited range of habitats. It is most commonly found on the outer reef slope in the sectors most often exposed to the prevailing winds (north-easterly). They are found from one foot (0.3 m) to 16 feet (4.9 m) deep, but their greatest concentration is from 4 to 6 feet (1.2 - 1.8 m) deep. This species is gregarious, especially sheltering under plate corals (*Acropora spp*), along surge channels and under ledges. It is also found in the wave washed zone on the reef flats, and to a lesser extent it is present within lagoons, but only where the wind and wave action is sufficient. The carapace size ranges of *P. penicillatus* caught by Ebert and Ford (1986) in their study at Enewetak were 37.5 mm to 139.8 mm for the males and 31.7 mm to 108.4 mm for females.

P. versicolor is a smaller species (< 4 lbs) and prefers calm water inside and outside the lagoon to a depth of 70 feet (21 m). The species is often found under *Porites lutea* coral heads. It is not gregarious, with adults rarely sharing the same shelter.

P. longipes femoristriga is small (< 1.5 lbs) and occupies a habitat intermediate to the above species. It occupies clear water just on the lagoon side of active reef edges amongst dense coral growth. It can sometimes be found in the shallow water below the surge zone outside the reefs.

The slipper lobsters are apparently uncommon, with some species occupying the surge zone with *P. penicillatus*.

Carapace size at sexual maturity for *P. penicillatus* in Palau is 10 cm and in the Solomons 7.5 to 7.9 cm; for *P. versicolor* in Palau it was around 8.2 cm (MacDonald, 1982 in Nichols, 1991; Skewes, 1990). *P. penicillatus* and *P. versicolor* at Palau reproduce throughout the year, with about 40 percent of females being ovigerous (bearing eggs) in any month (MacDonald, 1979). The total standardized crude reproductive rate of female *P. versicolor* is much greater than that of *P. penicillatus* (MacDonald, 1979). Larvae of tropical lobsters remain planktonic for many months, perhaps as long as six to ten months (MacDonald, 1971). The duration of the larval stage depends on a variety of oceanographic conditions such as food availability and water temperature (Clarke, nd). Therefore recruitment may occur from spawning adult populations a considerable distance away. After settling on the reef, *P. penicillatus* take about two years for females and three years for males to reach maturity (Clarke, nd).

1.3.2 The Fishery

Utilization: Spiny lobsters are exploited as a subsistence food resource throughout the RMI. Trap fishing in Micronesia is not successful as *P. versicolor* does not enter traps and the habitat of *P. penicillatus* is unsuitable for trapping (MacDonald, 1971). Spiny lobsters are most often speared by divers, mostly during the day but also at night with flashlights. *P. penicillatus* were traditionally caught by hand on the reef flats at night during low tide by torch light (Hiatt, 1951). Ebert and Ford (1986) conducted their sampling at Enewetak Atoll by searching the reef flat at night during low tide. They found that females ventured further up onto the reef flat than did males.

Production & Marketing: There is no information available on the level of subsistence harvest in the RMI. There is reportedly some sale of lobster in the local stores. There are reports that approximately four years ago there was some export of lobsters to Hawaii, but no details could be located. Milone, *et al* (1985) lists the landings and value of lobsters recorded by the Majuro Fishermen's Cooperative Association from 1978 to 1982: 1978 - 400 lb (US$400); 1979 - 100 lb (US$100); 1980 - 200 lb (US$200); and none in 1981 and 1982.

1.3.3 Status Of The Stocks

The only information available on the status of the spiny lobster stocks in the RMI is from Ebert and Ford's (1986) study at Enewetak Atoll. They estimated the population size for their three study sites as: 164 per km (Enjebi Is.); 87 per km (Ananij Is.) and 35 per km (Enewetak Is.). From their data they estimated a total of 7,800 lobsters for the windward half of the atoll (assuming a 1:1 sex ratio). They calculated the natural mortality rate to be 25% per year (M = 0.284) for males and 22% per year (M = 0.244) for females. They used a

dynamic-pool model to evaluate characteristics of yield related to potential fishing intensity, and their calculations indicated that moderate levels of fishing (with the instantaneous fishing mortality coefficient, F = 0.5) would provide average lobster weights of about 450 gm. This would be an annual fishing rate of about 40 percent. With a stock of 7,800 lobsters this would be about 3,000 animals each weighing about 450 gm. They conclude that *P. penicillatus* could support a modest fishery that would yield about one metric tonne (total wet weight) per year for the windward half of the atoll.

The relationship between stock and recruitment could not be deduced from Ebert and Ford's (1986) data. However, they believe that due to the long (up to ten months) planktonic period of the larvae, fishing pressures at a single site such as Enewetak Atoll should have minimal effect on the recruitment rate at Enewetak.

Clarke (nd) made an estimate of the potential lobster fishery production level based on Ebert and Ford's (1986) data. Using biomass estimates of 126 lobsters (450 gm/lobster) per kilometer of windward exposure reef and 35 lobster per kilometer of non-windward exposed reef, provided a total of 4,279 total lobsters on Maloelap Atoll.

No documentary evidence could be found to suggest that lobster stocks are being over-harvested at the present time in the RMI, although MIMRA staff indicated that Majuro Atoll may be over-harvested.

1.3.4 Management

Current Legislation/Policy Regarding Exploitation: There is no legislation or policy specifically regarding the harvesting or management of lobsters in the RMI.

Recommended Legislation/Policy Regarding Exploitation: There is presently very little information on which to formulate policies. Of prime importance is the collection of catch, market and export data. Clarke (nd) recommends that fishermen be required to report at the time of sale of their lobsters: the number of hours spent searching for lobsters; the number of lobsters caught but not sold, i.e. used for consumption; and the number of berried females or small lobsters caught but returned to the reef.

If the export of lobsters is to be reintroduced, then close monitoring of collection areas, size and quantities exported needs to occur. Control of export could be regulated through the current MIMRA Act if needed.

MacDonald (1971) argues against regulations prohibiting the take of females with eggs. He asserts that the number of mature females is not the limiting factor for lobster

population size in Micronesia, but that the lack of suitable habitat for larval settlement is. He further suggests that even heavy removal of mature females will leave enough spawners to provide sufficient young to maintain high population levels. The inaccessibility of the lobsters' habitat due to strong winds and heavy surf for half the year provides enough protection to maintain stocks. He believes that the variation in stocks that occur have resulted from favorable or unfavorable marine environmental conditions regardless of the size of the spawning stock.

However, Clarke (nd) disagrees, and recommends that female lobsters bearing external egg masses should be prohibited from commercial harvest or sale. Until further studies are conducted, it is advisable to opt for conservative management options, and therefore not permit the sale of egg bearing females.

Clarke (nd) recommends that lobsters with carapace lengths of less than three inches (75 mm) be prohibited from commercial harvest or sale. The size recommendation is based on the fact that 50 percent of the Enewetak males are mature at 71.4 mm and 50 percent of the females are mature at 67.9 mm (Ford and Ebert, 1986).

In relation to minimum size limits, MacDonald (1971) recommends that if imposed, they should not serve to insure that lobsters spawn at least once, but should rather exist as an economic regulation to prevent harvest of unmarketable individuals and/or as a biological regulation to maintain maximum sustainable yield. Further, he considers that management proposals to discontinue spearing are not warranted unless the market value can be substantially improved by alternate methods or unless the quality of the product is jeopardized through rapid spoilage after spearing.

1.4 DEEP-WATER SHRIMP

1.4.1 The Resource

Species Present: The caridean shrimps *Heterocarpus laevigatus* (smooth nylon shrimp) and *Heterocarpus ensifer* (armed nylon shrimp). Other species are also present, but are of minimal significance commercially.

Nautilus species are also caught in deep-water shrimp traps and may represent a valuable by-catch. The deep-sea red crab, *Geryon spp.*, is of commercial value in the US and is caught in depths greater than 330 fathoms (600 m)(King, 1986).

Distribution: Cardinean shrimps have been caught on the deep slopes around the atolls of the RMI. Their distribution is highly depth related, with species occupying different but overlapping depth ranges. Medium sized *Heterocarpus* species predominate in catches over 220 fathoms (400 m), and the largest, *H. laevigatus* is common below about 270 fathoms (500 m)(King, 1986). Trapping tests indicate that the depth distributions of these species may change seasonally (King, 1986).

Biology & Ecology: *H. ensifer* is a medium sized shrimp, ranging from 20 - 45 gm (0.7 - 1.6 oz) weight and up to a carapace length of 1.1 inches (29 mm) (4.9" or 125 mm total length). *H. laevigatus* is larger and can exceed 90 gm (3.2 oz) weight and up to a carapace length of 2.2 inches (56 mm) (about 8.5" or 217 mm total length)(King, 1986; Nichols, 1991).

Very little is known of the biology of caridean shrimps. Analysis of length-frequency data of *H. laevigatus* has provided some growth estimates. Data suggest a mean age for first capture of about 1.2 years (16 mm carapace length) and sexual maturity at approximately 4 to 5 years (40.5 mm carapace length)(King, 1986). A combination of slow growth rates with high natural mortality rates suggests that the biomass of shrimps from a given recruitment is maximized at an early age. After which the available biomass rapidly declines (King, 1986).

1.4.2 The Fishery

Utilization: Deep-water shrimp are specialty food items suitable for local tourist restaurants or export (frozen or iced).

Production & Marketing: An established business in Majuro attempted deep-water shrimp fishing on a trial basis for about one year in 1984 (Kramer, pers. comm., 1992; Milone, *et al*, 1985). Two vessels were used but the manager felt the operation was hindered by a lack of efficient equipment. A number of styles of traps were tested, but most commercial

traps were not as effective as those constructed by the company. A large proportion of the commercially available traps were lost to strong currents and coral. They found sandy areas to produce higher catches. Traps were set over night and hauled during the day. Due to inadequate equipment they could only haul about eight traps per day.

The production figures from the project are no longer available, but traps would catch a maximum of 10 to 15 kg (22 - 33 lbs) per trap per night. Average catches were less than a "couple of hundred" pounds per day (Kramer, pers. comm., 1992).

The lack of relative abundance and distribution information hindered the project. Requests for outside assistance to conduct exploratory surveys and for technical assistance (including proper handling and in developing markets) were unsuccessful (Kramer, pers. comm., 1992).

Elsewhere in Micronesia (Palau, Yap and Kosrae) brief exploratory fishing has occurred (Saunders, 1987, 1988; Saunders & Hastie, 1989). Those surveys recommended that systematic studies be undertaken to assess the potential of the resources. However, the potential for this fishery appears to be limited. Considerable investments in vessels and specialized equipment for catching and handling would be required.

Kramer (pers. comm., 1992) found that the shrimp tended to spoil very quickly, and lasted longest if cooked and then frozen.

There may be limited markets in Majuro (restaurants), but most produce would need to be exported. Markets for caridean shrimps already exist in Guam and Hawaii. Saunders (1988) suggests that *H. laevigatus* could bring about US$7 - 8/lb at market.

1.4.3 Status Of The Stocks

There is no information available on the status of deep - water shrimp stocks in the RMI.

1.4.4 Management

Current Legislation/Policy Regarding Exploitation: There is no legislation concerning deep-water shrimps or their exploitation.

Recommended Legislation/Policy Regarding Exploitation: No serious effort at exploiting deep-water shrimp should be undertaken without first conducting a survey of the resource's potential and careful monitoring of any catch statistics. It appears that these species are particularly vulnerable to even moderate trapping (King, 1986).

2. MOLLUSCS

2.1 TROCHUS

2.1.1 The Resource

Species Present: The trochus shell, *Trochus niloticus*.

Distribution: The natural distribution of trochus is on tropical reefs from the Andaman Islands in the Indian Ocean to the islands of Fiji and Wallis in the Pacific (Bour, 1990). They were introduced to the RMI by the Japanese during the 1930s, with introductions to Jaluit, Majuro, Ailinglaplap and apparently also Arno, Kwajalein and Enewetak (Asano & Inenami, 1939 and McGowan, 1958, cited in Wright, *et al*, 1989). Gillett (1991) lists the following details of transplants in the RMI: 1939 - Truk to Jaluit, 6143 tonne cargo ship carried shells in four water tanks; 1939 - Palau to Jaluit, shells transferred to other atolls of the Marshalls including Majuro and Ailinglaplap, with a transfer to Ebon not successful; 1954 - unknown location to Kili, attempt was unsuccessful; 1984 - somewhere in the Marshalls to Ebon, Aur, Maloelap, done in conjunction with trolling resource survey.

Biology & Ecology: Trochus prefer to live on the ocean side of reefs where the wave action is greatest. The larger shells are generally found in 2 to 20 feet (0.6 - 6 m) of water, and the smaller trochus on the inter-tidal reef-flats (Bour, 1990). Trochus are rarely found below 40 feet (12 m). The ideal trochus habitat in Palau has been characterized by Heslinga *et al* (1984) as having an unobstructed exposure to surf caused by the northeast trade winds, a gently sloping bottom, a wide boulder strewn reef-flat that is exposed at low tides, a substrate that is predominantly pavement, and an abundance of coralline algae and low filamentous algae at three to ten feet (0.9 - 3 m) depth.

The sexes are separate but cannot be determined by any secondary external sexual features. Fertilization occurs externally, the eggs and sperm being released into the surrounding water at night, usually a few days before the new moon (Bour, 1990). Spawning appears to be initiated by males. It is believed that spawning takes place throughout the year at each new moon but with different females; and each female spawns about every two to four months (Bour, 1990). The fertilized eggs become planktonic larvae after 9 to 10 hours, and settle out as juveniles on the reef flat after a few days. Trochus show rapid growth during the first three to four years, the rate being strongly determined by environmental conditions. Trochus spawned at the Pohnpei Marine Resources Division's hatchery grew to about 0.6 inches (15 mm) in six months (Curren, pers. comm., 1992). Sexual maturity in Palau is reached at 2.2 to 2.6 inches (55 - 65 mm) basal diameter size, which is approximately two years of age (Bour, 1990). Fecundity is high and increases with size. At three inches (8

cm) the gonads are about 2.3 times larger than 2.4 inch (6 cm) animals.

2.1.2 The Fishery

Utilization: There is some subsistence use of trochus in the atolls where it has been planted, mainly for food. The depletion of trochus around Majuro Atoll has been attributed to subsistence harvesting for food (MIMRA staff, pers. comm., 1992).

When harvesting first started was not clear, but McGowan (1958) noted that in 1957 "sporadic" harvests had occurred at Jaluit, Majuro, Ailinglaplap and Arno atolls. In recent years harvesting has occurred at Enewetak, Ailinglaplap, Mili, Arno and Jaluit.

Production: Accurate production figures are not available. The following figures for the 1987 to 1990 harvests have been obtained from a number of sources and due to the discrepancies between them, can only be considered indicative of the actual harvests. The following table lists all the figures that could be obtained from different sources and refer to export weights and values of cleaned shell.

YEAR	LOCATION	AMOUNT (tonnes)	VALUE (US$)	SOURCE
1987	Enewetak	100		1
	Enewetak	74		2
	?	?	179,000	3
1988	Enewetak	150		1
	Enewetak	130		2
	?	?	350,000	3
1989	Enewetak	98.75		4
	?	?	467,000	3
	Enewetak	31		5
	Ailinglaplap	15		5
1990	Mili/Jaluit	[23 bags]		4
	?	8	28,000	4
	?	38	178,800	2
	Enewetak	15		5
	Ailinglaplap	18.99		5
	Mili	10		5
	Arno	11		5
	Jaluit	0.36		5
1991	?	36	79,366	2
	Enewetak	180		6

1 = Wright, *et al* (1989), obtained from the Mayor of Enewetak and supported by a Majuro trochus buyer.

2 = Export records from Division of Revenue & Taxation, Ministry of Finance.

3 = Statistical Abstracts 1989/1990, Office of Planning & Statistics.

4 = MIMRA trochus file.
5 = One Majuro trochus buyer's records.
6 = Clarke (1992:29).

To obtain permission for an open season, the local governments make a request to the Nitijela, and the Cabinet declares the season's timing, location, and any restrictions. Open seasons, each of three months duration, were approved for 1987 (all atolls; August to October), 1989 (Enewetak; September to November), and for 1990 (Enewetak; September to November).

The construction and equipping of a trochus button factory occurred a number of years ago, however, no actual processing was done and the facility is now derelict.

Marketing: There are currently three trochus shell buyers based in Majuro, two of whom are Marshallese and the other is an RMI resident. One buyer indicated that he purchases cleaned shell from the outer atolls for US$1.25/lb, or if shipped into Majuro, for between US$1.75 to $2.00/lb. In return, he receives US$2,000 per 15 metric tonne container sent to Korea.

2.1.3 Status Of The Stocks

From available information there appears to have been only three surveys for trochus in the Marshall Islands. In the mid-1950s McGowan studied trochus throughout the Trust Territory of the Pacific Islands, with results recorded in two reports (McGowan, 1957 & 1958). He found trochus present on Majuro, but sporadically distributed; a small population established on Arno; populations on Ailinglaplap, but not widely distributed; trochus present at Jaluit, but limited to the southern and southeastern reefs; and none on Kili (despite plantings in 1954), Ebon or Likiep (McGowan, 1958).

Wright, *et al* (1989:5) note that:

> "In 1984, in response to a proposal to open a trochus shell button factory, the government of the Marshall Islands conducted a survey of the trochus resources of Majuro, Arno, Mili, Kwajalein, Jaluit, and Ailinglaplap. Apparently, no report of these surveys was produced (Elanzo, pers. comm.)."

Wright, *et al* (1989) conducted a trochus assessment survey of Enewetak and Bikini Atolls. They found no record of trochus introductions at Bikini Atoll, and no evidence of trochus were found there during the survey. Based on a limited number of transects at Enewetak Atoll, a crude average population density in the inter-island channels was estimated to be 556 $\pm$ 707 per hectare (0.06 $\pm$ 0.07 per m^2) [$\pm$ S.D., n=8], and on the reef flats to seaward, trochus were estimated to average 962 $\pm$ 371 per hectare (0.10 $\pm$ 0.04 per m^2) [$\pm$ S.D., n=2] (Wright, *et al*, 1989). Enewetak Atoll has been the site for most of the recent commercial harvests. Introductions occurred there

during the late 1930s and at the time of the survey populations were found to be only moderately abundant relative to other Pacific regions where commercial harvesting occurs.

2.1.4 Management

Bour (1990) summarizes the main management options available for trochus. They are:

-Size limitations - these have the advantage of being relatively easy to enforce. He suggests the smallest size should not be less than 8 cm (3.2") diameter in order not to disrupt production of juveniles. In addition, a maximum size of not more than 12 or 13 cm (4.7-5.1") is suggested in order to leave some brood stock whose shell is of less value but whose potential fertility is still high.

-Catch quotas: this option requires CPUE data over an extended period of time to be able to set realistic quotas.

-Fisheries closures: this involves prohibiting harvesting in certain areas or for time periods. Experience in other areas has shown that enforcement is difficult, and the irregular production of shell affects export potential.

-Sanctuaries: These protected areas serve as brood stock reservoirs to supply adjacent reefs with trochus through dispersal of larvae.

As very little survey or harvest data are available for the RMI, it is extremely difficult to provide specific management recommendations. Trochus are a valuable resource, but without careful management can be easily over-harvested, as has occurred in the past in other areas of Micronesia. Until such information becomes available I would support the recommendation of Wright, *et al* (1989:10-11) that:

"...a quota of 1.5 tonnes of trochus for each nautical mile of reef face be applied to each atoll. This figure is based on the estimated sustainable yield for trochus fisheries that operate on reefs elsewhere in Micronesia. For Enewetak this could yield an annual harvest of approximately 100 tonnes of shell."

As soon as feasible, annual surveys should be conducted at the atolls that are to be harvested. The density surveys should be standardized to enable comparisons between atolls and from year to year. Bour (1990) notes some simple rules which should be observed when designing a sampling plan:

-sampling sites should be distributed at random throughout the trochus biotype and not concentrated on patches of great abundance known to fishermen;

-the surface area surveyed should be estimated as accurately as possible;

-if possible the same transect should be examined by two divers to limit the "observer effect";

-the hidden fraction of the trochus population must be assessed (night diving) and a minimum size for counting should be determined beforehand (generally 30 mm (1.2")).

Counts should also be supplemented by measurements to enable the calculation of densities by weight from a size/weight ratio. An SPC workshop on trochus held in Vanuatu in 1991 was attended by one of MIMRA's staff. At that workshop a standardized survey method was suggested to permit data comparisons within the Pacific region. If possible, MIMRA should adopt that method to permit comparisons and population estimates to be made. Wright, *et al* (1989) also provided suggestions on survey methodology aimed at providing reliable density estimates.

During harvesting greater effort needs to be made to collect catch per unit effort (CPUE) data. This can be achieved through a closer monitoring of the harvests. The system of "catch receipts" used in Pohnpei and soon to be used in Yap, should be reviewed, and if possible modified and adopted for the RMI.

As recommended by Wright, *et al* (1989), the immediate need is for MIMRA to resolve the apparent discrepancies between the various accounts of the trochus harvests reported by different government agencies, the commercial sector, and the fishermen. The registration of at least the trochus buyers/traders, and preferably also the harvesters, and making accurate reporting of shell transactions a condition of registration, would help considerably. Revenue from registration could assist in the costs of surveying and monitoring. Similar systems are operating in Pohnpei and proposed for Yap.

RMI currently has a minimum harvestable shell size of three inches basal diameter. Wright, *et al* (1989) recommend a maximum size of five inches also be introduced. Experiences in the FSM (Pohnpei, Yap and Kosrae) have resulted in those states opting for a maximum size of only four inches. If the aim of trochus harvesting in the RMI is to have a sustainable annual harvest, then until stock assessments are regularly conducted, it is better to opt for conservative management strategies until more data are available.

Trochus sanctuaries are a management option which should be seriously considered. These have been used in Palau (see Heslinga, *et al*, 1984), Pohnpei and Kosrae. Wright, *et al* (1989) recommend the establishment of a trochus reserve on the northern or eastern reef rim of Enewetak Atoll. They further recommend that for convenience and ease of identification of

the reserve boundaries, that two islands be used as the edge of the reserve area and all harvesting be banned on the reef between the islands and on the reef flat to seaward. The reserve should be sited on the northern or eastern reefs to permit larval dispersal by currents to the remainder of the atoll's reefs, rather than out to sea.

The limiting of the duration of the open season is another management option. Since 1986, Pohnpei's trochus season has been reduced progressively from one month, to three days, to 24 hours, to 8 hours, and in 1992 to 6 hours duration. In areas of high population density (i.e. areas of potential high harvest rates) this management strategy may need to be considered.

Current Legislation/Policy regarding exploitation: The harvesting of trochus in the RMI is regulated by the "Marine Resources (Trochus) Act 1983". The Act applies to the internal and territorial waters of the RMI. Except as permitted, the taking or harvesting of trochus, or any intentional or reckless interference with the growth of trochus is prohibited. The Act allows for the Cabinet to declare an open season for harvesting, but is not allowed to exceed three months in any twelve month period. During an open season harvesting is only permitted by a citizen of the RMI living in an area in which he has, in accordance with customary law, a right to fish, or under a license issued by MIMRA for the taking of trochus. No shells with a basal size of less than three inches in diameter may be taken.

Permission (via a permit) for transplanting trochus for the purpose of introduction or propagation may be given by the Minister at any time, to any person. Additionally, the Cabinet, in the public's interest, may authorize the removal and transplanting of a whole trochus bed if underwater operations may interfere with the bed.

Any contravention of the Act will be dealt with as for a contravention of the MIMRA Act. That is:

Civil penalties: Fines not to exceed US$1,000,000 for each violation. In determining the amount the nature, circumstance, extent and gravity of the violation will be taken into account.

Criminal penalties: Fines not to exceed US$250,000.

Forfeitures and seizures: Vessels and associated fishing gear may be seized pursuant to a civil proceeding.

Recommended Legislation/Policy Regarding Exploitation: The following suggestions relate directly to the management of harvesting and may require some legislative changes or at least the promulgation of regulations.

Maximum size: In addition to a minimum shell size, a maximum size is also advisable. That size limit should preferably be set at four inches, but not greater than five inches.

Sanctuaries: Legislation permitting the establishment of trochus sanctuaries/reserves is needed.

Harvest regulations: Regulations which should be considered are: registration of harvesters and buyers/traders; requirements for providing CPUE data by harvesters; prohibition of the use of SCUBA equipment in harvesting; quotas (for the short-term at least) for amounts harvested at each atoll.

Additionally, a policy concerning the granting of open seasons should be established. Requests from the local governments for trochus open seasons should be forwarded to MIMRA well in advance of the proposed season. MIMRA should then conduct density surveys at the relevant atoll, and provide recommendations to the Cabinet on whether a harvest is feasible, and what restrictions, if any, should apply.

2.2 CLAMS

2.2.1 The Resource

Species Present: *Tridacna gigas*, *T. squamosa*, *T. maxima*, *Hippopus hippopus* occur naturally. *T. derasa* has been introduced recently for mariculture purposes. *Tridacna crocea* is listed in the fossil record for Enewetak Atoll (Kay & Johnson, 1987).

Distribution: Tridacnid clams are restricted in their distribution to the Indo-Pacific region. In many areas populations of the larger species have been significantly reduced due to subsistence harvesting.

Within the RMI *T. gigas*, *T. maxima*, *T. squamosa* and *H. hippopus* are found in the wild. Hatchery raised *T. derasa* have been received from the Micronesian Mariculture Demonstration Center (MMDC) in Palau.

Biology & Ecology: The tridacnid clams include the largest bivalve molluscs in the world. A unique feature is the thick fleshy mantle containing colorful symbiotic algae, called zooxanthaellae, which provide the animal tissue with by-products of photosynthesis (sugars, oxygen and proteins). The contribution of the zooxanthaellae to the energy budget of the clam is considerable. Sunlight required for the zooxanthaellae to photosynthesize restricts the clams to relatively shallow, clear water environments.

Growth and reproductive biology are well known for the larger species. Growth is rapid, at up to four inches/year (10 cm/yr) for *T. gigas*. Giant clams are initially male, but after maturing at about two years of age, become hermaphrodites, and spawn by releasing their sperm and eggs at different times. Large clams may produce hundreds of millions of eggs. After hatching, the larvae drift in the water column and settle on the substrate within ten days. Natural mortality rates are low for clams above four inches (10 cm). Recovery of overfished areas is slow, indicating low recruitment rates.

2.2.2 The Fishery

Utilization: Clams are an important traditional resource throughout the RMI. Hiatt (1951) noted that on Arno Atoll clams were not used extensively for food, but *T. crocea* and *T. elongata* [*sic*] were used to fertilize breadfruit trees. They are primarily collected as a food resource but the shells are also valuable as tourist curios (ashtrays, soap holders, decorations, etc). In former times the shells were used in the construction of tools. Over-harvesting of *T. gigas* in the past for subsistence purposes has resulted in it being severely depleted, and in some atolls harvested to extinction.

Clams are collected while swimming or wading over the reefs.

The smaller attached clams are removed by severing the byssal threads by inserting a knife or a long, thin piece of metal through one of the siphons. With the exception of the kidney, all the meat and viscera of the clam are edible.

Commercial exploitation of wild stocks elsewhere in the region has been solely for the adductor muscle, primarily for the South-East Asian markets. Markets exist for four other types of giant clam products: aquarium specimens, seed stock, broodstock and shell (Shang, *et al*, nd).

There are currently three clam production operations: the MIMRA clam hatchery at Likiep Atoll; Marshall Islands Aquaculture (MIA)/Marshall Islands Aquaculture Farmers Cooperative (MIAFC) on Bue Island, Mili Atoll; and Robert Reimers on Wau Island, Mili Atoll. In addition there are a number of grow-out farms. Ebeye (Kwajalein Atoll) also has a clam farm, but minimal information is available except that it is funded by KADA and obtained some *T. derasa* from MMDC in Palau.

Production: There are no estimates available for subsistence harvest levels of wild clam stocks in the RMI.

A document not seen by the consultant, but which appears to be relevant is a report prepared by Heslinga (1989) on the status of giant clam mariculture in the RMI.

MIMRA's giant clam reseeding project was initiated in January 1990 and was terminated in June 1991 when the Pacific Fisheries Development Foundation (PFDF), through which the Saltonstall-Kennedy grant was administered, ceased operating. MIA was sub-contracted by MIMRA to conduct the project. The objective of the project was to provide giant clams to the outer atolls to eventually be used as brood stock for reseeding, and to train a small number of men to become clam farmers (MIA, 1991). Reports state that 12,000 *Tridacna derasa* were purchased from the Micronesian Mariculture Demonstration Center (MMDC), although records indicate that approximately 17,000 were sent, of which about 11,900 survived transportation to the farm sites. All clams were held in floating trays designed and built by MIA. The use of the trays enabled easy access (no SCUBA required) for cleaning, and proved suitable for farms in remote areas. Training was conducted on four atolls (Likiep, Mili, Majuro and Arno). At the termination of the project there were two farms on Likiep (Jebal and Lado islets), one large farm (MIAFC) on Mili Atoll (Bue Islet), one on Majuro Atoll (Uliga area; College of the Marshall Islands' farm), and Arno Atoll.

The largest farm site is the MIAFC on Mili. They currently have *T. gigas* brood stock, from which spawnings have been induced a number of times since June 1990 using a floating tank. They currently have *T. gigas*, *T. derasa*, *T. maxima*, *T. squamosa* and *Hippopus hippopus* stocks.

MIMRA's hatchery and growout facility at Likiep Atoll is in the process of being developed with the assistance of MIA. The objectives of this operation are to provide seed clams to future aquaculture farmers and to develop a "Mariculture Center" for training. The facility currently has about 3,000 *Tridacna derasa* seed stock from Palau, and about 29 *T. gigas* and 32 *H. hippopus* collected locally. Construction of the facilities is on going.

The Job Training Partnership Act (JTPA) program has a (substrate) growout farm at Kalalin, Majuro Atoll. This farm is used to train outer islanders in clam farm maintenance and to educate about clam stock depletion. They currently have 684 *T. derasa* obtained from Palau, 134 *T. derasa* and 183 *T. gigas* purchased from MIA and RRE at Mili. Six men have been trained to date, and they now tend three small nurseries set up at Jaluit (97 *T. derasa*), Ailinglaplap (24 *T. derasa*; 76 *T. gigas*) and Namu (26 *T. derasa*; 74 *T. gigas*) atolls.

Marketing: Clam meat (*T. maxima*, *T. squamosa* and *H. hippopus*) is sold locally in stores, mostly marinated in vinegar/lime/salt, and occasionally fresh. Fresh meat sells for about US$2.50/lb, and a 1.8 liter bottle of marinated clam meat sells for about US$5.00. The clam meat mostly comes from Jaluit, Arno, Mili and sometimes Kiribati.

Most tridacnid clam species are protected in international trade by CITES (Convention on International Trade in Endangered Species) prohibitions. Shipments into the US mainland for the aquarium trade, or into Hawaii, Guam, or other US Territories for the sushi/sashimi trade require certificates of origin from the RMI government. Shipments into Okinawa will also require CITES clearance and permits (Anon., 1991; Shang, *et al*, nd).

Shang, *et al* (nd) note that export markets exist for five types of giant clam products: food, aquarium specimens, seedstock, broodstock and shells. They conclude that the seedstock and broodstock markets appear to be short-run oriented, with a declining demand expected. In Taiwan, a market exists for adductor muscles in fresh or frozen form, with a market potential of 240 tonnes annually. However, muscles from five year old clams or older are preferred. There is an existing market in Okinawa for whole clams for the sashimi and sushi trade. *T. crocea* is the preferred species, and cultured *T. derasa* is unknown and would require considerable test marketing to evaluate consumer acceptance. A limited market potential exists for giant clams as aquarium specimens in the US and Japan.

The identification and establishment, and/or penetration, of both export and local markets remains one of the main obstacles in developing commercial/artisanal giant clam farming. A detailed marketing and production study is urgently

needed for the RMI.

A number of preliminary marketing reviews have been conducted for the Micronesian region (APTA, 1990; Anon., 1991; Shang, *et al*, nd). All emphasize that care must be taken in interpreting market forecasts for giant clams, as there is little information available on product demand, production costs, or the level of potential competition from other farms and hatcheries within the region.

2.2.3 Status Of The Stocks

Hiatt (1951) states that *H. hippopus* was most abundant in the northern Marshall Islands, but was not common at Arno Atoll, *T. squamosa* was rare at Arno, and *T. gigas* was absent.

No quantitative surveys of wild giant clam stocks have been conducted in the RMI. From discussions with MIMRA staff and private clam farm operators, the status of the stocks appear to be:

T. maxima - this is the most common species throughout the RMI and is the mainstay of the subsistence harvest.

T. squamosa - still found throughout the RMI but in low to very low numbers.

T. gigas - There are wild stocks still remaining in the RMI, although they appear to have been depleted on some atolls.

T. derasa - No record of wild stocks within the RMI were found. The species has been introduced for seeding and farming purposes.

H. hippopus - Wild stocks are apparently present throughout out the RMI, but stocks vary considerably in status between atolls.

The following exerts from Thomas (1989) come from a survey of the northern atolls:

Taongi Atoll - "Despite a great abundance of smaller clam species (*T. maxima*, *T. squamosa*, *H. hippopus*) there was a total lack of giant clams (*T. gigas*). No dead giant clam shells were observed. The abundance of smaller clam species at Taongi was greater then that reported at any of the other atolls and reefs visited during the survey."[pp 34]

Bikar Atoll - "Although no giant clam species were found, smaller clam species were very abundant, particularly *H. hippopus* and *T. maxima*....A large mound of dead *Tridacna sp.* shells were found in the lagoon off Jaboero islet, indicating human harvesting activity from an anchored small boat."[pp 42]

Taka Atoll - "The presence of large numbers of dead and some live giant clams apparently decimated by an overseas fishing boat about five years previously was noteworthy."[pp 49]

Jemo Island - "...no *Tridacna sp.* of any species...were found."[pp 55]

Wotho Atoll - "The numbers of giant clams observed at Wotho exceeded those seen on any other atoll - 15 live and 16 dead compared with 5 live and 27 dead on Taka...This was a little surprising as local sources informed the survey team that large numbers of giant clams had been harvested by a Taiwanese fishing vessel eight years previously. However, it was also revealed that the Wotho islanders (and Marshallese generally) do not normally harvest this species, preferring the smaller *Tridacna* species for food. Also, apart from the one isolated but devastating incident mentioned above, the presence of inhabitants obviously discourages poaching. Despite recording the highest abundance of living clams the almost 1:1 ratio of live to dead giant clams on Wotho indicates the vulnerability of such a population to exploitation, even on a 'one time' basis occurring several years previously. It was noticeable that there were fewer of the smaller clam species tending to confirm that these are locally preferred to giant clams."[pp 62]

Rongerik Atoll - "...only four live giant clams were observed compared to 16 dead shells, indicating heavy exploitation in the past ten years. Smaller clam species were present although not in particular abundance suggesting that these too, have been exploited in the past."[pp 72]

Erikub Atoll - "...small clams were not overly abundant...Of the smaller clams only *Hippopus hippopus* and *Tridacna maxima* were common with *T. squamosa* occurring very occasionally. Only one giant clam was seen although poor habitat in the form of steep lagoon slopes which preclude large benthic organisms finding a stable environment, may be the reason rather than heavy fishing pressure."[pp 78]

One MIMRA staff member noted that Utirik Atoll was formally known for its *T. gigas* stocks, but is now depleted.

2.2.4 Management

Current Legislation/Policy regarding Exploitation: There is no national legislation concerning giant clams.

Recommended Legislation/Policy Regarding Exploitation: If necessary there is the Endangered Species Act under which endangered or threatened species can be listed. There are, however, exemptions in the Act for subsistence harvest and

controlled farming.

The subsistence harvest of giant clams would be difficult to regulate or enforce, except through customary marine tenure and use rights, where they are still strong.

Once farms are established legislation will be required to prohibit poaching. To encourage farming, only farmed clam products should be allowed to be exported. This will be necessary anyway to send to countries that are signatures of CITES.

Thomas (1989) notes that the giant clam, *Tridacna gigas*, are registered in the "Intermediate" category[7] by IUCN (1983).On the basis of their survey, they consider giant clams in danger of local extinction in the Marshall Islands if continued heavy exploitation is not stopped. They provide the following conservation recommendations (Thomas, 1989:85):

"That the giant clam be recognized as an endangered species under the Marine Resources Act and provisions introduced to provide for the formulation of regulations for their conservation in conjunction with traditional landowners and Atoll Local Councils.

-that the status of giant clam populations on all atolls be surveyed by MIMRA in conjunction with Atoll Local Councils;

-that on the basis of this survey the MIMRA make recommendations to Atoll Local Councils/landowners for the conservation of giant clams, including the introduction of moratoriums on harvesting if appropriate (at least 6 years to allow stocks to recover);

-that where conservation controls are introduced, monitoring of population recovery be undertaken by MIMRA and Atoll Local Council;

-that the feasibility of re-seeding depleted populations using baby clams or breeding stock obtained from the MMDC, Palau be investigated. Re-seeding should be conducted at atolls accepted for some form of protected area status and management;

-that provisions for heavier penalties for the violation of giant clam conservation provisions for commercial gain by Marshall Islanders, including the confiscation of boats and equipment, be introduced;

[7] The "intermediate" category is for species known to be "endangered", "vulnerable" or "rare" but where there is not enough information to say which of the three categories is appropriate.

-that monitoring, surveillance and enforcement measures be increased to discourage illegal exploitation of this species and heavy penalties be provided for under the MIMRA Act for violations by vessels of distant water fishing nations.

2.3 PEARL OYSTER

2.3.1 The Resource

Species Present: The blacklip pearl shell, *Pinctada margaritifera*.

Distribution: The blacklip pearl shell is widespread throughout the Pacific, and is found in the RMI, but not in large quantities. It has been reported from Namodrik, Majuro and Arno Atolls, and may also be present at Mili Atoll (MIMRA staff, pers. comm., 1992).

P. margaritifera is found down to around 130 feet (40 m), but is naturally abundant just below the low-water mark.

Biology & Ecology: Blacklip pearl shell exhibits fast initial growth rates reaching a shell diameter of 3.9 to 4.7 inches (10 - 12 cm) in two years. Maximum sizes have been calculated to be between 5.5 and 6.7 inches (14 - 17 cm) shell diameter. Like many bivalves, they are hermaphrodites, reaching maturity in their second year of growth, but with an uneven sex ratio until that time. Growth rates of juveniles measured on Nukuoro (Pohnpei State, FSM) showed oysters reaching mature size in about two years (PMRD, 1991). Spawning is often not limited to distinct seasons and a planktonic larval stage occurs lasting two to four weeks prior to settlement (Sims, 1988).

2.3.2 The Fishery

Utilization: Most mother-of-pearl (MOP) shell is used for the manufacture of buttons and other clothing and jewellery items. Pearls are used for jewellery. MOP shell and handicrafts incorporating MOP shell are currently sold in local handicraft shops. Traditionally, pearl shell was used for trolling lures in the Marshall Islands (Hiatt, 1951).

Production: Dashwood (1991) has summarized what is known of the pearl oyster exploitation for Namodrik:

-In the early 1930s, a Japanese living on Ebon collected and shipped live pearl oyster from Namodrik to Ebon.

-During the mid-1970s, between 10,000 and 15,000 oysters were harvested over a two week period. Harvesting stopped when it was established that the purchasing company lacked the necessary permits. The shell was not sold and later discarded.

-In 1987, a Korean businessman arrived on Namodrik and offered to purchase pearl shell for US$1.25 per pound. Approximately 1,000 pounds of shell were harvested in three days, but was stopped when the Island Council become aware of the activities. The shell was never sold.

From 1935 to 1942, Shinju Kabushiki Kaisha of Tokyo conducted pearl culture experiments on Ebon Island, but plantings were abandoned in 1942 (Uwate, *et al*, 1984).

The Namodrik Alele Local Government, with assistance from MIMRA, have started spat collection with plans to establish a pilot pearl farm. In November 1990, a consultant was brought in to assist with the deployment of spat collectors, establish a sub-surface pilot pearl oyster culture farm, construct an underwater platform, and discuss with Namodrik residents the outline of a pearl oyster management plan for the lagoon (see Dashwood, 1991). A total of 3,500 spat collectors were distributed within the lagoon at that time, with recommendations for up to 1,000 a month to be deployed over the following 12 months (this has not occurred). Ten people were contracted for 15 months through the council (paid for by JTPA) to maintain the farm.

A total of 1,500 spat collectors were deployed in April and June, 1991, with MIMRA's assistance. At that time, fouling of the bags was severe and most spat collected until then had died. It is worth noting that the 300 spat collectors made of local materials, although equally efficient as collectors, were all eaten by puffer and trigger fish. There is currently only about 450 collectors remaining. A total of about 3,000 juvenile oysters had been collected and hung on lines, and more than 6,000 from spat bags transferred to lantern baskets (about 300 baskets with 20 to 25 per basket) (Alfred, pers. comm., 1992).

A small private pearl oyster farm at Arno Atoll ceased operating about three years ago. No other information concerning its operation could be obtained.

Marketing: Dashwood (1991) notes an unconfirmed account of a Japanese button manufacturing company (Nakai Industries Ltd, Nara Prefecture) having purchased MOP from Namodrik at US$0.30 per pound during the mid-1980s.

2.3.3 Status Of The Stocks

Dashwood (1991) notes that a survey of some of the RMI lagoons was conducted in 1984, but with the exception of Namodrik, little or no black-lip pearl oysters were encountered.

A survey of pearl oyster stocks was conducted in Namodrik Atoll in 1989. From 28 transects (11,200 m^2) the average density was estimated to be 0.014 per square meter (Alfred & Kilma, 1989). Dashwood (1991) found that pearl oysters were moderate in numbers around and in close proximity to coral heads. Over fifty percent of the lagoon is too deep to support wild oyster populations, which severely restricts settlement area for oyster larvae. He also notes that wild stocks are insufficient to support a fishery based on the sale of mother-of-pearl.

A survey was conducted at Nadikdik (Mili Atoll) in 1991, but found no live pearl oyster and only one dead shell (Kilma & Alfred, 1991). Another survey of Ebon Atoll, where the former Japanese oyster farm was located, found no oysters at all.

Stocks exist in both Majuro and Arno atolls, but no density surveys have been conducted (Alfred, pers. comm., 1992).

2.3.4 Management

Current Legislation/Policy Regarding Exploitation: The Marine Resources Act (Title 33, Chapter 1, Section 5) specifically controls the harvesting of *Pinctada margaritifera* (black-lip mother-of-pearl oyster):

-none may be taken from the first day of August to the thirty-first day of December;

-at no time may shell be taken which is less than four inches in minimum diameter;

-any shell, of any size, may be taken at any time for scientific purposes when authorized by the Cabinet.

Penalties: a fine not exceeding US$100 or imprisonment for not more than six months, or both.

In 1985, the Namodrik Alele Local Council enacted the "Namodrik Alele Local Government Pearl Culture Ordinance". This ordinance basically prohibits the harvesting and marketing of pearl oysters by anyone without the approval of the Council. Penalties involve fines and/or imprisonment (Dashwood, 1991).

Recommended Legislation/Policy Regarding Exploitation: The current legislation needs to be updated to preserve wild stocks, and to allow for the cultivation of pearl oysters. The level of penalties should also be increased.

Dashwood (1991:17-18) outlines the requirements for a management plan for the pearl oyster resource of Namodrik:

"The main objectives of the management plan should take into consideration the following:

1.that any development of the pearl oyster resource should not detract from the traditional island ownership of that resource;

2.development should be structured in such a manner that it takes into account the traditional socio-cultural values of the people of Namodrik; and

3.that any development should have the blessing of central

government and that close liaison should be maintained between the Council and Government at all levels of development.

Other issues that should be addressed in the management plan are:

1. setting a realistic quota of oysters for the communal farm;

2. conserving pearl oyster stocks to insure that there will always be sufficient brood stocks;

3. establish recognised pearl oyster husbandry techniques for the operation of the communal pearl farm;

4. strengthen the existing Namodrik Alele Local Government Pearl Oyster Ordinance by providing for the complete ban on the taking of pearl oysters other than for the purpose of establishing sufficient seed stock for the communal farm;

5. the prohibition of the transfer of pearl oysters from locations outside of Namodrik; and

6. the establishing of a permanent pearl oyster reserve or sanctuary."

2.4 ORNAMENTAL SHELLS

2.4.1 The Resource

Species Present: Collectors' shells of the classes Gastropoda (sea shells), Pelecypoda (bivalves), Scaphopoda (tusk shells) and Cephalopoda (nautilus) are present throughout the RMI.

Distribution: Shells occur in all of the world's seas but their center of distribution, and maximum diversity, is generally considered to be that area of ocean bordered by Indonesia, Papua New Guinea and the Philippines. Shells can be found in every type of marine habitat, from coral reefs and sand to silt and mud. Most species are habitat specific.

Lists of species found throughout the RMI were not available, but a species list for Enewetak Atoll can be found in Kay and Johnson (1987).

2.4.2 The Fishery

Utilization: Five categories of shells are recognized in the shell trade: ornamental shells (e.g., cones and cowries); shells used in shell craft (e.g., money cowries and helmet shells); specimen and rare shells (e.g., golden cowrie); commercial shell (e.g., trochus, pearl oyster); and shells used for food (Kay & Smalley, 1989).

Marine shells have been extensively used throughout the RMI for subsistence purposes, including tools, ornaments, and food. Currently they are also used for the tourist trade, either in the production of handicrafts or the sale of the shells themselves.

Shells are collected by people walking over areas of sand or coral at low tide, and by looking under rocks, or by searching through areas of sand or mud. Shells in deeper water, such as *Cassis cornutus* (helmet shell), *Charonia tritonis* (giant triton) and *Lambis lambis* (spider shell) require diving.

The larger shells (except for cowries) can be boiled to extract the meat, but smaller species should be left to decompose buried in the sand.

Brost and Cole (1981) have published a guide to shell collecting in the Kwajalein Atoll, but a copy could not be located in Majuro.

Production & Marketing: There is no information on shell collecting in the RMI. Currently in the RMI there is only the tourist market for ornamental, rare and shell-craft shells.

2.4.3 Status Of The Stocks

There are no estimates of ornamental shell stocks in the RMI.

2.4.4 Management

Current Legislation/Policy Regarding Exploitation: There is no legislation or policies regarding ornamental shell exploitation.

Recommended Legislation/Policy Regarding Exploitation: The collection of ornamental shells for export (to shell collectors or the aquarium trade) should not be permitted until stock assessments have been conducted to assess the feasibility of a shell trade. The export of clam shells is discussed in the clam profile. The use of small shells in handicrafts should not be restricted at this time.

The collection of shells currently listed as threatened in the IUCN Red Data Book (IUCN, 1983) should be prohibited, especially the giant triton, *Charonia tritonis*.

2.5 OCTOPUS & SQUID

2.5.1 The Resource

Species Present: None of the literature reviewed identified which octopus species are presently exploited in the RMI. The common octopus, *Octopus cyaneus*, is commonly found throughout the Indo-Pacific region.

No information on which species of squid are present in the RMI was found.

Distribution: Octopuses are found throughout the RMI, both intertidally and subtidally around reefs and rocky areas.

Squid are also distributed throughout the RMI, but in the oceanic and lagoon waters.

Biology & Ecology: Octopuses are active predators feeding mainly on crustaceans and molluscs. Sexes are separate in cephalopods, and prior to mating there is often an elaborate mating ritual involving color changes and touching of tentacles. One of the male's tentacles is modified to carry the sperm to the mantle cavity of the female. In octopuses the eggs are usually brooded and develop directly into a tiny adult form.

Octopuses are usually solitary whereas squid form schools. Squid are known to carry out diurnal vertical movements between the surface at night and deeper layers during the day. Little is known about seasonal migrations.

2.5.2 The Fishery

Utilization: Within the RMI octopus is used roughly equally as a food as well as a bait for handline fishing. Octopus are most often caught by using a hooked piece of metal or wire to remove them from their lairs, they are killed by biting them between the eyes. They are also caught by spearing. They can be taken while walking on the reef flat at low tide or by diving in deeper water.

No information was available on squid usage.

Production & Marketing: There are no estimates of the subsistence harvest of octopus for any areas of the RMI. Small amounts of octopus are sold in some stores.

2.5.3 Status Of The Stocks

There is no information on the status of octopus or squid stocks in the RMI.

2.5.4 Management

Current Legislation/Policy Regarding Exploitation: There is no legislation regarding octopus or squid exploitation.

Recommended Legislation/Policy Regarding Exploitation: As there are no estimates of stock size or of harvest levels, no recommendations can be provided. Discussions with marine resources personnel indicated there appears to be currently no problem with harvest levels.

3. MISCELLANEOUS INVERTEBRATES

3.1 SEA CUCUMBERS (BECHE-DE-MER)

3.1.1 The Resource

Species Present: There are about 1,200 species of holothurians (also known as sea cucumbers, beche-de-mer and trepang) distributed world wide. About 12 species are considered of commercial value (Anon., 1979). Richmond (nd) notes the presence of *Holothuria (Microthele) nobilis* (black teatfish) and *Actinopyga mauritiana* (surf redfish) in Majuro lagoon, and Ebert (1978) studied *Holothuria (Halodeima) atra* (lollyfish) at Enewetak Atoll. Other publications which would list sea cucumber species present in the RMI, but were unavailable to the author, are Clark (1952) and Devaney, *et al* (1987a).

Distribution: No information was available on the distribution of sea cucumbers within the RMI.

Biology & Ecology: Relatively little is known about the biology of sea cucumbers, most research to date has concentrated on taxonomy. A study at the University of Guam Marine Laboratory on the sea cucumber fisheries development in Micronesia involves studies of the life history characteristics, determination of reproductive timing, research on larval rearing and other aspects of sea cucumber ecology and physiology (Richmond, 1991 & nd). Results show distinct periods of reproductive activity, two to three years to attain the age of first reproduction, and relatively low levels of natural recruitment (Richmond, 1991). Some species are known to undergo asexual fission and a few species are hermaphroditic, but the majority are dioecious (Cannon & Silver, 1986). Most species release their eggs and sperm into the water and fertilization is external. Most species reach their peak spawning period during the summer and some species have a second winter peak (Cannon & Silver, 1986). Richmond (nd) found that in Guam both *Thelenota ananas* and *Actinopyga mauritiana* have distinct reproductive peaks commencing in spring (April), with steep declines by July. However, he found that *Holothuria nobilis* has multiple peaks during the year.

Sea cucumbers are primarily detritivores, feeding on the organic content of sand, mud and surface films.

3.1.2 The Fishery

Utilization: Smith (1947:19) briefly notes that sea cucumbers "...are sometimes pulped for use as a fish poison in the Marshalls." Hiatt (1951) stated that at Arno Atoll sea cucumbers were not used for any purpose.

During the Japanese administration, sea cucumbers were extensively harvested throughout Micronesia, but the centers of production were Chuuk, Palau, Pohnpei, Saipan and Yap, with

no mention of the Marshall Islands (Smith, 1947).

There is a high demand internationally for processed sea cucumbers as they are relatively high in protein while low in fat. The processing involves gutting, boiling and finally drying. Properly produced beche-de-mer requires no refrigeration and can be stored for many months if kept dry and well ventilated.

Sea cucumbers contain quantities of saponins, which are toxic substances. However, relatively little is known concerning the bioactivity of these products, which may be potentially valuable to the pharmaceutical industry (Richmond, nd).

Production: Sea cucumbers represent a commercially valuable marine resource that is not utilized. The history of sea cucumber fisheries in the Micronesian region has been basically boom and bust due to over-harvesting. Sea cucumbers were extensively harvested within Micronesia late last century as well as during the Japanese mandate. During the Japanese administration in the early 1940s, as many as one million pounds of beche-de-mer were exported annually from Chuuk (Beardsley, 1971).

At the present time, one local businessman in Majuro is planning to have sea cucumbers collected from the outer atolls for export.

Marketing: Reliable markets for sea cucumbers already exist, chiefly in south-east Asia, with Hong Kong and Singapore dominating. The Chinese consider sea cucumbers as a culinary delicacy, ensuring markets exists wherever large Chinese communities occur. Top quality products sell for up to US$28/kg ($13/lb) dry weight (Infofish Trade News, No.7/91, 15 April, 1991). During 1988, species found in Micronesia were selling for US$8 to $12/lb dry weight in Hong Kong, while in San Francisco's Chinatown, prices were from US$11 to $13/lb (Richmond, 1991).

3.1.3 Status Of The Stocks

No information on the status of the sea cucumber stocks of the RMI could be located.

3.1.4 Management

For over four years the University of Guam Marine Laboratory has been involved in a project, "Sea Cucumber Fisheries Development in Micronesia". This project has identified the critical biological parameters needed to support the development of a sustainable fishery in Micronesia (Richmond, 1991). According to Richmond (1991) the reproductive cycles have been defined, techniques for assessing resources have been developed, the ability to spawn individuals in captivity has been perfected, and a system for raising the larvae is

under development. He believes that the final and critical stage is the establishment of a plan for exploitation at a sustainable level. To this end he is facilitating the meeting of Fisheries Officers from throughout Micronesia to discuss regional harvesting and management matters.

Current Legislation/Policy Regarding Exploitation: There is no legislation or policies concerning sea cucumber exploitation in the RMI.

Recommended Legislation/Policy Regarding Exploitation: The history of sea cucumber exploitation throughout the Pacific region has not been one of successful resource management. For a commercial sea cucumber fishery to be established in the RMI, and operated as a sustainable fishery, there is a need for regional cooperation.

Richmond (1991) considers enough biological data now exists to develop a set of guidelines for sustainable exploitation. They include: establishment of seasons for collecting, size limits, and incorporating some low-technology mariculture. He believes the problem is to determine the maximum sustainable yield (MSY) and to cooperate on a regional basis to maximize the economic return. He lists the key considerations as:

-Price is directly related to sea cucumber size - larger equals higher quality. A restriction on size increases the value of the resource while also allowing individuals to become reproductive prior to collection.

-Buyers wish to come into the islands and get as much resource as possible, as quickly and as cheaply as possible. Dealing through such middle men reduces the income into the islands that possess the resource. A better approach would be for the islands to sell quality product at the markets.

-Each of the island groups possess a finite quantity of valuable marine resources. None has enough to sustain a profitable fishery for more than three to five years.

-Competition among the islands will cause a lowering of prices, and increased harvesting to maintain the same economic benefit.

As sea cucumbers do represent a valuable marine resource, but one which history has shown to be easily over-fished without appropriate management controls, I would recommend that the RMI actively pursue the possibility of regional harvesting and management regimes, as suggested by Richmond (1991).

3.2 SPONGES

3.2.1 The Resource

Species Present: There are no sponges currently exploited commercially within the RMI. In 1939 and 1940 the Japanese seeded Ailinglaplap Atoll with sponges: tentatively identified as a variety of *Spongia officinalis* ("Pacific wool sponge", "fine levent" or "turkey solid") (Smith, 1947). Worldwide only about 15 of the more than 5,000 species of sponge have some commercial value (Josupeit, 1991).

Distribution: The Japanese conducted sponge culture experiments in Likiep, Ailinglaplap and Namodrik atolls (Wilson, circa 1968, cited in Uwate, *et al*, 1984). No surveys have been conducted to determine the availability or distribution of potentially commercial sponges in the RMI. Skinner (pers. comm., 1992) said he has observed commercial sponges at a number of sites, including Ebon Atoll.

The Pacific wool sponge is found in waters from 5 to 100 feet (1.5 - 30 m) deep and in a wide variety of habitats, but are not found in areas of brackish water or extreme silt (Croft, pers. comm., 1992). Croft (1990) found no relationship between geographical and/or oceanographical features and sponge growing areas in Pohnpei (FSM).

Biology & Ecology: There are a number of factors that favor Pacific wool sponges as a commercial resource. They have no known predators; no locally reported sponge blights (both the Mediterranean and Caribbean stocks have recently been affected by disease); they can grow in a variety of habitats and depths; can regenerate from cuttings; they are non-motile; and are filter-feeders. On the negative side they are slow growing; have low recruitment; and there appear to be limited wild stocks.

Japanese studies in Palau estimated a minimum of 1.5 to 2 years for a cut sponge to reach minimum commercial size ("fist size") (Cahn, 1948). Croft (1990) has found a growth period of two to three years is required to reach commercial size in Pohnpei.

3.2.2 The Fishery

Utilization: Sponges from wild stocks appear to have had some limited domestic use traditionally in the Marshall Islands (Hiatt, 1951).

Today, natural sponges are primarily used in hospitals (able to withstand high sterilization temperatures), in industry (lubricant applicators), by artisans and craftsmen, for applying and removing cosmetics, and for general household use (Croft, pers. comm., 1992).

Production: Smith (1947) summarizes what is known concerning the Japanese sponge culture trials at Ailinglaplap Atoll from 1939. Samples were apparently taken to Japan for testing, but no commercial harvesting occurred. When Smith visited in 1946 there were still several hundred sponges remaining on the aluminum wires.

Within the Micronesian region the only sponge farms operating are in the FSM. Both the Pohnpei demonstration farm and the private farm use a submerged culture method. Each culture unit consists of 20 to 30 nylon lines measuring 60 to 70 feet (18 - 21 m) long with a breaking strength of 150 lb (68 kg). These lines are attached to quarter inch (0.6 cm) polypropylene lines of 30 to 50 feet (9 - 15 m) length, tied between large coral heads in about 30 to 40 feet (9 - 12 m) deep water and about 4 to 6 feet (1.2 - 1.8 m) above the bottom. Sponge cuttings are strung on the 150 lb test nylon lines. In May 1991 there were more than 10,000 sponges under cultivation in the private farm, and more than 4,000 in the demonstration farm. For the last 2 to 2.5 years, growth and survival rates have been measured. The current survival rate is in excess of 95 percent (Croft, 1991). The initial investment for sponge culture is low and is estimated to be about US$105 per culture unit with an annual depreciation of about US$15 per culture unit (Shang, 1991). Labor requirements for sponge cultivation (mainly for seeding, harvesting and cleaning) is low, with two people being able to care for 40 culture units or 50,000 sponges (Shang, 1991). In addition, the type of work required is culturally appropriate to Micronesians. It is essentially a 'plant it and leave it' style of mariculture.

As a large commercial farm has yet to be set up anywhere in Micronesia, there are only estimates of potential output available from Pohnpei's experiments. The operating costs for a two-year growing period is estimated at US$269 per culture unit. At 95 percent survival, one unit can produce about 1,188 sponges.

The Mediterranean and the Caribbean are the main raw sponge producers, with the final processing being in Greece, France, Italy and Germany (Josupeit, 1991). Total world production oscillated between 160 to 270 tonnes during the 1980s (Josupeit, 1991). There are no figures available on the present cultured sponge production worldwide, but projects are underway in both the Caribbean and the Mediterranean (Josupeit, 1991).

Marketing: In 1986, France accounted for about 37 percent of world sponge imports, followed by the USA (26%), Japan (10%), Italy (9%), Spain (8%), Germany (6%) and Greece (4%) (Shang, 1991). In the 1980s total world sponge imports varied between 260 to 300 tonnes (this figure exceeds the world production as some imported sponges are re-exported)(Josupeit, 1991). The world market is currently experiencing fluctuations due to over-harvesting and diseases, and if a high quality product

can be obtained, then sponge farming in the Pacific region could fill the supply gap (Shang, 1991).

In Pohnpei, the cost of production per sponge was estimated by Shang (1991) to be US$0.23, or about US$3 per kilogram ($1.36/lb). At the market price range of US$5 to 25 per kg of raw sponge in the US, the profit potential is there. Sample product was sent to the US and favorable responses from buyers was received, expressing interest in obtaining from 12,000 to 200,000 sponges per year. The Pacific Aquaculture Association has recently approved funding for a marketing study for Pohnpei sponges, aimed at the Japanese tourist markets in Guam and Saipan. If the RMI were to develop farms, a similar study would be required.

3.2.3 Status Of The Stocks

No surveys have been conducted in the RMI to assess the availability or extent of sponge resources. Smith (1947:36) noted that sponges at "...Likiep...are abundant enough to be used in place of a towel after bathing, and for scouring cooking utensils."

Surveys in Pohnpei (Croft, 1990; Stevely, 1989; Wilkinson, 1989), Chuuk (Croft, pers. comm., 1992) and Yap State (Bridgeland, pers. comm., 1992) found wild stock levels insufficient to support commercial exploitation. A similar situation might be expected for the Marshall Islands. It would therefore be necessary to farm sponges on a total replacement basis if commercial farms are to be set up.

3.2.4 Management

Current Legislation/Policy Regarding Exploitation: The Marine Resources Act includes a section on the control of sponges: "No sponges artificially planted or cultivated shall be taken or molested, except by permission of Cabinet" (Title 33, Chapt. 1, section 3).

Recommended Legislation/Policy Regarding Exploitation: The commercial exploitation of sponge resources in the RMI is a potential resource. However, as no surveys have been conducted here, it is difficult to assess the extent of wild stocks. All the surveys in the FSM to date have indicated that the wild stocks are inadequate to support direct commercial harvesting, but in some areas they are sufficient to supply nursery farms, from which commercial farmers could obtain their cuttings.

Prior to establishing any commercial farms in the RMI, in addition to the current legislation protecting planted sponges, legislation would also be needed to protect wild stocks from commercial exploitation. Provision should be made for collecting wild sponges to stock *nursery* farms. Legislation will also be required to permit only cultivated sponges to be exported or sold locally.

Croft (pers. comm., 1992) suggested that regulations may be needed to exclude people from sponge farms to minimize poaching.

3.3 CORALS

3.3.1 The Resource

Species Present: Species of corals sought for ornamental or curio purposes, such as branching corals (*Acropora*, *Seriatopora*, *Pocillopora*), stinging corals (*Millepora*, *Stylaster*), organpipe corals (*Tubipora*), brain corals (*Goniastrea*, *Euphyllia*) and mushroom corals (*Fungia*), are found throughout the RMI. Black coral, *Antipathes spp.*, apparently occur in some areas in the RMI, but no documents confirming this were located.

Distribution: Ornamental corals are most abundant in shallow reef waters. The semi-precious black coral is found at depths of 65 to 330 feet (20 - 100 m), generally in areas of strong current and clean hard substrate.

Biology & Ecology: Coral growth varies considerably, some branching corals grow rapidly (some *Acropora* can grow up to six inches (15 cm) per year) whereas others such as the *Favia* and *Porites* grow very slowly (Veron, 1986). Growth of black corals is very slow, less than two or three inches a year (Anon., nd).

Stony corals are subject to considerable damage by natural forces such as typhoons and in some areas crown-of-thorns starfish (*Acanthaster planci*). Regeneration occurs at variable rates, with some rapid recovery but complete regeneration may take 20 years for some species.

3.3.2 The Fishery

Utilization: Corals are collected for a number of purposes in the RMI. Some are collected for the tourist trade, and some are exported as "aquarium rocks" to the US. Corals are also used for road surfacing and as building and fill materials.

Production & Marketing: Virtually no information is available on production or marketing of corals in the RMI. In the four and a half months since February 1992, 31,942 pounds (14,488.7 kg) of corals ("aquarium rocks") have been exported by one local company to California for the aquarium trade. Only dead coral pieces are allowed to be collected.

3.3.3 Status Of The Stocks

The main threat to stony corals appears to be around the urban centers of each state, through dredging, filling, siltation through runoff and various development projects, and waste (solid and liquid) disposal. The recently commenced export of coral is also a potential threat if not closely monitored. There have also been small outbreaks in the RMI of crown-of-thorns starfish in the past (note: Sablan (1972) may provide more details, but was not seen by the consultant).

3.3.4 Management

Current Legislation/Policy Regarding Exploitation: There is currently no legislation that specifically relates to corals.

Recommended Legislation/Policy Regarding Exploitation: Provisions should be made to prohibit the export of corals from the RMI, unless specifically authorized and the harvesting very closely monitored. The export of black corals should be prohibited.

Legislation and policy is needed to control the use of live corals (such as brain corals) for construction purposes, and to ensure that damage to coral reef areas through development is prevented or at least minimized. The NEP Act should be adequate to regulate development activities.

4. REPTILES

4.1 TURTLES

4.1.1 The Resource

Species Present: *Chelonia mydas* (green turtle), *Eretmochelys imbricata* (hawksbill turtle), and *Dermochelys coriacea* (leatherback turtle).

Distribution: Green and hawksbill turtles are distributed throughout the RMI, with green turtles being the most abundant and hawksbills relatively scarce. Green turtles have been recorded nesting throughout the RMI. Pritchard (1982) notes that nesting of green turtles is concentrated on the more remote atolls and the uninhabited islets of populated atolls. He further states that Bikar has the highest levels of nesting, followed by Bikini and Taongi Atolls. The survey of some of the northern atolls by Thomas (1989) also identified Bikar Atoll to have the highest levels of nestings. However, they found no signs of nesting at Taongi and did not visit Bikini. Nesting of hawksbill turtles is rarer, Thomas (1989) identified one possible nesting site on Bikar Atoll.

Leatherback turtles are known from RMI waters (MIMRA files), but no details are documented. They inhabit the open waters.

Biology & Ecology: The basic stages of the life cycles are similar for all species. The key biological aspects relevant to management are their very slow growth rates, the high mortality of hatchlings and juveniles, the long times to maturity, and their highly migratory nature. The following will concentrate on the green turtle as it is the major species for the region. Most of the life cycle of turtles is known, but there are still some significant gaps.

The female turtle lays her eggs at night in a nest she digs in the sand. The size of the egg clutch depends on the number of times she has already laid that season, but is generally somewhere between 90 and 140 eggs. She can expect to lay about three to seven times, 10 to 15 days apart, during her nesting season.

The eggs take around 48 to 70 days to hatch, depending on the sand temperature. The sex of the hatchlings is determined by the temperature of the nest. If the nest is hot (e.g. laid in the open beach) then most turtles will be female; if the nest is cool (e.g. if the nest is laid under bushes) then the majority of hatchlings will be male. In the mid-temperature range, the sex ratio can vary depending on the local weather conditions. Moving the eggs after about four to six hours after laying usually causes the embryo within the egg to die. Disturbing nests will reduce turtle hatching success by altering the nest structure and may increase its vulnerability to predation.

When the turtles hatch they do so as one group, or two or three smaller groups over one to three days. By hatching together the number killed by predators on the beach (e.g. ghost crabs, birds) and in the water (e.g. sharks and fish) are reduced, as the predators cannot eat all at once. The hatchlings locate the direction of the water by the lighter color of the water, so any lights inland of a hatching nest can disorient them. When they reach the sea the hatchlings immediately swim for the open ocean, only stopping after several days. Only then do the hatchlings rest and begin feeding on planktonic animals near the surface. Little is known of the pelagic stage of their life cycle. The small turtles sometimes take refuge amongst floating seaweed. How long they drift in the open ocean is unknown, but is thought to be several years. In that time they may make one or more circuits of the full ocean gyres before changing to a bottom dwelling existence around reefs and islands.

The sub-adult and adult green turtles are herbivores, eating mainly seagrass and algae. Hawksbills are primarily carnivores, eating mainly corals, tunicates, sponges and algae. Leatherbacks feed on jellyfish and other epipelagic invertebrates. In the wild turtles mature very slowly. It has been estimated that green turtles take between approximately 25 years (Hawaii) and 30 years (Australia) to reach sexual maturity. Males that are sexually mature can be identified by the long tail protruding from under their shell. Once the turtles are mature they will commence their long migrations back to the area where they hatched. These journeys can be retraced by tagging turtles at their nesting beaches and receiving tag returns from their feeding grounds. The reverse, tagging at feeding grounds and returns from nesting beaches, is much less common. From females tagged nesting at Ulithi in Yap State (FSM) in mid-1991, one was caught in the Philippines later in the year and another in the Marshall Islands early in 1992. Tagged turtles have been recorded making migrations of thousands of miles in various parts of the Pacific.

Mating occurs in the vicinity of the nesting areas. The female is receptive to males for about one week, during which time she will mate with a number of males and store their sperm. The male is sexually active for about one month and mates with a number of females. After mating the males migrate back to their feeding areas. The females will move up to 60 miles to their nesting beaches. After completing her nesting cycle she will migrate back to her feeding area. The same female will not usually breed in successive years, but will wait from two to eight years (a three year cycle is common) before breeding again. As yet no one knows to what age turtles live, but is at least greater than 30 to 40 years.

Nesting is believed to occur during most of the year in the RMI, but with peaks in the summer months (April - August). Significant numbers of green turtles are known to nest on

Bikar Atoll (Pritchard, 1982; Thomas, 1989). During their survey of northern atolls in the RMI, Thomas (1989) recorded green turtle nesting on the following atolls/islands: Bikar (264 pairs of tracks counted); Jemo (53); Erikub (49); Rongerik (34); Taka (24); and Wotho (8). Although Pritchard (1982) noted Taongi Atoll as a significant nesting area, Thomas (1989) found no signs of nesting.

4.1.2 The Fishery

Utilization: Turtles have always played an important role in the nutrition, ritual and social lives of Micronesians living on the atolls and low islands. The historical and cultural uses of turtles in this region have not been well documented. Tobin (1952) describes an elaborate ritual associated with the "opening of the season" on Jemo Island and other taboos associated with green turtle hunting on that island. However, these rituals and taboos had ceased to be observed by 1952. Johannes (1986:25) says: "Although occasional references to the use of turtle shell for ornaments in the Marshall Islands can be found (e.g. Kramer and Neverman, 1938) this reader gains the impression that hawksbill turtles were not as frequently captured here as they have been in the Caroline Islands."

Hiatt (1951) noted that at Arno Atoll green turtles were not common, and hawksbills less so, and no fishery existed for either despite their being "frequently" caught in fish traps.

Until recent times, turtles were caught only when they came up to nest. Now turtles are caught by diving and grabbing them (especially at night), or by diving down and securing them with a line attached to a hook (the hook may be held by hand, or on a short - 4 to 5 foot - stick) (Alfred, pers. comm., 1992).

Green turtles are caught primarily for their meat, and secondarily for their shells. Turtle eggs are collected for food. Hawksbill turtles are primarily caught for their shell, but the meat is also eaten. The scutes of both species are used for producing handicrafts, for example, as the center piece of pandanas fans woven for tourists. The whole shell is also sold for decorative purposes.

Production: The level of exploitation of turtles within the RMI is unknown. Thomas (1989:83) states that: "With the exception of Bikar there was evidence that this species [green turtle] is under heavy hunting pressure for its shell, meat and its eggs on most atolls." The following extracts are from Thomas's (1989) report and refer to specific atolls:

Taka Atoll - "Traditionally, Taka has been a 'pantry' atoll for the people of nearby Utirik who harvest the birds, fish, turtles and clams several times a year. ...relatively recent campsites indicated continuing human

visitation..."[pp 50]

Jemo Island - "Our survey found evidence of frequent human visitation and turtle/egg foraging on Jemo."[pp 56]

Wotho Atoll - "...one female green turtle was taken from Long Island...by the crew and villagers after it had laid its eggs. ...Turtles are harvested infrequently with 'several' being taken from the outer islets each summer. Indications are that the local people are very conscious of the vulnerability of the nesting turtle population and limit their harvesting activities accordingly, consuming turtles only on ceremonial occasions."[pp 62]

Erikub Atoll - "...from the evidence of frequent visits by people from Wotje Atoll, the number of nest marker sticks, temporary camps and "middens" of turtle remains, it is clear that human predation on eggs and adult females must account for a high percentage of the annual production."[pp 79]

With the migration of northern outer islanders to the urban centers, especially Majuro, there is now a greater demand for turtle meat to be sold in the centers (Alfred, pers. comm., 1992). Turtles are being shipped in from the outer atolls due to the lack in Majuro lagoon.

There is no information concerning the level of production of hawksbill turtle shell goods in the RMI.

Marketing: In the outer atolls turtle usage is still largely for subsistence purposes. On Majuro and Ebeye (urban centers) turtles are sold for both meat and the shells. Eggs are rarely sold. Turtles are sold either whole or butchered, with the fishermen preferring to sell whole, but the shops require them to be cleaned. When selling to individuals they are usually sold whole.

In Kwajalein turtles are sold for a maximum of US$200, but may go for less if small. In Majuro, a whole green turtle sells for between US$100 to $150. The sale of one very small green turtle for US$10 was observed by the consultant. Whole hawksbills sell for about US$75 to $100. All turtle meat (including the intestines and other viscera) sells for between US$0.85 to $1.00 per pound (Alfred, pers. comm., 1992).

Hawksbill turtle shell products can be found for sale in some of the stores selling handicrafts to the tourists.

4.1.3 Status Of The Stocks

With over-harvesting and habitat (nesting beach) destruction, the world turtle populations are declining. The IUCN Red Data Book (1982) lists five of the seven species of sea turtles as

endangered[8] (including the hawksbill and green). All species are on Appendix I of the Convention on International Trade in Endangered Species (CITES), which prohibits any commercial trade. The RMI is not a signatory to the CITES agreement.

There are no reports available on the status of turtle stocks in the RMI, however, anecdotal accounts indicate that stocks have declined considerably, especially near the urban centers.

4.1.4 Management

MIMRA currently has a proposal awaiting funding to conduct a tagging trip to Bikar Atoll, with two brief tagging stops at Erikub Atoll and Jemo Island (MIMRA files). The objectives are: 1) to tag and measure as many turtles as possible at the three sites; 2) to reduce the rodent population on Bikar which is known to prey on turtle eggs and hatchlings; 3) identify other turtle nesting sites in the RMI through interviews and discussions; 4) to establish a physical presence to discourage the illegal entry of foreign fishing vessels to Bikar; 5) to obtain some hatchlings to be transported back to Majuro for raising and eventual release ("headstarting"). The stated longer term goals are: 1) to initiate a long term nationwide turtle tagging and monitoring program for the Marshall Islands; 2) to determine the relationship, if any, between the nesting turtles on the major rookeries with those found elsewhere in the RMI; 3) to develop a nationwide awareness of the importance of proper management of the resource through a concerted educational program, utilizing the hatchling headstart nursery in the capital.

Current Legislation/Policy Regarding Exploitation:

Section 3 of the Marine Resources Act (Title 33, Chapter 1) sets out the limitations on the taking of turtles:

-No hawksbill turtles or sea turtles shall be taken or intentionally killed while on shore, nor shall their eggs be taken.

-No hawksbill turtle shall be taken or killed except whose shell is at least 27 inches when measured over the top of the carapace shell lengthwise; no green turtle shall be taken or killed except whose shell is at least 34 inches when measured over the top of the carapace shell lengthwise.

-No sea turtle of any size shall be taken or killed from the 1st day of June to the 31st day of August inclusive, nor from the 1st day of December to the 31st day of January

[8] An "endangered" listing in the IUCN Red Data Book refers to species in danger of extinction and whose survival is unlikely if the causal factors continue operating.

inclusive.

-Not withstanding any provisions of this section to the contrary, taking of sea turtles and their eggs shall be allowed for scientific purposes when specifically authorized by Cabinet.

Penalties: a fine not exceeding US$100 or imprisonment not exceeding 6 months, or both.

Recommended Legislation/Policy Regarding Exploitation: Enforcement of the current legislation is non-existent. This partly stems from the fact that the legislation is derived from the former TTPI laws which were written over 30 years ago, primarily for hawksbill turtles in Palau.

The legislation addresses harvesting, but not the sale of turtles and turtle products. Any turtle protection legislation for the RMI should, at a minimum, encompass the following topics:

-definition of the species involved, using the scientific, common english, and vernacular names;

-the commercial sale of turtle products;

-the collection of turtle eggs;

-protection of hatchlings;

-turtle capture methods, including seasons;

-protection of turtle nesting habitat;

-the use of vessels, including government vessels, to facilitate turtle hunting; and

-customary usage and controls.

Any commercial usage of turtle products, whether by individuals or stores, places too great a pressure on the country's turtles. The sale of turtle shell products to tourists should be stopped as soon as possible. The RMI should consider becoming a signatory to the CITES convention to help prevent the trade in turtle products. However, allowances could be made for the exchange/giving of traditional implements within the country for customary purposes only, if they exist. Obviously this involves a large "grey" area that can only be resolved through consultations between the government and traditional leaders. Detailed education programs need to be developed to explain the need for regulation of turtle harvesting.

Assistance can be obtained for the development of turtle conservation and management programs from the South Pacific

Regional Environmental Programme's Regional Marine Turtle Conservation Programme.

Thomas (1989:84) provides specific recommendations for the conservation of turtles in the RMI:

-a ban on the taking of all hawksbill turtles;

-provisions for marine turtle habitat protection through the establishment of reserves and sanctuaries;

-provision for the monitoring of marine turtle populations and the scientific estimation of sustainable yields;

-establishment under the Marine Resources Act of restricted fishing zones off all major nesting areas (e.g. Bikar; Jemo; Enewetak islet at Rongerik Atoll; and Enego islet at Erikub Atoll), other sites could be included as further investigations are undertaken;

-discouragement and very heavy penalties under the Marshall Islands Marine Resources Authority Act for distant water and local fishing vessels found to be exploiting marine turtles for commercial gain;

-provision for heavier penalties for the violation of the conservation provisions of the Marine Resources Act by Marshall Islanders including the confiscation of boats and equipment;

-provision for public education on the need for marine turtle conservation;

-investigation of the feasibility of a joint MIMRA and proposed Conservation Service "headstart" program for marine turtles;

-accession of the RMI to the CITES Convention and a ban on the taking of turtles for commercial purposes and on the commercial trading in turtle products.

5. CHONDRICHTHYES (CARTILAGENOUS FISHES)

5.1 SHARKS

5.1.1 The Resource

Species Present: A diverse range of sharks are present in RMI waters. What harvesting occurs largely consists of carcharhinid sharks, but other families are also caught.

Distribution: Sharks occur from reef and inshore areas through to the open oceans, at all depths, and are widely distributed throughout the RMI.

Biology & Ecology: Sharks utilize a variety of reproductive modes, but all fertilization is internal. Most species bear their young alive in broods ranging from a few individuals to nearly one hundred. As sharks produce so few young and because from the limited data available it is believed they are, in general, slow growing, their populations can be greatly reduced by heavy fishing. When these top level carnivores are removed from a community such as a reef system, adverse effects may result (Randall, *et al*, 1990).

5.1.2 The Fishery

Utilization: Sharks are used as a minor subsistence resource in the RMI, mainly being consumed by people originally from Kiribati (MIMRA staff, pers. comm., 1992).

There is a by-catch of shark in the tuna longline fishery (see Japanese longline shark catch figures listed in the "tuna" profile). The shark fins from the by-catch of the Majuro based longline vessels are currently being purchased by one businessman on Majuro. This businessman is also trying to obtain shark fins from the outer atolls.

The collection of live small/juvenile sharks for the US aquarium fish trade is also being considered by MIA.

Production & Marketing: No information was located on subsistence exploitation of sharks in the RMI.

In 1989, US$8,000 worth of shark fins were listed as being exported (OPS, nd). The only buyer of shark fins, located on Majuro, started operating in November 1991, and sells to a New York based company. The amounts purchased from March to June 1992 were: March - 252 lbs; April - 274 lbs; May - 109 lbs; June - 204 lbs; for a total of 839 lbs (380.6 kg) for the four months. Fins from all species are purchased from two sources: longline vessels (two US and one Taiwanese) off-loading at the Majuro Fish Base; and from outer atolls (the May figure includes 49 lbs (22.2 kg) of fins from Mili Atoll). Dried fins (no meat) from oceanic species receive US$16/kg ($7.30/lb) and for reef species US$20/kg ($9.09/lb) FOB. The local buyer

receives a 20 percent commission from the New York buyer. Prices were set by the New York buyer and have not changed since the operation began.

The New York buyer has expressed interest in purchasing shark meat as well, but only from "grey", "black" and "white" sharks (no clear indication of exactly which species was made to the local buyer). Two forms would be accepted: salted shark meat strips would receive about US$0.40/lb; and whole frozen shark (headed, tailed and gutted only; price has yet to be determined).

A Guam based company has also expressed interest in purchasing shark fins from the RMI.

5.1.3 Status Of The Stocks

No information is available on any shark stocks in RMI waters.

5.1.4 Management

Current Legislation/Policy Regarding Exploitation: There is no legislation directly related to shark fishing. Fishing by foreign and local commercial vessels would be covered under the MIMRA Act.

Recommended Legislation/Policy Regarding Exploitation: The effects of over-harvesting of sharks is not clearly understood. However, as they are top level carnivores, removal from the reef ecosystem may have adverse effects on other reef species.

As an initial step data should be collected from the buyers, and if possible a record of where the sharks are being caught (locality in the RMI; whether reef, sea mounts, or open ocean), the quantity, the species (or at least whether reef associated or open ocean species), and ideally, but very difficult to achieve, CPUE data. For vessels that require MIMRA licensing, the collection of data on shark catches could be made part of their licensing requirements.

As the present harvest appears to be relatively small, except for data collection requirements (for monitoring), there does not seem to be a need for restrictions on harvesting. This situation would, however, require periodic review.

6. OSTEICHTHYES (BONY FISHES)

6.1 TUNA

6.1.1 The Resource

Species Present: Commercially important tuna species: skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*) and albacore (*Thunnus alalunga*). Tuna species that are also artisanally important: mackerel tuna (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tuna (*Auxis rochei*) and dogtooth tuna (*Gymnosarda unicolor*).

Distribution: All species are found throughout the RMI. The skipjack tunas form large near-surface schools; the smaller yellowfin also inhabit the near-surface waters, whereas the larger yellowfin and bigeye tunas dwell in the deeper waters above the thermocline. Dogtooth tunas are primarily reef dwellers, occurring in mid-water along steeply sloping lagoon pinnacles, channel walls and seaward reefs to depths of 55 fathoms (100 m).

Biology & Ecology: Despite being the basis of the world's largest fishery, there is still a lot of unknowns regarding the life history of tunas. Many tuna species migrate considerable distances, swimming continuously. They eat substantial amounts of food and have rapid growth. Many species maintain core body temperatures several degrees above the surrounding sea temperature. Open sea species feed largely on epipelagic fishes, squids, and crustaceans. Near-reef species also utilize the larval and early juvenile stages of reef fish and crustaceans as prey. Reef-associated species prey on large zooplankton or fish occupying the water above the reef (Myers, 1991).

The spawning areas for yellowfin and skipjack tunas extend through the RMI EEZ (Joseph, *et al*, 1988).

Analysis of tag returns from the SPC's Skipjack Survey and Assessment Programme (SSAP) indicated that 37 percent of the recruits to the skipjack pole-and-line fishery in the Marshall Islands had moved into the area from the FSM. This was by far the highest level of interaction between countries observed during the whole program (Anon., 1988).

Of considerable importance to the tuna fishery in the RMI EEZ is the influence of the North Equatorial Current (NEC) and the North Equatorial Counter-Current (NECC). The NEC is a westward flowing current that intensifies during December to April and is centered on 12^{o}N, while the NECC is an eastward flowing current that intensifies during June to November and is centered on 5^{o}N. The transition zone between these currents is approximately 8^{o}N. While the actual locations of these currents at any given time is quite variable, the northern area of the Marshall Islands EEZ is influenced predominantly by the NEC

and the southern area by the NECC (Anon., 1988:2).

6.1.2 The Fishery

Utilization: Tunas form a significant part of the subsistence, artisanal and especially the commercial fisheries of the RMI. Tuna still form a major part of the subsistence diet for those living on the outer atolls. Most catches are usually made by trolling from small outboard powered boats. In the urban centers tunas are sold fresh in the local stores.

Commercial pole-and-line fishing for skipjack has been carried out in the RMI by the Japanese since the late 1920s, and by the mid-1930s live-bait and skipjack fishing grounds included Ailinglaplap and Jaluit atolls (Smith, 1947; Tuna Programme, 1984). Most of the skipjack caught was for "katsuobushi" (dried tuna), but a small cannery operated on Jaluit Atoll (Tuna Programme, 1984). The highest fishing effort in the Marshall Islands was from February to April, then from August to November (Tuna Programme, 1984). The fishery was interrupted by World War II and resumed in the late 1950s.

Also in the 1950s the Japanese began longlining for yellowfin tuna in the former TTPI region, with the Koreans and Taiwanese following in the late 1960s.

The Japanese and the United States both conducted several purse seine pilot studies in Micronesian waters in the early 1970s.

The commercial tuna fishing in the RMI in recent years has been by pole-and-line, longline and some purse seining.

Both the longlining and the pole-and-line fishery in RMI EEZ waters has been dominated by the Japanese. The number of Japanese longline and pole-and-line vessel registrations and permits issued in recent years are shown below (source: MIMRA database):

Method	**1989/90 regist./permits**	**1990/91 regist./perm.**	**1991/92 regist./perm.**
Longline	131/93	126/70	144/133
Pole & line	53/110	48/63	43/9
Total:	184/203	174/133	187/142

Pole-and-line vessels target the surface skipjack schools with a small by-catch of yellowfin (about 1%). The RMI pole-and-line fishery is highly seasonal. Fishing effort and catch in both the northern (NEC) and southern (NECC) areas of RMI's EEZ are concentrated in the December to May period, but particularly high during April (45 percent of the total catch

between 1984 and 1987 was recorded in April). The fishing effort during these peak months was higher in the southern area of the EEZ (Anon., 1988).

Skipjack CPUE is highly seasonal in the northern area, peaking during the summer months, however, CPUE in the southern area is relatively constant. This suggests the possibility of movement of skipjack northwards into the NEC during summer months, or an increase in vulnerability to pole-and-line fishing in the NEC at that time (Anon., 1988).

During the period 1979 to 1987, fishing intensity was highest in the southern area of the RMI EEZ, resulting in the catches being the highest in that area (Anon., 1988). However, skipjack CPUE appeared to be highest in the northern area. A number of possible reasons have been suggested to account for this, including: a higher average abundance of skipjack in the northern area; higher catchability in the northern area; a tendency for larger, more efficient vessels to fish in that area; and reduced competition for skipjack schools in the northern area due to the lower effort expended there (Anon., 1988).

Apart from the Japanese longline vessels there are currently two US and one Taiwanese longline vessels based in Majuro, fishing in the RMI EEZ under joint venture agreements.

The longline vessels target the deeper yellowfin and bigeye tunas. The seasonality of the Japanese longline fishery in RMI waters is similar to the pole-and-line fishery, with most effort and catch concentrated in the first four months of the year for both the northern and southern areas of the EEZ (Anon., 1988).

Yellowfin CPUE is much higher in the southern areas and shows little seasonal change. In the northern area the CPUE decreases steadily from about May to October before recovering in November to December. There is little difference in bigeye CPUE between the two areas, but tends to decrease slightly from April to October, with the reduction slightly greater in the northern area (Anon., 1988).

The longline effort in RMI waters is concentrated in the southern and western regions of the EEZ. The catch of bigeye mirrors the distribution of effort, with a fairly uniform CPUE in all but the very northern region, where bigeye CPUE tends to be lower. Yellowfin catch is more concentrated in the southern areas, and yellowfin CPUE is also conspicuously higher in this area (Anon., 1988).

Until the implementation of the Multilateral Treaty on Fisheries with the United States, purse seining had not been generally permitted in RMI waters.

In 1989, the RMI government, through MIDA, entered into a

joint venture agreement with a US tuna seining company to own and operate a 1,100 ton capacity tuna seiner. In mid-1990, MIDA acquired an interest in a second tuna seiner in conjunction with another tuna seining firm (Clarke, 1992).

The purse seiners target the large surface schools of skipjack and yellowfin. Although no figures were available for the RMI, in the FSM yellowfin tuna constitute approximately 25 percent of the purse seine fishery catch (Diplock, 1991).

A very small cannery exists on Jaluit Atoll but is not operating. One business on Majuro has the equipment for a tuna cannery in storage, but has no definite plans for building a cannery. In the mid-1980s, a "katsuobushi" factory operated for about three to five years on Majuro, and was supplying the domestic market, however, it ceased operating partly because it could not obtain enough wood for curing/smoking the skipjack (MIMRA staff, pers. comm., 1992).

A joint venture between the national government and a foreign interest plans to build a small (about 30 ton capacity) tuna cannery and transshipment facility in Majuro (MIMRA, 1991).

Production: No production figures are available for the subsistence harvest of tunas. Figures for domestic tuna production are unclear as most pelagic species (tunas, wahoo, mahimahi, etc) are combined together with reef and bottom fish species (see "inshore fish" and "other pelagic fish" profiles).

Figures from the Division of Revenue and Taxation for 1991 showed that at least 136,137 kg (value: US$778,871) of frozen/fresh tuna was exported from locally based vessels.

The following figures are for Japanese fishing vessels operating in the RMI EEZ. The figures for 1979 to 1983 were listed in the RMI Statistical Abstracts 1988/1989, and the figures for 1987 to 1991 were from Japanese catch reports (MIMRA files). The figures listed in the RMI Statistical Abstracts 1989/1990 for the 1987 to 1989 catch differ slightly to those listed below and as they could not be verified they have not been included here.

Total Fish Catches by Japanese Fishing Vessels by Type of Fish, 1979 - 1983 (in metric tonnes):

Type of Fish	1979	1980	1981	1982	1983
skipjack	61.5	6,644.5	10,308.5	9,213.5	22,441.1[1]
yellowfin	-	-	17.0	136.2	127.9
bigeye	-	-	17.0	47.8	70.8
other	-	113.4	97.0	42.7	21.7

Total:	61.5	6,757.9	10,439.5	9,440.2	22,661.5

[1 = Anon. (1988) gives an alternate figure of 50,000 tonnes]

Total Fish Catches by Japanese Fishing Vessels by Type of Fish, 1987 to 1991 (in metric tonnes):

Type of Fish	1987	1988	1989	1990	1991
skipjack[1]	11,281.0	35,185.0	4,136.0	3,843.0	722.0
yellowfin	2,507.5	1,034.8	1,483.4	1,437.4	1,389.6
bigeye	1,997.7	855.5	989.2	2,288.9	1,809.2
albacore	10.8	41.8	23.2	15.1	30.8
blue marlin	252.9	305.9	182.7	201.9	187.2
sharks	15.0	8.7	0.0	28.3	4.1
others[2]	96.6	47.7	47.2	65.0	40.4
Totals:	16,161.5	37,479.4	6,861.7	4,036.9	3,461.3

1 - All pole-and-line catch has been listed as skipjack.
2 - Others include: striped marlin; black marlin; sailfish; swordfish; & others

The following figures show the change in average catch composition (tonnes and percent) for the periods 1987-89 and 1989-91 for the Japanese longline catch:

Species	Total 1987-89	% Comp.	Total 1989-91	% Comp.
yellowfin	5,025.6	51	4,310.4	42
bigeye	3,842.4	39	5,087.3	50
albacore	75.8	1	69.1	1
blue marlin	741.5	7	571.8	6
sharks	23.7	<1	32.4	<1
others	191.5	2	152.6	1

Of significance is the increase of bigeye tuna from 39 percent to 50 percent of the catch. This is possibly a reflection of the vessels discarding the lower value yellowfin and retaining the bigeye, rather than a change in catch rates between the species.

Pole-and-line fishery: During the 1970s, Japan harvested an average of 33,000 tonnes of skipjack from the Marshall Islands by pole-and-line (Tuna Programme, 1984). Apart from 1983 when a record catch of more than 50,000 tonnes was reported, catch and effort by the Japanese distant-water pole-and-line fleet during the 1980s was generally less than during the 1970s (Anon., 1988).

Longline fishery: Since 1962 when records became available, longlining effort in the RMI EEZ has been variable, fluctuating between 4 and 12 million hooks per year, and with a long-term average of approximately 7.5 million hooks per year (Anon., 1988).

Marketing: The artisanal catches of tunas are mostly marketed locally, as are the catches from the Arno Fisheries Development (AFD) project. The proportion of tuna caught and sold locally from the AFD project is not known (see "inshore fish" profile).

In 1990, MIDA entered into a joint venture agreement with a Hawaii-based company for the export of sashimi grade tunas from the RMI. The fish are caught by locally based longline vessels and landed in Majuro, for shipment to either Japan, Hawaii, or the US mainland by Air Marshall Islands (Clarke, 1992).

The catches of the Japanese longline and pole-and-line fisheries are sold directly to markets in Japan. The purse seine catches are usually off-loaded in American Samoa.

6.1.3 Status Of The Stocks

There is no information available on the status of the non-commercial species in the RMI. Currently information is only available for skipjack tuna.

Skipjack tuna: The SPC's SSAP conducted three surveys in former TTPI and Guam waters between 1978 and 1980 (Tuna Programme, 1984). The results of the study were combined for the whole region (Palau, FSM, Northern Marianas, Guam and the Marshall Islands) for analysis. The skipjack standing stock vulnerable to the fishery was estimated to be between 373,000 and 1,305,000 tonnes for Micronesian waters. This was about 22 percent of the population estimate of 2.5 to 3.7 million tonnes for the total SSAP study area. The turnover rate (due to natural mortality, fishing mortality, emigration and growth out of the vulnerable size classes) was estimated to be 23 percent per month (14% to 36% confidence interval). Under normal conditions, this meant that between 103,000 and 252,000 tonnes of skipjack were moving through the fishery each month. The harvest ratio was estimated to be between 2 and 4.8 percent. At the time of the study, it was concluded that the low harvest ratio for the former TTPI and Guam area indicated that there was potential for greatly increased catches from this region before recruitment would be affected (Tuna Programme, 1984).

Yellowfin and bigeye: No stock information for yellowfin or bigeye tunas was available at the time this report was prepared. Data is currently being collected for the region by the SPC and FFA.

Pole-and-line fishery: The CPUE for skipjack for the period 1982 to 1987 showed an increasing trend. This was attributed to the larger, more efficient vessels having remained in the fishery, while the smaller, less efficient vessels retired (Anon., 1988).

Longline fishery: The yellowfin CPUE showed no long-term trend up to 1987, however, there have been periods of decline followed by recovery. The situation was very similar for bigeye for the same period (Anon., 1988). Comparisons of longline CPUEs up to 1987 indicate that, in general, yellowfin CPUE was lower in the RMI EEZ compared to the SPC region as a whole, whereas the reverse was true for bigeye (Anon., 1988).

The 1987 Tuna and Billfish Assessment Programme Marshall Islands' country report (Anon., 1988:7) concluded:

> "The catch, effort and CPUE time series would indicate that stocks of skipjack, yellowfin and bigeye in Marshall Islands waters are generally in good condition, with no significant and lasting reductions in CPUE detected. In particular, pole-and-line catch rates for skipjack and longline catch rates for yellowfin in the Marshall Islands waters do not appear to have been adversely affected thus far by the large increases in the catch of both species by the purse seine fishery. In the case of skipjack, this is despite a substantial movement of fish from the waters of Federated States of Micronesia (where a large proportion of purse seining is carried out) to Marshall Islands being demonstrated during the SSAP. While these estimates of movement were obtained under somewhat different conditions than exist today, the lack of an observable interaction in the Marshall Islands pole-and-line CPUE data is probably still indicative of the large size of the skipjack resources in the western tropical Pacific."

There are major deficiencies in the knowledge of the biology of yellowfin and bigeye which preclude conclusive stock analysis (Diplock, 1991). The SPC Regional Tuna Tagging Project (RTTP) will provide much needed information on stock structure, migrations, growth and interactions to allow better stock assessments to be made in the future.

6.1.4 Management

The currently running SPC RTTP is expressly designed to provide answers to questions concerning tuna fisheries interaction and tuna exploitation generally in the SPC region. The project aims to provide information on the population characteristics of yellowfin, skipjack and, to a lesser extent, bigeye.

Current Legislation/Policy Regarding Exploitation: The management of the tuna fishery in the RMI EEZ is the responsibility of MIMRA under the MIMRA Act. MIMRA is responsible for monitoring both the foreign and domestic fishing vessels to ensure that the total EEZ catch is monitored.

Additionally, the MIMRA (Amendment) Act 1989 prohibits the use of drift nets in RMI waters.

Relating to the tuna purse seine fishery, the Marine Mammal Protection Act 1990 protects dolphins and other marine mammals captured in the course of commercial fishing operations in the eastern tropical Pacific Ocean by flag vessels of the RMI.

Finally, there is a "Regulation, Administrative Action and Decree" banning the import and export of certain yellowfin tuna or tuna products containing yellowfin tuna. This regulation bans the import into or export from the RMI of any yellowfin tuna or tuna products containing yellowfin tuna that are banned from direct export to the US, including any caught with commercial fishing technology which results in the incidental kill or serious injury of ocean mammals in excess of the US standards.

Recommended Legislation/Policy Regarding Exploitation: One of the key problems facing MIMRA is obtaining reliable catch and effort data from the DWFN to assist in their stock and harvest assessments. Additionally, obtaining data from the domestic vessels is also urgently needed. At the moment, the relative newness of MIMRA, and the lack of staff, precludes it from conducting its duties as legislated. The proposed staff restructuring may help to some degree, but in the short term MIMRA will have to continue to rely on the technical assistance of FFA and SPC.

6.2 OTHER PELAGIC FISH

6.2.1 The Resource

Species Present: This category includes all the non-tuna pelagic fish: billfish - including blue marlin (*Makaira nigricans*), black marlin (*Makaira indica*), striped marlin (*Tetrapturus audax*), broadbill swordfish (*Xiphias gladius*), sailfish (*Istiophorus platypterus*) and others; wahoo (*Acanthocybium solandri*); mahimahi or dolphin-fish (*Coryphaena hippurus*); rainbow runner (*Elegatis bipinnulatus*); and barracudas (*Sphyraena spp*).

Distribution: These species are distributed throughout the RMI and form an important part of the subsistence and artisanal fisheries. Some species, such as the billfish, form a part of the longline by-catch.

Biology & Ecology: All these species are predators, mostly of fish and squid. The billfish are solitary, and the others tend to form small to medium sized schools, although some of the larger barracudas are solitary. The billfish and dolphin-fish undergo migrations believed to be associated with spawning. Large barracudas are potentially ciguatoxic.

The striped marlin and blue marlin are both believed to spawn in the RMI EEZ (Joseph, *et al*, 1988; Anon., 1988). Japanese research cruises have found a broad concentration of blue marlin larvae in the northern area of the EEZ and in international waters to the east (Anon., 1988).

6.2.2 The Fishery

Utilization: Miscellaneous non-tuna pelagic fish form about half of the subsistence and artisanal trolling catch. The catches tend to be seasonal, partly due to the relative inaccessibility of the open sea by small boats during the north-east trade winds (boreal winter), and partly due to the seasonality of some species. Peak wahoo season is around November to March.

Billfish and other non-tuna pelagic fishes are a by-catch of the Japanese longline fishery in RMI waters. The gamefish species (billfish, tuna, wahoo, mahimahi, etc) are also exploited as a sport fishery resource by the Marshall's Billfish Club and some tourists.

Production & Marketing: No information is available on the subsistence/artisanal catch levels. What limited information is available for pelagic fish rarely separates tunas from other pelagics. In some cases all pelagic fish and inshore fish are grouped together. For example, the data collected from stores for seven months from October 1988 for the market survey program combined all fish together (see "inshore fish" profile).

Figures are available for the Majuro Fisherman's Cooperative Association which operated from 1978 to 1982. The amount of pelagic fish landed, their value, and the percentage of the total fish catch are given below:

Pelagic fish landings (lbs), value (US$) and percentage of the total fish landings for the MFCA, 1978 to 1982.

	pelagic fish	value	% of total fish
1978	208,000	14,000	70
1979	300,000	173,000	79
1980	92,000	60,000	68
1981	80,000	61,000	60
1982	46,000	39,000	54

The Arno Fisheries Development project divides their catch into "reef" and "pelagic" for marketing purposes, but do not separate tunas from other pelagic fish (see "inshore fish" profile). For the 12 months from June 1991 to May 1992, 28,973 lbs (value: US$34,838) of pelagic fish were sold to local stores, which represented 29 percent of all fish they sold. The average monthly sale of pelagic fish was 2,414 lbs (value: US$2,903).

The Japanese longline by-catch of non-tuna pelagic fish for 1987 to 1991 is shown below:

Non-tuna pelagic fish by-catch of Japanese Longline vessels, 1987 to 1991 (in metric tonnes):

Type of fish	1987	1988	1989	1990	1991
blue marlin	252.9	305.9	182.7	201.9	187.2
others[1]	96.6	47.7	47.2	65.0	40.4
Totals:	349.5	353.6	229.9	266.9	227.6

1 - Others includes: striped marlin; black marlin; sailfish; swordfish; and others.

The percentage of the total catches that they represent for that period has not varied much. For the period 1987 to 1989 blue marlin represented about 7 percent of the total catch and "others" 2 percent; for the period 1987 to 1991 the figures were 6 percent and 1 percent, respectively.

The CPUE for blue marlin in the Japanese longline fishery tends to be higher in the northern region of the RMI EEZ (Anon., 1988). The catch has declined from a high of 25,000 fish (about 1,300 tonnes) in 1962 to 5,000 - 10,000 fish (about 250 - 500 tonnes) since 1975. The CPUE also declined dramatically between 1962 and 1975, from almost 4 fish per 1000 hooks to less than 1 fish per 1000 hooks (Anon., 1988).

6.2.3 Status Of The Stocks

There is no stock assessment information available on the non-tuna pelagic fishes caught either for subsistence or commercial purposes. With the exception of blue marlin, there is no evidence to suggest that any species is being over-exploited.

A comparison of the longline CPUE for blue marlin between RMI waters and the SPC region as a whole, shows that the CPUE is approximately double in the RMI (Anon., 1988). The TBAP 1987 country report for the Marshall Islands notes that there is some concern regarding the status of blue marlin in RMI waters, where longline CPUE has, since the mid-1970s, been approximately 25 percent of its 1962 level. They recommend that future catches of blue marlin be carefully monitored and regular assessments made (Anon., 1988).

6.2.4 Management

Current Legislation/Policy Regarding Exploitation: There is no legislation or regulations in place specifically regarding the above species. The general government policy is to encourage greater effort in exploiting the pelagic species for commercial purposes.

Recommended Legislation/Policy Regarding Exploitation: With the exception of monitoring blue marlin catches, none is considered necessary at this time.

6.3 BAITFISH

6.3.1 The Resource

Species Present: Baitfish are small pelagic fishes from a number of families. The most commonly caught species during baitfishing in the RMI have been *Sardinella sirm*, *Spratelloides delicatulus*, *Hypoatherina ovalaua* and *Atherinomorus lacunosa* (Tuna Programme, 1984). Below are listed the species considered as small pelagics or baitfish in the South Pacific region (after Dalzell & Lewis, 1989:1):

Common name	Genus
Anchovies	*Stolephorus* spp, *Thryssa* spp.
Sardines	*Sardinella* spp, *Amblygaster* spp.
Round herrings	*Dussumieria* spp.
Herrings	*Herklotsichthys* spp, *Pelona* spp.
Sprats	*Spratelloides* spp.
Mackerels	*Rastrelliger* spp.
Scads	*Decapterus* spp, *Selar* spp, *Selaroides* spp, *Atule* spp.
Fusiliers	*Pterocaesio* spp, *Caesio* spp, *Gymnocaesio* spp.
Flying fish	Exocoetidae
Half beaks	*Hemiramphus* spp, *Hyporhamphus* spp.

Distribution: Baitfish are widely distributed throughout the RMI. Lewis, *et al* (1983) reviewed the catches of baitfish from the SPC's tuna program in the South Pacific, and the species found in the RMI are given below (cited in Dalzell & Lewis, 1989:3):

Family	# Species
Sardines & sprats	3
Silversides	2
Scads	1
Mackerel	1
Total:	7

Biology & Ecology: The majority of baitfish species are planktivores, form schools and are often seasonal. They occupy a range of habitats from estuarine waters, coral reefs and lagoons to the open ocean.

6.3.2 The Fishery

Utilization: Small pelagic fish have been used extensively in the subsistence fisheries of the RMI. Their use as baitfish has been minimal. Smith (1947) notes that by the early 1930s Japanese pole-and-line tuna boats operated out of Jaluit, but the lack of baitfish was a limiting factor to further development.

Baitfish are commonly caught as bait for longlining or pole-and-line tuna fishing. They are usually caught by use of dip

nets or "bouke-ami" nets. The fish are aggregated around lamps suspended from the boats at night. During the setting and hauling of the nets the lights are raised to near the surface and dimmed to compact the baitfish schools (Dalzell & Lewis, 1989).

Small pelagics subsistence fisheries use a variety of methods including dip-nets, beach seines and handlines.

Production & Marketing: A number of baitfishing surveys have been conducted in the Marshall Islands since the Japanese administration. The FJTFCA/NFFCA (1983) report on their baitfish survey in the Marshall Islands was not seen by the consultant, but should provide additional information on baitfish resources.

Recent baitfishing at Lobikaere islet, Majuro Atoll (April 1992) resulted in 37 buckets (approximately 1.5 kg of baitfish per bucket) of blue sprat (*Spratelloides delicatulus*; mean length = 56.9 mm) and silversides (*Stenatherina panatela*; mean length = 60.8 mm) in one "bouke-ami" haul (Itano, 1992).

SPC's SSAP report (Tuna Programme, 1984:23) notes:

> "Previous surveys in Marshall Islands encountered highly variable baitfish abundance. Hida & Uchiyama (1977) found that herring (*Herklotsichthys quadrimaculatus*) and hardyheads (*Atherinomorus lacunosa*) at Majuro fluctuated widely in abundance between May 1972 and April 1973. JAMARC pole-and-line vessels, similar to the Programme's, surveyed seven atolls for bait in October-November 1977 (JAMARC 1978) and eleven atolls between August and November 1978 (Iwasa & Mizuno 1979). At Majuro, their catches averaged approximately 90 kg per haul in 1977, and 194 kg per haul in 1978. Similar variability occurred between visits to Jaluit (30 kg per haul in 1977 versus 124 kg per haul in 1978). Species of sprats, hardyheads and sardines were included in Japanese catches at both atolls. A more recent Japanese survey in 1982 at Majuro (Anon. 1983) encountered poor weather and low baitfish catches."

During the SPC's SSAP pole-and-line fishing in this region, they conducted baitfishing at Majuro and Jaluit (Tuna

Programme, 1984). The ten most common species caught with "bouke-ami" gear were:

Bait Species	Total (kg)	Kg/haul	%/haul
Sardinella sirm	402	50	60
Hypoatherina ovalaua	146	18	24
Spratelloides delicatulus	44	6	8
Atherinomorus lacunosa	4	1	1
Apogon cypselurus	-	-	-
Herklotsichthys quadrimaculatus	-	-	-
Bregmaceros sp.	-	-	-
Atherinomorus lacunosa	-	-	-
Sp. of Holocentridae	-	-	-
Grammatorcynus bicarinatus	-	-	-
Total caught:	609	76	99
Total loaded alive:	567	71	
hauls:	8		
nights:	5		
Total catch per night:	122		

SPC did an analysis of the baitfishing catch, effort and species composition for Micronesia arising from their tuna project, to assess the differences between high islands and atoll lagoons (Tuna Programme, 1984). They found that the catch per effort was, on average, almost twice as high at high island sites than atolls, and the species composition at high islands was more varied. In addition, the degree of variability of catch per effort at atoll sites was greater than at high island sites, and atoll catches included less effective species for pole-and-line fishing. They concluded that atolls in general offer much less potential for commercial baitfishing than high islands (Dalzell & Lewis, 1989; Tuna Programme, 1984).

6.3.3 Status Of The Stocks

The status of RMI's baitfish stocks is unknown. From the above mentioned surveys, the indications are that the stocks seem to be seasonally variable and too limited to sustain heavy commercial usage (for commercial tuna fishing).

6.3.4 Management

Current Legislation/Policy Regarding Exploitation: No specific legislation or policies could be located regarding baitfishing. Baitfishing operations for commercial purposes, to some extent, would be covered by the MIMRA Act.

Recommended Legislation/Policy Regarding Exploitation: There is currently no commercial baitfish operations in the RMI, and virtually nothing is known about the status of the stocks. The current MIMRA Act should be adequate for the immediate future. However, with the planned increase in locally operated

longline vessels, specific controls on baitfish operations may be deemed necessary. At the minimum, catch, effort and location information will need to be collected from any operators.

6.4 DEEP-SLOPE FISHES

6.4.1 The Resource

Species Present: The deep-slope (also known as deep-bottom or deep-water) resources of the RMI are dominated by the Lutjanidae (snappers), of which the subfamily Lutjaninae (shallow-water snappers) predominate. Other important components are the Serranidae (groupers) and Lethrinidae (emperors). Other components of dropline fishing catches are given in the table below. Dominant species of the deep-slope catches recorded for the RMI include: *Aprion virescens*, *Pristipomoides filamentosus*, *P. auricilla*, *P. zonatus*, *Aphareus rutilans*, *Caranx lugubris*, *Lutjanus bohar*, *L. gibbus*, *Lethrinus kallopterus* and *Lethrinus miniatus* (Dalzell & Preston, 1991).

Percentage catch composition by numbers and weight from SPC dropline fishing in the RMI (after Dalzell & Preston, 1991:7).

Family	Common Name	% by No.	% by Wt
Etelinae/Apsilinae	deep-water snappers	9.6	8.5
Lutjaninae	shallow-water snappers	28.7	14.3
Lethrinidae	emperors	14.1	6.5
Serranidae	groupers & coral trouts	25.9	10.1
Carangidae/ Scombridae	trevallies, jacks, tunas & mackerels	7.5	8.1
Gempylidae	oilfish & snake mackerel	2.8	1.1
Sphyraenidae	barracudas	0.7	0.3
Other teleosts	(bony fish)	2.6	2.3
Sharks		8.1	48.9

Distribution: Deep-slope species are distributed throughout the RMI around the atolls, islands and sea mounts. Deep-water snapper are generally found between 44 and 220 fathoms (80 - 400 m). Dalzell & Preston (1991) found a decline in species number in the dropline catches from west to east in the Pacific, with 44 species of deep reef slope fish recorded for the RMI (cf: Palau - 102; FSM - 88 in Chuuk to 63 in Kosrae).

Biology & Ecology: Deep-slope fish, especially snappers, tend to have slow growth, and recruitment may be low, resulting in their being highly susceptible to over fishing. They are usually top level carnivores.

6.4.2 The Fishery

Utilization: The deep-slope resources of RMI have not been commercially targeted. The Arno Fisheries project tried deep-slope fishing (80 - 200 m) between April 1989 and May 1990.

The SPC Deep Sea Fisheries Development Project has only made one visit to the RMI, fishing around Majuro and Arno Atolls

(Taumaia, in press, cited in Dalzell & Preston, 1991). The SPC master fisherman used an 11 m (36 ft) vessel fitted with Samoan-type wooden handreels to conduct the deep-water dropline fishing (Dalzell & Preston, 1991).

Production & Marketing: The above surveys were conducted exclusively on unfished virgin populations, and therefore the following production figures would most likely over-estimate the catches available if commercially harvested.

The following summary of the SPC survey was taken from Dalzell and Preston (1991):

From a total of 318 reel-hours of fishing around Majuro and Arno, the average catch rate was 11.0 kg/line-hour (24.3 lb/line-hr). About half of this catch was sharks (see table above) and the CPUE of teleosts was only 5.6 kg/line-hour (12.3 lb/line-hr). Eteline snappers comprised only 8.5 percent of the catch and were dominated by the green jobfish, *Aprion virescens*. Lutjanine snappers comprised the largest proportion of the teleost catch and the catch by weight was comprised mainly of *Lutjanus bohar* and, secondarily, *L. gibbus*.

6.4.3 Status Of The Stock

The following information on the stocks was taken from Dalzell and Preston (1991) and is based on the very limited SPC Deep Sea Fisheries Development Project. Extreme caution should therefore be taken in interpreting or extrapolating these results.

The deep-slope stocks within the RMI are apparently unexploited. The total length of the 100 fathom isobaths in the RMI is about 1,420 nautical miles. The empirical total unexploited biomass was estimated to be 1,108 tonnes. Accordingly, the maximum sustainable yield (MSY) would be expected to lie between 111 and 332 tonnes per year, with a range of CPUE at MSY of 2.9 to 9.5 kg/line-hour (6.4 - 20.9 lb/line-hr).

The catch rate from droplining would be expected to decline at the MSY to around 5.5 kg/line-hour (12.1 lb/line-hr). This assumes that during the course of fishing, catch composition remains unchanged and that the sharks continue to form half the catch. Under intensive fishing, however, top level predators such as sharks and larger carnivorous teleosts are the first to decline in catches. The CPUE of the teleosts might therefore be a more realistic index of the productivity of the virgin biomass and under intensive exploitation would decline to around 2.8 kg/line-hour (6.2 lb/line-hr) as the MSY was approached.

6.4.4 Management

In their review of the SPC deep reef slope fisheries surveys,

Dalzell and Preston (1991) note that, generally, the catch rates at the maximum sustainable yield for most stocks may be reduced by about 50 percent from the initial CPUEs. Further, unchecked expansion of fishing effort may lead to severe declines of deep reef fish stocks, particularly on submerged pinnacles and sea mounts. They also note that sustained fishing, even by a single individual, may be sufficient to reduce populations on such structures rapidly.

Regionally, it was found that catch rates are far more variable around atolls than high islands. Further, the data indicated that atoll catches contained significantly lower proportions of eteline species and larger amounts of low value species such as shark and gempylids (Dalzell & Preston, 1991).

Based on what information there is available concerning the productivity of deep-slope fishes and their ability to sustain harvesting, it appears that they are not well suited to commercial exploitation on a sustained basis. There may, however, be sufficient stocks to permit small scale (artisanal) level exploitation if the fishery is regulated and carefully monitored.

Current Legislation/Policy Regarding Exploitation: There is currently no legislation specifically regarding deep-slope bottom fishing. The regulation of any commercial exploitation would be under the "MIMRA Act 1988", especially Part III (Foreign Fishing) and Part IV (Activities Other Than Foreign Fishing).

Recommended Legislation/Policy Regarding Exploitation: The present legislation appears adequate to control deep-slope fisheries by foreign as well as domestic operations.

6.5 INSHORE FISH

6.5.1 The Resource

Species Present: This category includes all the reef, shallow bottom and lagoon associated fish. As no studies or reports on specific inshore species could be located, all inshore fishes will be profiled together.

Myers (1991:14) lists the number of known fish species for the Marshall Islands as:

Island	# Known species	# Reef fish species (<60m)
Marshalls	827	799

Species lists of inshore fishes of the RMI can be found in: Myers (1991), Randall (1986), and Randall and Randall (1987).

The families most commonly caught include: snappers (Lutjanidae), emperors (Lethrinidae), groupers (Serranidae), wrasses (Labridae), rabbitfish (Siganidae), surgeonfish (Acanthuridae), trevallies and jacks (Carangidae), mullets (Mugilidae), parrotfishes (Scaridae), and soldierfishes and squirrelfishes (Holocentridae). The following families are the mainstay of the aquarium fish trade[9]: angelfishes (Pomacanthidae), butterflyfishes (Chaetodontidae), damselfishes and anemonefishes (Pomacentridae), wrasses (Labridae) and some triggerfishes (Balistidae).

Distribution: Within Micronesia, the richest reef fish fauna occurs in the west (Palau) and diversity gradually decreases moving east to the Marshall Islands (Myers, 1991). Over 96 percent of the Micronesian fish fauna may be expected[10] at Palau (1,357 expected species; 1,223 reef fish species), followed by 82 percent in the Eastern Carolines (1,149 species, of which 1,040 are reef fish) and slightly less than 66 percent in the Marshalls (875 expected species; 824 reef fish species) (Myers, 1991).

Biology & Ecology: The multitude of species upon which the inshore fishery is based have very divergent life histories

[9] The person operating the aquarium fish export business to the US was off-island during the period of the consultancy, and so the considerable information he posseses - species lists, export data, etc - was unavailable for this profile.

[10] "Number of species expected" is based on interpolation of gaps in the known distribution of each species. These include species with "uncertain" distributions at island groups to the west of where they are known to occur by assuming they are not Pacific Plate endemics. The estimates do not consider species not yet known from Micronesia and are therefore conservative (Myers, 1991:14).

and biological parameters. Myers (1991:17) provides a simplified breakdown of the Micronesian inshore fish fauna relative to major habitat, behavioral and trophic groupings:

Habitat/behavioral group	Number of species by trophic category				No. species	% of total fish fauna
	herbivore	omnivore	planktivore	carnivore		
diurnal reef	109	141	94	198	542	40.4
cryptic reef	48	6	15	319	388	29.0
nocturnal reef	0	0	73	51	124	9.3
sand, mud, & rubble 11	6	4	105	126	9.4	
mid-water reef	0	9	37	65	111	8.3
pelagic	0	0	17	32	49	3.7
Total no. species:	168	162	240	770	1340	
% of total fish fauna:	12.5	12.1	17.9	57.5	100	

Myers (1991:20) notes that the life histories of the different reef fishes are diverse, with spawning either demersal or pelagic. Pelagic spawning can be either in pairs or schools. After a pelagic larval phase, larvae settle back to the reef where they quickly develop into pigmented juveniles. Settlement sites vary among species, with some living amongst the mangroves or on flats as juveniles, then migrating to outer reef areas as subadults. Many species that normally live on coastal or inner reefs, migrate to specific spawning sites while others live in or near permanent spawning territories.

Ciguatera fish poisoning has been a problem in the RMI since at least the Second World War. Tebano (1991) has conducted a brief survey of fish poisoning cases in the RMI. The medical records at Majuro hospital showed 67 cases of fish poisoning for 1990 and 28 cases for the first eight months of 1991. Between 1982 and 1987 the number of cases increased, but have shown a decrease in early 1990. Poisonings averaged over 300 cases per 100,000 people per year. The main species implicated are: *Seriola dumerili*, barracuda, surgeon fish, *Lethrinus miniatus* and *Lutjanus bohar*. The atolls known to have ciguatera are Majuro, Bikini, Kwajalein, and Enewetak. Tebano (1991) suggests that the most plausible explanation is the extensive military infrastructure and activities related to the 66 nuclear test explosions at Enewetak and Bikini atolls between 1946 and 1958, and to the Kwajalein missile range. In addition, the blasting and dredging activities around the urban centers are believed to be a contributing factor.

6.5.2 The Fishery

Utilization: The inshore fishery is of prime significance to the subsistence and artisanal fisheries sectors. In the more remote areas of the RMI the subsistence inshore fishery provides the major portion of protein for the people. Around the urban centers the sale of inshore fish also provides a source of income to many fishermen.

Capture methods vary widely from the more traditional techniques to modern methods. Currently, the most commonly used methods include: spearfishing (both during the day and at night by flashlight); handlining; trolling; gillnetting and cast-nets. Most artisanal fishing is done from wooden or GRP boats of 15 to 20 feet (4.6 - 6.1 m), powered by outboard motors mostly in the 15hp to 30hp range, but occasionally larger (especially at the urban centers, when fishing outside the atolls motors of 70hp or more are used). In the outer atolls small paddling canoes remain the most common fishing vessels for subsistence fishing.

The Arno Atoll Fisheries Development Project has been set up by the Japanese Overseas Fishery Cooperation Foundation (OFCF) to develop a small scale commercial bottom fish and trolling fishery. The project started in August 1989 and to date has trained about 200 fishermen. The project currently has 8 small GRP boats which are rotated amongst teams of two to four fishermen, one of whom is trained and designated as the boat operator. Initially, the OFCF technicians provided gear, bait, ice and coolers free of charge, but now the fishermen pay partial costs from the income from the fish. OFCF also provides engine and vessel maintenance and purchases the catch from the fishermen and markets it in Majuro. The project has also involved infrastructure development, with the construction of causeways, docks, jetties, cold store facilities, funded (approximately US$4 million) by the Japan International Cooperation Agency (JICA).

An aquarium fish export business has been operating out of Majuro for about the last 10 to 15 years. There is currently one main operator, and a couple of smaller ones. The latter mostly sell to the main operator. Virtually all fish are caught in Majuro lagoon. Fish are usually caught using hand-nets and sticks while using both SCUBA and free-diving techniques. One small operator employs eight divers six days per week.

Production: With the exception of the Arno project, the available information on inshore fisheries production is virtually non-existent or old. A fishery statistics project to establish a standardized data collection system in Micronesia began in about 1986. The major components of the project were to involve field surveys, interviews, collection of market data and length/weight sampling of certain species. The RMI section commenced in 1988, but store receipts were only collected for eight months. The information collected is shown below:

Market survey - Majuro. All fish (reef & pelagic) in pounds (MIMRA files).

	1988			1989				
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total
All fish (lbs)	8,473	21,918	11,016	13,869	9,811	20,178	13,016	98,281

No. stores (7)[1]	(8)	(7)	(7)	(6)	(9)	(6)

1 = 19 stores were listed as selling fish but not all cooperated, and some only intermittently. The figure in parenthesis notes the number of stores that provided information for that month.

Milone, *et al* (1985:11) list the landings and value data for the years 1978 to 1982 when the Majuro Fishermen's Cooperative Association (MFCA) was functioning. They note that there were approximately 280 members in the coop of whom 20 were considered full time fishermen. Landings at the coop began to decline in 1980 due to a number of problems with the MFCA, which caused many fishermen to market their catches elsewhere. The following shows the annual landings and value at the MFCA from 1978 to 1982 (source: Milone, *et al*, 1985:11):

Fishery Landings and Value at MFCA (in '000).

	Pelagic		Reef		Bottom		Lobster		Total	
	lbs	$	lbs	$	lbs	$	lbs	$	lbs	$
1978	208	14	68	36	23	12	.4	.4	300	163
1979	300	173	54	33	27	16	.1	.1	381	221
1980	92	60	35	26	9	6	.2	.2	136	92
1981	80	61	41	31	13	9	--	--	134	102
1982	46	39	32	29	7	5	--	--	85	73

The catch data on the following page was taken from the Arno Fisheries Development Project's monthly reports. Based on the Arno project's sales figures (only data available which distinguishes reef from pelagic species) for the 12 months June 1991 to May 1992, 71,219 lbs (71%) were reef fish and 28,973 lbs (29%) were pelagic species.

As noted above, production figures for the aquarium fish operations on Majuro were unavailable, however, MIMRA estimates that approximately 3,000 fish, consisting of about 30 to 50 species are exported each week. The biggest seller is apparently the flame angelfish (*Centropyge loriculus*).

Marketing: Data on the weight and money received for the Arno project fish sold in Majuro are shown in the above table. Over the duration of the project (34 months) 6.4 percent of the fish bought from the fishermen went unsold. The monthly average was 5.7% (S.D. $\pm$ 7.9 %).

The prices paid and received for the Arno project fish were:

	Buying	Wholesale	Retail
pelagic fish	$0.70/lb	$1.25/lb	$1.85/lb
reef fish	$0.85/lb	$1.25/lb	$1.85/lb
bottom fish	$0.85/lb	$1.25/lb	$1.85/lb
flying fish	$0.50/lb	$1.00/lb	?
parrot fish	$0.50/lb	$0.87/lb	?

No information was available on the marketing of aquarium

fish.

Arno Fisheries Development Project - monthly catch data.

Year & Mth	Catch[1] weight (lbs)	Catch[1] value (US$)	Sales[2] weight (lbs)	Sales[2] value (US$)
1989				
Aug.	1,264	964	1,389	1,485
Sep.	4,052	3,340	3,413	4,267
Oct.	6,962	4,680	6,793	8,034
Nov.	4,403	3,598	4,594	5,581
Dec.	5,193	3,884	5,290	6,054
1990				
Jan.	10,284	7,612	9,152	10,293
Feb.	8,730	6,250	8,349	9,543
Mar.	5,340	3,833	5,082	5,544
Apr.	4,973	3,494	4,821	4,942
May	4,251	3,198	3,924	4,362
Jun.	3,604	2,776	3,550	4,025
Jul.	3,868	2,919	3,093	3,532
Aug.	4,766	3,749	3,897	4,616
Sep.	4,070	3,296	4,476	5,382
Oct.	4,538	3,343	4,160	4,612
Nov.	3,157	2,437	2,789	3,284
Dec.	5,546	4,093	5,809	7,170
1991				
Jan.	6,621	4,767	5,516	6,796
Feb.	5,125	3,859	4,852	5,761
Mar.	5,934	4,730	4,933	6,100
Apr.	8,019	6,320	7,873	10,114
May	7,450	5,850	7,183	8,478
Jun.	9,654	7,707	8,373	10,009
Jul.	9,165	7,419	7,659	9,435
Aug.	10,466	8,444	9,393	11,878
Sep.	8,034	6,610	7,845	9,834
Oct.	12,026	9,685	10,765	13,246
Nov.	7,979	5,688	8,266	9,799
Dec.	8,073	6,067	8,435	9,930
1992				
Jan.	7,566	5,572	7,569	9,164
Feb.	9,215	6,218	8,529	10,272
Mar.	8,118	5,105	7,658	8,659
Apr.	8,262	6,155	7,486	8,744
May	8,804	6,557	8,215	9,763
Totals:				
	225,509	170,219	211,128	250,706

1 = Weight of all fish (reef & pelagic) caught by Arno fishermen (including fish caught by non-project fishermen but sold to the project) and the amount paid to the fishermen.

2 = Weight and money received from all fish (reef & pelagic) sold to stores in Majuro.

6.5.3 Status Of The Stocks

No reports on stock assessments of individual species or families of inshore fish in the RMI could be located. MIMRA staff were unaware of any having occurred.

One operator noted that there had been a noticeable decline in aquarium fish numbers in Majuro lagoon.

6.5.4 Management

The major concern for inshore fish is around the urban centers, where both over-fishing and pollution are major problems. In addition, construction (especially of causeways blocking water flow from the lagoons to the open ocean) and other development activities are having considerable effect upon the inshore fish resources. The development of an overall marine resources and coastal zone management plan, which encompasses all land areas (not just the coastal zone defined in the Coast Conservation Act) is urgently required. This will be a major undertaking as it will involve a number of government agencies as well as levels of government.

The uncontrolled use of monofilament gillnets was identified by MIMRA staff as being of concern, especially the reduction in mesh size over the last few years.

There is apparently no concern at the moment over flashlight spearfishing (MIMRA staff, pers. comm., 1992). This may be partly due to parrot fish not being a preferred food fish in the Marshall Islands. It is these fish which are key targets of flashlight spearfishing elsewhere in Micronesia.

As a management strategy, most aquarium fish operators rotate the areas they harvest, but this is largely dependent on weather conditions. With a number of operators working in the one lagoon they often harvest the same areas, so that even if one rotates to relieve fishing pressure, another may still harvest that area.

Current Legislation/Policy Regarding Exploitation: The Marine Resources Act prohibits fishing with explosives, poisons, chemicals or other substances which kill fish or marine life, or to possess or sell fish caught by those means.

Penalties: A fine of not less than US$100 or more than US$2,000, or imprisonment for not less than six months or more than two years, or both.

No other legislation or regulations could be found that specifically relate to inshore fisheries resources.

The licensing for commercial harvest of all fisheries resources by both foreign and local vessels is covered by the MIMRA Act. In addition, the NEP Act allows the EPA to provide

recommendations relating to the rational exploitation of fisheries resources, and to provide regulations on the harvesting and marketing of threatened species of fish.

Recommended Legislation/Policy Regarding Exploitation: Consideration should be given to developing a policy concerning the reserving of reef fish for artisanal and domestic use first, and only when the local market is saturated (and if stocks permit) should the export of reef fish be permitted.

In consultation with the local atoll governments, policies should be developed concerning gillnet usage and mesh size. If enough cooperation and support is obtained at that level, then national regulations concerning the sale of gillnets (length, mesh size, etc) could be developed. Without local government support and enforcement any national regulations concerning gillnets would have minimal effect.

More data is required concerning inshore fish harvesting and sales. To a very limited extent this will be addressed through Asian Development Bank funded technical assistance, but the assigning of one MIMRA staff member to fulltime fisheries data collection is also required.

As aquarium fish collecting has been conducted successfully for a considerable number of years in Majuro lagoon, this would tend to indicate that it has been done so at a sustainable level. However, with the increase in operators, and a perceived decline in catch per unit effort, it may now be necessary to work closely with the established collectors to develop an appropriate management plan. An initial step would be to analyze the harvest and sales records of all operators to get a better idea of the state of the fishery.

7. FLORA

7.1 SEAWEED

7.1.1 The Resource

Species Present: The potentially economic seaweed *Eucheuma cottoni*.

Distribution: *Eucheuma* was introduced from Pohnpei to Majuro in 1990 for growth trials. From Majuro it was introduced to Mili and Likiep. At the present time there is apparently none at Majuro.

Biology & Ecology: Seaweeds can be grown intensively, requiring only sunlight and nutrients in the water. Damaged plants can be attacked by fungus and other diseases (Anon., nd; Zingmark, 1990). Problems can be experienced with attacks by herbivorous fish, especially *Siganus spp* (rabbitfish).

7.1.2 The Fishery

Utilization: The major commercial use of seaweeds, especially *Eucheuma*, is as a primary source of phycocolloids for the production of agar and carrageenan, which are important stabilizing and suspension components in a variety of food, cosmetic, medicinal and other products.

There were no reported subsistence harvests of seaweeds in the RMI. Production would therefore be for the export market only.

Eucheuma farming can be done by attaching cuttings to lines suspended off the bottom, or by raft culture. The rafts used in the RMI pilot study farms measured four by six feet (1.2 x 1.8 m). They consisted of a PVC framework floating 0.5 m (1.6 ft) below the surface and anchored in about 20 feet (6 m) of water over sandy bottoms. Each frame held 56 plants and each plot 224 plants (Zingmark, 1990).

Under Fijian conditions, and using the stake and line method, the weed is best harvested after ten weeks. A portion of the harvest is retained, the weed cut into pieces and used to replant the lines (Anon., nd). The harvested raw seaweed is sun-dried, pressed and baled, then shipped to processing plants. Production of the purified final product is a highly technical operation, but an intermediate level raw seaweed can be treated with an alkali (potassium hydroxide) to produce weed chips (Anon., nd).

Production: The major culture areas are Taiwan, Philippines, Indonesia and Fiji. About 17,000 tonnes of carrageenan and 7,000 tonnes of semi-refined product were produced worldwide in 1989.

The objectives of the RMI pilot study were: to test the

feasibility of growing *Eucheuma*, using photosynthesis rates, growth rates and final weight to estimate productivity and yields; to evaluate the commercial quality of the carrageenan and its marketability from the plants grown in the RMI; and to train Marshallese to grow *Eucheuma* for profit. No reports of the project could be located, except a brief proposal to extend the project (see Zingmark, 1990). The researcher involved is no longer in the RMI, although he is currently trying to generate interest in developing *Eucheuma* farming in the RMI.

Trials were conducted at Majuro (two sites), Mili Atoll (in association with MIA's clam farm), and in Likiep Atoll (in association with the MIMRA mariculture facility). Zingmark (1990) notes that early growth estimates indicate that the seaweed may double in size every two to three weeks, however, no data has been provided to substantiate this. One site in Majuro developed "ice-ice" disease (a gradual whitening and necrosis of plants) and was suspected to be related to poor water quality associated with the urbanization of Majuro.

One major problem with seaweed farming in this region is predation by rabbitfish. The only options to minimize this problem would be fencing (too costly and labor intensive) or to develop a farm large enough that predation destroys only a small portion of the seaweed. Harvesting of rabbitfish may, however, provide an additional income source.

Marketing: *Eucheuma* prices have been very erratic over the last five years, ranging from US$350/tonne in 1987 to US$700/tonne in recent years (all prices are delivered Europe). Recent price increases have been partially attributed to new uses for carrageenan and a leveling of supply from the Philippines (APTA, 1990). How long the prices will remain at high levels is unknown. If prices should fall it will be the smaller producers that buyers will withdraw from first.

There is no local use for raw or processed *Eucheuma* in the RMI, so any future production would be restricted to the export market. Prior to any extensive development of seaweed farms in the RMI, a *detailed* marketing study is required to determine its economic feasibility. A review of the seaweed farming projects in Pohnpei (FSM), admittedly based on limited information (APTA, 1990; Shang, 1989), found that the project was unlikely to prove commercially viable, and felt that further evaluation was required before expanding. Those seaweed farms have since ceased production. The social feasibility of seaweed farming also needs consideration. Recently, seaweed farmers in Kiribati gave up tending their seaweed farms to make copra as the price of copra increased.

7.1.3 Status Of The Stocks

There is currently no commercial seaweed production in the RMI. The only stocks are very limited amounts remaining from

the pilot study.

7.1.4 Management

Current Legislation/Policy Regarding Exploitation: There is currently no legislation or policy regarding seaweed exploitation in the RMI.

Recommended Legislation/Policy Regarding Exploitation: Due to the problems involved with seaweed farming the government should have minimal input into establishing farms, allowing the private sector to set-up and develop the industry if it considers it feasible. The government's role should be as a facilitator, not a subsidizer. The failures of recent attempts in the region to establish seaweed farms was partly due to government subsidies - when they were removed the operations failed.

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